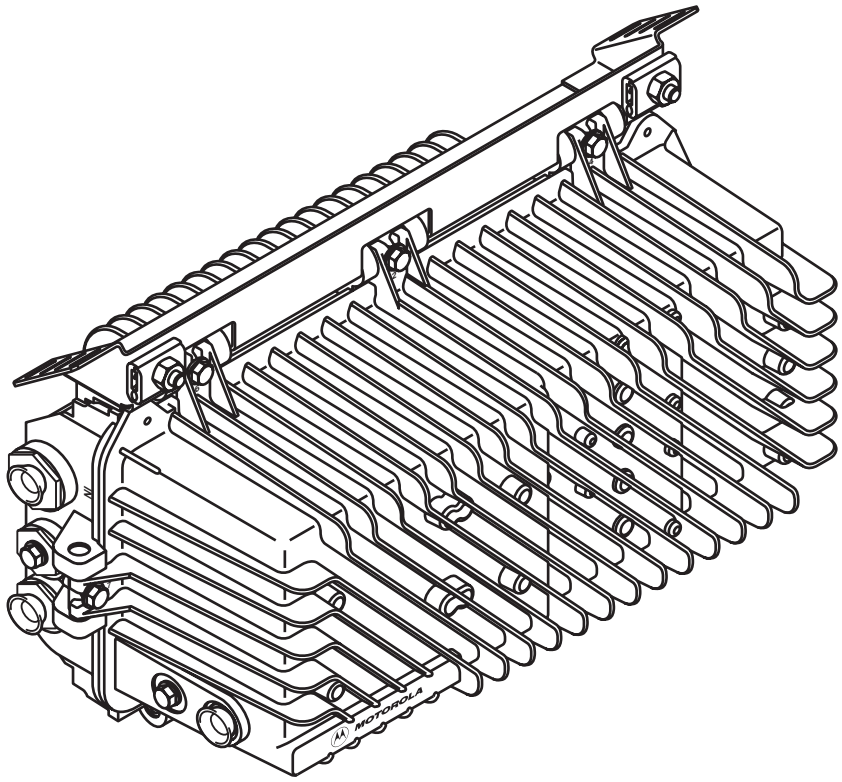
STARLINE®

SLW2500
Telecommunications Optical Node

Installation and Operation Manual

Exclusively for

AT&T



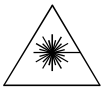
MOTOROLA

Caution

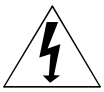
These servicing instructions are for use by qualified personnel only. To reduce the risk of electrical shock, do not perform any servicing other than that contained in the Installation and Troubleshooting Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

Special Symbols that Might Appear on the Equipment

This is a class 1 product that contains a class IIIb laser and is intended for operation in a closed environment with fiber attached. Do not look into the optical connector of the transmitter with power applied. Laser output is invisible, and eye damage result. Do not defeat safety features that prevent looking into optical connector.

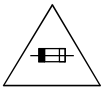


This product contains a class IIIb laser and is intended for operation in a closed environment with fiber attached. Do not look into the optical connector of the transmitter with power applied. Laser output is invisible, and eye damage can result. Do not defeat safety features that prevent looking into optical connector.



This symbol indicates that dangerous voltage levels are present within the equipment. These voltages are not insulated and may be of sufficient strength to cause serious bodily injury when touched. The symbol may also appear on schematics.

The exclamation point, within an equilateral triangle, is intended to alert the user to the presence of important installation, servicing, and operating instructions in the documents accompanying the equipment.



For continued protection against fire, replace all fuses only with fuses having the same electrical ratings marked at the location of the fuse.

FCC Compliance

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 the 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 Installation 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 the user will be required to correct the interference at his/her own expense. Any changes or modifications not expressly approved by Motorola could void the user's authority to operate this equipment under the rules and regulations of the FCC.

Canadian Compliance

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.
Cet appareil numérique de la classe A respects toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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Section 1

Introduction

Motorola's® STARLINE® light-wire telecommunications optical node, Model SLW2500, performs lightwave-to-RF and RF-to-lightwave signal conversions in an optical transmission link. It supports a wide variety of advanced hybrid-fiber/coaxial network topologies.

As broadband communication systems continue to evolve, the demand increases for optical links that carry the signal further into the transport system. These systems require additional features and functionality such as digital compression and alternative access at significantly lower costs. Fully configured, the SLW2500 supports these next-generation telecommunication networks. It also supports a variety of single and two-way broadband network applications such as broadcast video, interactive video, telephony, and data.

Figure 1-1 illustrates a closed SLW2500 optical node:

Figure 1-1
SLW2500 — closed

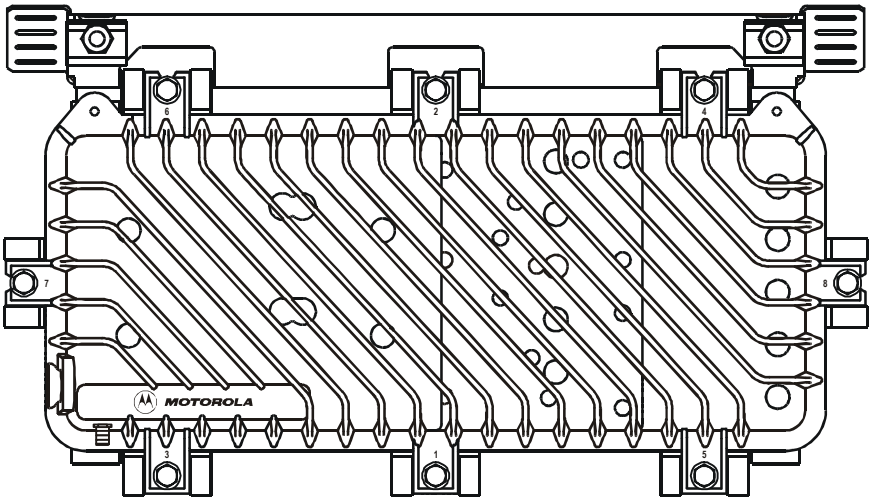
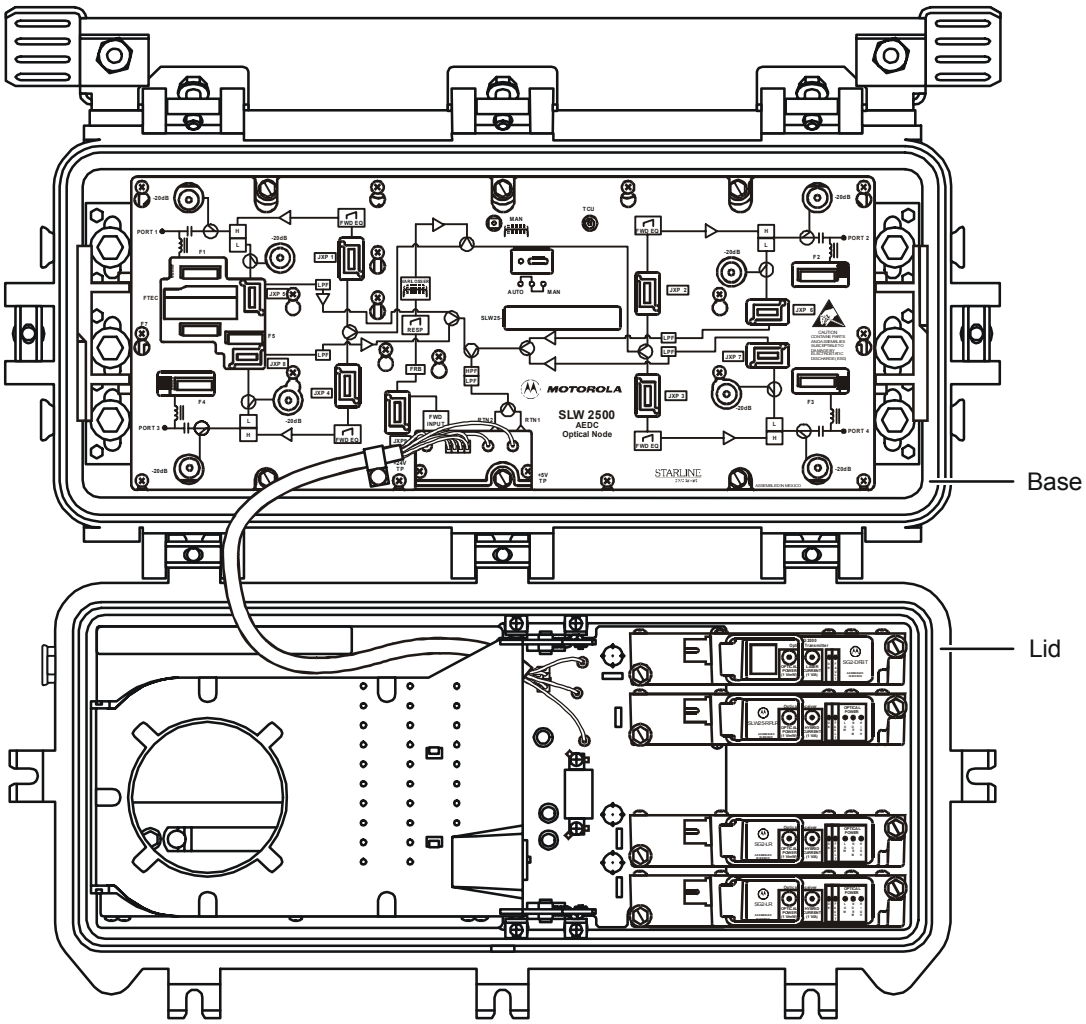


Figure 1-2 illustrates an open SLW2500 optical node:

Figure 1-2
SLW2500 node — open



Features include:

- 54 MHz to 870 MHz forward passband; 10 MHz to 48 MHz return standard
- Advanced return path implementation using high-speed digital technology
- Up to three optical receivers (broadcast, narrowcast, and targeted services)
- Four independent RF outputs
- Thermal gain control
- Modular plug-in diplex filters and equalizers
- 60/90 volt powering; 200 volt handling capability
- 15 amp power passing
- One separate ac power port available
- Channel add/drop kit option

Using This Manual

The following sections provide information and instructions to install, configure, and operate the SLW2500 in an AT&T™ system:

Section 1	**Introduction** provides a product description, related documentation, the technical help line, and repair/return information.
Section 2	**Overview** describes the functions of the SLW2500 and includes details regarding options and their functions.
Section 3	**Bench Setup** provides full configuration, setup of options, and bench testing procedures that are recommended before installation.
Section 4	**Installation** provides instructions for installing the SLW2500 in a distribution system.
Section 5	**Operation** provides information governing the use of various options and applications required by your system.
Appendix A	**Specifications** provides the technical specifications for the SLW2500 and major options.
Appendix B	**Torque Specifications** provides the appropriate torque specifications for the screws, clamps, connectors, and bolts used in the SLW2500.
Abbreviations and Acronyms	The **Abbreviations and Acronyms** list contains the full spelling of the short forms used in this manual.

Related Documentation

Although the *Return Path Level Selection, Setup, and Alignment Procedure Reference Guide* provides information that may be of interest to you, it is not required to install or operate the SLW2500.

Document Conventions

Before you begin using the SLW2500, familiarize yourself with the stylistic conventions used in this manual:

Bold type	Indicates text that you must type exactly as it appears or indicates a default value
SMALL CAPS	Denotes silk screening on the equipment, typically representing front- and rear-panel controls and input/output (I/O) connections, and LEDs
*** (asterisk)**	Indicates that several versions of the same model number exist and the information applies to all models; when the information applies to a specific model, the complete model number is given
Italic type	Denotes a displayed variable, a variable that you must type, or is used for emphasis

If You Need Help

If you need assistance while working with the SLW2500, call Motorola's Technical Response Center (TRC) at **1-888-944-HELP (1-888-944-4357)**. The TRC is open from 8:00 AM to 7:00 PM Eastern Time, Monday through Friday. When the TRC is closed, emergency service *only* is available on a call-back basis.

When contacting the TRC from outside the United States, call the main switchboard number, **1-215-323-1000**, and ask for extension **4200**.

Calling for Repairs

If repair is necessary, call Motorola's Repair Facility at **1-800-642-0442** for a Return for Service Authorization (RSA) number before sending the unit. The RSA number must be prominently displayed on all equipment cartons. The Repair Facility is open from 7:00 AM to 4:00 PM Pacific Time, Monday through Friday.

When calling from outside the United States, use the appropriate international access code and then call **526-314-1000**, extension **3194**, to contact the Repair Facility.

When shipping equipment for repair, follow these steps:

1. Pack the unit securely.
2. Enclose a note describing the exact problem.
3. Enclose a copy of the invoice that verifies the warranty status.
4. Ship the unit **PREPAID** to the following address:
   Motorola, Inc.
   c/o William F. Joffroy, Inc.
   Attn: RSA #_____
   1480 North Industrial Park Dr.
   Nogales, AZ 85621

Section 2

Overview

The STARLINE SLW2500 is the newest addition to the next generation of telecommunications optical nodes. It supports evolving fiber-deep networks and meets AT&T's needs for a single and two-way broadband network application that includes broadcast video, telephony, and data.

The forward path is factory-configured with one SG2-LR receiver and four high-level RF outputs. Return-path configuration consists of an SG2-DFBT optical transmitter and SLW25-LPLR return-path receiver. The forward passband is extended to 870 MHz to increase channel capacity and support advanced interactive services and global applications. Modular design enables system upgrades and component replacement with minimal system interruption.

To accommodate unique AT&T system criteria, the SLW2500 is shipped as a non-configured product.

Standard features include:

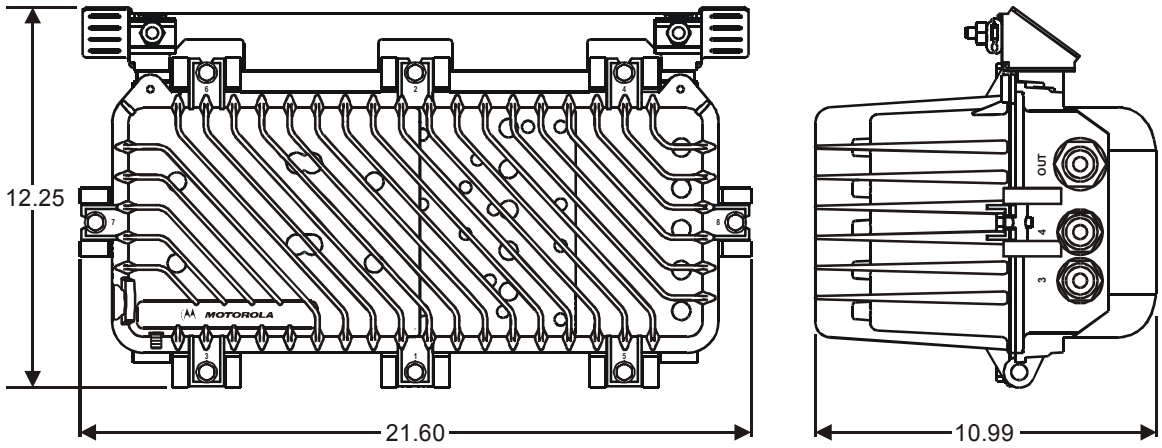
- Enhanced gallium arsenide (GaAs) output and driver hybrids
- User-friendly fiber management
- Pedestal or strand mount housing
- Housing performance up to 1.1 GHz
- Service cable option
- SC/APC connectors
- Fast Trigger Electronic Crowbar (FTEC) surge protection
- Phased migration path for future installation of a cable modem termination system (CMTS)
- Phased migration path (through E-pack swap) for future expansion including a high-band return path capability
- 10-48/54-870 MHz bandsplit
- 16 dB straight-line output slope
- Temperature Control Unit (TCU) thermal control

Housing

The SLW2500 optical node is furnished in an aluminum housing that protects the electronics from weather and dissipates internally generated heat.

Figure 2-1 illustrates the SLW2500 housing and provides its dimensions:

Figure 2-1
SLW2500 housing dimensions — front and side view



Coaxial cable connections to the housing are made using conventional 5/8 inch × 24 threads per inch, stinger-type connectors. For strand mounting, the optional bracket must be used. If the node is configured for strand mounting, the bracket is installed on the node at the factory. The bracket provides two clamps, located 16 and 7/8 inches apart, that secure the strand with 5/16 × 20 stainless steel bolts.

Mounting Holes

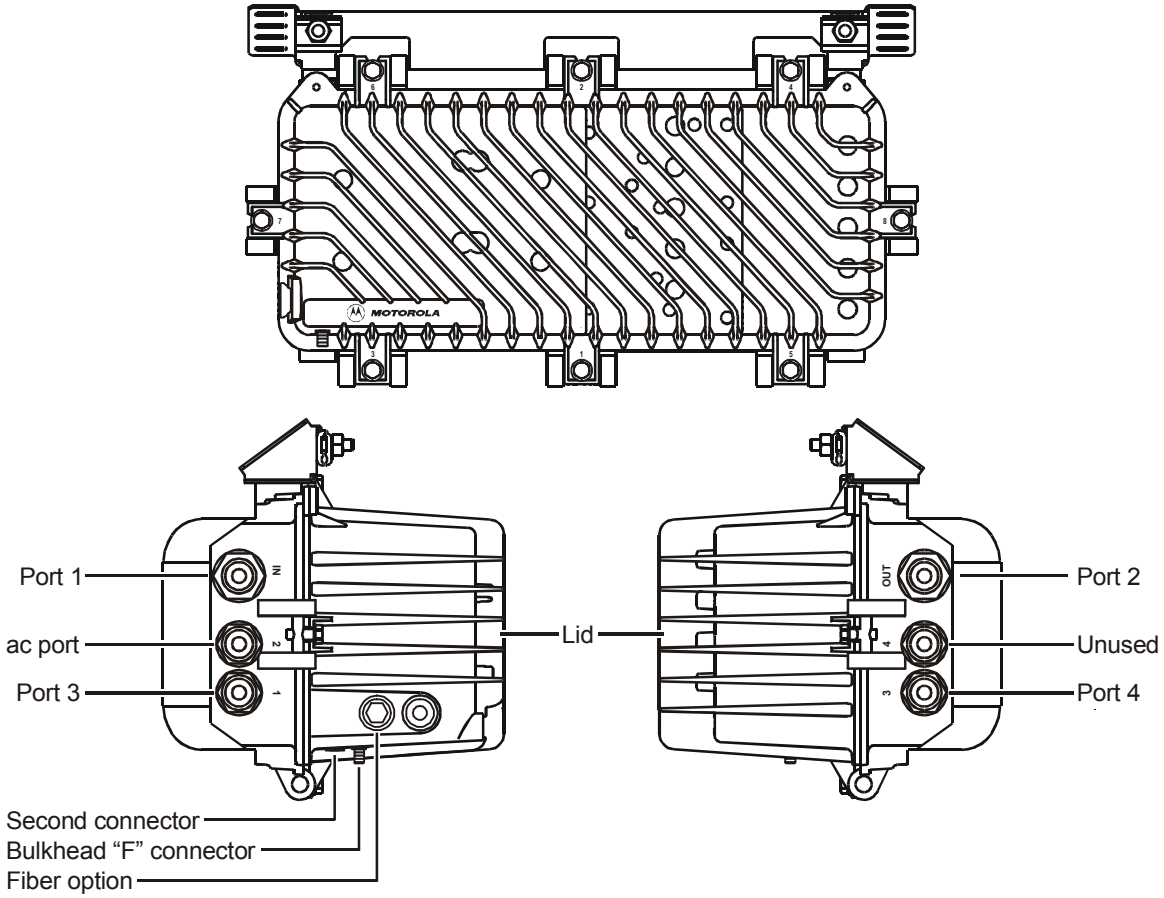
Two threaded holes are located on the horizontal center-line on the rear of the housing. These 5/16" × 18" × ¾" holes are separated by eleven inches center-to-center and can be used for pedestal or surface mounting.

Port Locations

Five housing ports provide connection for coaxial cables. Housing Port 2 (OUT) is used only for connection to an external 60 Vac or 90 Vac power supply. Side-by-side connector fittings are limited to .750 inches at Port 1 (IN) and 2 and/or Port 3 (1) and 4 (3). All ports are protected by factory-inserted threaded plugs or plastic cap plugs. Discard these plugs when you install the cable connectors.

Figure 2-2 illustrates the housing port locations:

Figure 2-2
Housing port locations

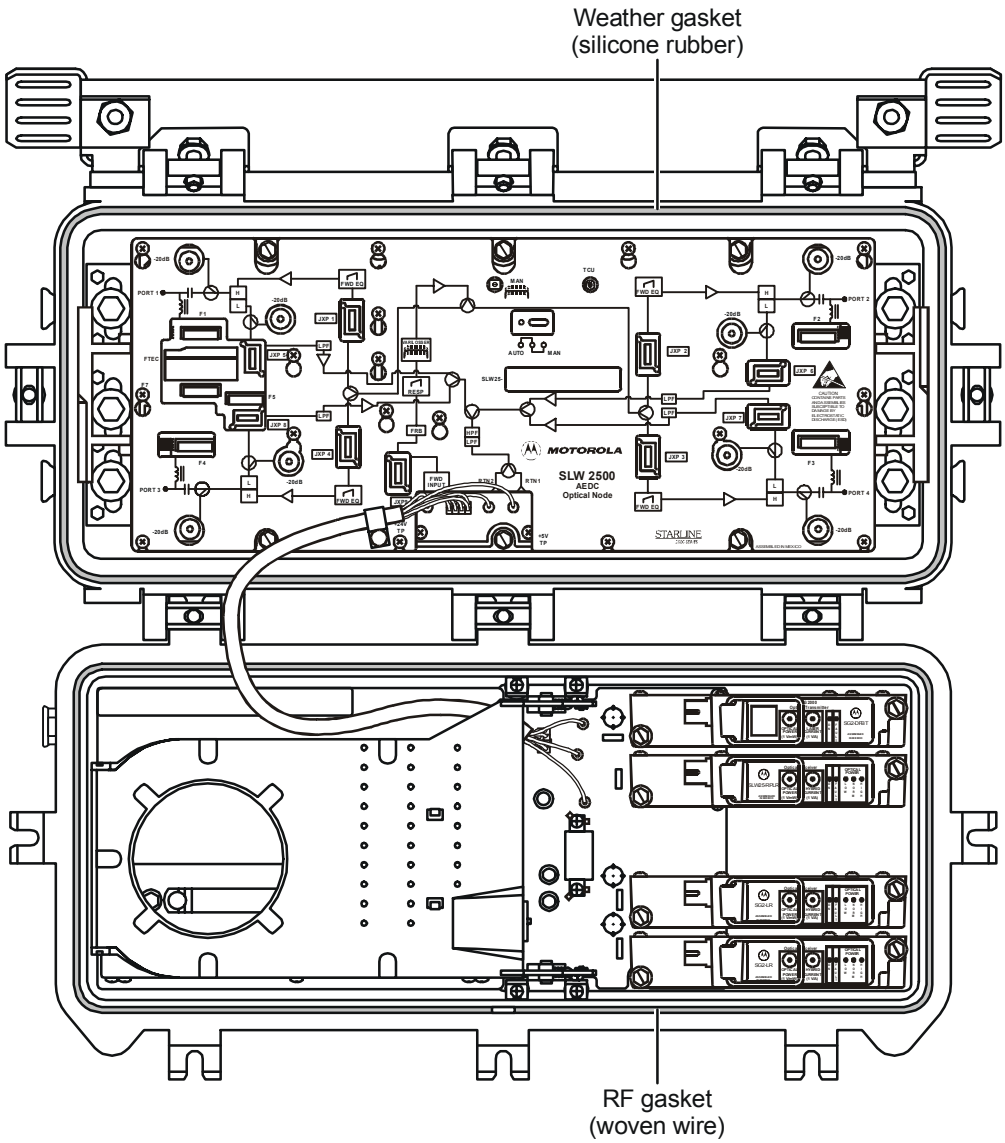


Gaskets

Each housing is equipped with a woven-wire RF gasket and a silicone-rubber gasket to provide a seal between the housing base and lid. These gaskets provide efficient ground continuity, RF shielding, and weather protection. Both gaskets must be in place and in good condition to ensure proper operation and protection of the station. The weather gasket should be lightly coated with silicone grease each time the node is opened. Replace this gasket if it becomes damaged or deformed.

Figure 2-3 illustrates the housing gaskets:

Figure 2-3
Housing gaskets



Power Supply

The SLW2500 power supply (SG2-PS) is located in the housing lid to optimize heat transfer and to balance the thermal load between the base and the lid. An umbilical cord connects the SG2-PS to the base.

You can power the node from either 60 Vac (LO) or 90 Vac (HI) system power supplies. The unit is shipped from the factory set for 60 Vac powering. For systems equipped with 90 Vac powering, the suitcase jumper on the dc power supply can be repositioned to optimize the supply start-up voltage for the higher input range. A description of this procedure is in Section 3, "Bench Setup".

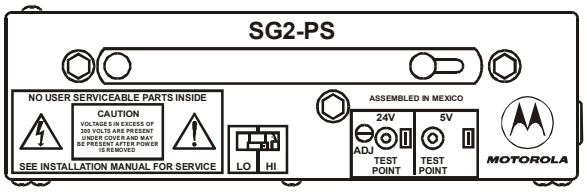
A flexible power-distribution design enables you to power the node from any of the four main RF ports, as well as, a single dedicated power input port. Using fuses and shunts, you can configure the node to distribute power to the remaining active ports. It can also be powered from the power input port while a second power source is passed through on any combination of the main RF ports.

The power supply circuit includes a heavy-duty, gas-discharge, tube surge protector located on the amplifier module. You can replace this surge protector with the optional FTEC surge protector. The FTEC triggers at approximately 230 V and presents a short circuit to the line during periods of overvoltage. After the ac input voltage returns to normal, the FTEC returns to its open circuit state. This provides the node with a level of protection against surge currents on the ac line.

Twenty-ampere fuses are installed at the factory to provide power passing to additional amplifiers. The fusing options are detailed in Section 3, "Bench Setup".

Figure 2-4 illustrates the SG2-PS power supply:

Figure 2-4
SG2-PS power supply

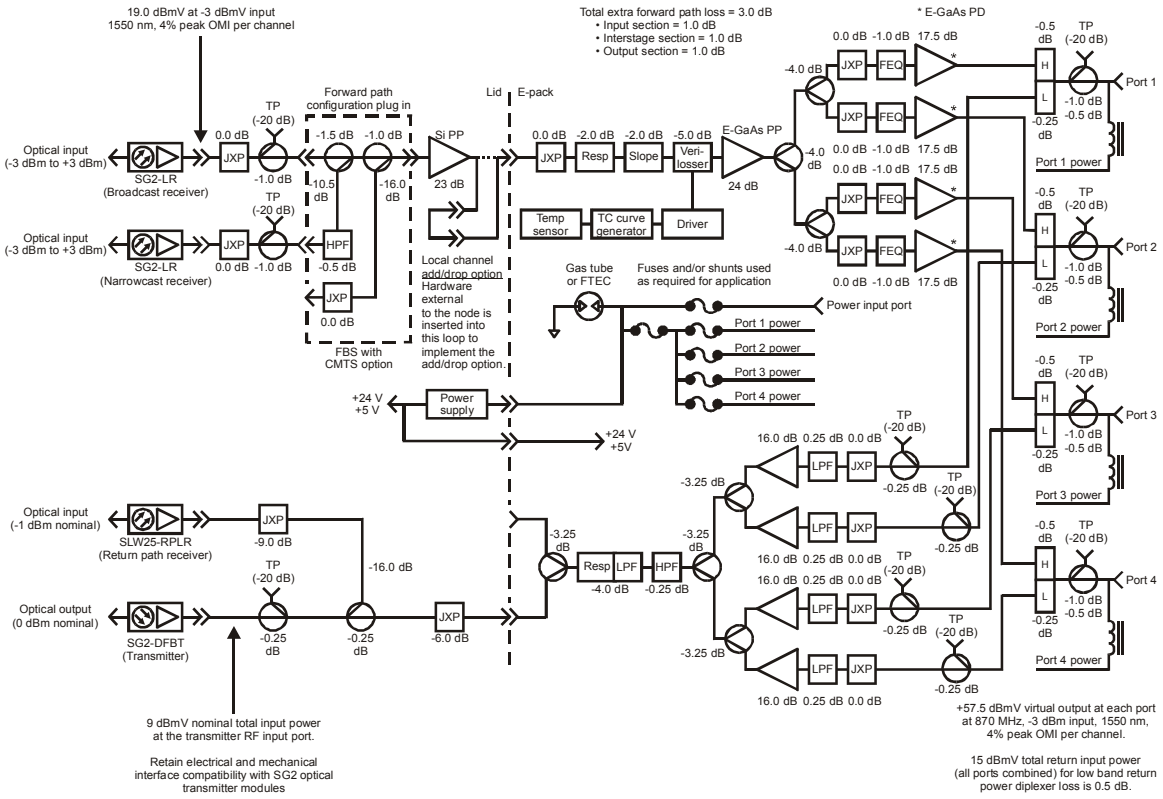


Forward Path

The multiple receiver functionality of the platform accommodates split-band applications. A typical split-band configuration has analog signals in the 54 MHz to 450 MHz band feeding one receiver. Digital transmissions or narrowcast signals are carried between 450 MHz and 870 MHz on another fiber and processed by the second receiver.

Figure 2-5 provides a diagram of the signal flow-path through the SLW2500:

Figure 2-5
Signal flow diagram



To assess fiber link status, the optical-power monitor circuit is active at all times. An integrated optical bulkhead connector and module link status indicators enhance fiber management and reduce troubleshooting time.

A plug-in board is available to configure the SLW2500 lid board for single or narrowcast receiver arrangements. A low-noise pre-amplifier hybrid amplifies the signal to a level suitable for connection to the RF chassis.

At the input to the RF chassis, a flatness circuit compensates for hybrid and accessory response signatures. A variable attenuator circuit enables fine adjustment of the output level. It is driven by the standard thermal control unit (TCU) to compensate for temperature variations.

The MDR-*/* circuit board provides a fixed linear equalizer for 870 MHz. The MDR-*/* also compensates for the low frequency roll-off inherent in plug-in diplexers.

A driver-hybrid amplifies the signal to a sufficiently high level to feed up to four power-doubling output stages. These output hybrids use enhanced gallium arsenide (GaAs) types for higher station output at low distortion. Plug-in facilities are available ahead of each output stage for individual equalizer boards. These can be installed to customize the tilt for the various ports.

Minus 20 dB directional test points are available at various points in the signal paths of the node. Because these test points are 75-ohm source impedance, special test probes are not required.

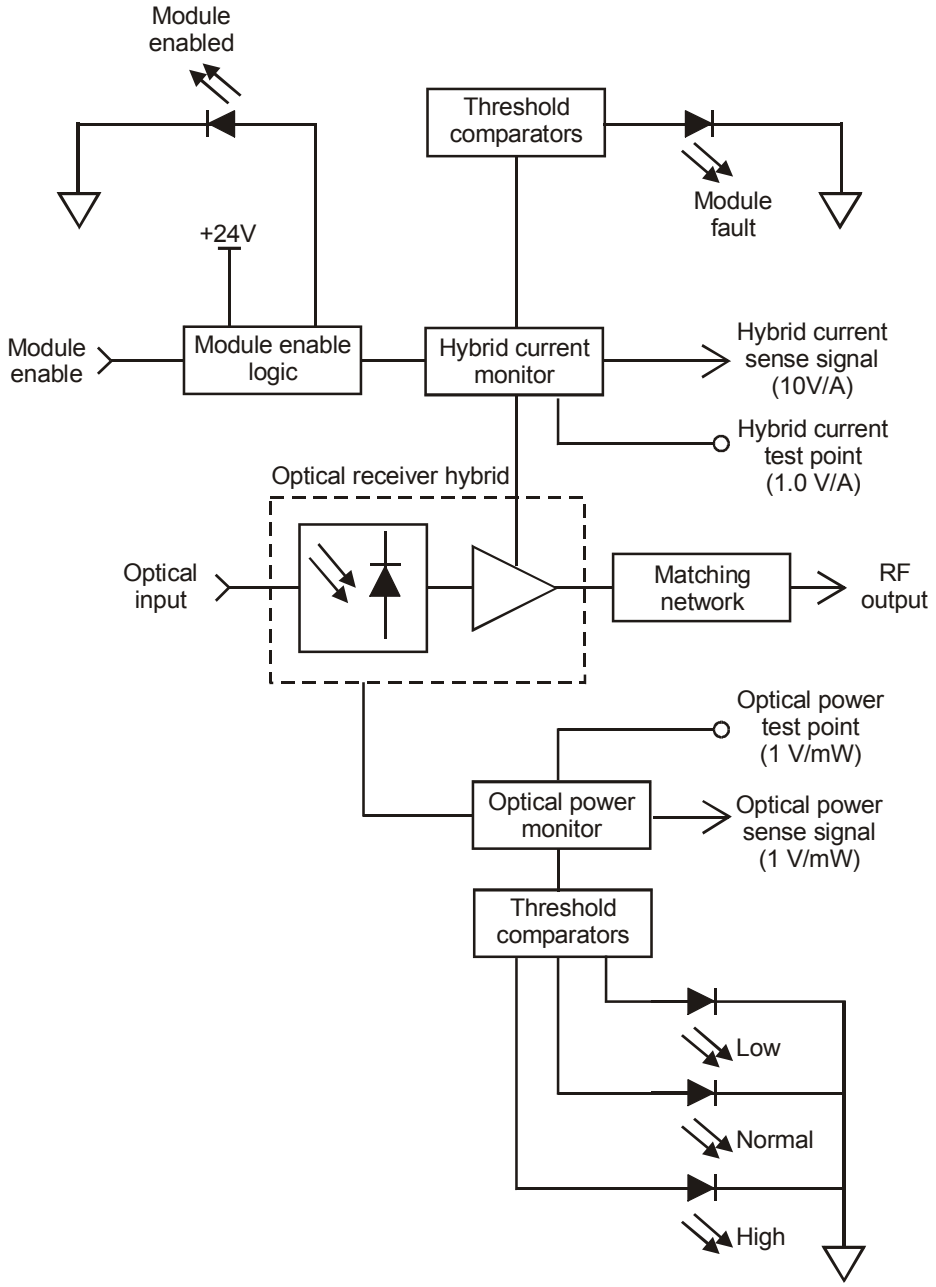
Model JXP-* attenuator pads are used for adjusting signal levels within the signal path.

SG2-LR Receiver

The receiver module, SG2-LR, is designed specifically for high performance in the SLW2500. The SG2-LR receiver uses an integrated optical-hybrid photo-detector for improved RF performance over the entire 54 MHz through 870 MHz passband.

Figure 2-6 illustrates a functional block diagram of the SG2-LR receiver:

Figure 2-6
SG2-LR receiver functional diagram



Return Path

To meet future return-path requirements, you can upgrade the SLW2500 with various optical transmitters to accommodate data and video signal transmission.

Signal levels are adjusted in the return path using model JXP-* attenuator pads. Units are typically shipped with a JXP-6 (6 dB) attenuator pad at the input of the transmitter.

Optical Return Transmitters

Three optical return transmitters are available to meet the needs of most return applications.

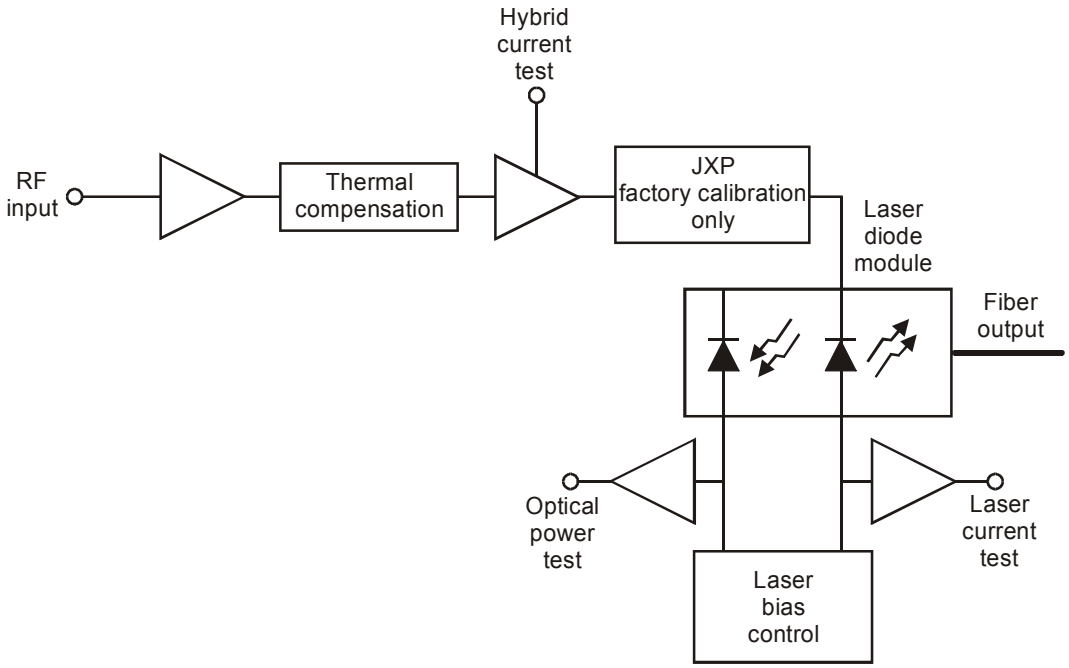
The three optical return transmitters and their features are:

SG2-DFBT/* (standard)	Uses an uncooled, isolated DFB laser operating at 1 mW for improved link performance. Carries a full 35 MHz of digital data or up to two video channels.
SG2-DFBT/3 (optional)	Uses an uncooled, isolated DFB laser operating at 2 mW for improved link performance. Carries a full 35 MHz of digital data or up to two video channels.
SG2-DRT (optional)	Uses a digitally modulated laser housed in a module with an RF input port and analog-to-digital conversion functionality.

All transmitters include thermal compensation circuitry to minimize the change in received optical and RF signal level at the headend as the node temperature varies. An integrated optical bulkhead connector and module status indicators enhance fiber management and reduce troubleshooting time.

Figure 2-7 illustrates a functional block diagram of the SLW2500 transmitter:

Figure 2-7
SLW2500 transmitter block diagram



Level Control

The gain of hybrid IC amplifiers varies with temperature. In addition, changes in system channel loading and/or splices in the fiber link can change the level of the received signal.

The standard TCU board compensates for anticipated hybrid gain changes by sensing housing temperature and signaling needed changes to the RF attenuator.

Options and Accessories

Table 2-1 provides a list of SLW2500 options and accessories available to AT&T:

Table 2-1
Options and accessories

Model	Description	Function
TCU	Thermal control unit	Controls amplifier gain for changes in hybrid gain at the sensed temperature.
JXP-*A	Fixed attenuators	Are used to adjust amplifier levels and are available in 1 dB steps from 1 through 24 dB. The appropriate value must be installed.
JXP-ZX	0 dB attenuator	This attenuator is used in place of JXP-*A pads when no attenuation is needed.
FTEC	Crowbar overvoltage protection	An electronic crowbar/surge protector that can be used to replace the existing 230 volt gas discharge surge protector.
GFAL	Test probe	Used to evaluate node performance.
F/JXP	Injection probe	Used to inject a signal for test purposes.
SG2-SB/*	Strand bracket	For hanging a strand mounted node.
SG2-PS	Power supply	Provides the +24 V and +5 V dc supply to the station. It has an extended voltage range and is power-factor corrected.
SG2-SERCAB/*	Service cable	A 6-fiber service cable available with SC/APC or FC/APC connectors.
SG2-FE-*/870	Forward equalizers	Used to increase output tilt at one or more ports in an 870 MHz system. They are available in 1 dB increments from 2 dB through 6 dB.
SG2-LR	Forward path lightwave receiver	Converts the received optical signal to broadband RF.
SG2-*	Analog return transmitters	Refer to the list provided in “Optical Return Transmitters” in this section.
DS-SG2-DRT*	Digital return transmitter	Refer to the list provided in “Optical Return Transmitters” in this section.
SLW25-RPLR	Return path laser receiver	Converts the received return path optical signal to return path RF.

Gain Selection

To use the gain option selection chart, Figure 2-8, first find the point on the left hand axis that corresponds to the expected optical input power at the node. Move across this horizontal line to the right until it intersects a vertical line corresponding to the desired RF output level.

If this intersection is above and to the left of the diagonal standard gain line for the channel loading under consideration, the SLW2500 will give optimum performance with minimum padding. Operation at a combination of input and output levels below and to the right of the standard gain line is not possible.

Figure 2-8 illustrates the gain option selection chart for 870 MHz:

Figure 2-8
Optical input versus 870 MHz gain

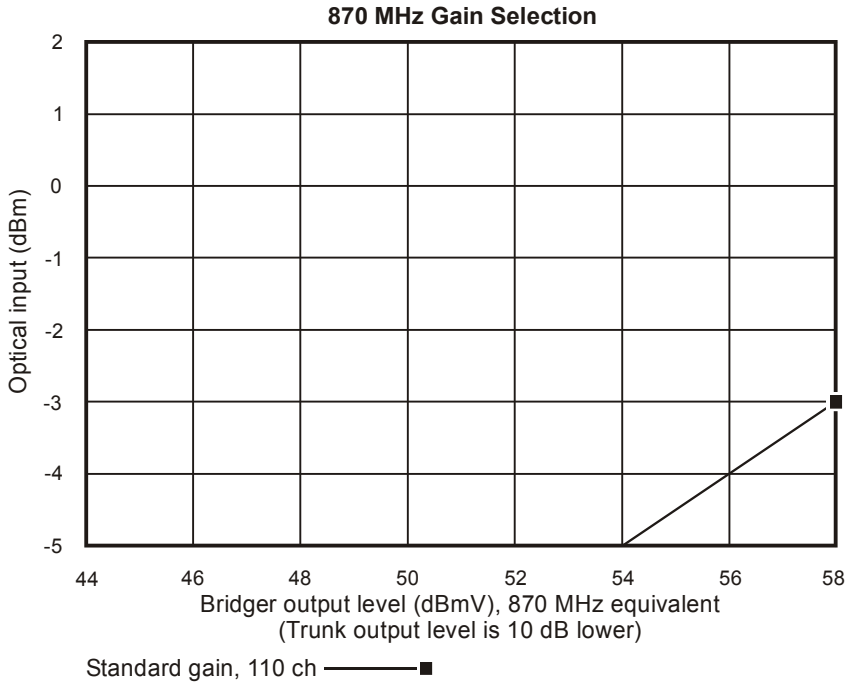
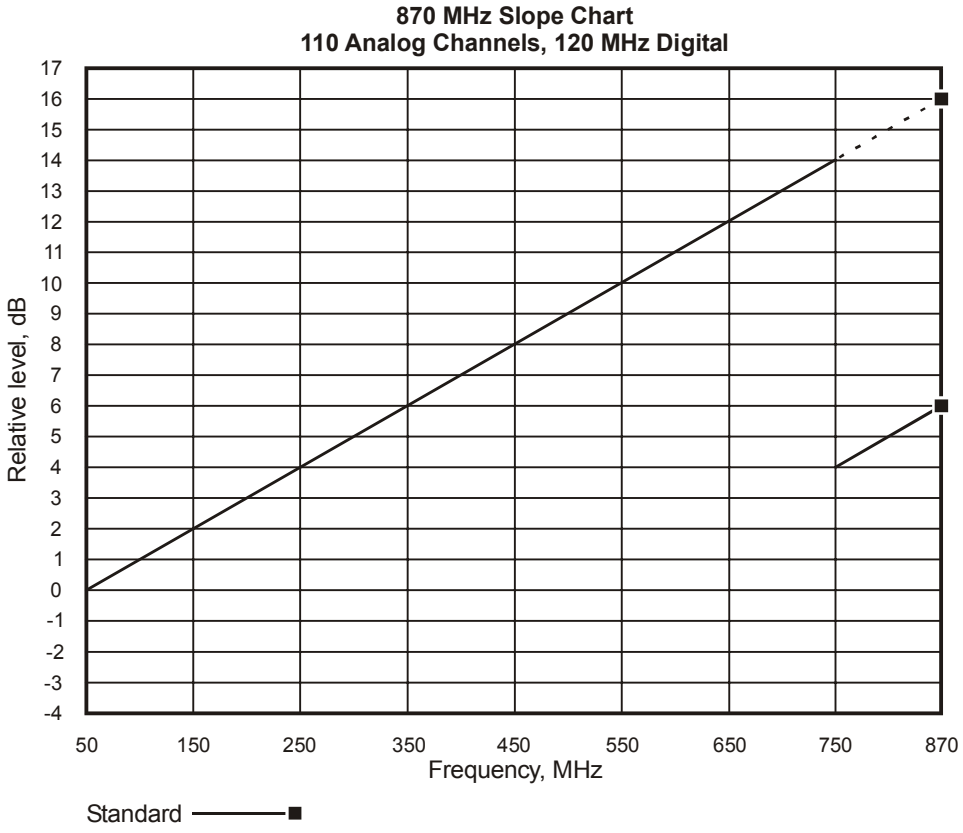


Figure 2-8 gives the output level at 870 MHz. For a system loaded with analog channels to 750 MHz, the actual level at 750 MHz is 2.4 dB lower with the standard overall tilt of 16 dB.

Tilt Selection

Tilt is factory set to 16 dB. Figure 2-9 illustrates the tilt for 870 MHz bandwidth and 110 channel load:

Figure 2-9
Relative level dB versus 870 MHz slope 110 channels



Section 3

Bench Setup

Before you install the SLW2500, it must be set-up to meet the power and configuration requirements for the node location. Bench set-up and quick check procedures are recommended to ensure proper functioning of all components and simplify field installation.

Figure 3-1 illustrates the upper-half housing or lid of the SLW2500 and identifies the location of all major components:

Figure 3-1
SLW2500 lid showing major components

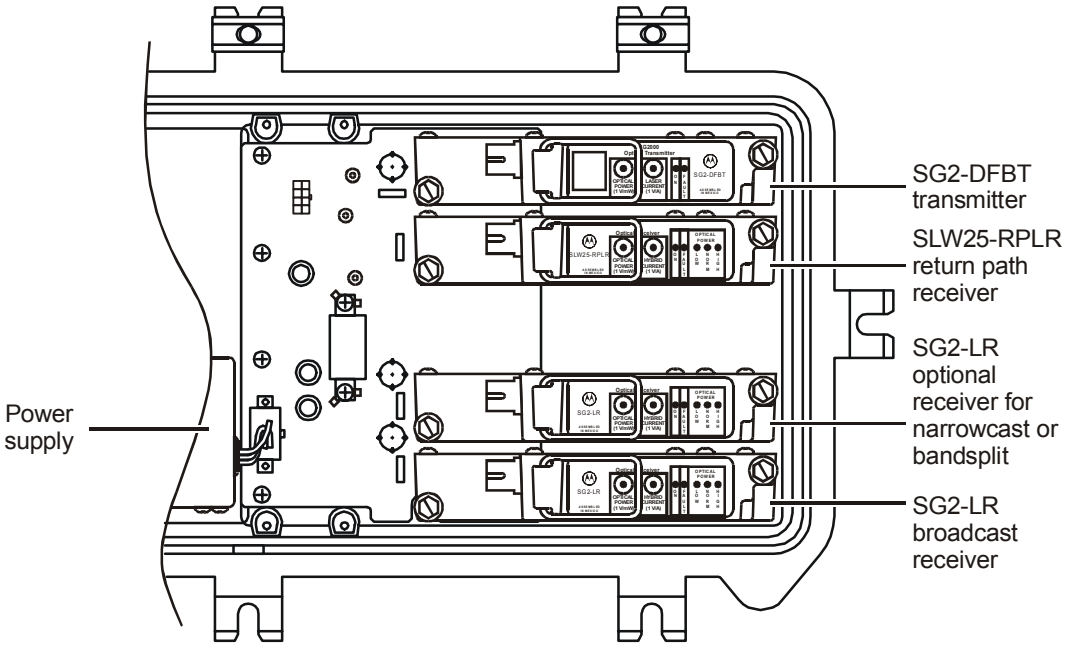
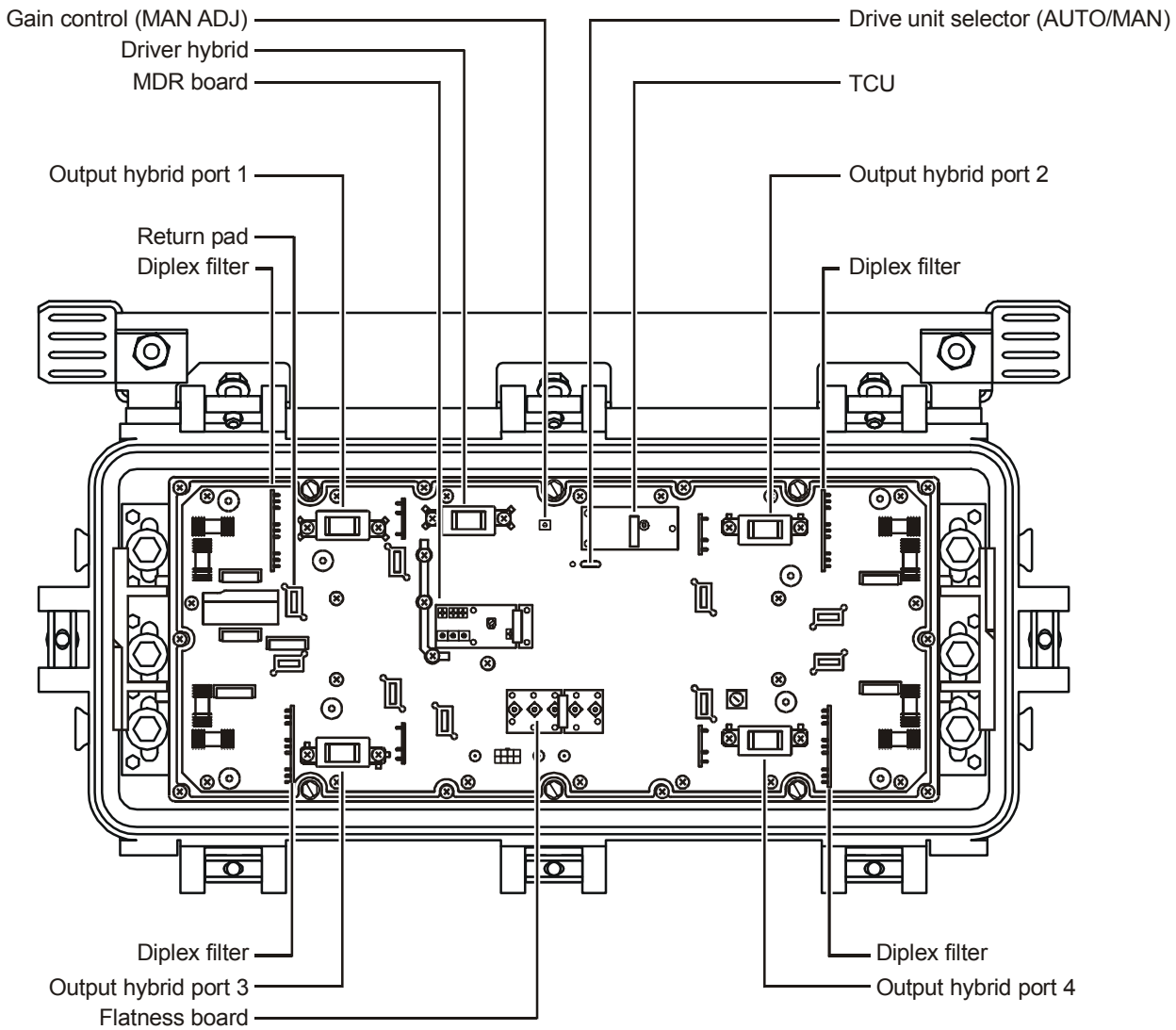


Figure 3-2 illustrates the RF chassis with the cover removed indicating the location of major components:

Figure 3-2
SLW2500 RF chassis



Powering the Node

You can conveniently power the SLW2500 by applying 60 Vac or 90 Vac to housing Port 2 (ac port). This port is not used for RF purposes. All ports are rated at 15 amperes maximum and are fused with common, blade-type 20 ampere automotive fuses. The 10 ampere fuse protects the dc power supply wiring and can also be used to disconnect ac power from the power supply. Figure 3-4 illustrates the ac fuse locations in the RF chassis of the SLW2500.

In addition to providing overcurrent protection, fuse locations also determine the paths for ac bypassing through the housing.

Figure 3-3 diagrams fuse configurations for ac and dc powering:

Figure 3-3
Fuse configuration

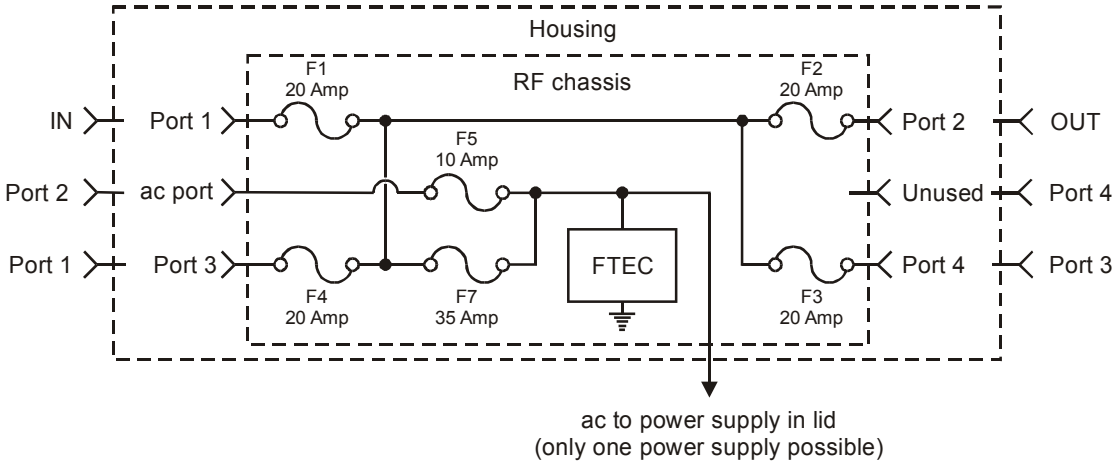


Table 3-1 identifies and describes the ac fuse options:

Table 3-1
AC fuses

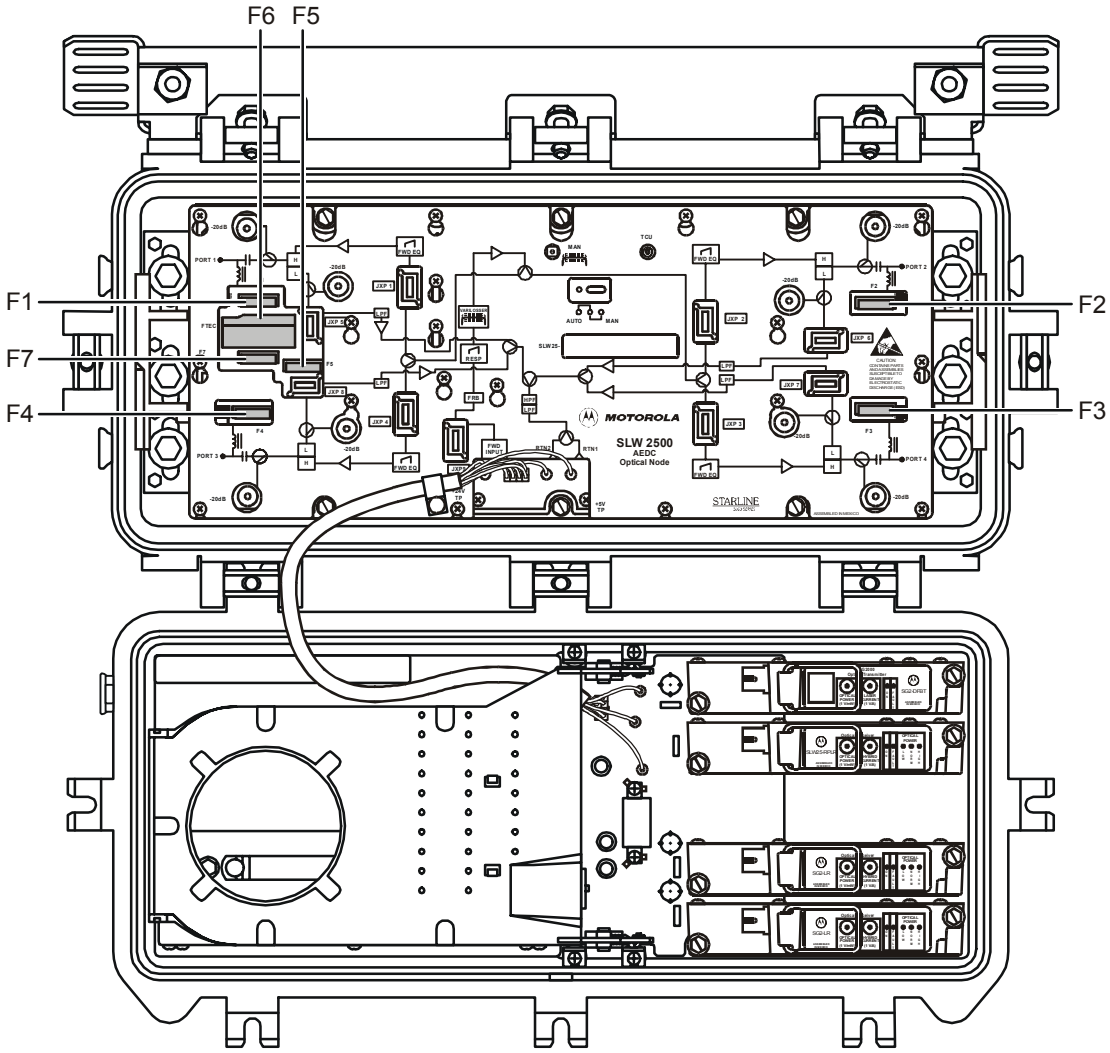
Fuse	Function	Rating	Type
F1	Passes ac to/from Port IN of node housing base.	20 A, 32 Vdc	Auto, plug-in, fast blow
F2	Passes ac to/from Port OUT of node housing base.	20 A, 32 Vdc	Auto, plug-in, fast blow
F3	Passes ac to/from Port 3 of node housing base.	20 A, 32 Vdc	Auto, plug-in, fast blow
F4	Passes ac power to/from Port 1 of the node housing base.	20 A, 32 Vdc	Auto, plug-in, fast blow
F5	Passes ac from the ac only port (Port 2 of the node housing base).	10 A, 32 Vac	Auto, plug-in, fast blow
F6	FTEC		
F7	This fuse delivers ac power to/from all ports. It is always required except when power from the ac input (port 2) must be blocked at this location.	35 A, 32 Vdc	Auto, plug-in, fast blow

CAUTION!

Voltages up to 90 Vac are accessible. To avoid shock hazard confirm that no power is applied to the node before removing cover or replacing fuses.

Figure 3-4 illustrates the RF chassis cover showing the location of the ac fuses:

Figure 3-4
AC fuse locations

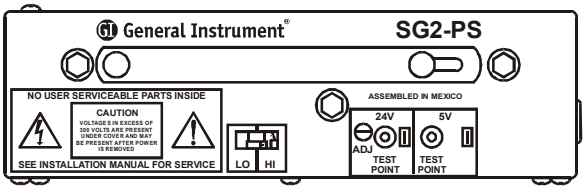


Power Supply Settings

You can power the SLW2500 from 60 Vac or 90 Vac system supplies. The unit is shipped from the factory set for 60 Vac (LO). If your system uses 90 Vac powering, reposition the suitcase jumper on the dc power supply to the 90 Vac (HI) position to optimize the supply turn-on voltage for the higher input range. Note that no damage results if the jumper is not changed. In a 90 Vac system, changing the jumper ensures that the dc supply does not turn on until the proper input voltage level is reached. This prevents excessive loading of the cable plant power supply during turn-on after a power-off situation.

Figure 3-5 illustrates the location of the LO/HI jumper:

Figure 3-5
SLW2500 power supply



The dc supply can deliver 4.3 A at +24 V and 0.850 A at +5 V. Test points are provided for 24 Vdc and 5 Vdc supplies. Two green LEDs on the power supply indicate the overall health of the nodes dc power bus. The power supply is factory calibrated for 24 V and should not need output voltage adjustment; however, R51 is available if required. Figure 3-5 illustrates the location of R51 (ADJ).

The ac input from the feederline to the power supply must be between 44 Vrms and 90 Vrms with a line frequency of 50 Hz or 60 Hz. The waveshape of the input voltage must be quasi-squarewave. The power supply features a self-protection attribute that shuts it down for instantaneous line voltages higher than 200 V. A precision output regulator protects against overcurrent and short circuits, thus providing a precise output voltage.

Quick Checks - Functional Testing

It is recommended that you perform the procedures presented in the following subsections before you place the SLW2500 in service.

Forward Path

Figure 3-1 illustrates the location of the forward-path receiver module.

To set up the forward-path receiver:

1. Confirm the receiver configuration required. For a broadcast only receiver configuration use position A. For broadcast/narrowcast receivers, use optical receiver A and B positions.
2. Test the optical power input level using an optical power meter.

   Figure 5-1 illustrates the optical power test point on the top panel of the SG2-LR receiver module. The scaled voltage present at this test point is 1.0 V/mW. For 0 dBm input, the receiver output is approximately 25 dBmV for 77 channels. Other output levels are presented in Table 5-2.

3. Verify that the green ON LED, located on the top panel of the receiver, is illuminated to confirm enable status.
4. Verify that the green NORM LED, also located on the top panel of the receiver, is illuminated to confirm that the optical power is within the recommended operating range. See Section 5, "Operation" for other LED functions.
5. Select a JXP-* pad from Table 3-2. Insert the pad to the left of the receiver at the receiver pad facility. The test point and pad location for receiver C is located adjacent to the receiver as illustrated in Figure 3-1.
6. Check all four outputs at the amplifier test points located in the four corners of the RF chassis cover as illustrated in Figure 3-4. These test points have 20 dB loss. Therefore, for example, if the output is 51.5 dBmV at 550 MHz, the test point should read 31.5 dBmV.
7. Set the gain reserves using one of the following gain control options. Adjust the selected gain control option using the procedure presented in the appropriate subsection below.
   - Manual control only –there is no compensation for changes in amplifier gain due to input level or temperature fluctuations.
   - Thermal control –the standard thermal control unit (TCU) is installed at the factory and compensates for gain changes due to temperature fluctuations only.

Manual Gain Control

1. Connect a signal level meter to the FORWARD TEST POINT and tune it to a channel near 550 MHz.
2. Position the drive selector to the MAN position. Figure 3-2 illustrates the location of the AUTO/MAN drive selector.
3. Turn the gain control, MAN ADJ, to maximum (fully clockwise) and then turn it counterclockwise to reduce the output by 3 dB.

   If the output level is greater than required, change the pad at the receiver output location to obtain the desired level. To calculate the correct pad value, subtract the desired level from the measured level and increase the pad by that amount.

Thermal Control, Model TCU

1. Perform the steps under Manual Gain Control.
2. Position the drive unit selector to the AUTO position.
3. Turn the level control potentiometer on the TCU to achieve the same output level as in the MAN position.

Return Path

Figure 3-1 illustrates the location of the return-path transmitter module.

To set up the return-path transmitter:

1. Confirm that the transmitter is installed in the optical transmitter A position.
2. Measure the optical power level at the test point labeled OPTICAL POWER (1V/MW) provided on the top panel of the transmitter as illustrated in Figure 5-2. The scaled voltage present at this test point is 1.0 V/mW.
3. Verify that the green ON LED, located on the top panel of the transmitter, is illuminated to confirm enable status. Refer to Section 5, “Operation,” for FAULT LED functions.
4. Measure the return-path system levels.

   The unit is configured to drive the laser to the recommended level (+9 dBmV) when the total combined power at all ports is approximately +15 dBmV.

For more specific information regarding return path setup procedures, refer to the supplemental document *Return Path Level Selection, Setup, and Alignment Procedure.*

Forward Path Padding

The pad values, presented in Table 3-2, serve as a starting-point reference for typical installations. While this chart is prepared specifically for 77 channel loading, the difference for 110 channel loading is slight, approximately 1 to 2 dB less.

Table 3-2 provides JXP values as a function of the optical input and RF output level.

Table 3-2
SLW2500 pad chart

Input (dBm)		Output (dBmV)								
		50	51	52	53	54	55	56	57	58
2.0	Receiver JXP				8	7	7	7	7	7
	Mid-stage JXP				7	7	6	5	4	3
	Output JXPs				0	0	0	0	0	0
1.5	Receiver JXP			8	7	7	7	7	7	7
	Mid-stage JXP			7	7	6	5	4	3	2
	Output JXPs			0	0	0	0	0	0	0
1.0	Receiver JXP		8	7	7	7	7	7	7	7
	Mid-stage JXP		7	7	6	5	4	3	2	1
	Output JXPs		0	0	0	0	0	0	0	0
0.5	Receiver JXP	8	7	7	7	7	7	7	7	7
	Mid-stage JXP	7	7	6	5	4	3	2	1	0
	Output JXPs	0	0	0	0	0	0	0	0	0
0.0	Receiver JXP	7	7	7	7	7	7	7	7	6
	Mid-stage JXP	7	6	5	4	3	2	1	0	0
	Output JXPs	0	0	0	0	0	0	0	0	0
–0.5	Receiver JXP	7	7	7	7	7	7	7	6	5
	Mid-stage JXP	6	5	4	3	2	1	0	0	0
	Output JXPs	0	0	0	0	0	0	0	0	0
–1.0	Receiver JXP	7	7	7	7	7	7	6	5	4
	Mid-stage JXP	5	4	3	2	1	0	0	0	0
	Output JXPs	0	0	0	0	0	0	0	0	0
–1.5	Receiver JXP	7	7	7	7	7	6	5	4	3
	Mid-stage JXP	4	3	2	1	0	0	0	0	0
	Output JXPs	0	0	0	0	0	0	0	0	0
–2.0	Receiver JXP	7	7	7	7	6	5	4	3	2
	Mid-stage JXP	3	2	1	0	0	0	0	0	0
	Output JXPs	0	0	0	0	0	0	0	0	0
–2.5	Receiver JXP	7	7	7	6	5	4	3	2	1
	Mid-stage JXP	2	1	0	0	0	0	0	0	0
	Output JXPs	0	0	0	0	0	0	0	0	0
–3.0	Receiver JXP	7	7	6	5	4	3	2	1	0
	Mid-stage JXP	1	0	0	0	0	0	0	0	0
	Output JXPs	0	0	0	0	0	0	0	0	0

Output is the equivalent at the highest frequency.
Reserve gain set for 3 dB.

Section 4

Installation

Installation consists of:

- Splicing the six-fiber service cable to the transportation fiber
- Installing the housing and electronics on the messenger strand
- Applying power
- Placing the unit in service

To avoid excess weight and the possibility of damage during installation, the housing is normally mounted before the inclusion of the expensive electronic components. It is assumed that the node components have been removed, configured, and tested on the bench and only minimal alignment may be required following field installation.

Splicing Fiber

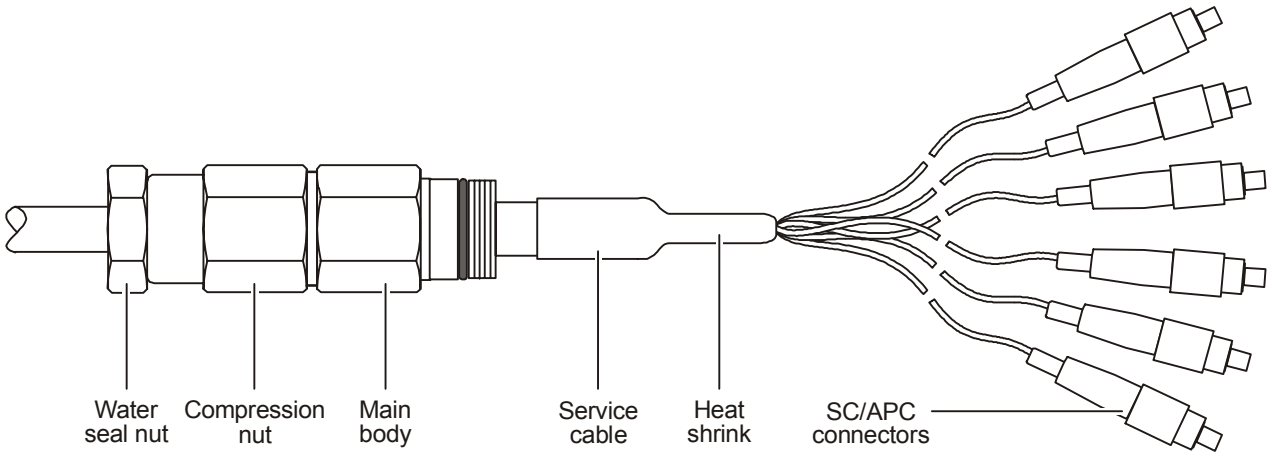
The six-fiber service cable can be spliced to the transportation cable at any time during the node installation. Splicing does not need to coincide with the installation of the housing.

Fusion splicing is recommended because it has low insertion loss and is the most reliable method. The splicing should be done by a technician experienced in splicing fiber.

To perform fusion splicing:

1 Obtain the 50-foot, six-fiber service cable with the compression fitting supplied in the node package. Figure 4-1 illustrates this cable:

Figure 4-1
Service cable connection and compression fitting



2 Splice each fiber according to procedures recommended by the manufacturer of the splicing equipment being used. A blue-coded fiber is suggested for the forward signal distribution and a brown-coded fiber is recommended for the return path. Cleanliness in the work area is essential.

CAUTION!

It is important that the connections at the headend be duplicated. If they are different from the above recommendations, follow the scheme used for the headend connections.

WARNING!

To avoid possible injury to personnel or damage to the equipment, remove 60/90 volt ac power from the system before you install the node.

3 Assemble the splice enclosure following the instructions furnished with the enclosure.

4 Complete the splicing and installation of the splice enclosure. Suspend the extra cable from the messenger strand using locally accepted methods. Commonly used methods include suspending it from the messenger along its entire length, and/or fashioning a figure eight coil and suspending it from the messenger.

If the housing is to be installed at a later time, protect the end of the service cable with the compression fitting and the fiber connectors from dirt and moisture.

Strand Wire Mounting

Two strand clamps and bolt assemblies are located on a bracket attached to the top of the housing for normal horizontal mounting below the strand. Figures 4-2 and 4-3 illustrate the front, rear, and side views of an installed bracket:

Figure 4-2
Mounting bracket-front view

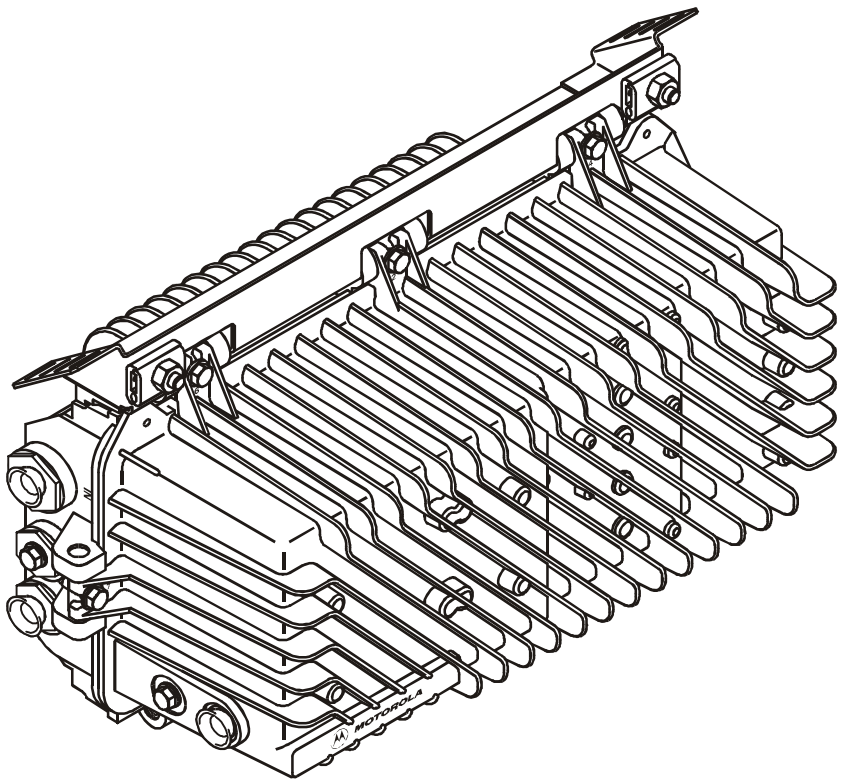
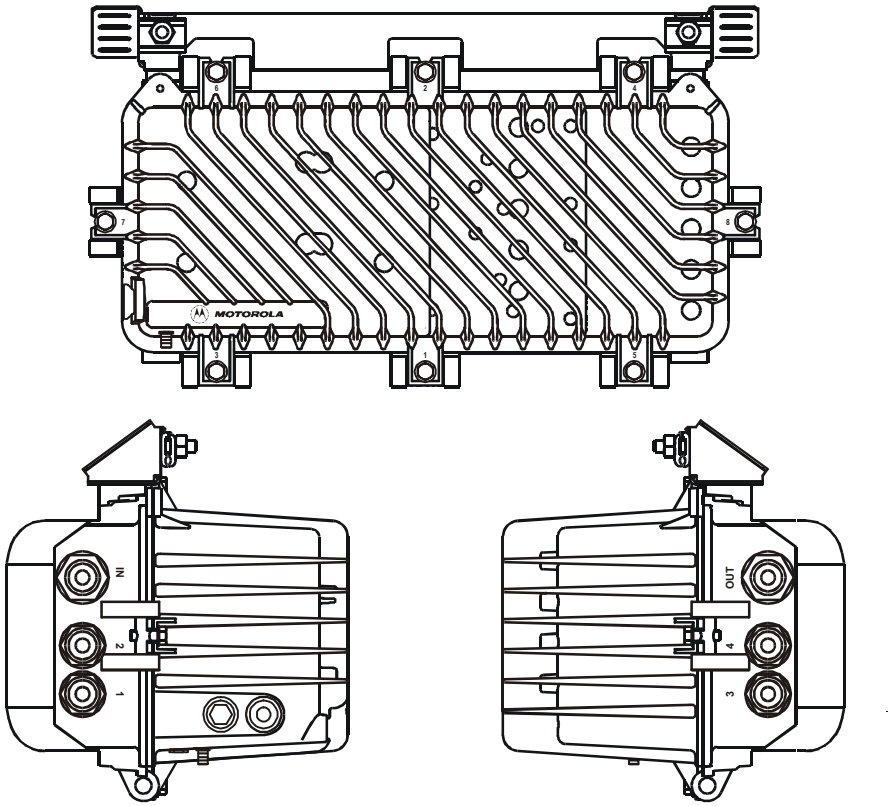


Figure 4-3
Mounting bracket-rear and side views



To mount the housing to the strand wire:

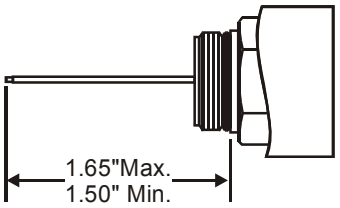
1. Attach the bracket to the housing using the two 5/16 × 18 bolts.
2. Loosen the 3/8 × 16 strand clamp bolt located on each mounting bracket.
3. Engage the strand clamp in the housing strand clamps. Do not tighten the hex-head bolts at this time.

   This enables the clamps to slide along the strand wire until the housing is finally positioned with respect to the cables.
4. Re-install all modules and electronic components if they were removed before the housing was installed.

Connections to the housing are made using standard KS-type housing port entry connectors. Pin-type connectors with a nominal center conductor diameter of 0.067 inches are required. Measuring from the seating plane of the connector, the center conductor pin length must be 1.50 inches minimum and 1.65 inches maximum.

Figure 4-4 illustrates the dimensions of the center conductor:

Figure 4-4
Center conductor length



There are no surge protectors over the center seizure screws and none should be installed. Adding surge protectors degrades the return loss of the housing port.

Coaxial Cables

To install coaxial cables in the base:

1. Loosen, but do not remove, the three bolts on top of the housing and the bolt on each side of the housing. Rotate these bolts away from the cover.
2. Swing the housing lid away from the lower housing base.
3. Remove the protective port cap(s) in the base and verify that the seizure screw within either the trunk or feeder port is loosened to accept the center pin of the cable connector.
4. Secure the cable end in the cable connector as described in the instruction sheet for the connector.
5. Insert the center conductor fully until it enters the seizure mechanism. Tighten the terminal screw onto the cable connector and torque to 12 in-lbs (1 ft-lb).
6. Repeat steps 3 through 5 for all other cable connections required.
7. Protect all cable connections with heat-shrink tape or tubing.
8. Lash the cables to the strand where they approach it and secure the cable lashing wire to the strand with commercial clamps.
9. Verify that port plugs on any unused ports are firmly seated and torqued to 5 ft-lbs.

Fiber Cables

To install fiber cables in the lid:

1. Remove the protective port plug from the side of the housing lid and carefully pass the connector ends of the fiber service cable through this port. It is necessary to insert one connector at a time. Be careful not to bend the fiber any more than is necessary.
2. Thread the compression fitting into the port. The compression nut and rubber grommet must be sufficiently loose to enable the fitting to be turned without turning the fiber cable at the same time. Torque the main body of the fitting to 60 to 72 in-lbs (5 to 6 ft-lbs).
3. Carefully dress the excess fiber into the ramp of the fiber spool tray. Wrap the fiber around the spooling cylinder one to two times depending on the length of the fiber. The diameter of the spool tray is matched to the bend radius of the fiber. Also ensure that the fiber is routed under the retaining flanges and through the pegs of the fiber tray for proper routing to the optics modules. Figures 4-5 and 4-6 illustrate the housing lid and fiber spool tray.

Figure 4-5
Housing lid and fiber spool tray

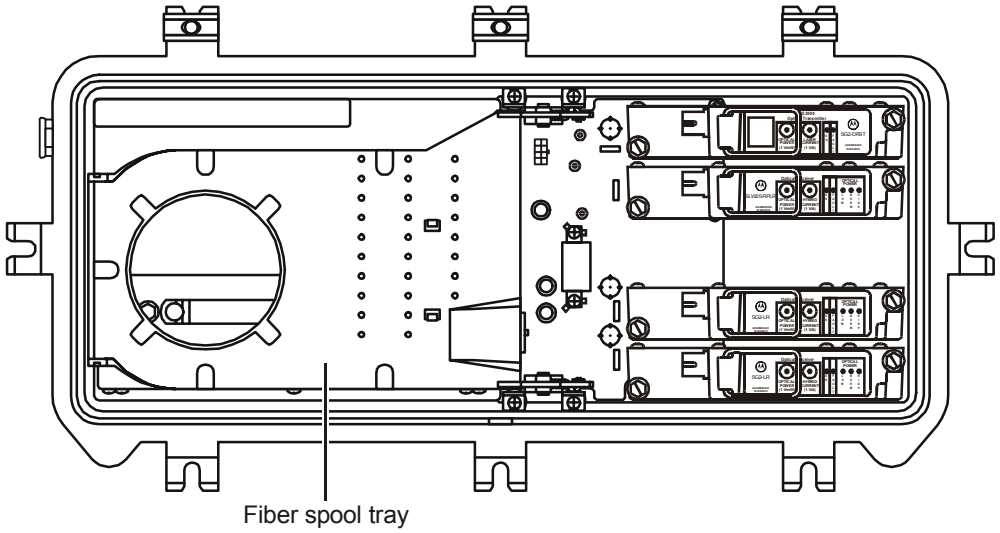
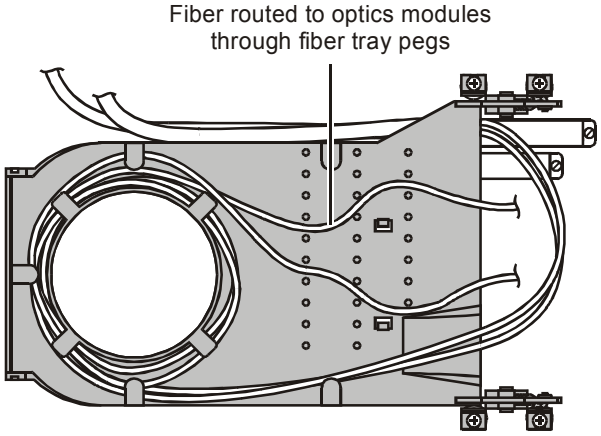


Figure 4-6
Fiber spool tray



4 Connect each fiber by removing the protective boot from the fiber connector, cleaning the connector with pure isopropyl alcohol (99%) using a lint-free wipe, and drying it with filtered compressed air. After cleaning the fiber, insert it into the appropriate receiver or transmitter module.

5 Position the fiber service cable in the compression fitting to provide some slack in the fibers inside the housing. Tighten the compression nut until it bottoms out. Finally, tighten the water seal nut until there is no gap between it and the compression nut.

6 Close the housing and use a torque wrench to sequentially and progressively tighten the housing bolts to a final torque of 12 ft-lbs. in the sequence stamped on the housing lid.

Section 5

Operation

This section provides information concerning the use of various options and applications required by AT&T. It may be helpful to refer to Figures 3-1 and 3-2 that illustrate the major components in the SLW2500 lid and RF chassis.

SLW2500 Optical Modules

The forward- and return-path optical modules available for the SLW2500 include:

- SG2-LR –forward path optical receiver
- SG2-DFBT –isolated DFB return transmitters
- SLW25-RPLR –return path laser receiver

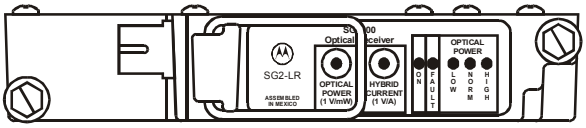
Designed specifically for use in the SLW2500 node platform, the modules combine high performance and easy maintenance.

SG2-LR Optical Receiver

The SG2-LR is a line of forward-path optical receivers used in the SLW2500 node platform. It is designed to be used in conjunction with a Motorola AM-Blazer, AM-OMNI-LM*, AM-OMNI-ALM, MegaStar, or other similar optical transmitter.

Figure 5-1 illustrates the SG2-LR:

Figure 5-1
SG2-LR



Tables 5-1 and 5-2 provide additional information on the user-related features and output levels of the SG2-LR:

Table 5-1
SG2-LR features

Feature	Description
Optical power test point	This test point enables monitoring of the optical power level at the input to the module. The nominal scale factor is 1.0 V/mW.
Hybrid current test point	This test point enables monitoring the current drawn by the amplifier section of the integrated optical receiver hybrid. The nominal scale factor is 1.0 V/A. The hybrid current test-point voltage is between 0.150 V and 0.350 V (hybrid current of 150 mA through 350 mA) when the module is enabled under normal operating conditions.

Feature	Description
Receiver enable	A green LED that provides visual indication of the receiver's enable status.
Fault indicator	A red LED that illuminates when the module is enabled but the hybrid current is outside the normal operating range.
Optical power status	A green LED that is ON when the optical power is within the recommended operating range (refer to Table A-4). Two red LEDs indicate that the optical power is above (HIGH) or below (LOW) the recommended optical input power range.

Table 5-2
SG2-LR minimum output levels

Optical input level	Output (dBmV) 77 channels	Output (dBmV) 110 channels
2.00	29.2	27.6
1.50	28.2	26.6
1.00	27.2	25.6
0.50	26.2	24.6
0.00	**25.2**	**23.6**
–0.50	24.2	22.6
–1.00	23.2	21.6
–1.50	22.2	20.6
–2.00	21.2	19.6
–2.50	20.2	18.6
–3.00	19.2	17.6
–3.50	18.2	16.6
–4.00	17.2	15.6

Typical output levels are approximately 2 dB greater than the minimum levels
Optical modulation index (OMI) for 77 channels (per channel): 0.0403
OMI for 110 channels (per channel): 0.0337
Optical transmitter wavelength is 1310 nm.

SG2-DFBT Optical Transmitter

The SG2-DFBT is an isolated distributed feedback (DFB) return path optical transmitter used in the SLW2500 node platform. It has a nominal optical output power of 1.0 mW and is used in conjunction with an AM-RPR, AM-OMNI-RPR/2, or other similar return-path optical receiver.

Figure 5-2 illustrates the SG2-DFBT:

Figure 5-2
SG2-DFBT

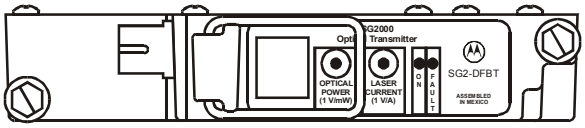


Table 5-3 provides information on the user-related features of the SG2-DFBT:

Table 5-3
SG2-DFBT features

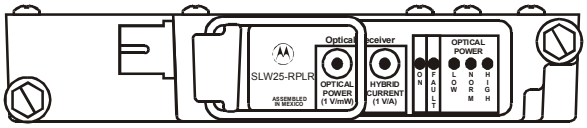
Feature	Description
Optical power test point	This test point enables monitoring of the optical output level of the module. The nominal scale factor is 1.0 V/mW. The optical power test-point voltage is between 0.945 V through 1.055 V (optical power of 0.945 mW through 1.055 mW) when the module is enabled under normal operating conditions. Note that the optical power test point does not track changes in optical power due to the laser tracking error.
Laser current test point	This test point enables monitoring of the current drawn by the laser diode. The nominal scale factor is 1.0 V/A. The laser current test point voltage is between 5 mV through 110 mV (laser current of 5 mA through 110 mA) when the module is enabled under normal operating conditions. The laser current is expected to vary widely with changes in temperature, but should always remain between the limits.
Transmitter enable	A green LED that provides visual indication of the transmitter's enable status.
Fault indicator	A single red LED that lights if the hybrid current is outside the normal operating range, the laser output power is below normal limits, or the laser current is above normal limits. Because the laser output requires a short period of time to stabilize, it is acceptable for the fault indicator to illuminate during the stabilization interval (approximately 2 seconds). Note that the module must be enabled for the fault indicator to function.

SLW25-RPLR Return-Path Laser Receiver

The SLW25-RPLR is a return-path optical receiver used in the SLW2500 node platform. It is used in conjunction with a Motorola AM-Blazer, AM-OMNI-LM*, AM-OMNI-ALM, MegaStar, or other similar optical transmitter.

Figure 5-3 illustrates the SLW25-RPLR:

Figure 5-3
SLW25-RPLR



Tables 5-4 and 5-5 provide additional information on the user-related features and output levels of the SLW25-RPLR:

Table 5-4
SLW25-RPLR features

Feature	Description
Optical power test point	This test point enables monitoring of the optical power level at the input to the module. The nominal scale factor is 1.0 V/mW.
Hybrid current test point	This test point enables monitoring the current drawn by the amplifier section of the integrated optical receiver hybrid. The nominal scale factor is 1.0 V/A. The hybrid current test-point voltage is between 0.150 V and 0.350 V (hybrid current of 150 mA through 350 mA) when the module is enabled under normal operating conditions.
Receiver enable	A green LED that provides visual indication of the receiver's enable status.
Fault indicator	A red LED that illuminates when the module is enabled but the hybrid current is outside the normal operating range.
Optical power status	A green LED that is ON when the optical power is within the recommended operating range (refer to Table A-4). Two red LEDs indicate that the optical power is above (HIGH) or below (LOW) the recommended optical input power range.

Table 5-5
SLW25-RPLR output levels

Typical Output (dBmV)	dBm/mW	Test Point (volts)
45.0	2.0/1.6	1.6
43.0	1.0/1.3	1.3
41.0	0.0/1.0	1.0
39.0	–1.0/0.8	0.8
37.0	–2.0/0.6	0.6
35.0	–3.0/0.5	0.5

Configuration

The following subsections describe your options in preparing the SLW2500 for service in the distribution system.

Forward Path RF

For forward path operation, the SLW2500 lid motherboard (LIDB) houses a single optical receiver, SG2-LR, in the receiver A position.

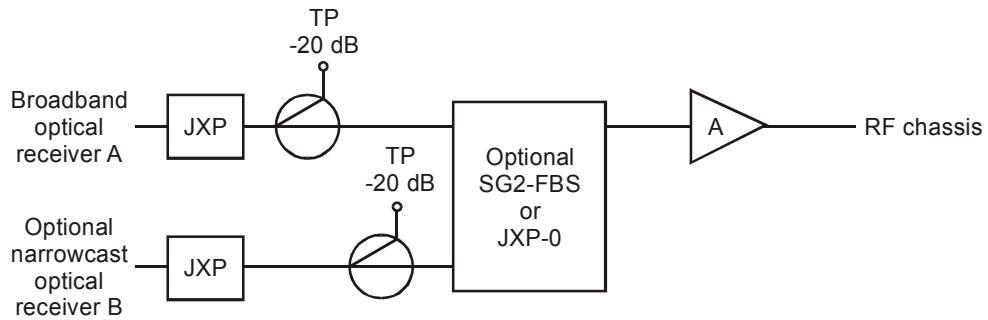
Forward Bandsplit Option

To use the forward bandsplit option, you must purchase an additional SG2-LR optical receiver module and the SG2-FBS jumper board.

The broadband optical receiver module, SG2-LR, must be installed in the optical receiver A position. The optional narrowcast optical receiver module, SG2-LR, must be installed in the receiver B position. A forward bandsplit, SG2-FBS jumper board or JXP must also be plugged into the LIDB. Figure 3-1 illustrates the location of the two SG2-LR receivers.

The SG2-LIDB distributes an RF signal from the receiver to the RF chassis as illustrated in Figure 5-4:

Figure 5-4
Single receiver



Wavelength Selection Jumper

The SG2-LR can be used with either 1310 nm or 1550 nm transmitters. An internal wavelength selection jumper optimizes the optical power test point and optical power status indicator calibration for the system wavelength. Note that the jumper has no effect on the optical-to-RF performance (gain, flatness, slope) of the module.

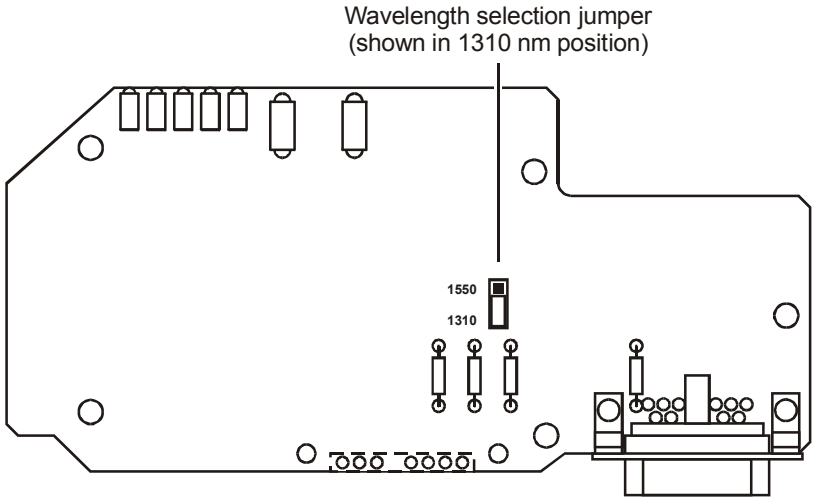
The wavelength selection jumper is factory-set and provides optimum calibration in a 1310 nm system.

If you need to reset the jumper:

1. If necessary, remove the SG2-LR from the node.
2. Remove the five screws securing the sheet metal cover to the module casting and remove the cover. Note the position of the optical connector assembly so that you can replace it in the same position when you re-assemble the module.
3. Carefully lift the fiber coiling tray until the wavelength selection jumper is visible. To avoid damaging the fiber, do not lift the tray any more than is necessary to expose the wavelength selection jumper.
4. Position the jumper block on the appropriate pins for the desired wavelength.

   Figure 5-5 illustrates the circuit board that is labeled to facilitate this step:

Figure 5-5
Wavelength selection jumper



5. Replace the fiber tray in the module taking care not to pinch the fiber between the coiling tray and the circuit board or casting. Position the optical connector assembly in its original position.
6. Replace the sheet metal cover, being careful not to pinch the fiber. Install the five screws to secure the cover. Torque the screws to 10-12 in-lbs.

CAUTION!

CAUTION! Do not pull the optical connector out more than two inches from the casting wall. If you pull the connector out too far, you must disassemble the module and respool the fiber.

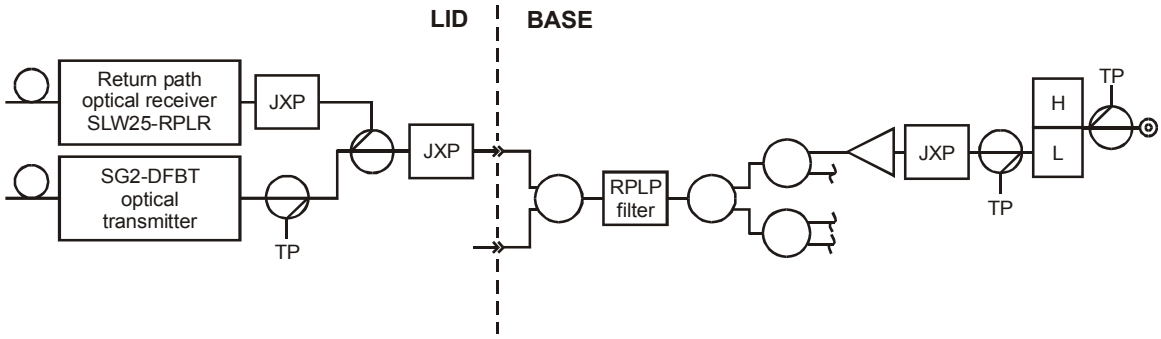
7 To verify the position of the optical connector assembly, lift the metal tab and attempt to remove the optical connector assembly from the module casting. The connector assembly should slide out easily. If not, remove the sheet metal cover and verify the position of the optical connector assembly. Release the metal tab and snap the optical connector assembly back into place.

8 If necessary, re-install the SG2-LR in the node.

Return Path RF

The SG2-DFBT optical transmitter must be installed in the nodes optical transmitter B location. The SLW25-RPLR must be installed in the A location. Figure 3-1 illustrates the correct location for each module.

Figure 5-6
Typical return configuration



Cleaning the Optical Connector

The design of the SLW2500 optical module connector enables you to clean it easily without removing the module from the node.

To clean the connector:

1 If necessary, disconnect the service cable from the module's optical connector assembly. Place a dust cover on the service cable connector.

2 Lift the metal tab to release the optical connector assembly and pull it out of the module.

CAUTION!

CAUTION! Do not pull the optical connector out more than two inches from the casting wall. If you pull the connector out too far, you must disassemble the module and respool the fiber.

3 Remove the bulkhead adapter from the internal optical connector.

4 Carefully clean the optical connector and bulkhead adapter using a suitable optical connector cleaning kit. If an optical connector cleaning kit is not available, clean the connector using pure isopropyl alcohol (99%) and a lint-free wipe.

5 Dry it with filtered compressed air. You can also clean the bulkhead adapter using filtered compressed air.

6 Re-assemble the bulkhead adapter to the internal optical connector. Ensure that you install the internal optical connector in the end of the bulkhead adapter bearing the metal tangs.

7 Snap the optical connector assembly back into the module.

8 If necessary, clean and reconnect the service cable.

Appendix A

Specifications

Specifications for the SLW2500 are valid over the given bandpass and operating temperature range listed in this section. The current catalog may contain additional information not provided below.

Table A-1 lists the optical characteristics for the SLW2500 node:

Table A-1
Optical Characteristics

Parameter	Specification
Optical wavelength	1310 ±20 nm through 1550 ±30 nm
Received optical power	
minimum	–3 dBm
maximum	+2 dBm (continuous)
Optical input return loss	40 dB minimum
Equivalent input noise current	8 pa/$Hz^{1/2}$

Table A-2 lists the station RF characteristics for the SLW2500 node:

Table A-2
Station RF characteristics

Parameter	Specification
Forward passband frequency	54 MHz through 870 MHz (dependent upon split)
Return passband, each port	5 MHz through 48 MHz (T-split)
Return loss	16 dB
Minimum full gain	
RF amplifier	42 dB
Gain control range	8 dB
Operational gain	
RF amplifier	38 dB
Flatness over passband	±0.75 dB, all ports
Operational tilt (standard)	870 MHz: 16 dB ±1 dB (standard) (plug-in equalizers available)

Table A-3 lists the general characteristics for the SLW2500 node:

Table A-3
General characteristics

Parameter	Specifications
AC input voltage	44 Vac through 110 Vac quasi-squarewave
AC bypass current	15 A
Hum modulation	–70 dB @ 15 A bypass current
Operating temperature	–40°C through +60°C (–40°F through +140°F)
Housing dimensions	21.6”(L) × 10.6”(W) × 11.0”(D), (without bracket)
Weight	Minimum 36 lbs./maximum 42 lbs. (without bracket)

Table A-4 lists the general specifications for the SG2-LR optical receiver:

Table A-4
SG2-LR

Parameter	Specification
Optical input power range-recommended	–4.0 dBm to +2.0 dBm
Optical input power-maximum recommended[1]	3 dBm
Optical input return loss	40 dB minimum
RF passband	40 MHz through 870 MHz
Gain at 40 MHz[2]	19.5 dB minimum
Flatness	1.25 dB P-V maximum
Tilt	–0.5 dB to +2.0 dB maximum
Equivalent noise input current	8 $pA/Hz^{1/2}$ maximum

[1] Absolute maximum optical input power that can be applied to the optical input connector.

[2] Relative to an ideal photodetector terminated in a 75-ohm impedance.

Table A-5 lists the RF performance specifications for the SLW25-RPLR laser transmitter:

Table A-5
SLW25-RPLR

Parameter	Specification
Optical input power range-recommended	–4.0 dBm to +2.0 dBm
Optical input power-maximum recommended[1]	3 dBm
Optical input return loss	40 dB minimum
RF passband	5 MHz through 300 MHz
Gain at 40 MHz[2]	19.5 dB minimum
Flatness	1 dB P-V maximum
Tilt	–0.5 dB to +1.0 dB maximum
Equivalent noise input current	8 pA/$Hz^{1/2}$ maximum

[1] Absolute maximum optical input power that can be applied to the optical input connector.
[2] Relative to an ideal photodetector terminated in a 75-ohm impedance.

Table A-6 lists the RF performance specifications for the SG2-DFBT laser transmitter:

Table A-6
SG2-DFBT

Parameter	Specification
Nominal RF input impedance	75-ohms
RF passband	5 MHz through 200 MHz
Flatness (peak to valley)	1 dB P-V maximum
RF input return loss	18 dB minimum
Recommended total input power	+15 dBmV
Carrier to noise ratio 9 dB link, 35 MHz BW	41 dB minimum

Table A-7 lists the current requirements for various options and the two platforms available in the SLW2500:

Table A-7
Current requirements

Option	Watts AC power	Amps @90V	Amps @60V	Amps @52V	Amps @44V
Basic- platform (one-way, single receiver, GaAs)	92.72	1.37	2.06	2.38	2.81
Add for:					
Additional receiver-split band or RPLR	8.96	0.13	0.20	0.23	0.27
Return transmitter	9.84	0.15	0.22	0.25	0.30

Table A-8 lists nominal distortion and c/n performance for the SLW-87 with a load of 77 channels:

Table A-8
SG2-87 performance, with 77 channels

77 Channels	Link	Launch	System
C/N	50	69	50
CTB	–56	–69	–54
CSO	–64	–56	–55

Link: SG2-LR w/ALM9, 77 ch, 20km
Loss budget 9.0 dB
Output level (550 MHz), 52 dBmV/ch
Output level (50 MHz), 42 dBmV/ch

Table A-9 lists nominal distortion and c/n performance for the SLW-87 with a load of 94 channels:

Table A-9
SLW-87 performance, with 94 channels

94 Channels	Link	Launch	System
C/N	49	68	49
CTB	–56	–68	–54
CSO	–64	–55	–52

Link: SG2-LR w/ALM9, 94 ch, 20km
Loss budget 9.0 dB
Output level (650 MHz), 54 dBmV/ch
Output level (50 MHz), 42 dBmV/ch

Table A-10 lists nominal distortion and c/n performance for the SLW-87 with a load of 110 channels:

Table A-10
SG2-87 performance, with 110 channels

110 Channels	Link	Launch	System
C/N	49	67	48
CTB	–55	–67	–53
CSO	–63	–54	–51

Link: SG2-LR w/ALM9, 110 ch, 20km
Loss budget 9.0 dB
Output level (750 MHz), 56 dBmV/ch
Output level (50 MHz), 42 dBmV/ch

Appendix B

Torque Specifications

Torque specifications are valid for all models of the SLW2500 node.

			Torque	
Fastener	**Screw Size**	**Wrench Size**	**In-lbs**	**Ft-lbs**
Strand clamp/pedestal mounting	5/16-18	1/2 inch	120-144	10-12
Housing/lid closure	5/16-18	1/2 inch	48-72	4-6
Port plugs	5/8-24	1/2 inch	25-40	2.1-3.3
Seizure	#8-32	3/16 inch	11-12	.9-1
Chassis (E-pack)	#10-32	5/16 inch	18-22	1.5-1.8
Chassis cover	#6-32	¼ inch	15-17	1.3-1.4
Optical module	#6-32	Phillips	8-12	.67-1
Service cable fitting into housing	5/8-24	¾ inch	60-72	5-6
Hybrid	#6-32	Phillips	15-17	1.3-1.4
F-type connector		7/16 inch	30	2.5

Abbreviations and Acronyms

The abbreviations and acronyms list contains the full spelling of the short forms used in this manual.

A	ampere
ac	alternating current
ADU	automatic drive unit
AGC	automatic gain control
APC	angled physical contact
BW	bandwidth
CATV	Community Antenna Television
c/n	carrier-to-noise ratio
CSO	composite second order
CTB	composite triple beat
CU	control unit
dB	decibel
dBc	decibels relative to the carrier
dBm	decibels relative to 1 milliwatt
dBmV	decibels relative to 1 millivolt
dc	direct current
DFB	distributed feedback
FC	ferrule connector
FM	frequency modulation
FTEC	fast trigger electronic crowbar
I/O	input/output
ICS	ingress control switch
km	kilometer
MCB	manual control board
MHz	megahertz
µW	microwatt
mA	milliamp
mW	milliwatt
NTSC	National Television Standards Committee
OMI	optical modulation index
P-V	peak-to-valley
pA	picoampere
RF	radio frequency

RIN	relative intensity noise
RSA	return for service authorization
SC	snap connector
TCU	thermal control unit
V	volt

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