USERS MANUAL
For
48750 Series Cellular Repeater

RADIO FREQUENCY SYSTEMS
CELWAVE Cablewave

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GENERAL STATEMENTS

MAXIMUM PERMISSIBLE EXPOSURE LIMITS

THIS PRODUCT IS CATAGORICALLY EXCLUDED FROM ROUTINE ENVIRONMENTAL EVALUATION ACCORDING TO CFR 47 SECTION 1.1307.

Repeaters like the 48750 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 bulliten 65.

- ANTENNA INSTALLATION BY QUALIFIED TECHNICAL PERSONNEL ONLY.
- INSTALLATION INSTRUCTIONS ARE FOR THE PURPOSE OF SATISFYING FCC RF EXPOSURE COMPLIANCE AND ARE NOT OPTIONAL.
- ALL ANTENNAS (DONOR AND SERVICE) ARE TO BE FIXED MOUNTED AND PHYSICALLY SECURE TO ONE LOCATION.
- MAXIMUM DONOR ANTENNA GAIN 28 DB
  - NON-BUILDING MOUNTED DONOR ANTENNAS MUST BE GREATER THEN 10 METERS ABOVE GROUND.
- MAXIMUM SERVICE AREA ANTENNA ERP IS 1.0 WATT
  - MINIMUM SEPERATION TO ANY BODY PART OF ANY PERSON IS 25 CM

There are two types of antennas attached to the 48750. The donor antenna is typical roof mounted and service antennas are typically mounted in publically assesable areas. All of the antennas are 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 (824-849 MHz) back to the base site (uplink path). These are typically mounted on roof tops or tower structures. The maximum composite power of the 48750 uplink path is 1000 mW (+30 dBm). Section 1.307 (b) (1) excludes from routine environmental evaluation facilities, operations, and transmitters that, according to table 1 "Cellular Radiotelephone Service", are less then 1000 W ERP for building mounted antennas and less then 1000 W and greater then 10 meters above ground for non-builidng mounted antennas. As such, with a maximum power from the 48750 uplink path of 1000 mW (+30 dBm) and a maximum antenna gain of 28 dB, the donor antenna installation will not exceed 1000 Watts (+60 dBm) and is catagorically exlcuded.

However, according to section 1.1307 (b) (1), the appropriate exposure limits of 1.1310 are applicable to all facilities, operations, and transmitters. As such, the MPE (maximum permissable exposure) of section 1.1310 apply to the donor antenna installation. OET Bulliten 65 provides some methods calculating the 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 for every installation. As mentioned in the beginning of this section, it is the responsibility of the installer to know and assure that sections 1.1307 and 1.1310 are being met.

Nonetheless, a reccomended installation senario for the donor antenna is provided. Assuming a roof top installation and that the area is uncontrolled/ general population (worse case), the MPE at 824 MHz is .549

mW per cm^2. A higher level is specified for controlled areas in 1.1310 table 1 (A). Using a 10 dB gain yagi antenna (typical in about 80% of installations) and assuming the uplink is being driven to its maximum output power (+30 dBm), the resultant ERP is +40 dBm or 10,000 mW. OET Bulliten 65 provides the formula below for calculating the power density with the EPA reccomended factor for ground relfection:

$1.05 \text{ ERP} / \pi R^2$ Where R is the distance to center (any body part of person)

Solving for 10,000 mW at 3 ft. (91.44 cm) we get a power density of .4 mW per cm^2.

The yagi antenna in this senario must be mounted in such a way that no body part of any person may come closer then 3 feet in the direction of the main power beam. This will limit exposure to well within the MPE

Service antennas are also fixed mounted and covered by the same MPE considerations as the donor antenna. However, it can be assumed that the area is always general population/uncontrolled and that the minimum distance in most installations will be less then 3 feet. According to table 1 (B) of section 1.1310, the MPE for power density at 894 MHz (worse case downlink) is .596 mW / cm2. The maximum power out of the 48750 on the downlink (base to service area) is +30 dBm (1000 mW). Assuming no feeder able loss and a service area antenna gain of 0 dB, a save minimum seperation of 25 cm (10 inches) is required to stay within the MPE.

1.05 x 1000 mW / 3.14 x 252 = 1050 / 1962.5 = .535 mW / cm2

Thus, the service area antennas should be mounted such that a no body parts of any person may come closer that 25 cm. The service area antenna gain is 0 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 3 dB to make up for the loss of the spliter 3.6 dB. The maximum service area antenna gain for any specific location can be calculated by: 0 dB + accumulated losses to the antenna.

FIELD TUNE-UP, ALIGNMENT OR CALIBRATION

The 48750 series of bi-directional amplifers are aligned and calibrated at the time of manufacture. These units are designed to retain this calibration for the useful life of the product. There is no field tune-up or alignment necessary.

FCC ID AND CANADA CERTIFICATION NUMBERS

The listed models have been tested and granted Certification by the FCC in accordance with Title 47, Part 22, and have been granted Certification by the DOC in accordance with RS 118, Issue 2.

The FCC identification number for each particular model appears on a label within the amplifier enclosure as required by the FCC. Applicable FCC Identification and DOC Certification Numbers are shown in Table 1.

FCC ID Number	CANADA

IWD 48750 XXXX XXXX

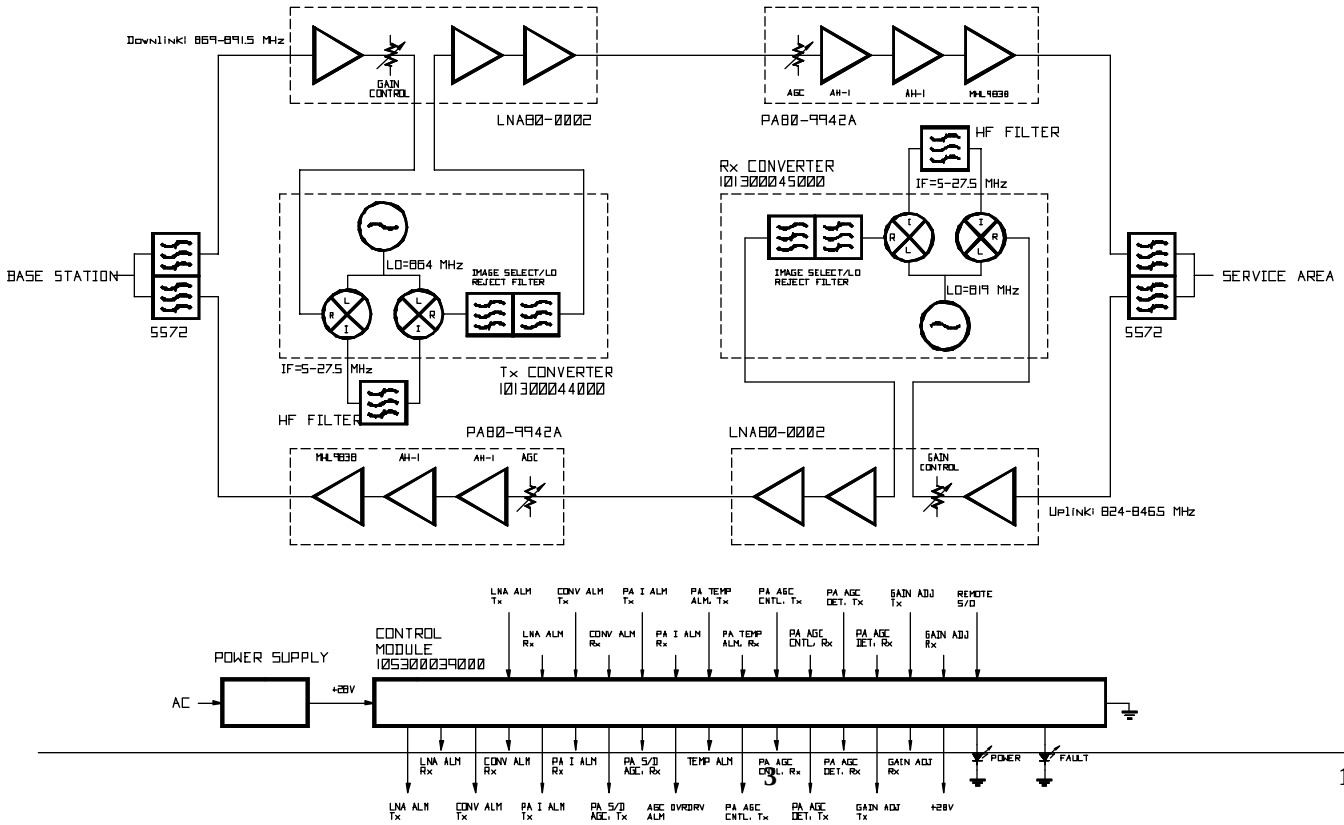
PRODUCT OVERVIEW and GENERAL INFORMATION

The 48750 series band specific Cellular Repeaters are designed to enhance radio communications in buildings, basements, tunnels and other RF shielded environments. The 48750 is tuned for A band only operation, the 48751 is tuned for B band only.

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, amplifed in the "uplink"RF path to be radiated back to the base via the donor antenna.

Duplexing band pass filters direct the RF signal to the proper gain path. Band selective down conversion filtering is used to provide exceptional band edge rejection of the competitive spectrum. Amplification consist of independent amplifiers in the Down and Up links respectively, as shown in the block diagram. Both links have AGC to prevent overdrive. Manual gain adjustment is provided. The composite output power is set at the factory and limited by the AGC circuitry so that intermodulation signals will not exceed -13 dBm as specified by the FCC.

LED indicators provide visual diagnostics for the 48750 series. DC and TTL Test points provide more indepth information for set up and troubleshooting. Together with the diagnostics section of this manual, these features make field set up and repair fast and easy.



ELECTRICAL / MECHANICAL SPECIFICATIONS

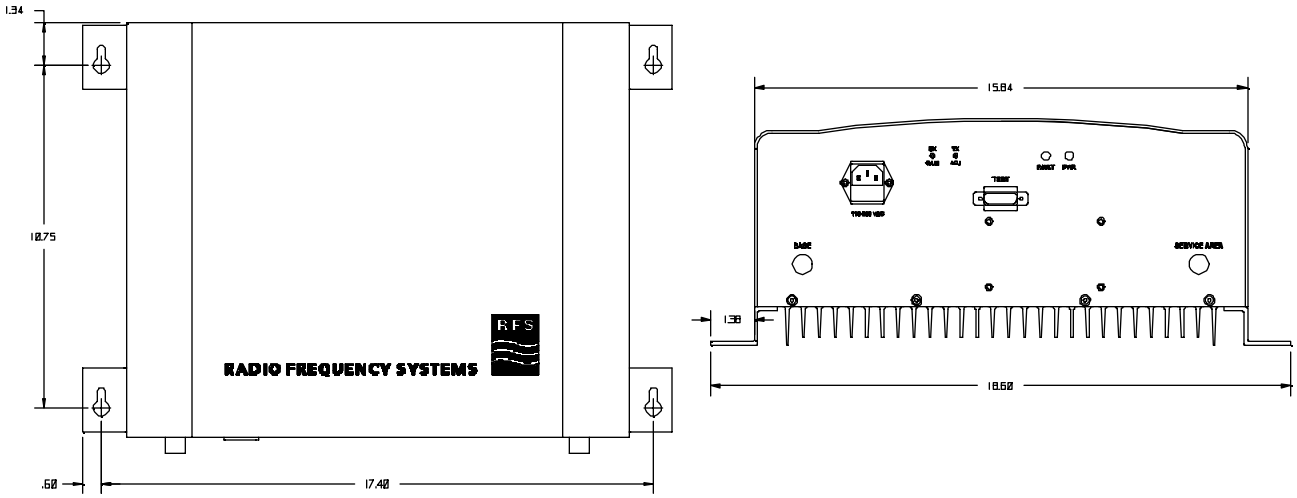
SPECIFICATIONS	Downlink	Uplink
48750 Frequency, MHz	869-880 / 890-891.5	824-835 / 845-846.5
48751 Frequency, MHz	880-890 / 891.5-894	835-845 / 846.5-849
Gain, no Attenuation, Typ.	79 dB	79 dB
Gain Flatness, Typ.	±1.0 dB	± 1.0 dB
Manual Attenuator Range	15 dB	15 dB
Output Limiter Range, automatic*	20 dB	20 dB
Noise Figure, Typ.	9.0 dB	9.0 dB
Composite Power**	+30 dBm	+30 dBm
CDMA, TDMA	+27 dBm	+27 dBm

Power listed is for single channel operation. Power per channel for multiple signal operation is reduced proportionally such that typical power per channel for 8 channels = +18 dBm, 16 channels = +14 dBm, 32 channels = +10 and 64 channels = +6 dBm.

Impedance	50 Ohms
VSWR, input, both ports	1.5
Propagation Delay, worse case at band edge	< 3.0 microsecond
Power , IEC-320 Socket	120 VAC @ 1.6 A
Operating Temperature, ambient	-30 to +50° C
Connectors, RF	N Female
Size L X W X D, wall mount, 40 lbs	13.5 X 18.0 X 7.3 Inches
Diagnostics:	TTL, Analog Voltages

Power and Fault LEDs plus 15 pin diagnostics port.
Alarms for each component, overdrive and over temperature
Output DCV for AGC level and Output detectors, Uplink and Downlink
Remote Shutdown

* AGC circuitry monitors the output power and reduces the gain to prevent overdrive or oscillation.
** BDA output power is limited via internal circuitry to assure that IM levels do not exceed -13 dBm.



INTERMODULATION PRODUCTS, AGC, AND OUTPUT POWER

A general requirement exists within 47 CFR 90, Subpart I and 47 CFR 22, Subpart K regarding emissions outside of any particular channel of operation. As a general rule, there shall be no spurious emissions greater than {43 + 10 Log10 (Power Out watts)} dB below the carrier Power Out (dB) level. This is always equivalent to a fixed level of -13 dBm maximum spurious emission.

Radio Frequency Systems has designed the 48750 amplifier line using a combination of an automatic gain control and a low distortion power amplifier to achieve maximum output while automatically maintaining spurious intermodulation levels below -13 dBm for any number of input channels.

AGC automatically varies the overall gain of the system by up to 20 dB. The gain set by AGC is a function of the total power present in the amplifier at the final output power amplifier stage. The total power level is the sum of all signals within the applicable bandwidth. This includes all active channels, all intermodulation products, and any other noise power in the band.

Table 4 lists the typical output power per channel which can be expected from the amplifier for a given number of active channels operating at equal input levels. The numbers given in Table 4 are valid only when operating within the active AGC region of the AGC amplifier stage. Operation in the AGC region occurs for input power levels such that the sum of total input power plus the amplifier's maximum gain exceeds the stated maximum level for the given number of channels. AGC will then actively limit the total output power to the stated maximum levels.

TABLE 1. TYPICAL OUTPUT POWER

Number of		
Signals	dBm	mW
1	30.0	1000
2	26.0	398
4	22.0	160
8	18.0	63
16	14.0	25
32	10.0	10
64	6.5	5

AGC AUTOMATIC SHUTDOWN

When the automatic gain control circuit reaches its control limit, power to the power amplifier stage is cut. This feature ensures that spurious emissions are never allowed to exceed permissible levels. Note that only the path (Tx or Rx) which has reached its control limit is shut down.

Shutdown will only occur if the AGC control limit is reached and maintained for about a half second. Power is then cut for 5 to 7 seconds. After this time-out, power is brought back on-line. If the overload condition is still present, shutdown will again occur in about a half second. This cycle will be repeated until the condition causing AGC to reach its limit is removed. Conditions which can cause AGC to reach

its limit include the presence of one or more very strong channels, a strong in-band noise source, amplifier oscillation, etc.

INSTALLATION ISSUES

ANTENNA ISOLATION

Proper implementation of the antennas is absolutely crucial to the repeater system. Several important issues must be considered when selecting and implementing the antennas. The most important consideration, besides the obvious concerns for gain and area of coverage, is the antenna isolation. Radio Frequency Systems Technical Support is available at 800-659-1880 to assist with antenna selection and installation considerations.

BASE STATION AND SERVICE AREA ANTENNA ISOLATION SHOULD BE A MINIMUM OF 20 dB GREATER THAN THE MAXIMUM 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 chains and continuously activate the AGC auto-shutdown circuitry. This situation will be apparent by all status LEDs lighting up and then quickly off every 5 seconds.

Also, gain ripple as a function of frequency, antenna spacing, and antenna isolation is always present in the system due to feedback. The feedback is a function of the frequency and spacing (i.e., the standing wave between the antennas). The magnitude of the ripple can be expected to be on the order of 5.7 dB for a 10 dB isolation-gain margin. 11 dB ripple for a 5 dB isolation margin, 1.7 dB ripple for a 20 dB margin, and 0.5 dB for a 30 dB isolation margin. The ripple goes to infinity at 0 dB margin thus indicating runaway oscillation. In general the magnitude of ripple may be calculated from:

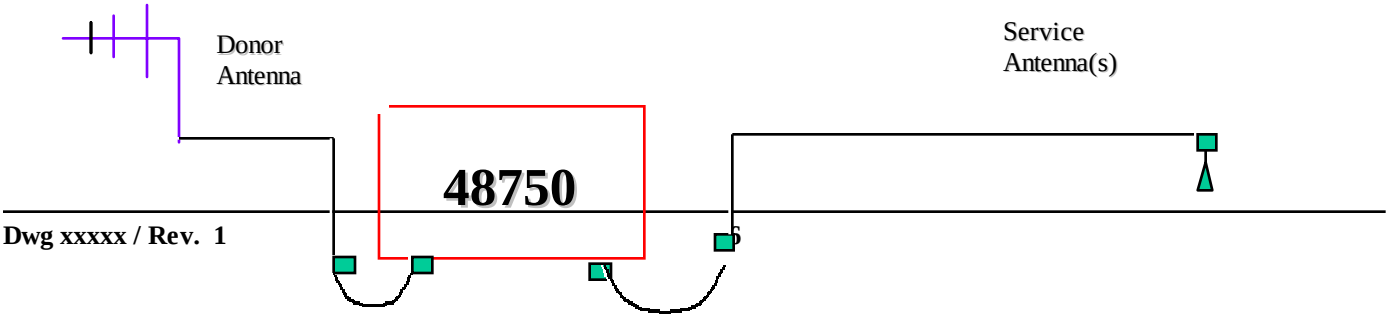
Ripple = 20 LOG10 {(1 + [A] [B]) / (1 - [A] [B])} dB

where:

[A] is the magnitude of the forward voltage gain of the repeater as a function of frequency.
[B] is the feedback voltage "gain" magnitude as a function of frequency.

Antenna isolation may be achieved by several means. High-gain (high directivity) antennas usually have a significant front-to-back ratio (isolation between front and back). Additional decoupling can be achieved by spatially separating the antennas. Other factors influencing isolation include multi-path reflections, structures, other antennas, passing vehicles, personnel proximity, etc.

Generally, for in-building applications with one outside antenna and one or more indoor antennas, the isolation due to spatial separation and the structure itself is adequate. It is always best to measure the actual isolation under worst case conditions, if possible. 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.



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INSTALLATION PROCEEDURE

Review this entire manual

Do not apply power until antennas have been connected to botht eh base and service area ports

- Install donor antenna, aligned with desired base site and measure base signal strength.
  The 48750 has sufficiniet filtering to prevent undesired signals from causing interference, however, it is best to use a directional donor antenna to reduce the chance for interfernece by directing the mobile signals only towards the desired donor base site.
  The 48750 will work with a wide range of RF input signal levels. Ideal levels on the down link are in the range of –60 to –70 dBm. These levels will provide the maximum output power while not causing significant ovedrive.
- Connect the donor antenna to the 48750 via 50 ohm coaxial cable.
  Size and type of cable are a matter of choice. Typically ½" Flexwell foam coax is used, plenum rated for inside buildings and work areas. However, 7/8th cable may be used to reduce the longitudinal loss. ½' or smaller superflex cables are easier to install but have higher longitudinal loss.

- Install service area antenna(s).
  Determine 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 that has to be installed. However, in buidlings with extensive obstructions it may be neccesary to install several service area antennas For assistance with antenna placement contact RFS Applications Engineering. ***Observe MPE cautions*** when determining the type and location of all antennas (see section 1)!
- Connect service antenna(s) via 50 ohm coaxial cable
  Multiple service area antenna(s)/radiating cable runs may be connected the 48750. Splitters and taps may be used to accommodate unique distribution systems.

- Mount the 48750 Repeater upright, make sure there is sufficient space above and below the unit to allow air to flow through the heat sink. Check to make sure the AC power cord can reach the power source. Also provide adaquet bending room for the coxial cable.
- Connect 50 ohm cables – donor antenna to "Base", service antenna(s) to "Service"
- Connect AC power to the 48750 and observe power and fault lights

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 VAC outlet. A 5 x 20 mm, 3.15 amp fast blow fuse is used to cut power in the event of a severe AC fault. 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 is located on the control board.

WARNING: ALWAYS REMOVE POWER BEFORE CHECKING OR CHANGING FUSES. 120 VAC can be lethal. **Always unplug** the amplifier before servicing the interior. **Never insert** conductive objects into any opening. **Do not remove or probe** under the plastic safety cover over the AC terminals of the 24 VDC power supply. **Always use** a standard 3-wire electrical outlet with safety ground for AC power.

DIAGNOSTICS

A green power LED will light up when AC power is supplied. If this fails, check power source and the the AC fuse located in the EIC plug. If the power source and fuse are OK then the internal switching power supply has failed and will need replacement.

The Red LED indicates a summary fault from any of the fault conditions identified in the Test Points section. Specific action is describe in that section.

TEST POINTS

The D-sub connector is located on the bottom of the unit. A DC VOM can be used to quickly assess the health of the 48750. The following is the D-sub pin-out:

1 Rx LNA Alarm, logic, low = fault
2 Tx LNA Alarm, logic, low = fault
3 Rx Converter Alarm, logic, low = fault
4 Tx Converter Alarm, logic, low = fault
5 Rx PA Alarm, logic, low = fault
6 Tx PA Alarm, logic, low = fault
Conditions 1 – 6 require unit to be sent in for service

7 Temperature Alarm, logic, low = fault
Check for air flow past heat sink. If this fails, send unit in for repair.

8 AGC Alarm, logic, low = fault
Indicates overdrive. Check for excessive input signal or inadequate antenna isolation.

9 Disable (input), logic, high = disable
Remote disable feature

10 Rx AGC Voltage, analog, no AGC approx. 26.5VDC, Full AGC approx. 7.65VDC
11 Tx AGC Voltage, analog, no AGC approx. 26.5VDC, Full AGC approx. 7.65VDC
Pins 10 and 11 provide indication of the amount of AGC attenuation. Full AGC indicates strong drive signal or possible oscillation and should be avoided. Check drive levels and antenna isolation. Reduce manual gain to relax AGC level if needed.

12 Rx Drive Voltage, analog, approx. 0 to 3VDC @ approx. 0.3VDC per dB with no AGC, changes very little in AGC
13 Tx Drive Voltage, analog, approx. 0 to 3VDC @ approx. 0.3VDC per dB with no AGC, changes very little in AGC

14 Ground
15 +5VDC, thermally fused (self-resetting), 50mA max.
Pins 14&15 are used to drive a diagnostics module which will provide LED indication of the D-sub pins.

MAINTENANCE, REPAIR, AND WARRANTY

PERIODIC MAINTENANCE

There is no maintenance for the 48750. As long as the amplifiers are kept away from extreme temperatures and moisture, the amplifier should provide long-term, care-free operation.

However, as a system periodically check all RF connections for corrosion, strain damage, and tightness and periodically check the AC power connections for integrity

ORDERING & RETURNING COMPONENTS

For technical assistance call Radio Frequency Systems Sales 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 and serial number of the BDA as well as a description of the symptoms of the problem.

Send components or units freight-paid with the Return Authorization Number on the outside of the package to:

Radio Frequency Systems Corvallis
4100 S.W. Research Way
Corvallis, Oregon 97333

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 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 plant 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.

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