RADIO FREQUENCY SYSTEMS

Bi-Directional Amplifier System

Part Numbers
48760

Operation and Installation Manual

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0	LZ	LZ			For FCC

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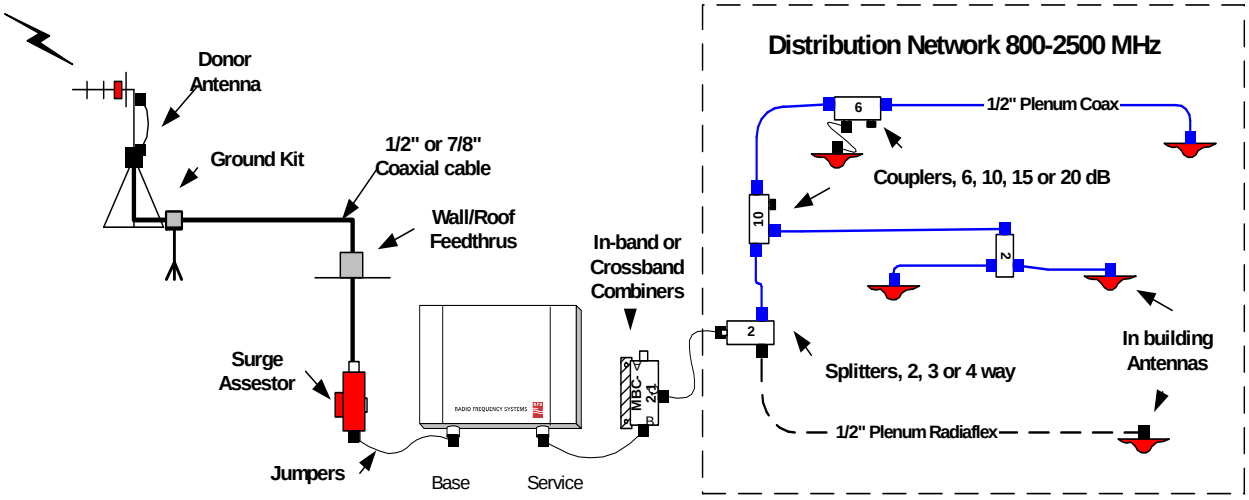
General Statements

Thank you for selecting this RFS product. We are confident that you will find this product in proper working order and meeting all stated specifications. If not, please contact customer service immediately at 1-800-321-4700 and we will resolve the issue without hesitation.

Please read this manual. A full understanding of product operation will support optimal performance and prevent accidental damage not covered by the stated warranty.

- Do not operate this product without proper loads on both antenna ports. You must connect both antenna ports to an antenna or a 50-Ohm load, rated for at least 1 watt.
- These products receive and amplify RF signals. As such, these products are intended for use by the licensee of the respective service and should not be used without the expressed permission of the licensee.
- Normally, you do not need to remove the cover. There are no internal adjustments. Manual gain adjustment is clearly marked on the faceplate. For more information, see installation section.
- The terminology “RX” and “TX” are being replaced by “UL” for uplink and “DL” for downlink respectively.
- PM700-10 has been superseded by PM800-10. Either monitor is compatible with the 48760.

The 48700 series SMR band repeaters are designed and optimized for low cost, high reliability, and ease of use. This manual provides information on the proper operation and care of the repeater; however, Radio Frequency Systems can provide the total package of components and hardware for any type of repeater installation. See our catalog for the full line of antennas, coaxial cables, and accessories at www.rfsworld.com.



For distribution network design assistance, contact RFS Applications Engineering at 1-800-659-1880.

Maximum Permissible Exposure Limits

THIS PRODUCT IS CATEGORICALLY EXCLUDED FROM ROUTINE ENVIRONMENTAL EVALUATION ACCORDING TO CFR 47, SECTION 1.1037.

Signal repeaters like the 48760 bi-directional amplifier generate radio signals and thereby give rise to electromagnetic fields. The installer is expected to have a complete understanding of CFR Title 47, Sections 1.1307 and 1.1310. A brief discussion follows but is not intended to be a substitute. Additional information can also be obtained from OET Bulletin 65.

- ***Antenna installation should be performed by qualified technicians only.***
- ***Installation instructions are not optional and are for the purpose of satisfying FCC RF Exposure Compliance.***
- ***All antennas (donor and service) are to be fixed-mounted and physically secured to one location.***
- ***Non building-mounted donor antennas must be greater than 10 meters above ground.***
- ***Maximum gain for the donor antenna is 28 dB.***
- ***Maximum gain for service area antenna(s) is 3 dB + network losses.***
- ***Minimum separation to any body part of any person is 25cm.***

There are two types of antennas attached to this unit. The *donor antenna* is typically roof mounted and the *service antenna* is usually mounted in a publicly accessible area. Both antennas should be fixed mounted. Installation considerations for both of these will be discussed separately.

Donor antennas receive the base site TX signals and transmit the mobile TX signals back to the base site (uplink paths). These are typically mounted on rooftops or tower structures. The maximum output power of the uplink path is less then 500 mW (+27dBm). Section 1.307(b)(1) excludes from routine environmental evaluation, facilities, operations and transmitters that, according to Table 1 (titled "Cellular Radiotelephone Service"), are less than 1000W ERP for building mounted antennas and less than 1000W and greater than 10 meters above ground for non building-mounted antennas. As such, with maximum power from the uplink path at 500 mW (+27dBm) and a maximum antenna gain of 28 dB, the donor antenna installation will not exceed 1000 Watts (+60 dBm) and is categorically excluded.

However, according to Section 1.1307 (b)(1), the appropriate exposure limits of 1.1310 are applicable to all facilities, operations, and transmitters. Therefore, the MPE (Maximum Permissible Exposure) of Section 1.1310 applies to the donor antenna installation. OET Bulletin 65 provides methods of calculating power density based upon the ERP and distance. It would be impossible to cover every possible configuration in this manual. Likewise, it would be unreasonable to dictate the exact parameters of every installation; therefore, it is the responsibility of the qualified technician to know and ensure that Sections 1.1307 and 1.1310 of CFR Title 47 are being met.

Service antennas are also fixed mounted and covered by the same MPE considerations as the donor antenna. However, this assumes that the area is always general population/uncontrolled and that the minimum distance in most installations will be less than 3 feet. According to Table 1(B) of Section 1.1310, the power density at 894 MHz is 0.596 mW/cm^2. The maximum output power in the 48760 downlink (base to service area) is less then +27 dBm (500 mW). Assuming no feeder cable loss and a service area antenna gain of 3 dB, a safe minimum separation of 10 inches (25 cm) is required to stay within the MPE.

1.05 x 1000 mW/3.14 x 25^2 = 1050/1962.5 =0.535 mW/cm^2

Therefore, the service area antenna should be mounted such that no body part of any person may come closer than 10 inches (or 25 cm). The service area antenna gain is 3 dB in the example above, but may be increased to make up for cable and/or splitter or tap losses. For example, if a 2-way splitter is used to provide for two antennas in different parts of the service area, then the antenna gain may be increased to 6.6 dB to make up for the loss of the splitter 3.6 dB. The maximum service area antenna gain for any specific location can be calculated as follows:

3dB+ accumulated losses to the antenna.

Product Overview

Field Tune-up, Alignment or Calibration

There is no field tune-up or calibration necessary for the 48760 bi-directional amplifier. These units are aligned and calibrated at the time of manufacture and are designed to retain calibration throughout the life of the product. Manual gain adjustment is provided to optimize the installation and discussed in Section 10.

FCC ID and Canada Certification Numbers

The listed models have been tested and granted certification by the FCC in accordance with CFR Title 47, Part 90 and by the DOC in accordance with RS 131, Issue 131.

The FCC identification number for each particular model appears on a label on the faceplate of the unit. Applicable FCC identification and Canadian ISC numbers are as shown:

FCC ID	**Canada**
IWD48760	1634B-48760

Theory of Operation

The 48760 BDA is designed to enhance radio communication in buildings; basements, tunnels and other RF shielded environments. The 48760 is a dual band BDA that will amplify both the 800 and 900 SMR as listed in the electrical specifications.

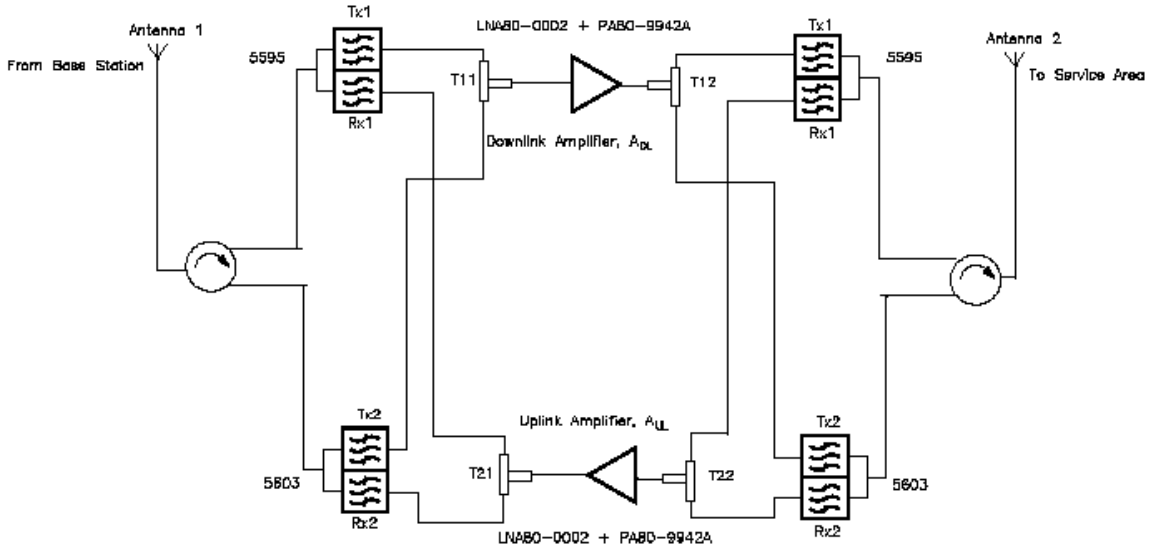
These units work by receiving and amplifying the base TX signals via a donor antenna directed at the desired base site. This RF path is called the downlink. The amplified base TX signal is re-radiated via antenna(s) or radiating cable into the Service Area. Subscriber mobile RF signals are received by the same service area radiating elements and amplified in the uplink RF path to be radiated back to the base via the donor antenna.

The uplink and downlink amplifiers are broadband to accommodate all the channels in the passband. Differentiation is provided by the duplexing filters. These determine the basic pass band and prevent oscillation between the uplink and downlink by attenuating the opposing link frequencies.

Both the downlink and uplink gain paths have Manual and Automatic Gain Control (AGC) to prevent an overdrive condition. The AGC set point is factory set so that the output of the link will not exceed FCC limits for spurious emissions (-13 dBm). Further discussion is provided in page 10.

The control board distributes DC power to the amplifier modules and monitors each module for any fault conditions. LED indicators provide visual diagnostics while the 15 pin Dsub connector has DC and TTL test points for more in-depth trouble shooting. Each unit includes a PM800-10 hand held performance monitor.

Block Diagram



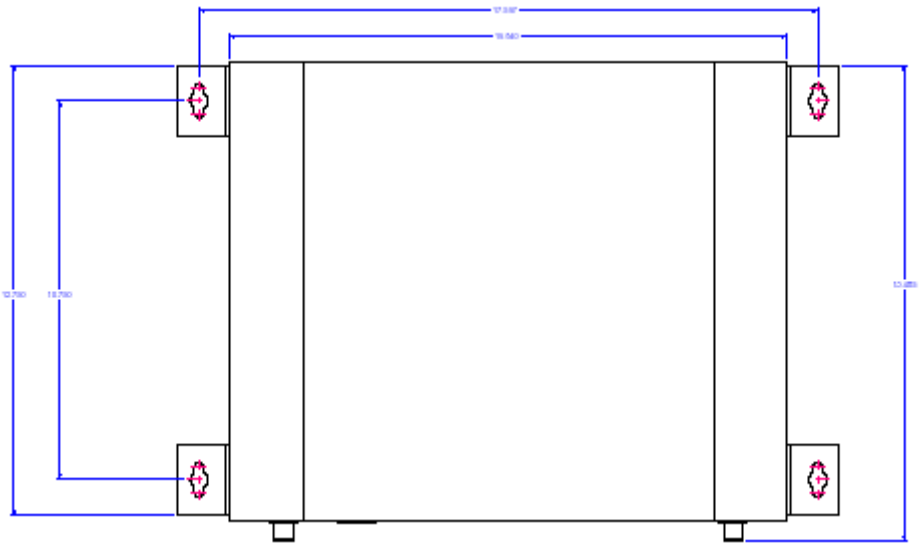
Electrical Specifications

	Downlink	Uplink
48760 Freq, MHz	851-869	806-824
Freq, MHz	935-941	896-902
Gain**	79 dB	79dB
Gain Flatness, typical**	±2.0 dB	±2.0 dB
Manual Attenuator Range	>20 dB	>20 dB
Output Limiter Range, Automatic*	>20 dB	>20 dB
Noise Figure, typical**	5.0 dB	5.0 dB
Composite Power, typical*	+27 dBm	+27 dBm
Impedance	50 Ohms	50 Ohms
VSWR, input	1.8	1.8
Propagation Delay, worst case at band edge	<3.0 microsecond	<3.0 microsecond
Power, 120/220 Auto Ranging, IEC-320 Socket	110 VAC@ .2 A	
20 dB band width, typical	25Mhz for 851-869 12Mhz for 935-941	25Mhz for 806-824 12Mhz for 896-902

*AGC circuitry monitors the output power and reduces the gain to prevent overdrive and oscillation.
**No attenuation and at room temperature.

Mechanical Specifications	
Connectors, RF	N Female
Weight	43 lbs
Size, L x W x D	13.5 X 18.5 X 7.3 Inches
Diagnostics	Power and Fault LEDs and 15 Pin Dsub Connector

Environmental Specifications	
Operating Temperature, ambient	-30 to +50 ℃
Maximum humidity	95% RH (non condensing)
Environmental Rating	Similar to NEMA 3R



Intermodulation, Power, and AGC

FCC requires that spurious emissions be less than {43+ 10 Log 10 (Power Out Watts)} dB below the carrier Power Out (dB) level. This is always equivalent to -13 dBm. The primary contributor to spurious emissions is multiple signal intermodulation. As multiple signals are amplified, they generate intermodulation products (IM). The level of IM is a factor of the amplifiers linearity or 3rd Order Intercept Point (IP3), and the number and power of signals being amplified (Pout).

IM = 3xPout - 2xIP3

The 48700 signal boosters use a combination of low distortion amplifiers and automatic gain control (AGC) to achieve maximum output while automatically limiting spurious intermodulation levels to -13 dBm. A detector on the output of the amplifier provides a DC voltage proportional to the output power. This voltage is compared to a factory setting. As long as this voltage is less than the setting, no action is required. However, when the combination of signal level and or number of signals causes the composite power to exceed the safe level, the AGC's comparator generates a DC voltage to a pin diode attenuator that increases attenuation in proportion to the level of the DC voltage.

The attenuation reduces the output power until the detector voltage is at a safe level again. If the number or power of the signals is reduced, the DC offset voltage will reduce the level of attenuation. In typical operation, the AGC is only active when needed to prevent overdrive. If the AGC is constantly activating, RFS suggests that you reduce the gain via the manual attenuator and verify that an oscillation between the base and service antenna systems does not exist.

AGC in the uplink is rarely needed in modern radio installations. As a portable comes closer to the internal antenna network, its signal becomes stronger at the base site. Typically, the dynamic power control at the base will turn the portable's power down to reduce interference and conserve power.

Overdrive is more likely to occur on the downlink path. All active signals at the donor base site will be amplified by the repeater regardless of whether or not they are in use in the service area. Ideally, the donor antenna is directional. This limits the number of donor base sites the repeater recognizes and reduces the potential for interference. RFS recommends that you observe the signal levels before connecting the repeater. Out of band signals can also cause overdrive. The most likely cause of an overdrive condition is oscillation from inadequate antenna isolation.

Table 1 lists the typical output power per signal, which can be expected from the 48760 for a given number of active signals operating at equal input levels. For a donor site that has 16 signals, the full power per signal would be +11 dBm, assuming the incoming signal is sufficient so that that level will be achieved.

Number of signals	dBm	mW
1	27.0	500
2	23.0	200
4	19.0	80
8	15.0	32
16	11.0	13
32	7.0	5

TABLE 1: TYPICAL OUTPUT POWER PER SIGNAL

AGC Automatic Shutdown

If the attenuation capability of the AGC circuitry is exceeded, power to the power amplifier stage is shut down to prevent harmful distortion and potential damage to the 48760. Shutdown will occur if the AGC control limit is exceeded for about 1/2 second. Power is then cut for two seconds. After this timeout, power is brought back on-line. If the overload condition is still present, shutdown will again occur in approximately one second. This cycle will be repeated until the condition is removed. Conditions that can cause AGC to shut down include the presence of one or more very strong channels, a strong in-band noise source, or amplifier oscillation due to inadequate antenna isolation.

Manual Gain Adjustment

The independent manual attenuators, RX for uplink and TX for downlink, are accessible from the faceplate on the bottom of the unit. These are pre-set in the fully counterclockwise position, at minimum attenuation, maximum gain. Manual attenuation is separate from the AGC attenuators. At the full clockwise position, >20 dB of attenuation will be introduced in the respective gain path.

AC/DC Power

AC power is supplied through a standard 3-wire male plug connected through a standard IEC-320 plug. Connect this plug to any standard 3-wire 120-240 VAC outlet. A 5x20 mm, medium time lag fuse 3A/250v. A 5 amp mini ATO fuse is used between the 28 VDC from the power supply and the control board, which distributes the power to all components. This fuse is located on the control board.

DANGER
Always remove power before checking or changing fuses. 120VAC can be lethal.

- ⌧ Always unplug the amplifier before servicing the interior.
- ⌧ Never insert conductive objects into any opening.
- ⌧ Never remove or probe under the plastic safety shield covering the AC terminals of the 24 VDC power supply.
- ⌧ Always use a standard 3-wire electrical outlet, with safety ground, for connection to AC power.

Grounding and Surge Protection

The unit is case grounded through the three-prong plug. The donor antenna feeder cable should have a cable ground attached to it, along with an inline surge arrestor between the donor antenna and the 48760. The distribution network need not be grounded in building installations. However, the distribution network in tunnels, subways or outdoor installations should also include a cable ground and inline surge arrestor at or near the “service” port.

Installation

WARNING
Do not connect AC power until antennas have been connected to both the base and service area ports.

- **Choose an optimal location.** The choice of a location for the 48760 to reside is often dictated by circumstance. These units can withstand a wide range of environmental conditions, but a cooler environment will increase the life of the product. The 48760 is not intended for outdoor operation without environmental protection. A central location to minimize cable loss in any leg of the distribution network is ideal. In addition, a stacking room near a riser for easy access to the roof and other floors will facilitate the installation.

- **Mount repeater upright, with the connections toward the floor**. Ensure there is sufficient space above and below the unit to allow airflow through the heat sink. Check to make sure the AC power cord can reach the power source. Also, provide adequate bending radii for the coaxial cables.

- **Install directional donor antenna and align with desired base site**. A directional yagi, corner reflector or panel antenna is highly recommended. The 48760 has filtering to prevent out-of-band signals from causing interference; however, it is best to reduce the potential for interference by directing the mobile signals only towards the desired base site.

- **Check the incoming donor signals.** A spectrum analyzer is recommended to confirm that the desired base TX (DL) signals are strong enough to achieve the desired output power. Also check for strong undesired signals in the pass band or on the pass band edge; these may cause overdrive and AGC gain reduction. The donor antenna may need to be realigned to optimize the signal levels.

- **Install service area antenna(s).** Determining the location and type of service area antennas is part of the distribution system design. Generally, it is desired to minimize the amount of coax to be installed. However, in buildings with extensive obstructions, it may be necessary to install several service area antennas. For assistance with antenna placement, contact RFS Applications Engineering.

IMPORTANT
Observe Maximum Permissible Exposure cautions when determining the type and location of all antennas.

- **Connect service antenna(s) to "Service" port via a 50-ohm coaxial cable**. Multiple service area antennas/radiating cable runs may be connected to the 48760. Splitters and taps may be used to accommodate unique distribution systems. Size and type of cable are a matter of choice. Typically, 1/2" Flexwell foam coax is used, plenum rated for inside buildings and work areas. However, 7/8" cable may be used to reduce longitudinal loss. Superflex cables are easier to install but have higher longitudinal loss. Fiber optic distribution systems may be used with the 48760. Observe the input power requirements of the manufacturer. RFS has all the components needed to complete even the largest installations. Visit our website at: www.rfsworld.com, or call us.

- **Connect the service area antennas to the "Service" port.**
- **Connect the donor antenna cable to "Base" port.**
- **Connect AC power to the unit and observe power and fault LEDs**

Ideally, a spectrum analyzer should be used to confirm the DL signal at the service port. However, the 48760 has diagnostics to assist with optimization as discussed below.

Confirm the green "PWR" LEDs are lit in both the uplink (UL) and downlink (DL) and that the red "Fault" LED is not lit. Connect the PM800-10 to the test port via cable provided. If there is a red fault LED lit, check the trouble shooting section for details. If the yellow DL AGC LED is lit then it is suggested to reduce the gain in the DL via the manual attenuator. Turn the adjustment clockwise to reduce gain until the AGC LED goes out. Then adjust the UL gain to the same setting to minimize noise generated in the uplink and balance the links.

If both LEDs are lit then there is likely an oscillation between the antennas – see "Antenna Isolation". Also read the section on "Intermodulation, Power, and AGC"

- **Test the coverage**.

Ideally, this test should include multiple subscribers in various locations of the service area with one subscriber in close proximity to the 48760. This will check to ensure that a nearby subscriber does not overdrive the uplink and reduce coverage for the other users.

If the UL AGC LED lights during the system test it most likely indicates that there is a hot spot in the service area, where the subscriber signal is overdriving the uplink. It is best to minimize this effect by relocating the nearest service antenna or adding an attenuator pad to reduce the UL signal strength at the offending antenna. In some cases, a coupler may be needed to add a low power antenna in specific locations. For this reason it is best to have extra antennas, splitters, couplers and coax.

Antenna Isolation

Isolation between the donor (base) antenna and service area antenna should be 20 dB greater than the gain of the repeater amplifier.

If the isolation is less than the amplifier gain, then positive feedback sufficient for oscillation is present in the system. Such oscillations will overdrive one or both amplifier links and may continuously activate the AGC auto-shutdown circuitry.

Antenna isolation is usually not a problem for in-building installations. Isolation is improved by using a directive donor antenna and facing it away from the distribution or service antenna(s). Decoupling is achieved by spatially separating the antennas vertically and/or horizontally. Other factors influencing isolation include multi-path reflections, structures, other antennas, passing vehicles, personnel proximity, etc.

It is always best to measure the isolation before connecting the 48760. The most direct way to measure the isolation is to inject a known signal into one antenna, and measure the coupled signal at the other antenna. This should be done across the applicable bandwidth to account for the frequency dependency of standing waves.

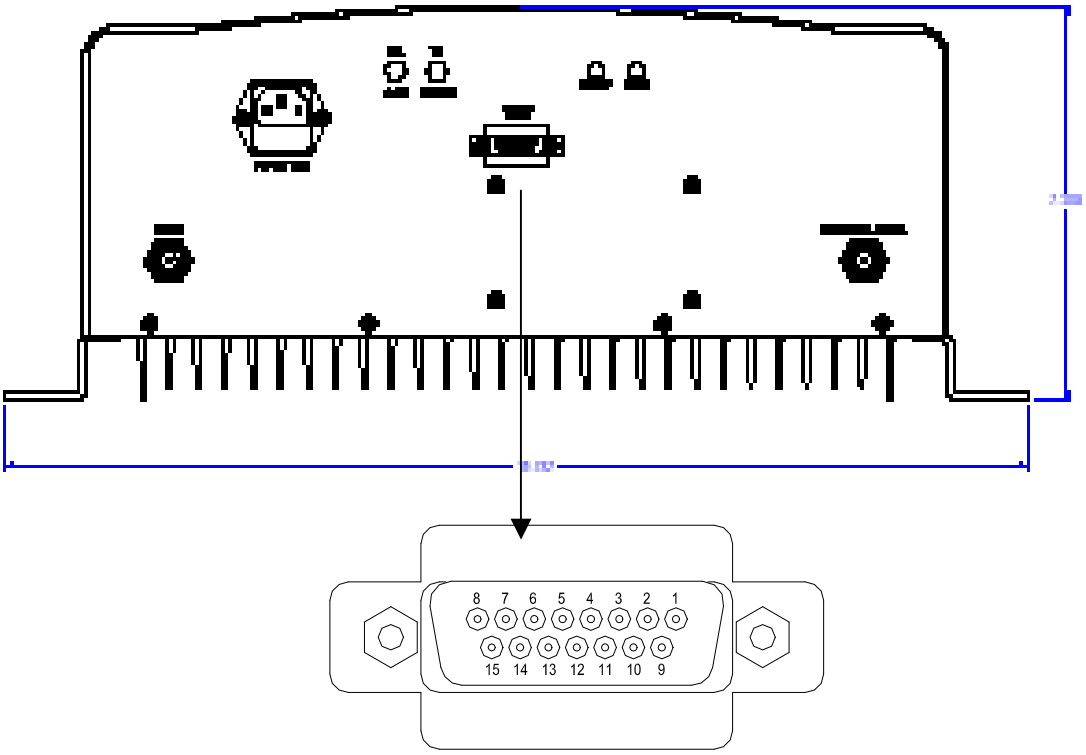
Diagnostics/Troubleshooting

Problem:	Solution:
Green power LED on faceplate not lit.	Check power source and the AC fuse located in the EIC plug. Check for DC voltage (see below).
Green power LED lit and no red Fault LED on faceplate; unit does not appear to be working.	Check for a break in the donor or distribution networks. First, check both RF output via the DC voltages on Pins 12 and 13 or RxDET.V and TxDET.V from the performance monitor. Also, check to ensure the donor signal is still available to the repeater. An obstruction could be blocking the donor base site or the donor antenna could have become misaligned. Then, check the integrity of the distribution network. Coaxial cable has a minimum bending radius, if that is exceeded the inner conductor may crack or break causing excessive reflections to the signals.
Yellow AGC LED on performance monitor is lit.	AGC LEDs indicate an overdrive condition in the respective link. Reduce the respective link gain via the Gain Adjust until the LED goes out. Generally, the opposing link gain should be adjusted to approximately the same setting. If the LED does not go out, then the input signal is too strong and should be attenuated with a 10 dB in-line attenuation pad on the Base or Service port.
Red LED on faceplate is lit.	The red LED indicates a summary fault from any of the fault conditions identified in the Test Points section. Specific action is described in that section.
Checking DC Voltage	DC Voltage can be checked via the 15-pin test port. Pins 10 and 11 are the DC voltage associated with the AGC circuitry. There should be at least 7 volts to ground-pin 14. Alternatively, you can plug in the performance monitor into the test port and measure the Rx AGCV to ground.

Test Point Descriptions

The performance monitor is included with all 487XX series Band Specific Repeaters and is designed to provide convenient visual readout. A DC VOM can be used to quickly assess the health of the unit. The 487XX provides the output voltages and the power to operate the performance monitor. The monitor includes a 10-foot extension. A 30-foot extension cable (part #: 103300014900) is also available for remote mounting or the monitor can be directly plugged into the 15-pin test port located on the front plate of any 487XX series. Should the performance monitor become damaged, contact RFS customer service at 1-800-321-4700 to order a replacement.

In the following performance monitor description, the term “pin number” refers to the connector pins in the bottom of the 487XX series or the associated performance monitor LED indicators. Pin numbering starts upper right and proceed from right to left, top to bottom when viewed externally, as seen below. The functions are explained below with details on how the unit is used in practical applications.



Detail of 487XX Faceplate Dsub

- **Pins 1-8: Max sink/source = 15mA, output only. Accidental input max = 6.0 VDC**
  1. RX LNA Alarm, logic, low=fault
  2. TX LNA Alarm, logic, low=fault
  3. RX Converter fault, not used
  4. TX Converter fault, not used
  5. RX PA Alarm, logic, low=fault
  6. TX PA Alarm, logic, low=fault
  7. Temperature Alarm > +85 C, logic, low=fault
  8. AGC Alarm, logic, low=fault

Pins 1-6 each refer to a specific module inside the 497XX. A low TTL voltage will light the associated LED, indicating a fault condition with that component. See the Component Location section to find the associated component's part number. The faulty component may be removed and sent in for repair, or a replacement may be ordered.

Pin 7 is a temperature alarm indication that the internal temperature has risen above +85℃. The 487XX series uses convection cooling, not fans. It is rated for +55℃ ambient. In the event of the temperature alarm, check to make sure the unit is mounted upright and vertical. There must be sufficient room below and above the unit to allow airflow to the heat sink.

Pin 8 indicates that the unit is in automatic shutdown mode due to an overdrive that is exceeding the AGC's range. The AGC is non-latching and will clear itself when the overdrive is removed. The alarm light will remain lit even though the shut down feature is powering on and off to check for the overdrive condition.

Conditions that can cause AGC to reach its limit include the presence of one or more very strong channels, a strong in-band noise source, or amplifier oscillation due to inadequate antenna isolation. Disconnect the power and the Base and Service cables. Use a spectrum analyzer to look for strong input signals coming from the base donor antenna or the service area distribution network. If there are no strong input signals, check the antenna isolation as described in this manual. Reducing the gain may also help to clear the condition. See AGC section for more information.

Strong uplink signals may be intermittent. These may be present when a mobile in the coverage area is close in to the service area antenna. In this case, the service area antenna must be moved to prevent overdrive under normal operating circumstances.

- **Pin 9: Max sink = 7uA. Max input = 6.0 VDC**

Pin 9 is a remote disable feature. Connecting pin 15 to pin 9 via a relay will cause the repeater to shut down. This can be accomplished with a remote control unit like the RPM800 (remote performance monitor).

9. Disable (input), logic, high=disable

- **Pins 10-13: Max sink = 8mA. Max source = 15mA**.

10. Rx AGC Voltage, analog, no AGC approximately 26.5 VDC, Full AGC approximately 7.65 VDC
11. Tx AGC Voltage, analog, no AGC approximately 26.5 VDC, Full AGC approximately 7.65 VDC
12. Rx Det. Voltage, analog, approximately 0 to 3VDC @ approximately 0.3VDC per dB
13. Tx Det. Voltage, analog, approximately 0 to 3VDC @ approximately 0.3VDC per dB

Pins10 and 11 are the indicators for Automatic Gain Control. Please see the section on AGC in this manual for more information. The circuitry is housed in the PA amplifier stage. It monitors the output power and controls a pin attenuator to reduce gain and thus, the output power if needed to prevent overdrive. The DC voltages on pins 10 and 11 represent the amount of attenuation:

No AGC approx. 26.5VDC, full AGC approx. 7.65VDC. The yellow LEDs light up when the AGC is active (adding attenuation).

AGC may be intermittent due to temporary overdrive conditions. If the LED is constantly lit then reducing the manual gain via adjustment on the faceplate should cause the LED to go out. The manual attenuator is separate from the AGC attenuator. Reducing the gain via the manual attenuator will optimize the installation and preserve the full AGC attenuation for overdrive conditions.

Pins 12 and 13 are detector output voltages for the associated path. The DC voltage represents the output power. These voltages can be used to roughly estimate the amount of output power. For example, the donor antenna can be rotated to look for maximum output power if a spectrum analyzer is not available.

- **Pin 14: Max sink = 1A**.

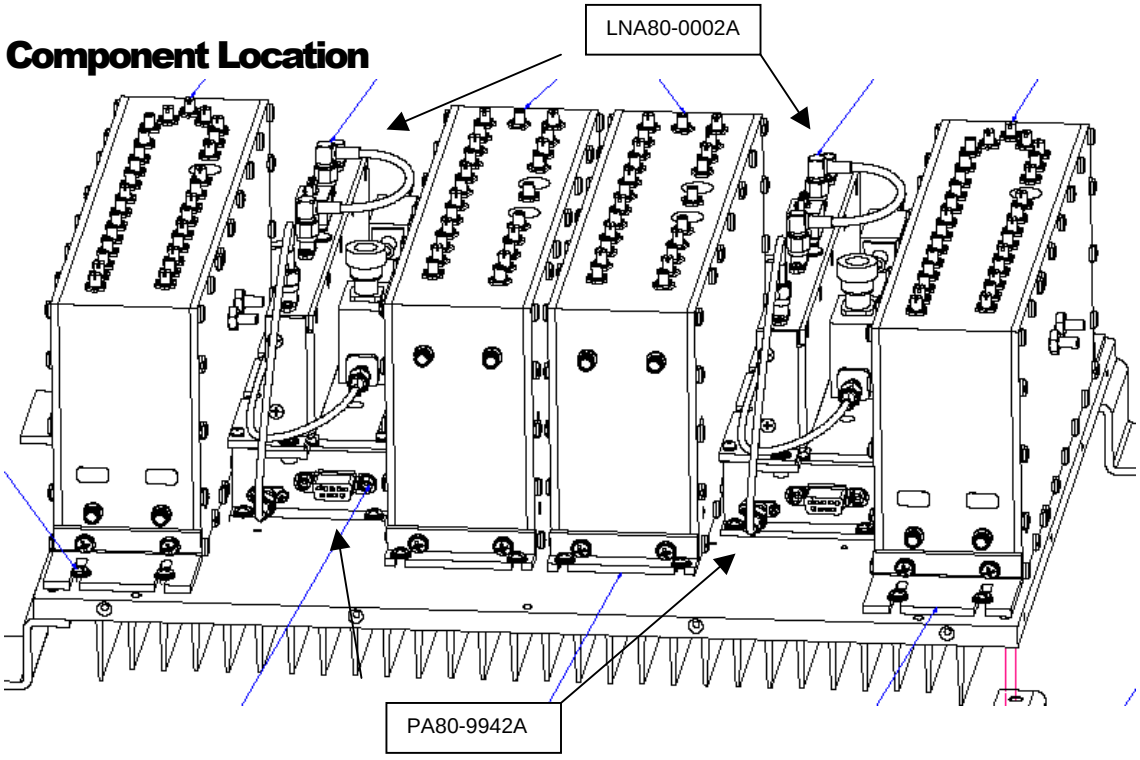
  14. Ground for Pins 10-13.

- **Pin 15: Max source = 80mA**.

  Pin 15: +5VDC, thermally fused (self resetting), 50mA max.

Pin 15 can be used as the drive voltage to disable the unit using Pin 9. It is also used to power the performance monitor, when attached.

Component Location



Field repair for the 48760 is recommended only for the following parts:

Power Supply	315300001900
Pre-Amp Stage:	LNA80-0002A
Power Amplifier:	PA80-9942A

Recommended Spare, per 4 units:
1 PA80-9942A Power Amplifier, 1 315300001900 Power Supply

Maintenance, Repair and Warranty

Periodic Maintenance

No periodic maintenance is required for the 48760. As long as the units are kept away from extreme temperatures and moisture, they should provide long-term, carefree operation.

However, periodically check all RF connections for corrosion, strain damage, and proper tightness. Also, periodically check the AC power connections for integrity.

Ordering and Returning Components

For technical assistance, call Radio Frequency Systems Applications Engineering at 1-800-659-1880.

For returns, repairs, and ordering, contact Radio Frequency Systems Customer Service at 1-800-321-4700 for a Return Authorization Number. Be prepared to provide the model number, serial number of the unit, as well as a description of the symptoms of the problem. Send components or units freight pre-paid with the Return Authorization Number on the outside of the package to:

Radio Frequency Systems
175 Corporate Court
Meriden, CT 06450

Limited Warranty

The Seller warrants that, at the time of shipment, the products manufactured by the Seller are free from defects in material and workmanship. The Seller's obligation under this warranty is limited to replacement or repair of such products within one year from the date of shipment. No material is accepted for replacement or repair without written authority of the Seller. Replacement or repair is made only after an examination at the Seller's facility shows defective material or workmanship at the time of manufacture. All shipping charges on the returned material must be prepaid by the Buyer.

The seller is in no event liable for consequential damages, installation costs or other costs of any nature as a result of the use of the products manufactured by the Seller, whether used in accordance with instructions or not. The Seller is not liable for replacement of any product damaged by lightning.

This warranty is in lieu of all others, either expressed or implied. No representative is authorized to assume for the Seller any other liability in connection with the Seller's products.