









1 GHz GainMaker Broadband
Amplifier Platform Reverse
Segmentable High Gain Balanced
Triple Node
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.

Notices

Trademark Acknowledgments

Cisco and the Cisco Logo are trademarks or registered trademarks of Cisco and/or its affiliates in the U.S. and other countries. A listing of Cisco's trademarks can be found at www.cisco.com/go/trademarks.

Third party trademarks mentioned are the property of their respective owners.

The use of the word partner does not imply a partnership relationship between Cisco and any other company. (1009R)

Publication Disclaimer

Cisco Systems, Inc. assumes no responsibility for errors or omissions that may appear in this publication. We reserve the right to change this publication at any time without notice. This document is not to be construed as conferring by implication, estoppel, or otherwise any license or right under any copyright or patent, whether or not the use of any information in this document employs an invention claimed in any existing or later issued patent.

Copyright

© 2013 Cisco and/or its affiliates. All rights reserved. Printed in the United States of America.

Information in this publication is subject to change without notice. No part of this publication may be reproduced or transmitted in any form, by photocopy, microfilm, xerography, or any other means, or incorporated into any information retrieval system, electronic or mechanical, for any purpose, without the express permission of Cisco Systems, Inc.

Contents

Important Safety Instructions	ix
--------------------------------------	-----------

Laser Safety	xvii
---------------------	-------------

Introduction	1
---------------------	----------

Description.....	3
Node Amplifier Module	3
Power Supply	4
Input and Output Ports.....	4
Node Amplifier Configuration	4
Test Points	4
AC Shunt Power Directors	4
Ordering Matrix	5
Accessories	7
Customer Installable Accessories	7
Miscellaneous Accessories.....	7
Illustrations	8
Amplifier Test Points.....	8
High Gain Balanced Triple Accessories.....	8
Reverse Segmentable HGBT Node Amplifier Module.....	8
Dual Redundant Receiver Module.....	9
Block Diagrams	10

Installation and Configuration	13
---------------------------------------	-----------

Before You Begin.....	14
Tools.....	14
Accessories.....	14
Torque Specifications	14
Weight Specifications	15
Housing Dimensions.....	15
Opening and Closing the Node Housing.....	17
To Open the Node Housing	17
To Close the Node Housing	17
Torquing Sequence	18
Module and Housing Compatibility	19
Housing Base.....	19
Connecting the Fiber Optic Service Cable to the Node	20
Warning: Radiation	20
Fiber Cable Handling	20
Fiber Connectors and Fiber Optic Service Cable.....	20

Contents

To Attach the Service Cable Connector	22
Attaching the Fiber Connectors	24
To Unstow the Fiber Management Tray.....	24
To Prepare the Fiber Connectors	24
To Attach the Fiber Connectors	25
To Stow the Fiber Management Tray.....	26
Attaching the Coaxial Connectors.....	27
To Trim the Center Conductor.....	27
To Connect the Coaxial Cable Pin Connector to the Node Housing.....	27
Mounting the Node	29
To Install the Node on a Strand (Aerial).....	29
To Install the Node in a Pedestal	30
Installing Accessories	31
To Install Attenuator Pads.....	31
To Install Equalizers	32
To Install the Crowbar Surge Protector	33
Installing the Amplifier Module	35
To Install the Amplifier Module	35
Removing and Installing AC Shunt Power Directors.....	37
To Remove and Insert AC Shunt Power Directors	37
Removing and Reinstalling the Optical Modules	39
To Remove or Reinstall the Optical Transmitter	39
To Remove or Reinstall the Optical Receiver.....	41
To Remove/Reinstall Dual Redundant Receiver	42
Installing and Removing the Status Monitor Transponder Module (Optional)	45
To Install the Status Monitor Transponder Module	45
To Remove the Status Monitor Transponder Module.....	46

Balancing and Setup 47

Preparing for Forward Path Balancing	48
Bode Network	48
To Verify the Input Signal Level.....	48
Balancing the Forward Path	51
To Determine the Output Tilt	51
To Set the Output Tilt.....	52
To Set the Output Level	52
Balancing the Reverse Path.....	53
About Reverse Path Balancing.....	53
Balancing and Alignment Procedures	54
To Prepare the Amplifier for Initial Reverse Path Balancing	58
To Calculate the Proper RF Signal Level	58
To Complete Reverse Path Balancing	59
Configuring the Reverse Path	61
Segmented Reverse Path.....	61
Combined Reverse Path with Transmitter Redundancy	62

Combined Reverse Path without Transmitter Redundancy..... 63
 To Reorient or Replace the RCM Plug-in 64
 To Replace the OIB Plug-in 64

Troubleshooting 67

Equipment..... 68
 No AC Power..... 69
 No AC Power Troubleshooting Table..... 70
 No DC Power..... 71
 No DC Power Troubleshooting Table..... 72
 Low RF Output..... 73
 Boot Color Table..... 74
 No Forward RF Signal..... 75
 No Forward RF Signal Troubleshooting Table..... 75
 Low or Degraded Forward RF Signal..... 76
 Low or Degraded Forward RF Signal Troubleshooting Table 76
 No Reverse RF Signal 77
 No Reverse RF Signal Troubleshooting Table 77
 Low or Degraded Reverse RF Signal 78
 Low or Degraded Reverse RF Signal Troubleshooting Table 78
 Troubleshooting Carrier-to-Noise Problems 80
 Miscellaneous Problems..... 81
 Cleaning Optical Connectors 83
 Recommended Equipment..... 83
 Tips for Optimal Fiber Optic Connector Performance 83
 To Clean Optical Connectors 83
 Fiber Optic Connector Cleaning Instructions 84

Appendix A Technical Information 87

“Linear” Tilt Charts 88
 Amplifier Output “Linear” Tilt Chart for 1 GHz 88
 Amplifier Output “Linear” Tilt Chart for 870 MHz 88
 Forward Equalizer Loss Charts 90
 1 GHz/870 MHz Forward Linear Equalizer Loss Chart..... 90
 1 GHz/870 MHz Forward Inverse Cable Equalizer Loss Chart 91
 GainMaker Node Accessory Part Numbers..... 92
 Attenuator Part Numbers 92
 1 GHz/870 MHz Forward Linear Equalizer Part Numbers 94
 1 GHz/870 MHz Forward Inverse Equalizer Part Numbers 94
 Plug-in Pad Part Numbers..... 96
 Configuration Plug-in Module Part Numbers..... 97
 Specifications 99
 Torque Specifications 99

Appendix B bdr Digital Reverse Multiplexing Applications 101

Digital Reverse System Overview	102
Features	102
System Functional Diagrams	103
System Block Diagram	104
2:1 bdr Transmitter Module	105
2:1 bdr Dual Receiver Module	108
Digital Reverse Transmitter Module Installation.....	110
Before You Begin.....	110
Operating Environment.....	110
To Install the Transmitter Module.....	110
Transmitter Module Setup Procedure	112
Reverse Balancing the Node with Digital Reverse Modules	113
Introduction.....	113
Method of Generating and Monitoring Test Signals	113
Reverse Balancing and Alignment Procedure	114
Troubleshooting.....	116
Equipment.....	116
Transmitter Module Troubleshooting Chart	116

Appendix C EDR Digital Return Multiplexing Applications 118

Enhanced Digital Return System Overview	119
Features	119
System Functional Diagrams	120
System Block Diagram	122
EDR Transmitter Module	124
EDR Receiver Module	129
Receiver Operating Modes	131
EDR OPM.....	135
Enhanced Digital Return (EDR) System Installation	136
Before You Begin.....	136
Operating Environment.....	136
To Install the Transmitter Module.....	137
Installing the EDR Receiver.....	142
Transmitter Module Setup Procedure	143
EDR Transmitter Status Indicators.....	144
Reverse Balancing the Node with the Enhanced Digital Return (EDR) Modules	145
Introduction.....	145
Method of Generating and Monitoring Test Signals	145
Reverse Balancing and Alignment Procedure	146
Troubleshooting.....	148
Equipment.....	148
Transmitter Module Troubleshooting Chart	148

Customer Support Information	153
Support Telephone Numbers.....	154
Glossary	155
Index	161

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 access 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.



WARNING:

To reduce risk of electric shock, perform only the instructions that are included in the operating instructions. 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 chassis covers and access any of the components inside the chassis.

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, Service Closet, Equipment Room or Underground Vault Installation



WARNING:

Avoid the 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).

- 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 may be 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.

Important Safety Instructions

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.

General Servicing Precautions



WARNING:

Avoid electric shock! Opening or removing this equipment's cover may expose you to dangerous voltages.



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 that 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.

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.

Batteries

This product may contain batteries. Special instructions apply regarding the safe use and disposal of batteries:

Safety

Important Safety Instructions

- Insert batteries correctly. There may be a risk of explosion if the batteries are incorrectly inserted.
- Do not attempt to recharge 'disposable' or 'non-reusable' batteries.
- Please follow instructions provided for charging 'rechargeable' batteries.
- Replace batteries with the same or equivalent type recommended by manufacturer.
- Do not expose batteries to temperatures above 100°C (212°F).

Disposal

- The batteries may contain substances that could be harmful to the environment
- Recycle or dispose of batteries in accordance with the battery manufacturer's instructions and local/national disposal and recycling regulations.



廢電池請回收

- The batteries may contain perchlorate, a known hazardous substance, so special handling and disposal of this product might be necessary. For more information about perchlorate and best management practices for perchlorate-containing substance, see www.dtsc.ca.gov/hazardouswaste/perchlorate.

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.

Electromagnetic Compatibility Regulatory Requirements

This equipment meets applicable electromagnetic compatibility (EMC) regulatory requirements. Refer to this equipment's data sheet for details about regulatory compliance approvals. EMC performance is dependent upon the use of correctly shielded cables of good quality for all external connections, except the power source,

when installing this equipment.

- Ensure compliance with cable/connector specifications and associated installation instructions where given elsewhere in this manual.

EMC Compliance Statements

Where this equipment is subject to USA FCC and/or Industry Canada rules, the following statements apply:

FCC Statement for Class A Equipment

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when this equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case users will be required to correct the interference at their own expense.

Industry Canada - Industrie Canadienne Statement

This apparatus complies with Canadian ICES-003.
Cet appareil est conforme à la norme NMB-003 du Canada.

GENELEC/CISPR Statement with Respect to Class A Information Technology Equipment

This is a Class A equipment. In a domestic environment this equipment may cause radio interference in which case the user may be required to take adequate measures.

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 such as eye loupes, magnifiers, or 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.

Safe Operation for Software Controlling Optical Transmission Equipment

If this manual discusses software, the software described is used to monitor and/or control ours and other vendors' electrical and optical equipment designed to transmit video, voice, or data signals. Certain safety precautions must be observed when

Laser Safety

operating equipment of this nature.

For equipment specific safety requirements, refer to the appropriate section of the equipment documentation.

For safe operation of this software, refer to the following warnings.



WARNING:

- **Ensure that all optical connections are complete or terminated before using this equipment to remotely control a laser device. An optical or laser device can pose a hazard to remotely located personnel when operated without their knowledge.**
- **Allow only personnel trained in laser safety to operate this software. Otherwise, injuries to personnel may occur.**
- **Restrict access of this software to authorized personnel only.**
- **Install this software in equipment that is located in a restricted access area.**



Maximum Laser Power

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

Warning Labels

One or more of the following labels are located on this product.



T12489



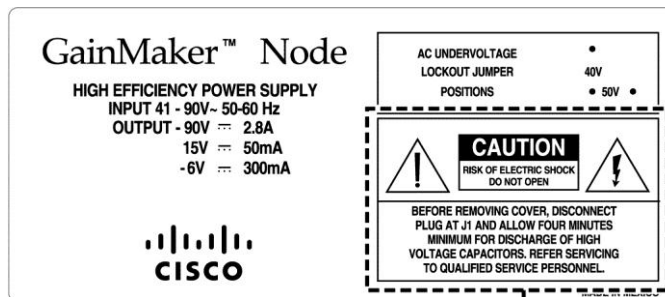
T13485



T13484



T9851



T14292

Electric Shock Warning

Location of Labels on Equipment

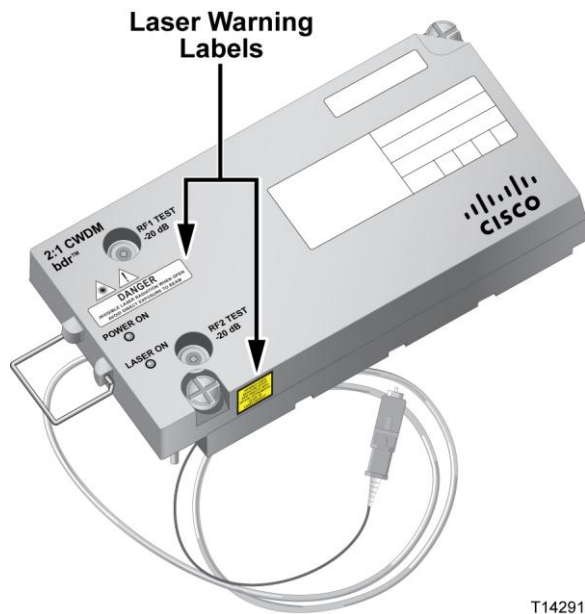
The following illustrations display the location of warning labels on this equipment.

Transmitter Examples



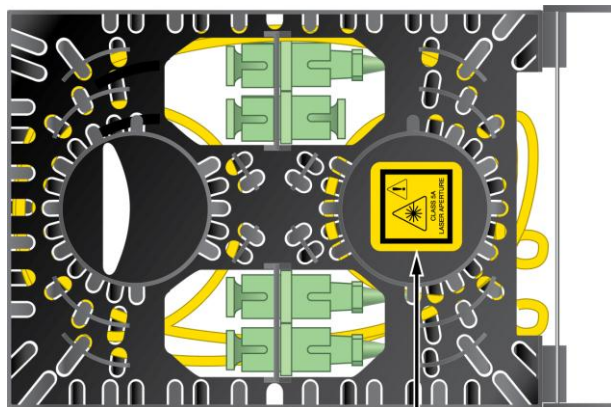
T14290

Laser Warning Label



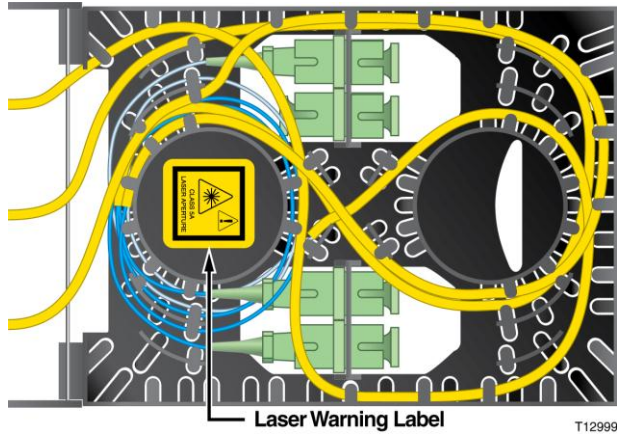
T14291

Node Fiber Tray Examples



Laser Warning Label

T12998



1

Introduction

Overview

This chapter introduces you to the Reverse Segmentable High Gain Balanced Triple (HGBT) GainMaker® Node and describes its main components, configuration options, and accessories.

Purpose

This guide provides instructions for installing, configuring, setting up, and troubleshooting of the Reverse Segmentable HGBT GainMaker 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



WARNING:

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 Reverse Segmentable HGBT GainMaker Node
- Procedures for strand (aerial) and pedestal installation
- Configuring the node amplifier and major modules
- Balancing the forward and reverse signal paths
- Troubleshooting the Reverse Segmentable HGBT GainMaker Node
- Descriptions of configuration options and accessories

Document Version

This is the fourth release of this guide (Rev D).

In This Chapter

- Description 3
- Accessories..... 7
- Illustrations..... 8

Description

The Reverse Segmentable HGBT GainMaker Node is available in the following forward bandwidths.

- 1 GHz

The Reverse Segmentable HGBT GainMaker Node is available with the following amplifier types.

- High Gain Balanced Triple (HGBT)
- High Gain High Output Balanced Triple (HO HGBT)

The Reverse Segmentable HGBT GainMaker Node is available in the following reverse/forward path splits.

- 40/52 MHz (Standard or High Output)
- 42/54 MHz (Standard or High Output)
- 55/70 MHz (Standard Output)
- 65/86 MHz (Standard Output)

Node Amplifier Module

The node amplifier module has the following characteristics.

- -20 dB test points, located electrically outside of the diplex filter, provide testing of forward output signals and reverse input signals without disrupting normal operation
- Upgradeable from the GainMaker amplifier
- Direct module plug into the housing provides superior amplifier heat sinking
- Symmetrical housing and modules provide convenient mounting
- AC circuitry provides 15 A of steady state current capability that is able to withstand 25 A of peak current (for a maximum of 2 hours)
- Surge-resistant circuitry provides improved resistance to high voltage transients
- Coated housing protects outdoor equipment in coastal areas and other corrosive environments
- Input and output reverse pad locations to increase flexibility in reverse path design and alignment

This node can also be set up to operate at 870 MHz by using 870 MHz equalizers. Refer to *Accessories* (on page 7).

Power Supply

The DC power supply has the following features.

- Located in housing lid for ease of maintenance
- AC and DC test points provided on both the power supply and the amplifier board
- Selectable AC undervoltage lockout feature
 - The 40 volt lockout is for 60/90 volt systems (factory default)
 - The 50 volt lockout position can be selected for operation in 90 volt systems (field configurable by moving a jumper)

Input and Output Ports

Input and output ports for the node are configured for the following amplifier type.

High Gain Balanced Triple

This amplifier has one optical input port and three RF output ports.

Node Amplifier Configuration

All node amplifier modules are configured with the following.

- Diplex Filters
- Reverse Amplifier
- Forward Interstage Equalizer (Linear)
- Forward Interstage and Output Attenuator Pads
- RF Interface Board

The reverse signal paths in the node can be configured to meet the needs of different applications. The node ships from the factory with a segmented reverse path configuration, but it can be upgraded in the field to a combined reverse path configuration with or without transmitter redundancy. For additional information, see *Configuring the Reverse Path* (on page 61).

Test Points

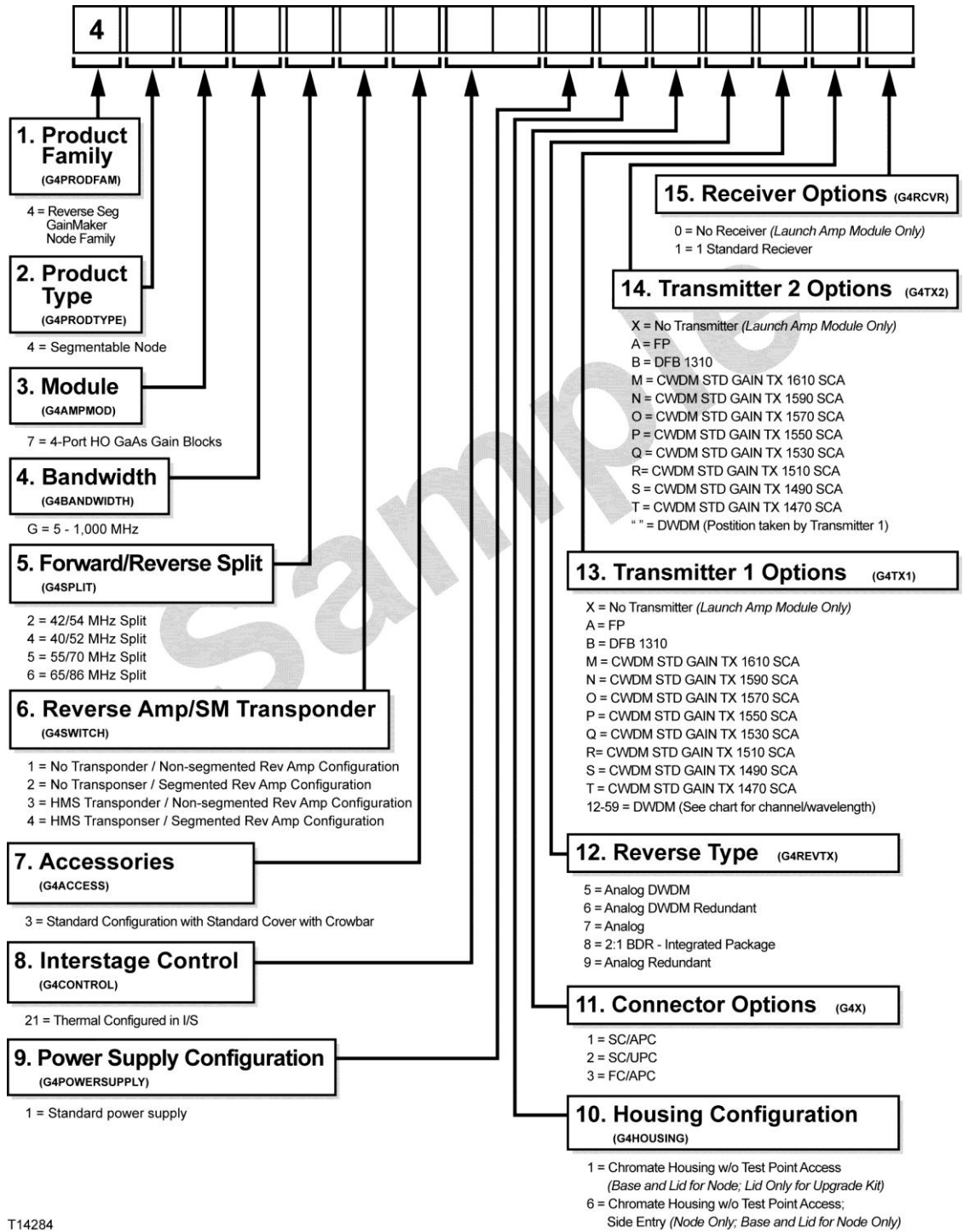
There are seven RF and four voltage test points on the node.

AC Shunt Power Directors

The node amplifier has four AC shunt power directors located near the ports of the amplifier. These are used to direct AC current to and from the amplifier input and output ports.

Ordering Matrix

The following matrix lists the node stations, amplifiers, and amplifier-to-node upgrade kits available. A node station consists of a configured amplifier with a complete housing, power supply, optical receiver and/or transmitter, and wiring harness. For ordering information, contact your customer service representative.



T14284

Accessories

The Reverse Segmentable HGBT GainMaker Node is equipped to work with the following customer installable and miscellaneous accessories.

Customer Installable Accessories

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

Note: All GainMaker Node accessories are unique to the GainMaker Broadband Amplifier product line.

Accessory	Part Number
Attenuator pads	589693 through 589734 0 dB through 20.5 dB in 0.5 dB increments
75 ohm terminator	589735 In Attenuator Pad Package
Forward Linear Equalizer Jumper	4007228
Forward Linear Equalizer 1 GHz/870 MHz	4008778 through 4008787 4019258 through 4019261 1.5 dB through 21 dB in 1.5 dB increments
Forward Inverse Equalizer 1 GHz	4007486 through 4007495 1.6 dB through 16.2 dB in 1.5 dB increments
System Trim Jumper	589285 (shipped with each node)

Miscellaneous Accessories

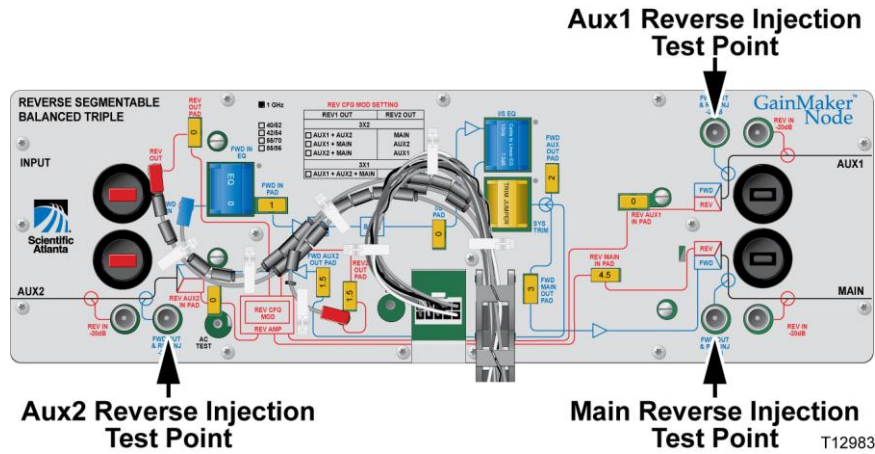
The following table lists the miscellaneous accessories used with all GainMaker Nodes along with their part numbers.

Accessory	Part Number
Surge protector	715973
Status monitoring transponder	744234
GainMaker amplifier upgrade kit	Refer to <i>Ordering Matrix</i> (on page 5).

Illustrations

Amplifier Test Points

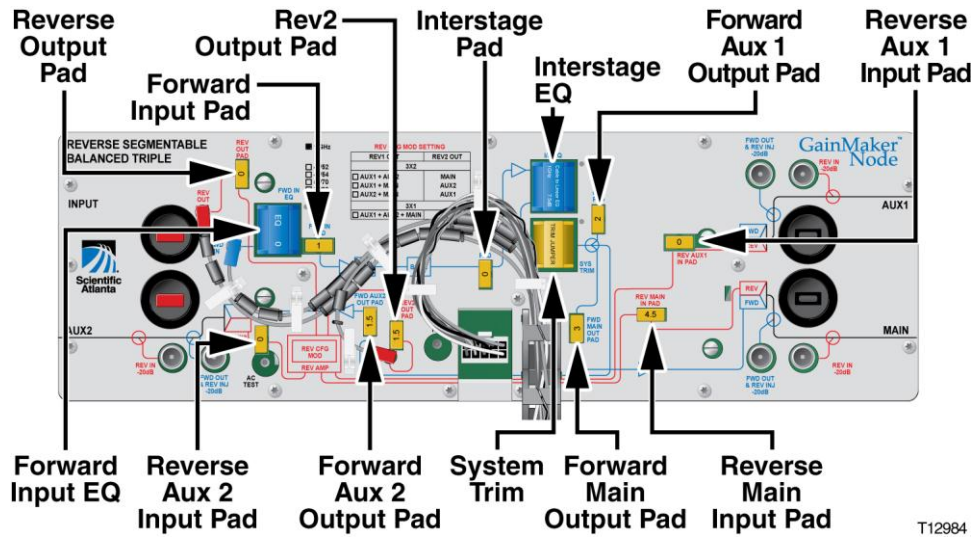
The following illustration shows the test points on the amplifier module.



Note: Test points shown are -20 dB, except for AC and DC test points.

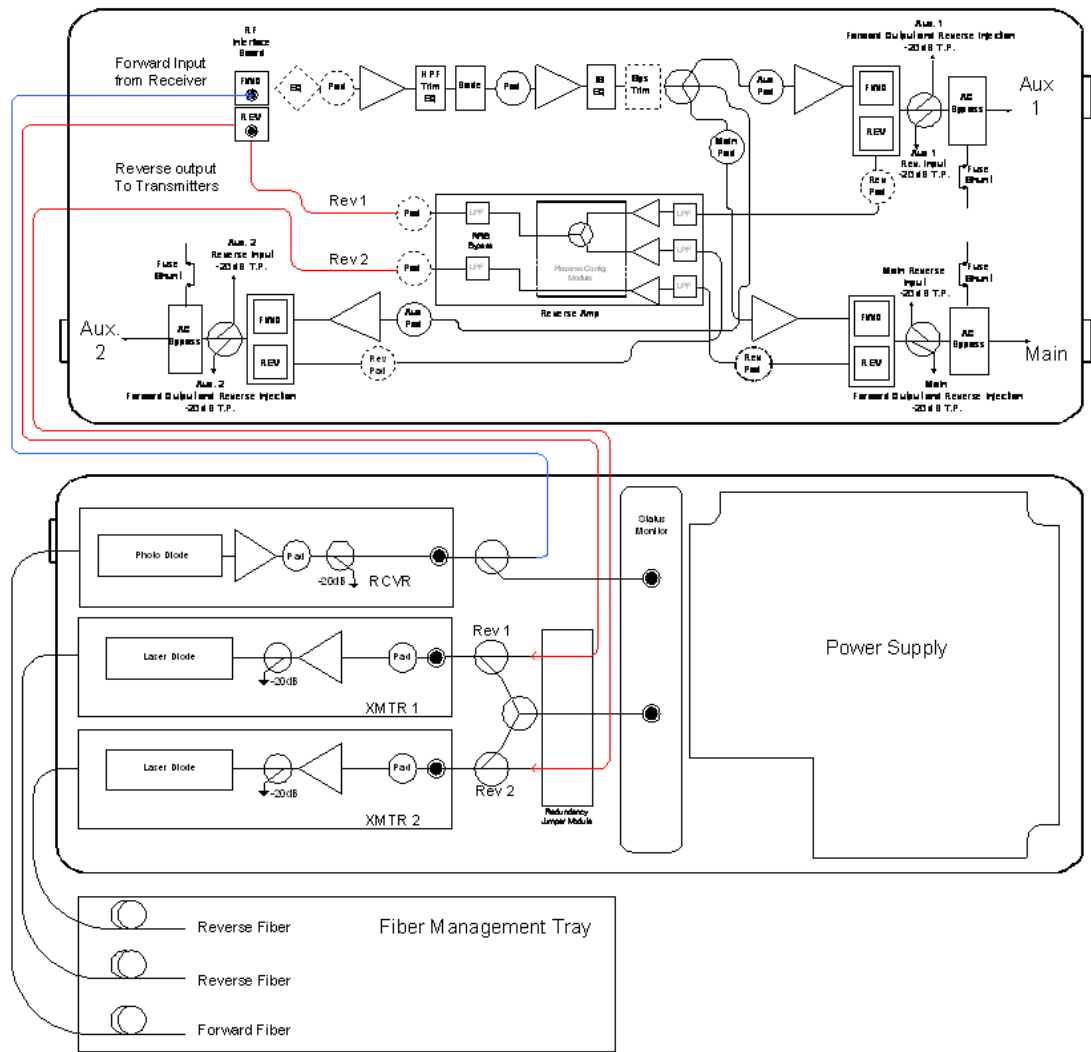
High Gain Balanced Triple Accessories

The following illustration shows the accessory locations of the High Gain Balanced Triple amplifier module.



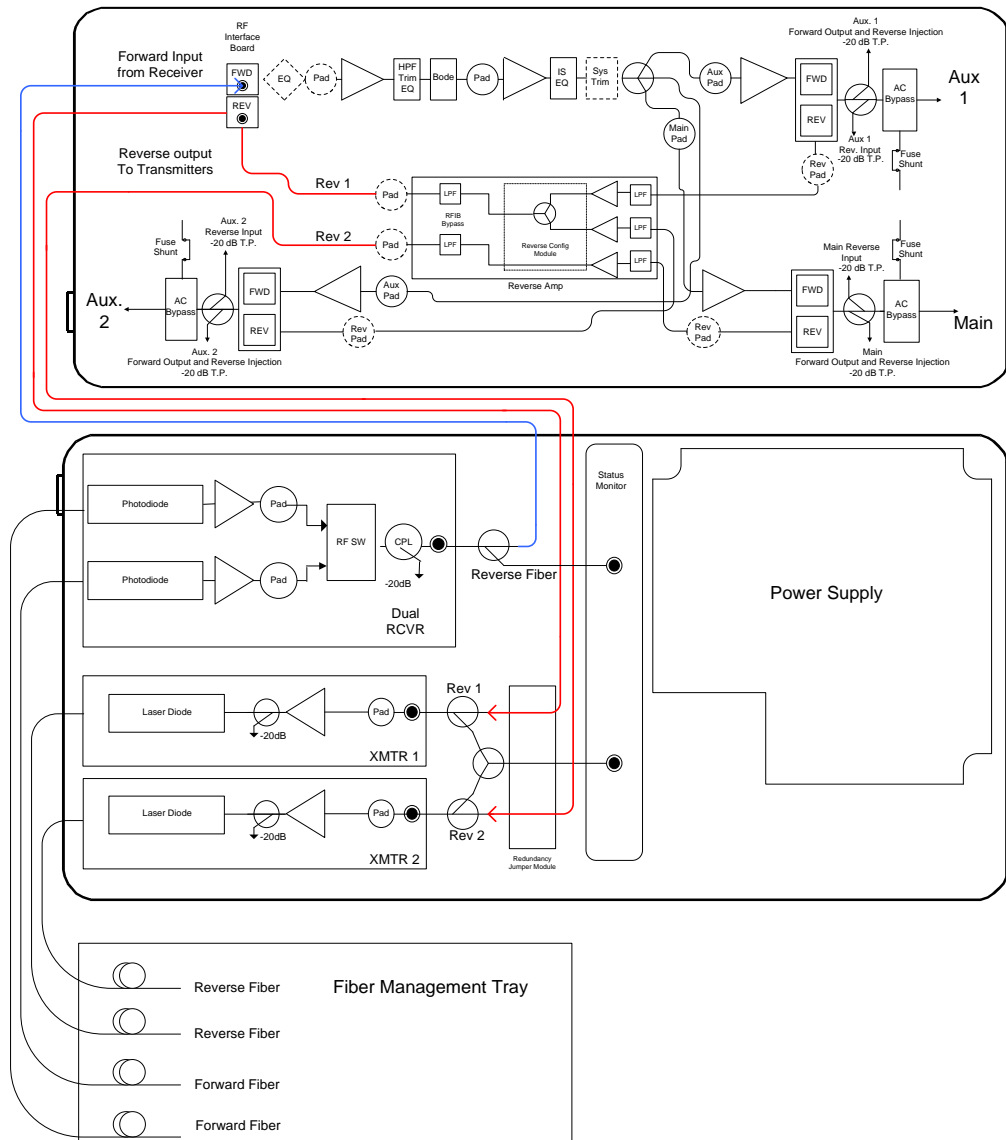
Reverse Segmentable HGBT Node Amplifier Module

The following illustration shows the Reverse Segmentable HGBT Node amplifier module.



Dual Redundant Receiver Module

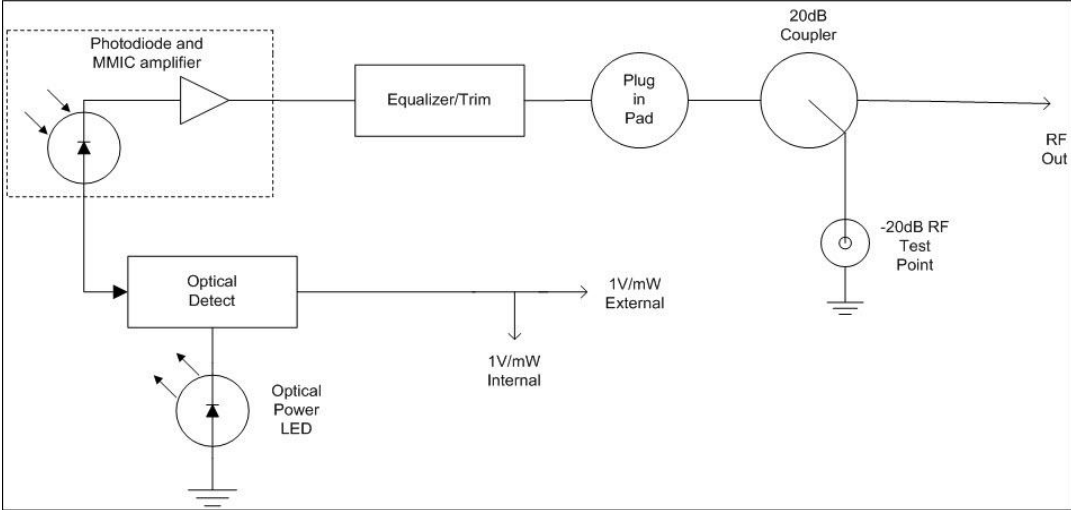
The following illustration shows the Dual Redundant Receiver module.



Block Diagrams

The following block diagrams show the single receiver and the dual redundant receiver.

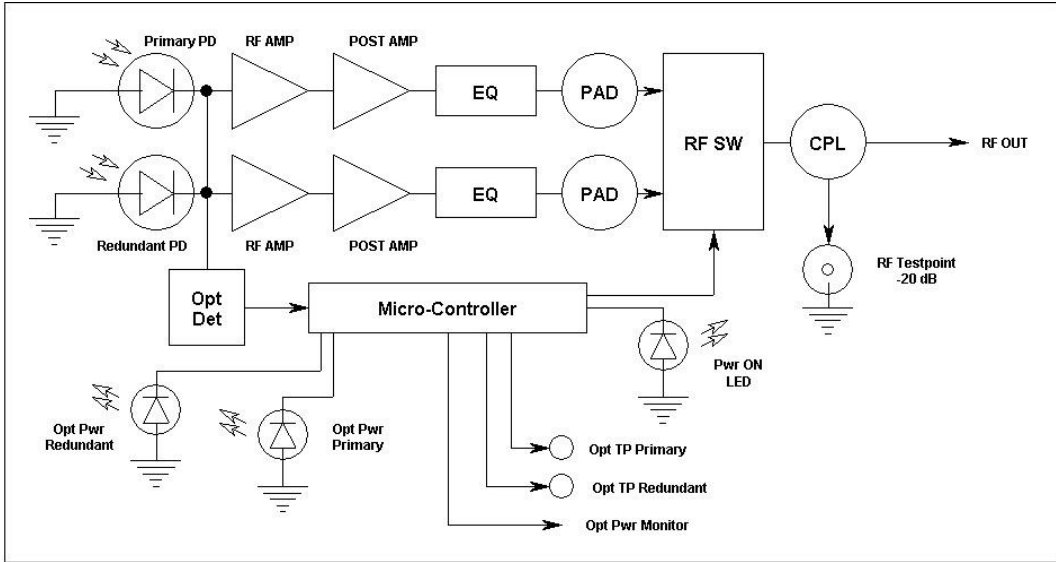
Single Receiver Block Diagram



Dual Redundant Receiver Block Diagram

Benefits

- Two photodiodes
- Two gain stages
- Equivalent to two receivers in one housing



2

Installation and Configuration

Introduction

This chapter provides instructions for installing and configuring the GainMaker Node in your cable system.

In This Chapter

■ Before You Begin	14
■ Opening and Closing the Node Housing.....	17
■ Module and Housing Compatibility.....	19
■ Connecting the Fiber Optic Service Cable to the Node.....	20
■ Attaching the Fiber Connectors.....	24
■ Attaching the Coaxial Connectors.....	27
■ Mounting the Node.....	29
■ Installing Accessories.....	31
■ Installing the Amplifier Module.....	35
■ Removing and Installing AC Shunt Power Directors.....	37
■ Removing and Reinstalling the Optical Modules	39
■ Installing and Removing the Status Monitor Transponder Module (Optional).....	45

Before You Begin

Before you start the installation procedure, make sure you have all the tools and accessories ready. You also need to know the torquing specifications for the GainMaker Node.

Tools

The following tools are needed to configure and install the node:

- Torque wrench with a 1/2-inch socket
- Hex driver or ratchet
- Flat-blade screwdriver
- Phillips-head screwdriver

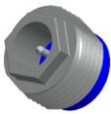



Accessories





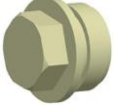



The following accessories may be necessary to configure and install the node:

- Heat shrink tubing (optional)
- Heavy-duty wire cutters or snips for cutting the cable
- A propane torch or electric heat gun applicator for heat shrink (if shrink tubing is used)
- A selection of attenuators (pads) with values ranging from 0 dBm to 20.5 dBm
- A selection of forward and reverse equalizers

Torque Specifications

The following table gives the torque specifications for the node.

Fastener	Torque Specification	Illustration
Seizure nut	2 ft-lb to 5 ft-lb (2.7 Nm to 6.8 Nm)	
Housing hinge screw	5 in-lb to 8 in-lb (0.56 Nm to 0.90 Nm)	
Power supply module securing screws	18 in-lb to 20 in-lb (2.0 Nm to 2.3 Nm)	
Strand clamp mounting bracket bolts	5 ft-lb to 8 ft-lb (6.8 Nm to 10.8 Nm)	

Fastener	Torque Specification	Illustration
Pedestal mounting bolts	8 ft-lb to 10 ft-lb (10.8 Nm to 13.6 Nm)	
75 ohm terminator	Per manufacturer instructions	(Appearance varies by manufacturer)
System amplifier module shoulder screws (slotted head)	6 in-lb to 9 in-lb (0.7 Nm to 1.0 Nm)	
System amplifier module shoulder screws (cross head)	18 in-lb to 20 in-lb (2.0 Nm to 2.3 Nm)	
Housing closure bolts	5 ft-lb to 12 ft-lb (6.8 Nm to 16.3 Nm)	
Housing plugs Test point port plugs	5 ft-lb to 8 ft-lb (6.8 Nm to 10.8 Nm)	
Module securing screws (Tx, Rx, PS, SM/LCM modules)	25 in-lb to 30 in-lb (2.8 Nm to 3.4 Nm)	
RF cable connector	Per manufacturer instructions	
Fiber optic cable connector	20 ft-lb to 25 ft-lb (27.1 Nm to 33.9 Nm)	

Weight Specifications

Before strand (aerial) mounting or pedestal mounting the node, follow the precautions below.



WARNING:

The node weighs approximately 23 lbs (10.4 kg). To avoid personal injury and damage to the equipment, perform the following:

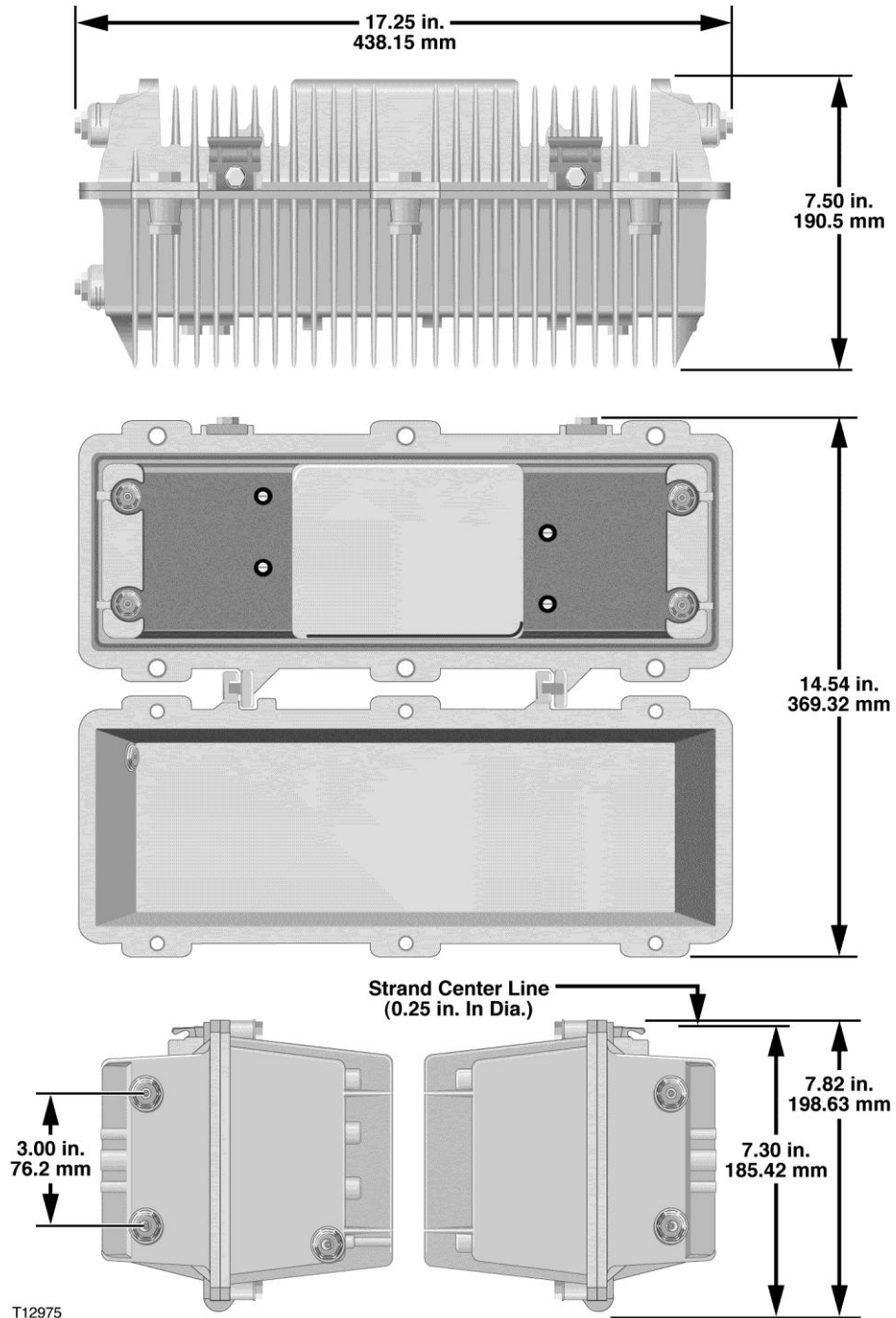
Ensure that the strand or pedestal can support the weight of the node.

Use safe handling and lifting practices in accordance with your organization's procedures.

Housing Dimensions

This illustration shows the dimensions, in inches and millimeters, of the node housing with a standard lid. Use these measurements to calculate clearance requirements for your installation.

Chapter 2 Installation and Configuration



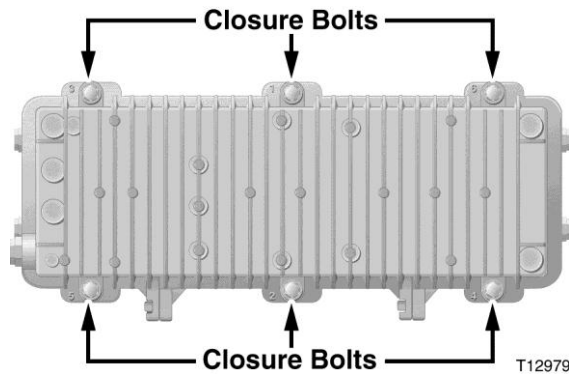
Opening and Closing the Node Housing

To Open the Node Housing

Complete the following steps to open the node housing.

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

- 1 Unscrew the ½-inch housing closure bolts on the housing lid until they are loose.



- 2 Open the housing.

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

To Close the Node Housing

Complete the following steps to close the node housing.

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

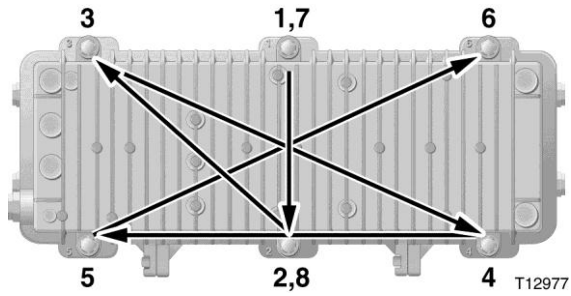
- 1 Make sure that the housing gaskets are clean and in the correct position. Wipe off any excess dirt and debris.
- 2 Close the housing.

CAUTION:
Ensure that all the cables are out of the way when closing 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 25 in-lb (2.8 Nm).
Important: Tighten the closure bolts in the correct sequence as specified in *Torquing Sequence* (on page 18).
- 5 Using the same pattern, tighten the housing closure bolts from 5 ft-lb to 12 ft-lb (6.8 Nm to 16.3 Nm).

Torquing Sequence

The following diagram shows the proper torquing sequence for closing the housing. Use the torque settings provided in *Torque Specifications* (on page 14).



Module and Housing Compatibility

Housing Base

The node is compatible with the GainMaker Amplifier housing base, System Amplifier III housing bases, and System Amplifier II or II+ housing bases.

Important: The GainMaker Node amplifier modules are marked with a blue label to indicate 15 ampere capability. The RF connectors in these modules are also blue. The amplifier module must be used in conjunction with a 15 ampere capable housing base, which is marked with a blue label.

Note: 15 ampere capable System Amplifier III housings with the blue label and System Amplifier II or II+ housings that have been upgraded to 15 ampere capability with an available seizure upgrade kit are compatible with GainMaker Node amplifier modules.

Connecting the Fiber Optic Service Cable to the 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 product emits invisible laser radiation. Avoid direct exposure to the laser light source.
-
- Do not apply power to this product if the fiber is unmated or unterminated.
 - Do not stare 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.

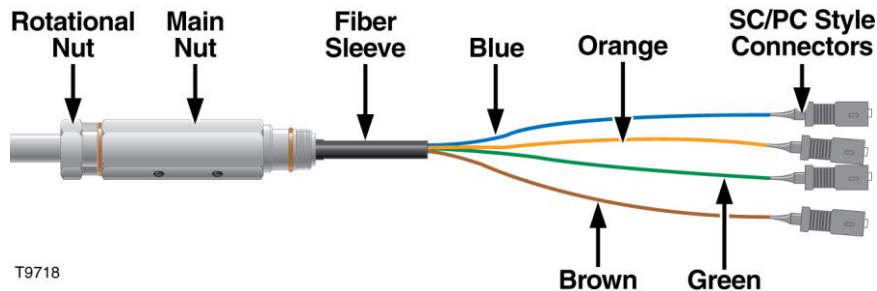
Fiber Cable Handling

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 and FC style connectors.

Fiber Connectors and Fiber Optic Service Cable

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



T9718

Note: To order additional service cables, refer to the following chart.

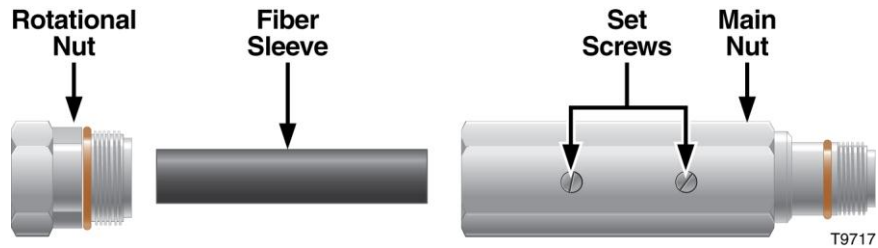
Connecting the Fiber Optic Service Cable to the Node

Model	Part Number
4-Channel Service Cable, 60-ft cable, SC/APC	739776
4-Channel Service Cable, 100-ft cable, SC/APC	739777
6-Channel Service Cable, 60-ft cable, SC/APC	739778
6-Channel Service Cable, 100-ft cable, SC/APC	739779
8-Channel Service Cable, 60-ft cable, SC/APC	739780
8-Channel Service Cable, 100-ft cable, SC/APC	739781
4-Channel Service Cable, 60-ft cable, SC/UPC	739782
4-Channel Service Cable, 100-ft cable, SC/UPC	739783
4-Channel Service Cable, 60-ft cable, FC/APC Narrow Key	739784
4-Channel Service Cable, 100-ft cable, FC/APC Narrow Key	739785

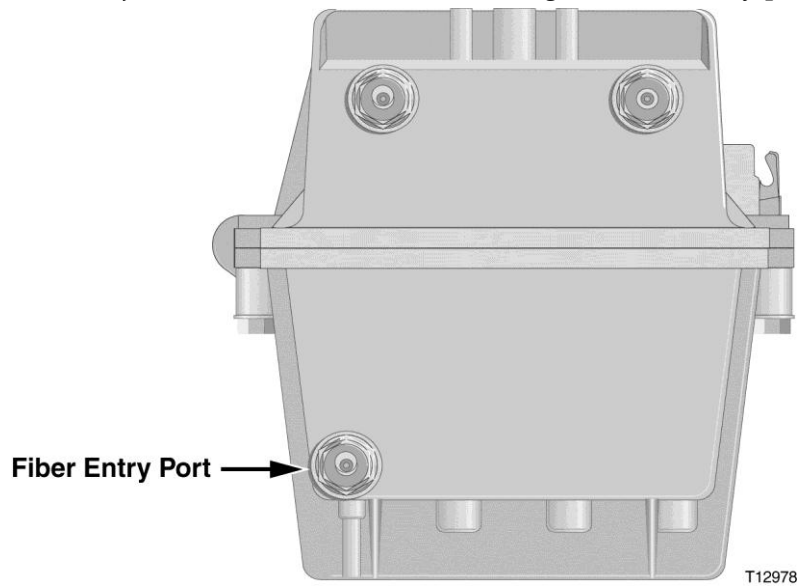
To Attach the Service Cable Connector

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

- 1 Unscrew the rotational nut from the main nut.

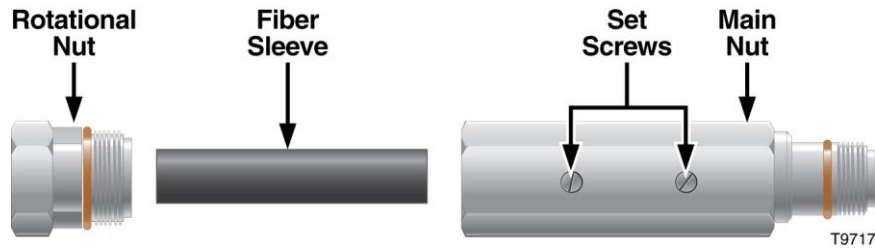


- 2 Slide the main nut forward to disengage the fiber protective sleeve.
- 3 Feed the jacketed fibers one at a time through the fiber entry port.



Connecting the Fiber Optic Service Cable to the Node

- 4 Screw the main nut into the fiber entry port and torque from 20 ft-lb to 25 ft-lb (27.1 Nm to 33.9 Nm).
- 5 Push the fiber sleeve back into the main nut.
- 6 Screw the rotational nut back onto the main nut and torque from 20 ft-lb to 25 ft-lb (27.1 Nm to 33.9 Nm).
- 7 Secure the setscrews on the main nut per recommended instructions supplied with the fiber optic service cable.



- 8 Use heat shrink to seal as required.
- 9 Proceed to *Attaching the Fiber Connectors* (on page 24).

Attaching the Fiber Connectors

Note: Before attaching the fiber connectors, make sure that the node housing is open. For instructions, refer to *To Open the Node Housing* (on page 17).

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

- Unstow the fiber management tray.
- Prepare the connectors for installation.
- Install the fiber connectors.
- Stow the fiber management tray.

The procedure provided below gives step-by-step instructions for each of these activities. For best results, follow this procedure exactly.



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.

To Unstow the Fiber Management Tray

Complete the following steps to unstow the fiber management tray.

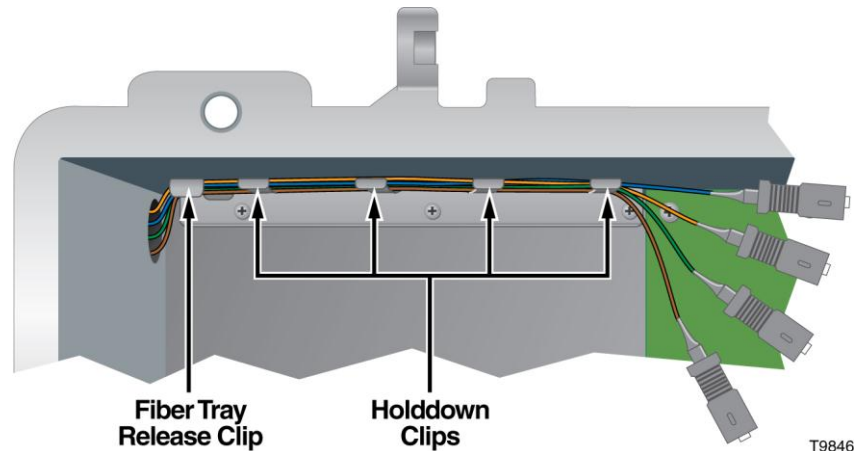
Important: Be careful not to damage the fibers.

- 1 Locate the fiber management tray stowed in the base of the node housing above the transmitter and receiver modules.
- 2 Using your index finger, pull up on the fiber tray's pull-tab lever to unlock the tray from its stowed position.
- 3 Rotate the tray upward roughly 90 degrees until it clicks into an unstowed position.

To Prepare the Fiber Connectors

Complete the following steps to prepare the fiber connectors.

- 1 Pull the fiber pigtails the rest of the way through the port into the housing.
Note: Be careful not to damage the connected fibers.
- 2 Route the fiber pigtails behind the fiber tray release clip and the four hold-down clips on the back of the housing as shown in the illustration.



To Attach the Fiber Connectors

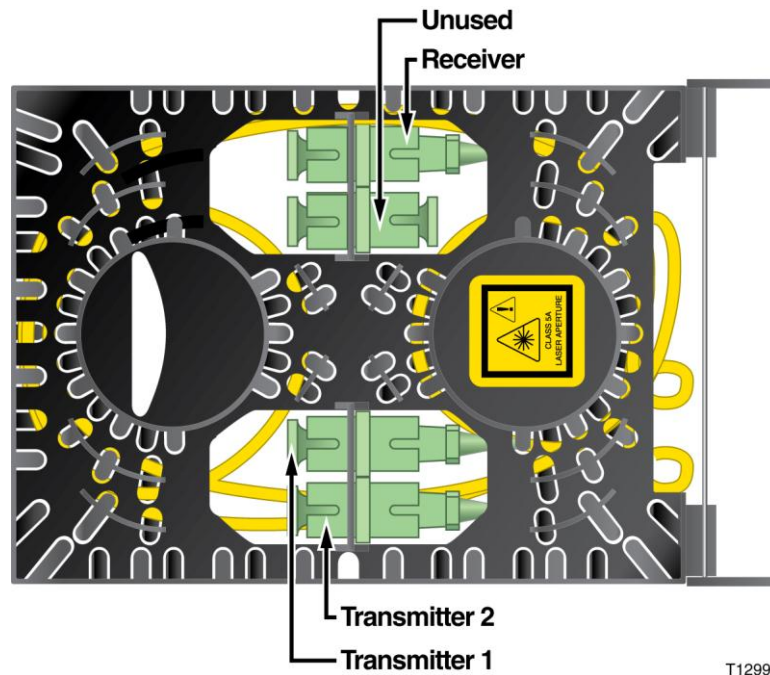
Complete the following steps to attach the fiber connectors.

- 1 Route the fiber pigtails through the rectangular slot at the right side of the fiber tray near the hinge.
- 2 Carefully route the pigtails through the fiber tray channels one at a time so that each fiber pigtail connector lines up with its corresponding connector in the fiber tray.

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 of the tray as possible.
 - Be careful not to use a tight fiber radius. The radius should be at least 1.5 in. (3.8 cm).
 - The fiber tray has three unstowed locking positions at 70, 90, and 110 degrees. Change positions as needed while working.
- 3 Adjust the fiber positions as needed. The pigtails must be adjacent to the connectors.
 - 4 Clean the tips of the fiber connectors. Refer to Cleaning Optical Connectors.
 - 5 Attach the fiber connectors as shown in the following illustration.



To Stow the Fiber Management Tray

Complete the following steps to stow the fiber management tray.

- 1 Using your index finger, push down on the fiber tray's pull-tab lever to release the tray from its unstowed position.
- 2 Continue pushing the tray downward to return it to its stowed position, ensuring that it locks behind the fiber tray release.
- 3 Close the node housing. Refer to *To Close the Node Housing* (on page 17).

Attaching the Coaxial Connectors

To Trim the Center Conductor

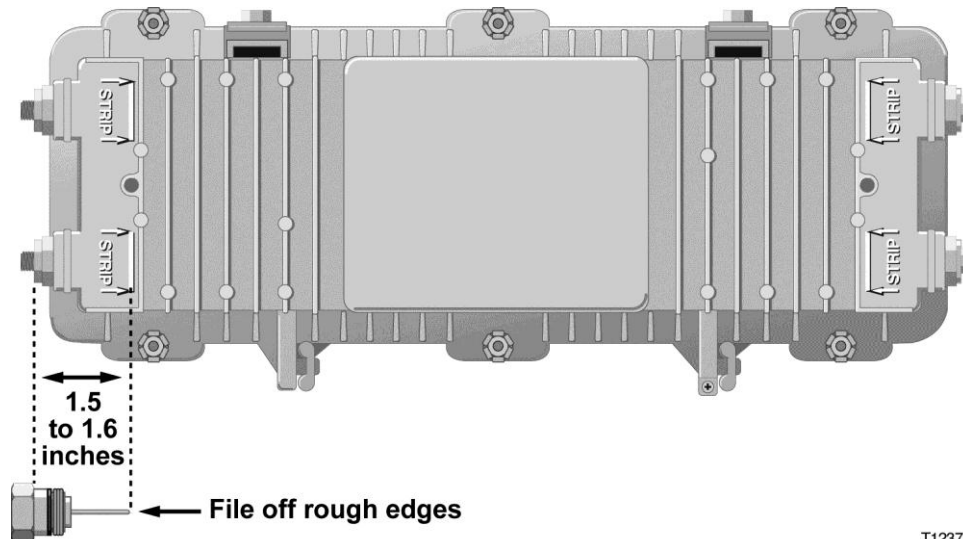
The GainMaker Node requires pin-type connectors for all RF connections.

Standard pin connectors, with pins extending 1.5 in. to 1.6 in. (3.8 cm to 4.1 cm) from the conshoulder, require no trimming. You must trim longer pins before inserting them into the housing.

Complete the following steps to trim long pins.

- 1 Place the connector above the entry port so that it lines up with its installed position.
- 2 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.



T12377

To Connect the Coaxial Cable Pin Connector to the Node Housing

Complete the following steps to connect the coaxial cable pin connector to the node housing.

- 1 Open the node housing. Refer to *To Open the Node Housing* (on page 17).
- 2 If the center conductor pin extends beyond the **STRIP** line on the housing, trim the pin with heavy-duty wire cutters.
- 3 Insert the appropriate coaxial connector into the housing at the desired housing port. Tighten the connector nut according to the manufacturer's specifications.
- 4 Tighten the seizure screw from 2 ft-lb to 5 ft-lb (2.7 Nm to 6.8 Nm).
- 5 Repeat steps 2 through 4 for each RF port used.
- 6 Check for the presence of RF at an unused port.

Chapter 2 Installation and Configuration

- If RF is present, insert a 75 Ohm housing terminator into the port and tighten according to manufacturer specifications.
- If RF is not present, insert a housing plug into the port and tighten from 5 ft-lb to 8 ft-lb (6.8 Nm to 10.8 Nm).

Mounting the Node

The following procedures detail how to install the GainMaker node housing on a strand (aerial) or in a pedestal.

To Install the Node on a Strand (Aerial)

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

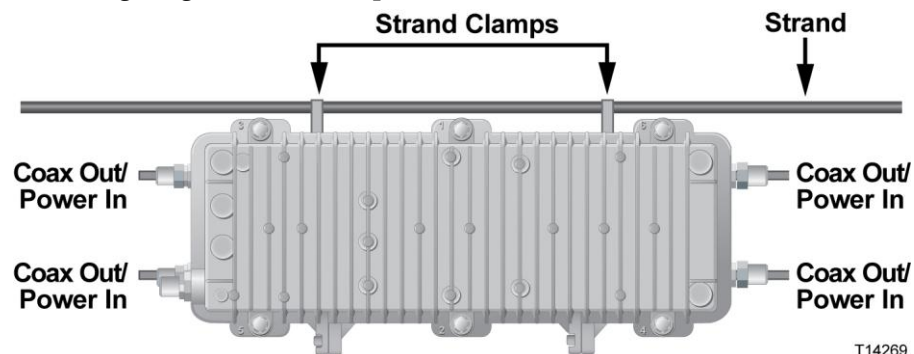
Important: The minimum strand diameter should be 5/16 inch.



CAUTION:

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

- 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 following diagrams for examples.



Note:

- **Power In** may be switched or combined with the **Coax Out** to maintain street access.
 - If supplying power to the node through the main input port, a power inserter must be installed to terminate the RF signal.
- 5 Tighten the strand clamp bolts (using a ½-inch torque wrench) from 5 ft-lb to 8 ft-lb (6.8 Nm to 10.8 Nm). Make sure there is good mechanical contact between the strand and the housing.

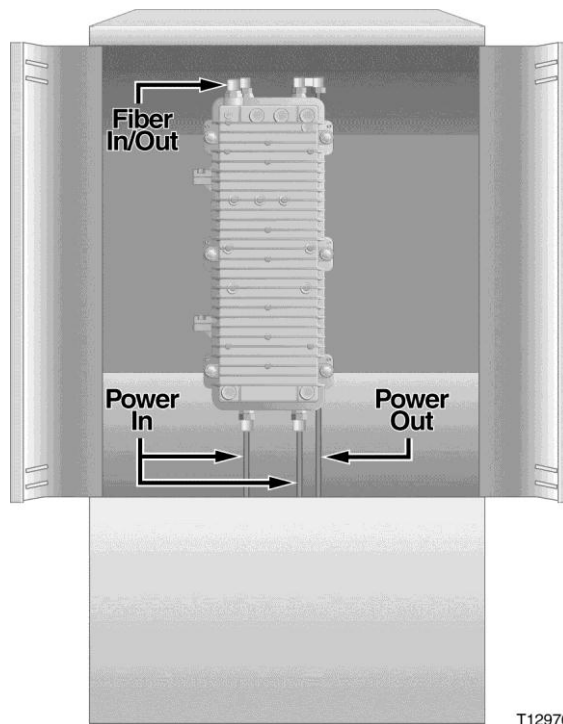
Note: A slight tilt of the face of the housing is normal. Cable tension will cause the housing to hang more closely to vertical.
 - 6 Connect the coaxial cable to the pin connector according to connector manufacturer specifications.

- 7 Proceed to *Installing Accessories* (on page 31).

To Install the Node in a Pedestal

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

- 1 Remove the cover of the pedestal.
- 2 Remove the self-tapping bolts from the strand clamps and set the bolts and strand clamps aside.
- 3 Position the housing in the pedestal frame as shown in the following illustration. Line up the self-tapping bolt holes on the bottom of the housing with the mounting holes on the bracket.



Note: The housing mounts to the bracket provided by the pedestal manufacturer.

- 4 Secure the housing to the bracket by using the bolts that you removed in step 2. Use the strand clamps as spacers if necessary. Torque the bolts from 8 ft-lb to 10 ft-lb (10.8 Nm to 13.6 Nm).
- 5 Connect the coaxial cable to the pin connector according to connector manufacturer specifications.
- 6 Proceed to *Installing Accessories* (on page 31).

Installing Accessories

The following section provides instructions for installing accessories into the Reverse Segmentable GainMaker Node amplifier module.

To Install Attenuator Pads

Note:

- For best results, follow this installation procedure exactly.
- Install all desired accessories into the amplifier module before installing the amplifier module into the housing.

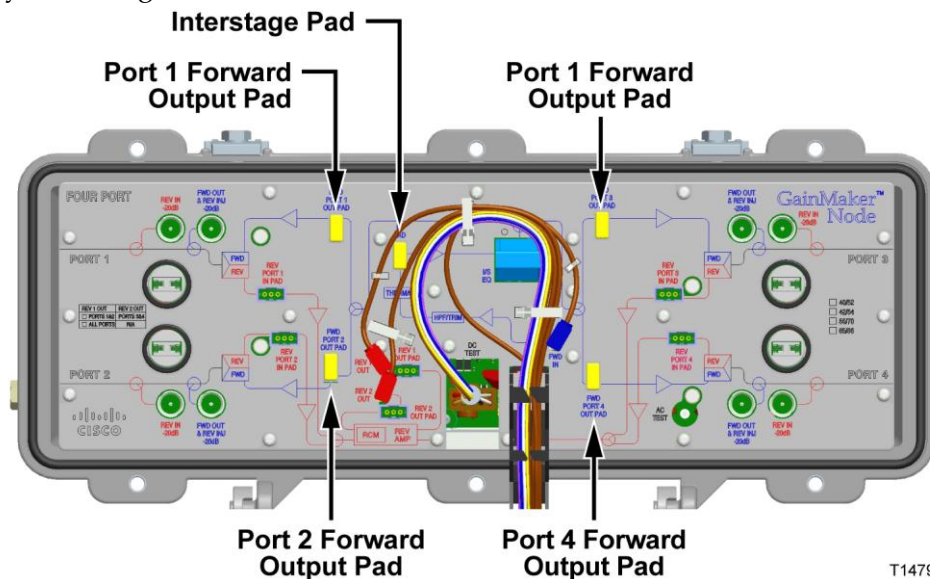
Complete the following steps to install the attenuator pads in the amplifier.

- 1 Begin this procedure with the housing open. Refer to *To Open the Node Housing* (on page 17).

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). For a list of available Node accessory pad values and part numbers, see *Technical Information* (on page 87).

Important: These pads should not be changed in the field, unless specified by the system design.



T14795

Note:

- Be sure all pins on the attenuator pad bottom align with the pinholes in the attenuator pad slot, allowing the attenuator pad to install flat against the amplifier module.
- Locations for attenuator pads are approximately the same for all GainMaker amplifiers.

- All forward output pads and the forward interstage pad are installed at the factory to set the operational gain of the station. Do not change these pads unless required by the system design.
- 3 Install other options or accessories as desired, or proceed to *Installing the Amplifier Module* (on page 35).

To Install Equalizers

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

Complete the following steps to install the equalizers in the amplifier.

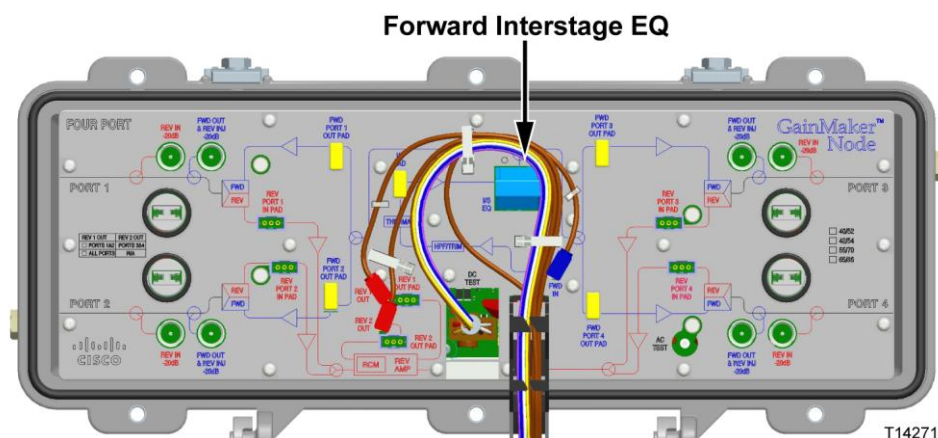
- 1 Begin this procedure with the housing open. Refer to *To Open the Node Housing* (on page 17).

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

- 2 Install the forward interstage equalizer specified by the design print in the forward interstage equalizer slot. Or, install the correct inverse equalizer specified by the design print for your system in the forward interstage equalizer slot. For a list of available GainMaker Node accessory pad values and part numbers, refer to *Technical Information* (on page 87).

Note:

- Be sure all the pins on the forward input equalizer or inverse equalizer bottom align with the pin holes in the equalizer slot, allowing the equalizer to install flat against the amplifier module.
- The same inverse equalizer is used for either 870 MHz or 1 GHz.
- The plug-in interstage equalizer produce the total internal tilt for the station. To optimize performance, the plug-in interstage equalizer value is different for each amplifier type.

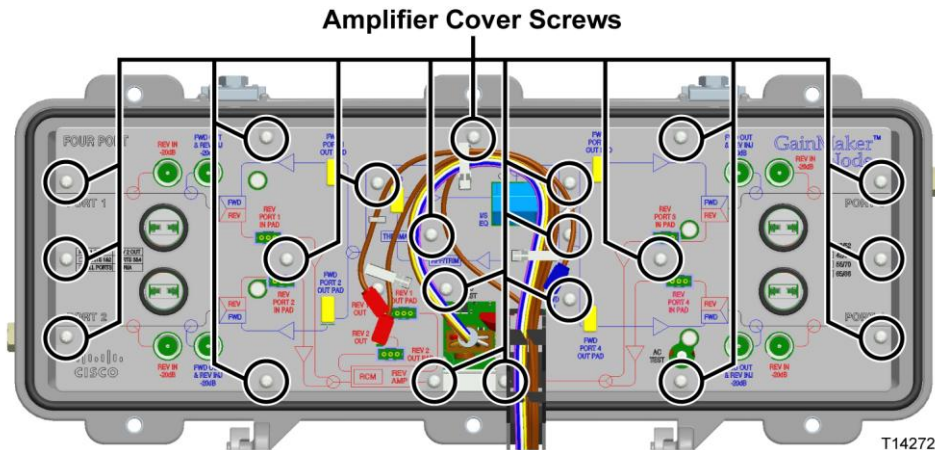


- 3 Install other options or accessories as desired, or proceed to *Installing the Amplifier Module* (on page 35).

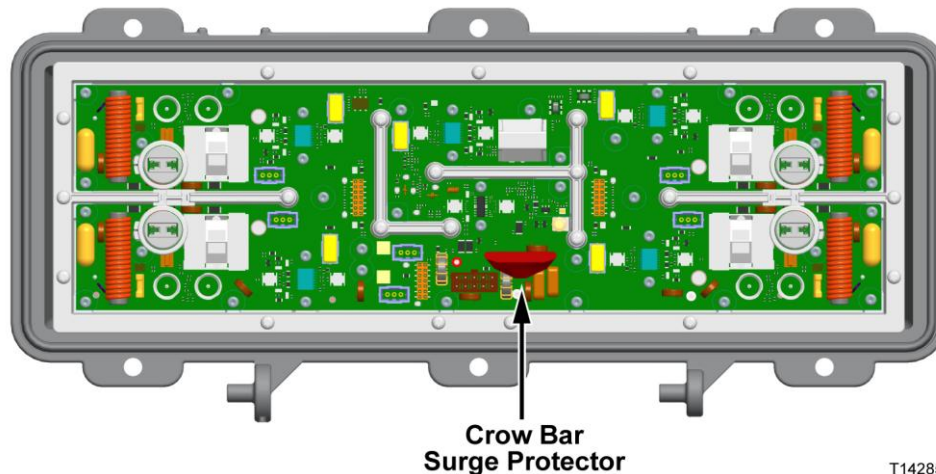
To Install the Crowbar Surge Protector

Complete the following steps to install the crowbar surge protector in the amplifier.

- 1 Open the node housing. Refer to *To Open the Node Housing* (on page 17).
- 2 Using a Torx T-15 bit screwdriver, remove the amplifier cover by loosening the amplifier cover screws.



- 3 Install the crowbar surge protector in the surge protector slot. Refer to the following illustration.



Note:

- Make sure that all the pins on the crowbar surge protector bottom align with the pin holes in the surge protector slot, allowing the surge protector to install flat against the amplifier module.
 - Make sure that the components face the outside of the station (see the preceding diagram for proper positioning). Heat shrink tubing has been added to prevent shorting.
- 4 Secure the cover to the amplifier module and tighten the amplifier cover screws. Tighten slotted head screws to 6 in-lb to 9 in-lb (0.7 Nm to 1.0 Nm), or cross head screws from 18 in-lb to 20 in-lb (2.0 Nm to 2.25 Nm).

Chapter 2 Installation and Configuration

Important: The cover should lie completely flat on the amplifier chassis. Make sure none of the amplifier accessories prevent the cover from lying flat.

- 5 Install other options or accessories as desired, or proceed to *Installing the Amplifier Module* (on page 35).

Installing the Amplifier Module

The amplifier module plugs into the strand-mounted or pedestal-mounted bottom of the housing via RF connectors on the bottom side of the module.

To Install the Amplifier Module

Complete the following steps to install the amplifier module.

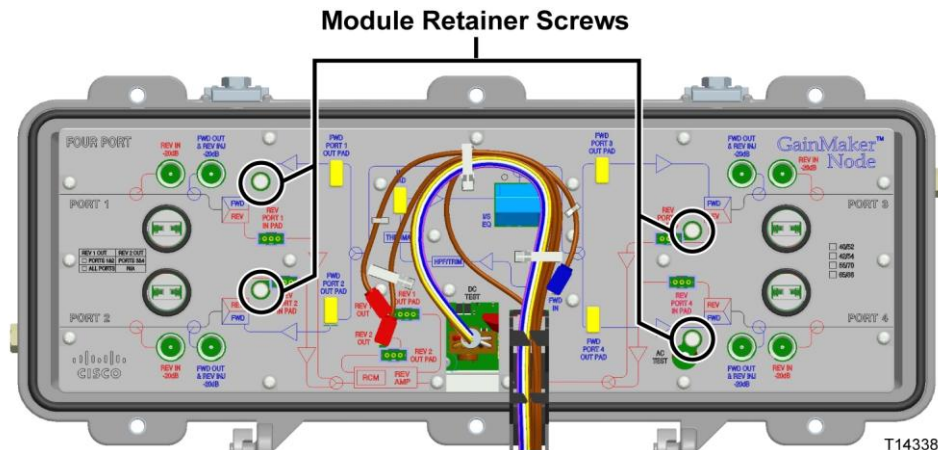
- 1 Perform the following if you are working with an amplifier station where AC is present.



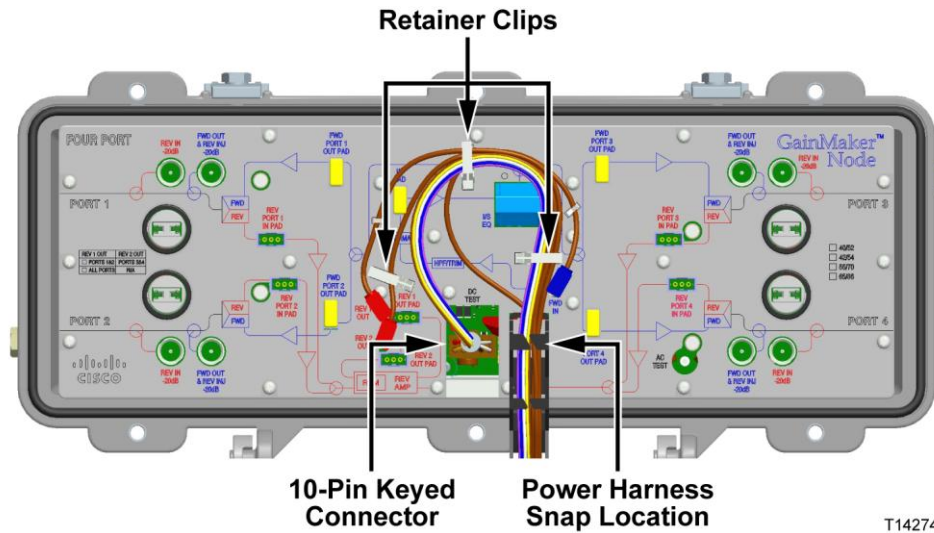
CAUTION:

Failure to follow these instructions may cause damage to module RF connectors and housing seizure assemblies.

- Install the AC shunt power directors in the amplifier *after* you install the amplifier module in the housing.
 - Remove the AC shunt power directors from the amplifier *before* you remove the amplifier module from the housing.
- 2 Line up the RF connectors on the amplifier module and the housing, and then push the amplifier module into the housing.
 - 3 Secure the amplifier module to the housing by tightening the four system amplifier module retainer screws. Tighten slotted head screws to 6 in-lb to 9 in-lb (0.7 Nm to 1.0 Nm), or cross head screws to 18 in-lb to 20 in-lb (2.0 Nm to 2.25 Nm). See the following illustration for the location of the retainer screws.



- 4 Snap the power cable harness into the holes in the amplifier module cover. See the following illustration for power cable harness snap location.
- 5 Route the excess power cable between the end of the molded power harness and the 10-pin keyed connector into the white plastic retainer clips on the module cover.



T14274

- 6 Attach the 10-pin keyed connector of the power cable and harness to the amplifier module.
 - The 10-pin keyed connector can be connected one way only. Be sure the connector installs securely to the amplifier module.
 - Make sure that the power harness locking tabs are fully seated under the amplifier cover.
- 7 Proceed to *Removing and Installing AC Shunt Power Directors* (on page 37).

Removing and Installing AC Shunt Power Directors

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



WARNING:

When AC is applied from RF ports to units downstream, the downstream equipment shall also be located in a restricted access location (access restricted to service personnel).

Power can come from the input or output ports, and each amplifier 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 amplifier.

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

Note: A red AC shunt power director is included with the unit. The red shunt is used to activate the port that supplies power. The red shunt should be removed before installing or removing the amplifier module from the housing.



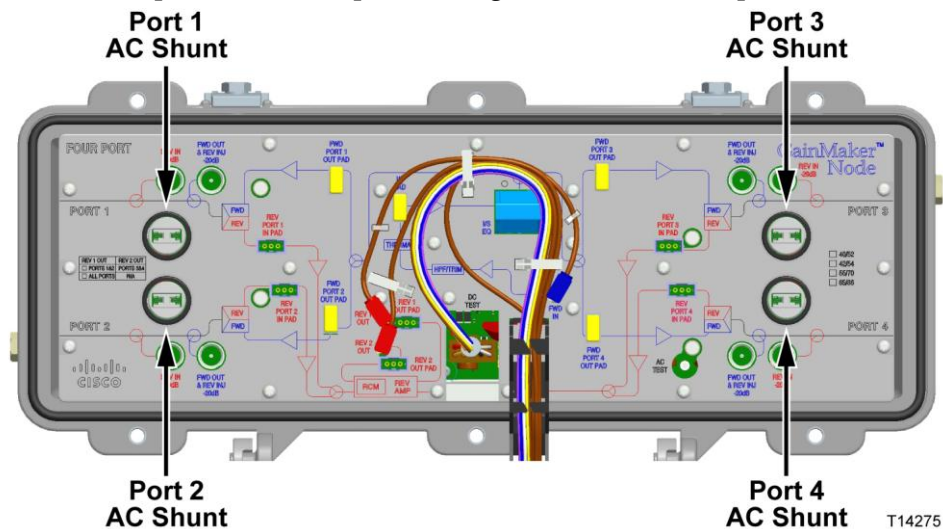
CAUTION:

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

To Remove and Insert AC Shunt Power Directors

Complete the following steps to remove and insert AC shunt power directors.

- 1 Open the node housing. Refer to *To Open the Node Housing* (on page 17).
- 2 To remove a power director, pull it straight out from the amplifier module.



Chapter 2 Installation and Configuration

- 3 To insert a power director, refer to the systems design print to determine AC power routing and install the AC shunt power directors in the required locations.
Note: If supplying power to the node through the main input port, a power inserter must be installed to terminate the RF signal.
- 4 Close the node housing. Refer to *To Close the Node Housing* (on page 17).

Removing and Reinstalling the Optical Modules

The following optical components can be removed and reinstalled from the node optical section. The node may contain one optical transmitter and up to two optical receivers.

To Remove or Reinstall the Optical Transmitter

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

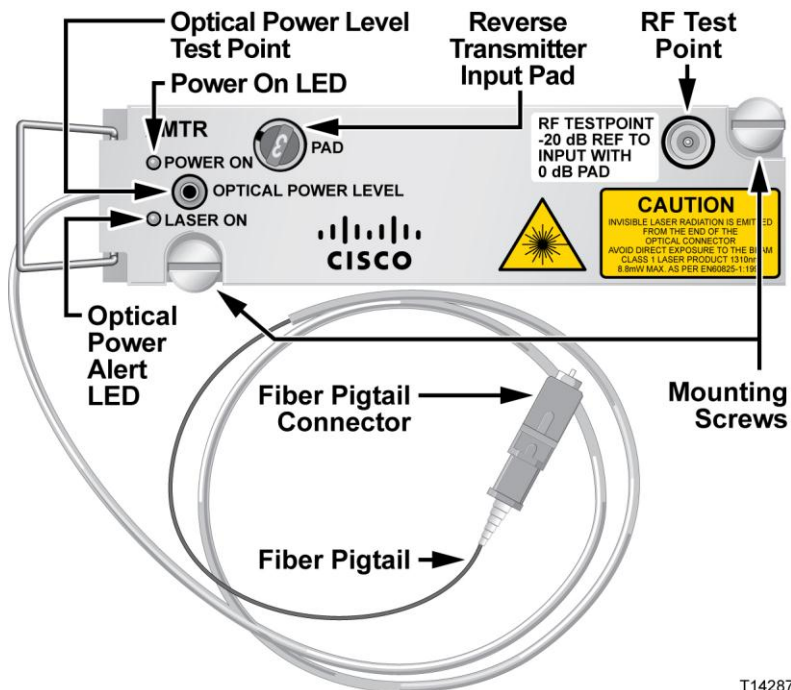


WARNING:

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.

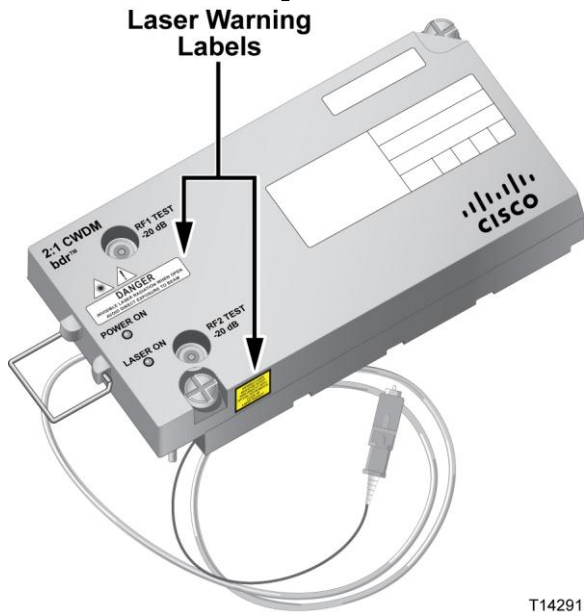
- 1 Open the node housing. Refer to *To Open the Node Housing* (on page 17).
- 2 Remove the AC shunt power directors.
- 3 Rotate the fiber management tray out of its stored position. Refer to *To Unstow the Fiber Management Tray* (on page 24).
Note: Using your index finger, pull up on the fiber tray pull-tab lever and rotate the fiber management tray to partially expose the optical modules below.
- 4 Disconnect the fiber connector from the fiber bulkhead in the fiber management tray.
- 5 Route the fiber pigtail through the fiber access slot.
- 6 Using a flat-blade screwdriver, loosen the two mounting screws to remove the optical transmitter.

GainMaker Optical Transmitter Module



T14287

GainMaker bdr 2:1 Optical Transmitter Module



T14291

- 7 Pull the transmitter out from the optical section.
 - 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 8.
- 8 Insert the transmitter in the appropriate slot and ensure that the transmitter is seated properly.

Note: Insertion slot is labeled on the optical interface board.
- 9 Use a flat-blade screwdriver to tighten the two mounting screws.
- 10 Route the fiber pigtail through the fiber access slot.

Note: Route excess fiber loosely through the fiber hold-down clip.



CAUTION:

Be careful not to damage the fiber or pigtails.

- 11 Reconnect the fiber connector to the fiber bulkhead adapter.
- 12 Rotate the fiber management tray to its stored position. Refer to *To Stow the Fiber Management Tray* (on page 26).
- 13 Insert the AC shunt power directors.

Note: If supplying power to the node through the main input port, a power inserter must be installed to terminate the RF signal.
- 14 Locate the proper fiber connector and connect to the fiber bulkhead adapter.
- 15 Close the node housing. Refer to *To Close the Node Housing* (on page 17).

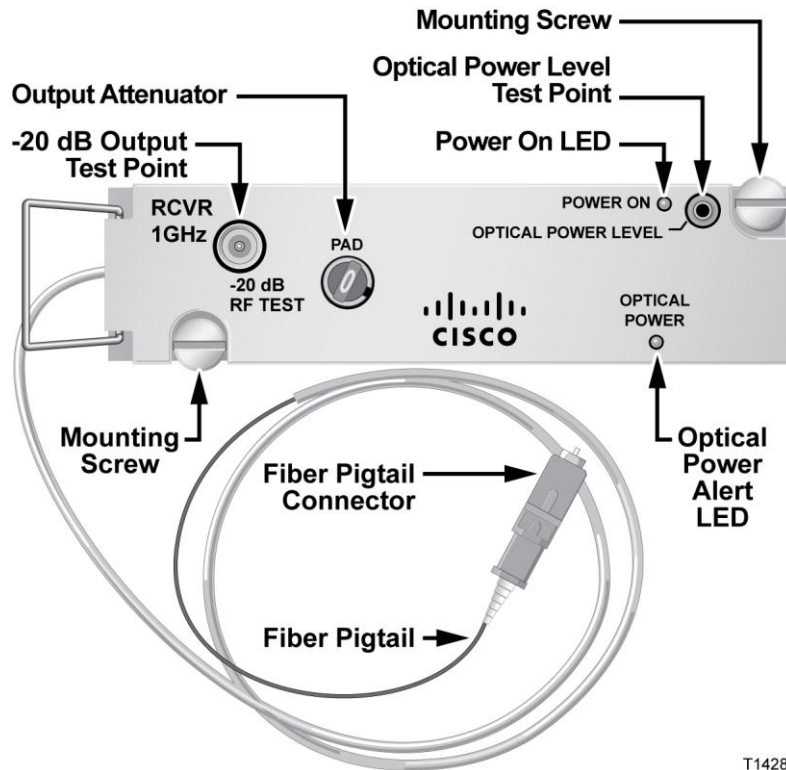
To Remove or Reinstall the Optical Receiver

Important: While performing this procedure, be sure to observe the precautions for handling an optical receiver.

Complete the following steps to remove or reinstall the single receiver from the optical section.

- 1 Open the node housing. Refer to *To Open the Node Housing* (on page 17).
- 2 Remove the AC shunt power directors.
- 3 Rotate the fiber management tray out of its stored position. Refer to *To Unstow the Fiber Management Tray* (on page 24).

Note: Using your index finger, pull up on the fiber tray pull-tab lever and rotate the fiber management tray to partially expose the optical modules.
- 4 Loosen the fiber connector in the fiber management tray.
- 5 Using a flat-blade screwdriver, loosen the two mounting screws.



T14283

- 6 Pull the receiver out from the optical section.
 - a If you are not reinstalling the receiver at this time, proceed to step 10.
 - b If you are reinstalling the receiver now, proceed to step 7.
- 7 Insert the receiver in the appropriate slot and ensure that the receiver is seated properly.

Note: Insertion slot is labeled on the optical interface board.
- 8 Use a flat-blade screwdriver to tighten the two mounting screws.
- 9 Route the fiber pigtail through the fiber access slot.

Note: Route excess fiber loosely through the fiber hold-down clips.



CAUTION:

Be careful not to damage the fiber or pigtails.

- 10 Locate the proper fiber connector and connect to the fiber bulkhead adapter.
- 11 Rotate the fiber management tray to its stored position. Refer to *To Stow the Fiber Management Tray* (on page 26).
- 12 Insert the AC power shunt directors.

Note: If supplying power to the node through the main input port, a power inserter must be installed to terminate the RF signal.
- 13 Close the node housing. Refer to *To Close the Node Housing* (on page 17).

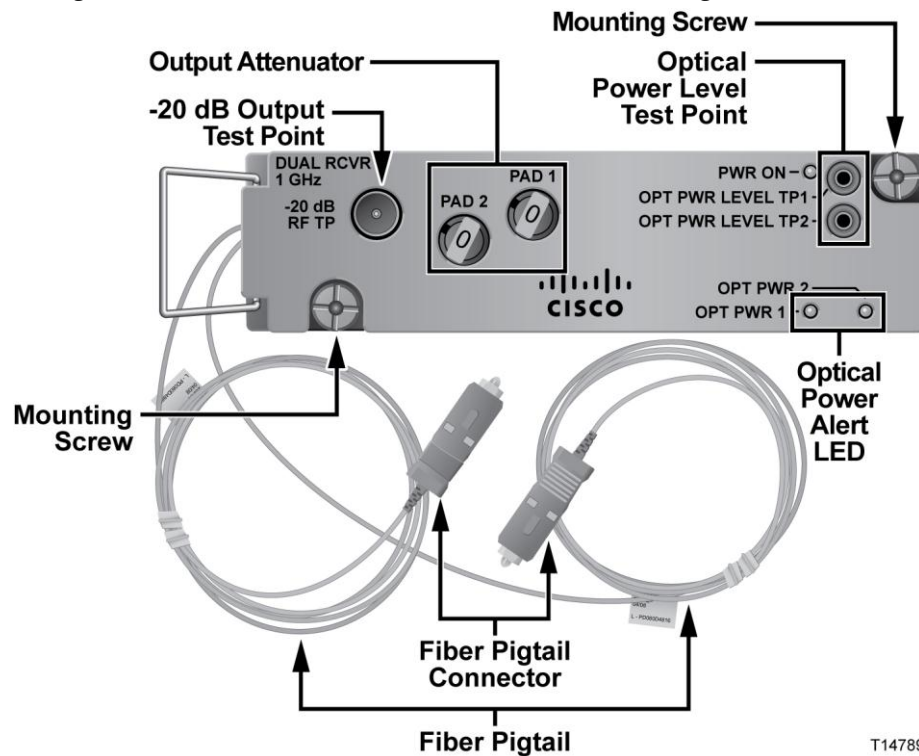
To Remove/Reinstall Dual Redundant Receiver

Important: While performing this procedure, be sure to observe the precautions for handling an optical receiver.

Removing and Reinstalling the Optical Modules

Complete the following steps to remove or reinstall the dual redundant receiver from the optical section.

- 1 Open the node housing. Refer to *To Open the Node Housing* (on page 17).
- 2 Remove the AC shunt power directors.
- 3 Rotate the fiber management tray out of its stored position. Refer to *To Unstow the Fiber Management Tray* (on page 24).
Note: Using your index finger, pull up on the fiber tray pull-tab lever and rotate the fiber management tray to partially expose the optical modules.
- 4 Loosen the fiber connectors in the fiber management tray.
- 5 Using a flat-blade screwdriver, loosen the two mounting screws.



T14789

- 6 Pull the receiver out from the optical section.
 - a If you are not reinstalling the receiver at this time, proceed to step 10.
 - b If you are reinstalling the receiver now, proceed to step 7.
- 7 Insert the receiver in the appropriate slot and ensure that the receiver is seated properly.
Note: Insertion slot is labeled on the optical interface board.
- 8 Use a flat-blade screwdriver to tighten the two mounting screws.
- 9 Route both fiber pigtails through the fiber access slot.
Note: Route excess fiber loosely through the fiber hold-down clips.



CAUTION:

Be careful not to damage the fiber or pigtails.

- 10 Locate the proper fiber connectors and connect to the fiber bulkhead adapter.

Chapter 2 Installation and Configuration

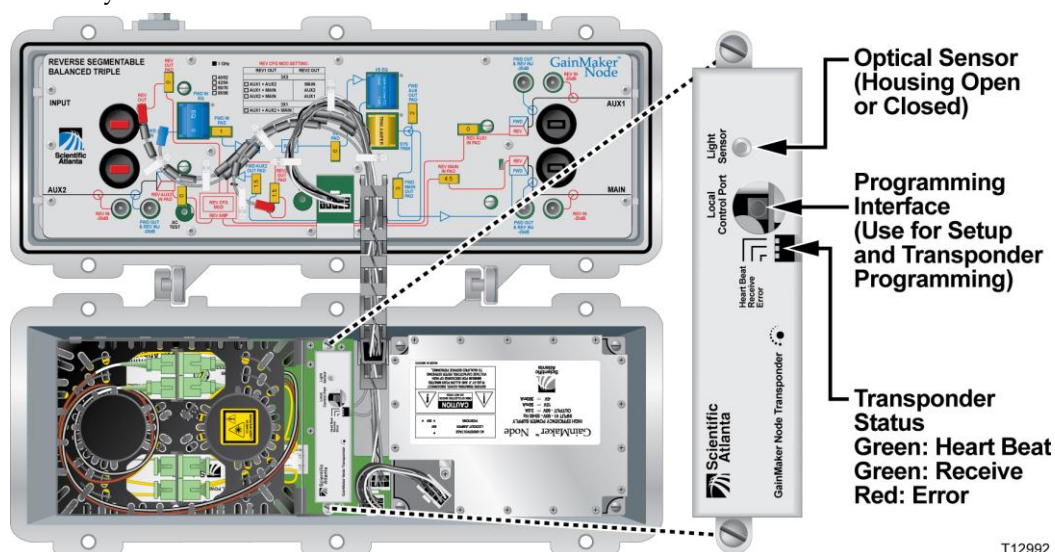
- 11 Rotate the fiber management tray to its stored position. Refer to *To Stow the Fiber Management Tray* (on page 26).
- 12 Insert the AC power shunt directors.
Note: If supplying power to the node through the main input port, a power inserter must be installed to terminate the RF signal.
- 13 Close the node housing. Refer to *To Close the Node Housing* (on page 17).

Installing and Removing the Status Monitor Transponder Module (Optional)

To Install the Status Monitor Transponder Module

Complete the following steps to install the status monitor module.

- 1 Open the node housing. Refer to *To Open the Node Housing* (on page 17).
- 2 Align the transponder module connectors with the connectors on the interface board. Use the tabs on the bottom of the transponder as a guide to position the transponder correctly onto the interface board.



- 3 Secure the status monitor transponder by pushing down on the module until it clicks into place.
- 4 Tighten the two module retaining screws on the transponder to 18 in-lb to 20 in-lb (2.0 Nm to 2.3 Nm).

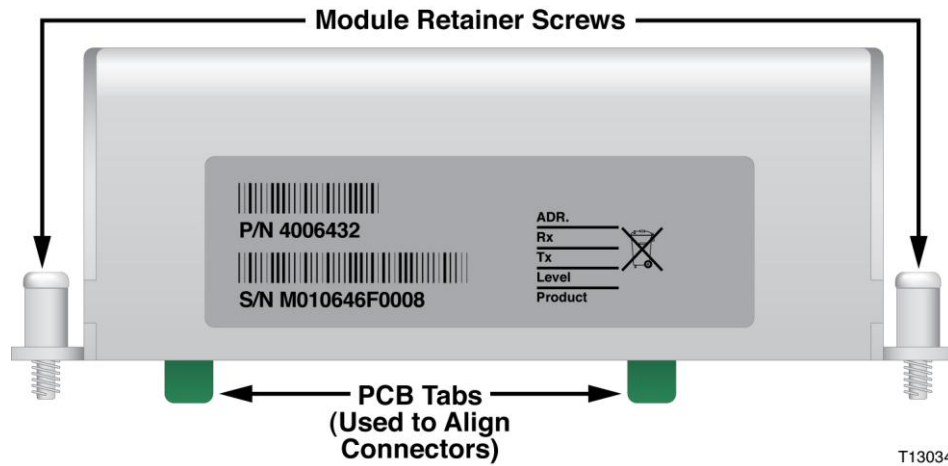
Result:

- If the GainMaker Node is active, the green “Heart Beat” LED flickers to indicate that the unit is operating.
 - If data packages are detected (e.g., to another transponder) the “Receive” LED flickers.
- 5 Close the node housing. Refer to *To Close the Node Housing* (on page 17).

To Remove the Status Monitor Transponder Module

Complete the following steps to remove the status monitor module.

- 1 Open the node housing. Refer to *To Open the Node Housing* (on page 17).
- 2 Using a screwdriver, loosen the two module retaining screws on the transponder.



- 3 With a firm grip, pull up on the transponder and remove from the interface board.
- 4 Close the node housing. Refer to *To Close the Node Housing* (on page 17).

3

Balancing and Setup

Introduction

This chapter provides instructions for selecting and implementing the correct balancing methods for the GainMaker 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

- Preparing for Forward Path Balancing..... 48
- Balancing the Forward Path..... 51
- Balancing the Reverse Path 53
- Configuring the Reverse Path..... 61

Preparing for Forward Path Balancing

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 node.

Before balancing, make sure that you have configured the node according to the specifications in your design print and that the 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 adapter (part number 562580) or F-81 female-to-female adapter	access the test points.
length of 75 ohm coaxial cable with F-connectors on each end	connect the test point adapter to the test equipment.
voltmeter	test the power supply AC and DC voltages.
reverse sweep receiver	test signals using a reverse sweep transmitter.
1/8-inch flat blade screwdriver	adjust switch S1, AGC Manual Backoff, and AGC Gain Control

Bode Network

The Bode Network, or Bode, is an interstage variable attenuation and slope network whose loss characteristics are driven by DC control voltage.

A thermistor (thermal) driven circuit on the amplifier sets the DC control voltage that drives the Bode. This circuit detects amplifier internal temperature, and generates the DC control voltage needed to set the proper loss characteristics of the Bode with respect to the current outdoor temperature.

To Verify the Input Signal Level

Single Optical Receiver

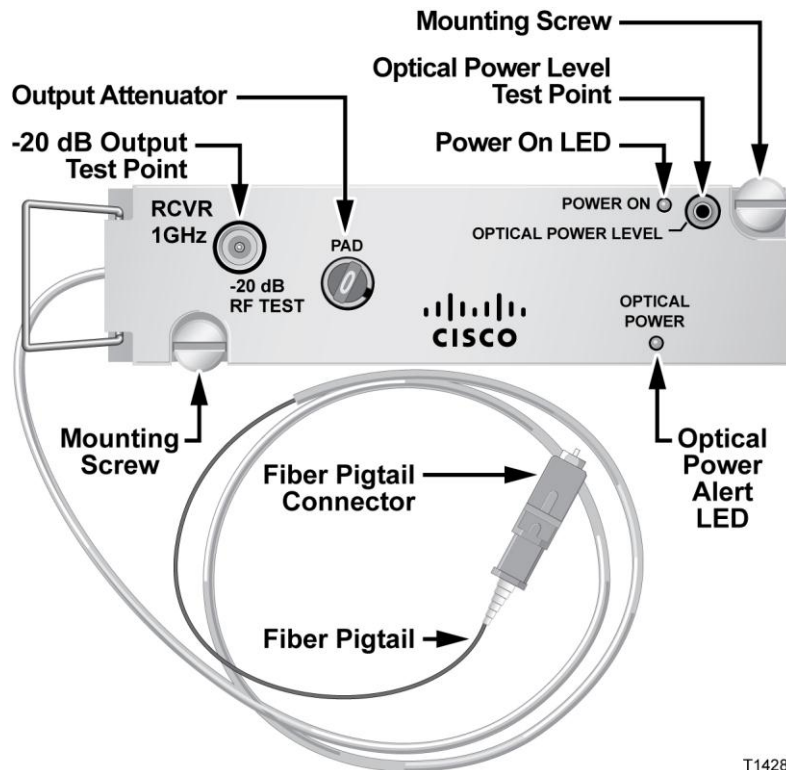
Complete the following steps to test the input signal level from the optical receiver.

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

Preparing for Forward Path Balancing

- 1 Connect the test equipment to the output test point on the receiver as shown in the following illustration.

Important: The receiver output test point performs as the input test point for the amplifier.



T14283

- 2 Measure the signal level at the following frequencies:
 - The lowest frequency specified in the system design
 - The highest frequency specified in the system design
- 3 Compare the measured levels to the design input levels on the system design print.
Note: Add 20 dB to the measured levels to find the true levels. The test point attenuates input signals by 20 dB.
- 4 Are measured levels within the desired 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 amplifier without the proper input signals.
- 5 Remove the test point adapter from the forward input test point, leaving other equipment connectors intact.

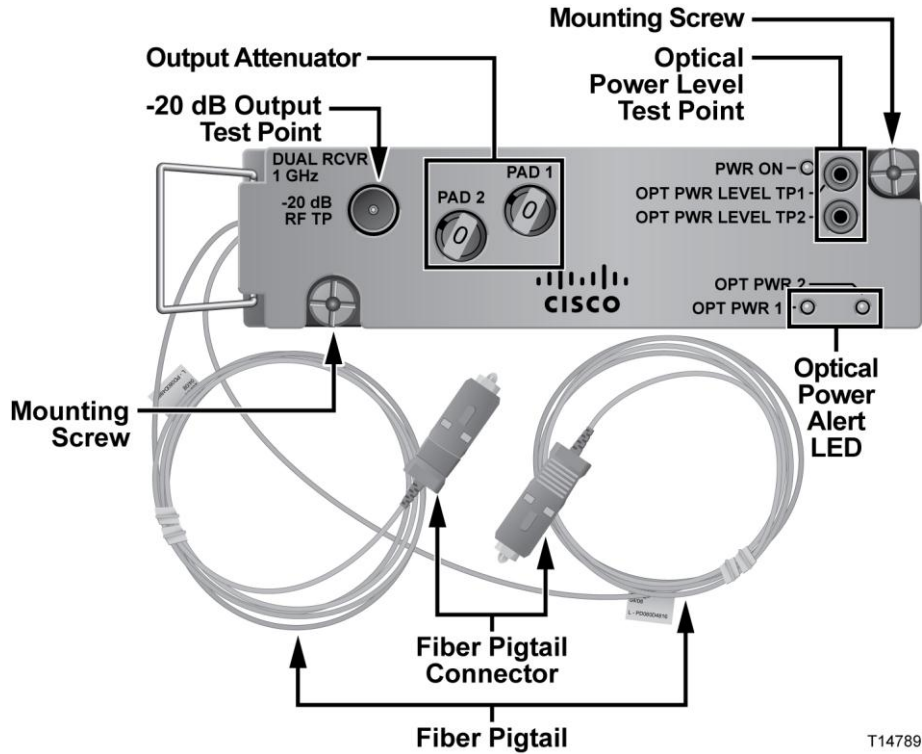
Dual Redundant Receiver

Complete the following steps to test the input signal level from the optical receiver.

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

- 1 Connect the test equipment to the output test point on the receiver as shown in the following illustration.

Important: The receiver output test point performs as the input test point for the amplifier.



T14789

- 2 Measure the signal level at the following frequencies:
 - The lowest frequency specified in the system design
 - The highest frequency specified in the system design
- 3 Compare the measured levels to the design input levels on the system design print.

Note: Add 20 dB to the measured levels to find the true levels. The test point attenuates input signals by 20 dB.
- 4 Are measured levels within the desired 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 amplifier without the proper input signals.
- 5 Remove the test point adapter from the forward input test point, leaving other equipment connectors intact.

Balancing the Forward Path

To complete the balancing procedure, you will perform the following tasks:

- Determine the output tilt.
- Set the output tilt.
- Set the output level.

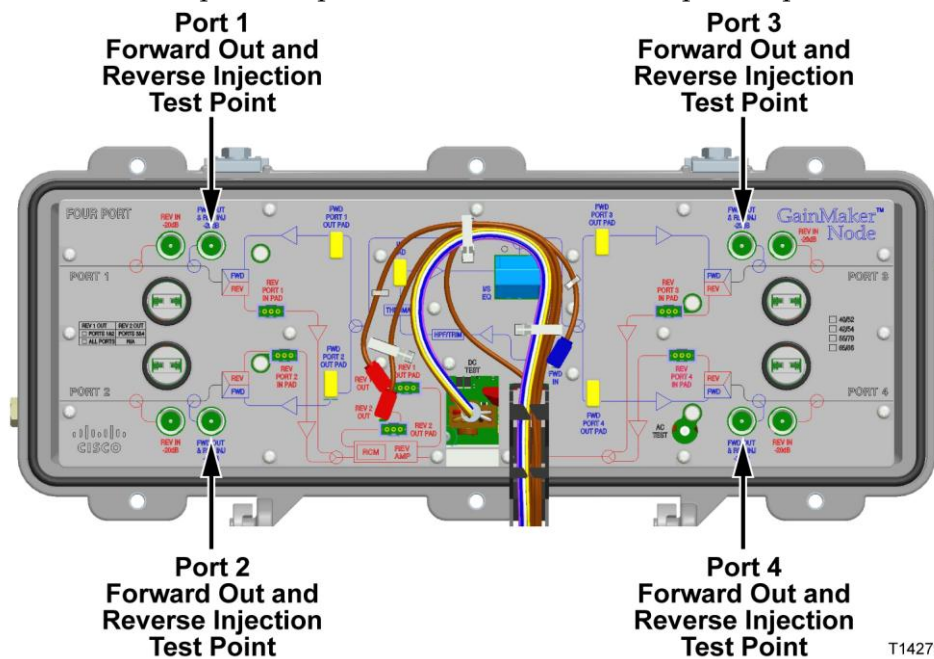
This section provides instructions for performing each of these tasks.

Note: Before you begin, make sure that you have configured the amplifier module according to the specifications in the design print, and that the amplifier has warmed up for approximately one hour.

To Determine the Output Tilt

Complete the following steps to determine the output tilt of the amplifier.

- 1 Connect the test point adapter to the Port 1 forward output test point.



- 2 Consult the design print to find the proper output tilt.
- 3 Measure the output signal levels at the frequencies you used in *To Verify the Input Signal Level* (on page 48).
- 4 To determine the actual output tilt, calculate the difference (in dB) between the levels of the lowest and highest specified frequencies.
- 5 Proceed to the next section, **To Set the Output Tilt**.

To Set the Output Tilt

Equalizers (EQs) are available in 1.5 dB increments. A 1.5 dB change in value changes the difference between low and high frequencies by approximately 1 dB.

- Increasing the FWD I/S equalizer value *reduces* the level at lower frequencies, relative to the level at 870 MHz/1 GHz.
- Decreasing the FWD I/S equalizer value *increases* the level at lower frequencies, relative to the level at 870 MHz/1 GHz.

Complete the following steps to select the proper forward input equalizer value.

- 1 Compare the calculated output tilt in step 4 of **To Determine the Output Tilt** with the design tilt (on the design print).
 - 2 Is the output tilt within ± 0.5 dB of the design tilt?
 - If the output tilt is within ± 0.5 dB of the design tilt, proceed to the next section, **To Set the Output Level**.
 - If the output tilt is more than design tilt, replace the forward interstage EQ with a lower value.
 - If the output tilt is less than design tilt, replace the forward interstage EQ with a higher value.
- Important:** While it is a 1 GHz equalizer, it is appropriate for use in both 1 GHz and 870 MHz applications.
- 3 Measure the output tilt again, and then return to step 1.

To Set the Output Level

After setting the tilt, complete the following steps to select the proper FWD I/S pad values for the amplifier. The output level of the amplifier is set by selecting the proper FWD I/S pad value.

- 1 Connect the test probe to the forward main output test point.
- 2 Measure the output level at the highest design frequency, and compare this level with the design level (on the design print).
- 3 Is the measured output level within ± 0.5 dB of the design level?
 - If the output level is within ± 0.5 dB of the design output level, proceed to step 5.
 - If the output level is more than the design output level, replace the forward interstage pad with a higher value pad.
 - If the output level is less than the design level, replace the forward interstage pad with a lower value pad.
- 4 Repeat steps 2 and 3 until the output level is correct.
- 5 Proceed to *Balancing the Reverse Path* (on page 53). Proceed to *Balancing the Reverse Path* (on page 53).

Balancing the Reverse Path

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.

About Reverse Path Balancing

Balancing should be completed in the following order.

- 1 Balance the reverse fiber link, i.e., the path from the node reverse optical transmitter to the headend or hub reverse optical receiver.
- 2 Balance the individual reverse amplifier cascades that combine at the node. Start with the amplifier closest to the node, and work from that point outward towards the first reverse amplifier in each upstream cascade.

Injection of Test Signal(s)

During the balancing process, a reverse RF test signal or signals of known amplitude are injected into the reverse RF input path of the amplifier station prior to the reverse amplification circuit. The injected signals are amplified and routed out the station reverse RF output port in the upstream direction. The injected test signals pass through any previously balanced amplifiers in the reverse cascade, as well as the reverse fiber link, and arrive at the node reverse optical receiver, which typically is located in the headend or hub.

Monitoring and Adjusting Received Amplitude and Tilt

The amplitude and tilt associated with the received signals are monitored at the headend or hub at an RF test point on the output of the reverse optical receiver associated with the particular node. The received amplitude and tilt of the test signals are compared to the desired (reference value) amplitude and tilt. Any deviations from reference value amplitude or tilt are then minimized by altering the (dB) value of the output pad or equalizer in the amplifier being balanced. This process is completed for each amplifier in the reverse cascade, working outward from the node.

Methods of Generating and Monitoring Test Signals

The reverse RF test signals to be injected into the reverse path of the amplifier being balanced may be generated by the following.

- Multiple CW signal (tone) generator
- Reverse sweep transmitter

The amplitude and tilt of the received test signals at the output of the reverse optical

receiver in the headend or hub may be measured and monitored using the following.

- Spectrum analyzer (when using a CW generator for test signals)
- Signal level meter (when using a CW generator for test signals)
- Reverse sweep receiver (when using a reverse sweep transmitter for test signal)

Communicating Test Results

The variance in relative amplitude and tilt of the received signal from desired (reference) may be relayed to the field technician via the following.

- Radio, by a second technician in the headend or hub who is monitoring a spectrum analyzer or signal level meter
- A dedicated forward TV channel whose associated modulator has its video input being generated by a video camera focused on the spectrum analyzer display
- An associated forward data carrier (if using a particular type of reverse sweep system)

If a portable reverse sweep generator with built-in forward data receiver is used to generate the reverse test signals, only one technician is required to perform the balancing. This type of system is becoming increasingly popular due to its ease of use.

In this case, the sweep system includes a combination reverse sweep receiver and forward data transmitter, which is located in the headend or hub. The frequency response characteristics of the received sweep signal, including relative amplitude and tilt, are converted by the headend sweep receiver to a data format and transmitted in the forward RF path as a data carrier by combining it into the forward headend combiner.

The portable sweep generator or data receiver that is injecting the test signals into the reverse path in the field is simultaneously receiving the incoming data carrier via the forward RF path, and converting it back to a sweep display which represents what is being received by the headend unit.

While one technician in the field can monitor the received amplitude and determine whether it deviates from reference or not, any variation in amplitude required at the output of the receiver in the headend would typically be accomplished by a second technician in the headend, who is in communication with the technician in the field.

Note: When using a reverse sweep system such as this, be sure to consult the manufacturer's guide to determine proper headend combining and to ensure proper telemetry levels.

Balancing and Alignment Procedures

This procedure applies whether balancing the reverse along with the forward or if balancing the reverse independently. It requires one technician at the node and one technician at the headend or hub site to set up the reverse fiber link.

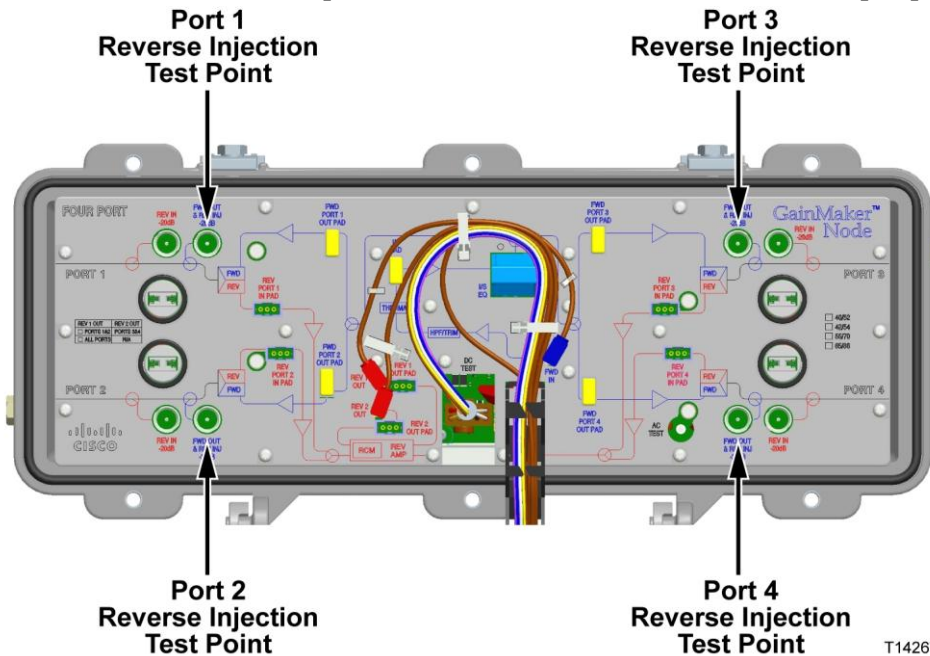
It is good practice to set up the link with the highest optical loss budget first, and to always balance the reverse fiber link before attempting to balance any of the reverse amplifiers in the distribution plant.

Complete the following steps to balance the reverse fiber link.

- 1 Ensure that the design value reverse pads are installed in the appropriate reverse pad slots in the amplifier and reverse optical transmitter input. The reverse pads are as follows:

- Reverse main input pad for each station port
- Reverse output pad
- Reverse transmitter input pad

Note: See illustration in step 4 for location of the reverse transmitter input pad.



- 2 Refer to the reverse system design print and inject the proper RF signal level into the amplifier via the reverse injection test point. For the exact location of the reverse injection test point, refer to the illustration in step 1.

The reverse system design print should specify a “design” reverse input level at the station’s reverse input port(s). You must inject the correct signal level into the reverse injection test point using an RF test probe and a reverse sweep transmitter or a CW signal generator. The reverse injection test point has 20 dB of insertion loss (-20 dB injection point).

Note: To calculate the correct signal level to inject, you must first calculate the input level to the reverse amplifier module.

Example:

- Specified port (station) input, per design = 19 dBmV
- Injection test point loss = 20 dB
- Port Input + Injection test point loss = Signal generator setting
- $19 \text{ dBmV} + 20 \text{ dB} = 39 \text{ dBmV}$

Set the signal generator output for + 39 dBmV. This signal, when injected through the reverse injection point, is attenuated by 20 dB, simulating the 19 dBmV port input level specified per design.

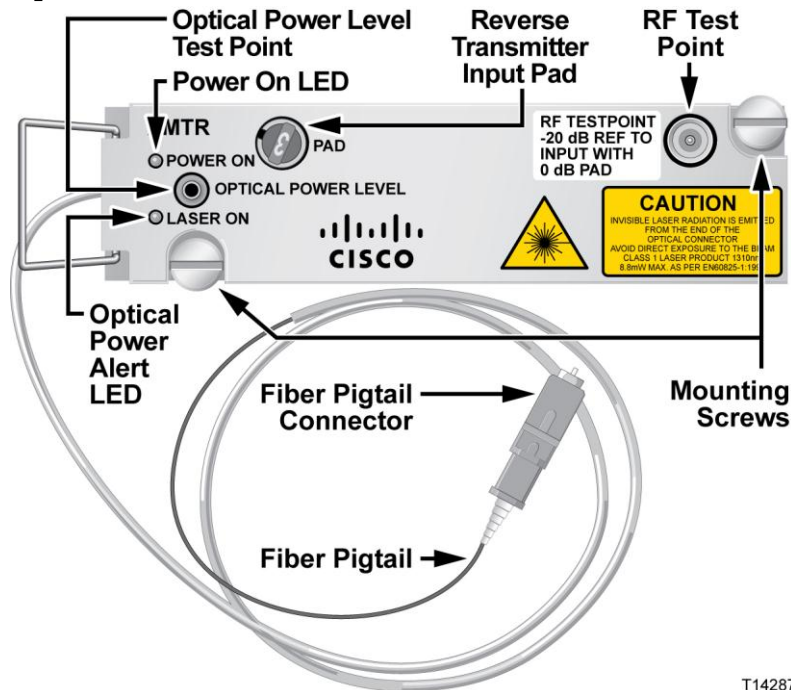
Important:

- If a CW signal generator is used, at least two carriers should be injected, one at the low end and one at the high end of the reverse bandpass. In a reverse system with a 5 MHz to 40 MHz bandpass, the low frequency carrier would be in the 5 MHz to 10 MHz range, and the high frequency carrier would be in the 35 MHz to 40 MHz range.
 - The amplitude of the signal generator output can be set higher or lower than the level specified by the calculation above, but the *difference* between the actual output level and the level calculated above must be known. If the generator output is x dB higher (or lower) than the level calculated, then the reference (desired) level received at the headend or hub should also be x dB higher (or lower) than the original headend reference level.
- 3 The station reverse input pad(s), reverse output pad, and reverse transmitter input pad are selected during the reverse system design and are based on the services to be transported by the reverse system. **DO NOT CHANGE ANY OF THESE PADS FROM THEIR DESIGN VALUES!** Reverse equalizer values may be changed if needed to obtain flat receiver output levels across the reverse frequency spectrum.
 - 4 Have the technician in the headend refer to the headend system design and set the output of the optical receiver to the specified output level. If using a sweep system that is x dB below standard design levels, be sure to consider that your receive level should also be x dB below the original design reference level.

See the instruction guide that was shipped with the optical receiver for setup procedures. It may be necessary to use an external attenuator at the RF output of the optical receiver, if the receiver does not have an RF output level adjustment control.

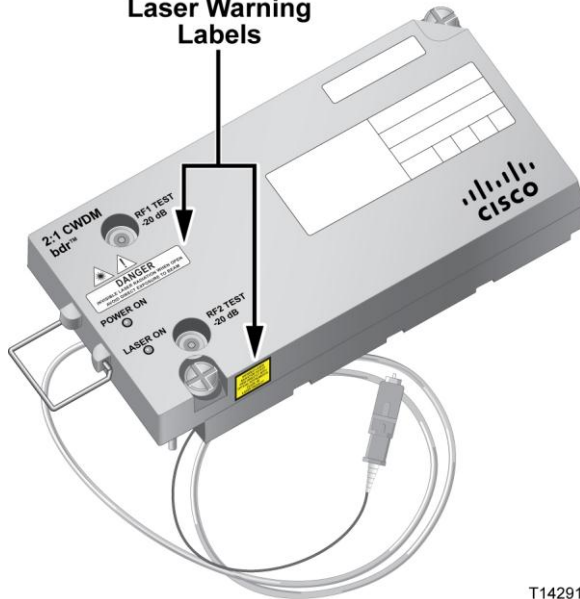
Note: If the required output level of the reverse receiver is not known, set up the longest optical link first. Set the remaining receivers for the same RF output level as that of the receiver connected to the longest optical link.

Optical Transmitter Module



T14287

**bdr 2:1 Optical Transmitter Module
Laser Warning Labels**



T14291

- 5 Once the reverse fiber link has been properly balanced, the reverse RF amplifier cascades feeding the node can be balanced.

To Prepare the Amplifier for Initial Reverse Path Balancing

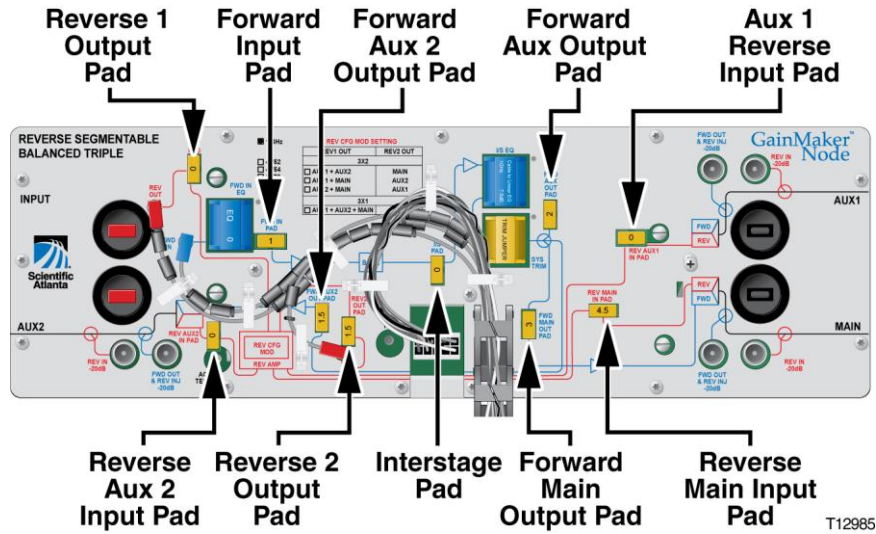
Complete the following steps for initial reverse path balancing.

- 1 Balance all of the reverse amplifiers off a given reverse input port for the node being worked on. The reverse amplifiers should be balanced sequentially from the node outward.

Note: Make sure the reverse fiber link has been properly balanced before proceeding.

- 2 Ensure that the design value reverse output equalizer and reverse pads are installed in the appropriate reverse slots in the amplifier. Refer to the following diagram.

Note: Record the pad values for each input port for later use.



- 3 Proceed to *To Calculate the Proper RF Signal Level* (on page 58).

To Calculate the Proper RF Signal Level

In order to calculate the correct RF signal level to inject, you must know the following.

- Design Reverse Port Input Level from the design print
- Total Injection Insertion Loss (20 dB)

To calculate the correct signal level to inject, add the total injection insertion loss to the design port input level.

Example

- Design amplifier reverse port input level = 19 dBmV
- Total injection insertion loss = 20 dB

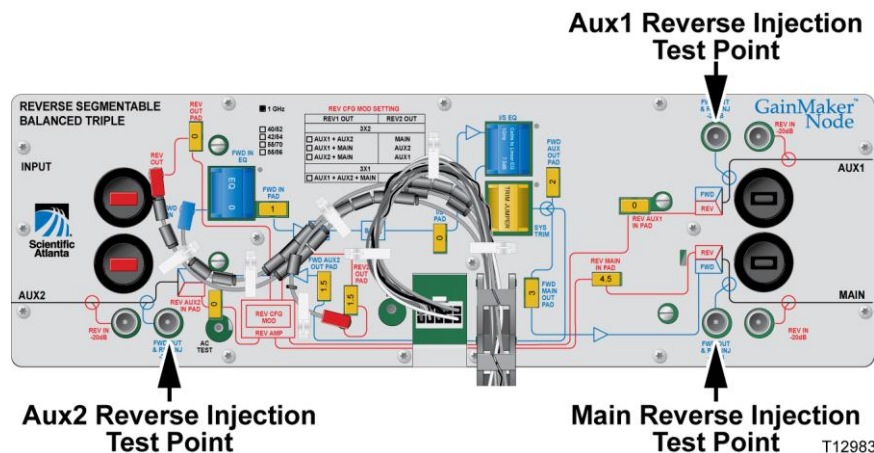
The design amplifier reverse port input level plus injection insertion loss equals correct RF signal level to inject.

In the example shown above, $19 \text{ dBmV} + 20 \text{ dB} = 39 \text{ dBmV}$. Therefore, you would set the signal generator output for + 39 dBmV.

Important:

- When using a CW signal generator, inject at least two carriers, one at the low end and one at the high end of the reverse bandpass. In a reverse system with a 5 MHz to 40 MHz bandpass, the low frequency carrier should be in the 5 MHz to 10 MHz range and the high frequency carrier should be in the 35 MHz to 40 MHz range.
- The amplitude of the signal generator output can be set higher or lower than the level specified by the calculation above, but the difference between the actual output level and the level calculated above must be known. If the generator output is x dB higher (or lower) than the level calculated, then the reference (desired) level received at the headend or hub should also be x dB higher (or lower) than the original headend reference level.
- The station reverse input pad values are selected during the reverse system design and are based on the need to minimize variations in return path losses for the various reverse inputs. Do not permanently alter the values of the reverse input pads without consulting a system designer.
- In the GainMaker node, the reverse input comes after the reverse injection point in the reverse path. Temporarily replacing the design value reverse input pad on the port being balanced with a 0 dB pad allows the reverse injection level and the receive levels at the monitoring end to remain constant from amplifier to amplifier and from port to port.

Insert the appropriate signal amplitude into the reverse injection test point. Refer to the following illustration.



Proceed to *To Complete Reverse Path Balancing* (on page 59).

To Complete Reverse Path Balancing

Complete the following steps to finish the amplifier setup.

- 1 Monitor the tilt of the signals being received at the headend or hub reverse optical receiver RF output test point.

Note:

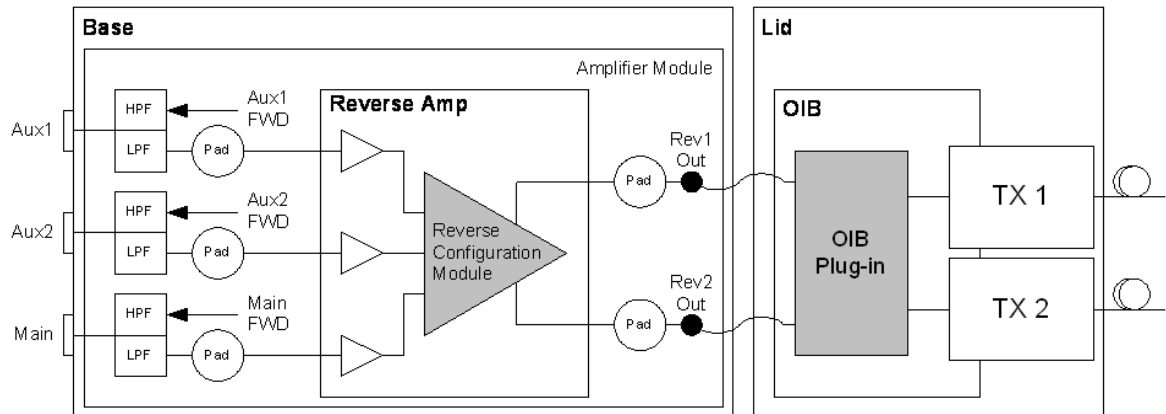
- The tilt is the difference in signal level between the highest and lowest frequencies in the reverse passband, or between the highest and lowest frequency CW test signals.
 - Most systems prefer to have minimal reverse tilt (flat levels) at the headend.
 - To minimize tilt, change the value of the amplifier reverse output equalizer.
- 2 Monitor the amplitude (level) of the signals being received at the headend or hub reverse optical receiver RF output testpoint.
 - a Compare the received level to the reference level desired.
 - b If using a sweep system that is x dB below standard CW carrier levels, be sure to consider that the receive level should also be x dB below the CW reference level.
 - c To adjust the receive level to make it match the desired reference level, alter the value of the amplifier reverse output pad. Each 1 dB increase in pad value should result in a corresponding 1 dB decrease in receive level, and each 1 dB decrease in pad value should give a 1 dB increase in receive level.
 - 3 Once the proper receive level and tilt of the test signals have been achieved, properly close the amplifier housing and repeat the process at the next reverse amplifier in the downstream cascade.

Important:

- Reinstall design print value reverse input pads for any port whose input pad may have been temporarily replaced with a 0 dB value pad for reverse path balancing purposes.
- Work outward from the node, and outward from each external split in the coaxial plant, until all amplifiers in the cascade have been balanced.
- Repeat the process for all of the reverse amplifier cascades off any remaining active node ports until all reverse amplifiers feeding into the node have been balanced.

Configuring the Reverse Path

The node reverse path includes up to three input ports and up to two output ports. The inputs can be routed to the outputs in a variety of ways to meet the needs of different applications.



TP 220

As shown in the preceding diagram, the node includes three reverse path input ports, Aux1, Aux2, and Main, and two output ports, Rev1 Out and Rev2 Out. A plug-in jumper called the reverse configuration module (RCM) determines how the signals at Main, Aux1, and Aux2 are combined and presented to the output ports Rev1 Out and Rev2 Out following amplification. A second plug-in jumper called the optical interface board (OIB) plug-in determines how the output ports Rev1 Out and Rev2 Out are routed to one or two transmitters mounted in the lid of the node.

The RCM and OIB plug-in modules work together to define one of three basic reverse path configurations:

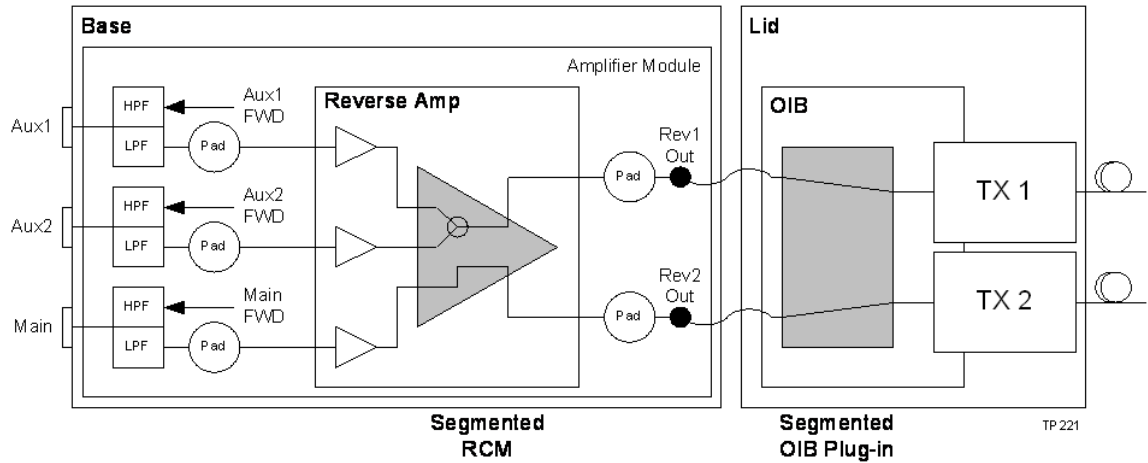
- Segmented Reverse Path
- Combined Reverse Path with Transmitter Redundancy
- Combined Reverse Path without Transmitter Redundancy

The initial configuration is determined by the 16-digit part number used when ordering. However, the configuration is upgradable in the field. This section provides the information needed to upgrade the node reverse path configuration. For additional information, see *Installation and Configuration* (on page 13).

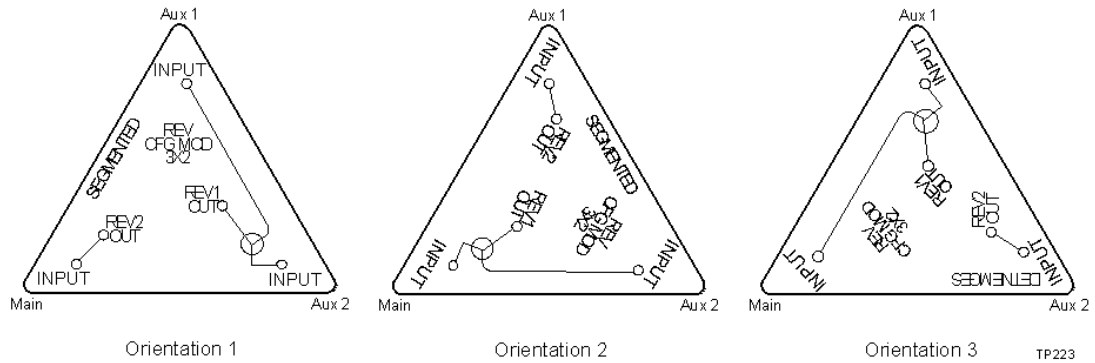
Segmented Reverse Path

Note: This configuration is recommended for use with a bdr 2:1 transmitter module. See *bdr Digital Reverse Multiplexing Applications* (on page 101) for additional details.

With a Segmented Reverse Path configuration, two input signals are combined and passed to Rev1 Out while the third input signal is passed to Rev2 Out. The signals at Rev1 Out and Rev2 Out are then passed to separate transmitters TX1 and TX2, respectively, as shown in the following diagram.



Reverse path segmentation is accomplished using the Segmented RCM (part number 4015143) and Segmented OIB plug-in (part number 4015162). The orientation of the RCM determines which two inputs are combined, as shown in the following diagram.



Orientation	Rev1 Out	Rev2 Out
1 *	Aux1 and Aux2	Main
2	Aux2 and Main	Aux1
3	Main and Aux2	Aux2

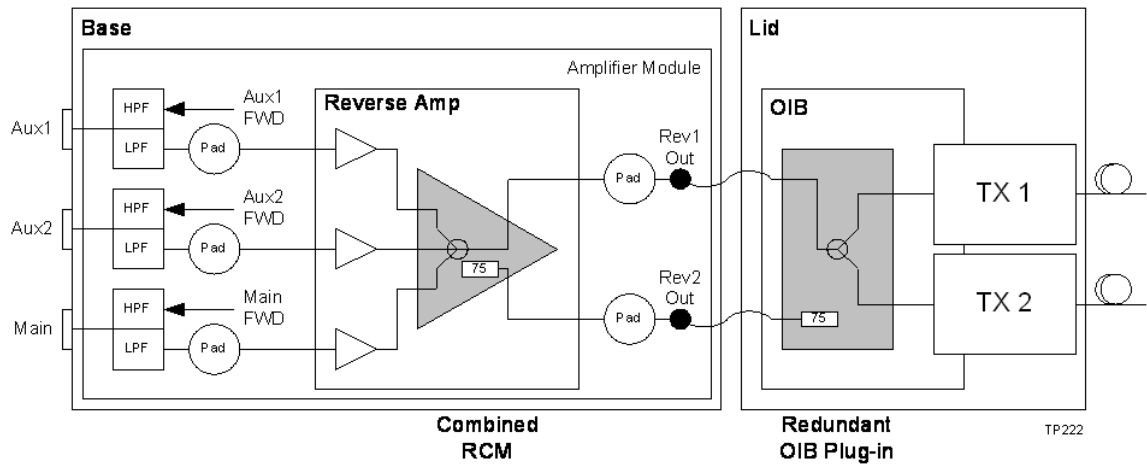
* Factory default.

Note: All plug-ins have equivalent loss, so the reverse path gain remains the same when the node is reconfigured.

Combined Reverse Path with Transmitter Redundancy

With a Combined Reverse Path configuration, all three reverse input ports are combined and passed to Rev1 Out. Rev2 Out is unused and is terminated by the plug-in modules. The Combined RCM (part number 4015147) routes the amplified input signals from Main, Aux1, and Aux2 to Rev1 Out while providing a 75 ohm termination for Rev2 Out. Unlike the Segmented RCM, the Combined RCM has only one correct orientation, so it is keyed to ensure correct installation.

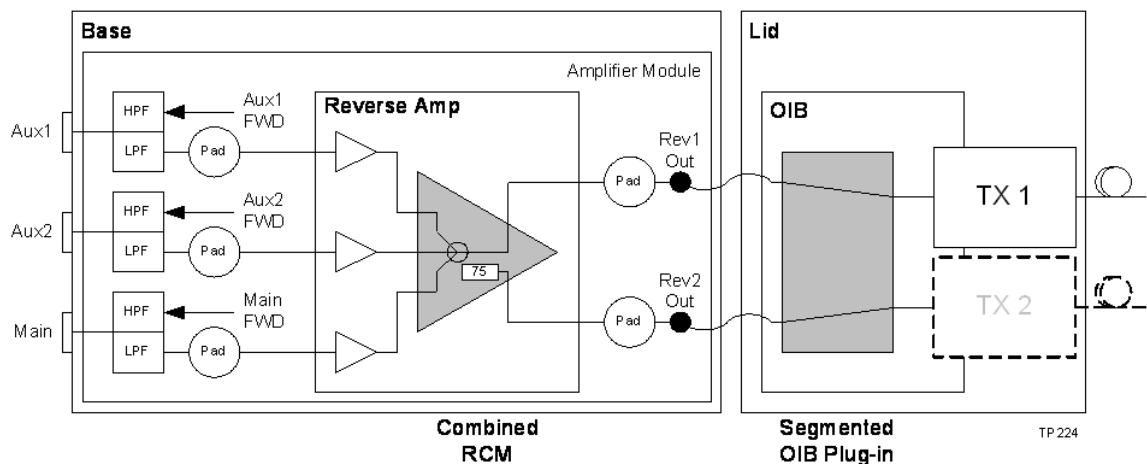
Configuring the Reverse Path



If the node includes two reverse transmitters as shown in the preceding diagram, the combined signals at Rev1 Out can be routed to both transmitter inputs to provide redundancy. This is accomplished using the Redundant OIB plug-in (part number 4015165), as shown in the preceding diagram. Note that the Redundant OIB also provides a 75 ohm termination for the unused output of Rev2 Out.

Combined Reverse Path without Transmitter Redundancy

With a Combined Reverse Path configuration, all three reverse input ports are combined and passed to Rev1 Out. Rev2 Out is unused and is terminated with the plug-in modules. The Combined RCM (part number 4015147) routes the amplified input signals from Main, Aux1, and Aux2 to Rev1 Out while providing a 75 ohm termination for Rev2 Out. Unlike the Segmented RCM, the Combined RCM has only one correct orientation, so it is keyed to prevent incorrect installation.

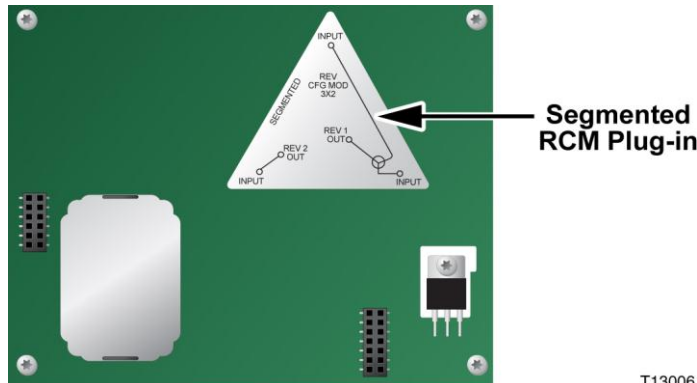


As shown in the preceding diagram, the node includes only one transmitter, so the Segmented OIB plug-in (part number 4015162) is used to route the combined output at Rev1 Out directly to the TX1 transmitter input. The Segmented OIB also allows for future segmentation through replacement of the RCM and installation of a second optical transmitter.

To Reorient or Replace the RCM Plug-in

Complete the following steps to replace the reverse configuration module (RCM) plug-in.

- 1 Open the housing. Refer to *To Open the Node Housing* (on page 17).
- 2 Remove the amplifier module. Reverse the steps for installing the amplifier as described in *Installing the Amplifier Module* (on page 35).
- 3 With the amplifier module inverted, remove the shielded cover plate from the rectangular enclosure cast into the back of the module.
- 4 Locate the triangular RCM plug-in on the interface board.



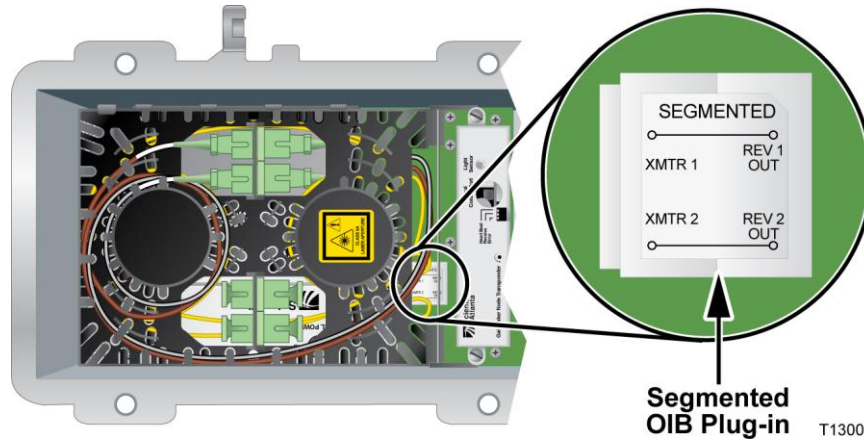
- 5 Carefully unplug the RCM plug-in from the interface board.
- 6 Reorient the RCM plug-in or install a replacement RCM, ensuring that all pins on the bottom of the plug-in align with their corresponding holes on the interface board.
- 7 Replace the shielded cover plate on the rectangular enclosure cast into the back of the amplifier module.
- 8 Replace the amplifier module in the node housing. Refer to *Installing the Amplifier Module* (on page 35).
- 9 When finished working inside the node, close the housing. Refer to *To Close the Node Housing* (on page 17).

To Replace the OIB Plug-in

Complete the following steps to replace the optical interface board (OIB) plug-in.

- 1 Open the housing. Refer to *To Open the Node Housing* (on page 17).
- 2 Press the fiber tray release toward the node housing, and then lift the fiber tray roughly 90 degrees to its unstowed position.
- 3 Locate the OIB plug-in on the interface board beneath the fiber tray hinge.

Configuring the Reverse Path



- 4 With one hand on either side of the fiber tray, carefully unplug the OIB plug-in from the interface board. Avoid pinching or pulling any nearby optical fibers.
- 5 Install the replacement OIB plug-in, ensuring that all pins on the bottom of the plug-in align with their corresponding holes on the interface board.
- 6 Return the fiber tray to its stowed position, ensuring that the fiber tray release locks the fiber tray in place.
- 7 When finished working inside the node, close the housing. Refer to *To Close the Node Housing* (on page 17).

4

Troubleshooting

Introduction

The GainMaker Node is configured with modules that support different functions. This modular design approach provides the following benefits:

- The housing design has the flexibility to accept a variety of modules.
- The modules contain few user serviceable parts. This provides ease of troubleshooting and minimal downtime during repairs.

This chapter describes the steps you may take to troubleshoot the node.

In This Chapter

■ Equipment	68
■ No AC Power	69
■ No DC Power	71
■ Low RF Output	73
■ Boot Color Table	74
■ No Forward RF Signal	75
■ Low or Degraded Forward RF Signal.....	76
■ No Reverse RF Signal.....	77
■ Low or Degraded Reverse RF Signal	78
■ Troubleshooting Carrier-to-Noise Problems	80
■ Miscellaneous Problems	81
■ Cleaning Optical Connectors	83

Equipment

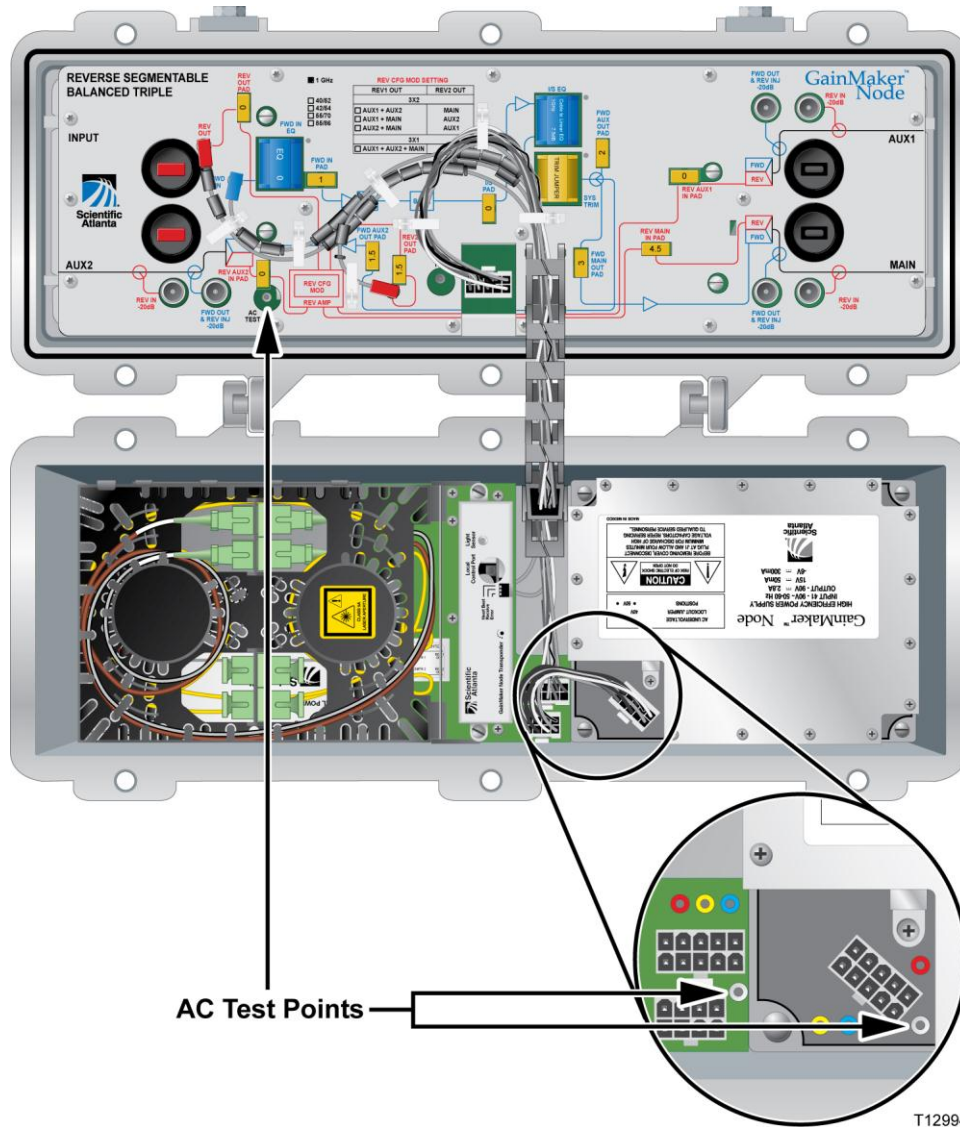
The following equipment may be necessary to perform some troubleshooting procedures.

- CLETOP or OPTIPOP ferrule cleaner (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
- Bulkhead swabs for LC or SC type connectors (choose appropriate type)
- Optical connector scope
- Optical power meter to measure light levels
- Proper fiber connector for optical power meter to make optical connections
- Digital voltmeter to measure voltages
- Spectrum analyzer or a field strength meter to measure RF levels
- Test point probe, part number 562580, to access test points

No AC Power

AC power can be measured at the AC test points on the AC/RF entry module, AC shunt power directors, and the power supply AC test point.

The following diagram illustrates the AC test point locations for the GainMaker Node.



T12994

No AC Power Troubleshooting Table

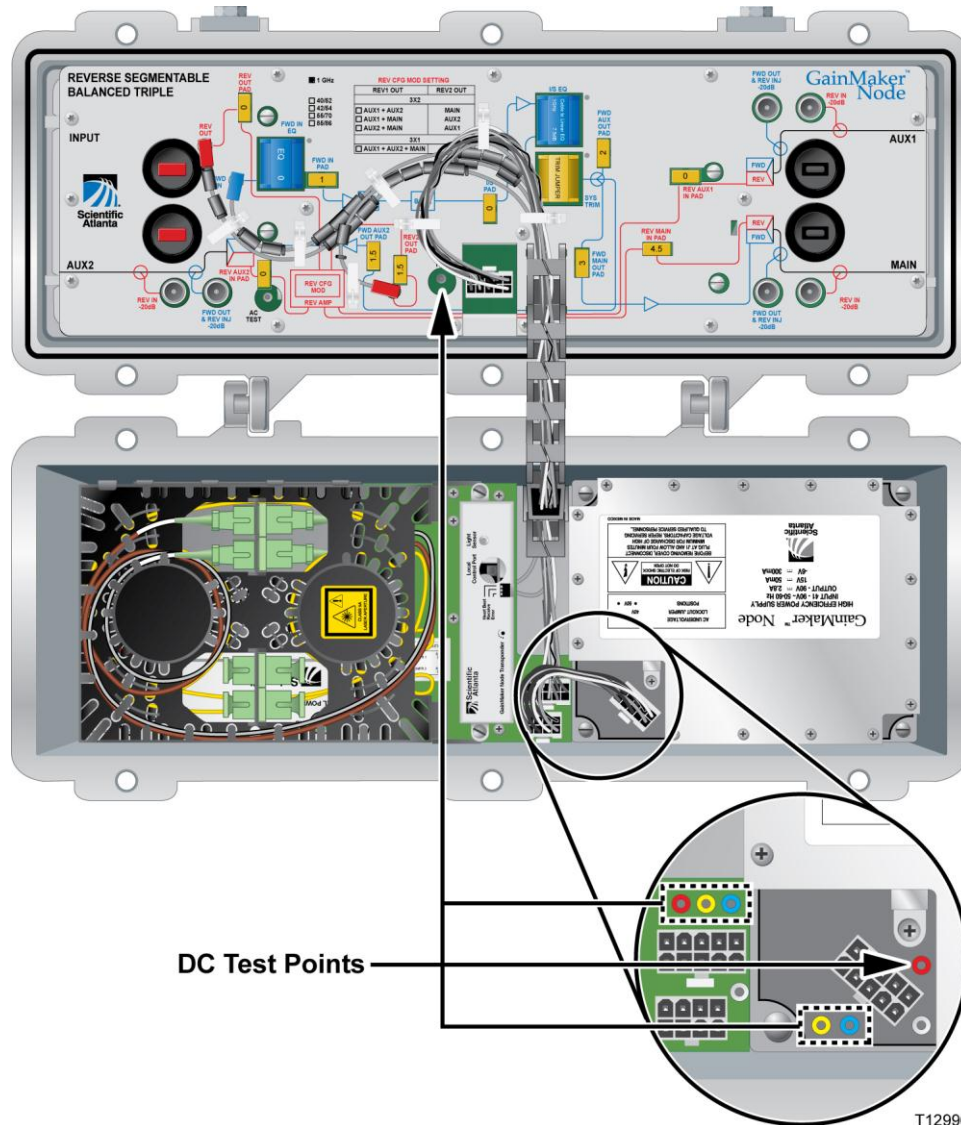
Before you begin troubleshooting for no AC power, verify that there is proper AC power input coming into the node.

Possible cause	Solution
No AC at the AC test point on the AC/RF entry module.	<ul style="list-style-type: none">■ Check the AC source.■ Check the AC shunt power director configuration at the amplifier feeding AC to this amplifier.
AC at the AC test point but not the AC shunt power director.	<ul style="list-style-type: none">■ Check and/or replace the AC shunt power director.■ Check and/or replace the amplifier module.
AC at the AC test point but not the power supply test point.	<ul style="list-style-type: none">■ Check and/or replace the power supply wiring harness.■ Check and/or replace the power supply.

No DC Power

DC power can only be measured at the DC power supply test point and power wiring harness.

The following diagram illustrates the DC test point locations for the GainMaker Node.



T12996

No DC Power Troubleshooting Table

Before you begin troubleshooting for no DC power, verify that there is proper AC power input coming into the DC power supply.

Possible cause	Solution
No DC power at the power supply.	■ Check and/or replace the power supply.
DC at the power supply but not at the end of the wiring harness.	■ Check and/or replace the power wiring harness. ■ Check and/or replace the power supply.
DC at the power supply and the wiring harness but amplifier not working.	■ Check and/or replace the amplifier module.

Low RF Output

Use the steps in the following table to troubleshoot low RF output of the optical receiver or amplifier.

Possible cause	Solution
Low RF input at the transmitter.	<ul style="list-style-type: none"> ■ 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).	<ul style="list-style-type: none"> ■ Replace or re-splice the coupler. ■ Make sure all unused fiber pigtailed are terminated.
Unterminated leg of the optical coupler.	<ul style="list-style-type: none"> ■ Make sure all unused fiber pigtailed are terminated.
Low optical input to the node. The optical input level should be typically 0 dBm. Refer to the system design print for the proper level.	<ul style="list-style-type: none"> ■ If connectors are dirty, clean them. Refer to Cleaning Optical Connectors. ■ Inspect fiber routing and management tray for fibers that might be wrapped too tightly. ■ Check for proper optical output from transmitter. ■ Check the link loss. ■ Replace any scratched connectors.
Unterminated leg of the optical coupler.	<ul style="list-style-type: none"> ■ Make sure all unused fiber pigtailed are terminated.
Failure in the optical receiver.	<ul style="list-style-type: none"> ■ Replace the receiver module. Use the output test point of the optical receiver to verify output levels.
Faulty coax jumper from the node optical motherboard to the RF amplifier.	<ul style="list-style-type: none"> ■ Replace the jumper between the optical motherboard and the RF amplifier forward input. <p>Note: An authorized repair center must perform this procedure.</p>

Boot Color Table

This table shows the factory standard for boot color that applies to SC connectors.

Connector Description	Boot Color
Ultra Polished, UPC	Blue
Angled polished, APC (standard)	Green

Note: For instructions on maintaining fiber optic connectors, see [Cleaning Optical Connectors](#).

No Forward RF Signal

The forward RF signal can be measured at the -20 dB RF test point on the optical receiver and the amplifier module forward output test points.

No Forward RF Signal Troubleshooting Table

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

Important: You cannot balance the amplifier without the proper forward RF input signal.

Possible cause	Solution
No forward RF signal at the forward optical receiver test point.	<ul style="list-style-type: none"> ■ Refer to <i>Low RF Output</i> (on page 73). <p>Important: You cannot balance the amplifier without the proper forward RF input signal.</p>
There is forward RF signal at the forward optical receiver test point, but no signal at one or all of the forward output test points.	<ul style="list-style-type: none"> ■ Verify that the amplifier module is receiving the proper AC and DC voltages. Refer to <i>No AC Power</i> (on page 69) and <i>No DC Power</i> (on page 71). ■ Verify that all the proper accessories, pads, EQs, 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. <p>Note: Verifying factory installations involves removing the amplifier module cover. Reinstall the amplifier module cover properly or RF signal degradation may result.</p> <ul style="list-style-type: none"> ■ Check/replace the wiring harness. ■ Replace the amplifier module.

Low or Degraded Forward RF Signal

The forward RF signal can be measured at the -20 dB RF test point on the optical receiver and the amplifier module 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 amplifier is receiving the proper forward RF input signal from the optical receiver.

Important: You cannot balance the amplifier without the proper forward RF input signal.

Make sure you have configured the amplifier module according to the specifications in the design print, and that the amplifier has warmed up for approximately 1 hour.

Make sure you are using the proper tilt reference when setting levels. An 870 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 870 MHz or 1 GHz. The tilt reference at 550 MHz is lower than the tilt reference at 870 MHz or 1 GHz.

Important: If the amplifier cover was ever removed, make sure it was properly reinstalled. Improperly reinstalling the amplifier module cover may result in RF signal degradation.

Possible cause	Solution
There is a proper forward RF signal at the forward optical receiver test point, but a low or degraded signal at one or all of the forward output test points.	<ul style="list-style-type: none"> ■ Verify that the amplifier module is receiving the proper DC voltages. Refer to <i>No DC Power</i> (on page 71). ■ Verify that all the proper accessories, pads, EQs, 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. <p>Note: Verifying factory installations involves removing the amplifier module cover. Reinstall the amplifier module cover properly or RF signal degradation may result.</p> ■ Replace the amplifier module.

No Reverse RF Signal

The reverse RF signal can be measured at the amplifier module reverse input test point and the reverse optical transmitter output test point.

No Reverse RF Signal Troubleshooting Table

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

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).	<ul style="list-style-type: none"> ■ Verify that the amplifier is receiving the proper reverse RF input signals from the downstream amplifiers. Important: You cannot balance the amplifier without the proper reverse RF input signals.
There are proper reverse RF signals at the reverse input test points, but no signal at the reverse transmitter output test point.	<ul style="list-style-type: none"> ■ Verify that the amplifier module is receiving the proper AC and DC voltages. Refer to <i>No AC Power</i> (on page 69) and <i>No DC Power</i> (on page 71). ■ Verify that all the proper accessories, pads, and EQs are firmly installed in the correct locations. ■ Verify that the factory installed accessories are firmly installed in the correct locations. ■ Verify that the reverse switch (if applicable) or its jumpers are properly and firmly installed. Note: Verifying factory installations involves removing the amplifier module cover. Reinstall the amplifier module cover properly or RF signal degradation may result. ■ Check/replace the wiring harness. ■ Replace the amplifier module.

Low or Degraded Reverse RF Signal

The reverse RF signal can be measured at the amplifier module reverse input test point and the reverse optical transmitter output test point.

Low or Degraded Reverse RF Signal Troubleshooting Table

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

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

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

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

Important: If the amplifier cover was ever removed, make sure it was properly reinstalled. Improperly reinstalling the amplifier module cover may result in RF signal degradation.

Possible cause	Solution
Low or degraded reverse RF signal at the reverse input test point(s).	<ul style="list-style-type: none"> ■ Verify that the amplifier is receiving the proper reverse RF input signals from the downstream amplifiers. <p>Important: You cannot balance the amplifier without the proper reverse RF input signals.</p>
There are proper reverse RF signals at the reverse input test points, but a low or degraded signal at the reverse transmitter output test point.	<ul style="list-style-type: none"> ■ Verify that the amplifier module is receiving the proper DC voltages. Refer to <i>No DC Power</i> (on page 71). ■ Verify that all the proper accessories, pads, EQs, 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 the reverse switch and its jumpers are properly and firmly installed. ■ Check/replace the wiring harness. <p>Note: Verifying factory installations involves removing the amplifier module cover. Reinstall the amplifier module cover properly or RF signal degradation may result.</p>

Possible cause	Solution
Reverse RF signal still low or degraded.	<ul style="list-style-type: none">■ Verify that any unused RF ports are properly terminated.■ Use a spectrum analyzer to look at the reverse RF input signal spectral quality at each reverse input test point and compare it to the reverse RF output signal spectral quality. Note: If degradation is generated by the downstream amplifier reverse RF signal, troubleshoot the RF amplifier feeding this station.■ Replace the amplifier module.

Troubleshooting Carrier-to-Noise Problems

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

Possible cause	Solution
Low optical input to the node. The optical input level should be typically 0 dBm. Refer to the system design print for the proper level.	<ul style="list-style-type: none"> ■ If connectors are dirty, clean them. Refer to Cleaning Optical Connectors. ■ Inspect fiber routing and management tray for fibers 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.	<ul style="list-style-type: none"> ■ Verify RF input to the transmitter. ■ Check all amplifiers preceding the transmitter for proper inputs and outputs.
Failure in optical receiver.	<ul style="list-style-type: none"> ■ Replace the receiver module. Use the output test point of the optical receiver to verify output levels.
Broken SMB jumper from node optical motherboard to the RF amplifier.	<ul style="list-style-type: none"> ■ Replace the jumper between the optical motherboard and the RF amplifier forward input. <p>Note: An authorized repair center must perform this procedure.</p>
Defective or improperly spliced optical coupler between headend transmitter and node.	<ul style="list-style-type: none"> ■ Replace or re-splice the coupler. ■ Make sure all unused fiber pigtails are terminated.
Unterminated leg of optical coupler.	<ul style="list-style-type: none"> ■ Make sure all unused fiber pigtails are terminated.

Miscellaneous Problems

Complete the following steps to troubleshoot miscellaneous problems.

Possible cause	Suggestion
No RF present in network.	<ul style="list-style-type: none"> ■ Check network power supply. ■ Verify that power is present at the node power supply. ■ Check that the optical signal is present on fiber. ■ Check that voltage level on the optical receiver is the same as it was when commissioned. ■ Check that output RF is present at receiver test point. ■ Check that cable from interface board is connected to module and that cable has not been crushed.
Poor pictures on network.	<ul style="list-style-type: none"> ■ Check RF input level at transmitter. ■ Check optical output of transmitter. ■ Check optical levels at forward optical receiver. ■ Check and clean fiber connectors. See Cleaning Optical Connectors. ■ Check RF output levels at the optical receiver. ■ Check RF levels at node outputs.
No RF output from headend or hub reverse optical receiver.	<ul style="list-style-type: none"> ■ Check receiver AC power. ■ Check fiber connector in headend or hub. ■ Check fiber for optical input level. ■ Check fiber connections. ■ Check reverse transmitter in node. ■ Check RF input level to transmitter in node. ■ Check RF jumper cable from optical interface board to amplifier module. ■ Ensure that cable is connected and not crushed. ■ Check for RF at amplifier reverse input test point.

Chapter 4 Troubleshooting

Possible cause	Suggestion
Excessive noise in return.	<ul style="list-style-type: none">■ Check fiber connections and clean if necessary.■ Check noise level at transmitter test point.■ Individual ports can be isolated and return levels can be lowered by inserting higher value pads in the input pad socket.
Sweep at test point exhibits standing waves.	<ul style="list-style-type: none">■ Place 10 dB in-line pad in line with test instrument.

Cleaning Optical Connectors

Recommended Equipment

- CLETOP or OPTIPOP ferrule cleaner (for specific connector type)
- Compressed air (also called “canned air”)
- Lint-free wipes moistened with optical-grade (99%) isopropyl alcohol
- Bulkhead swabs (for specific connector type)
- Optical connector scope with appropriate adaptor

Tips for Optimal Fiber Optic Connector Performance

- Do not connect or disconnect optical connectors with optical power present.
- Always use compressed air before cleaning the fiber optic connectors and when cleaning connector end caps.
- Always install or leave end caps on connectors when they are not in use.
- 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 to avoid microscopic damage to fiber mating surfaces.

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 conductors 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.



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, e.g., scratched, burned, etc., 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.

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

Chapter 4 Troubleshooting

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** below.
- 5 It is also recommended that all connectors be visually inspected after cleaning to verify the connector is clean and undamaged.

Verifying Equipment Operation

Perform circuit turn-up. If the equipment does not come up, i.e., 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 153).

A

Technical Information

Introduction

This appendix contains tilt, forward and reverse equalizer charts and pad values and part numbers.

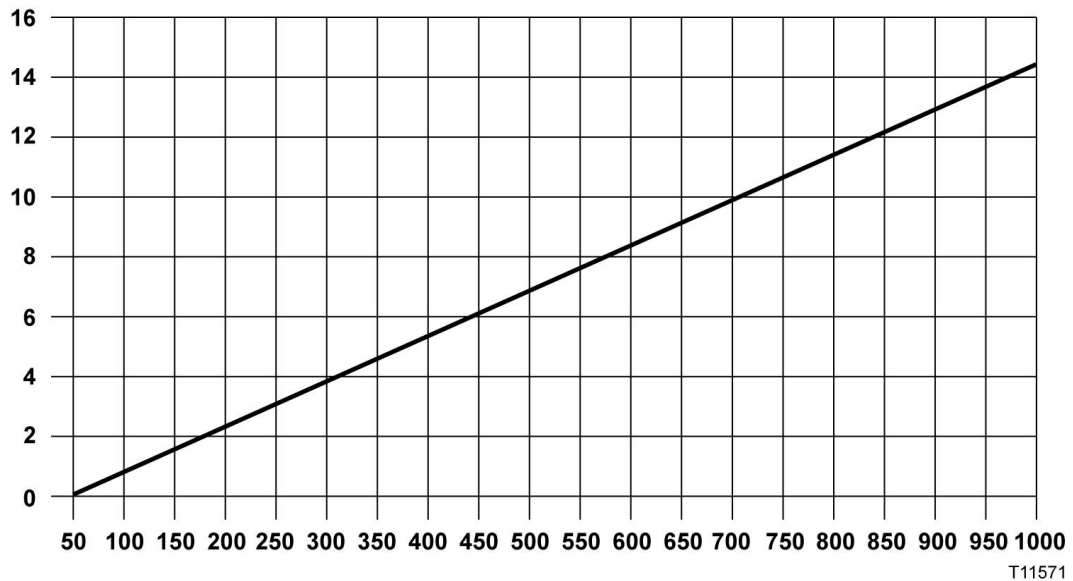
In This Appendix

- “Linear” Tilt Charts 88
- Forward Equalizer Loss Charts 90
- GainMaker Node Accessory Part Numbers..... 92
- Specifications..... 99

“Linear” Tilt Charts

Amplifier Output “Linear” Tilt Chart for 1 GHz

The following chart can be used to determine the operating level at a particular frequency considering the operating linear tilt.

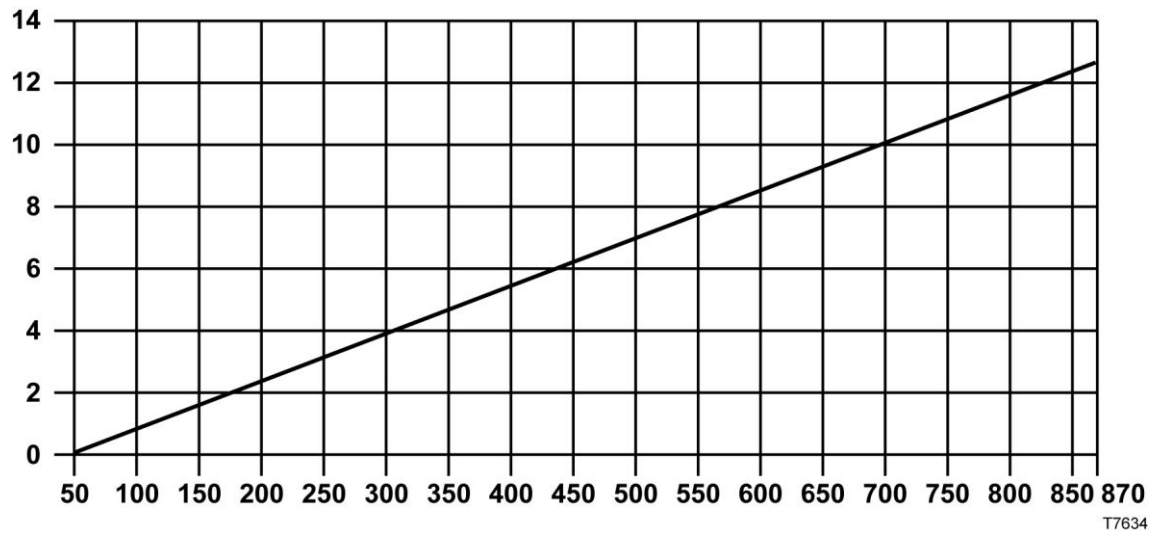


Example: If the amplifier’s 1 GHz output level is 49.0 dBmV with a linear operating tilt of 14.5 dB (from 50 to 1 GHz), the corresponding output level at 750 MHz would be 45.1 dBmV. This was found by taking the difference in tilt between 1 GHz and 750 MHz ($14.5 - 10.6 = 3.9$ dB). Then subtract the difference in tilt from the operating level ($49.0 - 3.9 = 45.1$ dBmV).

Amplifier Output “Linear” Tilt Chart for 870 MHz

The following chart can be used to determine the operating level at a particular frequency considering the operating linear tilt.

“Linear” Tilt Charts



Example: If the amplifier’s 870 MHz output level is 47.5 dBmV with a linear operating tilt of 12.5 dB (from 50 to 870 MHz), the corresponding output level at 650 MHz would be 44 dBmV. This was found by taking the difference in tilt between 870 and 650 MHz (12.5 - 9 = 3.5 dB). Then subtract the difference in tilt from the operating level (47.5 - 3.5 = 44 dBmV).

Forward Equalizer Loss Charts

1 GHz/870 MHz Forward Linear Equalizer Loss Chart

The following chart shows insertion loss for different EQ values at 1 GHz, 870 MHz, and various lower frequencies.

EQ Value (dB)	Insertion Loss at (MHz)									Total Tilt (52-1000 MHz)
	1000	870	750	650	600	550	86	70	52	
1.5	1.0	1.2	1.4	1.6	1.6	1.7	2.4	2.5	2.5	1.5
3.0	1.0	1.4	1.8	2.1	2.3	2.4	3.9	3.9	4.0	3.0
4.5	1.0	1.6	2.2	2.7	2.9	3.1	5.3	5.4	5.5	4.5
6.0	1.0	1.8	2.6	3.2	3.5	3.8	6.8	6.9	7.0	6.0
7.5	1.0	2.0	3.0	3.8	4.2	4.6	8.2	8.4	8.5	7.5
9.0	1.0	2.2	3.4	4.3	4.8	5.3	9.7	9.8	10.0	9.0
10.5	1.0	2.4	3.8	4.9	5.4	6.0	11.1	11.3	11.5	10.5
12.0	1.0	2.6	4.2	5.4	6.1	6.7	12.6	12.8	13.0	12.0
13.5	1.0	2.9	4.6	6.0	6.7	7.4	14.0	14.2	14.5	13.5
15.0	1.0	3.1	5.0	6.5	7.3	8.1	15.5	15.7	16.0	15.0
16.5	1.0	3.3	5.4	7.1	8.0	8.9	16.9	17.2	17.5	16.5
18.0	1.5	4.0	6.3	8.2	9.1	10.1	18.9	19.2	19.5	18.0
19.5	1.5	4.2	6.7	8.7	9.7	10.8	20.3	20.6	21.0	19.5
21.0	1.5	4.4	7.1	9.2	10.2	11.5	21.8	22.1	22.5	21.0

1 GHz/870 MHz Forward Inverse Cable Equalizer Loss Chart

The following table shows the 1 GHz and 870 MHz forward inverse cable equalizer loss.

Inv EQ Value (dB)		Insertion Loss at (MHz)									
1 GHz	870 MHz	52	70	55	86	550	600	650	750	870	1000
1.6	1.5	1.0	1.1	1.1	1.1	1.8	1.9	1.9	2.1	2.2	2.3
3.3	3.0	1.0	1.1	1.2	1.2	2.7	2.8	2.9	3.1	3.3	3.6
4.9	4.5	1.0	1.2	1.3	1.4	3.5	3.7	3.8	4.2	4.5	4.9
6.5	6.0	1.0	1.2	1.4	1.5	4.3	4.6	4.8	5.2	5.7	6.2
8.1	7.5	1.0	1.3	1.4	1.6	5.2	5.4	5.7	6.3	6.9	7.5
9.8	9.0	1.0	1.3	1.5	1.8	6.0	6.3	6.7	7.3	8.0	8.8
11.4	10.5	1.0	1.4	1.6	1.9	6.8	7.2	7.6	8.4	9.2	10.1
13.0	12.0	1.0	1.4	1.7	2.0	7.6	8.1	8.6	9.4	10.4	11.4
14.6	13.5	1.0	1.5	1.8	2.2	8.5	9.0	9.5	10.5	11.6	12.7
16.2	15.0	1.0	1.5	1.8	2.3	9.3	9.9	10.4	11.5	12.7	14.0

GainMaker Node Accessory Part Numbers

Attenuator Part Numbers

The following table provides part numbers and pad values for the GainMaker Node attenuators.

Attenuator Pad Value	Part Number
0 dB - 870 MHz/1 GHz	589693
0.5 dB - 870 MHz/1 GHz	589694
1.0 dB - 870 MHz/1 GHz	589695
1.5 dB - 870 MHz/1 GHz	589696
2.0 dB - 870 MHz/1 GHz	589697
2.5 dB - 870 MHz/1 GHz	589698
3.0 dB - 870 MHz/1 GHz	589699
3.5 dB - 870 MHz/1 GHz	589700
4.0 dB - 870 MHz/1 GHz	589701
4.5 dB - 870 MHz/1 GHz	589702
5.0 dB - 870 MHz/1 GHz	589703
5.5 dB - 870 MHz/1 GHz	589704
6.0 dB - 870 MHz/1 GHz	589705
6.5 dB - 870 MHz/1 GHz	589706
7.0 dB - 870 MHz/1 GHz	589707
7.5 dB - 870 MHz/1 GHz	589708
8.0 dB - 870 MHz/1 GHz	589709
8.5 dB - 870 MHz/1 GHz	589710
9.0 dB - 870 MHz/1 GHz	589711
9.5 dB - 870 MHz/1 GHz	589712
10.0 dB - 870 MHz/1 GHz	589713
10.5 dB - 870 MHz/1 GHz	589714
11.0 dB - 870 MHz/1 GHz	589715
11.5 dB - 870 MHz/1 GHz	589716
12.0 dB - 870 MHz/1 GHz	589717
12.5 dB - 870 MHz/1 GHz	589718

GainMaker Node Accessory Part Numbers

Attenuator Pad Value	Part Number
13.0 dB - 870 MHz/1 GHz	589719
13.5 dB - 870 MHz/1 GHz	589720
14.0 dB - 870 MHz/1 GHz	589721
14.5 dB - 870 MHz/1 GHz	589722
15.0 dB - 870 MHz/1 GHz	589723
15.5 dB - 870 MHz/1 GHz	589724
16.0 dB - 870 MHz/1 GHz	589725
16.5 dB - 870 MHz/1 GHz	589726
17.0 dB - 870 MHz/1 GHz	589727
17.5 dB - 870 MHz/1 GHz	589728
18.0 dB - 870 MHz/1 GHz	589729
18.5 dB - 870 MHz/1 GHz	589730
19.0 dB - 870 MHz/1 GHz	589731
19.5 dB - 870 MHz/1 GHz	589732
20.0 dB - 870 MHz/1 GHz	589733
20.5 dB - 870 MHz/1 GHz	589734

1 GHz/870 MHz Forward Linear Equalizer Part Numbers

The following table provides part numbers and corresponding EQ values for the forward linear equalizers available for 1 GHz/870 MHz GainMaker Node products.

Forward Linear EQ Part Number	1 GHz EQ Value	870 MHz Equivalent EQ Value
4007228	0 dB	0 dB
4008778	1.5 dB	1.3 dB
4008779	3.0 dB	2.6 dB
4008780	4.5 dB	3.9 dB
4008781	6.0 dB	5.2 dB
4008782	7.5 dB	6.5 dB
4008783	9.0 dB	7.8 dB
4008784	10.5 dB	9.1 dB
4008785	12.0 dB	10.4 dB
4008786	13.5 dB	11.6 dB
4008787	15.0 dB	12.9 dB
4019258	16.5 dB	14.2 dB
4019259	18.0 dB	15.5 dB
4019260	19.5 dB	16.8 dB
4019261	21.0 dB	18.1 dB

1 GHz/870 MHz Forward Inverse Equalizer Part Numbers

The following table shows the part number and pad values for the GainMaker Node 1 GHz/870 MHz forward inverse equalizers.

Inverse EQ	Part Number
1.6/1.5 dB - 1 GHz/870 MHz	4007486
3.3/3.0 dB - 1 GHz/870 MHz	4007487
4.9/4.5 dB - 1 GHz/870 MHz	4007488
6.5/6.0 dB - 1 GHz/870 MHz	4007489
8.1/7.5 dB - 1 GHz/870 MHz	4007490
9.8/9.0 dB - 1 GHz/870 MHz	4007491
11.4/10.5 dB - 1 GHz/870 MHz	4007492

GainMaker Node Accessory Part Numbers

Inverse EQ	Part Number
13.0/12.0 dB - 1 GHz/870 MHz	4007493
14.6/13.5 dB - 1 GHz/870 MHz	4007494
16.2/15.0 dB - 1 GHz/870 MHz	4007495

Plug-in Pad Part Numbers

The following chart provides part numbers and pad values for the GainMaker Node plug-in pads.

Plug-in Pad Value	Part Number
0 dB	279500
0.5 dB	565231
1.0 dB	279501
1.5 dB	565232
2.0 dB	279502
2.5 dB	565233
3.0 dB	279503
3.5 dB	565234
4.0 dB	279504
4.5 dB	565235
5.0 dB	279505
5.5 dB	565236
6.0 dB	279506
6.5 dB	565237
7.0 dB	279507
7.5 dB	565238
8.0 dB	279507
8.5 dB	565239
9.0 dB	279508
9.5 dB	565240
10.0 dB	279510
10.5 dB	565241
11.0 dB	279511
11.5 dB	565242
12.0 dB	279512
12.5 dB	565243
13.0 dB	279513
13.5 dB	565244

GainMaker Node Accessory Part Numbers

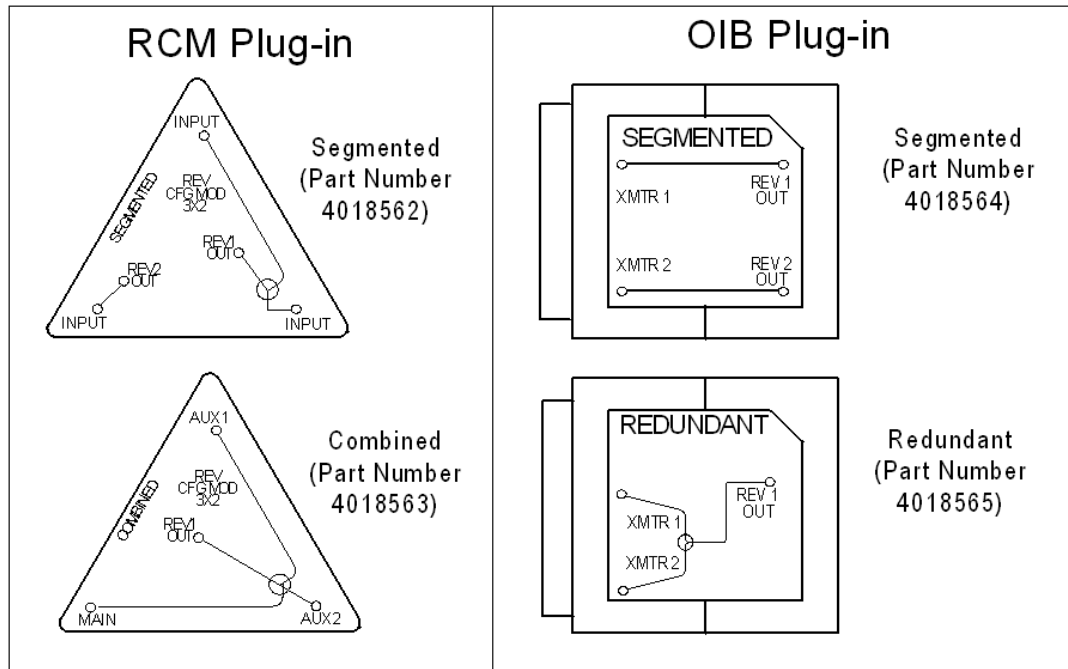
Plug-in Pad Value	Part Number
14.0 dB	504151
14.5 dB	565245
15.0 dB	504152
15.5 dB	565246
16.0 dB	504153
16.5 dB	565247
17.0 dB	504154
17.5 dB	565248
18.0 dB	504155
18.5 dB	565249
19.0 dB	504156
19.5 dB	565250
20.0 dB	504157
20.5 dB	565251
75 Ohm	279524

Configuration Plug-in Module Part Numbers

The following diagram provides part numbers for the Reverse Configuration Module (RCM) and Optical Interface Board (OIB) modules.

Note: The part numbers shown are for a box of five modules of the specified type.

GainMaker Node Accessory Part Numbers

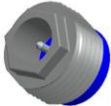


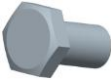




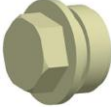





not to scale

TP225

Specifications

Torque Specifications

Fastener	Torque Specification	Illustration
Seizure nut	2 ft-lb to 5 ft-lb (2.7 Nm to 6.8 Nm)	
Housing hinge screw	5 in-lb to 8 in-lb (0.56 Nm to 0.90 Nm)	
Power supply module securing screws	18 in-lb to 20 in-lb (2.0 Nm to 2.3 Nm)	
Strand clamp mounting bracket bolts	5 ft-lb to 8 ft-lb (6.8 Nm to 10.8 Nm)	
Pedestal mounting bolts	8 ft-lb to 10 ft-lb (10.8 Nm to 13.6 Nm)	
75 ohm terminator	Per manufacturer instructions	(Appearance varies by manufacturer)
System amplifier module shoulder screws (slotted head)	6 in-lb to 9 in-lb (0.7 Nm to 1.0 Nm)	
System amplifier module shoulder screws (cross head)	18 in-lb to 20 in-lb (2.0 Nm to 2.3 Nm)	
Housing closure bolts	5 ft-lb to 12 ft-lb (6.8 Nm to 16.3 Nm)	
Housing plugs Test point port plugs	5 ft-lb to 8 ft-lb (6.8 Nm to 10.8 Nm)	
Module securing screws (Tx, Rx, PS, SM/LCM modules)	25 in-lb to 30 in-lb (2.8 Nm to 3.4 Nm)	
RF cable connector	Per manufacturer instructions	
Fiber optic cable connector	20 ft-lb to 25 ft-lb (27.1 Nm to 33.9 Nm)	

B

bdr Digital Reverse Multiplexing Applications

This appendix explains the installation and application of the bdr Digital Reverse 2:1 Multiplexing System in the 1 GHz GainMaker Node.

The integrated 2:1 bdr digital reverse module belongs to the Prisma® family of products that employ the baseband digital reverse technology. These products are intended for digital transmission of reverse path signals over a fiber optic link from the node to the headend.

The bdr Digital Reverse 2:1 Multiplexing System expands the functionality of the node by increasing the performance, reach, and efficiency of the reverse path transmissions.

In This Appendix

■ Digital Reverse System Overview	102
■ Digital Reverse Transmitter Module Installation.....	110
■ Transmitter Module Setup Procedure	112
■ Reverse Balancing the Node with Digital Reverse Modules.....	113
■ Troubleshooting.....	116

Digital Reverse System Overview

Features

The bdr Digital Reverse 2:1 Multiplexing System has the following features.

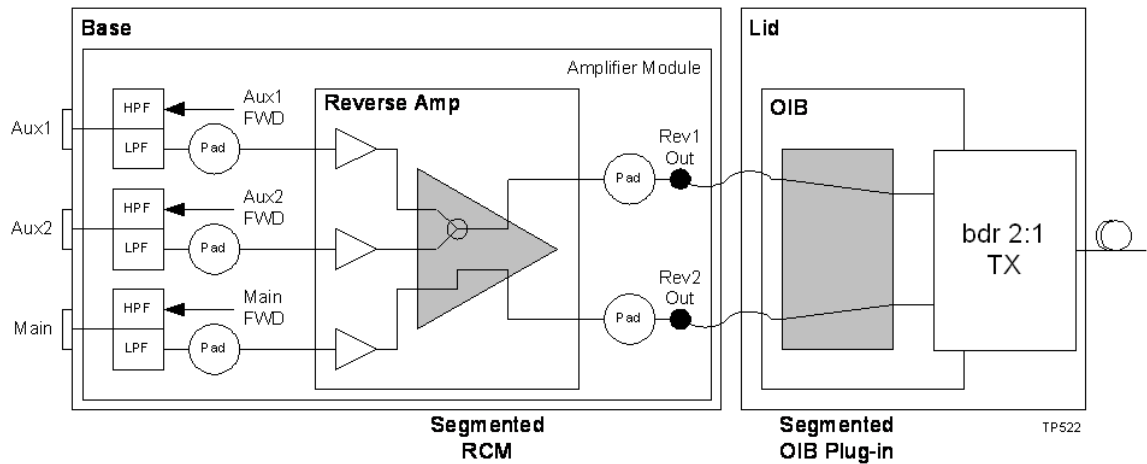
- High-performance bdr digital reverse technology, 12 bit encoding enables transmission of analog video and high-order digital modulation signals (e.g., 16 QAM, 64 QAM, and 256 QAM)
- 2:1 time division multiplexing reduces requirements for costly 1550 nm ITU transmitters by 50%
- Long reach transmission capabilities eliminate need for optical amplifiers reducing cost and space requirements
- Capable of sending four individual 5-42 MHz reverse signals over a single fiber
 - Leverages 2:1 time division multiplexing for doubling fiber usage
 - Compatible with our 22 wavelength Dense Wave Division Multiplexing (DWDM) system
- Flexible RF combining enables balancing of the reverse traffic from each of the four node ports
- Simplified set-up reduces installation time and expertise requirements
- Distance and temperature independent link performance simplifies engineering and maintenance requirements
- Space-saving, high-density deployment in Prisma II™ platform increases deployment cost efficiency
- High-speed remote control and monitoring via our ROSA® / TNCS system

System Functional Diagrams

1 GHz GainMaker Node Configuration

The following diagram shows how the 1 GHz GainMaker Reverse Segmentable Node functions in baseband digital reverse configuration with an integrated 2:1 bdr transmitter module installed.

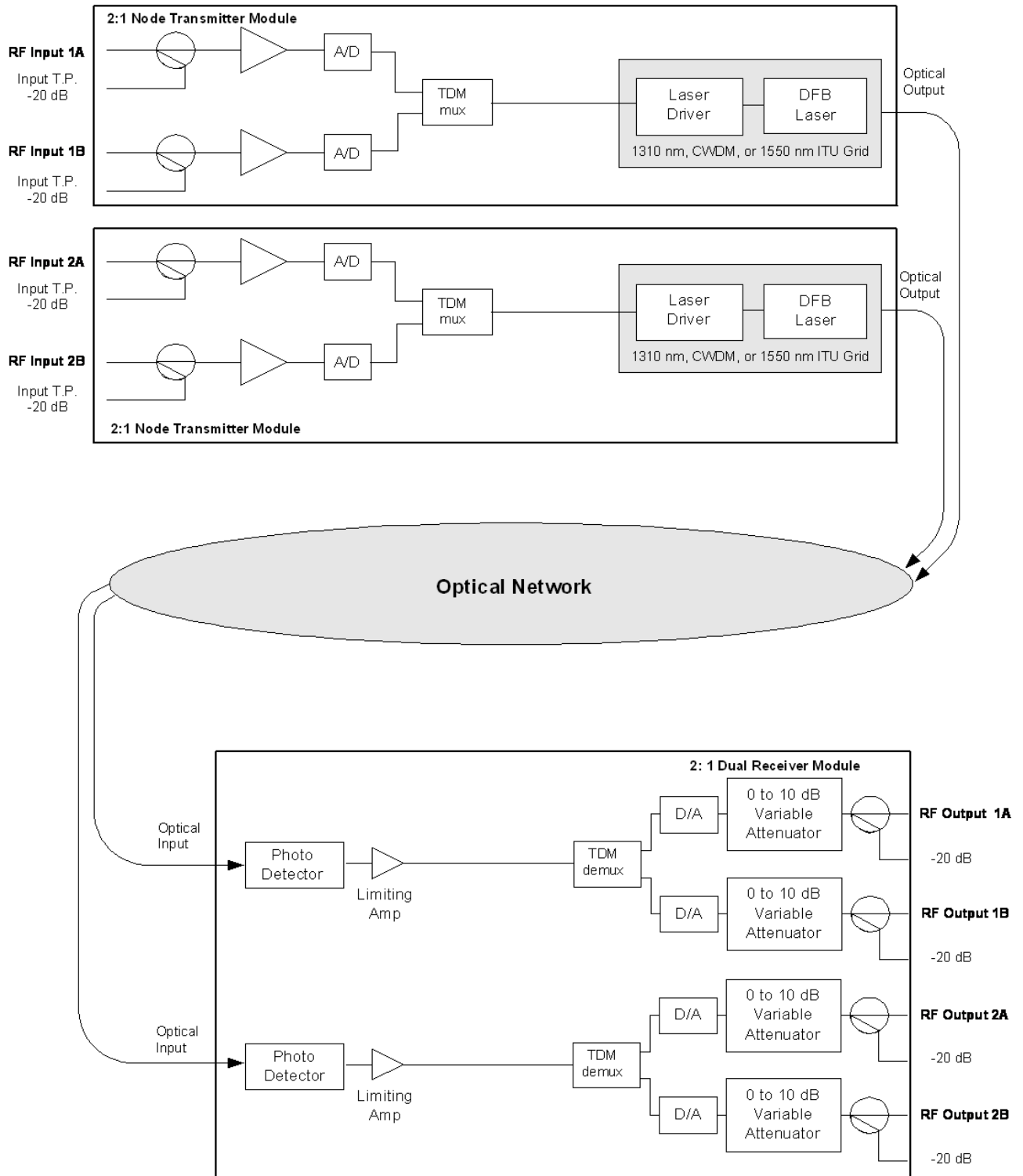
The Segmented Reverse Path configuration shown in the following diagram is recommended for use with the bdr 2:1 transmitter module.



Important: The Segmented Reverse Path configuration requires a Segmented RCM, part number 4015143, and a Segmented OIB plug-in, part number 4015162. For additional details, see *Configuring the Reverse Path* (on page 61).

System Block Diagram

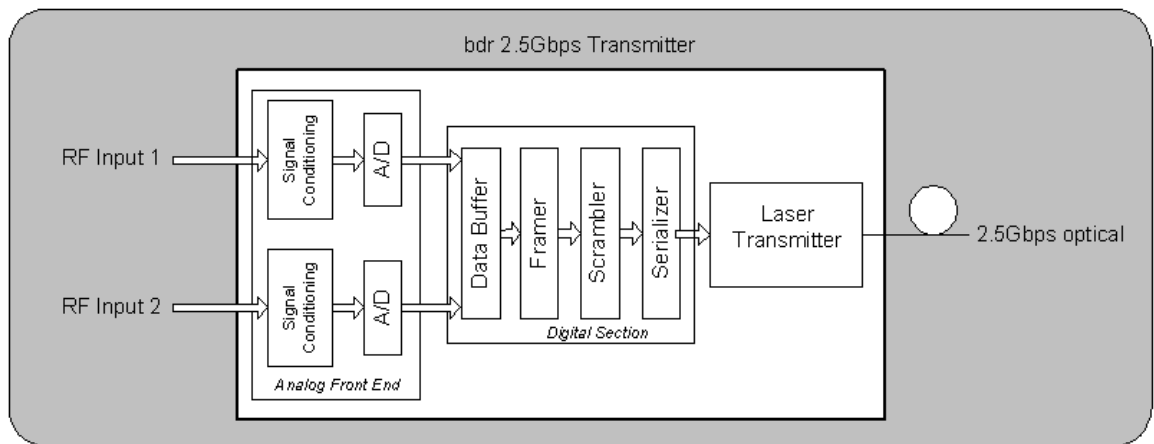
The following is a block diagram of the bdr Digital Reverse 2:1 Multiplexing System.



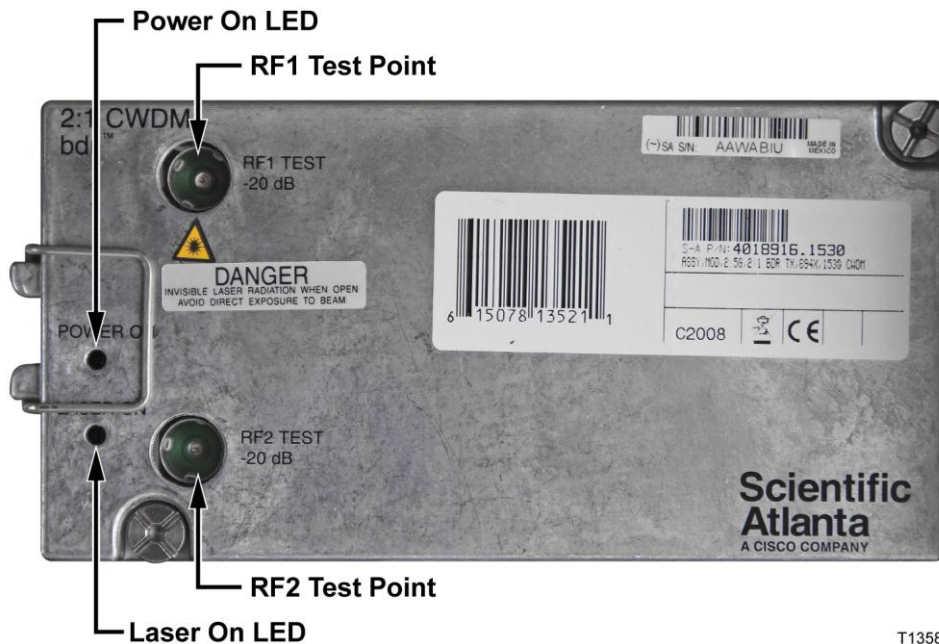
2:1 bdr Transmitter Module

At the node (transmit) end of the system, the 5 to 42 MHz reverse path RF input signals from each of the node's ports are combined and routed to an Integrated 2:1 bdr Reverse Optical Transmitter Module in the housing lid. There, two RF inputs produce two discrete 5 to 42 MHz RF signals. The transmitter module also converts each signal to a baseband digital data stream and time division multiplexes the two streams into a single data stream. The baseband data stream is converted to an optical signal for transmission back to the headend or hub at 1310 nm for either CWDM or DWDM channels. ITU grid wavelengths are used for DWDM applications.

The following block diagram shows the transmitter module's internal components.



The following illustration shows the transmitter module.

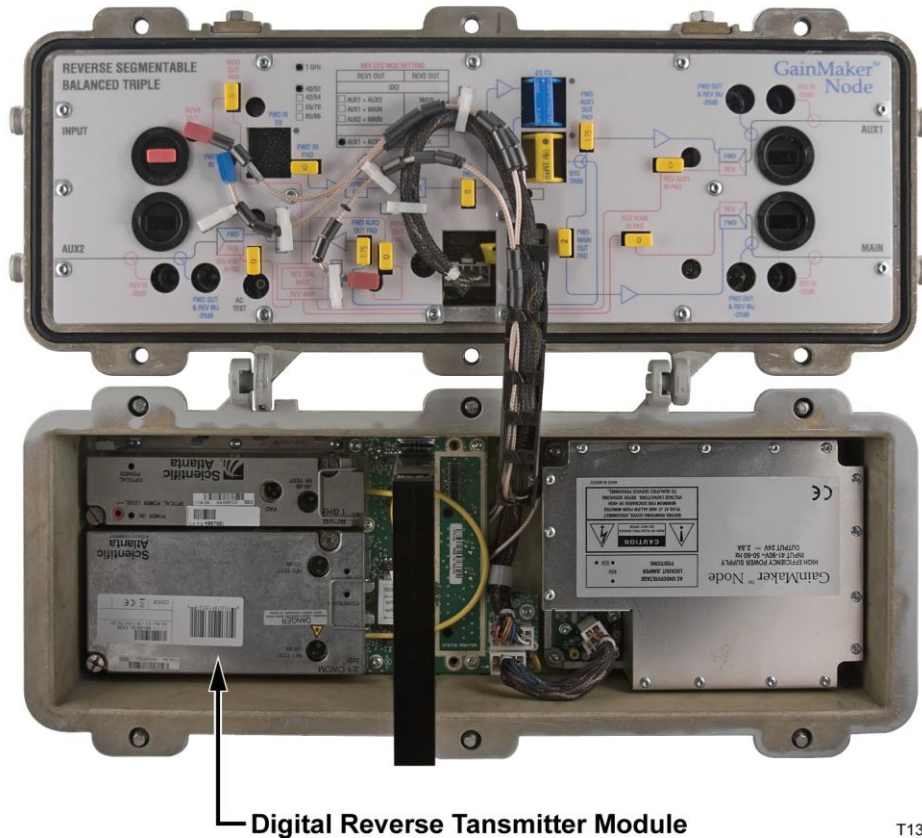


T13588

Digital Reverse System Overview

The transmitter module uses the same style housing as the optical receivers and transmitters, except that it uses a double-wide module housing. As such, it occupies two standard transmitter positions in the node lid.

The following illustrations show the location of the modules in the node.



T13589

Transmitter Status Indicators

The transmitter module has two status indicator LEDs.

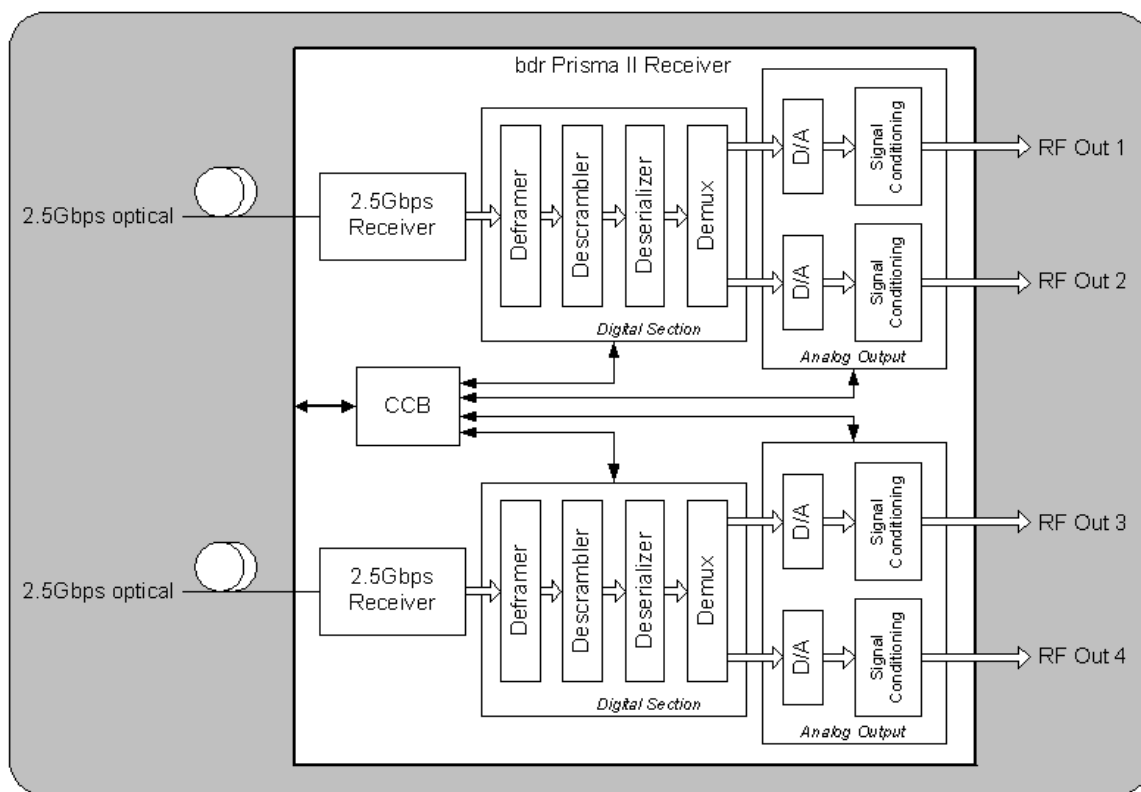
Status LED	Indication
Laser On (green)	ON - The laser is on and functioning with no faults reported. OFF - A laser fault condition exists.
Power On (green)	ON - Power supply is good and module is receiving power. OFF - Module is not receiving power from the power supply.

2:1 bdr Dual Receiver Module

On the receive end, typically in a large hub or headend, the bdr Dual Receiver Module receives the optical signal, performs conversion back to the baseband data stream, demultiplexes the data stream and converts the two resultant data streams back to analog reverse path signals for routing to termination equipment.

The bdr Dual Receiver Module contains two independent receivers, each with its own optical input and pair of RF outputs, integrated into one module. This equipment is housed in the Prisma II Chassis, the industry's first carrier-class platform – providing critical network reliability, equipment density, and high performance functionality. For instructions on installing the receiver, refer to the *Prisma II™ Integrated bdr 2:1 Dual Receiver Module Installation and Operation Guide*, part number 4021745.

The following block diagram shows the receiver module's internal components.



The following illustration shows the receiver module.



Digital Reverse Transmitter Module Installation

Before You Begin

Overview

Perform these installation instructions only if you are upgrading the 1 GHz GainMaker Reverse Segmentable Node with the digital reverse modules. If your node came with the digital reverse modules installed, go to *Reverse Balancing the Node with Digital Reverse Modules* (on page 113).

Required Tools

The following tools and equipment are needed to configure and install the digital reverse modules.

- 1/2-inch hex driver or ratchet
- Two adjustable wrenches for coaxial connectors
- Standard flat-head or phillips-head screwdriver
- Torque wrench, capable of settings up to 100 in-lb (11.3 Nm)

Operating Environment

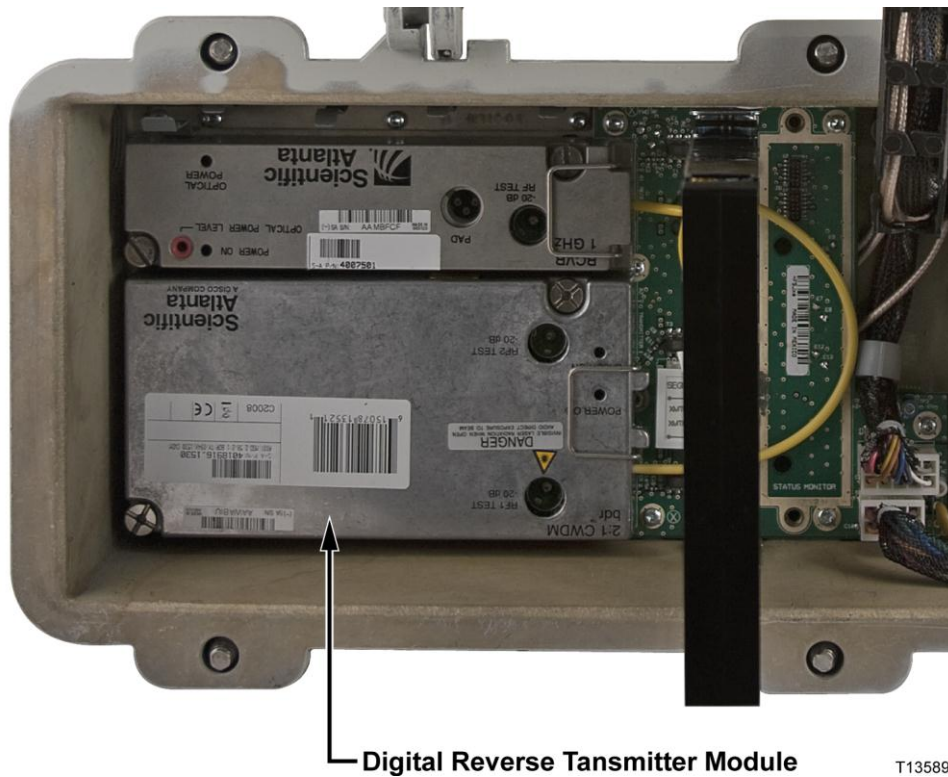
Before operating the node with the digital reverse modules installed, ensure that the operating environment meets the following standards.

- Ambient temperature range outside the node must be maintained between -40°C and +60°C (-40°F to 140°F).
- Storage temperature range of the digital reverse modules must be maintained between -40°C to +85°C (-40°F to 185°F).
- Humidity range must be maintained between 5% to 95% non-condensing before installation of the bdr digital reverse module(s).

To Install the Transmitter Module

The bdr transmitter module uses the same style housing as the optical receivers and transmitters, except that it uses a double-wide module housing. As such, it occupies two standard transmitter positions in the node lid.

The following illustrations show the location of the installed modules in the node.



Complete the following steps to install the bdr transmitter module.

- 1 See To Remove or Reinstall the Optical Transmitter for instructions on removing and installing the module in the housing.
- 2 Remove any existing transmitter modules from the positions in which you want to install the bdr transmitter module.
- 3 Install the bdr transmitter module in the housing lid in transmitter positions XMTR 1/XMTR 2.
- 4 Configure the node reverse path for Segmented Reverse Path operation as described in *Configuring the Reverse Path* (on page 61). Note that this configuration requires a Segmented RCM, part number 4015143, and a Segmented OIB plug-in, part number 4015162.



WARNING:

Laser transmitters when 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.

Transmitter Module Setup Procedure

Perform the following steps to set up the reverse transmitter module.

- 1 Open the housing. Refer to *To Open the Node Housing* (on page 17).
- 2 In the base of the housing, verify that the amplifier is configured for Segmented Reverse Path operation as described in *Configuring the Reverse Path* (on page 61).
- 3 Verify the level of the reverse path RF signal at the RF test points on the RF module. Nominal level is +17 dBmV per channel. Install the appropriate value input pad at the REV PORT IN PAD location to give the desired signal level into the node.
- 4 Repeat step 3 for each RF cable carrying a reverse path signal.
- 5 Measure the transmitter module optical output power.
- 6 Check the connection of the optical connector. Make sure the optical connector is seated and verify fiber bend radius is greater than 1 inch.



WARNING:

When handling optical fibers always follow laser safety precautions.

Reverse Balancing the Node with Digital Reverse Modules

Introduction

This section explains the reverse balancing procedures for the 1 GHz GainMaker Node using digital reverse modules.

When balancing the reverse path, reference your system design print for the required reverse signal level. Use appropriate padding and equalization to provide proper signal level to the reverse transmitter.



CAUTION:

Never attempt to reconfigure the unit beyond its normal setup. Changes to the node configuration may cause degradations that affect its performance. Do not use digital carrier measurement to set up the forward or reverse paths. Familiarize yourself with your cable system specifications before performing the setup.

The 2:1 baseband digital reverse technology is designed to carry reverse path signals from 5 MHz to 42 MHz. This technology digitizes the analog input and then sends a high-speed serial bitstream over fiber to a digital receiver at the link end. By converting the analog RF band to a digital format, two full bandwidth digital links can be multiplexed together over the same fiber and recovered at the receiver.

There are various 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. A reverse RF test signal (or signals) of known amplitude is injected into the RF path at the RF input of the node. The reverse transmitter converts the RF test signal(s) to an optical signal and transmits it to the headend (or hub site) via fiber optic cable. At the headend, the reverse optical receiver converts the optical signal back to an RF signal that is then routed out through the receiver RF output. The amplitude of the injected test signal must be monitored at the receiver output, and compared to the expected (design value) amplitude.

Method of Generating and Monitoring Test Signals

The reverse RF test signals that are injected into the reverse path of the RF launch amplifier being balanced may be generated by the following method.

- Multiple CW signal (tone) generator
- Reverse sweep transmitter

The amplitude of the received test signals at the output of the reverse optical receiver in the headend or hub may be measured and monitored using the following:

- Spectrum analyzer (when using a CW generator for test signals)

Reverse Balancing the Node with Digital Reverse Modules

- Signal level meter (when using a CW generator for test signals)
- Reverse sweep receiver (when using a reverse sweep transmitter for test signal)

The variance in relative amplitude of the received signal from desired (reference) may be relayed to the field technician via the following:

- Radio (by a second technician in the headend/hub who is monitoring a spectrum analyzer or signal level meter)
- A dedicated forward TV channel, whose associated modulator has its video input being generated by a video camera focused on the spectrum analyzer display
- An associated forward data carrier (if using a particular type of reverse sweep system)

If a portable reverse sweep generator with built-in forward data receiver is used to generate the reverse test signals, only one technician is required to perform the balancing. This type of system is becoming increasingly popular due to its ease of use.

In this case, the sweep system includes a combination reverse sweep receiver and forward data transmitter, which is located in the headend/hub. The frequency response characteristics of the received sweep signal (including relative amplitude and tilt) are converted by the headend sweep receiver to a data format, and transmitted in the forward RF path as a data carrier (by combining it into the forward headend combiner). The portable sweep generator/data receiver that is injecting the test signal into the RF launch amplifier's reverse path in the field is simultaneously receiving the incoming data carrier via the forward RF path. The incoming data is converted back to a sweep display that represents what is being received by the headend unit.

Reverse Balancing and Alignment Procedure

Overview

Baseband digital reverse technology is designed to have a constant link gain, regardless of the length of fiber or amount of passive optical loss in the link. That is, if the RF signal amplitude of all ports in all nodes is set to a constant value, the signal level at the output of the receiver will be balanced automatically to a constant power level. Minor differences in levels can be trimmed out at the receiver with no penalty to link performance.

Balancing and Alignment

Follow these steps to reverse balance and align the node with digital reverse modules.

- 1 Refer to the reverse system design print on the RF amplifier assembly cover and inject the proper level into the reverse injection (forward output) test point of a port of the RF launch amplifier with a reverse sweep transmitter or a CW signal generator. The insertion loss of all forward output test points is 20 dB (relative to corresponding port).

Note: For the location of the reverse injection test point of each port, see *Illustrations* (on page 8).

Reverse Balancing the Node with Digital Reverse Modules

Important: To calculate the correct signal level to inject, add the reverse input level (from the design print) to the insertion loss of the reverse injection test point.

Formula:

Reverse input + Insertion loss = Signal generator setting

Example:

Reverse input = 17 dBmV

Insertion loss = 20 dBmV

Result: Signal generator setting = 17 dBmV + 20 dB = 37 dBmV

Note: The ADC full-scale (100%) level for a single CW carrier is +33 dBmV. This is the level at which the ADC begins clipping.

Note: The reverse attenuator (pad) and reverse equalizer in the 1 GHz GainMaker Node is selected during the reverse system design, and it is based on the drive level into the digital module which is determined by system performance requirements, type and quantity of return carriers, etc. Consult data sheet to determine proper operational level.

- 2 Verify the level of the reverse output test point. This output level leaves the RF launch amplifier via the coaxial cable to the multiplexing digital module input. (Use an SMB connector to F-connector test cable.)
- 3 Have the person in the headend refer to the headend system design and set the output of the bdr receiver to the specified output level. See the instruction guide that was shipped with bdr receiver for setup procedures.

Troubleshooting

Equipment

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

- Fiber optic ferrule cleaner, part number 468517, to clean fiber optic connectors
- 99% alcohol and lint free wipes to clean fiber connectors
- Optical power meter to measure light levels
- Proper fiber connector for optical power meter to make optical connections
- Digital voltmeter to measure voltages
- Spectrum analyzer or a field strength meter to measure RF levels
- Test probe, part number 501111, to access test points
- External test probe, part number 562580, to access external test points

Transmitter Module Troubleshooting Chart

Follow the steps in the table below to troubleshoot the transmitter module.

Symptom	Possible Cause	Possible Solutions
No optical signal output	Laser temperature could be too high or low.	Allow up to one minute after power is ON for the temperature to stabilize. If still no output, contact the Scientific Atlanta Technical Service Center for assistance.
	Laser could be faulty.	Contact the Scientific Atlanta Technical Service Center for assistance.
	Automatic power control circuit failure.	Contact the Scientific Atlanta Technical Service Center for assistance.
	Damaged fiber.	Contact the Scientific Atlanta Technical Service Center for assistance.

Symptom	Possible Cause	Possible Solutions
No optical signal output (cont'd)	One or more power supply voltages are out of specification.	Check the power supply for proper operation.
	No AC at receptacle.	Check the receptacle for AC power.
	Blown fuse on the power supply.	Check the power supply fuse and replace as necessary.
	Faulty module.	Contact the Scientific Atlanta Technical Service Center for assistance.



EDR Digital Return Multiplexing Applications

This appendix explains the installation and application of the Cisco Enhanced Digital Return (EDR) 85 Multiplexing System in the Model GS7000 GainMaker Scalable 4-Port Node.

The products are intended for digital transmission of reverse path signals over a fiber optic link from the node to the headend.

The Cisco Enhanced Digital Return (EDR) 85 System expands the functionality of GS7000 and GainMaker 4-Port and Reverse Segmentable Nodes by increasing the performance, reach, and efficiency of the reverse path transmissions.

The Cisco EDR 85 System includes EDR Transmitter modules that install in GainMaker and GS7000 Nodes, and companion Cisco Prisma® high-density (HD) EDR PRX85 Receiver modules that install in a Prisma II or Prisma II XD chassis at the headend or hub. The transmitter and receiver use Small Form Factor Pluggable (SFP) optical pluggable modules (OPMs) for enhanced flexibility. The Cisco EDR 85 System operates over the 5-85 MHz range and supports all standard reverse frequency bandwidths at 40, 42, 55, 65, and 85 MHz.

The Cisco Enhanced Digital Return (EDR) 85 Systems includes the EDR 1:1 multiplexing system and the 2:1 multiplexing system.

In This Appendix

■ EDR System Overview.....	132
■ EDR Transmitter Module Installation	145
■ Transmitter Module Setup Procedure	150
■ Reverse Balancing the Node with EDR Modules.....	152
■ Troubleshooting.....	156

Enhanced Digital Return System Overview

Features

The EDR Enhanced Digital Return 1:1 and 2:1 Multiplexing Systems have the following features.

- High-performance Digital Return technology
 - 12 bit encoding enables transmission of analog video in the reverse band
 - High-order digital modulation signals (e.g., 16 QAM, 64 QAM, and 256 QAM)
- Multiple operating modes in the EDR receiver support EDR transmitter and legacy integrated bdr node transmitter
- Optical Pluggable Modules (OPM) enable flexible inventory management
- Long reach transmission capabilities eliminate the need for optical amplifiers, reducing cost and space requirements
- Capable of sending 80 individual 5 – 85 MHz reverse signals over a single fiber
 - Compatible with Cisco's 40 wavelength DWDM system
- Enables independent balancing of reverse traffic at EDR receiver RF ports
- Simplified setup reduces installation time and expertise requirements
- Distance- and temperature-independent link performance simplifies engineering and maintenance requirements
- Space-saving, high-density deployment in Prisma II or Prisma II XD chassis increases deployment cost-efficiency
- Optional monitoring of node (GS7000) and Tx (GS7000 and GainMaker) parameters available at the receiver

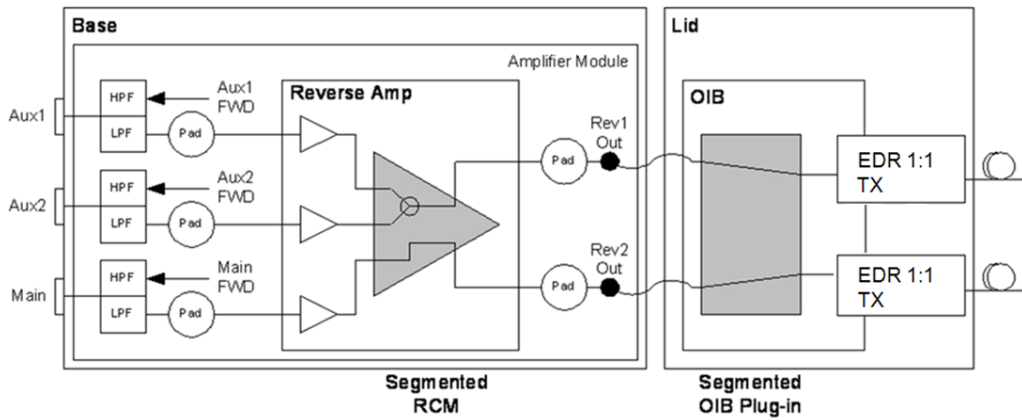
Same as the bdr multiplexing system, the EDR 2:1 Enhanced Digital Return Multiplexing System also leverages 2:1 multiplexing to reduce fiber usage.

System Functional Diagrams

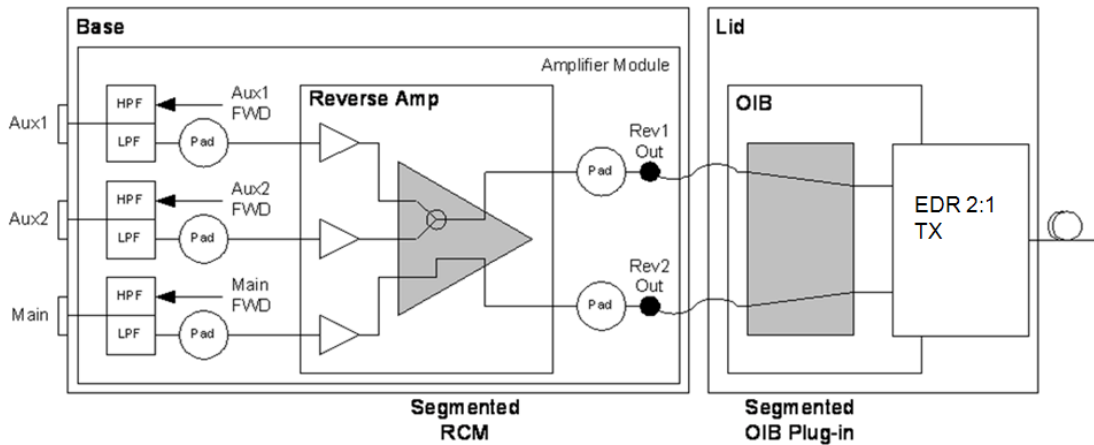
1 GHz GainMaker Node Configuration

The following diagram shows how the 1 GHz GainMaker Reverse Segmentable Node functions in enhanced digital return configuration with an 2:1 EDR transmitter module or up to 2 1:1 EDR transmitter modules installed.

The reverse path configuration shown in the following diagram is recommended for use with the EDR 1:1 transmitter module.



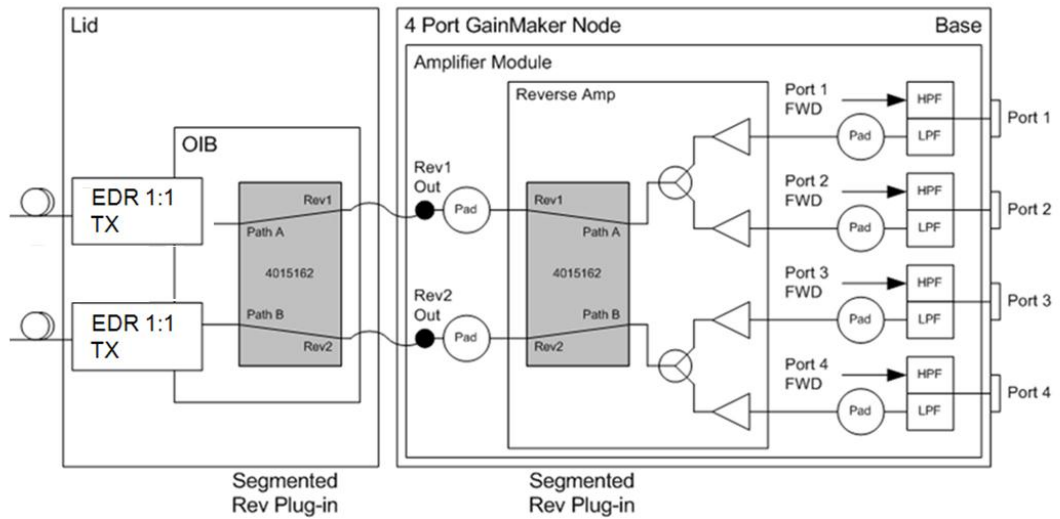
The reverse path configuration shown in the following diagram is recommended for use with the EDR 2:1 transmitter module.



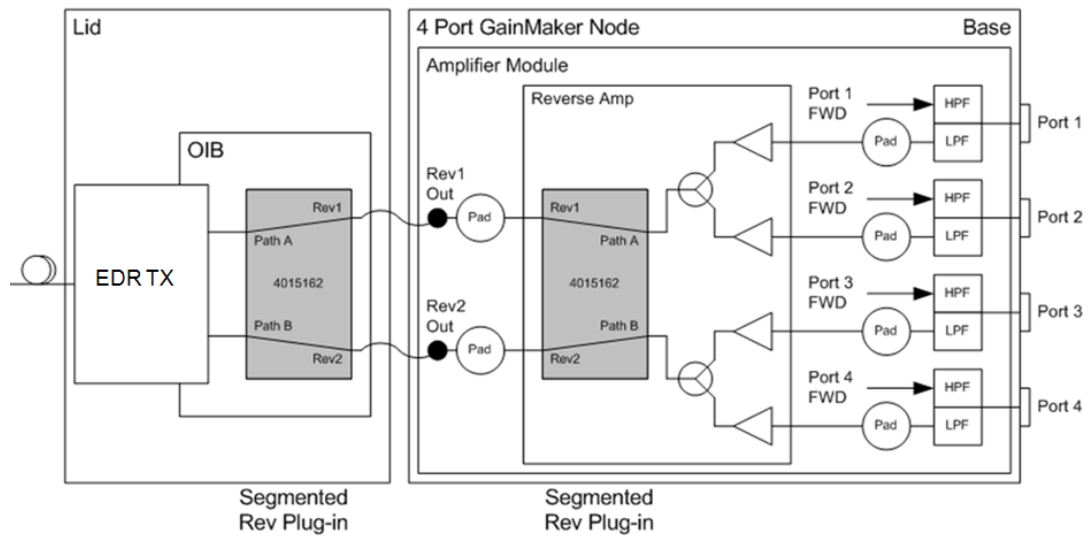
4-Port GainMaker Node Configuration

The following diagrams show how the 4-port GainMaker node functions in an enhanced digital return configuration with the EDR transmitters installed.

When the EDR 1:1 Transmitter is installed:



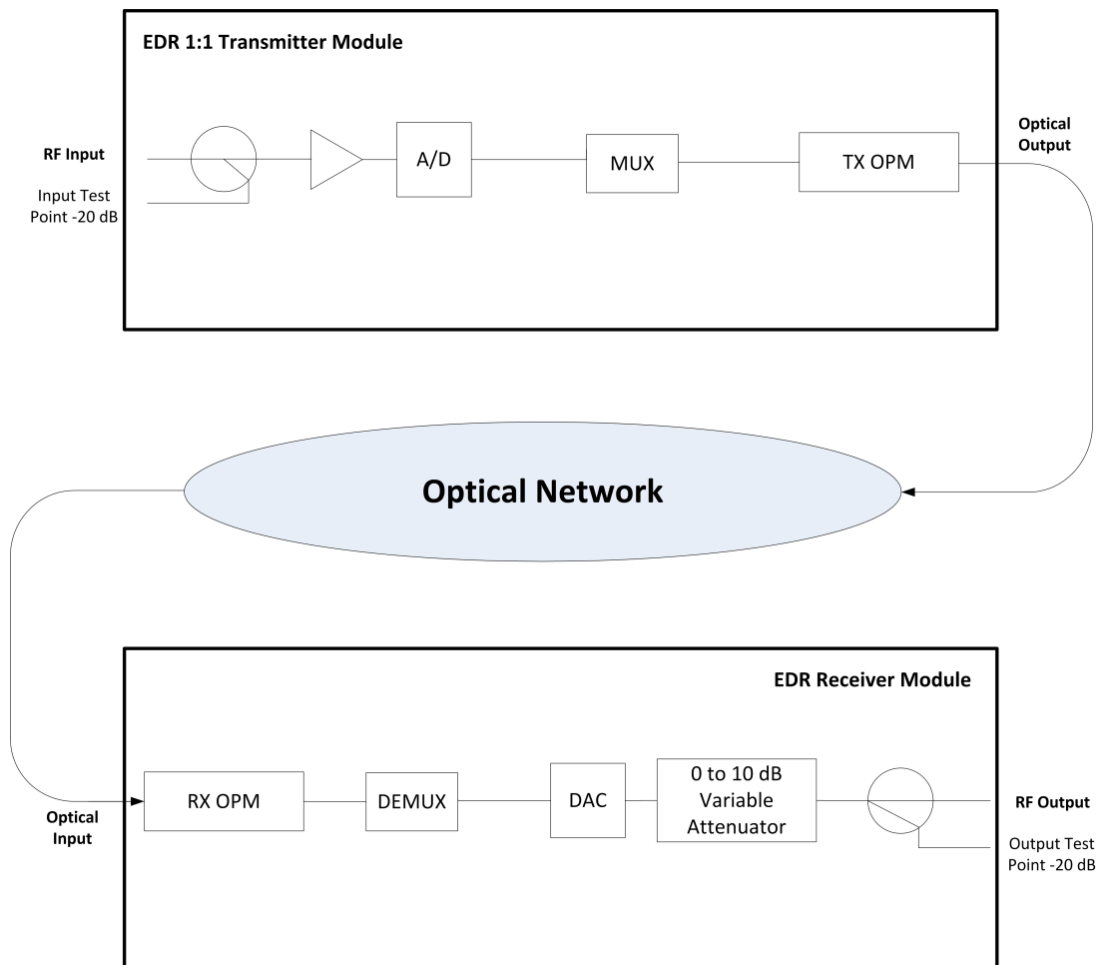
When the EDR 2:1 Transmitter is installed:



System Block Diagram

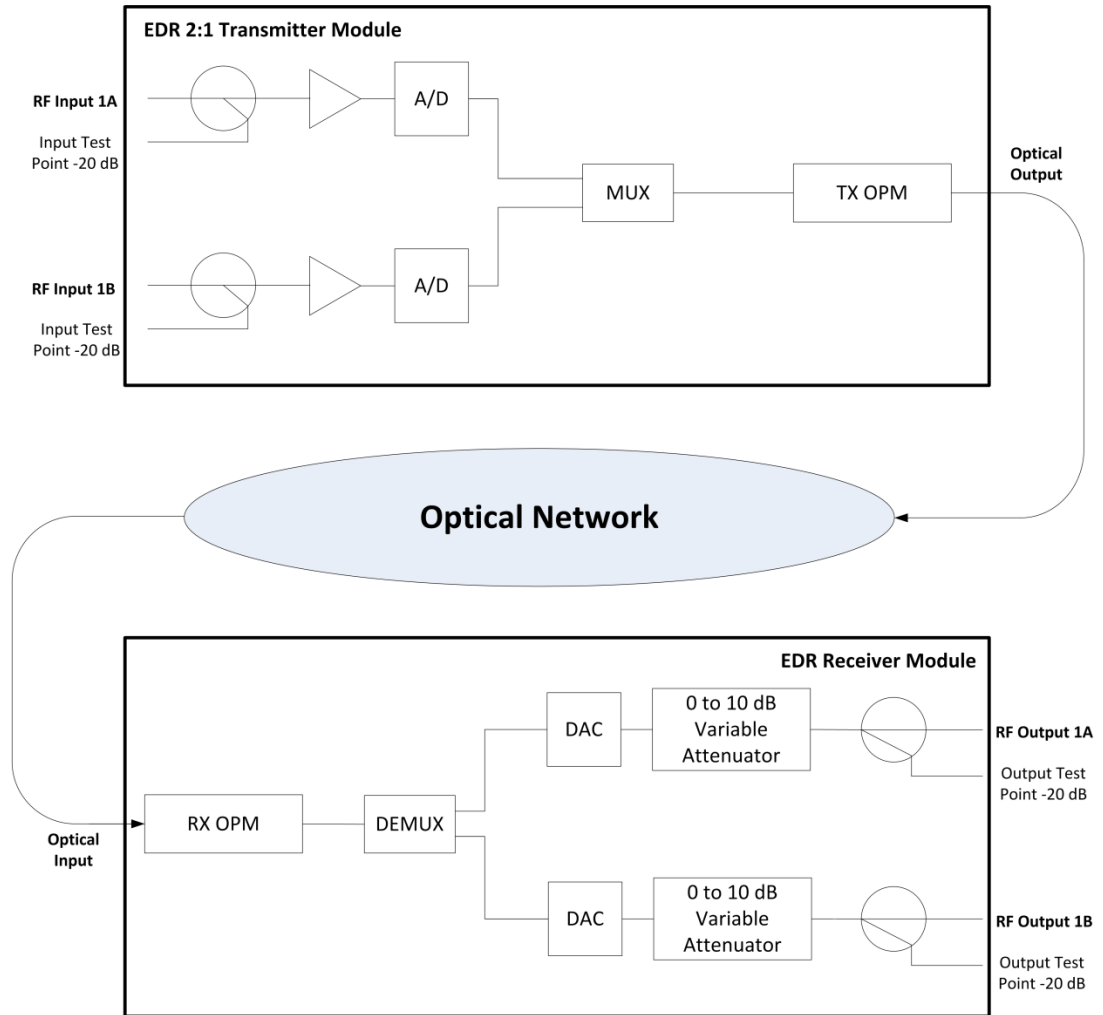
System Block Diagram For EDR 1:1 Transmitter Module

The following is a block diagram of the EDR Enhanced Digital Return 1:1 Multiplexing System.



System Block Diagram For EDR 2:1 Transmitter Module

The following is a block diagram of the EDR Digital Return 2:1 Multiplexing System.



EDR Transmitter Module

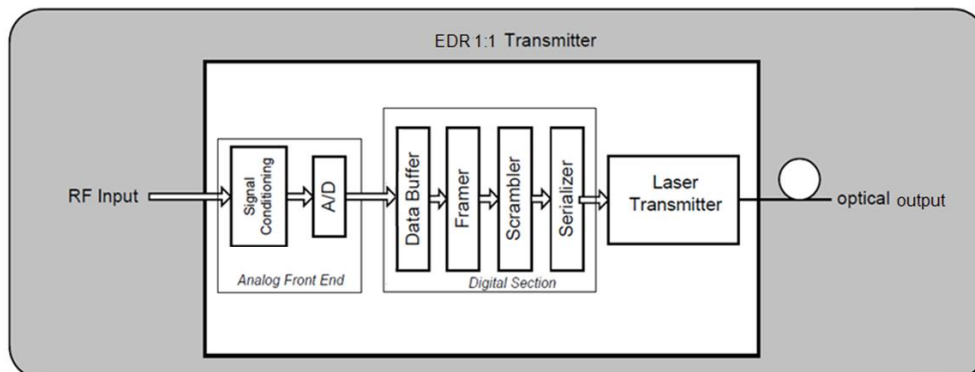
At the transmit (node) end of the system, reverse-path RF input signals from each node port are routed to an EDR 2:1 or EDR 1:1 Transmitter module in the housing lid. The transmitter module converts each signal to a baseband digital data stream and combines the signals into a serial data stream using time-division multiplexing (TDM). The baseband data stream is then converted to an optical signal for transmission to the headend or hub. The double-wide (2:1) transmitter modules occupy two transmitter slots and the 1:1 modules occupy one slot.

Two RF inputs produce two discrete 5 to 85 MHz RF signals. The EDR 1:1 transmitter module converts each signal to a EDR data stream. The EDR 2:1 transmitter module applies the time division technology to multiplex the two streams into a single data stream.

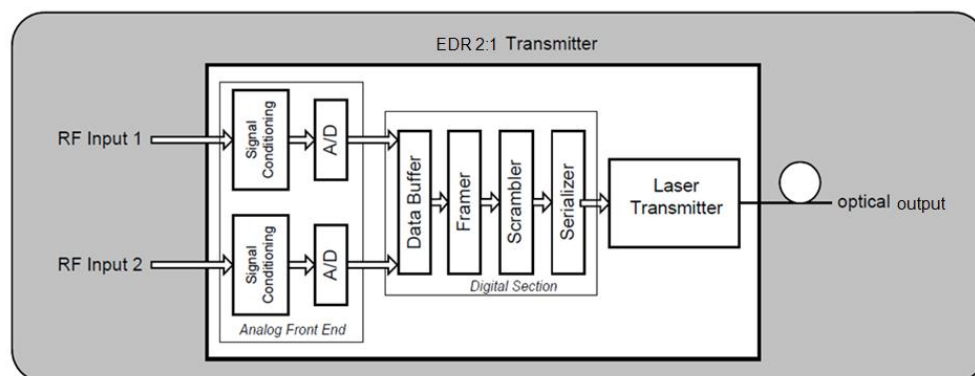
The data stream is carried optically over fiber, via an SFP type OPM module, to a remote hub or headend location where the optical signal is detected and converted back to a serial electrical signal. The data is then de-scrambled and de-framed and switched to a Digital-to-Analog Converter (DAC), where the analog spectrum that was sampled at the transmit side is reconstructed.

The EDR data stream is converted to an optical signal for transmission back to the headend or hub.

For EDR 1:1 Transmitter Module

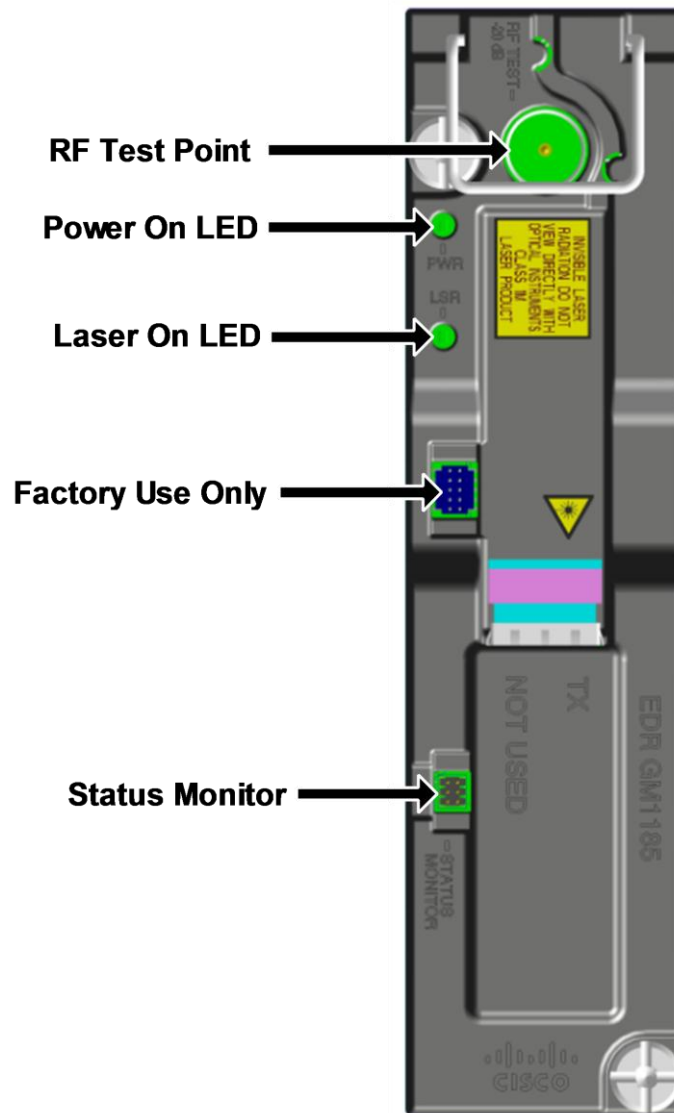


For EDR 2:1 Transmitter Module



The following illustrations show the transmitter module components.

For EDR 1:1 Transmitter Module



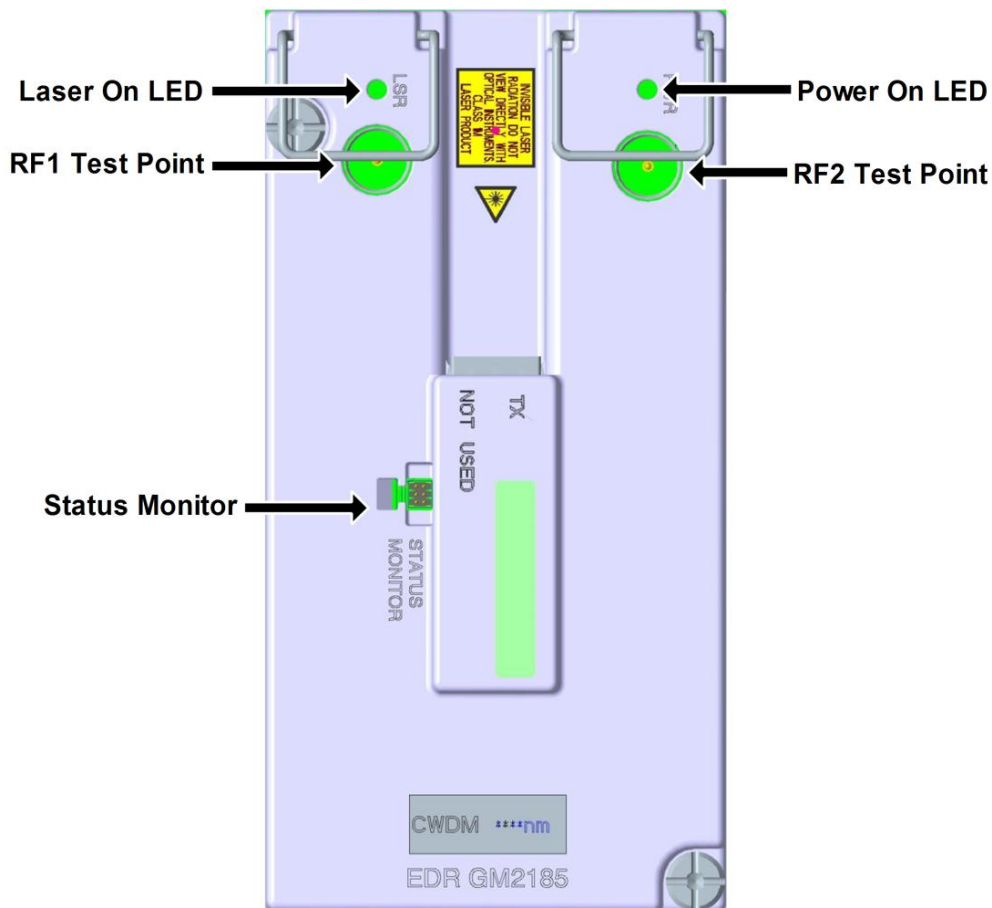
Note:

1. The EDR transmitter cannot monitor the GainMaker Node parameters.
2. The EDR LCM module needs to be installed for EDR transmitter status monitoring.
3. The status monitor interface is not used for data transmission. The Cisco DOCSIS transponder is needed when data transmission is required.

The transmitter module uses the same style housing as the optical receivers and transmitters, and it uses the same single-wide module housing. As such, it occupies one standard transmitter positions in the node lid.

Enhanced Digital Return System Overview

For EDR 2:1 Transmitter Module



Note:

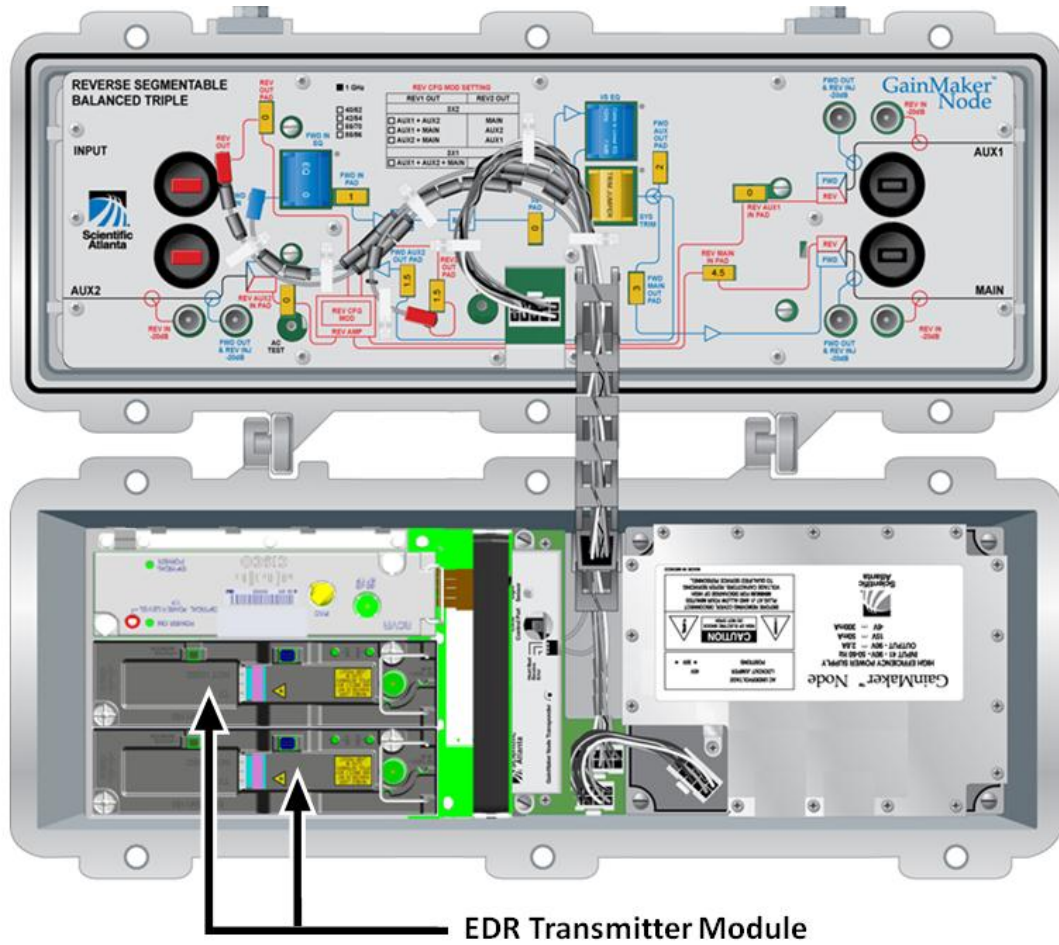
1. The EDR transmitter cannot monitor the GainMaker Node parameters.
2. The EDR LCM module needs to be installed for EDR transmitter status monitoring.
3. The status monitor interface is not used for data transmission. The Cisco DOCSIS transponder is needed when data transmission is required.

The transmitter module uses the same style housing as the optical receivers and transmitters, except that it uses a double-wide module housing. As such, it occupies two standard transmitter positions in the node lid.

Enhanced Digital Return System Overview

The following illustrations show the location of the modules in the node.

For EDR 1:1 Transmitter Module



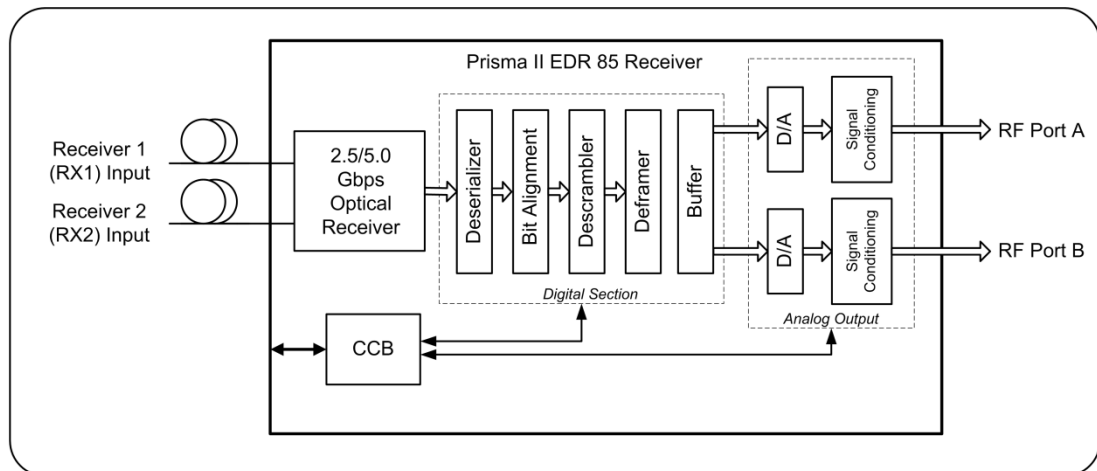
EDR Receiver Module

At the receive end, typically in a large hub or headend, the EDR Receiver module receives the optical signal and performs the conversion back to the baseband data stream. The resulting data streams are converted back to analog reverse path signals for routing to termination equipment. The EDR Receiver module is available in the High Density form factor. The receiver OPMs are available in Standard Range (SR) and Extended Range (XR) configurations. Both configurations feature a dual LC/PC optical input connector that feeds two independent reverse optical receivers, each with its own RF output port.

A single EDR Receiver module occupies one slot in a Cisco Prisma II XD chassis. Two EDR HD receiver modules can be vertically stacked in an associated Prisma II Host Module that occupies a single-wide slot in the Prisma II standard chassis. Up to 26 HD modules can operate in a standard 6 rack unit (6RU) chassis (the 56-connector version of the chassis is required to make use of both receivers in one chassis slot). Up to 16 HD modules can operate in the Prisma II XD chassis. The ability to mix EDR Receiver modules with other Prisma II HD modules in the same chassis greatly enhances the flexibility of the platform.

For instructions on installing the receiver refer to the *Prisma II Chassis Installation and Operation Guide*, part number 713375.

The following block diagram shows the receiver module's internal components.



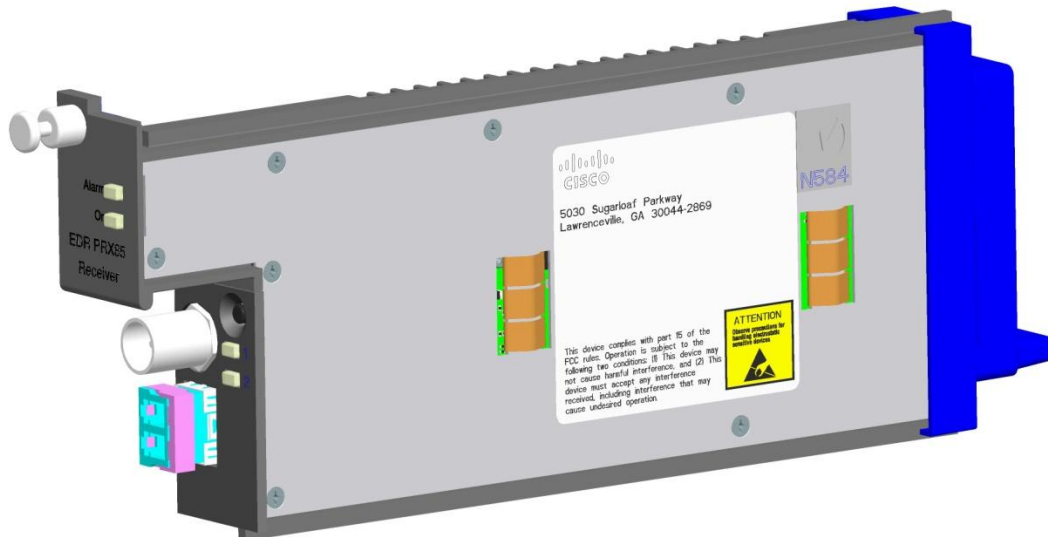
At the headend, the reverse optical receiver converts the optical signal back to an RF signal that is then routed out through the receiver's RF output.

Refer to *the Cisco Prisma II EDR Receiver Installation Guide*, part number OL-29646-01, for detailed information on the EDR receiver module.

Enhanced Digital Return System Overview

Receiver Module Diagram

The following illustration shows the receiver module.



Receiver Operating Modes

The receiver module supports receiver mode configuration performed by setting the proper mode ID numbers in the Prisma II Web UI system.

The following diagrams provide a basic walk-through of all the supported modes for the EDR receiver module.

The receiver can be configured for any of the following modes of operation:

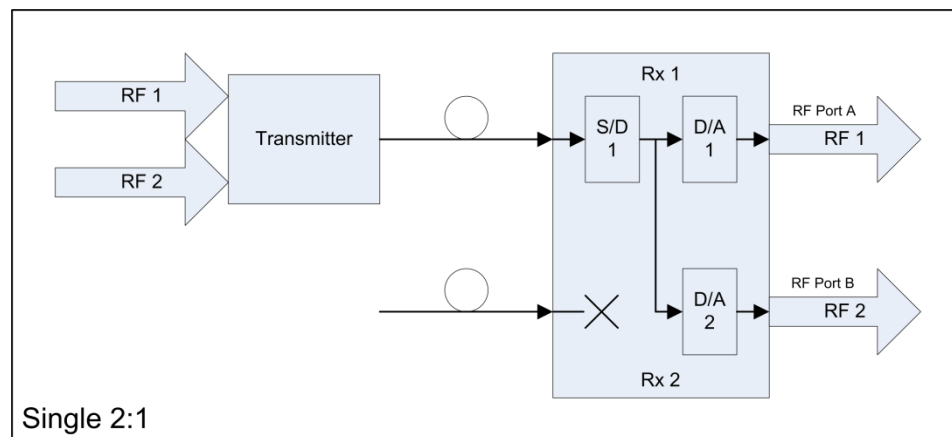
- Single 2:1
- Dual 1:1
- Dual 2:1
- Single 2:1 on Primary + Single 1:1 on Secondary
- Single 1:1 on Primary + Single 2:1 on Secondary
- Legacy Single 2:1
- Legacy Dual 2:1

Each of these operating modes is described below.

Single 2:1 Mode

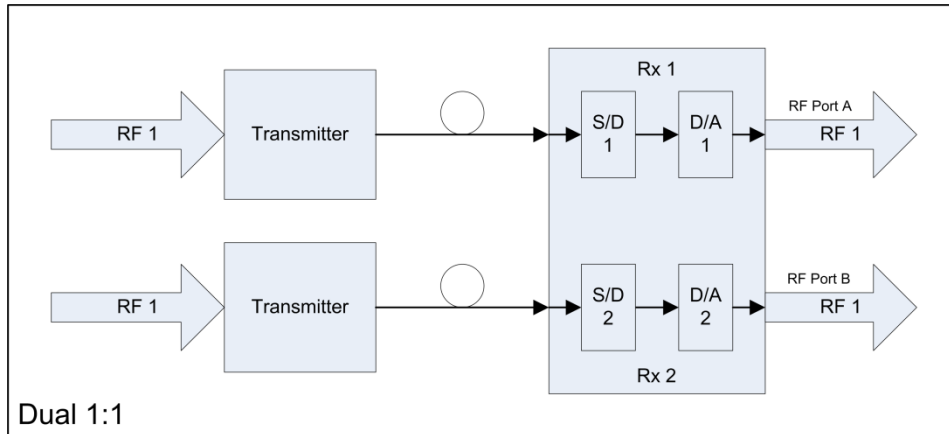
Referring to the diagram below, the EDR transmitter digitizes and combines two RF signals (RF 1 + RF 2) into one serial stream and transmits it over optical fiber to the receiver. At the receiver, the serial stream is de-serialized, converted back to its two analog RF components, and then sent to the two RF connectors on the back of the module. RF 1 appears on RF port A, and RF 2 appears on RF port B.

Note: The optical fiber must be plugged into the top receiver on the OPM.



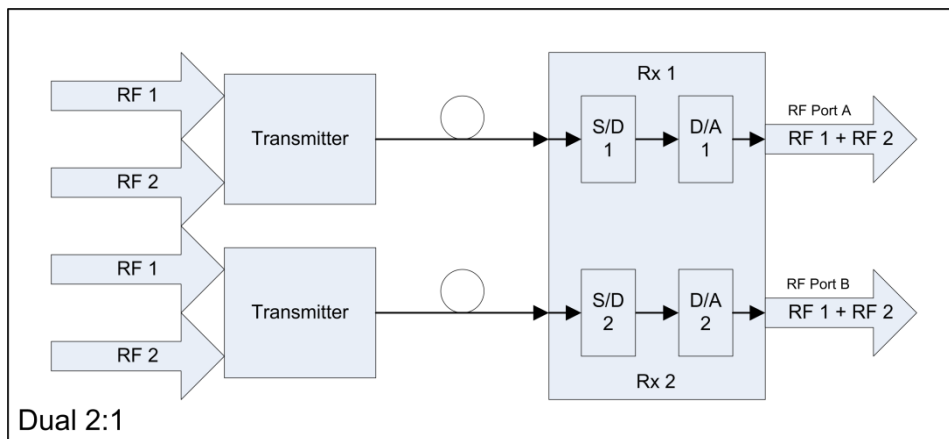
Dual 1:1 Mode

Referring to the diagram below, the EDR transmitter digitizes a single RF signal (RF 1) into a serial stream and transmits it over optical fiber to the receiver. At the receiver, the serial streams from two separate transmitters are deserialized and converted back to an analog RF signal. The RF signal (RF 1) for each transmitter is sent separately to the two RF connectors on the back of the module.



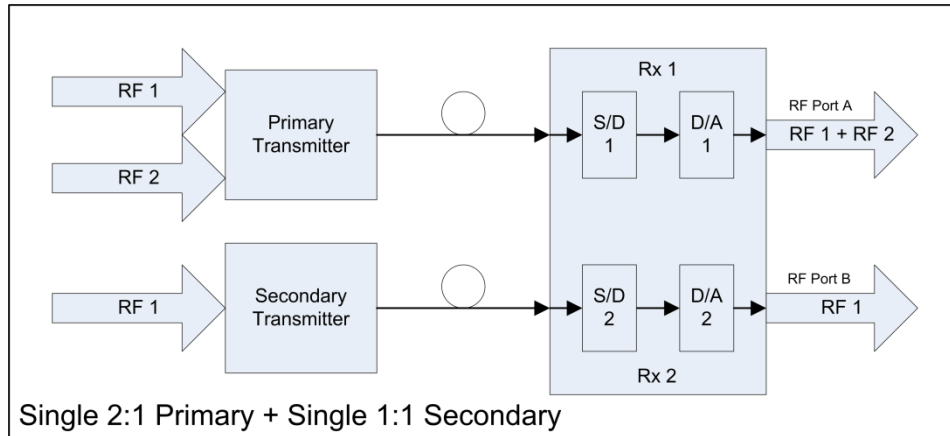
Dual 2:1 Mode

Referring to the diagram below, two EDR transmitters are connected to one receiver. Each EDR transmitter digitizes and combines two RF signals (RF 1 + RF 2) into one serial stream and transmits it over optical fiber to the receiver. At the receiver, the serial streams from the two separate transmitters are deserialized and converted back to their two analog RF components. Since the receiver only has two RF ports, the combined signals (RF 1 + RF 2) for each transmitter are sent to the two RF connectors on the back of the module.



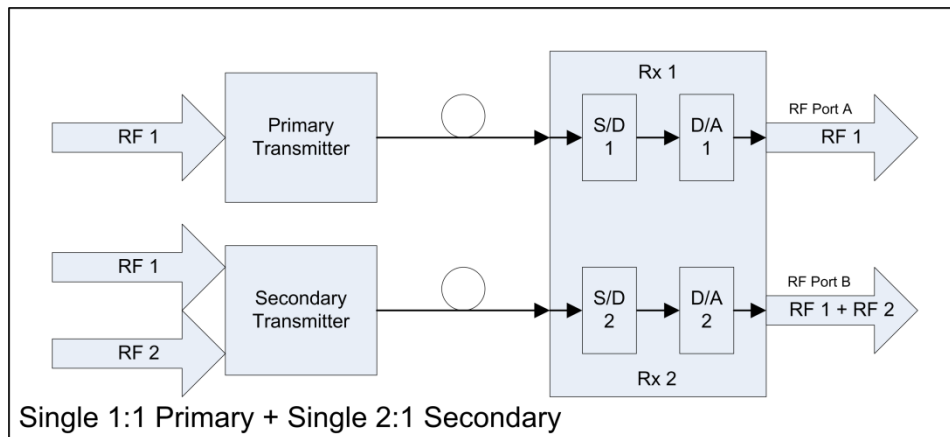
Single 2:1 on Primary + Single 1:1 on Secondary

This mode is a combination of the 2:1 and 1:1 modes described above. Referring to the diagram below, one EDR transmitter digitizes and combines two RF signals (RF 1 + RF 2) into one serial stream and transmits it over optical fiber to the receiver. The other EDR transmitter digitizes a single RF signal (RF 1). At the receiver, the serial streams from two separate transmitters are deserialized and converted back to their two analog RF components. The combined Transmitter 1 signal (RF 1 + RF 2) is sent to RF port A, and the Transmitter 2 signal (RF 1) is sent to RF port B on the back of the module.



Single 1:1 on Primary + Single 2:1 on Secondary

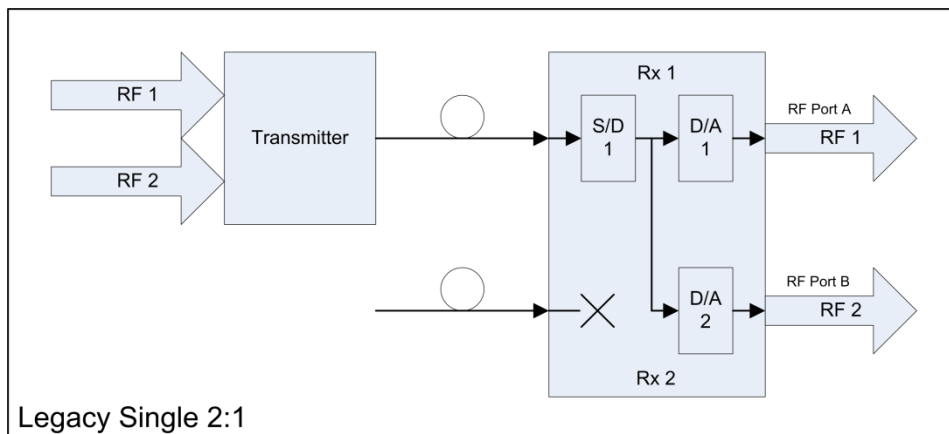
This mode is identical to the mode just described, except that the 2:1 transmitter is connected to the second receiver and the 1:1 transmitter is connected to the primary receiver.



Enhanced Digital Return System Overview

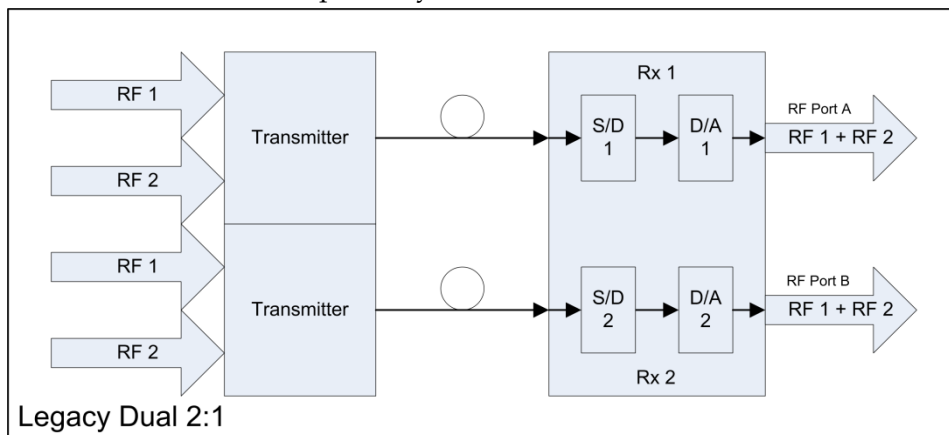
Legacy Single 2:1 Mode

This mode is identical to the Single 2:1 mode described earlier, except that it operates at half the data rate for compatibility with Cisco bdr 2.5 2:1 transmitters.



Legacy Dual 2:1 Mode

This mode is identical to the Dual 2:1 mode described earlier, except that it operates at half the data rate for compatibility with Cisco bdr 2.5 2:1 transmitters.

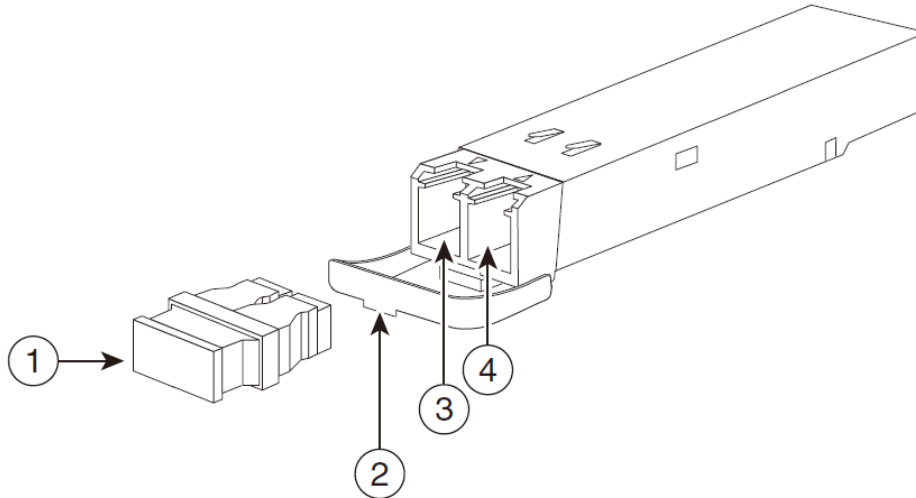


EDR OPM

About the OPM Module

The reverse transmitter converts the RF test signal(s) to an optical signal using the installed Optical Module (OPM) and transmits it to the headend (or hub site) via fiber optic cable. At the headend, the reverse optical receiver also converts the optical signal back to an RF signal that is then routed out through the receiver's RF output using its installed OPM module.

Item	Description
1	Dust Plug
2	Bale Clasp (Open, Push upward to close)
3	Transmit Bore (Not In Use for the Receiver)
4	Receive Bore (Not In Use for the Transmitter)



Enhanced Digital Return (EDR) System Installation

Before You Begin

Overview

Perform these installation instructions only if you are upgrading the 1 GHz GainMaker Reverse Segmentable Node with the digital reverse modules. If your node came with the digital reverse modules installed, go to *Reverse Balancing the Node with Digital Reverse Modules* (on page 113).

Required Tools

The following tools and equipment are needed to configure and install the digital reverse modules.

- 1/2-inch hex driver or ratchet
- Two adjustable wrenches for coaxial connectors
- Standard flat-head or phillips-head screwdriver
- Torque wrench, capable of settings up to 100 in-lb (11.3 Nm)

Operating Environment

Before operating the node with the digital reverse modules installed, ensure that the operating environment meets the following standards.

- Ambient temperature range outside the node must be maintained between -40°C and +60°C (-40°F to 140°F).
- Storage temperature range of the digital reverse modules must be maintained between -40°C to +85°C (-40°F to 185°F).
- Humidity range must be maintained between 5% to 95% non-condensing before installation of EDR transmitter and receiver module(s).

To Install the Transmitter Module

The EDR transmitter module uses the same style housing as the optical receivers and transmitters, except that it uses a double-wide module housing. As such, it occupies two standard transmitter positions in the node lid.

If your EDR transmitter comes without OPM module installed, you need to order the fiber jumper and the OPM module from our sales representatives, and perform the following steps to install the OPM module and connect the fiber jumper to the installed OPM module before installing the EDR transmitter.

To Install the OPM Module in the EDR Transmitter

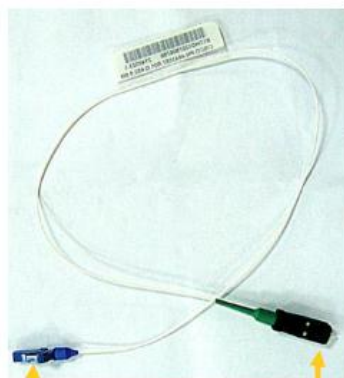
**CAUTION:**

Removing and installing an OPM module can shorten its useful life. Do not remove and insert OPM modules more often than is absolutely necessary.

**CAUTION:**

The OPM modules are electro-static sensitive devices. Always use an ESD wrist strap or similar individual grounding device when handling OPM modules or coming in contact with modules.

- 1 Connect the blue LC connector to the transmit bore of the OPM module before installing the module. Refer to the **EDR OPM and LCM** section on page 144 for details for the OPM module.

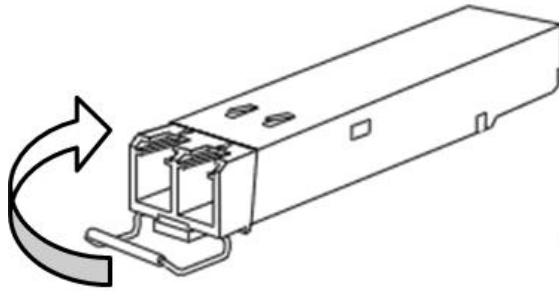


Blue LC Connector

Green SC Connector

EDR Digital Return Multiplexing Applications

- 2 Close the bale-clasp before inserting the OPM module.

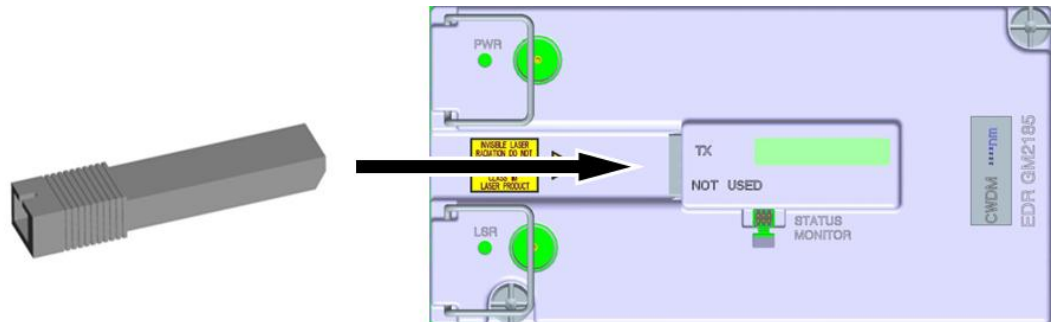


- 3 Line up the OPM module with the port, and slide it into the port.
- 4 Connect the LC/PC to SC/AC fiber jumper to the OPM module.
- 5 Proceed to next section for installation.

The following diagram shows the OPM module installed on the 1:1 transmitter module.



The following diagram shows the OPM module installed on the transmitter module installed on the GainMaker 4-Port Node.



CAUTION:

Removing and installing an OPM module can shorten its useful life. Do not remove and insert OPM modules more often than is absolutely necessary.

To Install the EDR Transmitter

Complete the following steps to install the EDR transmitter module.

- 1 See **To Install the OPM Module** for instructions on removing and installing the module in the housing.
- 2 Remove any existing transmitter modules from the positions in which you want to install the EDR transmitter module.
- 3 Install the EDR transmitter module in the housing lid in transmitter positions XMTR 1/XMTR 2.



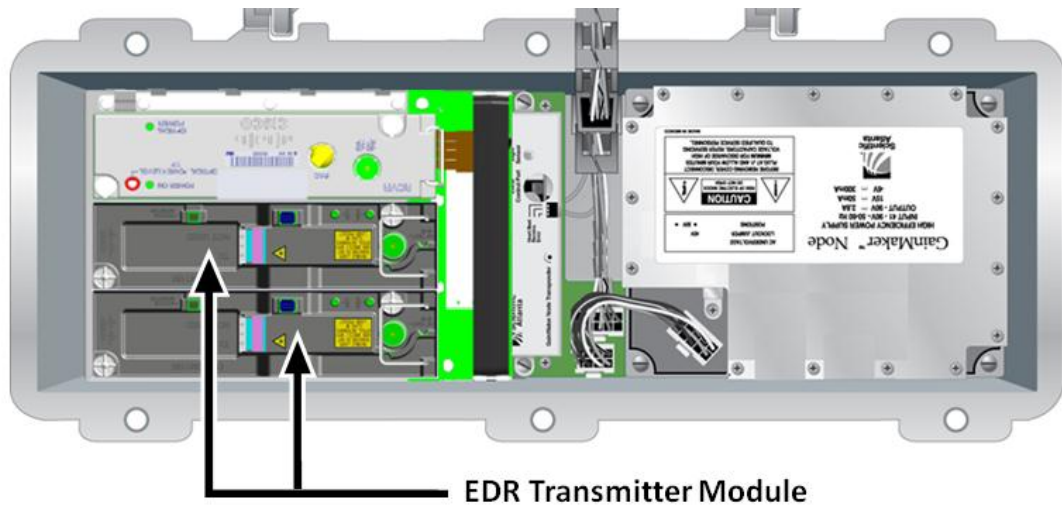
WARNING:

Laser transmitters when 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.

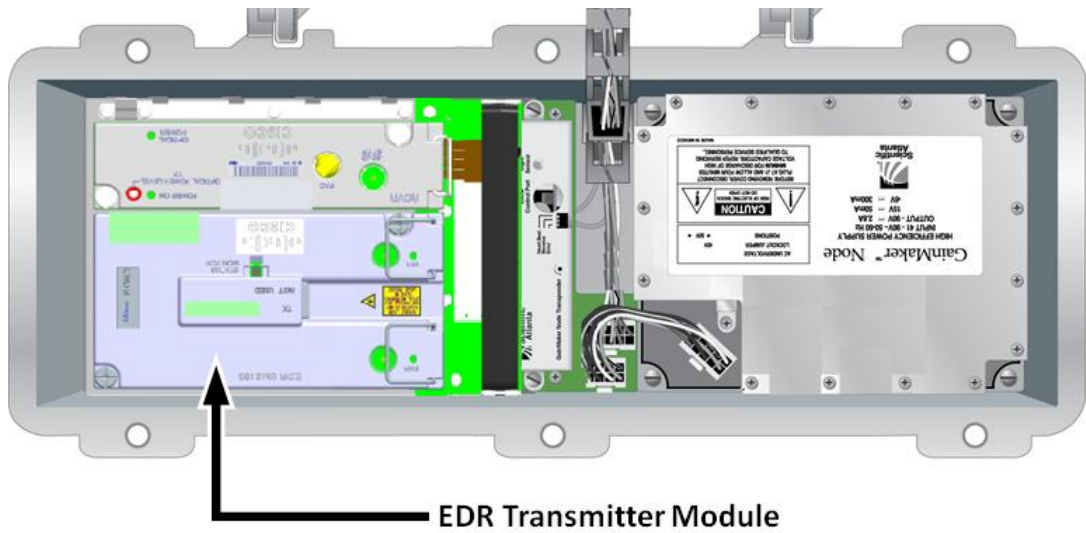
EDR Digital Return Multiplexing Applications

The following illustration show the location of the installed modules in the node.

For EDR 1:1 Transmitter Module:



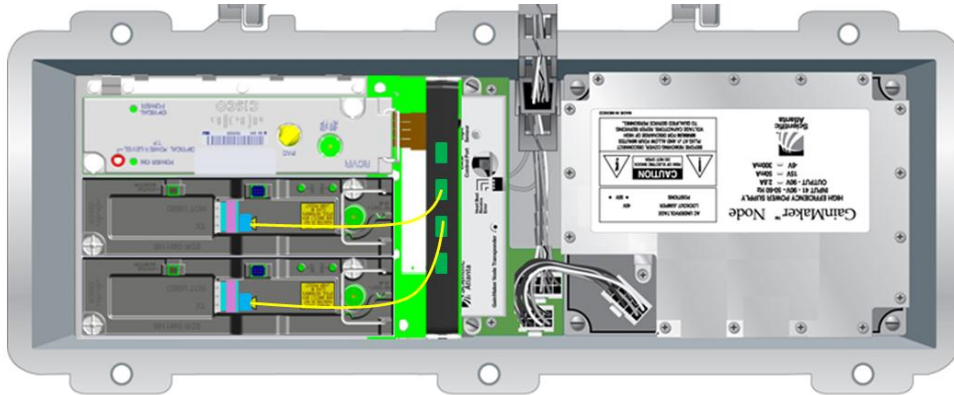
For EDR 2:1 Transmitter Module:



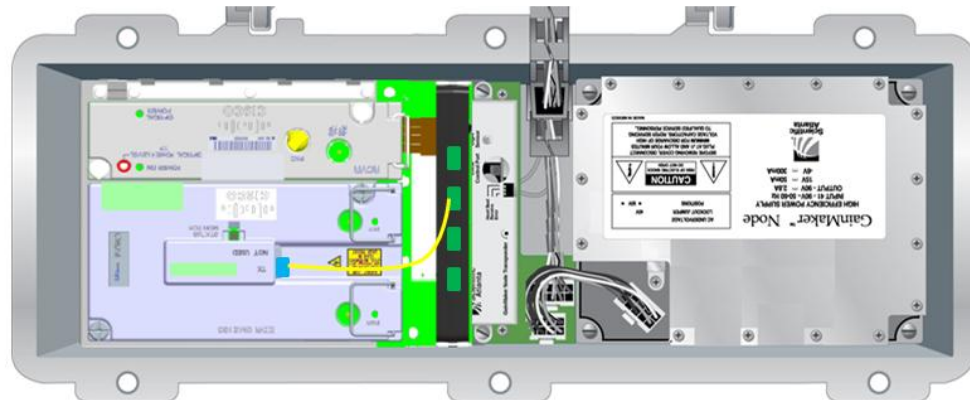
To Route the Fiber Jumper

The fiber jumper must be routed carefully. The Green LC connector must be connected to the proper fiber adapter, damage may be caused if the fiber jumper pigtail extends beyond the black fiber tray.

Fiber Jumper Routing for 1:1 transmitter module:



Fiber Jumper Routing for 2:1 transmitter module:



Note: When removing faulty OPM module, press and remove the blue LC connector before you can open the bale clasp.

To Connect Fiber

1. Insert the fiber-optic start-head to the optical adapter.
2. Route fiber on the fiber tray of GS7000 GainMaker Node.
3. Connect the fiber-optic end-head to the receive bore of the OPM module installed on the Receiver of the Prisma II platform.
4. The receiver OPM module requires LC connector, conversion maybe needed.
5. Clean the LC connector's fiber-optic end-faces.

See the following Tip for a pointer to a fiber-optic inspection and cleaning white paper.

http://www.cisco.com/en/US/tech/tk482/tk876/technologies_white_paper09186a0080254eba.shtml

Installing the EDR Receiver

Refer to *the Cisco Prisma II EDR Receiver Installation Guide*, part number 4044294, for detailed information on installing the EDR receiver module on the Prisma II.

To Install the OPM Module on the Receiver Module

The following diagram shows the OPM module installed on the receiver module of the Prisma II.



To Configure the Receiver Mode

The receiver mode can be configured in the Web UI interface through connection with the Prisma II platform.

For complete configuration steps and setup precautions, refer to the *Cisco Prisma II EDR Receiver Installation Guide*, part number OL-29646-01, and the *Cisco Prisma II Platform Configuration Guide*, after system release 2.05.30, part number OL-27998-01.

System View

ICM Details

Module Summary

Module Details

Alarm

Breakdown

Control

Monitor

System Settings

Event Log

User Mgmt

Help Window

Logout

Module Controls

P2 EDR-RX
(Chassis Slot: 0/10)

Label	Value	Units / Choices	Low	High	Step	
Mode	1	(0) Slave, (1) Single, (2) Master	0	2	1	Apply
Enabbl1	1	(0) Off, (1) On	0	1	1	Apply
Enabbl2	1	(0) Off, (1) On	0	1	1	Apply
RxInp1	1	(0) Off, (1) On	0	1	1	Apply
RxInp2	1	(0) Off, (1) On	0	1	1	Apply
RxInp3	1	(0) Off, (1) On	0	1	1	Apply
RxInp4	1	(0) Off, (1) On	0	1	1	Apply
RxInp5	1	(0) Off, (1) On	0	1	1	Apply
BwLmt	0	(0) Off, (1) On	0	1	1	Apply
RFAAttm1	0	dB	0	10	0.5	Apply
RFAAttm2	0	dB	0	10	0.5	Apply
Alarm	0	(0) Off, (1) On	0	1	1	Apply
RxMode	1	(0) Single21, (1) Dual21, (2) Dual1, (3) FS11S111, (4) FS11S21, (5) LgyS21, (6) LgyD21	0	6	1	Apply
NodeSel	1		1	2	1	Apply

Cancel

Transmitter Module Setup Procedure

Perform the following steps to set up the reverse transmitter module.

- 1 Open the housing. Refer to *To Open the Node Housing* (on page 17).
- 2 Verify the level of the reverse path RF signal at the RF test points on the RF module. Nominal level is +15 dBmV per channel. Install the appropriate value input pad at the REV PORT IN PAD location to give the desired signal level into the node.
- 3 Repeat step 3 for each RF cable carrying a reverse path signal.
- 4 Measure the transmitter module optical output power.
- 5 Check the connection of the optical connector. Make sure the optical connector is seated and verify fiber bend radius is greater than 1 inch.



WARNING:

When handling optical fibers always follow laser safety precautions.

EDR Transmitter Status Indicators

The transmitter module has two status indicator LEDs.

The following section describes the LED status and the correspondent indications. The input level overdrive indicates the input signal level exceeds the limit of 35 dBmV.

For EDR 1:1 transmitter module

The following table lists the LED status and the indicated OPM, and the overdrive status of the RF port.

LED		Indication	
Power (PWR)	Laser (LSR)	OPM Module	Port Input Overdrive
OFF	OFF	-	-
Green	Green	Cisco Standard OPM Module	No
Green	Orange (Solid)	Non-Cisco Standard OPM Module	No
Green	Orange (Blink)	Cisco Standard OPM Module/ Non-Cisco Standard OPM Module	Yes

For EDR 2:1 transmitter module

The following table lists the LED status and the indicated OPM, and the overdrive status of both RF port 1 and RF port 2.

LED		Indication		
Power (PWR)	Laser (LSR)	OPM Module	Port 1 Input Overdrive	Port 2 Input Overdrive
OFF	OFF	-	-	-
Green	Green	Cisco Standard OPM Module	No	No
Green	Orange (Solid)	Non-Cisco Standard OPM Module	No	No
Green	Orange (Blink)	Cisco Standard OPM Module	No	Yes
Orange (Blink)	Green	Cisco Standard OPM Module	Yes	No
Orange (Blink)	Orange (Solid)	Non-Cisco Standard OPM Module	Yes	No
Orange (Blink)	Orange (Blink)	Cisco Standard OPM Module	Yes	Yes

Reverse Balancing the Node with the Enhanced Digital Return (EDR) Modules

Introduction

This section explains the reverse balancing procedures for the node using digital reverse modules.

When balancing the reverse path, reference your system design print for the required reverse signal level. Use appropriate padding and equalization to provide proper signal level to the reverse transmitter.



CAUTION:

Never attempt to reconfigure the unit beyond its normal setup. Changes to the node configuration may cause degradations that affect its performance. Do not use digital carrier measurement to set up the forward or reverse paths. Familiarize yourself with your cable system specifications before performing the setup.

The 2:1 EDR technology is designed to carry reverse path signals from 5 MHz to 42 MHz. This technology digitizes the analog input and then sends a high-speed serial bitstream over fiber to a digital receiver at the link end. By converting the analog RF band to a digital format, two full bandwidth digital links can be multiplexed together over the same fiber and recovered at the receiver.

There are various 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. A reverse RF test signal (or signals) of known amplitude is injected into the RF path at the RF input of the node. The reverse transmitter converts the RF test signal(s) to an optical signal and transmits it to the headend (or hub site) via fiber optic cable. At the headend, the reverse optical receiver converts the optical signal back to an RF signal that is then routed out through the receiver RF output. The amplitude of the injected test signal must be monitored at the receiver output, and compared to the expected (design value) amplitude.

Method of Generating and Monitoring Test Signals

The reverse RF test signals that are injected into the reverse path of the RF launch amplifier being balanced may be generated by the following method.

- Multiple CW signal (tone) generator
- Reverse sweep transmitter

The amplitude of the received test signals at the output of the reverse optical receiver in the headend or hub may be measured and monitored using the following:

EDR Digital Return Multiplexing Applications

- Spectrum analyzer (when using a CW generator for test signals)
- Signal level meter (when using a CW generator for test signals)
- Reverse sweep receiver (when using a reverse sweep transmitter for test signal)

The variance in relative amplitude of the received signal from desired (reference) may be relayed to the field technician via the following:

- Radio (by a second technician in the headend/hub who is monitoring a spectrum analyzer or signal level meter)
- A dedicated forward TV channel, whose associated modulator has its video input being generated by a video camera focused on the spectrum analyzer display
- An associated forward data carrier (if using a particular type of reverse sweep system)

If a portable reverse sweep generator with built-in forward data receiver is used to generate the reverse test signals, only one technician is required to perform the balancing. This type of system is becoming increasingly popular due to its ease of use.

In this case, the sweep system includes a combination reverse sweep receiver and forward data transmitter, which is located in the headend/hub. The frequency response characteristics of the received sweep signal (including relative amplitude and tilt) are converted by the headend sweep receiver to a data format, and transmitted in the forward RF path as a data carrier (by combining it into the forward headend combiner). The portable sweep generator/data receiver that is injecting the test signal into the RF launch amplifier's reverse path in the field is simultaneously receiving the incoming data carrier via the forward RF path. The incoming data is converted back to a sweep display that represents what is being received by the headend unit.

Reverse Balancing and Alignment Procedure

Overview

The Enhanced Digital Return (EDR) technology is designed to have a constant link gain, regardless of the length of fiber or amount of passive optical loss in the link. That is, if the RF signal amplitude of all ports in all nodes is set to a constant value, the signal level at the output of the receiver will be balanced automatically to a constant power level. Minor differences in levels can be trimmed out at the receiver with no penalty to link performance.

Balancing and Alignment

Follow these steps to reverse balance and align the node with digital reverse modules.

- 1 Refer to the reverse system design print on the RF amplifier assembly cover and inject the proper level into the reverse injection (forward output) test point of a port of the RF launch amplifier with a reverse sweep transmitter or a CW signal generator. The insertion loss of all forward output test points is 20 dB (relative to corresponding port).

Note: For the location of the reverse injection test point of each port, see Illustrations.

Reverse Balancing the Node with the Enhanced Digital Return (EDR) Modules

Important: To calculate the correct signal level to inject, add the reverse input level (from the design print) to the insertion loss of the reverse injection test point.

Formula:

Reverse input + Insertion loss = Signal generator setting

Example:

Reverse input = 15 dBmV

Insertion loss = 20 dBmV

Result: Signal generator setting = 15 dBmV + 20 dB = 35 dBmV

Note: The ADC full-scale (100%) level for a single CW carrier is +33 dBmV. This is the level at which the ADC begins clipping.

Note: The reverse attenuator (pad) and reverse equalizer in the 1 GHz GainMaker Node is selected during the reverse system design, and it is based on the drive level into the digital module which is determined by system performance requirements, type and quantity of return carriers, etc. Consult data sheet to determine proper operational level.

- 2 Verify the level of the reverse output test point. This output level leaves the RF launch amplifier via the coaxial cable to the multiplexing digital module input. (Use an SMB connector to F-connector test cable.)
- 3 Have the person in the headend refer to the headend system design and set the output of the EDR receiver to the specified output level. See the instruction guide that was shipped with EDR receiver for setup procedures.

Troubleshooting

Equipment

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

- Fiber optic ferrule cleaner, part number 468517, to clean fiber optic connectors
- 99% alcohol and lint free wipes to clean fiber connectors
- Optical power meter to measure light levels
- Proper fiber connector for optical power meter to make optical connections
- Digital voltmeter to measure voltages
- Spectrum analyzer or a field strength meter to measure RF levels
- Test probe, part number 501111, to access test points
- External test probe, part number 562580, to access external test points

Transmitter Module Troubleshooting Chart

Follow the steps in the table below to troubleshoot the transmitter module on LED signaling.

For EDR 1:1 Transmitter Module

LED Warning		Indication	Possible Solutions
PWR	LSR		
OFF	OFF	No power supply.	<p>Verify the power supply of the node with the transmitter installed.</p> <p>Verify that connectors of the transmitter are clicked into the interface connectors in the transponder slot.</p> <p>If still no power supply, contact the Cisco Technical Service Center for assistance.</p>
Green	Orange (Solid)	Non-Cisco Standard OPM Module is installed.	<p>No need for troubleshooting.</p> <p>Cisco Standard OPM Module is highly recommended for better system performance and stability. See the data sheet of the node for ordering information.</p>

Troubleshooting

LED Warning		Indication	Possible Solutions
PWR	LSR		
Green	Orange (Blink)	Input Level Overdrive.	Verify the input level of RF port. The output level overdrive indicates the output signal level exceeds the limit of 35 dBmV.

EDR Digital Return Multiplexing Applications

For EDR 2:1 Transmitter Module

LED Warning		Indication	Possible Solutions
PWR	LSR		PWR
OFF	OFF	No power supply.	<p>Verify the power supply of the node with the transmitter installed.</p> <p>Verify that connectors of the transmitter are clicked into the interface connectors in the transponder slot.</p> <p>If still no power supply, contact the Cisco Technical Service Center for assistance.</p>
Green	Orange (Solid)	Non-Cisco Standard OPM Module is installed.	<p>No need for troubleshooting.</p> <p>Cisco Standard OPM Module is highly recommended for better system performance and stability. See the data sheet of the node for ordering information.</p>
Green	Orange (Blink)	Input Level Overdrive.	<p>Verify the input level of RF port 2.</p> <p>The output level overdrive indicates the output signal level exceeds the limit of 35 dBmV.</p>
Orange (Blink)	Green	Non-Cisco Standard OPM Module is in use.	<p>Verify the input level of RF port 1.</p> <p>The output level overdrive indicates the output signal level exceeds the limit of 35 dBmV.</p>
Orange (Blink)	Orange (Solid)	<p>Non-Cisco Standard OPM Module is in use.</p> <p>Output Level Overdrive.</p>	<p>Verify the input level of RF port 1.</p> <p>The output level overdrive indicates the output signal level exceeds the limit of 35 dBmV.</p> <p>Cisco Standard OPM Module is highly recommended for better system performance and stability. See the data sheet of the node for ordering information.</p>

Troubleshooting

Orange (Blink)	Orange (Blink)	Non-Cisco Standard OPM Module is in use. Input Level Overdrive .	Verify the input level of RF port 1. The output level overdrive indicates the output signal level exceeds the limit of 35 dBmV. Verify the input level of RF port 1. The output level overdrive indicates the output signal level exceeds the limit of 35 dBmV. Cisco Standard OPM Module is highly recommended for better system performance and stability. See the data sheet of the node for ordering information.
-------------------	-------------------	--	---

EDR Digital Return Multiplexing Applications

Follow the steps in the table below to troubleshoot the transmitter module.

Symptom	Possible Cause	Possible Solutions
No optical signal output	Laser temperature could be too high or low.	Allow up to one minute after power is ON for the temperature to stabilize. If still no output, contact the Technical Service Center for assistance.
	Laser could be faulty.	Contact the Technical Service Center for assistance.
	Automatic power control circuit failure.	Contact the Technical Service Center for assistance.
	Damaged fiber.	Contact the Technical Service Center for assistance.

Symptom	Possible Cause	Possible Solutions
No optical signal output (cont'd)	One or more power supply voltages are out of specification.	Check the power supply for proper operation.
	No AC at receptacle.	Check the receptacle for AC power.
	Blown fuse on the power supply.	Check the power supply fuse and replace as necessary.
	Faulty module.	Contact the Technical Service Center for assistance.

5

Customer Support Information

Introduction

This chapter contains information on obtaining product support.

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 Support center.
you have customer service questions about this product	call the nearest Customer Service center.

In This Chapter

- Support Telephone Numbers..... 154

Support 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: <ul style="list-style-type: none"> ■ Toll-free: 1-800-722-2009 ■ Local: 678-277-1120 (Press 2 at the prompt) For <i>Customer Service</i> , call: <ul style="list-style-type: none"> ■ Toll-free: 1-800-722-2009 ■ Local: 678-277-1120 (Press 3 at the prompt) ■ Fax: 770-236-5477 ■ Email: customer-service@cisco.com
Europe, Middle East, Africa	Belgium	For <i>Technical Support</i> , call: <ul style="list-style-type: none"> ■ Telephone: 32-56-445-197 or 32-56-445-155 ■ Fax: 32-56-445-061 For <i>Customer Service</i> , call: <ul style="list-style-type: none"> ■ Telephone: 32-56-445-444 ■ Fax: 32-56-445-051 ■ Email: service-elc@cisco.com
Japan	Japan	<ul style="list-style-type: none"> ■ Telephone: 81-3-5908-2153 or +81-3-5908-2154 ■ Fax: 81-3-5908-2155
Korea	Korea	<ul style="list-style-type: none"> ■ Telephone: 82-2-3429-8800 ■ Fax: 82-2-3452-9748 ■ Email: songk@cisco.com
China (mainland)	China	<ul style="list-style-type: none"> ■ Telephone: 86-21-2401-4433 ■ Fax: 86-21-2401-4455 ■ Email: xishan@cisco.com
All other Asia Pacific countries & Australia	Hong Kong	<ul style="list-style-type: none"> ■ Telephone: 852-2588-4746 ■ Fax: 852-2588-3139 ■ Email: saapac-support@cisco.com
Brazil	Brazil	<ul style="list-style-type: none"> ■ Telephone: 11-55-08-9999 ■ Fax: 11-55-08-9998 ■ Email: fattinl@cisco.com or ecavalhe@cisco.com
Mexico, Central America, Caribbean	Mexico	For <i>Technical Support</i> , call: <ul style="list-style-type: none"> ■ Telephone: 52-3515152599 ■ Fax: 52-3515152599 For <i>Customer Service</i> , call: <ul style="list-style-type: none"> ■ Telephone: 52-55-50-81-8425 ■ Fax: 52-55-52-61-0893 ■ Email: sa-latam-cs@cisco.com
All other Latin America countries	Argentina	For <i>Technical Support</i> , call: <ul style="list-style-type: none"> ■ Telephone: 54-23-20-403340 ext 109 ■ Fax: 54-23-20-403340 ext 103 For <i>Customer Service</i> , call: <ul style="list-style-type: none"> ■ Telephone: 770-236-5662 ■ Fax: 770-236-5888 ■ Email: keillov@cisco.com

Glossary

A

ampere. A unit of measure for electrical current.

ac, AC

alternating current. An electric current that reverses its direction at regularly recurring intervals.

AGC

automatic gain control. A process or means by which gain is automatically adjusted in a specified manner as a function of input level or other specified parameters.

attenuation

The difference between transmitted and received signal strength due to loss through equipment, lines, or other transmission medium. Usually expressed in decibels.

attenuator

A passive device designed to reduce signal strength without distorting the waveform. Usually specified in dB.

AUX

auxiliary.

bdr

baseband digital reverse. Proprietary technology for transporting reverse signals by converting them to from analog to digital format, optionally multiplexing two or more digitized reverse signals, and then converting the electrical signal to an optical format for transmission to a hub or headend via fiber optic link.

bit

binary digit. A bit is the smallest unit of information understood by a computer. A bit can take a value of 0 or 1. A byte, which is made up of 8 bits, can represent a single character, such as the letter A.

Glossary

BW

bandwidth. A measure of the information-carrying capacity of a communications channel, for example the range of usable frequencies that can be carried by a CATV system. The bandwidth corresponds to the difference between the lowest and highest frequency that can be carried by the channel.

C/N or CNR

carrier-to-noise ratio. The ratio, in decibels, of the carrier to that of the noise in a receiver's IF bandwidth after specified band limiting and before any nonlinear process such as amplitude limiting and detection takes place.

CCW

counterclockwise.

CW

continuous wave.

dB

decibel. One tenth of a bel, the number of decibels denoting the ratio of two amounts of power being ten times the common logarithm of this ratio.

dBm

decibels relative to 1 milliwatt.

dBmV

decibels relative to 1 millivolt.

dBuV

decibels relative to 1 microvolt.

dBW

decibels relative to 1 watt.

DC

directional coupler.

dc, DC

direct current. An electric current flowing in one direction only and substantially constant in value.

diplex filter

A filter which divides the frequency spectrum into a high frequency segment and a low frequency segment so that two different signals can be sent down the same transmission path.

distribution

The activities associated with the movement of material, usually finished products or service parts, from the manufacturer to the customer.

distribution system

The part of a CATV system consisting of the transmission medium (coaxial cables, fiber optic cables, etc.) used to carry signals from the headend system to subscriber terminals.

DVM

digital voltmeter.

EC

European Community.

EMC

electromagnetic compatibility. A measure of equipment tolerance to external electromagnetic fields.

EQ

equalizer.

equalization

The process of compensating for an undesired result. For example, equalizing tilt in a distribution system.

ESD

electrostatic discharge. Discharge of stored static electricity that can damage electronic equipment and impair electrical circuitry, resulting in complete or intermittent failures.

frequency

The number of similar shapes in a communications or electrical path in a unit of time. For example, the number of sine waves moving past a fixed point in a second.

frequency response

The effect that changing the frequency has on the magnitude of a signal.

Glossary

ft-lb

foot-pound. A measure of torque defined by the application of one pound of force on a lever at a point on the lever that is one foot from the pivot point.

gain

A measure of the increase in signal level, relative to a reference, in an amplifier. Usually expressed in decibels.

Hertz

A unit of frequency equal to one cycle per second.

HFC

hybrid fiber/coaxial. A network that uses a combination of fiber optics and coaxial cable to transport signals from one place to another. A broadband network using standard cable television transmission components, such as optical transmitters and receivers, coaxial cable, amplifiers, and power supplies. The broadband output stream is transmitted as an optical signal, over the high-speed, fiber optic transmission lines to local service areas where it is split, converted to electrical RF signals, and distributed to set-tops over coaxial cable.

HGBT

high gain balanced triple.

HGD

high gain dual.

IEC

International Electro-technical Commission.

IF

intermediate frequency. The common frequency which is mixed with the frequency of a local oscillator to produce the outgoing radio frequency (RF) signal.

LED

light-emitting diode. An electronic device that lights up when electricity passes through it.

LGD

low gain dual.

Nm

Newton meter. A measure of torque defined by the application of one Newton of force on a lever at a point on the lever that is one meter from the pivot point. (1 Nm = 0.737561 ft-lb)

NPR

noise power ratio.

OIB

optical interface board.

RCM

reverse configuration module.

reverse path

Signal flow direction toward the headend.

RF

radio frequency. The frequency in the portion of the electromagnetic spectrum that is above the audio frequencies and below the infrared frequencies, used in radio transmission systems.

RMA

return material authorization. A form used to return products.

RX

receive or receiver.

S/N or SNR

signal-to-noise ratio. The ratio, in decibels, of the maximum peak-to-peak voltage of the video signal, including synchronizing pulse, to the root-mean-square voltage of the noise. Provides a measure and indication of signal quality.

SA

system amplifier.

SAI, SAII, SAIII

system amplifier I, system amplifier II,
system amplifier III.

Glossary

SM

status monitor.

SNMP

simple network management protocol. A protocol that governs network management and the monitoring of network devices and their functions.

splitter

A device which divides a signal or power from an input to deliver multiple outputs.

sweep generator

A signal source which can automatically vary its frequency continuously from one frequency to another.

torque

A force that produces rotation or torsion. Usually expressed in lb-ft (pound-feet) or N-m (Newton-meters). The application of one pound of force on a lever at a point on the lever that is one foot from the pivot point would produce 1 lb-ft of torque.

TX

transmit or transmitter.

uV

microvolt. One millionth of a volt.

V

volt.

W

watt. A measure of electrical power required to do work at the rate of one joule per second. In a purely resistive load, 1 Watt = 1 Volt x 1 Amp.

Index

1

- 1 GHz GainMaker Node Configuration • 105
- 1 GHz/870 MHz Forward Inverse Cable Equalizer Loss Chart • 93
- 1 GHz/870 MHz Forward Inverse Equalizer Part Numbers • 96
- 1 GHz/870 MHz Forward Linear Equalizer Loss Chart • 92
- 1 GHz/870 MHz Forward Linear Equalizer Part Numbers • 96

2

2

- 1 bdr Dual Receiver Module • 113
- 1 bdr Transmitter Module • 109

A

- A • 125
- About Reverse Path Balancing • 54
- AC Shunt Power Directors • 5
- ac, AC • 125
- Accessories • 7, 14
- AGC • 125
- Amplifier Output • 90, 91
- Attaching the Coaxial Connectors • 27
- Attaching the Fiber Connectors • 24
- attenuation • 125
- attenuator • 125
- Attenuator Part Numbers • 94
- AUX • 125

B

- Balancing and Alignment Procedures • 56
- Balancing and Setup • 47
- Balancing the Forward Path • 51
- Balancing the Reverse Path • 54
- bdr • 125
- Before You Begin • 14, 115
- bit • 125
- Block Diagrams • 10
- Bode Network • 48
- Boot Color Table • 76
- BW • 126

C

- C/N or CNR • 126
- CCW • 126
- Cleaning Optical Connectors • 85
- Configuration Plug-in Module Part Numbers • 99
- Configuring the Reverse Path • 62
- Connecting the Fiber Optic Service Cable to the Node • 20
- Customer Support Information • 123
- CW • 126

D

- dB • 126
- dBm • 126
- dBmV • 126
- dBuV • 126
- dBW • 126
- DC • 126
- dc, DC • 127
- Description • 3
- Digital Reverse System Overview • 104
- Digital Reverse Transmitter Module Installation • 115
- diplex filter • 127
- distribution • 127
- distribution system • 127
- Dual Redundant Receiver • 10
- DVM • 127

E

- EC • 127
- EMC • 127
- EQ • 127
- equalization • 127
- Equipment • 70, 121
- ESD • 127

F

- Features • 104
- Fiber Cable Handling • 20
- Fiber Connectors and Fiber Optic Service Cable • 20
- Forward Equalizer Loss Charts • 92

Index

frequency • 127
frequency response • 128
ft-lb • 128

G

gain • 128
GainMaker Node Accessory Part Numbers • 94

H

Hertz • 128
HFC • 128
HGBT • 128
HGD • 128
Housing Base • 19
Housing Dimensions • 16

I

IEC • 128
IF • 128
Illustrations • 8
Input and Output Ports • 4
Installation and Configuration • 13
Installing Accessories • 31
Installing and Removing the Status Monitor
Transponder Module (Optional) • 45
Installing the Amplifier Module • 35
Introduction • 1, 118

L

LED • 128
LGD • 129
Low or Degraded Forward RF Signal • 78
Low or Degraded Forward RF Signal
Troubleshooting Table • 78
Low or Degraded Reverse RF Signal • 80
Low or Degraded Reverse RF Signal
Troubleshooting Table • 80
Low RF Output • 75

M

Method of Generating and Monitoring Test Signals
• 118
Miscellaneous Problems • 83
Module and Housing Compatibility • 19
Mounting the Node • 29

N

Nm • 129
No AC Power • 71
No AC Power Troubleshooting Table • 72
No DC Power • 73
No DC Power Troubleshooting Table • 74

No Forward RF Signal • 77
No Forward RF Signal Troubleshooting Table • 77
No Reverse RF Signal • 79
No Reverse RF Signal Troubleshooting Table • 79
Node Amplifier Block Diagram • 9
Node Amplifier Configuration • 4
Node Amplifier Module • 3
NPR • 129

O

OIB • 129
Opening and Closing the Node Housing • 17
Operating Environment • 115
Ordering Matrix • 6

P

Plug-in Pad Part Numbers • 98
Power Supply • 4
Preparing for Forward Path Balancing • 48

R

RCM • 129
Recommended Equipment • 85
Removing and Installing AC Shunt Power
Directors • 37
Removing and Reinstalling the Optical Modules •
39
Reverse Balancing and Alignment Procedure • 119
Reverse Balancing the Node with Digital Reverse
Modules • 118
reverse path • 129
Reverse Path Balancing, About • 54
RF • 129
RMA • 129
RX • 129

S

S/N or SNR • 129
SA • 129
SAI, SAII, SAIII • 130
SM • 130
SNMP • 130
Specifications • 101
splitter • 130
Support Telephone Numbers • 124
sweep generator • 130
System Block Diagram • 106
System Functional Diagrams • 105

T

Test Points • 4
Tips for Optimal Fiber Optic Connector

- Performance • 85
- To Attach the Fiber Connectors • 25
- To Attach the Service Cable Connector • 22
- To Calculate the Proper RF Signal Level • 59
- To Clean Optical Connectors • 85
- To Close the Node Housing • 17
- To Complete Reverse Path Balancing • 61
- To Connect the Coaxial Cable Pin Connector to the Node Housing • 27
- To Determine the Output Tilt • 51
- To Install Attenuator Pads • 31
- To Install Equalizers • 32
- To Install the Amplifier Module • 35
- To Install the Crowbar Surge Protector • 33
- To Install the Node in a Pedestal • 30
- To Install the Node on a Strand (Aerial) • 29
- To Install the Status Monitor Transponder Module • 45
- To Install the Transmitter Module • 115
- To Open the Node Housing • 17
- To Prepare the Amplifier for Initial Reverse Path Balancing • 59
- To Prepare the Fiber Connectors • 24
- To Remove and Insert AC Shunt Power Directors • 37
- To Remove or Reinstall the Optical Receiver • 41
- To Remove or Reinstall the Optical Transmitter • 39
- To Remove the Status Monitor Transponder Module • 46
- To Remove/Reinstall Dual Redundant Receiver • 43
- To Reorient or Replace the RCM Plug-in • 65
- To Replace the OIB Plug-in • 66
- To Set the Output Level • 52
- To Set the Output Tilt • 52
- To Stow the Fiber Management Tray • 26
- To Trim the Center Conductor • 27
- To Unstow the Fiber Management Tray • 24
- To Verify the Input Signal Level • 48
- Tools • 14
- torque • 130
- Torque Specifications • 14, 101
- Torquing Sequence • 18
- Transmitter Module Setup Procedure • 117
- Transmitter Module Troubleshooting Chart • 121
- Transmitter Status Indicators • 112
- Troubleshooting • 69, 121
- Troubleshooting Carrier-to-Noise Problems • 82
- TX • 130

U

- uV • 130

V

- V • 130

W

- W • 130

- Warning

- Radiation • 20

- Weight Specifications • 15



Americas Headquarters

Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA

<http://www.cisco.com>

Tel: 408 526-4000

800 553-6387

Fax: 408 527-0883

This document includes various trademarks of Cisco Systems, Inc. Please see the Notices section of this document for a list of Cisco Systems, Inc., trademarks used in this document.

Product and service availability are subject to change without notice.

© 2013 Cisco Systems, Inc. All rights reserved.

Part Number OL-29645-01

May 2013 Printed in United States of America

Rev A