



RF Measurement and Management in Your World

Installation and Operation Manual for Series 62 Signal Boosters

Manual Part Number

7-9470



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This warranty applies for one year from shipping date.

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Product part numbering in photographs and drawings is accurate at time of printing. Part number labels on TX RX products supersede part numbers given within this manual. Information is subject to change without notice.



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Version Number	Version Date
1	02/14/09
1.1	04/27/09

Symbols Commonly Used



WARNING



ESD Electrostatic Discharge



CAUTION or ATTENTION



Hot Surface



High Voltage



Electrical Shock Hazard



Heavy Lifting



Important Information



For Class A Unintentional Radiators

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which the user will be required to correct the interference at his own expense.



WARNING: Changes or modifications which are not expressly approved by TXRX Systems Inc. could void the user's authority to operate the equipment.



ATTENTION: This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

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Changes to this Manual

We have made every effort to ensure this manual is accurate. If you discover any errors, or if you have suggestions for improving this manual, please send your comments to our Angola, New York facility to the attention of the Technical Publications Department. This manual may be periodically updated. When inquiring about updates to this manual refer to the manual part number and revision number on the revision page following the front cover.

Contact Information

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OVERVIEW

Signal Boosters extend radio coverage into areas where abrupt RF propagation losses prevent reliable communication. No frequency translation (conversion) occurs with this device. The Series 62 signal booster is a broadband, bi-directional signal booster that has dual RF paths (uplink and downlink) to extend coverage in RF shielded environments. The signal boosters have either a 1 Watt or 10 Watt downlink output level @ 1dB compression

for single band models and either a 2 Watt or 10 Watt downlink output level @ 1 db compression for dual band models. **Table 1** lists all of the models available as well as their uplink / downlink pass-bands and downlink output power.

The Series 62 signal booster couples a low noise figure with a wide dynamic range to provide excellent selectivity for operation in a shared frequency band. The signal booster is based on a duplexed

Model Number	Uplink Band	Downlink Band	Downlink Output Power
62-89-A15-01-T3	806 - 821	851 - 866	1 W
62-89-A15-03-T3	806 - 821	851 - 866	10 W
62-90A-A03-01-T3	821 - 824	866 - 869	1 W
62-90A-A03-03-T3	821 - 824	866 - 869	10 W
62-89B-A03-01-T3	806 - 809	851 - 854	1 W
62-89B-A03-03-T3	806 - 809	851 - 854	10 W
62-89A-A18-01-T3	806 - 824	851 - 869	1 W
62-89A-A18-03-T3	806 - 824	851 - 869	10 W
62-88A-A06-01-T3	896 - 902	935 - 941	1 W
62-88A-A06-03-T3	896 - 902	935 - 941	10 W
62-91A-A25-01-T3	824 - 849	869 - 894	1 W
62-91A-A25-03-T3	824 - 849	869 - 894	10 W
62-83E-ADB-02-T3	806 - 824	851 - 869	2 W
62-83E-ADB-04-T3	806 - 824	851 - 869	10 W

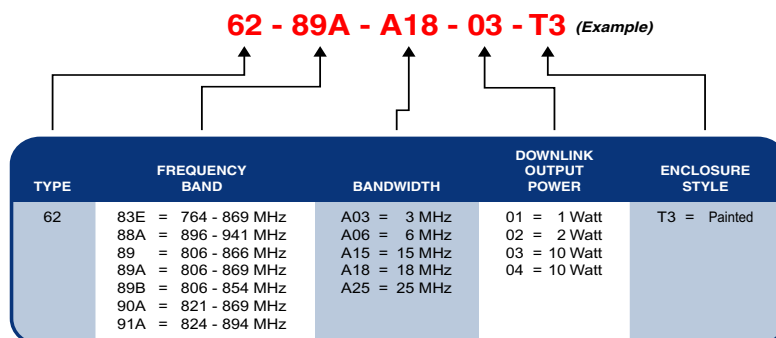


Table 1: Series 62 signal booster models.

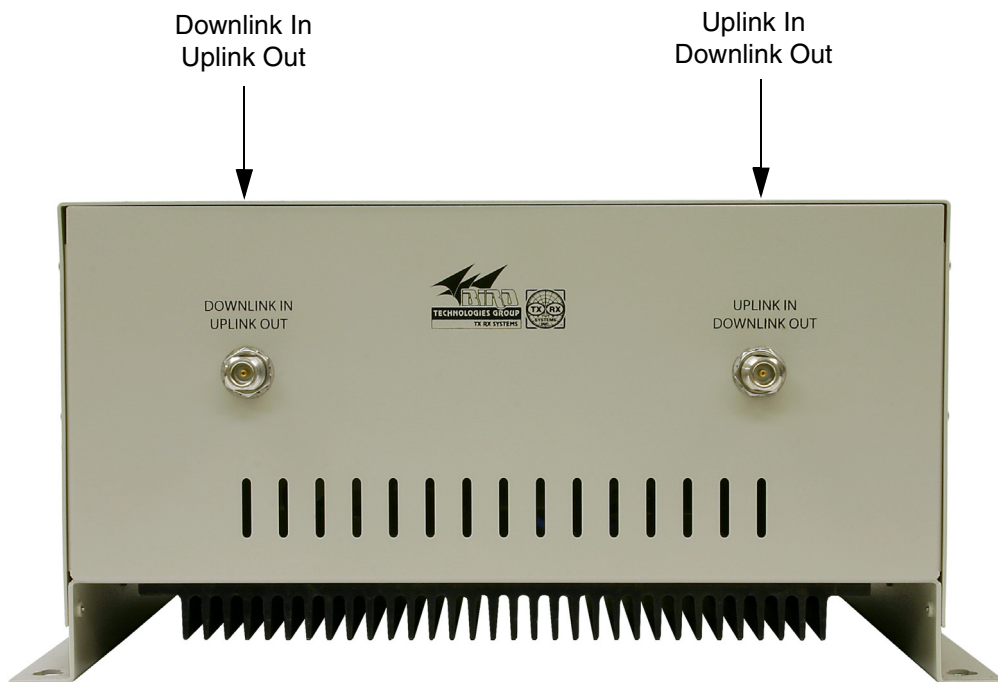


Figure 1A: Front view of the Series 62 signal booster.

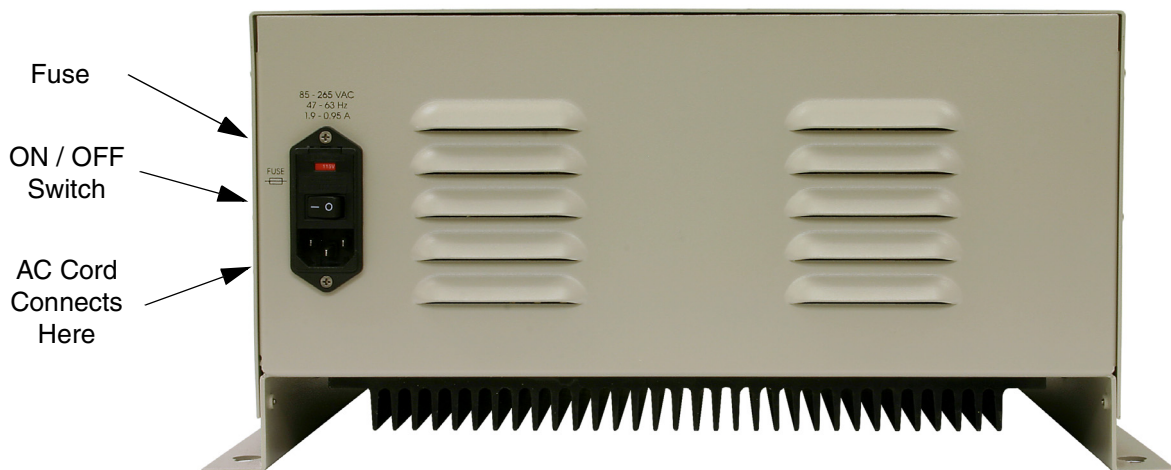


Figure 1B: Rear view of the Series 62 signal booster.

path configuration with sharp out of band attenuation assuring isolation between the receiving and transmitting paths. A front and rear view of the unit are shown in **Figures 1A** and **1B** respectively. Electrical, mechanical, and environmental specifications are listed in **Table 2**.

UNPACKING

It is important to report any visible damage to the carrier immediately. It is the customer's responsibility to file damage claims with the carrier within a short period of time after delivery (1 to 5 days). Care should be taken when removing the unit from the packing box to avoid damage to the unit. Use caution because the heat sink fins can have somewhat sharp corners.

BLOCK DIAGRAM DESCRIPTION

The Series 62 single-band signal booster is a broadband, bidirectional, dual branch (uplink and downlink) system. Linear RF active amplifiers, filters, and DC power sources are used to adequately boost and re-radiate the passband signals. Signal flow through the system is illustrated using the system interconnect diagram shown in **Figure 2**.

The signal booster system is composed of two symmetrical branches, uplink and downlink. The only difference between the two branches is the tuning of their duplexer passbands. The duplexers isolate the uplink and downlink paths from each others allowing common connectors to be used for

Electrical Specifications	
Passband Gain	80 dB Min (at max output power) 50 db Min (at min output power)
Manual Attenuation Range	0 to 30 dB in 2 dB steps
Passband Ripple	+/- 1.5 dB (typical)
Noise Figure	5 dB Max (at 25°C and max gain)
3rd Order Output Intercept Point	Uplink +40 dBm Min Downlink +52 dBm Min
Input / Output Impedance	50 ohms Nominal
Input / Output VSWR	1.5 : 1.0 (max)
Input Power	80 to 240 VAC at 50 / 60 Hz
Signal Test Ports	Optional -50 dB sample signal / additional BNC ports
Alarm Capability	Optional Form-C contacts (DB-9 connector)
Mechanical Specifications	
Paint	Gray Powder-Coat
Dimensions	15.0" x 14.6" x 8.1" (381 mm x 371 mm x 206 mm)
RF Connectors	N-type Female
Weight	30 lBs. (13.63 kg)
Environmental Conditions	
This unit is designed for indoor applications	
Operating Temperature	-30 to +50 °C
Table 2: Series 62 signal booster specifications.	

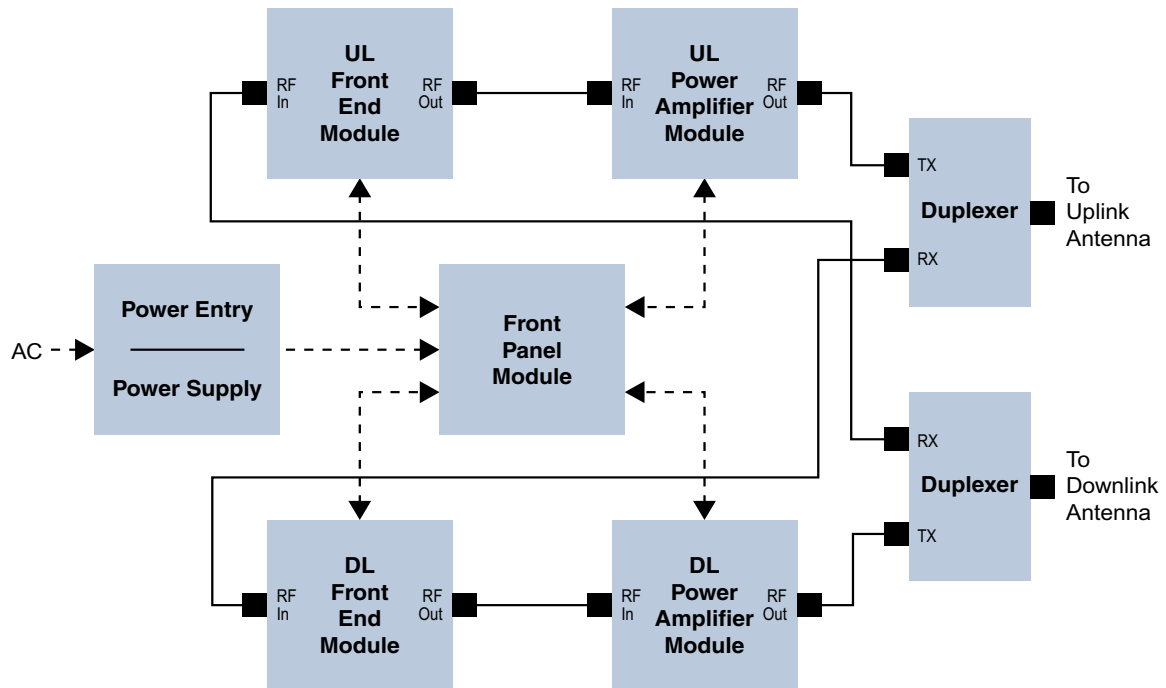


Figure 2: System interconnect diagram.

both input and output signals. The downlink path receives RF signals from the base station and amplifies and transmits them to the subscriber. The uplink path receives RF signals from the subscriber and amplifies and transmits them to the base station.

FRONT-END MODULE

The block diagram for the Front-End Module is shown in **Figure 3**. Received RF signals leave the duplexer and are routed to the Front-End Module which provides amplification, variable attenuation, and filtering. U3 is the first stage of amplification on the Front-End Module and is an LNA with ultra-low noise figure and high linearity. Following the first stage LNA is a Digital Attenuator U4. The positive control inputs for this device are provided by the user adjustable rotary dip switch located on the front panel module. The rotary switch allows the user to adjust system gain for the uplink and downlink paths individually during the installation of the booster.

The next functional device on the front-end module is the voltage variable attenuator U5. The control voltage for this attenuator is designated "VVA_CTL" and its source is the RF Detector circuit on the power amplifier module. The detector circuit produces an analog voltage proportional to the RF signal strength. This is an OLC (Output Level Control) feedback which is incorporated into the systems design for output power limiting and to minimize intermodulation products from excessively strong input signal levels. The OLC circuitry located on the power amplifier module senses the output power and automatically limits it by adjusting the variable attenuator U5. An LED located on the front panel module for both the uplink and downlink channels will illuminate whenever output power meets or exceeds the OLC factory preset level for that channel.

The next amplifier stage U1 following the variable attenuator is a broadband design that incorporates low noise as well as high IP3. The output from the amplifier is passed thru the low pass filter FL1 which provides harmonic rejection. Further amplifi-

UL Front End Module 3-22620

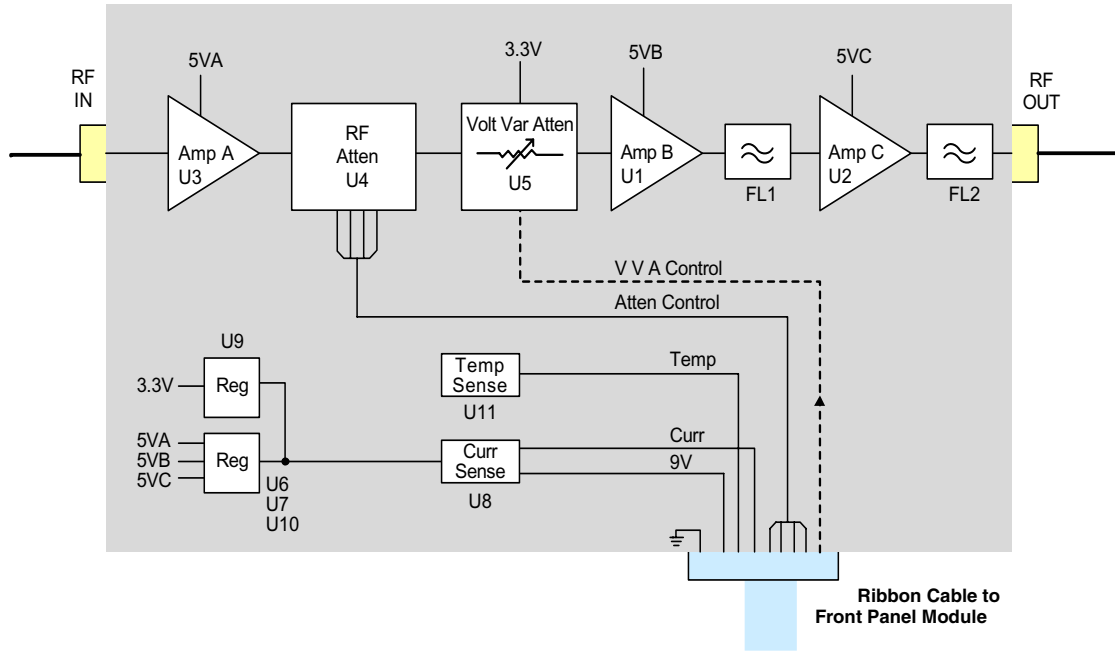


Figure 3: Front-End Module block diagram. Uplink shown as an example.

cation and filtering is provided by amplifier U2 and low pass filter FL2. RF signals then exit the Front-End module at the RF output connector and are applied to the Power Amplifier Module.

The front-end module also contains a Temperature Sensing and Current Sensing circuit, U11 and U8 respectively. These circuits are used to detect an excessive temperature or current draw condition. The output from the sensors are fed back to the Microcontroller on the Front Panel Module and are used to determine an alarm condition. There are four voltage regulators on the Front-End Module (U9, U6, U7, and U10) which are used to create bias voltages from the 9 VDC source voltage supplied to the module through the ribbon cable.

POWER AMPLIFIER MODULE

The block diagram for the Power Amplifier Module is shown in **Figure 4**. The first stage of the Power Amplifier Module is the driver amplifier U2. This is a medium power high linearity amplifier which serves as a preamp for the high power amplifier. U4 is the final output high power amplifier. This is an integrated multi-stage power amplifier with on-chip impedance matching. The output of the power

amplifier is applied to the directional coupler U3 which is used to sample the OLC feedback signal. RF signals leave the Power Amplifier Module at the RF output connector and are then applied to a duplexer which routes the signals to the appropriate antenna.

The power amplifier module also contains a Temperature sensing circuit U1 and two Current sensing circuits U8 and U9 for the driver amplifier and power amplifier respectively. These circuits are used to detect an excessive temperature or current draw condition. The output from the sensors are fed back to the Microcontroller on the Front Panel Module and used to determine an alarm condition. In addition, the temperature sensor and PA current sensor are used by the on-board Microcontroller U7 to turn off the power amplifier via the “PA OFF” control signal. This will protect the power amplifier under conditions of excessive current draw or temperature. There are two voltage regulators on the Front-End Module (U10 and U11) which are used to create bias voltages from the 28 VDC source voltage supplied to the module through the ribbon cable. The regulator U10 is the source of the 9 VDC used by the front-end module. A malfunction

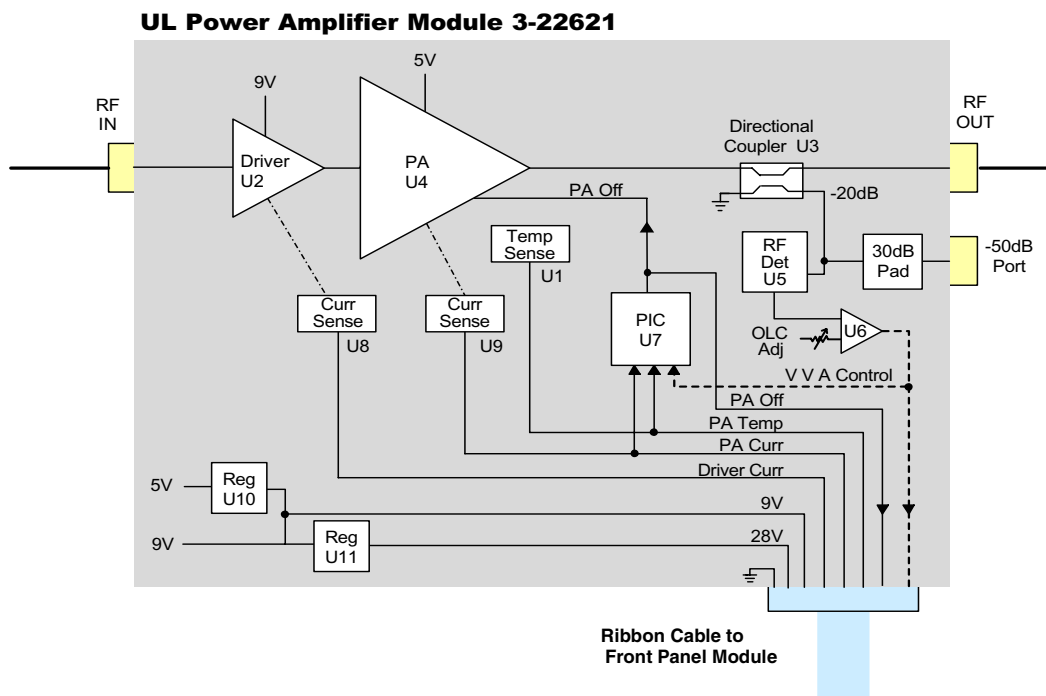


Figure 4: Power Amplifier Module block diagram. Uplink shown as an example.

of regulator U11 on the power amplifier module will shut down the front-end module.

FRONT PANEL MODULE

The block diagram for the Front Panel Module is shown in **Figure 5**. The Microcontroller U1 monitors the temperature and current control inputs from the front-end and power amplifier modules and will respond with an alarm whenever a control line is active. During an alarm the micro will illuminate the appropriate alarm LED (uplink or downlink).

The uplink and downlink “VVA_CTL” control signal is passed through the front panel module via ribbon cable J1 and J2. The microcontroller monitors these control lines and illuminates either the uplink or downlink OLC LED whenever the respective signal is active. The OLC LED will remain lit while output leveling is taking place. The Output Level Control (OLC) allows for output power limiting. A variable step attenuator gives 0 to 30 dB of attenuation in 2 dB steps. The use of these controls are covered in the “OPERATION” section, later in this document.

Voltage regulator U10 is used to create bias voltages from the 9 VDC source voltage supplied to the module through the ribbon cable. The power amplifier module is the source of the 9 VDC used by the front panel module. So a malfunction of regulator U11 on the power amplifier module will shut down the front panel module. There are two user adjustable rotary switches located on the front panel module, S1 for uplink and S2 for downlink. The rotary switch allows the user to adjust system gain for the uplink and downlink paths individually during the installation of the booster.

POWER ENTRY/SUPPLY

The booster is designed to operate between 80 and 240 VAC. **Figure 6** shows the block diagram for the Power Entry Module as well as the Power Supply. The power entry module has a dual pole switch for the incoming AC which is followed by a pair of inline fuses. When operating the booster at 110 VAC one fuse can be replaced by a jumper. Operation at 220 VAC will require both fuses to be used. RF interference is reduced by the EMI filtering. The power supply is a switching design that will operate at either 110 or 220 VAC and is programmed by jumpers. There is a green LED on the

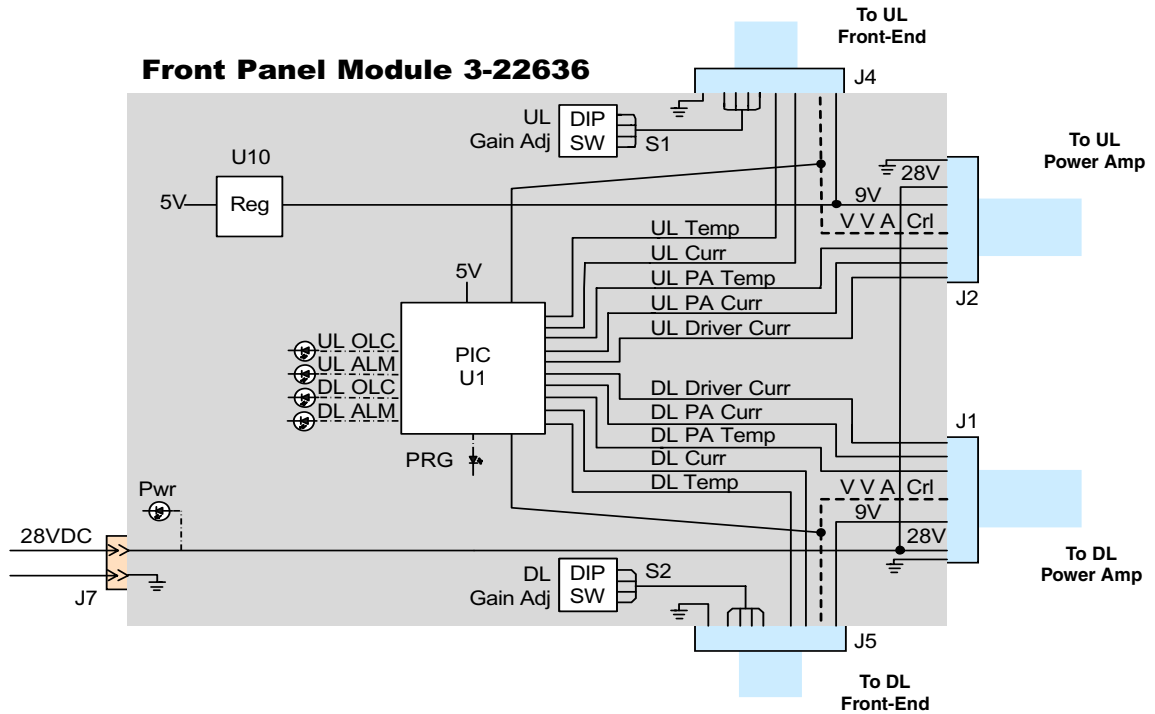


Figure 5: Front Panel Module block diagram.

supply which is illuminated whenever the supply is on. The output of the supply is 28 VDC which is applied to J7 on the front panel module.

CONNECTIONS

AC power is accepted through a standard 3-wire male plug (IEC-320) with phase, neutral and ground leads. The AC power is wired to a high efficiency DC switching power supply which is CE and

UL approved. The power supply runs all of the modules within the cabinet and the Power On LED on the front panel module. This LED provides an indication to the user that the system is powered. The metal enclosure of the signal booster is connected to ground.

RF connections are made via two type “N” female connectors. The RF connector labeled “Uplink Out

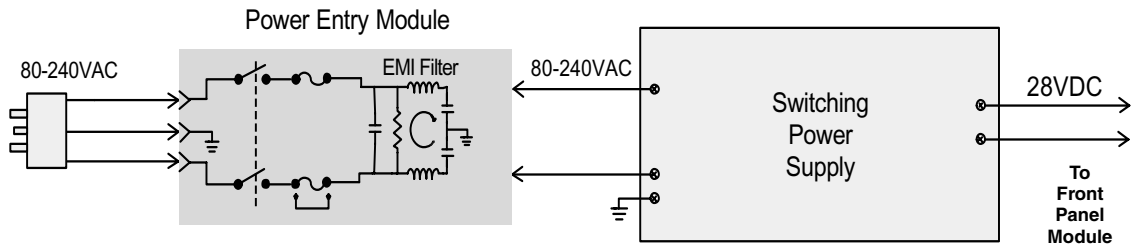


Figure 6: Power Entry / Supply.

“Uplink In / Downlink In” must be connected to the antenna pointing towards the base station. The RF connection labeled “Uplink In / Downlink Out” must be connected to the antenna facing the area to be covered by the signal booster. RF connections must be made through cables with characteristic impedance of 50 ohms.

Isolation between the two antennas should be at least 15 dB higher than the signal booster gain. Isolation less than this value can cause gain ripple across the band. Isolation equal to or less than the signal booster gain will give rise to oscillations which will saturate the amplifiers and possibly cause damage to the signal booster.

ALARMS CONDITIONS

The alarm circuit monitors the current and temperature of both the Uplink and Downlink amplifiers. An alarm condition will occur if either the Uplink or Downlink amplifiers are over or under their current tolerance. The respective front panel alarm LED will blink to indicate the alarm condition. An OLC over-range error which causes the booster to shut down for 10 minutes will be indicated by a continuously illuminated alarm LED.



An option is available for the booster that allows remote alarm sensing through a DB-9 connector which is added to the back of the unit in the lower right. Customers should connect their remote alarm sensing cables to this plug. Refer to **Figure 7**.

Normally Open, Common, and Normally Closed relay contacts are available at pins 1, 2, and 3 respectively of the DB9 connector. Refer to the pinout diagram in figure 7. In a Non-Alarm condition there will be continuity between the Normally Open and Common pins. During an Alarm condition continuity will switch to the Common and Normally Closed pins.

INSTALLATION

The following sub-sections of the manual discuss general considerations for installing the booster. All work should be performed by qualified personnel in accordance with local codes.

Location

The layout of the signal distribution system will be the prime factor in determining the mounting location of this unit. However safety and serviceability are also key considerations. The unit should be located where it can not be tampered with by the general public, yet is easily accessible to service personnel. Also, consider the weight of the unit and the possibility for injury if it should become detached from its mounting surface for any reason.

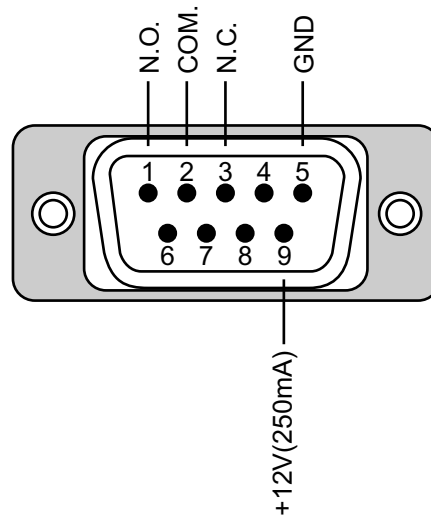


Figure 7: Remote alarm sensing connector.

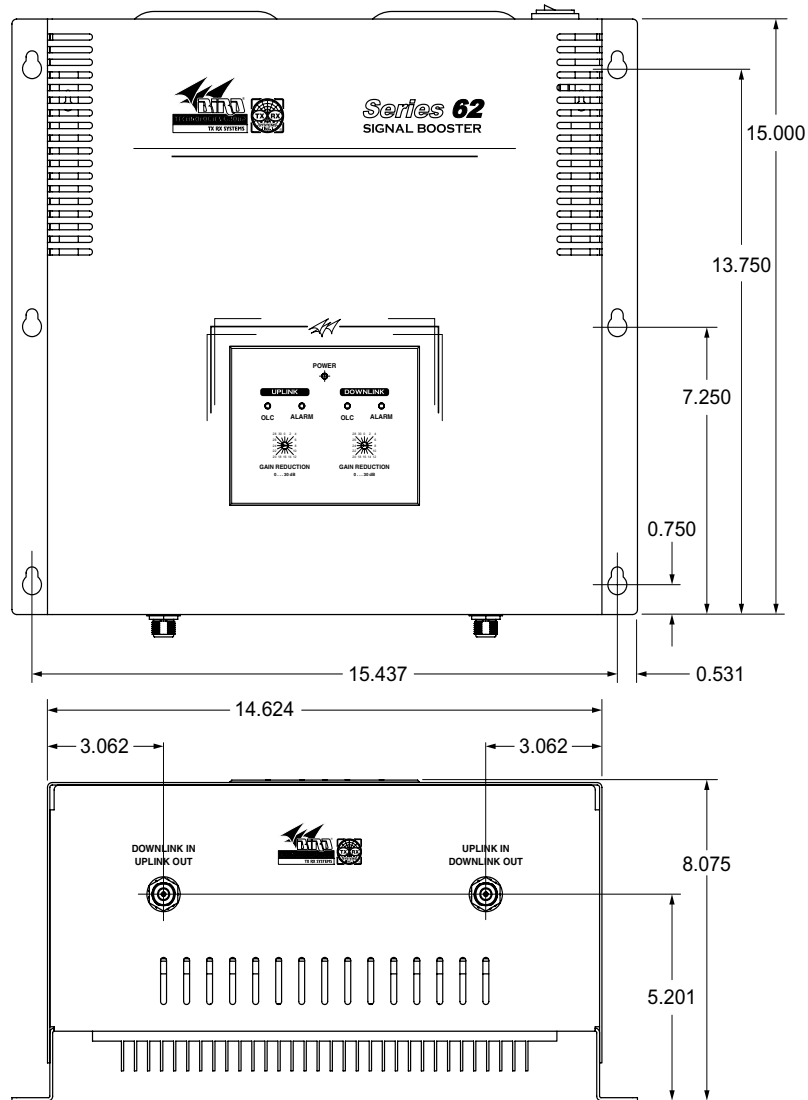


Figure 8: Mechanical dimensions.

The signal booster uses external heat sinks and needs to be mounted such that there can be unobstructed air flow over the heat sink fins. The cabinet will stay warm during normal operation so in the interest of equipment longevity, avoid locations that carry hot exhaust air or are continually hot.

Mounting

Figure 8 shows mounting hole dimensions and layout for the cabinet. Because TX RX Systems, Inc. cannot anticipate all the possible mounting locations and structure types where these devices

will be located, we recommend consulting local building inspectors, engineering consultants or architects for advice on how to properly mount objects of this type, size and weight in your particular situation. It is the customers responsibility to make sure these devices are mounted safely and in compliance with local building codes.

Antenna Isolation

Antenna isolation between uplink and downlink should be measured before connecting the signal booster to the antenna system. This step is neces-

sary to insure that no conditions exist that could possibly damage the signal booster and should not be skipped for even the most thoroughly designed system.

Just like the feedback squeal that can occur when the microphone and speaker get too close together in a public address system, a signal booster can start to self oscillate. This can occur when the isolation between the Uplink and Downlink antennas does not exceed the signal boosters gain by at least 15 dB. Oscillation will reduce the effectiveness of the system and may possibly damage amplifier stages. Isolation values are relatively easy to measure with a spectrum analyzer and signal generator.

REQUIRED EQUIPMENT

The following equipment is required in order to perform the antenna isolation measurements.

- 1) Signal generator for the frequencies of interest capable of a 0 dBm output level. Modulation is not necessary.
- 2) Spectrum analyzer that covers the frequencies of interest and is capable of observing signal levels down to -100 dBm or better.
- 3) Double shielded coaxial test cables made from RG142, RG55 or RG223 coaxial cable.

MEASUREMENT PROCEDURE

To measure the antenna isolation perform the following in a step-by-step fashion.

- 1) Set the signal generator for a 0 dBm output level at the center frequency of one of the boosters passbands.
- 2) Set the spectrum analyzer for the same center frequency and a sweep width equal to or just slightly greater than the passband chosen earlier in step 1.
- 3) Temporarily connect the test leads of the signal generator and spectrum analyzer together using a female barrel connector, see **Figure 9**. Observe the signal on the analyzer and adjust the input attenuator of the spectrum analyzer for a signal level that just reaches the 0 dBm level at the top of the graticule.
- 4) Referring to figure 9, connect the generator test lead to one side of the antenna system and the spectrum analyzer to the other then observe the signal level. The difference between this observed level and 0 dBm is the isolation between the sections. If the signal is too weak to observe, the spectrum analyzer's bandwidth may have to be narrowed and its input attenuation reduced. **The isolation value measured**

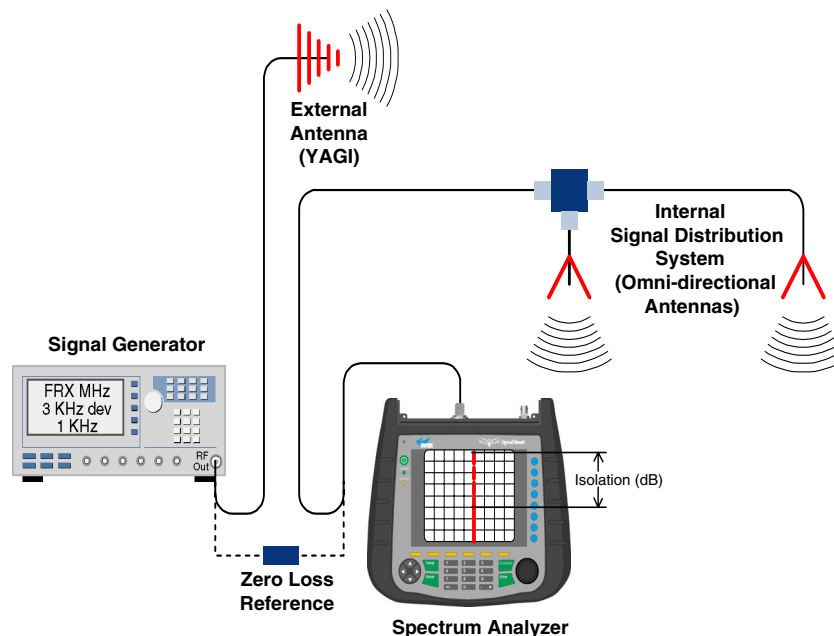


Figure 9: Typical test equipment interconnection for measuring antenna isolation.

should exceed the signal booster's gain figure by at least 15 dB.

- 5) Repeat step 4 again with the signal generator set to frequencies at the passbands edges in order to see if the isolation is remaining relatively constant over the complete width of the passband.
- 6) Repeat the isolation measurements at the other system passbands to determine the overall minimum isolation value for the system. Physical modification of the antenna system maybe required in order to reach an acceptable minimum value.

Installation Procedure

To install the signal booster perform the following in a step-by-step fashion.



CAUTION: DO NOT APPLY A.C. POWER TO THE SIGNAL BOOSTER UNTIL CABLES ARE CONNECTED TO BOTH PORTS OF THE SIGNAL BOOSTER AND THE ANTENNAS.

1. Mount the signal booster on the wall with the RF connectors pointing DOWN. Using appropriate screws and anchors, attach the signal booster to the wall at the six mounting holes on the side flanges. Refer to figure 8.
2. Ensure that the isolation between the donor antenna and the service antenna is at least 15 dB greater than the signal booster gain. (Use the higher of the Uplink and Downlink gains reported on the test data sheet).
3. Connect the cable from the donor antenna to the signal booster connector labeled "Uplink Out / Downlink In" and the cable from the service antennas to the signal booster connector labeled "Downlink Out / Uplink In".
4. Review the attenuator positions on the front of the signal booster and verify that both of the attenuator's are positioned to their maximum setting (30 dB).
5. Connect the AC power cord to the signal booster and then to the power source. Move the ON/OFF switch to the ON position and verify that the "Power ON" LED is illuminated.

Installation of the signal booster is now complete. To adjust the gain controls to suit the specific signal environment, refer to the next section of the manual.



For repeat installations of existing equipment, make sure the attenuation setting is positioned to its maximum setting (30 dB). After verification of the attenuation, follow the above steps starting with step 1.

OPERATION

Power is applied to the unit by turning ON the AC power switch located on the upper rear of the cabinet. The front panel Power Indicator LED should illuminate. Refer to **Figure 10** which is a view of the front panel.

Variable Step Attenuator

The signal booster gain can be reduced by up to 30 dB in 2 dB steps using the variable step attenuator. Gain adjustments are made with rotary switches on the front of the unit. The attenuators are labeled for Uplink and Downlink. Arrows on the shafts of these switches point to the value of attenuation selected. Gain can be determined by subtracting the attenuation value from the gain reported on the Test Data Sheet for that side of the unit. A small screwdriver should be used for making attenuator adjustments.

OLC (Output Level Control)

To minimize intermodulation products, each branch in the signal booster contains an OLC feedback loop. The OLC circuit senses the output power and limits it to a factory preset level on the Uplink and the Downlink.

Red indicator LEDs located on the front panel for both the uplink and downlink will illuminate when output power meets or exceeds the OLC factory preset level.

To establish proper operating gain on the Uplink and Downlink sides, start with the Downlink. Observe the downlink OLC indicator LED. Units are shipped with maximum attenuation. Decrease the downlink variable attenuator one step at a time until the downlink OLC lamp is lit. Then increase the step attenuation until the lamp goes off. Repeat the process for the Uplink. The OLC indicator LED is accurate to within +/- 0.4 dB of the OLC factory preset level.

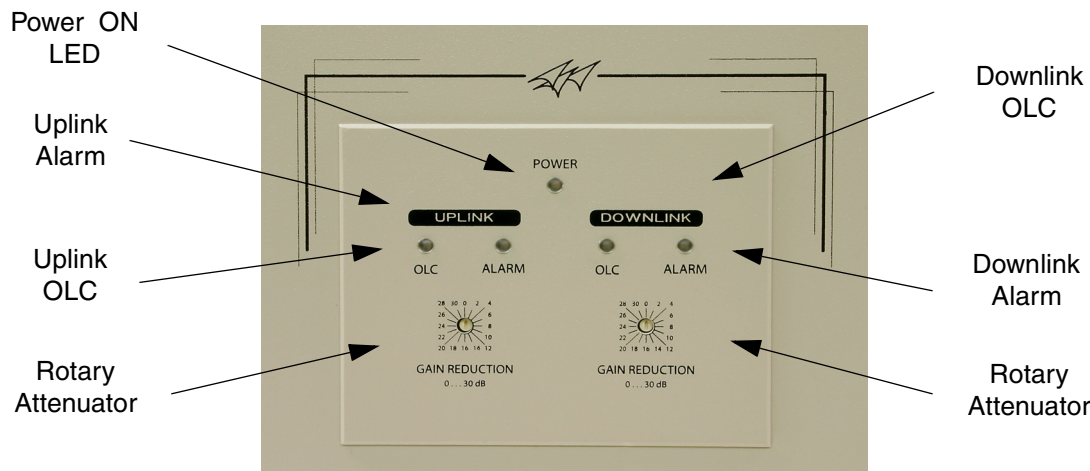


Figure 10: The Front Panel.



CAUTION: Operation of the signal booster at maximum gain with greater than -20 dBm average power incident on either of the RF Input connectors can cause damage to the signal booster.

RF EXPOSURE

In order to satisfy the FCC RF exposure requirements, the signal booster/antenna installation must comply with the following:

The outdoor antenna (Yagi type or similar directional antenna) must be installed so as to provide a minimum separation distance of 1.0 Meters (100 cm or 40 inches) between the antenna and persons within the area. (This assumes a typical antenna with gain of 10.1 dBi, VSWR < or = 1.5 : 1, Zo= 50 ohms, and a cable attenuation of between 1-10 dB).

The indoor antenna (omni directional) must be installed so as to provide a minimum separation distance of 0.4 Meters (40 cm or 16 inches) between the antenna and persons within the area. (This assumes a typical wide-beam type antenna with gain of 0-2 dBi, VSWR < or = 2 : 1, Zo= 50 ohms, and a cable attenuation of between 1-10 dB).

DIAGNOSTIC GUIDE

The signal booster provides long term, care-free operation and requires no periodic maintenance. There are no user-serviceable components inside the signal booster. This section covers possible problems that may be related to the installation or operating environment.

Gain Reduction

Possible causes: bad RF cables, bad RF connections to antennas or damaged antennas.

Excessive Intermodulation or Spurious

Possible causes: Amplifier oscillation caused by insufficient isolation. The isolation between two antennas is given by the equation:

$$\text{Isolation} = 92.5 + 20 \text{ Log} (F \times D) - G_t - G_r$$

F = frequency (GHz)

G_t = transmit antenna gain (in the direction of the receive antenna)

D = separation (Km)

G_r = receive antenna gain (in the direction of the transmit antenna)

For example, at the SMR frequencies, the antenna isolation at 100 m separation is about 71 dB for omni-directional antennas (0 dB gain). To increase isolation, the antennas should have higher directivity and must be pointed away from each other.

Occasional Drop-out of Some Channels

Possible causes: One channel with very strong power dominates the RF output of the amplifier.

Optional Sampler Ports

An option is available for the booster that brings the -50 db sampler ports on the power amplifier assembly out to the side panel near the RF connectors. This option provides a convenience for technicians installing or servicing the signal booster.

Return Loss vs. VSWR

Return Loss	VSWR
30	1.06
25	1.11
20	1.20
19	1.25
18	1.28
17	1.33
16	1.37
15	1.43
14	1.50
13	1.57
12	1.67
11	1.78
10	1.92
9	2.10

Watts to dBm

Watts	dBm
300	54.8
250	54.0
200	53.0
150	51.8
100	50.0
75	48.8
50	47.0
25	44.0
20	43.0
15	41.8
10	40.0
5	37.0
4	36.0
3	34.8
2	33.0
1	30.0

dBm = 10log P/1mW
Where P = power (Watt)

Insertion Loss

Input Power (Watts)

	50	75	100	125	150	200	250	300	
Insertion Loss	3	25	38	50	63	75	100	125	150
	2.5	28	42	56	70	84	112	141	169
	2	32	47	63	79	95	126	158	189
	1.5	35	53	71	88	106	142	177	212
	1	40	60	79	99	119	159	199	238
	.5	45	67	89	111	134	178	223	267

Output Power (Watts)

Free Space Loss

Distance (miles)

	.25	.50	.75	1	2	5	10	15	
Frequency (MHz)	150	68	74	78	80	86	94	100	104
	220	71	77	81	83	89	97	103	107
	460	78	84	87	90	96	104	110	113
	860	83	89	93	95	101	109	115	119
	940	84	90	94	96	102	110	116	120
	1920	90	96	100	102	108	116	122	126

Free Space Loss (dB)

Free space loss = 36.6 + 20log D + 20log F
Where D = distance in miles and F = frequency in MHz

