



Cisco GainStar Mini Node Modules and Pedestal Housings







Installation and Operation Guide

For Your Safety

Explanation of Warning and Caution Icons

 **Avoid personal injury and product damage! Do not proceed beyond any symbol until you fully understand the indicated conditions.**

The following warning and caution icons alert you to important information about the safe operation of this product:

-  You may find this symbol in the document that accompanies this product. This symbol indicates important operating or maintenance instructions.
-  You may find this symbol affixed to the product. This symbol indicates a live terminal where a dangerous voltage may be present; the tip of the flash points to the terminal device.
-  You may find this symbol affixed to the product. This symbol indicates a protective ground terminal.
-  You may find this symbol affixed to the product. This symbol indicates a chassis terminal (normally used for equipotential bonding).
-  You may find this symbol affixed to the product. This symbol warns of a potentially hot surface.
-  You may find this symbol affixed to the product and in this document. This symbol indicates an infrared laser that transmits intensity-modulated light and emits invisible laser radiation or an LED that transmits intensity-modulated light.

Important

Please read this entire guide. If this guide provides installation or operation instructions, give particular attention to all safety statements included in this guide.

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Important Safety Instructions

Read and Retain Instructions

Carefully read all safety and operating instructions before operating this equipment, and retain them for future reference.

Follow Instructions and Heed Warnings

Follow all operating and use instructions. Pay attention to all warnings and cautions in the operating instructions, as well as those that are affixed to this equipment.

Terminology

The terms defined below are used in this document. The definitions given are based on those found in safety standards.

Service Personnel-The term service personnel applies to trained and qualified individuals who are allowed to install, replace, or service electrical equipment. The service personnel are expected to use their experience and technical skills to avoid possible injury to themselves and others due to hazards that exist in service and restricted areas.

User and Operator-The terms user and operator apply to persons other than service personnel.

Ground(ing) and Earth(ing)-The terms ground(ing) and earth(ing) are synonymous. This document uses ground(ing) for clarity, but it can be interpreted as having the same meaning as earth(ing).

Electric Shock Hazard

This equipment meets applicable safety standards. Refer to this equipment's data sheet for details about regulatory compliance approvals.



WARNING:

Avoid electric shock! Opening or removing the equipment cover may expose you to dangerous voltages. Refer all servicing to qualified service personnel only.

Electric shock can cause personal injury or even death. Avoid direct contact with dangerous voltages at all times.

Know the following safety warnings and guidelines:

- Only qualified service personnel are allowed to perform equipment installation or replacement.
- Only qualified service personnel are allowed to remove equipment covers and access any of the components inside the chassis.

Continued on next page

Important Safety Instructions, Continued

Equipment Placement

 **WARNING:**

Avoid personal injury and damage to this equipment. An unstable mounting surface may cause this equipment to fall.

To protect against equipment damage or injury to personnel, comply with the following:

Install this equipment in a restricted access location (access restricted to service personnel).

Make sure the mounting surface or rack is stable and can support the size and weight of this equipment.

Strand (Aerial) Installation

 **CAUTION:**

Be aware of the size and weight of strand-mounted equipment during the installation operation.

Ensure that the strand can safely support the equipment's weight.

Pedestal Installation

 **WARNING:**

Avoid possibility of personal injury. Ensure proper handling/lifting techniques are employed when working in confined spaces with heavy equipment.

Ensure this equipment is securely fastened to the mounting surface or rack where necessary to protect against damage due to any disturbance and subsequent fall.

Ensure the mounting surface or rack is appropriately anchored according to manufacturer's specifications.

Ensure the installation site meets the ventilation requirements given in the equipment's data sheet to avoid the possibility of equipment overheating.

Ensure the installation site and operating environment is compatible with the equipment's International Protection (IP) rating specified in the equipment's data sheet.

Connecting to Utility AC Power

Important: If this equipment is a Class I equipment, it must be grounded.

If this equipment plugs into an outlet, the outlet must be near this equipment, and must be easily accessible.

Connect this equipment only to the power sources that are identified on the equipment-rating label, which is normally located close to the power inlet connector(s).

Continued on next page

Important Safety Instructions, Continued

- This equipment may have two power sources. Be sure to disconnect all power sources before working on this equipment.
- If this equipment **does not** have a main power switch, the power cord connector serves as the disconnect device.
- Always pull on the plug or the connector to disconnect a cable. Never pull on the cable itself.

Connection to Network Power Sources

Refer to this equipment's specific installation instructions in this manual or in companion manuals in this series for connection to network ferro-resonant AC power sources.

AC Power Shunts

AC power shunts may be provided with this equipment.

Important: The power shunts (where provided) must be removed before installing modules into a powered housing. With the shunts removed, power surge to the components and RF-connectors is reduced.



CAUTION:

RF connectors and housing seizure assemblies can be damaged if shunts are not removed from the equipment before installing or removing modules from the housing.

Grounding (Utility AC Powered Equipment in Pedestals, Service Closets, etc.)

This section provides instructions for verifying that the equipment is properly grounded.

Safety Plugs (USA Only)

This equipment is equipped with either a 3-terminal (grounding-type) safety plug or a 2-terminal (polarized) safety plug. The wide blade or the third terminal is provided for safety. Do not defeat the safety purpose of the grounding-type or polarized safety plug.

To properly ground this equipment, follow these safety guidelines:

Grounding-Type Plug

For a 3-terminal plug (one terminal on this plug is a protective grounding pin), insert the plug into a grounded mains, 3-terminal outlet.

Note: This plug fits only one way. If this plug cannot be fully inserted into the outlet, contact an electrician to replace the obsolete 3-terminal outlet.

Polarized Plug

For a 2-terminal plug (a polarized plug with one wide blade and one narrow blade), insert the plug into a polarized mains, 2-terminal outlet in which one socket is wider than the other.

Continued on next page

Important Safety Instructions, Continued

Note: If this plug cannot be fully inserted into the outlet, try reversing the plug. If the plug still fails to fit, contact an electrician to replace the obsolete 2-terminal outlet.

Grounding Terminal

If this equipment is equipped with an external grounding terminal, attach one end of an 18-gauge wire (or larger) to the grounding terminal; then, attach the other end of the wire to a ground, such as a grounded equipment rack.

Safety Plugs (European Union)

Class I Mains Powered Equipment

Provided with a 3-terminal AC inlet and requires connection to a 3-terminal mains supply outlet via a 3-terminal power cord for proper connection to the protective ground.


Note: The equipotential bonding terminal provided on some equipment is not designed to function as a protective ground connection.

Class II Mains Powered Equipment

Provided with a 2-terminal AC inlet that may be connected by a 2-terminal power cord to the mains supply outlet. No connection to the protective ground is required as this class of equipment is provided with double or reinforced and/or supplementary insulation in addition to the basic insulation provided in Class I equipment.

Note: Class II equipment, which is subject to EN 50083-1, is provided with a chassis mounted equipotential bonding terminal. See the section titled Equipotential Bonding for connection instructions.

Equipotential Bonding

If this equipment is equipped with an external chassis terminal marked with the IEC 60417-5020 chassis icon () , the installer should refer to CENELEC standard EN 50083-1 or IEC standard IEC 60728-11 for correct equipotential bonding connection instructions.

Continued on next page

Important Safety Instructions, Continued

General Servicing Precautions



WARNING:

Avoid electric shock! Opening or removing the equipment cover may expose you to dangerous voltages. Refer all servicing to qualified service personnel only.



CAUTION:

These servicing precautions are for the guidance of qualified service personnel only. To reduce the risk of electric shock, do not perform any servicing other than contained in the operating instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

Be aware of the following general precautions and guidelines:

- **Servicing** - Servicing is required when this equipment has been damaged in any way, such as power supply cord or plug is damaged, liquid has been spilled or objects have fallen into this equipment, this equipment has been exposed to rain or moisture, does not operate normally, or has been dropped.
- **Wristwatch and Jewelry** - For personal safety and to avoid damage of this equipment during service and repair, do not wear electrically conducting objects such as a wristwatch or jewelry.
- **Lightning** - Do not work on this equipment, or connect or disconnect cables, during periods of lightning.
- **Labels** - Do not remove any warning labels. Replace damaged or illegible warning labels with new ones.
- **Covers** - Do not open the cover of this equipment and attempt service unless instructed to do so in the instructions. Refer all servicing to qualified service personnel only.
- **Moisture** - Do not allow moisture to enter this equipment.
- **Cleaning** - Use a damp cloth for cleaning.
- **Safety Checks** - After service, assemble this equipment and perform safety checks to ensure it is safe to use before putting it back into operation.

Electrostatic Discharge

Electrostatic discharge (ESD) results from the static electricity buildup on the human body and other objects. This static discharge can degrade components and cause failures.

Take the following precautions against electrostatic discharge:

- Use an anti-static bench mat and a wrist strap or ankle strap designed to safely ground ESD potentials through a resistive element.
- Keep components in their anti-static packaging until installed.
- Avoid touching electronic components when installing a module.

Continued on next page

Important Safety Instructions, Continued

Fuse Replacement

- To replace a fuse, comply with the following:
- Disconnect the power before changing fuses.
- Identify and clear the condition that caused the original fuse failure.
- Always use a fuse of the correct type and rating. The correct type and rating are indicated on this equipment.

Modifications

This equipment has been designed and tested to comply with applicable safety, laser safety, and EMC regulations, codes, and standards to ensure safe operation in its intended environment. Refer to this equipment's data sheet for details about regulatory compliance approvals.

Do not make modifications to this equipment. Any changes or modifications could void the user's authority to operate this equipment.

Modifications have the potential to degrade the level of protection built into this equipment, putting people and property at risk of injury or damage. Those persons making any modifications expose themselves to the penalties arising from proven non-compliance with regulatory requirements and to civil litigation for compensation in respect of consequential damages or injury.

Accessories

Use only attachments or accessories specified by the manufacturer.

Laser Safety

Introduction

This equipment contains an infrared laser that transmits intensity-modulated light and emits invisible radiation.

Warning: Radiation



WARNING:

- **Avoid personal injury! Use of controls, adjustments, or procedures other than those specified herein may result in hazardous radiation exposure.**
 - **Avoid personal injury! The laser light source on this equipment (if a transmitter) or the fiber cables connected to this equipment emit invisible laser radiation. Avoid direct exposure to the laser light source.**
 - **Avoid personal injury! Viewing the laser output (if a transmitter) or fiber cable with optical instruments (such as eye loupes, magnifiers, or microscopes) may pose an eye hazard.**
- Do not apply power to this equipment if the fiber is unmated or unterminated.
 - Do not stare into an unmated fiber or at any mirror-like surface that could reflect light emitted from an unterminated fiber.
 - Do not view an activated fiber with optical instruments (for example, eye loupes, magnifiers, microscopes).
 - Use safety-approved optical fiber cable to maintain compliance with applicable laser safety requirements.

Warning: Fiber Optic Cables



WARNING:

Avoid personal injury! Qualified service personnel may only perform the procedures in this manual. Wear safety glasses and use extreme caution when handling fiber optic cables, particularly during splicing or terminating operations. The thin glass fiber core at the center of the cable is fragile when exposed by the removal of cladding and buffer material. It easily fragments into glass splinters. Using tweezers, place splinters immediately in a sealed waste container and dispose of them safely in accordance with local regulations.

Continued on next page

Laser Safety, Continued

Maximum Laser Power

The maximum laser power that can be produced through this product, due to misadjustment or component failure, is 8.8 mW.

Location of Laser Labels

The following illustration displays the location of warning labels on this equipment.

Transmitter Example



Chapter 1

Introduction

Overview

The GainStar Mini Node Platform addresses the needs of today's broadband networks. All GainStar Mini Nodes provide superior performance and reliability combined with a user-friendly layout.

This chapter introduces you to the GainStar Mini Node and describes its main components, configuration options, and accessories.

Purpose

This guide provides instructions for installing, configuring, setting up, and troubleshooting the GainStar Mini Node.

Who Should Use This Document

This document is intended for authorized service personnel who have experience working with similar equipment. The service personnel should have appropriate background and knowledge to complete the procedures described in this document.

Qualified Personnel



CAUTION:

Allow only qualified and skilled personnel to install, operate, maintain, and service this product. Otherwise, personal injury or equipment damage may occur.

Only appropriately qualified and skilled personnel should attempt to install, operate, maintain, and service this product.

Scope

This guide discusses the following topics.

- Description of the GainStar Mini Node
- Installing and Configuring the Mini Node
- Balancing and Setup of Forward and Reverse Signal Paths
- Troubleshooting the Mini Node
- Customer Support Information
- Description of Configuration Options and Accessories

Document Version

This is the Rev B of this document. The statuses of former releases are listed in the following table.

Document Release	Version	Status
Cisco GainStar Mini Node Modules and Pedestal Housings Installation and Operation Guide	REV A	Published

Continued on next page

Overview, Continued

In This Chapter

Topic	See Page
Description	1-3
Accessories	1-6
Illustrations	1-7
Block Diagrams	1-9

Description

The GainStar Mini Node is available in the following forward bandwidth.

- 1 GHz/862 MHz

The GainStar Mini Node is available in the following reverse/forward path splits.

- 42/54 MHz
- 65/87 MHz

All 1 GHz GainStar Mini Nodes contain a base and a lid. The base houses the RF mainboard, the power supply, and the Mini Node cover.

The following chapters provide a detail description of GainStar Mini Node components.

GainStar Mini Node Characteristics

The GainStar Mini Node has the following characteristics.

- Can be set up for 862 MHz or 1 GHz performance
- Selectable single or dual outputs with an onboard signal director
- LED display for optical input power
- AGC optical input range of -4 to +2 dBm
- Standard plug-in attenuators can be used to adjust the gain and equalization
- Both FP and DFB transmitters available
- Surge-resistant circuitry ensures resistance to high voltage transients (6kV)
- Thermal RF control minimizes gain movement over temperature
- 10 A current capacity (steady state) and 15 A surge survivability
- Outdoor housing is IP68 dustproof and watertight
- Strand and pedestal mount housing configurations are available
- All ports accept PG11 connectors or 5/8" connectors using provided adapters
- RoHS 6 / 6 compliant

Power Supply

The available input power voltages for the GainStar Mini Node are 44 VAC to 90 VAC or 100 VAC to 240 VAC.

Input and Output Ports

This Mini Node has one optical input port and one or two RF output ports. The number of output ports is determined by the signal director.

Continued on next page

Description, Continued

Configuration

All GainStar Mini Nodes are configured with the following items:

- Forward Interstage Attenuator
- Forward Output Equalizer with Attenuator
- Forward Output Attenuators
- Signal Directors
- Reverse Amplifier module (Not included in forward only configuration)
- Reverse Equalizer with Attenuator (Not included in forward only configuration)

Test Points

There are two RF test points on the GainStar Mini Node.

AC Shunt Power Directors

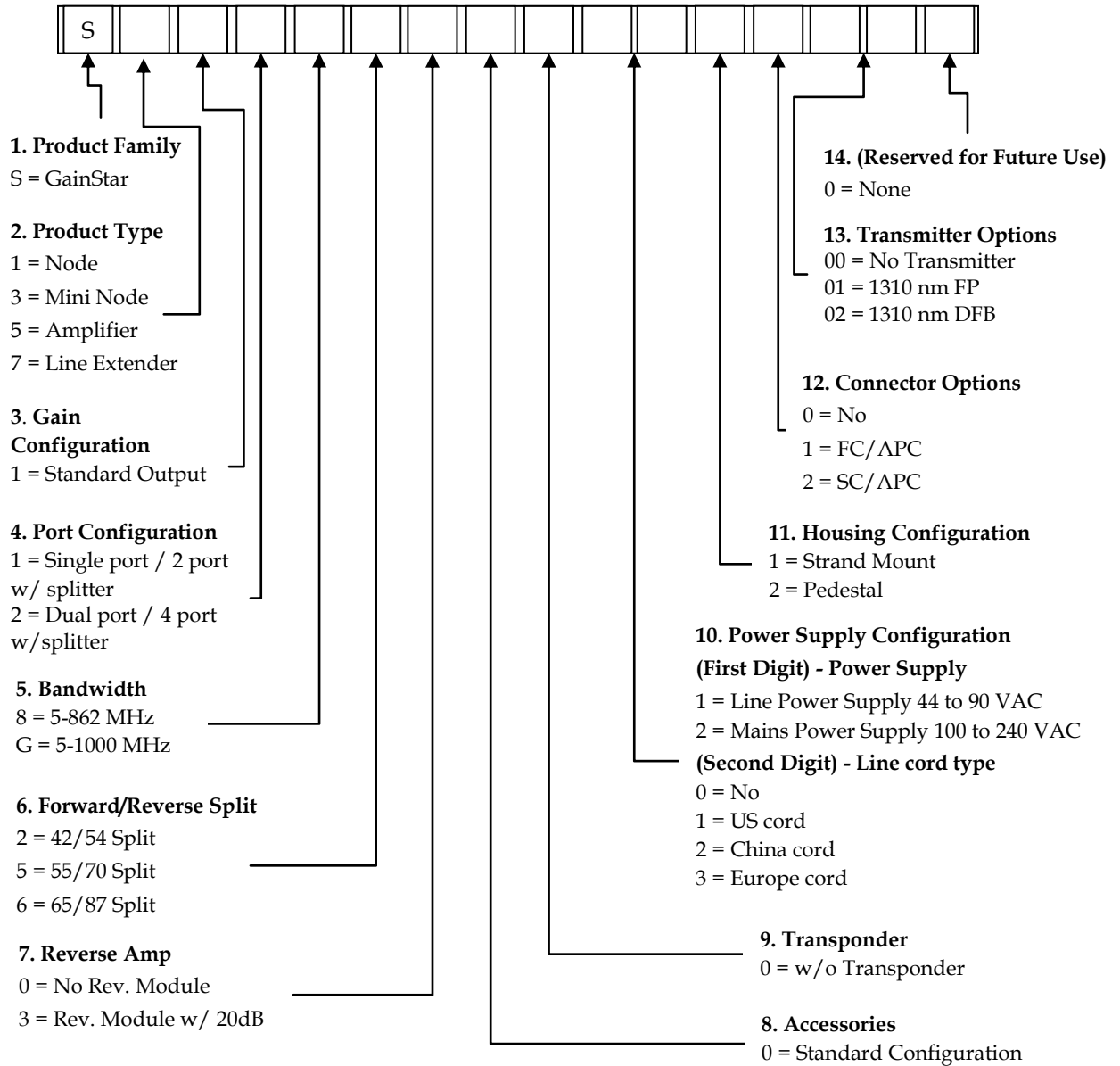
The GainStar Mini Node has two AC shunt power directors located near the ports of the Mini Node. These power directors are used to direct AC current to and from the Mini Node output ports.

Continued on next page

Description, Continued

GainStar Mini Node Ordering Matrix

For the latest available Mini Node ordering information, contact your customer service representative.



Accessories

Customer Installable Accessories for GainStar Mini Node

The GainStar Mini Node is equipped to work with the following accessories.

The following table lists the customer installable accessories and their part numbers.

Note: All GainStar Mini Node accessories are unique to the GainStar Mini Node Platform product line.

Accessory	Part Number	Quantity
Attenuator pads	4036021 (0 dB) through 4036041 (20 dB), 0 dB through 20 dB in 1 dB increments	1 required for reverse input (Not included in forward only configuration) 1 required for reverse output (Not included in forward only configuration)
Forward Linear Equalizer 1 GHz	4034459, 0 to 4 dB 4034460, 5 to 9 dB 4034461, 10 to 14 dB	1 required for forward output; 1 pad also required and plugged into EQ
Forward Linear Equalizer 862 MHz	4034456, 0 to 4 dB 4034457, 5 to 9 dB 4034458, 10 to 14 dB	
Reverse Cable Equalizer 65 MHz	4034462, 0 to 5 dB 4034463, 6 to 10 dB	0 to 5 dB EQ (4034462 or 4034465) and 0 dB Pad (4036021) are provided – Other values must be ordered. (Not included in forward only configuration)
Reverse Cable Equalizer 42 MHz	4034465, 0 to 5 dB 4034466, 6 to 10 dB	
GainStar mininode Upgrade Kit (order)	4040809	Fiber bulkhead, screw, Solid line clip

Note: When upgrading from forward only to a forward and reverse, the Reverse Transmitter, Reverse Amplifier Module, Reverse Equalizer with PAD, Reverse input PAD, and Reverse output PAD accessories are required.

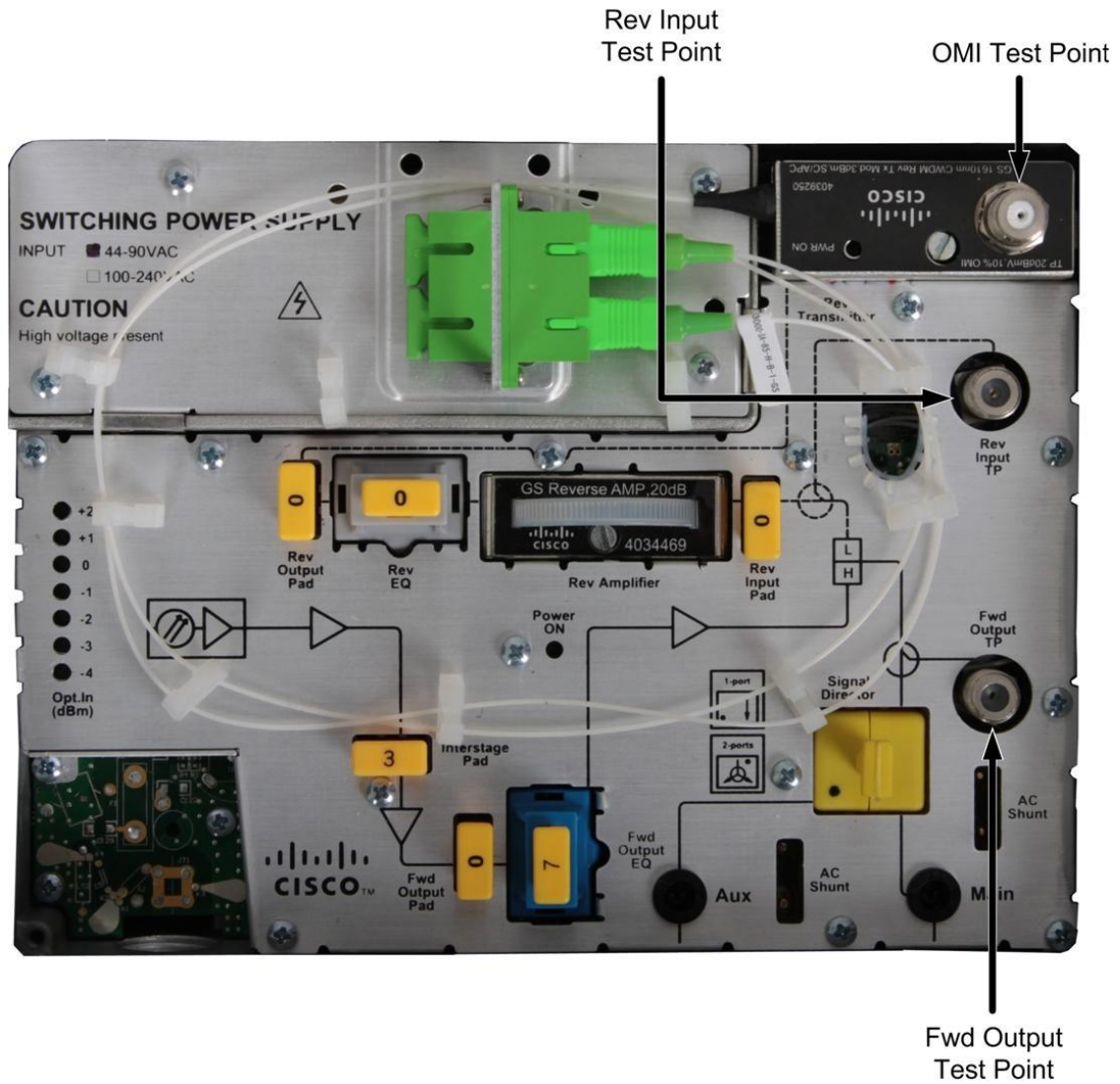
Illustrations

GainStar Mini Node Test Points

The following diagram shows the Mini Node test points.

Note:

- Test point shown is -20 dB/-16.5 dB (with signal director) for Forward output RF test point.
- Test point shown is -20 dB/-23.5 dB (with signal director) for Reverse input RF test point.
- OMI test point.

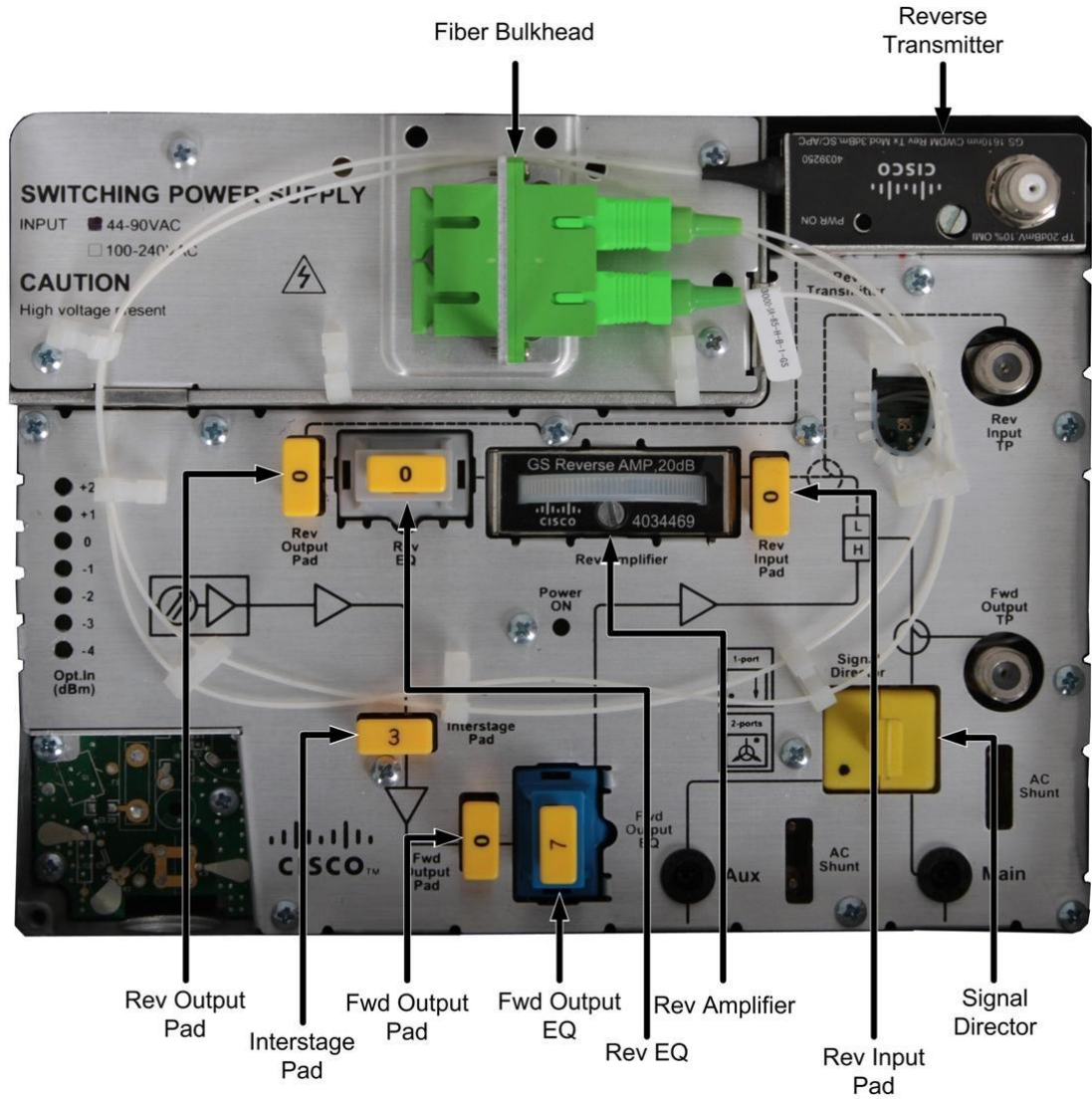


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Illustrations, Continued

GainStar Mini Node Accessories

The following diagram shows the accessory locations for the Mini Node module.

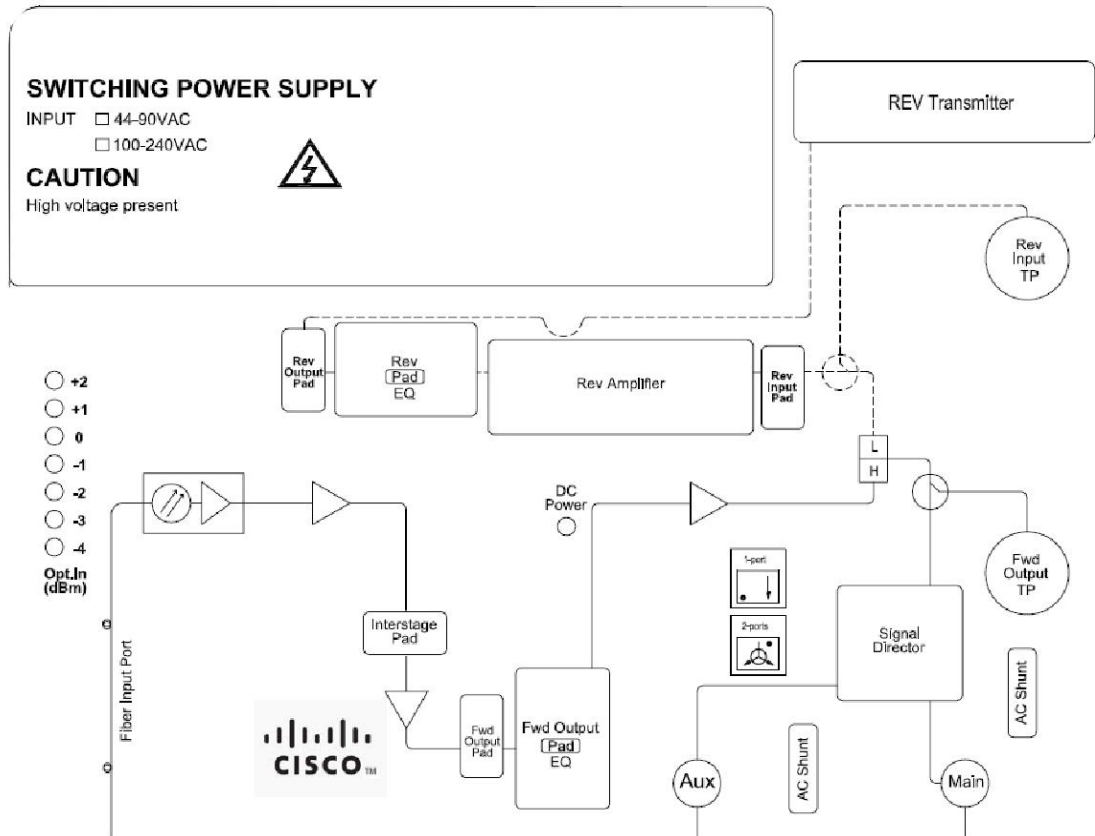


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Block Diagrams

GainStar Mainboard

The following block diagram shows the forward and reverse path of the GainStar Mini Node.



Continued on next page

Chapter 2

Installation and Configuration

Overview

Introduction

This chapter provides instructions for installing and configuring the Gain Star Mini Node in your cable system.

In This Chapter

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Connecting the Fiber Optical Service Cable to the Mini Node	2-19
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Installing the WDM Module	2-23
Closing the Mini Node Housing	2-26

Before You Begin

The procedures in this chapter assume that you have completed the following:

- Prepared the installation site
- Located the coaxial cable, with or without the pin-type coaxial connectors mounted on the cable






Required Tools

Before you start, make sure that you have the following tools:

- Torque wrench with a 1/2-inch socket
- Flat-blade screwdriver and Philips screw driver
- Heavy-duty wire cutters or snips
- Torque wrench set

Torque Specifications

The following table gives the torque specifications for the Mini Node.

Fastener	Torque Specification	Illustration
Housing closure bolts	6.8 Nm to 9.0 Nm	
Housing grounding screw	0.9 Nm to 1.0 Nm	
Housing plugs test point port plugs	6.8 Nm to 9.0 Nm	
RF PG11 to 5/8" adapter	12.0 Nm to 16.0 Nm	
Strand clamp mounting bracket bolts	6.8 Nm to 9.0 Nm	
RF F-Cable Connector	Per manufacturer instructions	
Hard Line Cable Connector	Per manufacturer instructions	
Bulkhead screw	0.3 Nm to 0.5 Nm	

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Before You Begin, Continued

Mini Node Module Cover

The Gain Star Mini Node module has an aluminum cover attached. To perform normal field maintenance, the cover will not have to be removed.

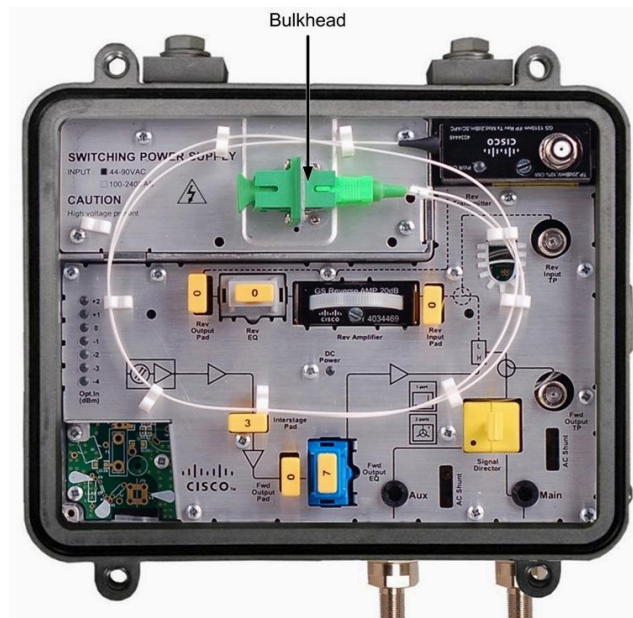
Mini Node RF Module

The following two diagrams display the two types of Gain Star Mini Node RF Module: 42/54 MHz split and 65/87 MHz split.

Note: This document is applicable for both splits while using the diagrams of 42/54 MHz split to display the installation and configuration in a general view.



42/54 MHz split RF Module



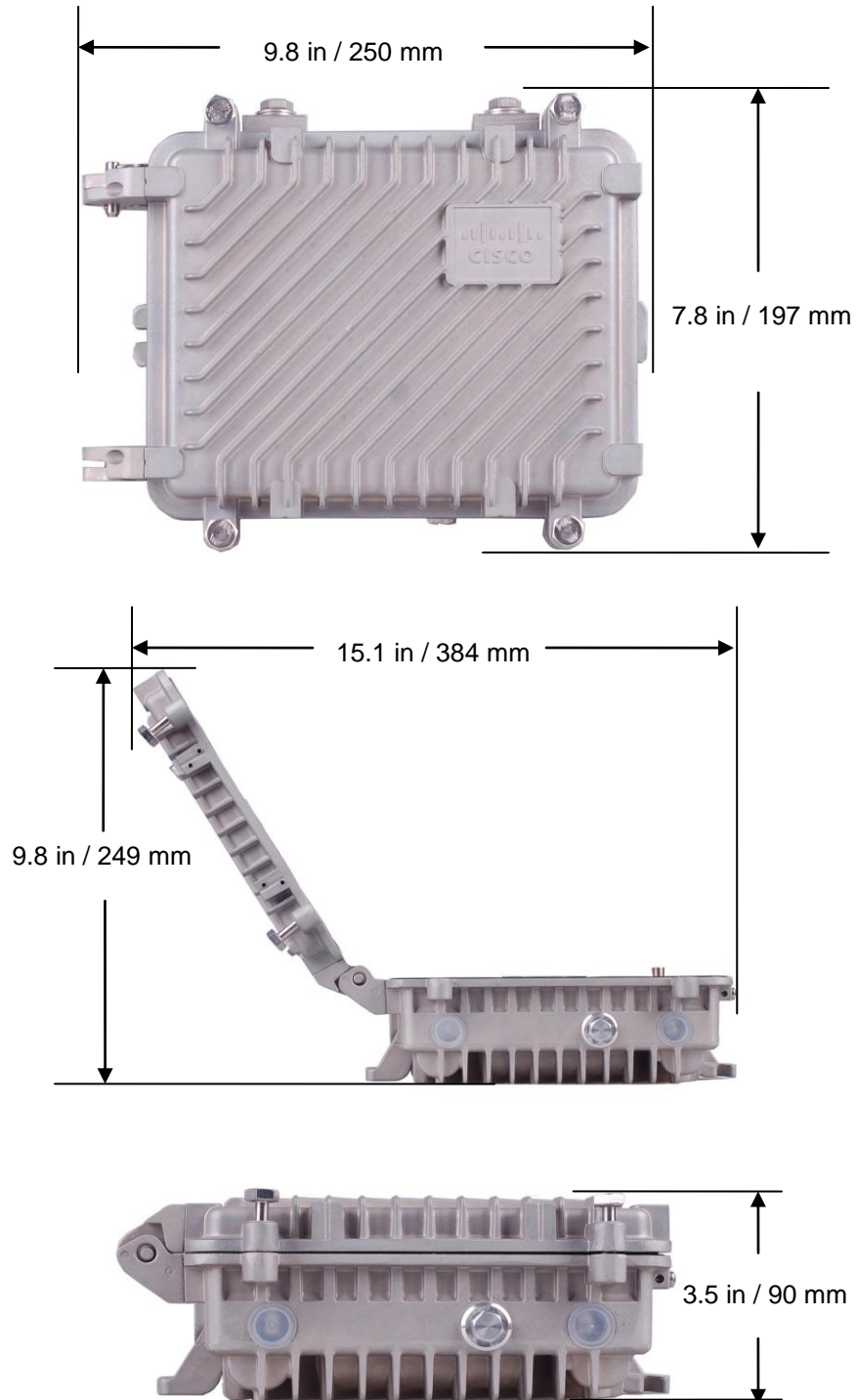
65/87 MHz split RF Module

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Before You Begin, Continued

Housing Dimensions

The diagram below shows the dimensions, in inches and millimeters, of the Mini Node housing with a standard lid. Use these measurements to calculate clearance requirements for your installation.



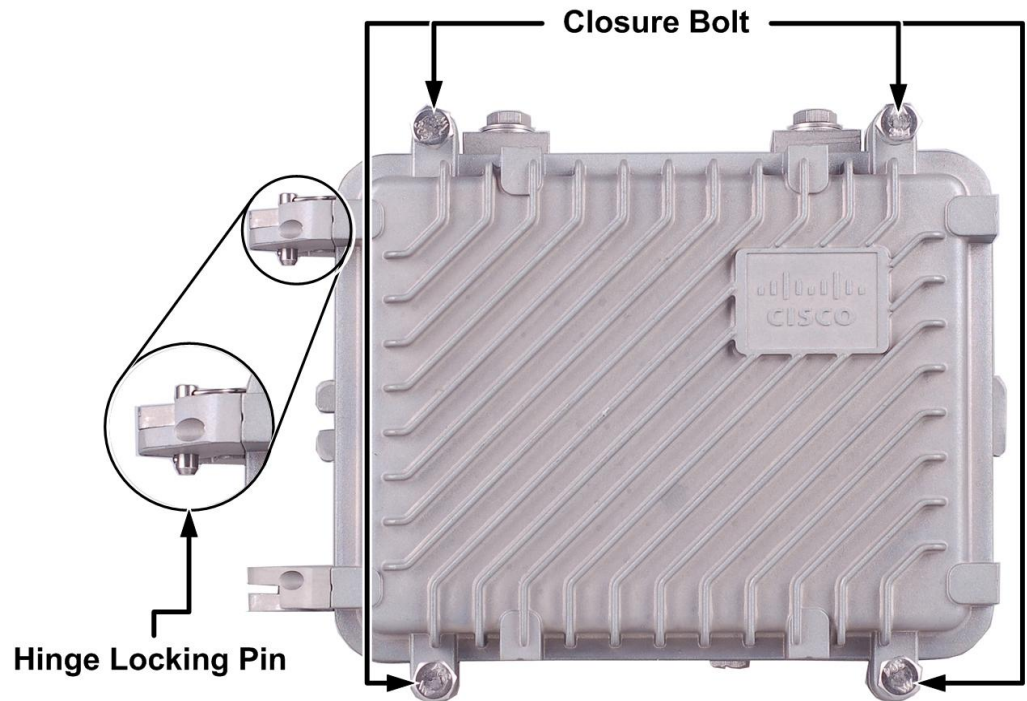
Opening the Mini Node Housing

To Open the Mini Node Housing

Complete the following steps to open the Mini Node housing.

Important: Before unscrewing the housing bolts, make sure the removable hinge locking pin is in place. The locking pin prevents separation of the lid from the base.

1. Loosen the housing closure bolts on the housing lid.



2. Open the housing.

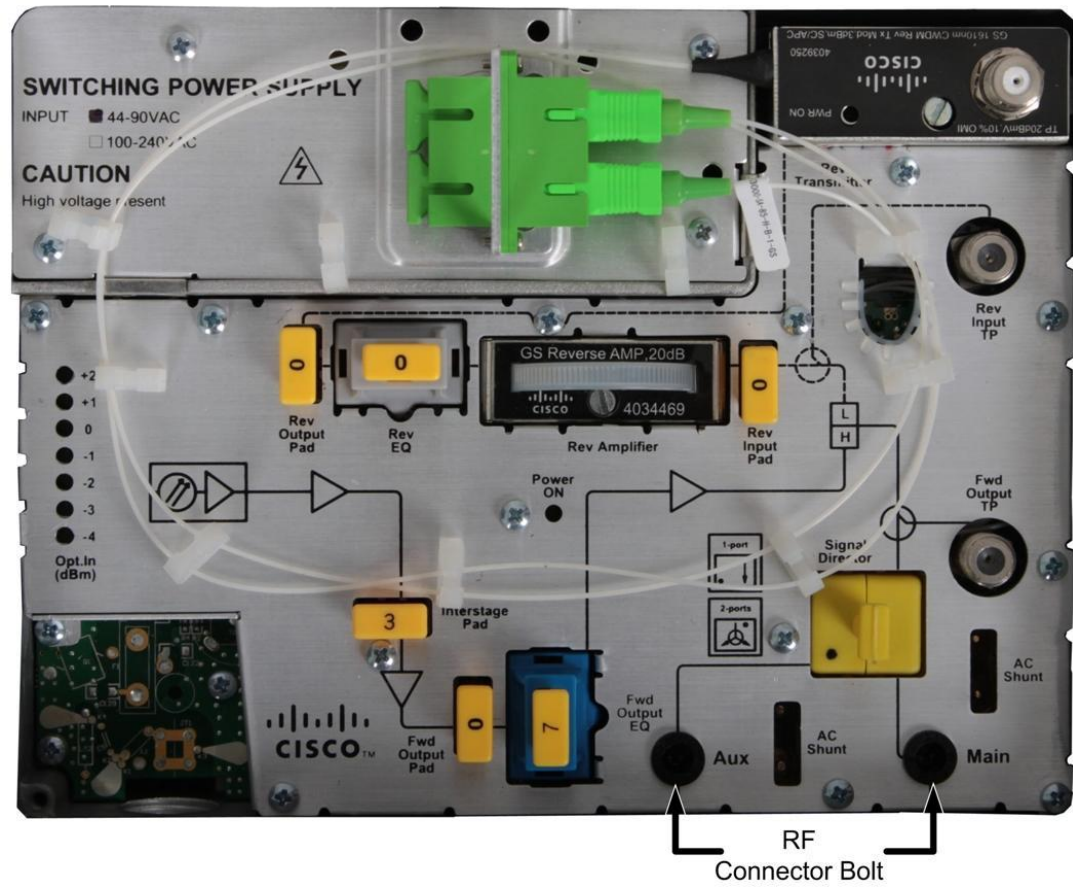
Note: The closure bolts should remain attached to the housing.

Attaching the Coaxial Connectors

To Prepre the Mini Node Module for Connector Installation

Complete the following steps to trim longer pins.

- 1 Loosen each RF connector bolt.

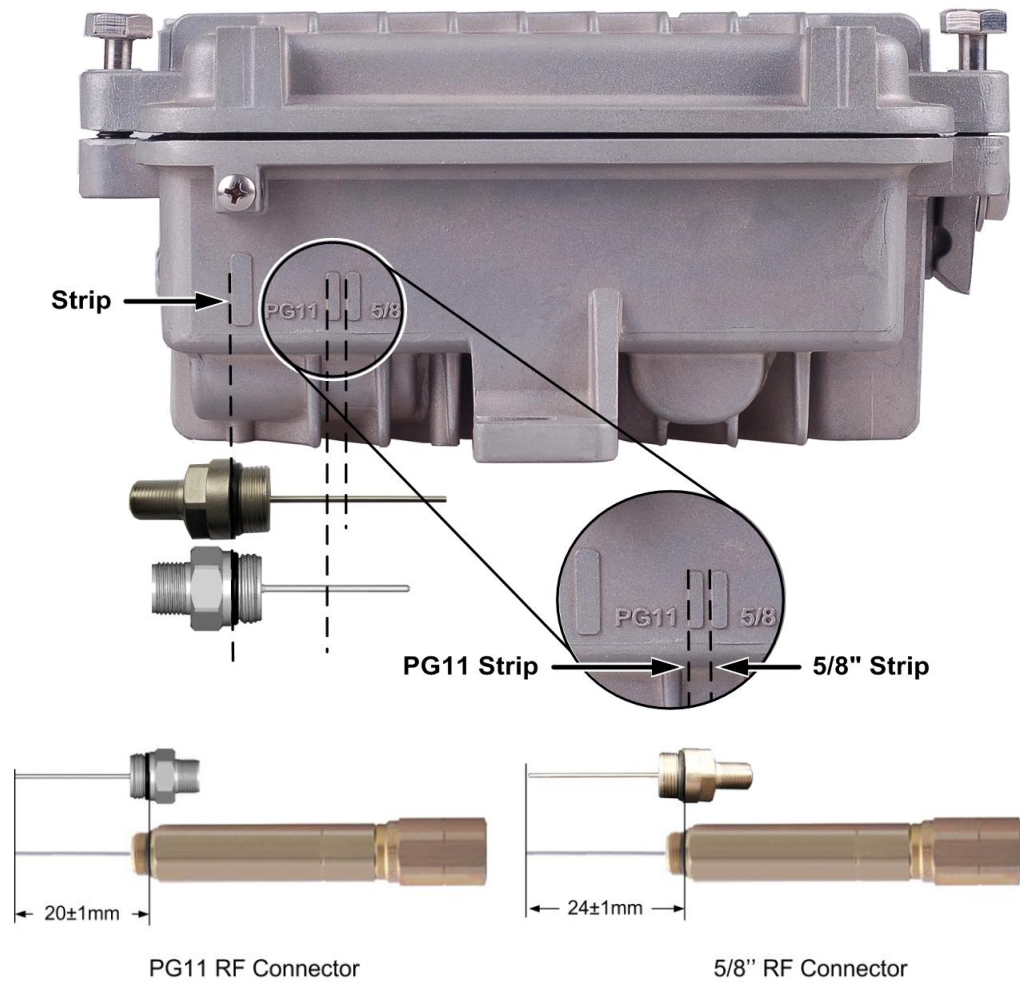


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Attaching the Coaxial Connectors, Continued

- The Gain Star Mini Node requires pin-type connectors for all RF connections. The 5/8" RF connector will be needed for pins extending from 23 mm to 25 mm (0.9 in. to 1.0 in). The PG11 RF connector will be needed for pins extending 19 mm to 21 mm (0.7 in. to 0.8 in). You must trim longer pins before inserting them into the housing.

If the center conductor pin extends past the STRIP line on the housing, trim the pin flush to the STRIP line. The following diagram shows a visual guide of the center conductor trim length.



Continued on next page

Attaching the Coaxial Connectors, Continued

To Connect the RF Connector Pin

Complete the following steps to connect the RF connector pin to the Mini Node housing.

- 1 Begin this procedure with the Mini Node housing open. Refer to *Opening the Mini Node Housing* (on page 2-5).
- 2 If the center conductor pin extends beyond the STRIP line on the housing, trim the pin with heavy-duty wire cutters.
- 3 If the RF connector is PG11, go to Step 4. If the RF connector is 5/8", screw the RF cable connector adapter onto the housing before proceeding to Step 4.
- 4 Insert the appropriate RF connector into the housing at the desired RF port. Tighten the connector nut according to manufacturer specifications.
- 5 Tighten the RF F-Cable connector bolt from 0.9 Nm to 1.0 Nm.
- 6 Repeat steps 2 through 4 for each RF port used.
- 7 Proceed to *Installing the Housing* (on page 2-9).



Installing the Housing

To Install the Housing on a Strand (Aerial)

Complete the following steps to install the housing on a strand (aerial). The housing does not need to be opened for strand installation.

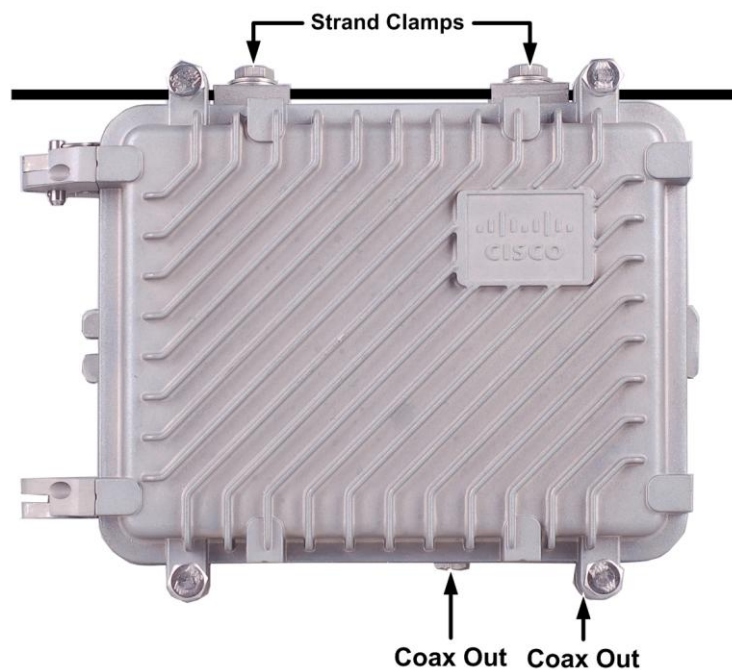
Important: The minimum strand diameter should be 5/16 inch.



CAUTION:

Be aware of the size and weight of the housing while strand mounting. Ensure that the strand can safely support the weight of the housing.

- 1 Loosen the strand clamp bolts.
- 2 Lift the housing into proper position on the strand.
- 3 Slip the strand clamps over the strand and finger-tighten the clamp bolts. This allows additional movement of the housing as needed.
- 4 Move the housing as needed to install the coaxial cable and connectors. See the diagram below.



- 5 Using a 1/2-inch torque wrench, tighten the strand clamp bolts from 6.8 Nm to 9.0 Nm. Make sure there is good mechanical contact between the strand and the housing.

Note: A slight tilt of the face of the housing is normal. Cable tension will cause the housing to hang more closely to vertical.

- 6 Connect the coaxial cable to the pin connector according to connector manufacturer specifications.
- 7 Proceed to *Installing the Accessories* (on page 2-11).

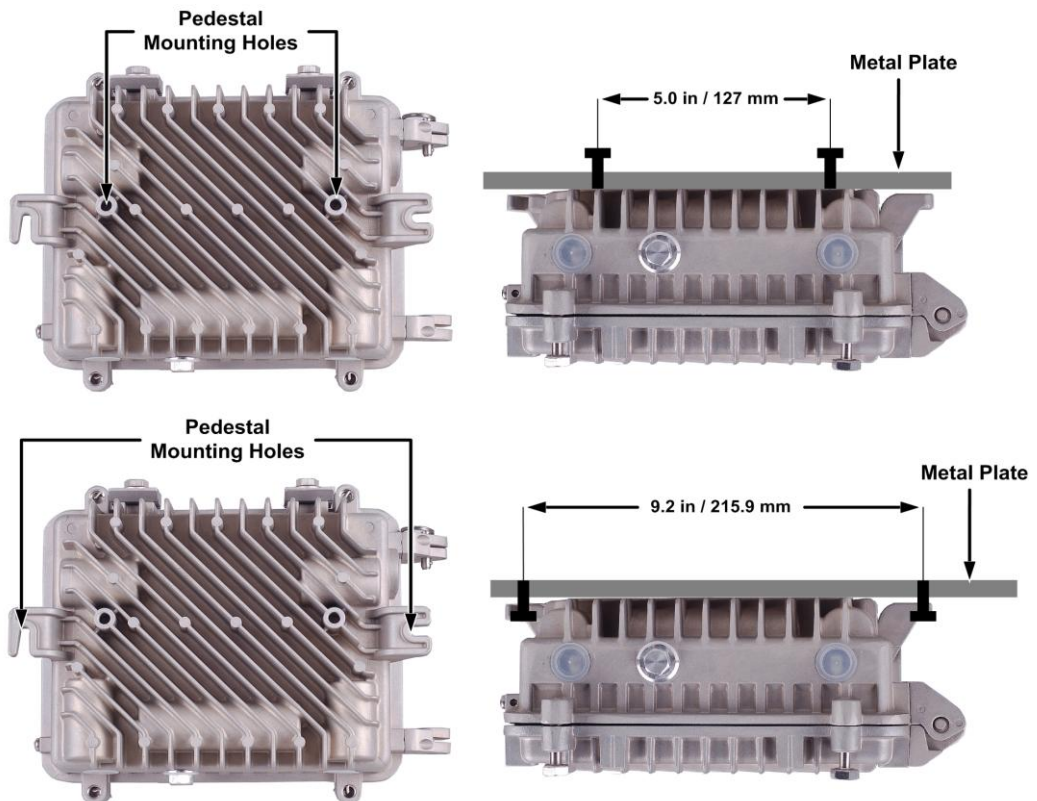
Continued on next page

Installing the Housing, Continued

To Install the Housing in a Pedestal

Complete the following steps to install the housing in a pedestal.

- 1 Drill two 3/8" holes in the mounting plate or mounting bracket with 127 mm or 215.9 mm distance. The thickness of the metal plate is 10 to 15 mm.
- 2 Lift the housing to proper position on the wall or box.
- 3 Align the pedestal mounting holes on the bottom of the housing with the two holes drilled in the metal plate and insert the bolts through the mounting plate into the two threaded mounting holes.



- 4 Using a 1/2-inch torque wrench, tighten the Pedestal clamp bolts from 6.8 Nm to 9.0 Nm.
Note: A slight tilt of the face of the housing is normal. Cable tension will cause the housing to hang more closely to vertical.
- 5 Connect the coaxial cable to the pin connector according to connector manufacturer specifications.
- 6 Proceed to *Installing the Accessories* (on page 2-11).

Installing the Accessories

To Install the Attenuator Pads

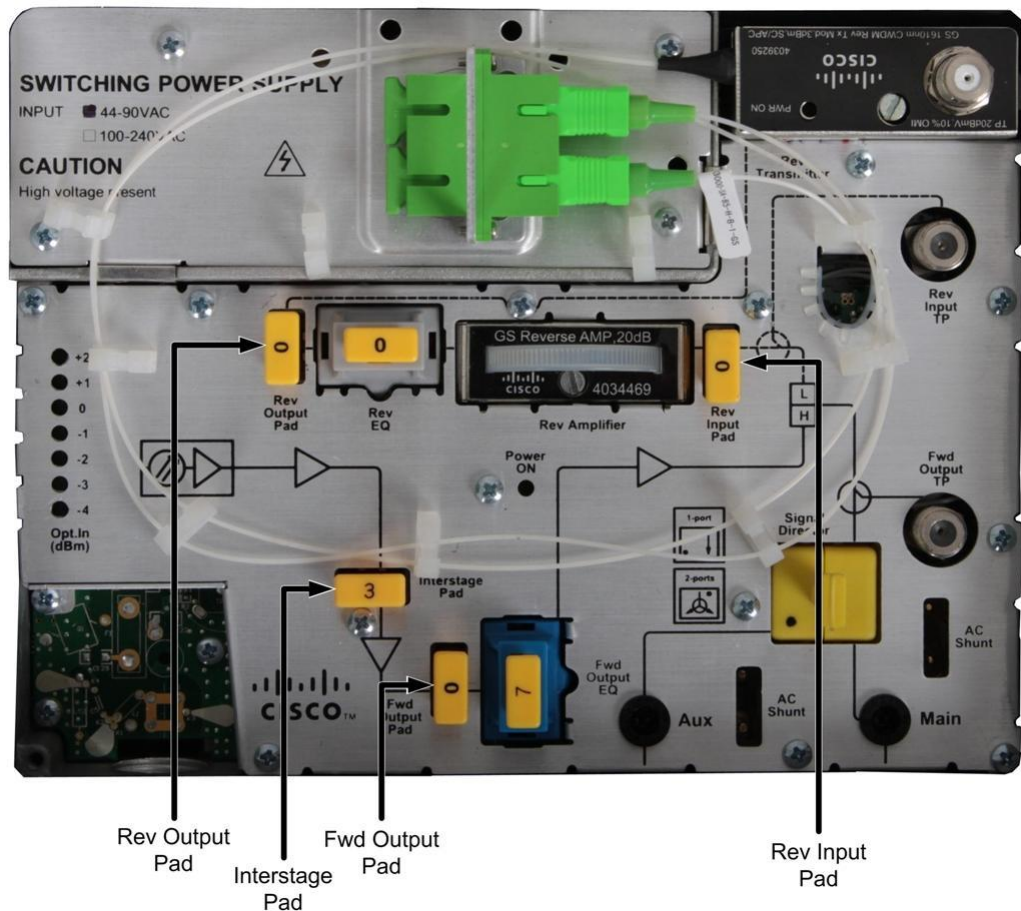
Complete the following steps to install the attenuator pads in the Mini Node.

Note: For best results, follow this installation procedure exactly.

- 1 Begin this procedure with the housing open. Refer to *Opening the Mini Node Housing* (on page 2-5).

Note: These accessories can be installed without removing the cover.

- 2 Install the pad(s) specified by the design print in the appropriate pad slot(s).



Note:

Be sure that all the pins on the attenuator pad bottom align with the pin holes in the attenuator pad slot, allowing the attenuator pad to install flat against the Mini Node module.

The forward output pad and forward Interstage pad (1 GHz: 3 dB; 862 MHz: 2 dB) are installed at the factory to set the operational gain of the station. Do not change these pads in the field unless required by system design.

- 3 Install other options or accessories as desired.

Continued on next page

Installing the Accessories, Continued

To Install the Equalizers

Complete the following steps to install the equalizers in the Mini Node.

Note: For best results, follow this installation procedure exactly.

1	<p>Begin this procedure with the housing open. Refer to <i>Opening the Mini Node Housing</i> (on page 2-5).</p> <p>Note: These accessories can be installed without removing the Mini Node cover.</p>
2	<p>Detailed instructions on tilt value set up can be found on page 3-4. For a list of available accessory pad values and part numbers, see Technical Information (on page 6-1).</p> <div data-bbox="418 674 1240 1388" data-label="Image"> </div> <p>Note:</p> <p>The forward output equalizer and pad (1 GHz: 7 dB; 862 MHz: 6 dB) are factory installed, and should not be changed in the field.</p> <p>The plug-in output equalizer and an on-board equalizer combine to generate the total internal tilt for the station. The plug-in output equalizer value is different from the 1 GHz, or 862 MHz platform, in order to achieve optimum performance.</p>
3	<p>Install the reverse equalizer specified by the design print in the reverse equalizer slot. The default factory reverse tilt is set at 0 dB. For the exact location of the reverse equalizer, refer to the accompanying illustration. For a list of available reverse equalizers, see Technical Information (on page 6-1).</p>
4	<p>Install other options or accessories as desired.</p>

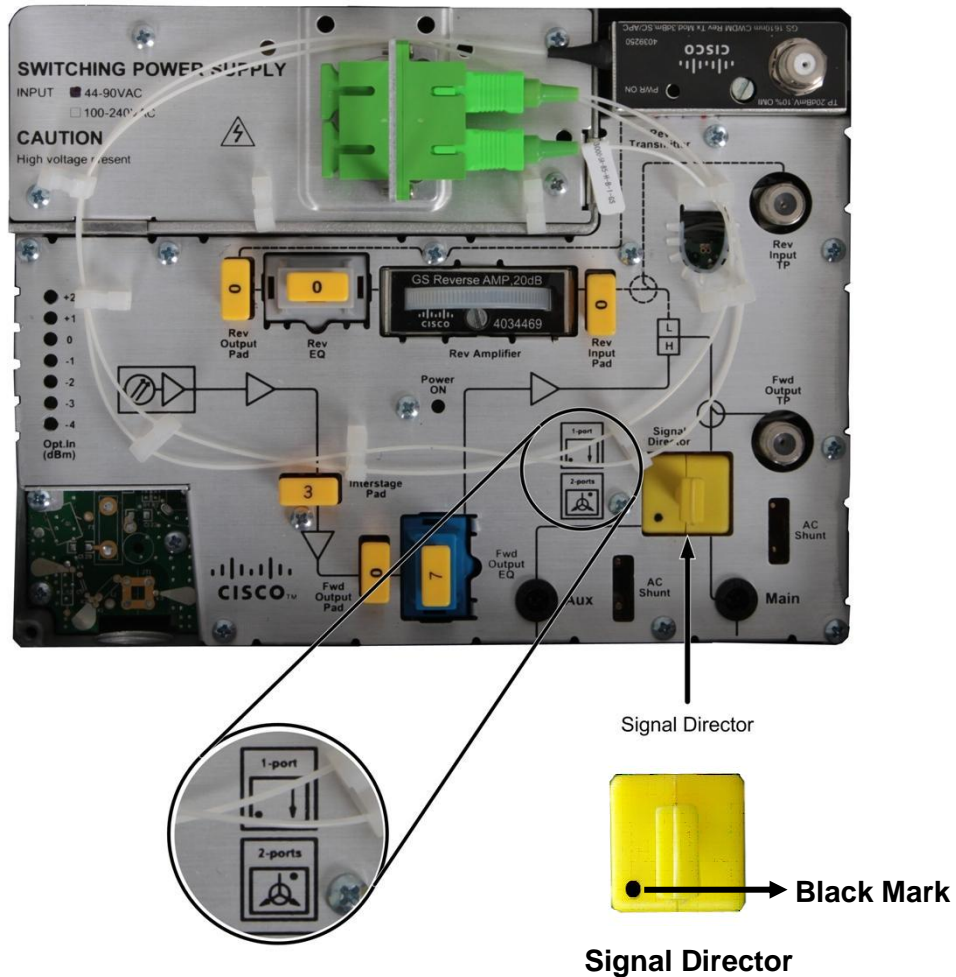
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Installing the Accessories, Continued

To Set up RF Output Port

Follow these steps to test the Gain Star Mini Node.

- 1 Factory default is one output port (Main shown below).
- 2 Before powering the Gain Star Mini Node, make sure all accessories are installed and properly seated.
- 3 Make sure the unit is properly connected to the power supply. Refer to *System Power* (on page 2-14).
- 4 For one High-level output, RF output Main is the active port. Make sure a Signal Director (SD) is installed in the position marked "Signal Director" on the Mini Node. The following diagram shows how to use the Signal Director.
- 5 For two outputs, Main, Aux are active ports.



System Power

System Power (44 to 90 VAC)

The Mini Node draw AC power from the coaxial cable. This AC power comes from an external AC power supply.



CAUTION:

RF connectors and housing seizure assemblies can be damaged if AC shunt power directors are not removed from the Mini Node before installing.

Power can come from the output ports, and each Mini Node can pass or block AC power flow on any port without affecting RF continuity. However, at least one port must pass AC power to bring power into the Mini Node.

Note: A red AC shunt power director is included with the unit. The red shunt is used to activate the port that supplies power.

To set the power direction, install AC shunt power directors for the ports through which you wish to pass AC.



CAUTION:

RF connectors and housing seizure assemblies can be damaged if AC shunt power directors are not removed from the Mini Node before installing or removing the amplifier model from the housing.

Before powering the Gain Star Mini Node, make sure all accessories are installed and properly seated.

Important: The Main and Aux ports are the RF/Power Ports.



Main Aux

Continued on next page

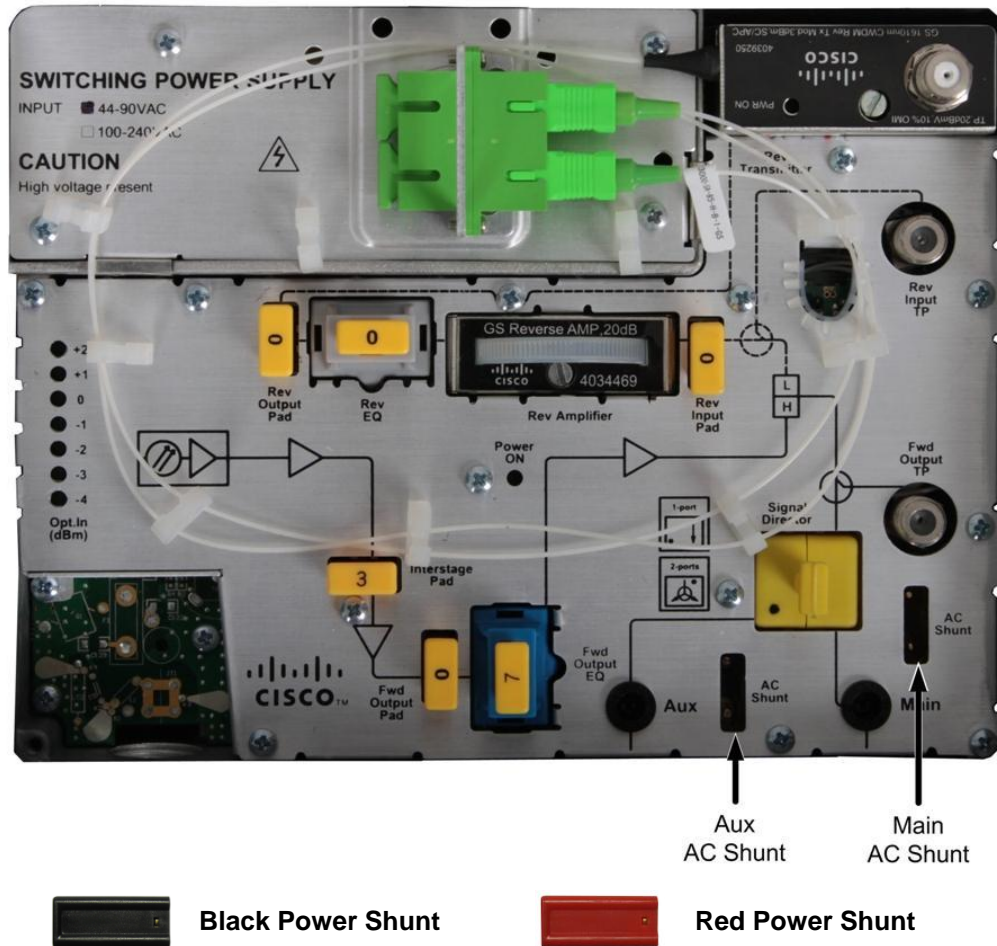
System Power, Continued

AC Shunt

Check the system maps to determine which AC Shunt should be inserted.

- 1 Open the housing. Refer to *Opening the Mini Node Housing* (on page 2-5).
- 2 Plug the Gain Star power shunt (red and black) into the AC shunt locations. The red AC shunt indicates where power is coming into the Gain Star Mini Node. The black AC shunt indicates where power is leaving the Gain Star Mini Node. See table below as an example. The black AC shunt should be installed before the red AC shunt.
- 3 Close the housing. Refer to *Closing the Mini Node Housing* (on page 2-23).

AC Shunt	Main	Aux
Powered from Main port	Red	Black
Powered from Aux port	Black	Red



Continued on next page

System Power, Continued

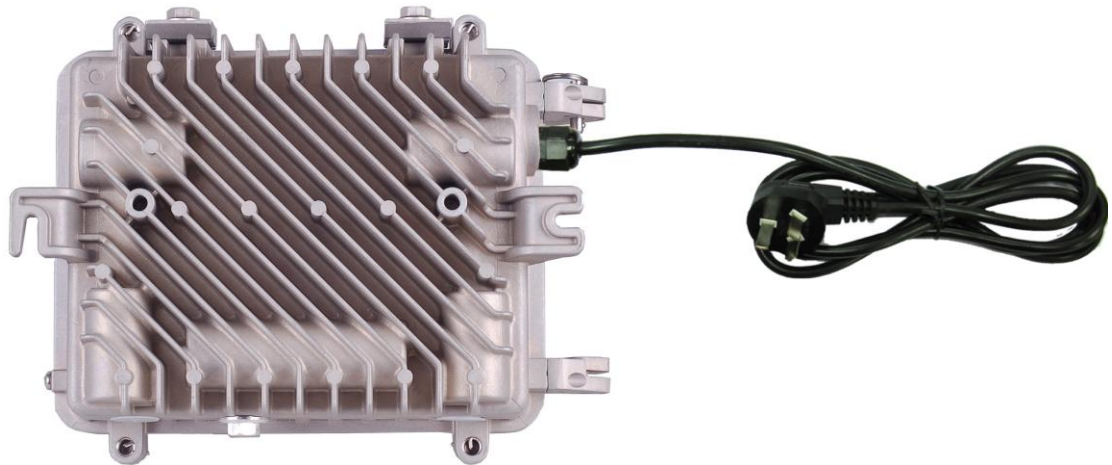
System Power (100 to 240 VAC)

The Mini Node can draw AC power from the local mains power.

The following information is applicable to the Mini Node powered by 100 to 240 VAC.

- Before powering the Gain Star Mini Node, make sure all accessories are installed and properly seated.

Note: There is no AC shunt for the Mini Node powered by 100 to 240 VAC.



Removing and Reinstalling the Optical Modules

The following optical components can be removed and reinstalled from the mini node optical section.

To Remove or Reinstall the Optical Transmitter

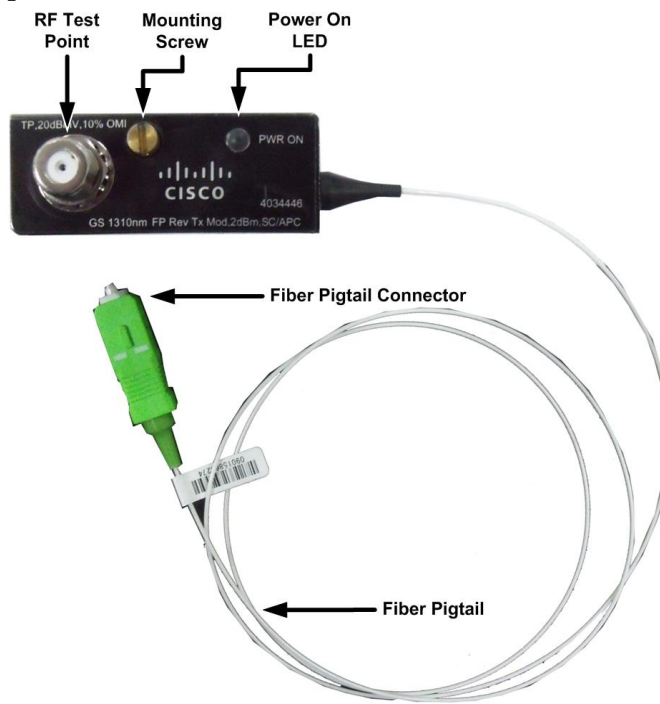
Complete the following steps to remove or reinstall an optical transmitter from the optical section.



WARNING:

Laser transmitters disconnected from their optical fiber path emit invisible laser radiation, which is harmful to the human eye. If viewed at close range, the radiation may be of sufficient power to cause instantaneous damage to the retina of the eye. Only trained service personnel using proper safety precautions and equipment, such as protective eyewear, should disconnect and service the laser transmitter equipment.

- 1 Open the housing. Refer to *Opening the Mini Node Housing* (on page 2-5).
- 2 Remove the AC shunt power directors (line power) or pull out the power plug (mains power). Refer to *System Power* (on page 2-14).
- 3 Disconnect the fiber connector from the fiber bulkhead on the cover.
- 4 Remove the fiber pigtail through the fiber retainer clips.
- 5 Using a flat-blade screwdriver, loosen the mounting screw to remove the optical transmitter.



Continued on next page

Removing and Reinstalling the Optical Modules, Continued

- 6 Pull the transmitter out from the Main board.
 - a) If you are not reinstalling the transmitter at this time, proceed to step 11.
 - b) If you are reinstalling the transmitter now, proceed to step 7.

- 7 Insert the transmitter in the slot and ensure that the transmitter is seated properly.

Note: Insertion slot is labeled on the cover.

- 8 Use a flat-blade screwdriver to tighten the mounting screw.

- 9 Route the fiber pigtail through the fiber retainer clips.

Note: Route excess fiber loosely through the fiber retainer clips.



CAUTION:

Be careful not to damage the fiber or pigtails.

- 10 Reconnect the fiber connector to the fiber bulkhead.
 - 11 Insert the AC shunt power directors (line power) or plug in the power plug (mains power). Refer to *System Power* (on page 2-14).
 - 12 Close the mini node housing. Refer to *Closing the Mini Node Housing* (on page 2-23).
-

Connecting the Fiber Optic Service Cable to the Mini Node

Warning: Radiation



WARNING:

- **Avoid personal injury! Use of controls, adjustments, or procedures other than those specified herein may result in hazardous radiation exposure.**
- **Avoid personal injury! The laser light source on this equipment (if a transmitter) or the fiber cables connected to this equipment emit invisible laser radiation. Avoid direct exposure to the laser light source.**
- **Avoid personal injury! Viewing the laser output (if a transmitter) or fiber cable with optical instruments (such as eye loupes, magnifiers, or microscopes) may pose an eye hazard.**

Do not apply power to this equipment if the fiber is unmated or unterminated.

Do not stare into an unmated fiber or at any mirror-like surface that could reflect light emitted from an unterminated fiber.

Do not view an activated fiber with optical instruments (for example, eye loupes, magnifiers, microscopes).

Use safety-approved optical fiber cable to maintain compliance with applicable laser safety requirements.

Fiber Cable Handling

With repeated use, optical connectors can become dirty or scratched. This can seriously degrade system performance. It is critical that connectors be maintained in good condition. Do not disconnect or connect any connectors unless absolutely necessary. Always clean both halves of each connector with a alcohol solution (99% recommended) and lint-free wipes when preparing to join the two halves. Use compressed air to clean the adapter.

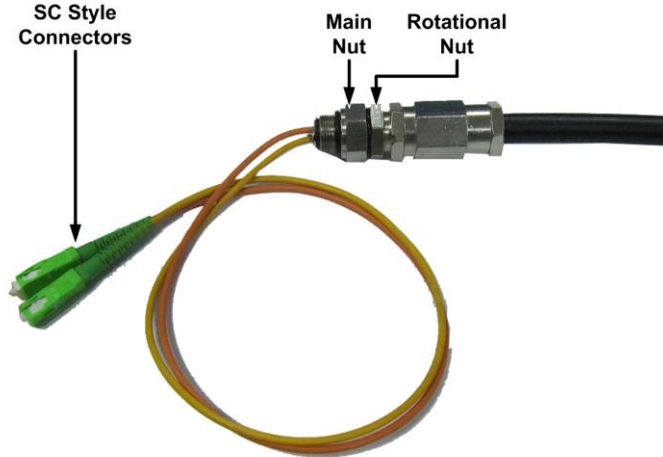
Note: A ferrule cleaner, part number 468517, may be ordered for use with SC style connector.

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Connecting the Fiber Optical Service Cable to the Mini Node, Continued

Fiber Connectors and Fiber Optical Service Cable

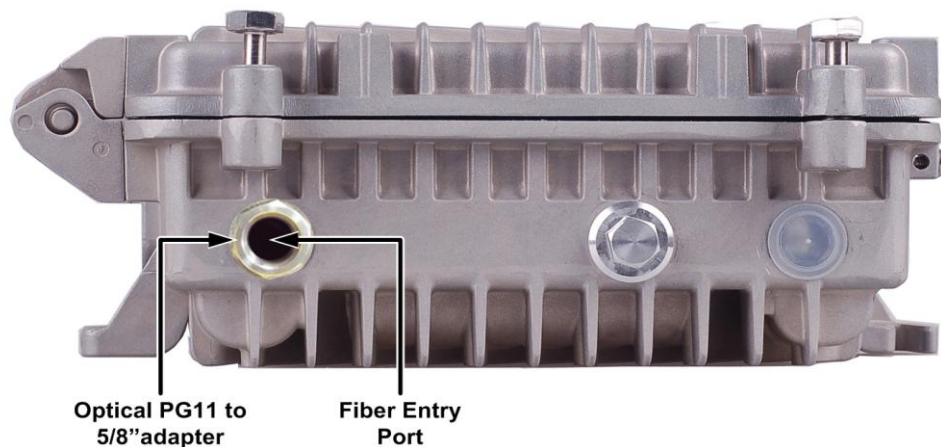
The following illustration shows the fiber connectors available with the mini node when using fiber optic service cables.



To Attach the Service Cable Connector

Complete the following steps to attach the connector to the housing.

- 1 Install the RF PG11 to the 5/8" adapter and torque from 12.0 Nm to 16.0 Nm.



- 2 Feed the jacketed fibers one at a time through the fiber entry port.
 - 3 Screw the main nut into the fiber entry port and torque from 6.8 Nm to 9.0 Nm.
 - 4 Screw the rotational nut back onto the main nut and torque from 9.0 Nm to 12.0 Nm.
 - 5 Use heat shrink to seal as required.
 - 6 Proceed to *Attaching the Fiber Connectors* (on page 2-21).
-

Attaching the Fiber Connectors

To Attach the Fiber Connectors

Note: Before attaching the fiber connectors, make sure the mini node housing is open. For instructions, refer to *Opening the Mini Node Housing* (on page 2-5).

To attach the fiber connectors, you must perform the following:

- Prepare the connectors for installation.
- Install the fiber connectors.



WARNING:

Protect yourself from electric shock and your system from damage! Take precautions when working with this equipment. Certain components can deliver an electrical shock or cause burns. Disconnect power before attempting this procedure.

Complete the following steps to attach the fiber connectors.

- 1 Carefully route the pigtails through the fiber retainer clips one at a time so that each fiber pigtail connector lines up with its corresponding connector on the cover.

Important: Do not attach the connectors until they have been cleaned. See step 4 below.

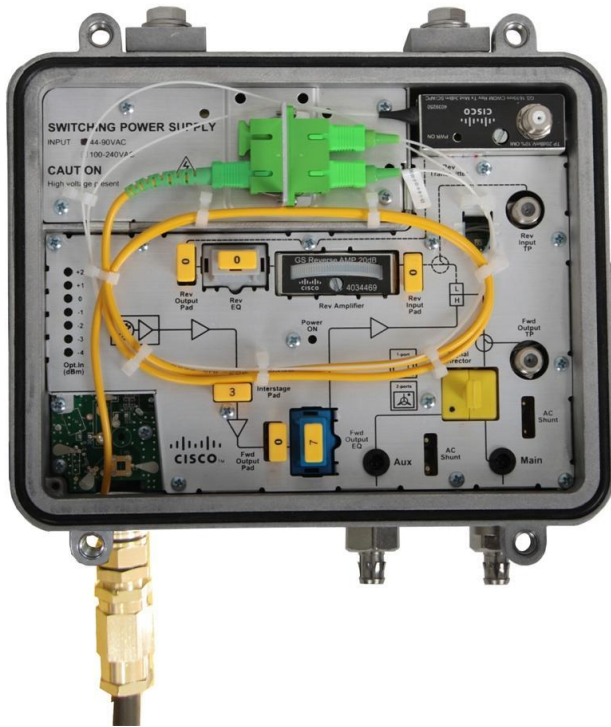
Note:

- Route the fiber pigtails clockwise and as close to the outside edge.
- Be careful not to use a tight fiber radius. The radius should be at least 30 mm.

- 2 Clean the tips of the fiber connectors.
- 3 Attach the fiber connectors as shown in the following illustration. The suggested fiber length is 580 mm.
- 4 Insert the forward input optical connector in the below fiber bulkhead.

Continued on next page

Attaching the Fiber Connectors, Continued



- 5 Insert the reverse output optical connector in the above fiber bulkhead.



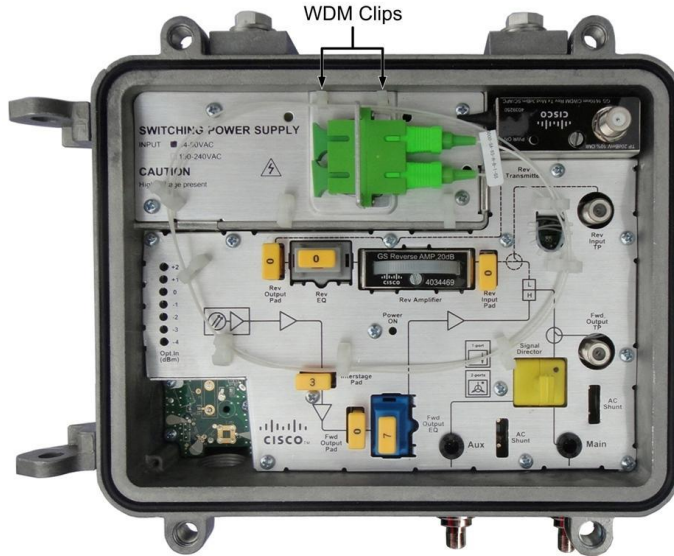
Installing the WDM Module

The following WDM can only be installed for the 42/54 MHz split Mini Node.

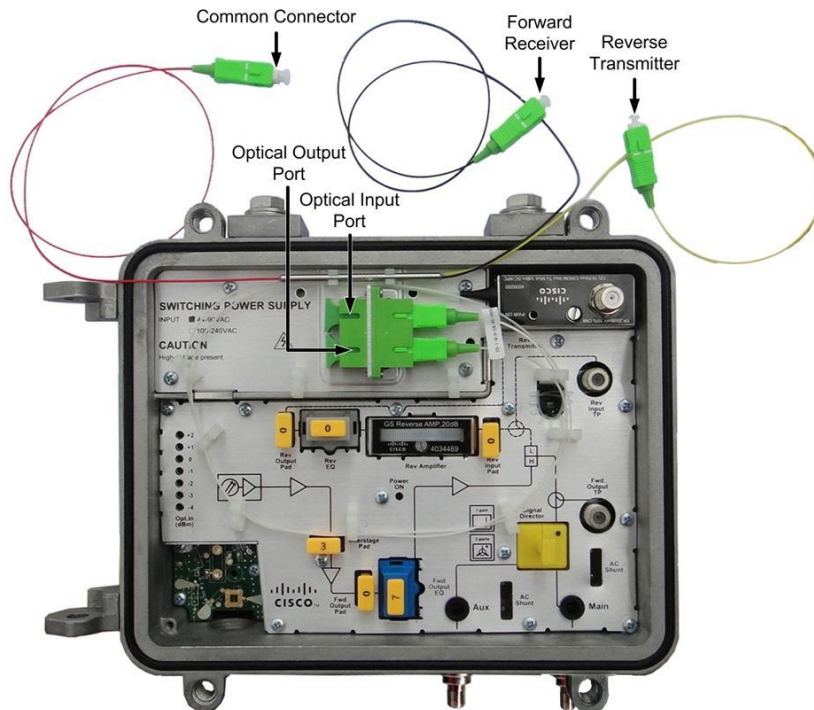
To install the WDM Module

Complete the following steps to install the WDM Module from the optical section

- 1 Insert the WDM clips in the board and ensure that the WDM clips are seated properly.



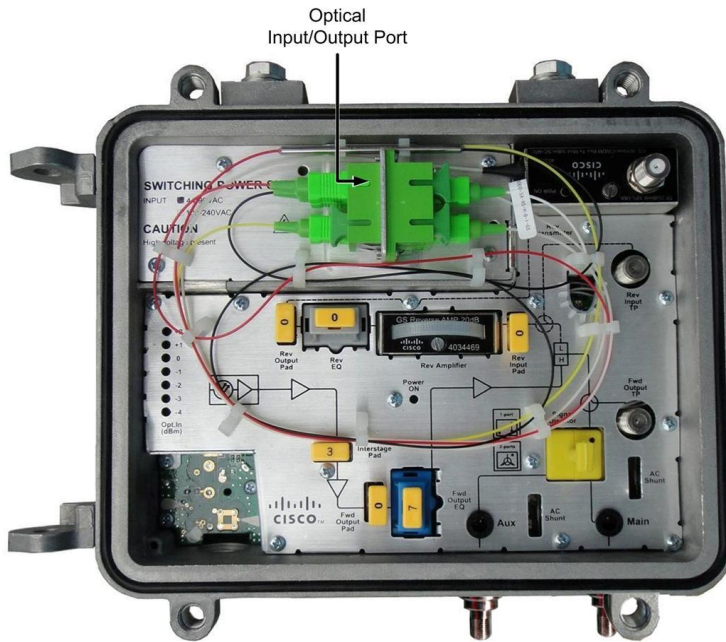
- 2 Insert the WDM into the WDM clips and ensure that the module is seated properly.



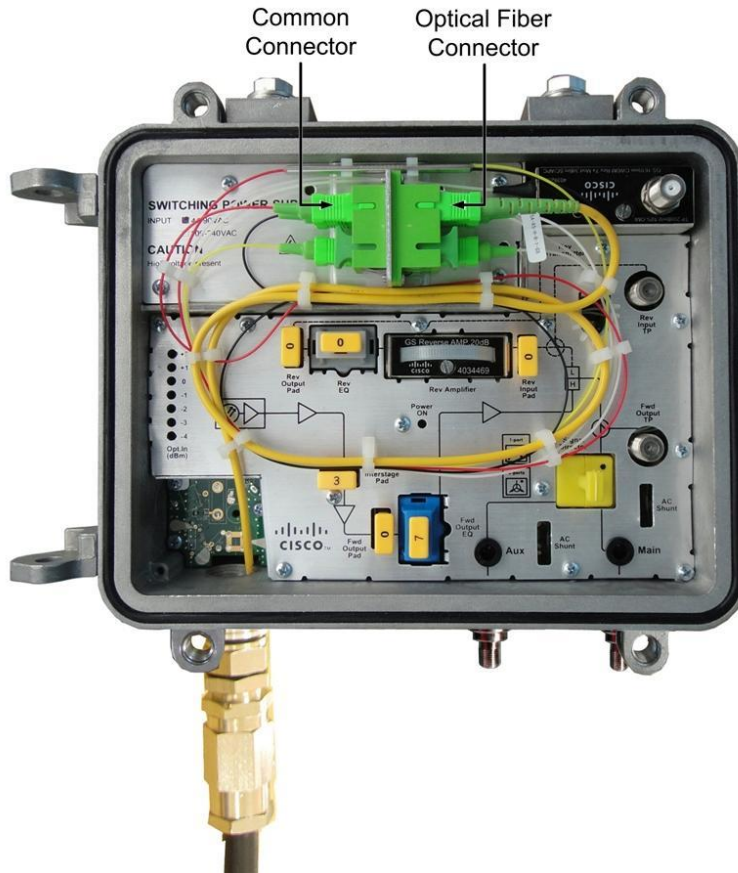
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Installing the WDM Module, Continued

- 5 Connect the Common Connector to the Optical Input/Output Port.



- 6 Insert the Optical Fiber Connector in the bulkhead.



- 7 Power up the Gain Star Mini Node referring to *System Power* (on page 2-14).
-

Closing the Mini Node Housing

To Close the Mini Node Housing

Complete the following steps to close the Mini Node housing.



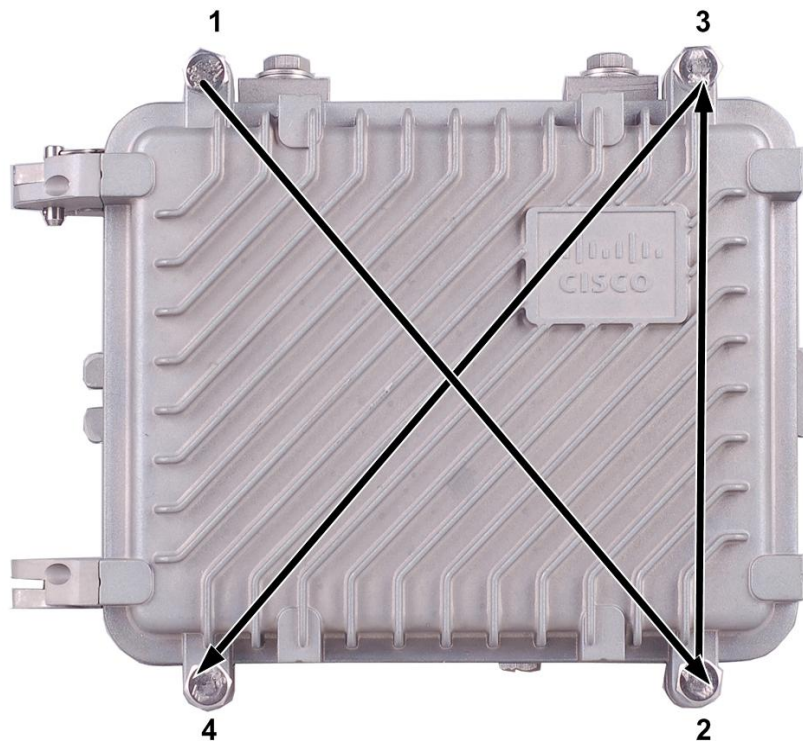
CAUTION:

Avoid moisture damage and RF leakage! Follow the procedure exactly as shown below to ensure a proper seal.

- 1 Make sure that the housing gaskets are clean and in the correct position. Wipe off any excess dirt and debris.
- 2 Close the housing.
- 3 Lightly secure the six ½-inch closure bolts with a hex driver or ratchet.
- 4 Using a torque wrench, tighten the six closure bolts to 2.8 Nm.
Important: Tighten the closure bolts in the correct sequence as specified in *Torquing Sequence (on page 2-2)*.
- 5 Using the same pattern, tighten the housing closure bolts from 6.8 Nm to 9.0 Nm.

Torquing Sequence

The following diagram shows the proper torquing sequence for the housing closure bolts.



Chapter 3

Balancing and Setup

Overview

This chapter provides instructions for selecting and implementing the correct balancing methods for the GainStar Mini Node in your cable system. Balancing sets the operating levels of the station to ensure proper performance.

Important: Use the information in this chapter to identify the equipment needed for balancing and to determine the correct forward path balancing method for your system installation.

In This Chapter

Topic	See Page
Preparing for Forward Path Balancing	3-2
Balancing the Forward Path	3-3
Balancing the Reverse Path	3-9
Setting OMI for Reverse Path Transmitter	3-14

Preparing for Forward Path Balancing

Before You Begin

Before you begin balancing, it is important to review and understand the following information. This information will show you which balancing process is appropriate for your Mini Node.

Before balancing, make sure you have configured the mainboard according to the specifications in your design print and that the Mini Node has warmed up for approximately one hour. The table below shows the items needed for balancing.

You need a ...	To ...
Copy of the design print	Determine expected input and output signal levels.
Torque wrench with 1/2-inch socket	Open and close the system amplifier housing.
Spectrum analyzer or signal analysis meter capable of working with frequencies up to the highest design frequency	Determine absolute and relative signal levels.
Test point probe (part number 1010409)	Access the test points.
Length of 75 ohm coaxial cable with F-connectors on each end	Connect the test point probe to the test equipment.

Balancing the Forward Path

Introduction

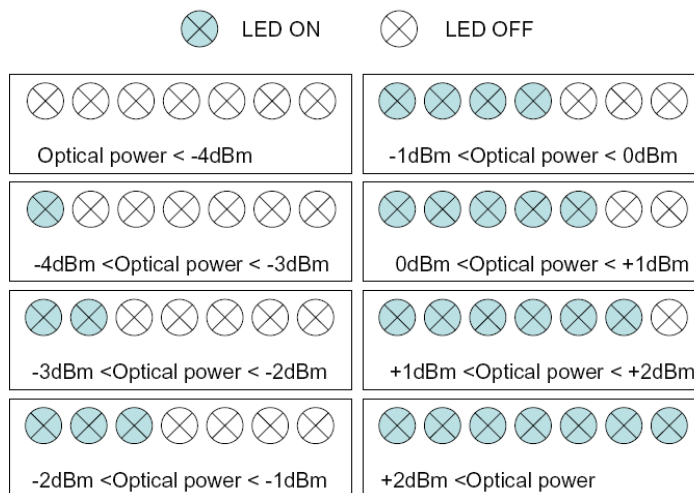
Be sure to use the correct procedure for forward path balancing. Refer to *To Test the Forward Input Optical Power* (on page 3-3) for help in identifying the procedure that best fits your system installation and node type. Before you begin, make sure that the mainboard is configured according to the specifications in the design print, and that the node has warmed up for approximately one hour.

The forward section of the GainStar Mini Node performs conversion, amplification, equalization, and test point functions for the forward path signal.

To Test the Forward Input Optical Power

Follow these steps to set or adjust input optical power.

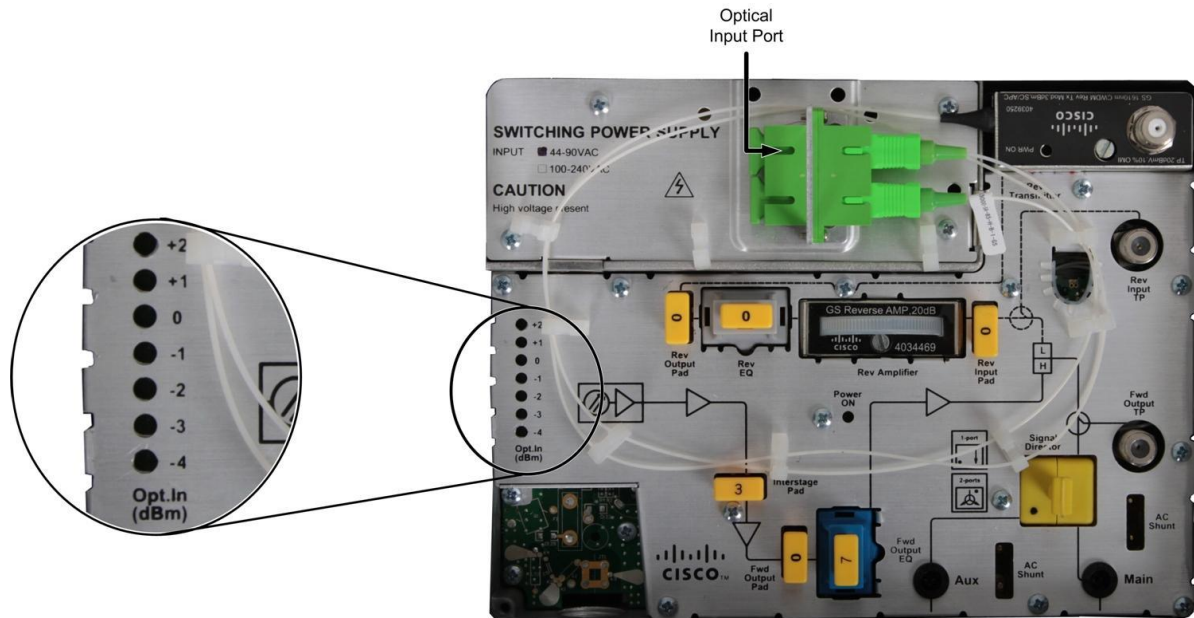
- 1 Clean the input fiber interface.
- 2 Connect the input fiber connector to see the Optical Power from the LED indicator. Following diagram shows the different input optical power level indicated by the lighting status of LED.



- 3 Read the input optical power from the LED indicator. The recommended range is -4 dBm to +2 dBm.
- 4 Compare the measured levels to the design input levels on the system design print.
 - a) Proceed to step 5.
 - b) Adjust the Optical Power.
- 5 Connect the input fiber to the below fiber bulkhead.

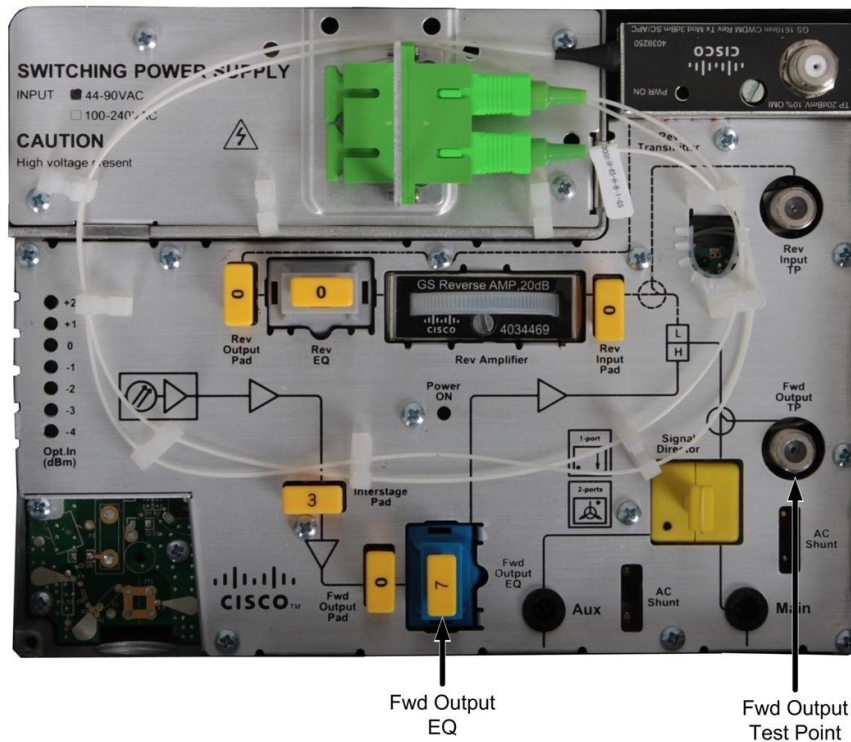
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Balancing the Forward Path, Continued



To Determine the Output Tilt

Complete the following steps to determine the output tilt of the Mini Node.



Continued on next page

Balancing the Forward Path, Continued

- 1 Connect the test point probe to the forward output test point.
- 2 Consult the design print to find the proper output tilt.
- 3 To determine the actual output tilt, calculate the difference (in dB) between the levels of the lowest and highest specified frequencies.
- 4 Proceed to *To Set the Output Tilt* (on page 3-5).

To Set Up the Output Tilt

862 MHz Equalizers

The forward output tilt can be adjusted using the Forward Equalizer (EQ). Each EQ has a range of values. Each EQ value is set by installing the appropriate attenuator pad value. There are three forward EQ's for the 862 MHz Platform: 0 dB to 4 dB, P/N 4034456; 5 dB to 9 dB, P/N 4034457; and 10 dB to 14 dB, P/N 4034458. See the table below for the full range of forward input and output tilt set up arrangements for the 862 MHz Platform.

Forward Equalization	Forward Equalizer		Pad for Forward Equalizer	
	Description	PN	Description	PN
0 dB	GS Fwd Linear EQ, 0 to 4 dB 862 MHz Platform	4034456	0 dB 1 GHz Plug-In Attenuator	4036021
1 dB			1 dB 1 GHz Plug-In Attenuator	4036022
2 dB			2 dB 1 GHz Plug-In Attenuator	4036023
3 dB			3 dB 1 GHz Plug-In Attenuator	4036024
4 dB			4 dB 1 GHz Plug-In Attenuator	4036025
5 dB	GS Fwd Linear EQ, 5 to 9 dB 862 MHz Platform	4034457	5 dB 1 GHz Plug-In Attenuator	4036026
6 dB			6 dB 1 GHz Plug-In Attenuator	4036027
7 dB			7 dB 1 GHz Plug-In Attenuator	4036028
8 dB			8 dB 1 GHz Plug-In Attenuator	4036029
9 dB			9 dB 1 GHz Plug-In Attenuator	4036030
10 dB	GS Fwd Linear EQ, 10 to 14 dB 862 MHz Platform	4034458	10 dB 1 GHz Plug-In Attenuator	4036031
11 dB			11 dB 1 GHz Plug-In Attenuator	4036032
12 dB			12 dB 1 GHz Plug-In Attenuator	4036033
13 dB			13 dB 1 GHz Plug-In Attenuator	4036034
14 dB			14 dB 1 GHz Plug-In Attenuator	4036035

Continued on next page

Balancing the Forward Path, Continued

1GHz Equalizers

The forward output tilt can be adjusted using the Forward Equalizer (EQ). Each EQ has a range of values. Each EQ value is set by installing the appropriate attenuator pad value. There are three forward EQ's for the 1 GHz Platform: 0 dB to 4 dB, P/N 4034459; 5 dB to 9 dB, P/N 4034460; and 10 dB to 14 dB, P/N 4034461. See the table below for the full range of forward input and output tilt set up arrangements for the 1 GHz Platform.

Forward Equalization	Forward Equalizer		Pad for Forward Equalizer	
	Description	PN	Description	PN
0 dB	GS Fwd Linear EQ, 0 to 4 dB 1 GHz Platform	4034459	0 dB 1 GHz Plug-In Attenuator	4036021
1 dB			1 dB 1 GHz Plug-In Attenuator	4036022
2 dB			2 dB 1 GHz Plug-In Attenuator	4036023
3 dB			3 dB 1 GHz Plug-In Attenuator	4036024
4 dB			4 dB 1 GHz Plug-In Attenuator	4036025
5 dB	GS Fwd Linear EQ, 5 to 9 dB 1 GHz Platform	4034460	5 dB 1 GHz Plug-In Attenuator	4036026
6 dB			6 dB 1 GHz Plug-In Attenuator	4036027
7 dB			7 dB 1 GHz Plug-In Attenuator	4036028
8 dB			8 dB 1 GHz Plug-In Attenuator	4036029
9 dB			9 dB 1 GHz Plug-In Attenuator	4036030
10 dB	GS Fwd Linear EQ, 10 to 14 dB 1 GHz Platform	4034461	10 dB 1 GHz Plug-In Attenuator	4036031
11 dB			11 dB 1 GHz Plug-In Attenuator	4036032
12 dB			12 dB 1 GHz Plug-In Attenuator	4036033
13 dB			13 dB 1 GHz Plug-In Attenuator	4036034
14 dB			14 dB 1 GHz Plug-In Attenuator	4036035

Continued on next page

Balancing the Forward Path, Continued



- Increasing the equalizer value reduces the level at lower frequencies, relative to the level at 862 MHz / 1 GHz.
- Decreasing the equalizer value increases the level at lower frequencies, relative to the level at 862 MHz / 1 GHz.

Note:

- The forward output equalizer is installed at the factory, and should not be changed in the field.
- The plug-in output equalizer and an on-board equalizer combine to generate the total internal tilt for the station. The plug-in output equalizer value is different from the 1 GHz, or 862 MHz platform, in order to achieve optimum performance.

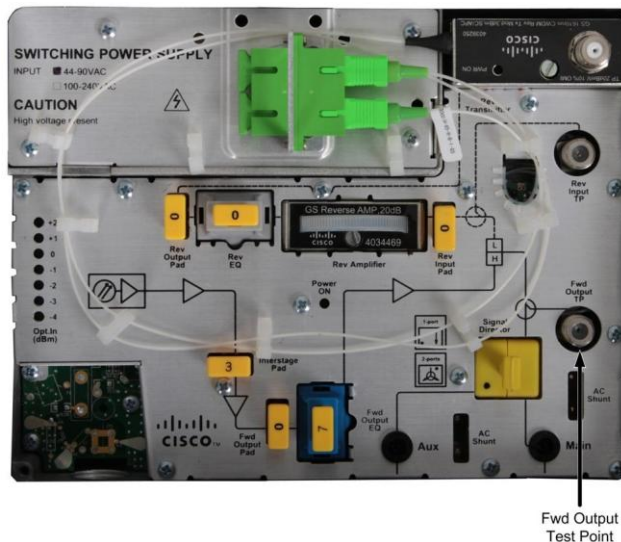
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Balancing the Forward Path, Continued

To Set Up the Forward Output Level

After setting the tilt, complete the following steps to select the proper pad values for the Mini Node. The output level of the Mini Node is set by selecting the proper pad value.

1	Connect the test probe to the forward output test point.
2	Measure the output level at the high test design frequency, and compare this level with the design level (on the design print). a) 862 MHz for 862 MHz version b) 1000 MHz for 1000 MHz version
3	Is the measured output level within ± 0.5 dB of the design level? Add 20 dB (signal output) or 16.5 dB (dual outputs) to the measured levels to find the true levels. a) If the output level is within ± 0.5 dB of the design output level, proceed to step 5. b) If the output level is more than the design output level, replace the forward output pad with a higher value pad. c) If the output level is less than the design level, replace the forward output pad with a lower value pad, and proceed to step 5.
4	Repeat steps 2 and 3 until the output level is correct. For optimum performance, the output level in each port should not exceed 50 dBmV (single output) or 46.5 dBmV (dual outputs)
5	Proceed to <i>To Set Up the Reverse Input Level</i> (on page 3-9).



CAUTION:

The pad should be configured carefully to control forward output level, otherwise, output module damage may occur, which results in Node distortion.

Balancing the Reverse Path

Introduction

This section covers reverse RF amplifier cascade balancing. Balancing refers to the process of individually aligning reverse amplifier station gain and tilt characteristics to achieve reverse amplifier cascades that have optimum, repeatable transmission characteristics.

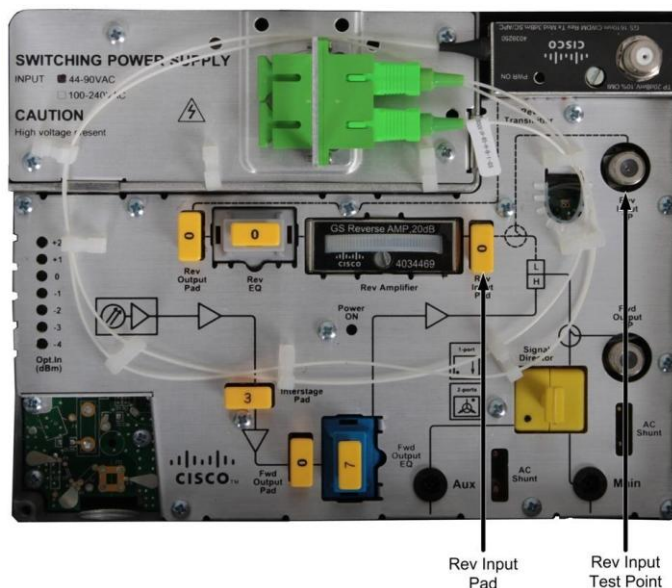
There are a variety of test equipment combinations that enable proper balancing of the reverse path. Regardless of the type of equipment used, the balancing process is fundamentally the same.

To Set Up the Reverse Input Level

Complete the following steps to test the reverse input level.

Important: You cannot balance the node without the proper reverse input signals.

- 1 Connect the test equipment to the reverse input test point shown in the illustration below.



- 2 The recommended input range is 5 dBmV/ch to 20 dBmV/ch.
- 3 Measure the input level, and compare this with the design level. The test point attenuates input signals by 20 dB (for one reverse input port), or 23.5 dB (for two reverse input ports).
- 4 Are measured levels within the design limits?
 - a) If yes, proceed to step 5.
 - b) If no, or if no signals are present, find the problem before proceeding. You cannot balance the node without proper input signals.
- 5 Remove the test probe from the reverse input test point, leaving other equipment connectors in place.

Continued on next page

Balancing the Reverse Path, Continued

To Set Up the Equalizer Values for Reverse Path

42 MHz Platform

The reverse output tilt can be adjusted using the Reverse Equalizer (EQ). Each EQ has a range of values. Each EQ value is set by installing the corresponding attenuator pad value. There are two reverse EQ's for the 42 MHz Platform: 0 dB to 5 dB, P/N 4034465; 6 dB to 10 dB, P/N 4034466. See the table below for the full range of configurations for the 42 MHz Platform EQs.

Reverse Equalization	Reverse Equalizer		Pad for Reverse Equalizer	
	Description	PN	Description	PN
0 dB *	GS Rev Cable EQ, 0 to 5 dB 42 MHz Platform	4034465	0 dB 1 GHz Plug-In Attenuator	4036021
1 dB			1 dB 1 GHz Plug-In Attenuator	4036022
2 dB			2 dB 1 GHz Plug-In Attenuator	4036023
3 dB			3 dB 1 GHz Plug-In Attenuator	4036024
4 dB			4 dB 1 GHz Plug-In Attenuator	4036025
5 dB			5 dB 1 GHz Plug-In Attenuator	4036026
6 dB	GS Rev Cable EQ, 6 to 10 dB 42 MHz Platform	4034466	6 dB 1 GHz Plug-In Attenuator	4036027
7 dB			7 dB 1 GHz Plug-In Attenuator	4036028
8 dB			8 dB 1 GHz Plug-In Attenuator	4036029
9 dB			9 dB 1 GHz Plug-In Attenuator	4036030
10 dB			10 dB 1 GHz Plug-In Attenuator	4036031

* The section in gray indicates factory default values.

Continued on next page

Balancing the Reverse Path, Continued

65 MHz Platform

The reverse output tilt can be adjusted using the Reverse Equalizer (EQ). Each EQ has a range of values. Each EQ value is set by installing the corresponding attenuator pad value. There are two reverse EQ's for the 65 MHz Platform: 0 dB to 5 dB, P/N 4034462; 6 dB to 10 dB, P/N 4034463. See the table below for the full range of configurations for the 42 MHz Platform EQs.

Reverse Equalization	Reverse Equalizer		Pad for Reverse Equalizer	
	Description	PN	Description	PN
0 dB *	GS Rev Cable EQ, 0 to 5 dB 65 MHz Platform	4034462	0 dB 1 GHz Plug-In Attenuator	4036021
1 dB			1 dB 1 GHz Plug-In Attenuator	4036022
2 dB			2 dB 1 GHz Plug-In Attenuator	4036023
3 dB			3 dB 1 GHz Plug-In Attenuator	4036024
4 dB			4 dB 1 GHz Plug-In Attenuator	4036025
5 dB			5 dB 1 GHz Plug-In Attenuator	4036026
6 dB	GS Rev Cable EQ, 6 to 10 dB 65 MHz Platform	4034463	6 dB 1 GHz Plug-In Attenuator	4036027
7 dB			7 dB 1 GHz Plug-In Attenuator	4036028
8 dB			8 dB 1 GHz Plug-In Attenuator	4036029
9 dB			9 dB 1 GHz Plug-In Attenuator	4036030
10 dB			10 dB 1 GHz Plug-In Attenuator	4036031

* The section in gray indicates factory default values.

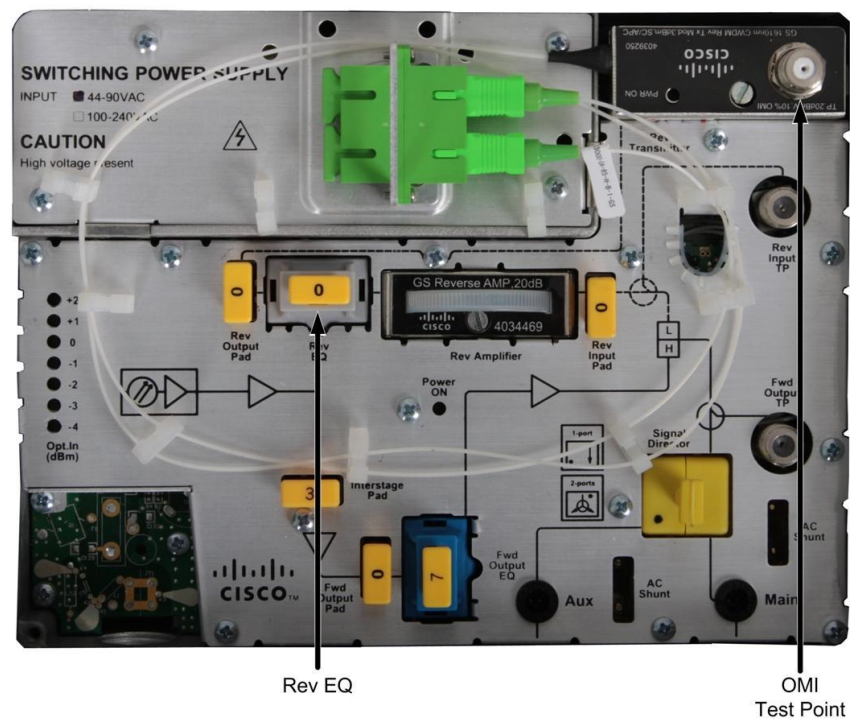
Continued on next page

Balancing the Reverse Path, Continued



Complete the following steps to select the proper reverse Equalizer value.

- 1 Connect the test point probe to the OMI test point.



- 2 Compare the calculated tilt with the design tilt (on the design print).

Continued on next page

Balancing the Reverse Path, Continued

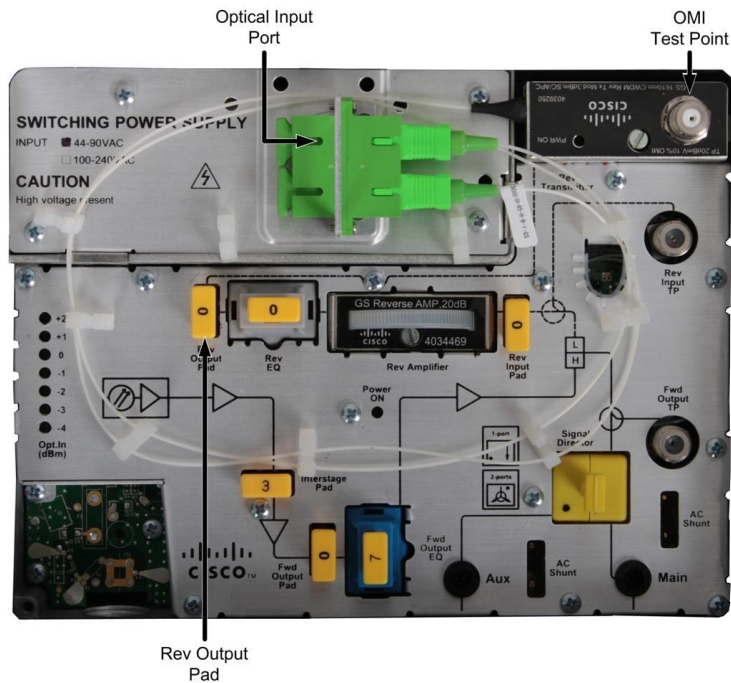
- 3 Is the reverse Output tilt within $\pm 0.5\text{dB}$ of the design tilt?
 - a) If the output tilt is within $\pm 0.5\text{dB}$ of the design tilt, proceed to the next section.
 - b) If the output tilt is more than the design tilt, replace the reverse EQ with a lower value.
 - c) If the output tilt is less than the design tilt, replace the reverse EQ with a higher value.
- 4 Measure the output tilt again, and then proceed to *Setting OMI for Reverse Path Transmitter* (on page 3-14)

Note: The reverse equalizer is installed at the factory with 0 dB pad.

Setting OMI for Reverse Path Transmitter

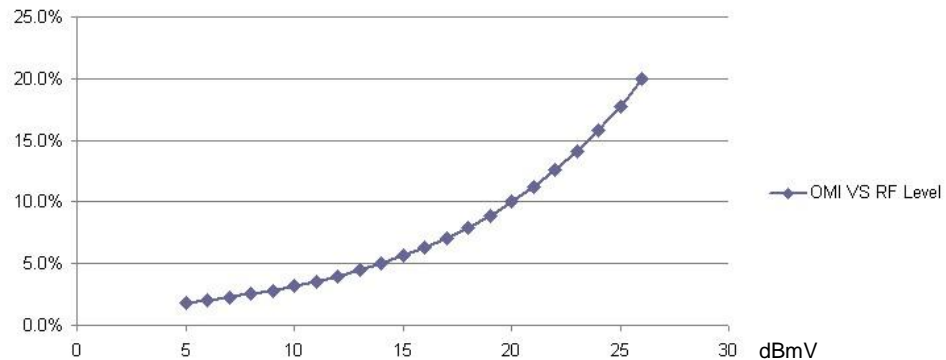
To Set Up the OMI for Reverse Path Transmitter

Follow these steps to setup OMI for the reverse path transmitter. See below.



- 1 Consult the system design print to find proper OMI levels.
When the GainStar Mini Node is powered on, the green LED will light.
- 2 Insert the test probe into the test probe as above position.
- 3 Test the signal level at the maximum frequency of reverse path.
- 4 When the measured level is 20 dBmV, the corresponding OMI of the reverse transmitter is 10%, OMI can be changed by adjusting the reverse output PAD. See the chart below.

OMI VS RF Level



- 5 Remove the test probe from the test point.

Chapter 4 Troubleshooting

Overview

This chapter describes the steps you may take to troubleshoot the GainStar Mini Node.

In This Chapter

Topic	See Page
Equipment	4-2
Low RF Output	4-3
No Forward RF Signal	4-4
Low or Degraded Forward RF Signal	4-5
No Reverse RF Signal	4-6
Low or Degraded Reverse RF Signal	4-7
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Miscellaneous Problems	4-10
No Power Supply	4-11
Cleaning Optical Connectors	4-12

Equipment

The following equipment may be necessary to perform some troubleshooting procedures.

- CLETOP or OPTIPOP ferrule (CLETOP Type A for SC, Type B for LC)
 - Compressed air (also called “canned air”)
 - Lint-free wipes moistened with optical-grade (99%) isopropyl alcohol
 - Optical connect scope
 - Optical power meter to measure light levels
 - Proper fiber connector for optical power meter to make optical connections
 - Spectrum analyzer or a field strength meter to measure RF levels
 - Test point probe, part number 1010409, to access test points
-

Low RF Output

Use the steps in the following table to troubleshoot low RF output of the GainStar Mini Node.

Low RF Output Troubleshooting Table

Possible Cause	Solution
Low RF input at the transmitter.	Verify correct RF input to the transmitter. Check the amplifiers preceding the transmitter for proper inputs and outputs.
Defective or improperly spliced optical coupler (between headend transmitter and node).	Replace or re-splice the coupler. Make sure all unused fiber pigtails are terminated.
Unterminated leg of the optical coupler.	Make sure all unused fiber pigtails are terminated.
Low optical input to the node. The optical input level should be typically -4 to +2 dBm. Refer to the system design print for the proper level.	If connectors are dirty, clean them. Refer to <i>Cleaning Optical Connectors</i> (on page 4-12). Inspect fiber routing that might be wrapped too tightly. Check for proper optical output from transmitter. Check the link loss. Replace any scratched connectors.
Failure in the optical receiver.	Replace the GainStar Mini Node. Use the output test point of the optical receiver to verify output levels.

No Forward RF Signal

The forward RF signal can be measured at the -20 dB RF test point on the mainboard forward output test points.

No Forward RF Signal Troubleshooting Table

Before you begin troubleshooting for no forward RF signal, verify that the Mini Node is receiving the proper optical input signal from the forward transmitter.

Important: You cannot balance the Mini Node without the proper optical input signal.

Possible Cause	Solution
No forward RF signal at the forward output test point.	Verify that all the proper accessories, pads, EQs, and signal directors are firmly installed in the correct locations. Verify that the factory installed accessories are firmly installed in the correct locations. Replace the mainboard.

Low or Degraded Forward RF Signal

The forward RF signal can be measured at the -20 dB RF test point on the mainboard forward output test points.

Low or Degraded Forward RF Signal Troubleshooting Table

Before you begin troubleshooting for a low or degraded forward RF signal, verify that the Mini Node is receiving the proper forward optical input signal from the forward transmitter.

Important: You cannot balance the Mini Node without the proper forward optical input signal.

Make sure you have configured the mainboard according to the specifications in the design print and that the node has warmed up for approximately one hour.

Make sure you are using the proper tilt reference when setting levels. An 862 MHz or 1 GHz design balanced at 550 MHz requires a corrected tilt reference to compensate for the difference in carrier levels between 550 MHz and 862 MHz or 1 GHz. The tilt reference at 550 MHz is lower than the tilt reference at 862 MHz or 1 GHz. Refer to *Technical Information* (on page 6-1) for more information.

Possible Cause	Solution
There is a proper forward RF signal at the forward output test point, but a low or degraded signal at one or all of the forward output test points.	Verify that all the proper accessories, pads, EQs, and signal directors are firmly installed in the correct locations. Verify that the factory installed accessories are firmly installed in the correct locations. Note: Verifying factory installations involves removing the mainboard cover. Reinstall the mainboard cover properly. Replace the mainboard.

No Reverse RF Signal

The reverse RF signal can be measured at the mainboard reverse input test point and reverse OMI test points.

No Reverse RF Signal Troubleshooting Table

Before you begin troubleshooting for no reverse RF signal, verify that the node is receiving the proper reverse RF input signals from the downstream amplifiers at the node reverse input ports.

Important: You cannot balance the amplifier without the proper reverse RF input signals.

Possible Cause	Solution
No reverse RF signal at the reverse input test point(s).	Verify the connection of the RF Cable Connector. Verify that the node is receiving the proper reverse RF input signals. Important: You cannot balance the node without the proper reverse RF input signals. Verify that all the proper accessories, pads, EQs, Reverse Amplifier, and signal director are firmly installed in the correct locations. Verify that the factory installed accessories are firmly installed in the correct locations. Replace the reverse amplifier module.

Low or Degraded Reverse RF Signal

The reverse RF signal can be measured at the mainboard reverse input test point and reverse OMI test points.

Low or Degraded Reverse RF Signal Troubleshooting Table

Before you begin troubleshooting for no reverse RF signal, verify that the node is receiving the proper reverse RF input signals from the downstream amplifiers at the node reverse input ports.

Important: You cannot balance the amplifier without the proper reverse RF input signals.

Make sure you have configured the mainboard according to the specifications in the design print and that the node has warmed up for approximately one hour.

Make sure you are using the proper total tilt reference when setting receive levels.

Refer to the reverse equalizer charts in *Technical Information* (on page 6-1) for more information.

Possible Cause	Solution
Low or degraded reverse RF signal at the reverse input test point(s).	Verify that the node is receiving the proper reverse RF input signals. Important: You cannot balance the node without the proper reverse RF input signals.
There are proper reverse RF signals at the reverse input test point, but a low or degraded signal at the OMI test point.	Measure the reverse input test point and the OMI test point. Subtract the reverse amplifier gain and add the pad values and EQ insertion loss to verify proper reverse amplifier gain. Verify that all the proper accessories, pads, EQs, Reverse amplifier, and signal directors (if applicable) are firmly installed in the correct locations. Verify that the factory installed accessories are firmly installed in the correct locations. Verify that any unused RF ports are properly terminated.

Continued on next page

Low or Degraded Reverse RF Signal, Continued

Reverse RF signal still low or degraded.	If degradation is generated in the reverse amplifier, replace the reverse amplifier. If degradation is generated by the downstream amplifier reverse RF signal, troubleshoot the RF module feeding this station. Replace the reverse amplifier module.
--	--

Troubleshooting Carrier-to-Noise Problems

Complete the following steps to troubleshoot carrier-to-noise problems.

Carrier-to-noise problems Troubleshooting Table

Possible Cause	Solution
Low optical input to the Mini Node. The optical input level should be typically -4 to +2 dBm. Refer to the system design print for the proper level.	If connectors are dirty, clean them. Refer to <i>Cleaning Optical Connectors</i> (on page 4-12). Inspect fiber routing that might be wrapped too tightly. Check for proper optical output from transmitter. Check the link loss. Replace any scratched connectors.
Low RF input at transmitter.	Verify RF input to the transmitter. Check all amplifiers preceding the transmitter for proper inputs and outputs.
Failure in optical receiver.	Replace the GainStar Mini Node module.
Defective or improperly spliced optical coupler between headend transmitter and node.	Replace or re-splice the coupler. Make sure all unused fiber pigtails are terminated.
Unterminated leg of optical coupler.	Make sure all unused fiber pigtails are terminated.

Miscellaneous Problems

Complete the following steps to troubleshoot miscellaneous problems.

Miscellaneous problems Troubleshooting Table

Possible Cause	Solution
No RF signal present in network.	<p>Check network power supply.</p> <p>Verify that power is present at the node power supply.</p> <p>Check that the optical signal is present on fiber.</p> <p>Check that voltage level on the optical receiver is the same as it was when commissioned.</p> <p>Check that output RF is present at forward output test point.</p>
Poor pictures on network.	<p>Check RF input level at transmitter.</p> <p>Check optical output of transmitter.</p> <p>Check optical levels at forward optical receiver.</p> <p>Check and clean fiber connectors. See <i>Cleaning Optical Connectors</i> (on page 4-12).</p> <p>Check RF levels at Mini Node outputs.</p>
No RF output from headend or hub reverse optical receiver.	<p>Check fiber connector in headend or hub.</p> <p>Check fiber for optical input level.</p> <p>Check fiber connections.</p> <p>Check reverse transmitter in node.</p> <p>Check RF input level to transmitter in node.</p> <p>Ensure that cable is connected and not crushed.</p> <p>Check for RF at amplifier reverse input test point.</p>
Excessive noise in return.	<p>Check fiber connections and clean if necessary.</p> <p>Check noise level at transmitter test point.</p>

No Power Supply

No Power Supply

Before you begin troubleshooting for the power supply, verify that the power supply is receiving power.

Important: You cannot balance the node without the proper power supply.

Possible Cause	Solution
No Power supply.	Verify that the power supply is receiving power. Important: You cannot balance the Mini Node without the proper power supply. Replace the GainStar Mini Node.

Cleaning Optical Connectors

Note: The proper procedure for cleaning optical connectors depends on the connector type. The following describes general instructions for cleaning optical connectors. Many companies have established procedures for cleaning connectors which should be followed. If your company has established procedures, the following instructions should be considered along with your procedures.

Cleaning fiber-optic connectors can help prevent interconnect problems and aid system performance. When optical connectors are disconnected or reconnected, the fiber surface can become dirty or scratched. If not addressed, this dirt or damage may lead to interconnect problems and reduced system performance.

Fiber-optic connectors should be inspected prior to mating and cleaned as needed to remove all dust and contaminants without leaving any residue. Connectors should be visually inspected after cleaning to confirm that they are clean and undamaged.

Recommended Equipment

The following equipment is recommended to clean the ends of fiber-optic connectors.

- CLETOP or OPTIPOP ferrule cleaner (CLETOP Type A for SC)
- Compressed air (also called “canned air”)
- Lint-free wipes moistened with optical-grade (99%) isopropyl alcohol
- Optical connector scope

Tips for Optimal Fiber-Optic Connector Performance

Follow these guidelines to ensure optimal connector performance.

- Do not connect or disconnect optical connectors while optical power is present.
- Always use compressed air before cleaning the fiber-optic connectors.
- Always use end caps on connectors when they are not in use.
- Always use compressed air to clean the end caps.
- If you have any degraded signal problems, clean the fiber-optic connector.
- Advance a clean portion of the ferrule cleaner reel for each cleaning.
- Turn off optical power before making or breaking optical connections in order to avoid microscopic damage to fiber mating surfaces.

Continued on next page

Cleaning Optical Connectors, Continued

To Clean Optical Connectors

Note: The proper procedure for cleaning optical connectors depends on the connector type. The following describes general instructions for cleaning optical connectors. Many companies have established procedures for cleaning connectors which should be followed. If your company has established procedures, the following instructions should be considered along with your procedures.



WARNING:

- **Avoid personal injury! Use of controls, adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.**
- **Avoid personal injury! The laser light source on this equipment emits invisible laser radiation. Avoid direct exposure to the laser light source.**
- **Avoid personal injury! Viewing the laser output with optical instruments (such as eye loupes, magnifiers, or microscopes) may pose an eye hazard.**

- Connect or disconnect fiber only when equipment is OFF or in Service mode.
- Do not apply power to this equipment if the fiber is unmated or unterminated.
- Do not look into an unmated fiber or at any mirror-like surface that could reflect light that is emitted from an unterminated fiber.
- Do not view an activated fiber with optical instruments such as eye loupes, magnifiers, or microscopes.
- Use safety-approved optical fiber cable to maintain compliance with applicable laser safety requirements.

Fiber Optic Connector Cleaning Instructions

Connector cleanliness is crucially important for optimum results in fiber-optic communications links. Even the smallest amount of foreign material can make it impossible to obtain the expected insertion and return losses. This can reduce the range of the equipment, shorten its expected service life, and possibly prevent the link from initializing at all.

New equipment is supplied with clean optical connectors and bulkheads. All optical connectors (bulkheads and jumpers) should be inspected using an appropriate optical scope prior to connector mating. If endface contamination is observed, the connector should be cleaned and then re-inspected to verify cleaning.

Connectors and Bulkheads

Most fiber-optic connectors are of the physical contact (PC) type. PC type connectors are designed to touch their mating connectors, thereby preventing air gaps which cause reflections. For optimum performance, all dirt must be removed.

Bulkheads can also become dirty enough to affect performance, either from airborne dust or from contamination introduced by connectors.

Continued on next page

Cleaning Optical Connectors, Continued



WARNING:

Avoid damage to your eyes! Do not look into any optical connector while the system is active. Even if the unit is off, there may still be hazardous optical levels present.

Important: Read the above warning before performing cleaning procedures.

Cleaning Connectors

Important:

- All external jumper connectors must be cleaned before inserting them into the optical module.
- Before you begin, remove optical power from the module or ensure that optical power has been removed.

Complete the following steps to clean fiber-optic connectors that will be connected to the optical module.

- 1 Inspect the connector through an optical connector scope. If the connector is damaged, for example, scratched, burned, and so forth, replace the jumper.
- 2 If the connector is dirty but otherwise undamaged, clean the connector as follows:
 - a) Make several swipes across the face of the connector with the appropriate ferrule cleaner. This will remove dust and some films.
 - b) Listen for a slight "squeak" typically generated during this process, indicating a clean connector.
 - c) Inspect the connector again through the scope to confirm that it is clean.
- 3 If a second inspection indicates that further cleaning is needed:
 - a) Use 99% isopropyl alcohol and a lint-free wipe to clean the connector.
 - b) Use the appropriate ferrule cleaner again to remove any film left over from the alcohol.
 - c) Inspect the connector again through the scope and confirm that it is clean.
- 4 If necessary, repeat steps 3a-3c until the connector is clean.

Continued on next page

Cleaning Optical Connectors, Continued

Cleaning Bulkheads

Important:

- Do not detach the bulkhead from the module front panel for cleaning under any circumstances. There is little or no slack in the fiber attached to the bulkhead, and any attempt to remove the bulkhead will risk damage to the fiber.
- It is generally more difficult to clean bulkhead connectors and verify their condition due to the inaccessibility of the fiber end face. For this reason, you should only attempt to clean a bulkhead connector when a dirty connector is indicated.
- Complete the following steps to clean the bulkhead.



WARNING:

- **Avoid personal injury! Use of controls, adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.**
- **Avoid personal injury! The laser light source on this equipment emits invisible laser radiation. Avoid direct exposure to the laser light source.**
- **Avoid personal injury! Viewing the laser output with optical instruments (such as eye loupes, magnifiers, or microscopes) may pose an eye hazard.**

- 1 Insert a dry bulkhead swab into the bulkhead and rotate the swab several times.
- 2 Remove the swab and discard.
Important: Swabs may be used only once.
- 3 Check the bulkhead optical surface with a fiber connector scope to confirm that it is clean. If further cleaning is needed:
 - a) Moisten a new bulkhead swab using a lint-free wipe moistened with optical grade (99%) isopropyl alcohol.
 - b) With the connector removed, fully insert the bulkhead swab into the bulkhead and rotate the swab several times.
 - c) Remove the swab and discard. Swabs may be used only once.
 - d) Repeat steps 1 and 2 with a new dry bulkhead swab to remove any excess alcohol or residue.
 - e) Check with a fiber connector scope again to confirm that there is no dirt or alcohol residue on the optical surface.
 - f) If any alcohol residue remains, repeat steps 3d-3f.
- 4 Mate all connectors to bulkheads and proceed to *Verifying Equipment Operation*.
- 5 It is also recommended that all connectors be visually inspected after cleaning to verify the connector is clean and undamaged.

Continued on next page

Cleaning Optical Connectors, Continued

Verifying Equipment Operation

Perform circuit turn-up. If the equipment does not come up, that is fails verification or indicates a reflection problem, clean the connectors and bulkheads again.

For Further Assistance

If you have any questions or concerns about cleaning fiber-optic connectors, contact Customer Service using the contact information provided in *Customer Support Information* (on page 5-1).

Chapter 5

Customer Support Information

Overview

This chapter contains information on obtaining product support.

In This Chapter

Topic	See Page
Obtaining Product Support	5-2

Obtaining Product Support

IF...	THEN...
you have general questions about this product	Contact your distributor or sales agent for product information or refer to product data sheets on www.cisco.com .
you have technical questions about this product	Call the nearest Technical Service center or Cisco office.
you have customer service questions or need a return material authorization (RMA) number	Call the nearest Customer Service center or Cisco office.

Support Telephone Numbers

Telephone Numbers

This table lists the Technical Support and Customer Service numbers for your area.

Region	Centers	Telephone and Fax Numbers
North America	Cisco Services Atlanta, Georgia United States	For <i>Technical Support</i> , call: Toll-free: 1-800-722-2009 Local: 678-277-1120 (Press 2 at the prompt) For <i>Customer Service</i> , call: Toll-free: 1-800-722-2009 Local: 678-277-1120 (Press 3 at the prompt) Fax: 770-236-5477 E-mail: customer-service@cisco.com
Europe, Middle East, Africa	Belgium	For <i>Technical Support</i> , call: Telephone: 32-56-445-197 or 32-56-445-155 Fax: 32-56-445-061 For <i>Customer Service</i> , call: Telephone: 32-56-445-444 Fax: 32-56-445-051 E-mail: service-elc@cisco.com
Japan	Japan	Telephone: 82-2-3429-8800 Fax: 82-2-3452-9748 E-mail: songk@cisco.com

Continued on next page

Obtaining Product Support, Continued

Korea	Korea	Telephone: 82-2-3429-8800 Fax: 82-2-3452-9748 E-mail: songk@cisco.com
China (mainland)	China	Telephone: 86-21-2401-4433 Fax: 86-21-2401-4455 E-mail: repaircentercn@external.cisco.com
All other Asia-Pacific countries & Australia	Hong Kong	Telephone: 852-2588-4746 Fax: 852-2588-3139 E-mail: support.apr@sciatl.com
Brazil	Brazil	Telephone: 11-55-08-9999 Fax: 11-55-08-9998 E-mail: fattinl@cisco.com or ecavalhe@cisco.com
Mexico, Central America, Caribbean	Mexico	For <i>Technical Support</i> , call: Telephone: 52-3515152599 Fax: 52-3515152599 For <i>Customer Service</i> , call: Telephone: 52-55-50-81-8425 Fax: 52-55-52-61-0893
All other Latin America countries	Argentina	For <i>Technical Support</i> , call: Telephone: 54-23-20-403340 ext 109 Fax: 54-23-20-403340 ext 103 For <i>Customer Service</i> , call: Telephone: 770-236-5662 Fax: 770-236-5888 E-mail: keillov@cisco.com

Chapter 6

Technical Information

Overview

This appendix contains forward and reverse equalizer typical insertion loss at various frequencies.

In This Appendix

Topic	See Page
Forward Linear Equalizer	6-2
Reverse Cable Equalizer	6-4
GainStar Mini Node Accessories Part Numbers	6-6

Forward Linear Equalizer

1 GHz Forward Linear Equalizer Loss Table

EQ Value (dB)	Part Number	Typical Insertion Loss (dB) at Various Frequencies (MHz)								
		54	77	86	550	600	650	750	870	1000
0	4034459	0.6	0.6	0.6	0.3	0.3	0.2	0.2	0.2	0.4
1		1.6	1.6	1.6	0.8	0.8	0.7	0.7	0.6	0.8
2		2.6	2.6	2.6	1.4	1.3	1.2	1.1	1.0	1.0
3		3.6	3.6	3.5	1.9	1.8	1.7	1.5	1.3	1.0
4		4.6	4.5	4.5	2.4	2.3	2.2	2.0	1.8	1.2
5	4034460	5.8	5.8	5.7	2.9	2.7	2.5	2.1	1.6	1.0
6		6.8	6.7	6.7	3.4	3.0	2.8	2.4	1.7	1.0
7		7.8	7.7	7.7	3.8	3.5	3.2	2.6	1.9	1.0
8		8.8	8.7	8.6	4.2	3.9	3.5	2.9	2.0	1.0
9		9.8	9.6	9.5	4.6	4.2	3.8	3.1	2.0	1.0
10	4034461	10.8	10.7	10.6	5.8	5.4	4.9	4.0	2.8	1.0
11		11.8	11.7	11.6	6.1	5.7	5.2	4.2	2.8	1.0
12		12.8	12.6	12.5	6.5	6.0	5.5	4.3	2.9	1.0
13		13.8	13.6	13.5	6.9	6.3	5.7	4.4	2.9	1.0
14		14.7	14.5	14.4	7.2	6.7	6.0	4.5	3.0	1.0

Continued on next page

Forward Linear Equalizer, Continued

862 MHz Forward Linear Equalizer Loss Table

EQ Value (dB)	Part Number	Typical Insertion Loss (dB) at Various Frequencies (MHz)							
		54	77	86	550	600	650	750	862
0	4034456	0.5	0.5	0.5	0.2	0.2	0.1	0.1	0.3
1		1.5	1.5	1.4	0.7	0.6	0.5	0.4	0.6
2		2.5	2.4	2.4	1.1	1.0	0.9	0.8	0.7
3		3.4	3.4	3.3	1.6	1.4	1.3	1.0	0.7
4		4.4	4.4	4.3	2.0	1.8	1.6	1.2	0.7
5	4034457	5.8	5.8	5.7	2.8	2.7	2.3	1.7	1.0
6		6.8	6.7	6.7	3.3	3.0	2.7	1.9	1.0
7		7.8	7.7	7.6	3.8	3.4	3.1	2.1	1.0
8		8.8	8.7	8.6	4.2	3.8	3.3	2.3	1.0
9		9.8	9.6	9.6	4.5	4.1	3.5	2.5	1.0
10	4034458	10.8	10.6	10.5	5.0	4.5	3.8	2.6	1.0
11		11.8	11.6	11.5	5.3	4.8	4.1	2.7	1.0
12		12.7	12.5	12.4	5.6	5.0	4.3	2.8	1.0
13		13.7	13.5	13.3	5.9	5.3	4.5	2.9	1.0
14		14.7	14.4	14.2	6.2	5.5	4.7	3.0	1.0

Reverse Cable Equalizer

42 MHz Reverse Cable Equalizer Loss Table

EQ Value (dB)	Part Number	Typical Insertion Loss (dB) at Various Frequencies (MHz)		
		5	40	42
0	4034465	0.7	0.5	0.5
1		1.7	0.6	0.6
2		2.6	0.7	0.7
3		3.6	0.8	0.7
4		4.5	0.9	0.8
5		5.5	1.0	0.9
6	4034466	6.7	1.0	1.0
7		7.6	1.0	1.0
8		8.6	1.1	1.0
9		9.5	1.2	1.0
10		10.4	1.2	1.0

Continued on next page

Reverse Cable Equalizer, Continued

65 MHz Reverse Cable Equalizer Loss Table

EQ Value (dB)	Part Number	Typical Insertion Loss (dB) at Various Frequencies (MHz)	
		5	65
0	4034462	0.8	0.6
1		1.8	0.7
2		2.8	0.8
3		3.8	0.9
4		4.8	1.0
5		5.7	1.0
6	4034463	6.7	0.6
7		7.7	0.6
8		8.6	0.6
9		9.6	0.6
10		10.6	0.7

GainStar Mini Node Accessories Part Numbers

The following table provides part numbers for the GainStar Mini Node accessories.

Attenuator Pad Value	Part Number
0 dB 1 GHz Plug-In Attenuator	4036021
1 dB 1 GHz Plug-In Attenuator	4036022
2 dB 1 GHz Plug-In Attenuator	4036023
3 dB 1 GHz Plug-In Attenuator	4036024
4 dB 1 GHz Plug-In Attenuator	4036025
5 dB 1 GHz Plug-In Attenuator	4036026
6 dB 1 GHz Plug-In Attenuator	4036027
7 dB 1 GHz Plug-In Attenuator	4036028
8 dB 1 GHz Plug-In Attenuator	4036029
9 dB 1 GHz Plug-In Attenuator	4036030
10 dB 1 GHz Plug-In Attenuator	4036031
11 dB 1 GHz Plug-In Attenuator	4036032
12 dB 1 GHz Plug-In Attenuator	4036033
13 dB 1 GHz Plug-In Attenuator	4036034
14 dB 1 GHz Plug-In Attenuator	4036035
15 dB 1 GHz Plug-In Attenuator	4036036
16 dB 1 GHz Plug-In Attenuator	4036037
17 dB 1 GHz Plug-In Attenuator	4036038
18 dB 1 GHz Plug-In Attenuator	4036039
19 dB 1 GHz Plug-In Attenuator	4036040
20 dB 1 GHz Plug-In Attenuator	4036041
Plug-In 75 Ω Terminator 3 - PIN	4036140
Power Shunt(black)	4034476
Power Shunt(red)	4034477
Signal Director	4034468
Test point probe	1010409



Cisco Systems, Inc.
5030 Sugarloaf Parkway, Box 465447
Lawrenceville, GA 30042

678 277-1120
800 722-2009
www.cisco.com

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