

CURRENT As Of 5/98



INSTRUCTION MANUAL
For
SERIES 48500 RF REPEATER
AMPLIFIERS

Place BDA serial label here.

*Attach BDA Test Data Sheet
 and Equipment List to
 inside of last page.*

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USER'S MANUAL**SERIES 48500 RF REPEATER AMPLIFIERS****FCC, DOC and INTERMODULATION**

The listed models with numbers in 48500 - 48530 range have been tested and granted Type Acceptance by the FCC in accordance with Title 47 of the Federal Code of Regulations, Part 90, Subpart I. For Canadian applications, these models have also been tested and granted Certification by the DOC in accordance with RSS 119, Issue 3. Models with numbers in the 48540 - 48560 range have been tested and granted Type Acceptance by the FCC in accordance with Title 47, Part 22, Subpart K 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.

TABLE 1. FCC ID AND CANADA CERTIFICATION NUMBERS

<u>FCC ID Number</u>	<u>CANADA</u>
IWD BDA48500-505	1634 B9444
IWD BDA48506-511	1634 B9445
IWD BDA48512-517	1634 B9436
IWD BDA48518	1634 B9435
IWD BDA48540-549	1634 B211
IWD BDA48550/52-N	1634 182188C
IWD BDA48551/53-N	1634 B267

INTERMODULATION PRODUCTS

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 $\{43 + 10 \text{ Log}_{10}(\text{Power Out watts})\}$ dB below the carrier Power Out (dB) level. This is always equivalent to a fixed level of -13 dBm maximum spurious emission.

For example, for an output power of 25 dBm (0.316 watts), there shall be no spurious emissions greater than $\{43 \text{ dB} + 10 \text{ Log}(0.316) \text{ dB}\} = 38 \text{ dB}$ below 25 dBm. This is equivalent to $25 \text{ dBm} - 38 \text{ dB} = -13 \text{ dBm}$. Likewise, for an output power of 30 dBm (1 watt), maximum spurious output shall be less than or equal to $30 \text{ dBm} - \{43 \text{ dB} + 10 \text{ Log}(1) \text{ dB}\} = -13 \text{ dBm}$.

Celwave has designed the 48500 amplifier line using a combination of an automatic gain control (AGC) amplifier 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 adjusts the gain of the amplifier chain to maintain a constant total output level. This total output level is set for each amplifier at the factory.

NOTE: OPERATION OF THE AMPLIFIER BEYOND THE AGC CONTROL RANGE RESULTS IN A TEMPORARY SHUTDOWN OF THE AMPLIFIER. This shutdown is self resetting. See the "Product Overview and General Information" section for further discussion of the AGC control range and shutdown.

SERIES 48500 RF REPEATER AMPLIFIERS**USER'S MANUAL****PRODUCT OVERVIEW and GENERAL INFORMATION**

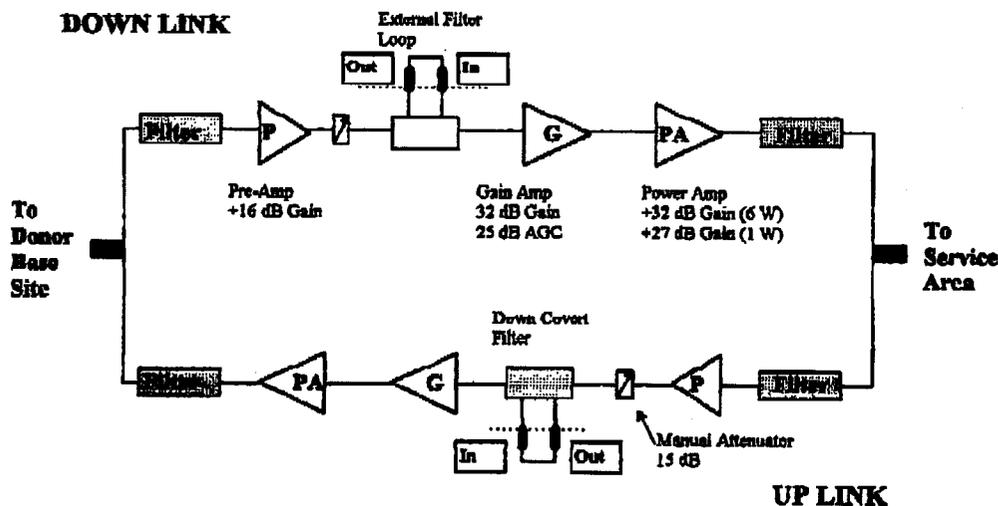
The 48500 series Bi-Directional Amplifiers (BDAs) are designed to enhance radio communications in buildings, basements, tunnels and other RF shielded environments. Units are available in rack mount or wall mount with thermally activated fan cooling for extremely high reliability. The package is not designed for harsh environments!

The BDA works by receiving and amplifying RF signals in the "Down Link" (from base station to subscriber) and "Up Link" (from subscriber to base station) communication paths. Duplexing band pass filters direct the RF signal to the proper gain path. Band select filtering may be added externally to modify the pass band via the external filter ports. Enhanced Cellular models, 48550-N and 48551-N, have additional down conversion filtering 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 in the Gain amplifiers. Some models may not have pre-amplifiers. There are two levels of power amplifiers; 1 Watt which is set for +25 dBm and 6 Watt which is set for +30 dBm.

Standard wall mount models have manual gain control in addition to the AGC. The usable 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. See the FCC and AGC sections in this manual for more information on these features.

LED indicators provide visual diagnostics for the BDA. DC Test points and RF pick off points provide more indepth information for set up and troubleshooting. A dry contact relay on wall mount units shipped after May 1994 provides an alarm interface for remote sensing. Together with the diagnostics section of this manual, these features make field repair fast and easy.

FIGURE 1. BDA FUNCTIONAL BLOCK DIAGRAM

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SERIES 48500 RF REPEATER AMPLIFIERS

TABLE 2. ELECTRICAL SPECIFICATIONS

Table 2 provides listing of the electrical specifications for all of the 48500 series BDAs. Many of the models shown have been discontinued from further production but are supported for repair. Detailed specifications of the particular BDA which came with this manual are in the back of this manual.

Model		Base Talk Out		Output		Mobile Back		Output		Included Features Notes	Current Draw		
120 VAC	220VAC	Pass Band	Gain	Power	Pass Band	Gain	Power	Pass Band	Gain		120 VAC	220 VAC	24 VDC
		-3 dB	-60 dB	dB	**dBm	-3 dB	-60 dB	dB	**dBm	Amps			
800 MHz SMRS		851-869 MHz				806-824 MHz							
48500	48501	18	32	57	25	18	34	57	25		0.4	0.2	1.5
48502	48503	18	32	74	25	18	34	57	25		0.4	0.2	1.6
48504	48505	18	32	74	25	18	34	74	25		0.5	0.2	1.7
48506	48507	18	32	62	30	18	34	62	30		1.3	0.7	5.0
48508	48509	18	32	79	30	18	34	62	30		1.4	0.7	5.1
48510	48511	18	32	79	30	18	34	79	30	*1,2	1.4	0.7	5.2
48512	48513	18	32	62	30	18	34	57	25		0.9	0.4	3.2
48514	48515	18	32	79	30	18	34	57	25		0.9	0.5	3.3
48516	48517	18	32	79	30	18	34	74	25		0.9	0.5	3.5
48561	48562	5	16	79	30	5	18	79	30	*1,2,3	1.4	0.7	
48566-N		3	9	78	30	5	18	79	30	*1,2,3	1.4	0.7	
48569		10	22	79	30	10	22	79	30	*1,2,3	1.4	0.7	5.2
900 MHz SMRS		935-941 MHz				896-902 MHz							
48518		6	18	79	30	6	18	74	25		0.9	0.5	
48522-N	48522	6	18	79	30	6	18	79	30	*1,2,3	1.4	0.7	5.2
Cellular A Band		869-891.5 MHz				824-846.5 MHz							
48532	48542	10	22	79	30	10	23	79	30		1.4	0.7	
48546	48547	22.5	33.5	79	30	22.5	35.5	79	30	2	1.4	0.7	
48549-N	N/A	22.5	33.5	78	30	22.5	35.5	79	30	*1,2,4	1.4	0.7	
48550-N	48552-N	22.5	23.5	79	30	22.5	23.5	79	30	*1,5	1.6	0.8	5.7
Cellular B Band		880-894 MHz				835-849 MHz							
48535	48545	10	22	79	30	10	23	79	30	2	1.4	0.7	
48543	48544	14	26	79	30	14	27	79	30	*1,2	1.4	0.7	
48551-N	48553-N	14	15	79	30	14	15	79	30	*1,5	1.6	0.8	5.7
Cellular A/B		869-894 MHz				824-849 MHz							
48548	48541	25	36	79	30	25	38	79	30	6	1.4	0.7	

* Indicates standard model. Contact the factory for availability of non standard models.

** Power stated at the AGC set point.

Add "-N" to models number for "Wall Mount" package. Models shown as "-N" are available in wall mount only.

Older versions of the models listed may not include options listed.

OPTIONS KEY: Options listed are included as standard equipment on current revisions.

- | | | |
|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------|---------------------------------|
| 1. 15 dB Variable Attenuator Included on the Wall Mount Package. | 3. Specify Frequency Range with Order. | 6. Not available in wall mount. |
| 2. External Filter Option-TNC Connectors. Order External Filters as Needed. | 4. Internal Notch Filter in TX Path. | |
| | 5. Internal Down Convert Filter, TX / RX. Prop Delay < 6.0 μ s, NF 9.0 dB Typ. | |

SERIES 48500 RF REPEATER AMPLIFIERS**USER'S MANUAL****TABLE 3. MECHANICAL/ENVIRONMENTAL SPECIFICATIONS**

Table 3 provides a listing of general specifications for the 48500 series. Two mechanical configurations are available for each model. A standard 19 inch Rack-Mount version is available, and a Wall-Mount enclosure option is available. Each option is intended primarily for indoor usage, although the Wall-Mount, "N", option can be used outdoors in moderately protected moisture and sun exposed environments.

WARNING: 48500 series amplifiers in Wall-Mount enclosures used outdoors should be protected against blowing rain, splashing water, and hose-directed water. This would imply that some sort of shelter is in order for exposed outdoor mounting.

Mechanical Specifications:

Dimensions	_____ (W x H x D) - inches (mm)
Rack Mount, Single Tray	_____ 19 x 7 x 18 (482.6 x 177.8 x 460.4)
Wall-Mount Enclosure, w/o mount plates	_____ 15½ x 15¼ x 8 (400 x 400 x 200)
Approximate Weight	_____ lbs.
Rack Mount	_____ 30
Wall-Mount Enclosure	_____ 50

Connectors

RF	_____ Two Type "N", Female
Models with External Filtering Option, add	_____ Four TNC, Female
24 VDC Models	_____ Screw Terminal Strip
	_____ (inside enclosure)
Power, AC	_____ IEC-320 Socket

Environmental Specifications:

Operating Temperature	_____ -30° C to +60° C
	Operation over 75° C voids warranty.
	Operation at case temperatures over 55° C should be limited to 200 hours per year.
Humidity	Non-condensing up to 85% relative for 0° C to 50° C within full specified data.

SELECTIVITY

Many of the Repeater Amplifiers offered by Celwave are broadband which, by definition, amplify a large passband of continuous spectrum, i.e., 806 MHz to 824 MHz. Some models provide for a narrower passband, 3 MHz or 5 MHz, within the normally broad operational passband of the other repeater models. Also, selectivity in some models is enhanced by adding additional internal band-select filters of a passive or active nature, or by providing external filter ports to allow the user to connect external passive band-select filtering.

Selectivity in all Celwave Repeater Amplifiers is determined by the filtering. The basic BDA passband is typically specified at the -3 dB points in the passband. The -30 dB points are also measured and listed in the "Specific Amplifier Performance Data" located at the back of this manual. Typically, band-edge slopes are about 10 dB per MHz roll-off; additional band-select filtering options can provide up to 100 dB per MHz slopes on targeted band edges. Gain versus frequency plots are provided on the specification data sheet.

USER'S MANUAL**SERIES 48500 RF REPEATER AMPLIFIERS****SELECTIVITY (Continued)**

Down conversion filtering (DCF) is provided in the 48550-N and 48551-N BDAs. These models are referred to as Enhanced Cellular because the DCF provides enhanced pass band performance. Specifically, the DCF, improves out of band signals rejection at the band edge. See the BDA brochure for typical filter performance curves. Actual measurements are provided in the back of this manual.

Schematically, the DCF assemblies are located at the options link (figure 1, page 2) in the up and down links after the PRE-amplifiers. Table 2, Electrical Specifications, on page 3 details the performance. The DCF increases group delay slightly, but does not impair the BDAs ability to work with digital signals.

Note: Attenuation of undesired neighboring signals is always best done at the antenna by using a highly directional donor antenna pointed at the desired base station donor. If unwanted channels continue to be a problem, contact Celwave BDA Technical Support at (800) 659-1880 for assistance.

AUTOMATIC GAIN CONTROL

All 48500 series amplifiers have an AGC gain stage. This stage automatically varies the overall gain of the system by up to 22 dB. The gain set by AGC is a function of the total power present in the amplifier just prior to 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.

The advantage of using the AGC stage is primarily two-fold. First, the dynamic range of the amplifier is increased. A wider range of input signal levels can be handled by the system. This advantage can also be stated in terms of gain. More gain can be put into the system to handle weak signals without risking premature compression and excessive intermodulation emissions due to stronger signals.

The second significant advantage is that intermodulation products are always automatically kept to acceptable levels. As more channels become active, or as some signals become stronger, gain is reduced and total output power is kept constant. The result is that intermodulation output is always kept within FCC allowable limits.

There is one disadvantage with using the AGC stage. A very strong input channel can dominate the gain leading to reduced gain for weaker signals. The extreme of this case would be the loss of link with a weak channel whenever a very strong channel becomes active. The obvious solution to this problem is to somehow limit the strong channel either through attenuation, filtering, or antenna orientation.

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 (see Table 2, page 3, for gain listings) 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.

AUTOMATIC GAIN CONTROL (Continued)

NOTE: If the sum of total input power plus the amplifier's *minimum* gain (max. gain minus AGC range limit) is greater than the maximum output power level, the amplifier may attempt to operate beyond the AGC control range. The AGC control circuitry will then remove power to the offending path (Tx or Rx). If this is expected to be a consistent problem, either a lower gain model should be selected, or some input attenuation or channel limitation arranged.

TABLE 4. TYPICAL OUTPUT POWER

1 Watt Amplifier		Number of Signals	6 Watt Amplifier	
dBm	mW		dBm	mW
25.0	316	1	30.0	1000
21.0	126	2	28.0	398
15.7	37	5	20.7	118
13.0	20	8	18.0	63
11.7	15	10	16.7	47
9.0	8	16	12.7	25
7.7	6	20	12.7	19
5.0	3	32	10.0	10
3.7	2	40	8.7	7

AGC AUTOMATIC SHUTDOWN

When the automatic gain control circuit in the AGC amplifier reaches its control limit, power to the AGC amplifier stage and the preamplifier stage (if applicable) 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. Also note that the power output amplifiers in both paths always remain on.

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.

The condition of the power supplied to each AGC/preamplifier path is displayed by the green PWR LED. A lit LED indicates that power is on for the associated amplifier chain; this is the normal condition. For a situation where there is continuous AGC overload, the green LED will flash on every 5-7 seconds.

It is possible to bypass the automatic shutdown feature. A jumper exists on the LED circuit board which will disable the shutdown circuitry. **NOTE THAT OPERATION BEYOND THE AGC CONTROL RANGE MAY RESULT IN EXCESSIVE SPURIOUS EMISSIONS.** Simply change the jumper to the off position. There is one jumper for each path (Tx is top jumper and Rx is bottom jumper). Leaving the shutdown circuitry intact is good insurance that spurious emissions will always remain within allowable levels.

USER'S MANUAL**SERIES 48500 RF REPEATER AMPLIFIERS****AC / DC POWER**

There are two power supply options for the 48500 series, 120 VAC and 24 VDC. The 120 VAC option comes with a standard 3-wire male plug with phase, neutral, and safety ground wires. AC power is only used to supply a high-efficiency 24 VDC switching power supply. All other components are powered by 24 VDC.

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.

NOTE: The 48500 series amplifiers connect the enclosure chassis to the green-wire safety ground. The lid and box portions of the Wall-Mount enclosure must be joined with a ground strap to maintain low impedance electrical continuity for the entire enclosure.

Amplifiers powered by 120 VAC first route the black phase wire to a 3AG, 2 amp fuse to cut power in the event of a severe AC fault. A second fuse, 3AG, 5 amp, is used between the 24 VDC positive wire and the components.

FAULT MONITORING

Each of the amplifier stages and DCF filter making up the system has an associated fault monitor LED located on the front panel of the Rack-Mount models and on the inside of the lid on the Wall-Mount models. A full system will have a total of eight fault LEDs, four for the Tx path and four for the Rx path. Each path is labeled accordingly, and each amplifier in the path is labeled according to its function in the system. The designator "PRE" is used for the optional preamplifier stage; "GAIN" is used for the AGC amplifier stage, and "POWER" designates the 1 watt or 6 watt power amplifier stage. DCF is used to identify the down conversion filter when used.

The two green LEDs below the six/eight red LEDs are power-on indicators for the associated Tx and Rx preamplifier and AGC amplifier chains. Normally, these LEDs are on indicating that power for the chain is on. An off green LED indicates power to the associated chain has been shutdown due to AGC out of range conditions.

The amplifier stages are labeled with the same designators, "PRE", "GAIN", and "POWER", as well as the associated path, "Tx" and "Rx" somewhere on the component box. In the event the labels are missing, the amplifier stages can be identified by locating the functional block in Figure 2. Note that each functional block in Figure 1 corresponds to a component box located within the enclosures.

The fault monitoring will detect conditions of extreme over-current and under-current conditions within an amplifier stage. Any amplifier experiencing such conditions will activate its associated LED. This feature greatly simplifies diagnostics and troubleshooting for the 48500 series. Detailed procedures for troubleshooting and diagnostics appear in the section entitled "Diagnostics and Troubleshooting Guide".

The down convert filter assemblies are monitored for failure conditions. The 48550-N and 48551-N have fault LEDs on the display panel labeled DCF for TX (downlink) and RX (uplink) paths. Any failure indication in the DCF will light the LED and Trip the alarm relay (see Alarm interface).

RF PICKOFF CONNECTORS

Each filter block in the amplifier system has a male BNC connector which accesses a coupled RF port. This port can be useful in some instances for diagnostics and for "on-line" observation of the system. Ordinarily, this port should remain undisturbed and capped.

Two filter blocks exist in each path, Tx and Rx. At the "front" of each path is a preselector bandpass filter, and at the end of the path is a band-limit output bandpass filter. The coupled port for each output filter is measured for each amplifier system to provide precise coupling ratios. This information is included in the "Specific Amplifier Performance Data" section at the end of this manual. The RF pickoffs in Rack-Mount models are brought out to the front panel.

TEST POINTS

The LED circuit board containing the six red fault LEDs and the two green power LEDs used in all BDA models includes five test points and a ground reference point. These points are labeled on both the Rack-Mount and the Wall-Mount models near the LEDs. These test points are primarily used by factory personnel for test and tune-up purposes; although, they may also be quite useful for field diagnostics. All test points provide a voltage referenced to the bottom ground test point labeled "GND".

The top two test points, "Tx AGC" and "Rx AGC", provide the control voltage internal to the AGC circuitry. This can be useful for ascertaining just where in the AGC range each path is operating. For example, a strip-chart recorder might be used with the test points to track AGC operation throughout some important period of time. Table 5 provides a listing of AGC test-point voltages and the associated approximate gains for various amplifier configurations.

The voltage across the "Tx AGC" and "Rx AGC" test points (with respect to "Gnd") ranges from 13.5 volts with no AGC limitation (max gain) to a minimum of about 2.75 volts during AGC saturation. (Remember, the power to the saturated path will be removed for 5 to 7 seconds when saturation occurs unless the shutdown jumper is disabled.) A voltage between 3 and 6 volts is typical during normal operation.

TABLE 5. AGC TEST POINT VOLTAGE VS AGC ATTENUATION

DC Voltage	13.47	8.41	7.2	6.75	6.3	5.96	5.54	5.15	4.79	4.46	4.17	3.92	3.71
Attenuation dB	0.00	1	2	3	4	5	6	7	8	9	10	11	12
DC Voltage	3.54	3.4	3.29	3.19	3.12	3.04	2.98	2.93	2.88	2.84	2.8	2.75	
Attenuation dB	13	14	15	16	17	18	19	20	21	22	23	24	

The middle test point, "TEMP", is the voltage across a 25k ohm thermistor. This thermistor is used for fan control to optimize the utilization and lifetime of the fan. The thermistor is attached to the heat sink of the highest powered amplifier stage in the system. The DC voltage associated with the temperature will vary slightly between units, these levels should be accurate to within 10%."

TEST POINTS (Continued)

TABLE 6. TEMP TEST POINT VOLTAGE VS TEMPERATURE

Voltage, DC:	20.8	15.6	12.0	9.5	7.2	5.0	3.5
Temp. °C:	10	20	30	40	50	60	70

The remaining two test points, "Tx PWR" and "Rx PWR", are simply attached to the 24 volt power line supplying DC power to the pre-amp (if applicable) and AGC amplifier stages in the associated path. It is this power which is removed when AGC saturation occurs. These test points can be used to verify the presence or absence of DC power for the associated path in the unlikely event that a green LED driving circuit has failed. These test points are more likely to be useful for implementation of some kind of external alarm or counting device used to track occurrences of AGC saturation and shutdown.

MANUAL GAIN ATTENUATOR

Some wall mount models are equipped with a 0 to 15 dB for each RF path. The control pots are located on the top of the LED chassis. The attenuator is placed in the usual position between the preamp and AGC amp in the RF path. This option may be useful for providing low levels of constant attenuation for environments where just a little less system gain is desirable.

If the attenuator is not installed or does not provide enough attenuation, the preamp stage (if applicable) should be removed (*This should not be done with Enhanced Cellular models 48550-N and 48551-N*). It is also then possible to reinsert the manual attenuator (or fixed attenuator pads) if even less gain is still desired. NOTE THAT FOR THIS CASE, THE NOISE FIGURE WILL INCREASE dB PER dB OF ADDITIONAL ATTENUATION.

Warning: Do not insert attenuation anywhere after the AGC "GAIN" amplifier. This will degrade the third-order intercept point of the BDA and may result in excessive intermodulation products.

EXTERNAL FILTER PORTS

External Filter ports allow the user to customize the passband of each RF path. Models equipped with this option bring TNC connectors out from the RF path to the BDA chassis. PASSIVE bandpass and/or bandreject filter may be attached to these connectors. Units with this option are shipped from the factory with TNC to TNC jumpers connected across the external filter ports. See the subsection "External Filter Installation" in the next section of this manual for more general details.

Warning: The External Filter option is intended for use with passive devices only. Connection of any active device nullifies FCC Type Acceptance and voids the unit's warranty.

INSTALLATION PROCEDURES

As mentioned in "Product Overview and General Information," both enclosure options are intended primarily for indoor applications. The Wall-Mount enclosure is similar to a NEMA 3R rating which indicates that it may be used outdoors with the addition of some protective measures against windblown dust, rain, and splashing or hose-directed water. The venting in the enclosure may allow forced moisture inside. It is also advisable to avoid a location with continuous high levels of sunlight exposure. High temperatures inside the enclosure will shorten component lifetime.

The Rack-Mount option is designed for a standard 19 inch equipment rack (EIA RS-310-C) using four #10-32 screws to secure in the rack. The Wall-Mount enclosure option has top and bottom mounting plates for attachment to a convenient structure (wall, post, tower, etc.).

CONNECTIONS

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. 24 VDC options are simply connected to the external 24 VDC supply by connecting the positive and negative supply wires to the appropriate screw terminal strips inside the enclosure. Terminal strips for these options are clearly labeled.

The primary RF connection is made via two type "N" female connectors. These connectors are on the bottom of the Wall-Mount box and on the back of the Rack-Mount enclosure. The connector labeled "To Base" must be connected to the antenna/system pointing towards the base station. The connector labeled "Service Area" must be connected to the antenna/system pointing into the area to be covered. *All RF connections are 50 ohms nominal impedance.*

It is recommended that amplifier operation be verified after installation. This may be accomplished by injecting a known signal into each type "N" RF connector (one at a time) and observing amplification at the opposite type "N" output connector (use attenuation!) or at the associated BNC pickoff connector. Single signal (channel) maximum output should be about 25 dBm for 1 watt models and 30 dBm for 6 watt models.

ALARM INTERFACE

All wall mount models will ship with an external fault alarm interface starting May 1994. This interface is a "dry contact" relay (form "C") with both normally closed and normally open contacts. The relay is accessible via a terminal strip mounted on the bottom of the package. The contact has a 2 Amp, 125 VAC or DC rating. A label identifies the normally closed (NC), common (COM), and normally open (NO) connections. The relay will activate as long as any of the following conditions exist. Once the alarm has cleared the relay returns to its normal condition.

Alarm Conditions:

1. Loss of AC or DC power.
2. Fault indication from any internal amplifier current/fault monitor (see page 10).
3. Excessively high temperature, indicating a fan failure or plugged filter (see page 24).

Note: A temporary "Automatic AGC Shutdown" due to signal overdrive will not trigger an alarm (see page 9).

USER'S MANUAL**SERIES 48500 RF REPEATER AMPLIFIERS****EXTERNAL FILTER INSTALLATION**

BDA models equipped with external filter ports come from the factory with a TNC male to TNC male cable connected across the external filter ports. This jumper must remain in place if no external filter is connected. Installation of any PASSIVE external filter is accomplished by simply connecting the external filter to these TNC connector ports. In most cases this will require a set of jumpers in the proper length and configuration for each filter.

Warning: Always disconnect AC power (or DC if applicable) from the BDA before making any connection! The External Filter option is intended for use with passive filters only. Connection of any active device nullifies FCC Type Acceptance and voids the unit's warranty.

In some applications, the proper orientation of the "IN" and "OUT" connections is critical to performance of the external filter. The 719610 Dual Reject Filter used to remove cellular B-Band Tx signals from the expanded A-band Tx spectrum is one such example. The direction of RF signal flow is crucial to proper operation of this filter system.

The connectors labeled "OUT" indicate that RF signals exit the BDA at this port (see Figure 1). Therefore, a BDA "OUT" connector must connect to the "IN" connector port on a direction sensitive filter. Likewise, the "OUT" connector of the filter connects to the "IN" connector on the BDA, where RF signals re-enter into the BDA.

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. Celwave 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:

$$\text{Ripple} = 20 \text{ LOG}_{10} \{ (1 + [A] [B]) / (1 - [A] [B]) \} \text{ dB}$$

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.

SERIES 48500 RF REPEATER AMPLIFIERS**USER'S MANUAL****ANTENNA ISOLATION (Continued)**

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. Ordinarily, reciprocity would dictate that measuring the isolation between antenna 1 and antenna 2 is adequate. However, the reflection paths may be different; therefore, the isolation measurements should be repeated in each direction.

PERIODIC MAINTENANCE

There is really very little to maintain in the 48500 series of RF repeater amplifiers. As long as the amplifiers are kept away from extreme temperatures and moisture, and these few simple maintenance items are observed, the amplifier should provide long-term, care-free operation.

Periodically, check the two type "N" RF connections for corrosion, strain damage, and tightness. Periodically, check the AC or DC power connections for integrity. (The connections could be quickly checked at the same time as performing fan filter maintenance.)

FAN and FAN FILTER:

Models with the 6 watt power amplifier stage come with a 24 VDC cooling fan. To maintain optimum cooling, the fan filter must be kept clear of dust and debris. Usually, just picking off the compacted "dust bunnies" or vacuuming the filter will sufficiently clear any blockage. In dusty environments, or after extended usage, it may be desirable to replace the filter material. Air intake is at the fan; therefore, the majority of dust accumulation will be on the outside surface of the fan filter.

On Rack-Mount enclosures, the fan filter is easily accessible on the front panel. In the Wall-Mount enclosures, the fan filter is located on the bottom plate assembly. The fan filter on all models is easily removed from the outside of the enclosure by pulling the plastic filter casing off of the filter mount. Replace the filter by snapping the square plastic casing back onto the mount.

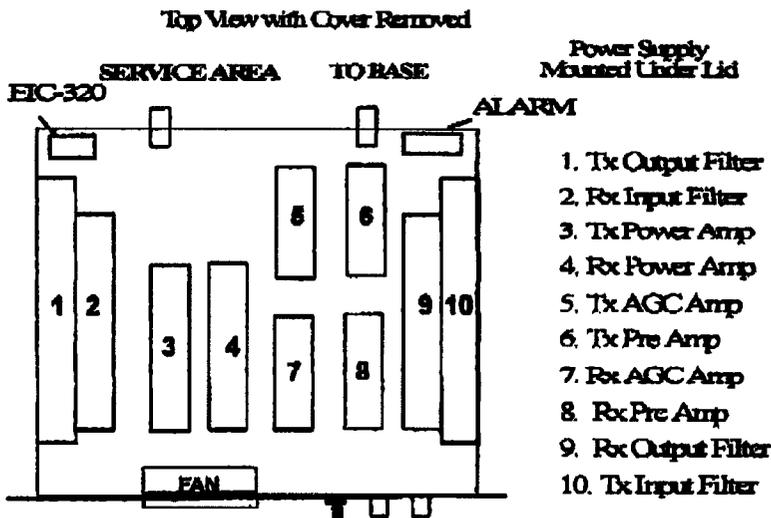
In very dusty environments, it may also be desirable to blow out the inside of the unit with compressed air at time of fan filter maintenance. It would also be a good idea to check the side louvers on the Wall-Mount enclosure for any significant blockages such as cocoons, wasp nests, thick spider webs, etc. This can be done entirely from outside the enclosure. Be careful not to puncture the bug screens blocking the vent openings.

FAN BEARINGS HAVE A LIMITED LIFE SPAN. REPLACE THE FAN ONCE EVERY FIVE YEARS.

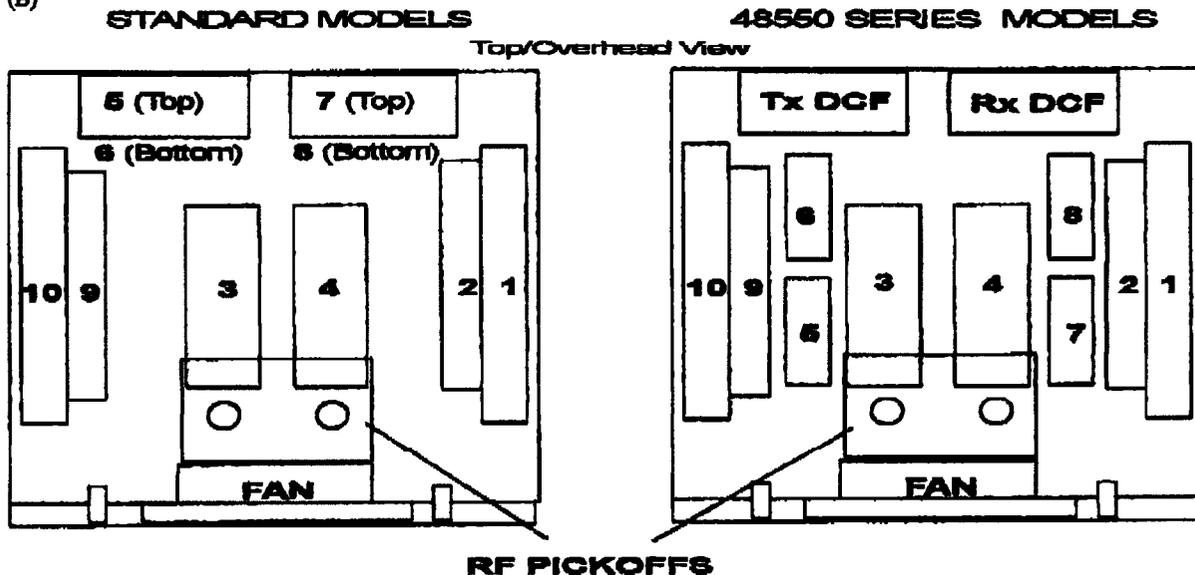
DIAGNOSTICS and TROUBLESHOOTING GUIDE (Continued)

FIGURE 2. COMPONENT LAYOUT DIAGRAM; (A) Rack-Mount, (B) Wall-Mount enclosures.

(A)



(B)



DIAGNOSTICS and TROUBLESHOOTING GUIDE (Continued)

Diagnosis of trouble in the 48500 series is particularly simple due to the inclusion of LED fault indicators. (Figure 9) shows the location and labeling of the LED fault indicators. The status of these LEDs generally provides sufficient information to immediately diagnose problems down to the functional block level.

This section describes how to use these LEDs to troubleshoot the 48500 series. Simply locate the condition highlighted in this section corresponding to the observed LED status. The end of this section also includes diagnostics for some problems which may not show up in the LEDs.

Red "DCF" LED is on:

This indicates that the associated DCF filter is experiencing a failure condition. Some early version of the DCF may experience a mis-start in cold weather. *Allow the BDA to warm up and then cycle the power a few times.* This should clear the problem. If you anticipate future failure modes of this kind, contact Celwave BDA technical support to have your BDA upgraded. If this does not clear the fault and you wish to by pass and/or repair the BDA in the field, follow the instructions below.

The DCF assemblies themselves are not field repairable and must be replaced or sent back for repair. The faulty DCF assembly may be by-passed to allow the BDA to continue to operate without the benefit of the DCF improved band edge signal rejection. The resultant performance will be the same as the Basic Cellular BDA (48543 or 48549). These units provide the same pass band with softer band edge attenuation.

By-passing the DCF assembly:

Figure 2B shows the location of the TX and RX DCF. The black box on the top with BNC connectors is the HF filter assembly (HFA) and does not need to be returned. The aluminum assembly underneath the HFA is the down convert assembly (DCA) that will need to be returned. The small aluminum assembly next to the attenuators is the local oscillator filter (LOF), it does not need to be returned. Some LOF versions are connectorize and may be disconnected and left in the BDA, others will have to be removed with the DCA and returned as part of the assembly.

Remove power! To by-pass the RX DCF, connect the RX Pre-amp OUT to the RX GAIN amp IN. Use the cable that is connected to the Pre-amp OUT connector. Disconnect this cable at J1 on the attenuator and connect it to the IN connector of the GAIN amp. This eliminates the attenuator and DCF from the RF path. The DCA may be removed and sent in for repair.

The TX DCF is not as easy. The cable from the PRE-amp OUT on some models is not long enough to reach the GAIN amp IN. If it is, do so and remove the DCA as described above. If the cable is too short, a 12" TNC to TNC jumper cable will be needed to do a temporary by-pass. If the DCF is to be removed immediately, then a jumper will not be needed.

On units with a connectorized LOF. The cable from the IN on the TX GAIN amp goes to the LOF, the other cable from the LOF goes to the DCA. Remove the HFA and remove and disconnect the DCA. Loosen the LOF assembly. Connect the LOF-DCA cable to the OUT connector of the TX PRE-amp. This will leave the LOF in the circuit and remove the DCF and attenuator. The LOF may remain as is until spares arrive, it will not effect the performance. If the LOA is not connectorized, then the cable from the GAIN IN will be connected to the DCA. Connect that cable to the PRE-amp OUT when the HFA, DCA and LOF are removed.

DIAGNOSTICS and TROUBLESHOOTING GUIDE (Continued)**All LEDs Are Off:**

For normal operation, the green "Rx PWR" and "Tx PWR" LEDs are lit indicating that DC power is being supplied to the AGC and preamplifiers. If these LEDs are continuously off, then some kind of power supply failure has likely occurred. Check fuses, DC supply terminals, and AC power.

WARNING: 120 VAC can be lethal. **Be extremely CAREFUL** about poking around with conductive probes during diagnostic procedures. The 120 VAC exists at the power supply terminals under a protective plastic cover AND on the AC fuse and fuse holder.

A subsequent failure of an AC fuse after replacement probably indicates a DC power supply high-current failure of some kind. A subsequent DC fuse failure likely indicates that a portion of exposed DC wiring is touching ground or a component has failed short-circuit / high current (all fault indicator LEDs may light briefly before the fuse fails).

A Red LED Fault Monitor Is Lit:

This indicates that the associated amplifier stage is receiving at least some DC power and a significant current fault has been detected in that stage (current either too high or too low). The associated amplifier must be replaced. (Figure 2) illustrates the typical location of each amplifier stage within each type of enclosure used for the 48500 series.

Note that in many cases, it may be possible to remove the faulty amplifier stage for repair and "jump" around it with a barrel connector or by rearranging the coaxial lines to temporarily provide continued system operation (at lowered gain and/or power) while the faulty amplifier stage is being repaired/replaced.

All Red LED Fault Monitors Light Up in One or Both RF Paths (Tx or Rx):

This is probably an indication of oscillation. Check the antenna isolation and amplifier gain margin (see "Installation Procedures, Antenna Isolation"). Such an oscillation will cycle the AGC shutdown circuitry and the LEDs will flash briefly on every five seconds. If the AGC shutdown circuitry is bypassed, an oscillation could damage components; so, do not bypass the AGC shutdown if an oscillation is possible.

It may also be possible for a voltage regulation failure within the DC supply to cause this LED status (only likely if both RF paths show failure). The DC power supply may be supplying some power (or too much), but not enough (or too much) for the amplifier stages to achieve proper bias. Check DC Power supply voltage and current capability.

One Green LED Occasionally Turns Off or Flashes Briefly On Every 5-7 Seconds:

The occasional or repetitive turn-off of a green LED indicates that power is being cut to the associated Tx/Rx preamplifier and AGC (Gain) amplifier chain. This is automatically done whenever the automatic gain control circuitry in the AGC amp has reached its control limit and stayed there continuously for about a half second.

The usual cause of this is a very strong signal (channel or noise source) or a large number of strong channels being simultaneously active. The AGC amplifier attempts to reduce the gain so that the total power remains within the maximum set point. If the total input power is too great, AGC reaches its limit and shuts down the DC supply line to the amplifier chain for 5 to 7 seconds so that excessive spurious emissions do not occur.

DIAGNOSTICS and TROUBLESHOOTING GUIDE (Continued)

The solution to this problem is to eliminate or attenuate the overly strong signal through filtering, attenuators, or antenna orientation. If this is not possible, then a 48500 series model with lower gain should be employed.

It is also possible that amplifier oscillation due to antenna feedback may cause this problem. Check the antenna isolation and amplifier gain margin. If the antenna isolation is marginal (less than 20 dB), temporary instabilities may arise due to reflection path variations; i.e., large mobile objects, wind tilt of antennas, or a specific channel whose frequency happens to phase just wrong when activated. More antenna isolation should cure these types of problems.

Both Green LEDs Flash on Briefly Every 5-7 Seconds:

The most likely cause of both paths simultaneously experiencing AGC automatic shutdown is amplifier oscillation. Check the antenna isolation and amplifier gain margin as discussed in "Antenna Considerations, Antenna Isolation." Disabling the automatic shutdown circuitry is not recommended for this case. If an oscillation is the cause, the automatic shutdown may be preventing component damage.

** The remainder of this section covers possible problems which may not show up in the LED fault indicators.

Gain Reduction:

The most likely cause of gain reduction is corruption of connections or cabling somewhere in the RF path from antenna to antenna. Check all cabling for integrity.

Another possible cause of gain reduction is a movement of the antenna, or a significant change in the surroundings leading to loss of RF signal to propagation losses.

Causes within the repeater amplifier include connections and cabling, bandpass filter detuning, and amplifier stage "soft" failure where the stage is functioning but component failure or degradation causes reduced gain. First check cables and connectors.

A failed amplifier stage or filter detuning may be diagnosed by tracing an injected RF signal through the amplifier. Test instrumentation may be connected at any point along each amplification path. The approximate power gain for each functional block is shown in Figure 1. Filter response is shown in "Specific Amplifier Performance Data" at the end of this manual.

Excessive Intermodulation or Spurious:

NOTE: This product is broad-band by nature; it will receive and amplify all in-band signals present at the input. Please verify that the offending signal is not present at some low level at the antenna terminals or the external filter terminals if that option is installed.

Excessive spurious emissions originating in the repeater amplifier are likely due to the over driving of an amplifier stage. Such overdrive is usually caused by an overly strong signal at the input which forces the amplifier into compression. An amplifier in compression is highly nonlinear, thus producing high levels of intermodulation and harmonics. The only solutions to this problem are to either reduce amplifier gain or reduce signal input.

DIAGNOSTICS and TROUBLESHOOTING GUIDE (Continued)**Excessive Intermodulation or Spurious: (Continued)**

Note that the later problem should not occur if the AGC shutdown circuitry is enabled; any overdrive condition should trigger AGC shutdown. See the section "Test Points", Table 5, for a method of checking for proper AGC operation. Also, spurious propagation through the BDA may be measured directly with a spectrum analyzer.

Another possible source of a large spurious signal is amplifier oscillation. Usually, the amplifiers will only oscillate if the antenna isolation is insufficient. It is also possible that "dirty" connections could be causing excessive noise output. This would be particularly evident while wiggling cables and connectors.

Occasional Drop-out of Some Channels:

The most probable cause of this behavior was mentioned in "Product Overview and General Information, Automatic Gain Control" (page 6). It is possible for one very strong channel to dominate the amplifier gain. The amplifier reduces the system gain to readjust the total output power to the set point. Since overall gain is suddenly reduced, the output levels of all other signals is also reduced. This sudden reduction in gain may cause a link loss with weaker channels.

The solution to this problem is to somehow limit the input power level of the offending signal/channel(s). This can be accomplished through attenuation at the source, or selective filtering at the amplifier input or external filter option. It is also often possible to utilize antenna orientation to steer away from offending channels. This can have the same effect as attenuating the signals at the input.

Note that simply a rapid increase in the number of active channels through the amplifier will have the same gain reducing effect. For example, the power output of 2 active channels drops by about 8 dB when 8 channels (all equal signal strength) become active (see Table 4). Consequently, borderline links may be lost during heavy activity.

Frequency Response Change:

A change in the frequency response of the repeater system is most likely due to bandpass filter detuning. This may be checked by comparing filter response with the data provided in "Specific Amplifier Performance Data" at the end of this manual. For information on retuning the filters, contact Celwave Sales Engineering at 800-659-1880. Otherwise, return the unit to Celwave for retuning.

It is also possible to see a change in the overall system frequency response due to changes in the antenna orientation and in the structural environment. Standing waves and multi-path reflections could be significantly altered due to such changes.

Call Quality Problems:

Problems with the sound quality of a radio link ("call"), such as clipping or an echo sound, are usually related to system components and parameters outside of the BDA unit. A problem within the BDA which may be affecting a call has likely already been covered under the diagnostic procedures detailed elsewhere in this section.

REPLACEMENT PARTS and RETURN for REPAIR**ORDERING & RETURNING COMPONENTS**

For technical assistance call Celwave Sales Engineering at 1-800-659-1880.

For returns, repairs and ordering, contact Celwave 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.

Replacement components are usually in stock and can be ordered for next day delivery.

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

**Celwave 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.

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.

USER'S MANUAL**SERIES 48500 RF REPEATER AMPLIFIERS****SPECIFIC AMPLIFIER PERFORMANCE DATA****TABLE 7. GENERAL SPECIFICATIONS**

Frequency, Mhz	PF861P	PF905B	PF901	PA9340
	806-941	B11 806-869 B12 869-941	P 806-869 Q 869-941	* See Below
Gain dB	16 - 17	10-32	25-28	32-34
Gain Flatness dB	± 1.0	± 1.0	± 1.0	± 0.5
Noise Figure, Max, dB	2.8	3.5	3.5	5.0
3rd Order IP3, Min, dBm	+32	+35	+40	+46
1 dB Comp Pt, Typ, dBm	+20	+24	+30	+39
Max Safe Input, Typ, dBm	+13	+10	+10	+10
VSWR, Max	1.5	2.0	2.0	2.0
Current Draw, Typ, mA	80	295	450	2200

*Pass Bands: A=806-824, B=824-849, C=849-869, D=869-902, E=902-928, F=928-941

All units 18-30 VDC, 50 Ohms impedance, unconditional stability and TNC connectors. Specifications are confirmed at room temperature. At 60° C the gain is typically 0.2 dB lower and the noise figure is 0.1 dB higher. At -40° C the reverse situation applies.

BDA EQUIPMENT LIST AND TEST RESULTS