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Installation and Operation Manual for the Two-Way Signal Booster System Model Number 61-88-50

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TX RX Systems Inc. reserves the right to replace with merchandise of equal performance although not identical in every way to that originally sold.
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Disclaimer

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

Symbols

Commonly Used


WARNING


CAUTION or ATTENTION


High Voltage


Use Safety Glasses


ESD Electrostatic Discharge


Hot Surface


Electrical Shock Hazard

Important Information

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

— Reorient or relocate the receiving antenna.

— Increase the separation between the equip- ment and receiver.

— Connect the equipment into an outlet on a circuit different from that to which the re- ceiver is connected.

— Consult the dealer or an experienced radio! TV technician for help.

WARNING

Changes or modifications not expressly approved by TX RX System Inc. could void the user's authority to operate the equipment.

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.

WARNING

To satisfy FCC RF exposure requirements for transmitting devices, a separation distance of 1.0 Meters or more should be maintained between the UPLINK antenna of this device and persons during device operation. To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 0.3 Meters or more should be maintained between the DOWNLINK antenna of this device and persons during device operation. To ensure compliance, operations at closer than these distances is not recommended.

The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

Antenna System Installation

The antenna or signal distribution system consists of two branches. An uplink branch typically uses an outdoor mounted, unidirectional gain antenna such as a yagi and a downlink signal radiating system consisting of a network of zero-gain whip antennas or lengths of radiating cable usually mounted inside of the structure.

Even though the antenna system may not be supplied or installed by TX RX Systems. The following points need to be observed because both the safety of the user and proper system performance depend on them.

1) Antenna system installation should only be performed by qualified technical personnel.

2) The following instructions for your safety describe antenna installation guidelines based on FCC Maximum RF Exposure Compliance requirements.

3) The uplink antenna is usually mounted outside and exchanges signals with the repeater base station or donor site. It is typically mounted permanently-attached to the building wall or roof. The gain of this antenna should NOT exceed 10 dB. Only qualified personnel should have access to the antenna and under normal operating conditions, no one should be able to touch or approach it within 1 meter (40 inches).

4) The downlink or in-building signal distribution system is connected to the downlink booster port using coaxial cable. The distribution system may use radiating coaxial cable or a network 1/4 wave whip antennas whose gain does not exceed 0 dB for any radiator. These antennas should be installed so that the user cannot approach any closer than 0.3 meters (12 inches) from the antenna.

Table of Contents

General Description **1**
Unpacking **1**
Installation **1**
Location 1
Mounting 3
Connections **5**
AC Line 5
Backup DC Power 5
Alarm Terminals (Form-C Contacts) 5
RF Connections 6
Pre-RF Connection Testing **6**
Test Equipment 6
Antenna Isolation 6
Procedure 6
Increase isolation or decrease gain? 7
Normal Operation **7**
LED Status Indicators 8
Front Panel LED's 8
Module LED's 8
OLC Light Bars 8
Front Panel Controls & the LCD Display 8
LCD Display Screen 8
Configuration Settings 10
Restore Original Configuration 10
Calibrate Currents 10
Set Gain 10
Set Output Level 10
Detailed Status Screens 10
Amplifiers 10
Power Supply 11
OLC 11
OLC Datalog 11
Alarms 11
LED Indicators 11
Form-C contacts 12
Performance Survey **12**
Maintenance and Repair **13**
Power Amplifier Replacement 13
Module Replacement 15
Display/User Interface Replacement 15
Power Supply Replacement 16
Filter Replacement 17
Card Cage Replacement 17
Recommended Spares **17**

Figures and Tables

Figure 1	Cabinet mounting hole layout	3
Figure 2	Front internal cabinet view	4
Figure 3	AC power entry	5
Figure 4	Measuring antenna isolation	7
Figure 5	Boot-up display	7
Figure 6	Operational status display	8
Figure 7	Menu System	9
Figure 8	Measuring Booster Gain	12
Figure 9	Performance Survey	13
Figure 10	Removing the Power Amplifier (1 of 3)	14
Figure 11	Removing the Power Amplifier (2 of 3)	14
Figure 12	Removing the Power Amplifier (3 of 3)	15
Figure 13	Disconnecting Display/User Interface	16
Table 1	Part Number Designations	1
Table 2	Model 61-88-50 Part Family	2
	Specifications	18
	Block Diagram High Gain (1 of 4)	19
	Block Diagram Med Gain (2 of 4)	20
	Block Diagram Low Gain (3 of 4)	21
	Block Diagram (4 of 4)	22
	Celcius to Farenheit Conversions	23

GENERAL DESCRIPTION

Signal boosters extend radio coverage into areas where abrupt propagation losses prevent reliable communication. No frequency translation (conversion) occurs with this device. Signal Booster II (SB II) is available in a variety of configurations as shown in **Table 1**. The product model number is used to describe each configuration available. This manual details the installation and operation of the 61-88-50 series of boosters. The complete product family for the 61-88-50 boosters are listed in **Table 2**.

The system can be ordered in one of three maximum gain configurations including High Gain (+80 dB gain max), Medium Gain (+60 dB gain max), and Low Gain (+45 dB max gain). The maximum gain of the system is determined by the exact type of cards plugged into the low and mid level slots as shown in the block diagrams at the back of this manual. The maximum gain of the uplink or downlink branch is adjustable and can be setup independently. In addition, the gain of each branch can be reduced up to 30 dB in 0.5 dB increments via software interface.

The bandwidth of the system is determined by the passband of the input/output filtering. Available bandwidths are shoen in Table 1.

Three cabinet styles are available. The G1 suffix denotes a NEMA-4 style cabinet which is suitable for indoor or outdoor use. The G2 suffix denotes a stainless steel NEMA-4X style cabinet suitable for corrosive environments such as salt air and the RM suffix a rack mount version which is intended for indoor mounting only.

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 external heatsink fins. Use caution because the heatsink fins can have somewhat sharp corners. Signal Booster II (SB II) weighs about 85 lbs. so use enough people when lifting the unit.

INSTALLATION

The following sections discuss general considerations for installing the booster. All work should be performed by qualified personal in accordance with local codes.

Location

The layout of the signal distribution system will be the prime factor in determining the mounting location of Signal Booster II. However, safety and serviceability are also key considerations. The unit should be located where it cannot 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 the unit should become detached from its mounting surfaces for any reason.

61 - 88 - 50 - A06 - G1

FAMILY	FREQUENCY BAND	MODEL	MAXIMUM GAIN	BANDWIDTH	ENCLOSURE TYPE
61 = 2 Way	88 = 896 - 902 935 - 941	50 = Signal Booster II	A = 80 dB B = 60 dB C = 45 dB	05 = 6 MHz	G1 = Painted, NEMA 4 G2 = Stainless NEMA4X

Table 1: Part number designations for 61-88-50 booster family.

Part Mumber	Relative Gain	Uplink/Dowlink (MHz)	Guardband (MHz)	Enclosure
61-88-50-A06-G1	High	896-902 / 935-941	33	NEMA 4
61-88-50-B06-G1	Mid	896-902 / 935-941	33	NEMA 4
61-88-50-C06-G1	Low	896-902 / 935-941	33	NEMA 4
61-88-50-A06-G2	High	896-902 / 935-941	33	NEMA 4X
61-88-50-B06-G2	Mid	896-902 / 935-941	33	NEMA 4X
61-88-50-C06-G2	Low	896-902 / 935-941	33	NEMA 4X

Table 2: SB II 61-88-50- part family.

Although signal boosters can operate for years without being attended to, the unit will need to be accessed by service personnel with troubleshooting equipment, such as digital multimeters and spectrum analyzer or a laptop computer from time to time. The location of the power source will also have a bearing on the mounting location. SB II uses external heat sinks and needs to be mounted where there can be an unobstructed air flow over the heat sinks fins. The SB II 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 1 shows mounting hole dimensions and layout for the cabinet. Mount the cabinet using 3/8" (10 mm) diameter steel bolts (not supplied). We recommend flat washers on both ends and a lock washer under the nut. Nut and bolt mounting is preferred to the use of lag bolts. Use backer blocks where necessary to spread the force over a larger surface area. In areas of known seismic activity, additional devices such as tether lines may be necessary.

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 customer's responsibility to make sure these devices are mounted safely and in compliance with local building codes.

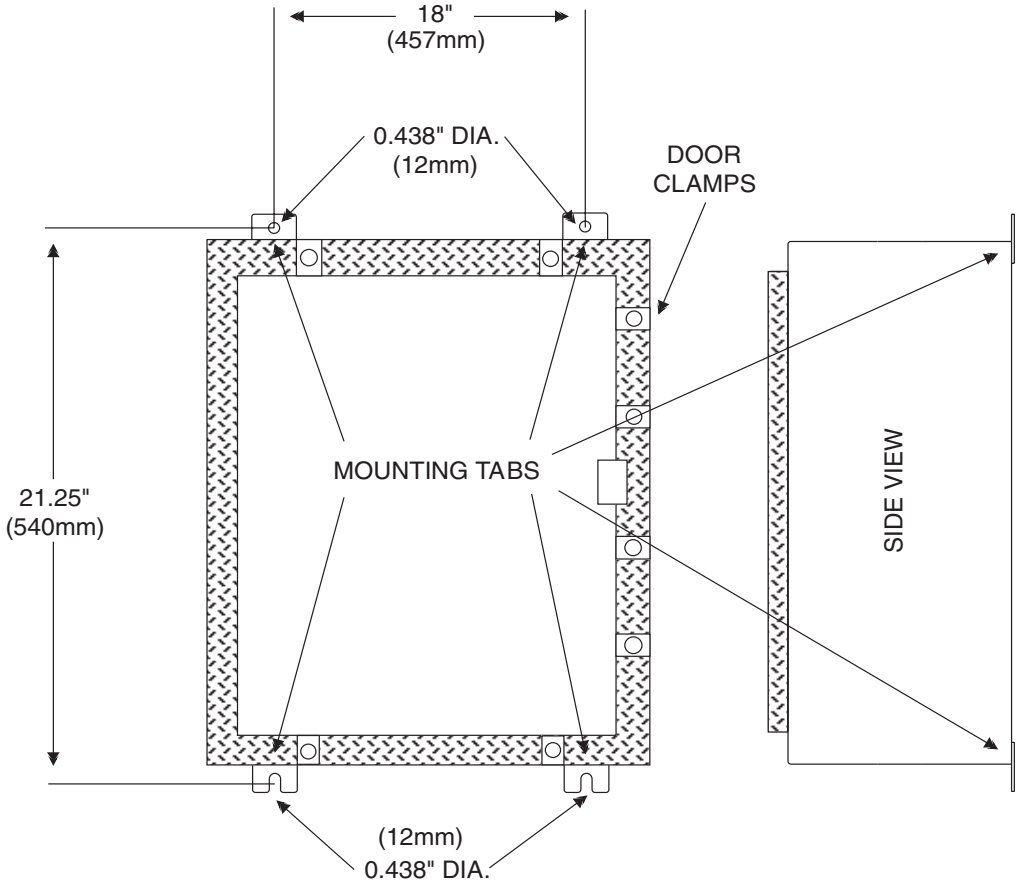

Figure 1: SB II cabinet mounting hole layout.

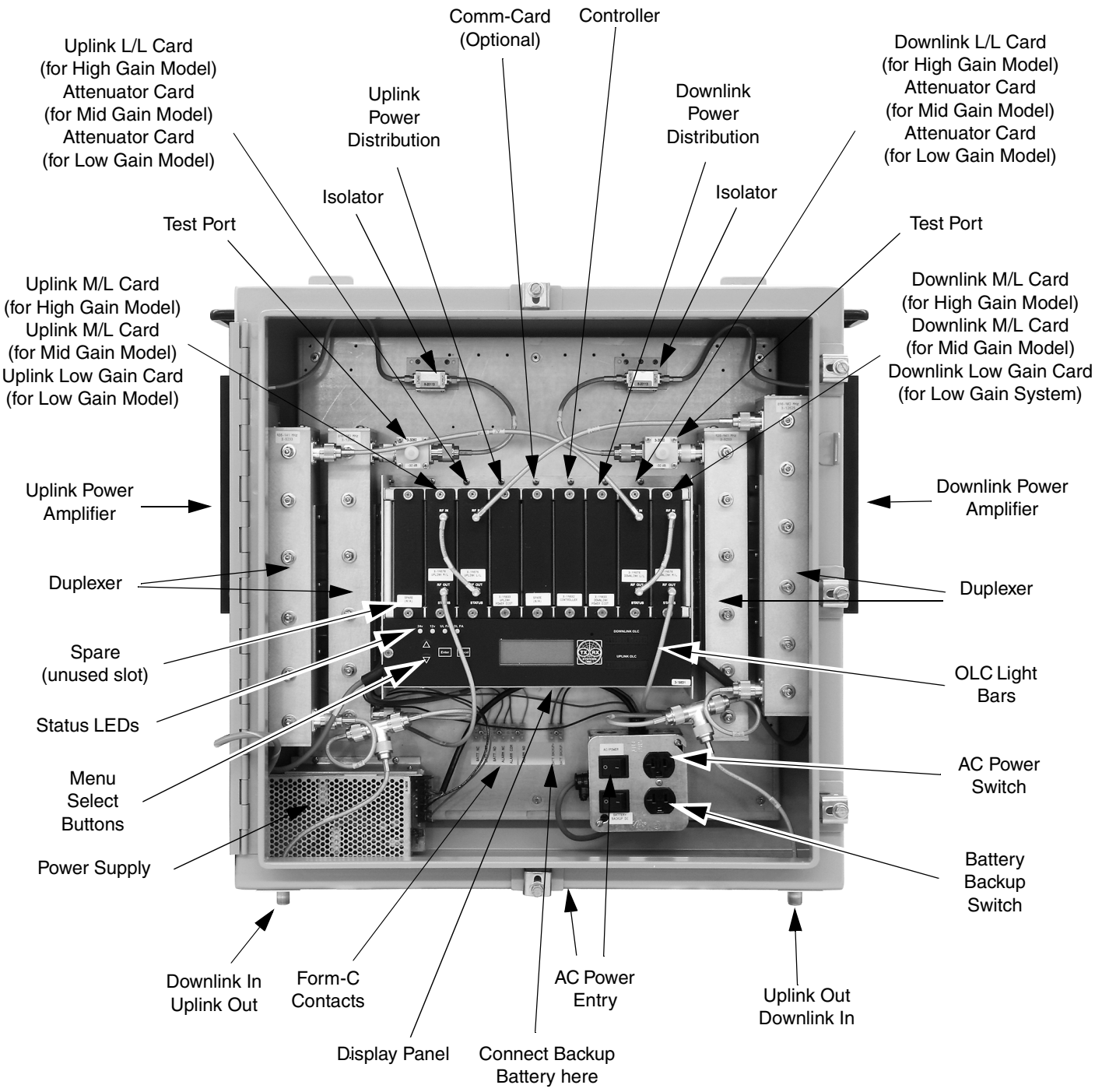

Figure 2: Front view of SB II. Model 61-88-50 two-way signal booster shown as an example.

CONNECTIONS

All cabling connections to the booster should be made and checked for correctness prior to powering up the system.

AC Line

Signal Booster II is designed to be hard-wired to 110 single phase AC lines at 50 - 60 Hz (see **Figures 2 and 3**). A junction box is provided for this purpose. There is a hole provided in the cabinet bottom-wall for bringing in the AC line. The entry box contains a standard two-receptacle AC outlet that serves as a junction for the incoming line and also provides a convenient AC outlet for running test equipment. See figure 3 below. Use conduit for running the wiring into SB II and #14 gauge or larger conductors.

Backup DC Power

SB II may be run on a DC power source that can supply 24 to 30 volts DC at 2.5 amps. Screw terminals are provided for this purpose (see figure 2). This line should be equipped with a fast-acting 3 Amp fuse. Use #16 or #18 gauge wire for this connection.

The power system in SB II automatically switches to this backup DC input when the AC supply fails for any reason including a power outage or intentional disconnection.

It is not necessary that this connection be made for normal operation on the AC line.

Alarm Terminals (Form-C contacts)

Two sets of contacts are provided to monitor the general operating condition of SB II and are intended for connection to a supervisory system. See figure 2.

One set changes state when the AC power supply shuts down for any reason and the unit switches to operation on the backup DC power system.

The other set of contacts changes state when any of a number of fault conditions arises within the electronics such as current drain outside of the expected operating range in some module.
A six-terminal strip is provided for the interface and uses screw terminals for ease of connection. Route the alarm wires through one of the access holes in the bottom of the box, strip about 3/16” of insula-

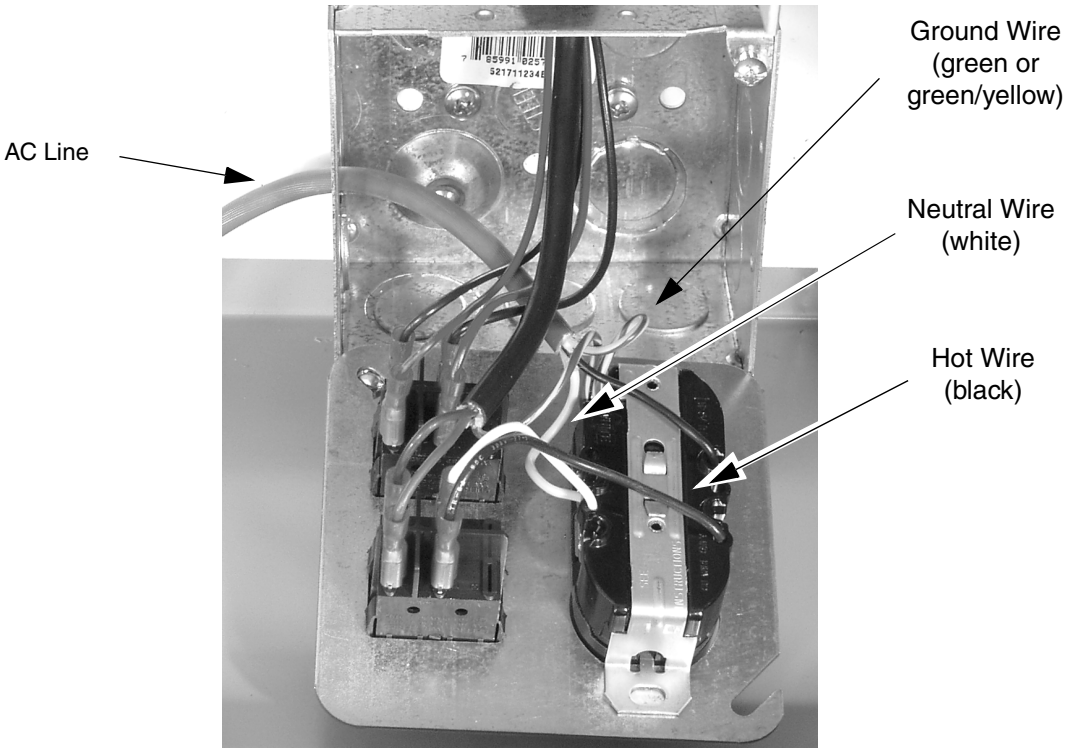

Figure 3: Wiring of AC line entry.

tion from each end, loosen the screw terminal, insert and retighten. Use #20 or #22 gauge insulated wire.

Use of these terminals is optional. SB II also has a number of status LEDs built-in to individual modules to indicate a fault condition.

RF Connections
N(F) bulkhead connectors are provided on the bottom of the cabinet for connection to the signal distribution system. Be sure that the correct branch of the distribution system is connected to its corresponding Uplink/Downlink connector or the system will not work properly. Using high-quality connectors with gold center pins is advised. Flexible jumper cables made of high-quality coax are also acceptable for connecting to rigid cable sections.

PRE-RF CONNECTION TESTS

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

Test Equipment
The following equipment is required in order to perform the pre-installation 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.

Antenna Isolation
Just like the feedback squeal that can occur when the microphone and speaker get too close to each other in a public address system, a signal booster can start to self oscillate. This can occur when the isolation between the input antenna or signal source and the output distribution system does not exceed the signal boosters gain by at least 15 dB. Oscillation will reduce the effectiveness of the system and may possibly damage the power amplifier stages.

In general, if one or both antenna ports are connected to sections of radiating coaxial cable (lossy cable) the isolation will be more than adequate because of the high coupling loss values that are encountered with this type of cable. When a network of antennas are used for the input and output, this problem is much more likely. Isolation values are relatively easy to measure with a spectrum analyzer and signal generator.

Procedure for Measuring Antenna Isolation

1) Set the signal generator for a 0 dBm output level at the center frequency of one of the signal boosters passbands (815 or 860 MHz)

2) Set the spectrum analyzer for the same center frequency and a sweep width equal to or just slightly greater than the passband (18 MHz) chosen in step one.

3) Connect the test leads of the signal generator and the spectrum analyzer together using a female barrel connector, see **Figure 4**. 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 4, connect the generator test lead to one side of the signal distribution system (external antenna) and the spectrum analyzer lead to the other (internal distribution system) and 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. Record the isolation value. **The isolation value measured should exceed the signal boosters gain figure by at least 15 dB.**

It is wise to repeat the procedure listed above for measuring antenna isolation 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.

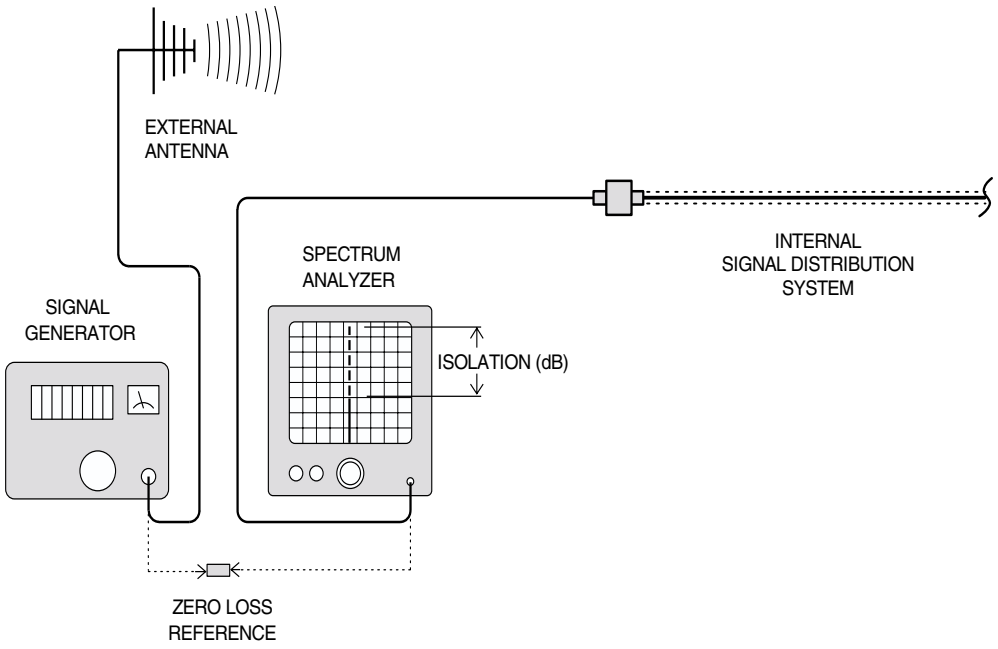

Figure 4: Typical test equipment interconnection for measuring antenna isolation.

Increase Isolation or decrease gain?

Modification of the signal distribution system is required to increase isolation between the up and downlink path. This will require significant changes that may or may not be practical from a cost or logistical standpoint. Gain reduction may be the only alternative but this is easy to achieve with Signal Booster II. Gain for both the uplink and downlink path can be set from 50 to 80 dB. Here are the steps to follow.

1) Subtract 15 dB from the measured isolation between uplink and downlink branches of the antenna/signal distribution system. This is the maximum usable gain level for both the uplink and downlink path.

2) Accessing the user menu through the front panel, set the gain of the uplink path to the level determined in step 1. A detailed explanation of how to negotiate the menu system is given on page 9.

3) Repeat step 2 for the downlink path.

NORMAL OPERATION

Power is applied to the signal booster by turning on the AC power switch located on the junction box inside the cabinet, refer to figure 2. The following startup sequence occurs.

1) At turn-on, the four status LEDs on the front panel glow red for about 5 seconds as the result of entering a self-check mode.

2) The two green OLC light bars will be fully lit along their length for approximately 5 seconds.

3) The LCD display shows the firmware revision screen for about 5 seconds (see **Figure 5**).

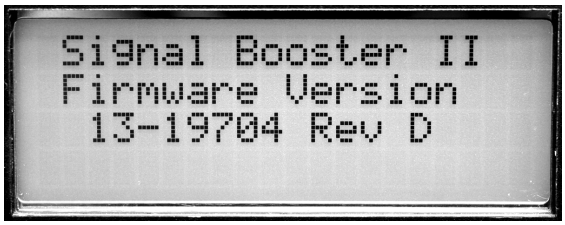

Figure 5: Software version is displayed briefly during the boot-up sequence.

4) After the self check is complete, the four status lights should turn green and the light bars should be dark unless a signal is activating OLC action in either the uplink or downlink.

WARNING

If the OLC light-bar segments on both the Uplink and Downlink display light-up and pulse on and off every 1 to 3 seconds simultaneously, **SHUT OFF THE POWER IMMEDIATELY!** The booster may be oscillating. Disconnect the uplink and downlink antenna connections and measure the isolation between the two branches to insure there is sufficient isolation. Reset the booster gain as needed.

5) The LCD display should appear similar to **Figure 6** after the self check is complete.

LED Status indicators
The SB II front panel has 4 status LEDs that glow

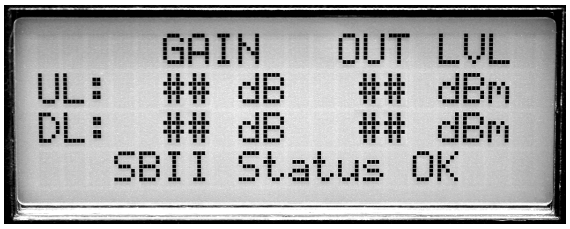

Figure 6: Normal Operational LCD Display.

green or red to indicate the general health of 4 subsystems from a DC perspective. Additionally, the plug-in, Low-Level and Mid-Level amplifier cards have tri-color (green-orange-red) status LEDs visible when the cabinet door is open.

FRONT PANEL LEDS:

24V: Green indicates the 24 volt DC Power system is operating properly.

12V: Green indicates the 12 volt DC power system is operating properly.

UL PA: Green indicates that the uplink power amplifier is drawing current within the expected operating range and at a safe temperature.
DL PA: Green indicates that the downlink power amplifier is drawing current within the expected operating range and at a safe temperature.

Module LEDS:

Mid-Level, Low-Level, Low Gain Module: Green indicates current or device temperature within the expected operating range. Orange indicates current or temperature slightly out of the expected range but the overall booster operation may still appear normal. Red indicates a large departure from normal current or device temperature and booster operation is likely to be affected. See page 9 for more details about alarm operation.

Attenuator Module: Green only indicating Dc power is applied to the card.

OLC LIGHT BARS
Ideally, there should be little or no light bar activity. Each light bar segment represents an average 3 dB of OLC gain reduction. OLC (output level control) is meant to reduce gain for transient episodes of very strong signals. However, when OLC is active, gain is reduced for all signals being processed by that booster branch and that reduction may compromise communications for weaker signals in the booster's passband.

If more than 2 or 3 light-bar segments are lit up more than occasionally, it is advised that the gain of that branch be reduced. See the SET GAIN paragraph on page 10 for details.

Front Panel Controls & the LCD Display
SB II is software directed so control of the system is accomplished via user interface with the control panel using the LCD display screen and the menu select buttons, see figure 2. A flow chart showing all of the possible user menu selections is shown in **Figure 7**.

LCD Screen
Once the boot-up sequence is completed (after several seconds) the LCD screen will switch to the main status display as shown in figure 6. This is the normal display for the signal booster. The system will return to this display from any other display if none of the menu interface buttons are pressed within 2 minutes. The exception is the OLC status

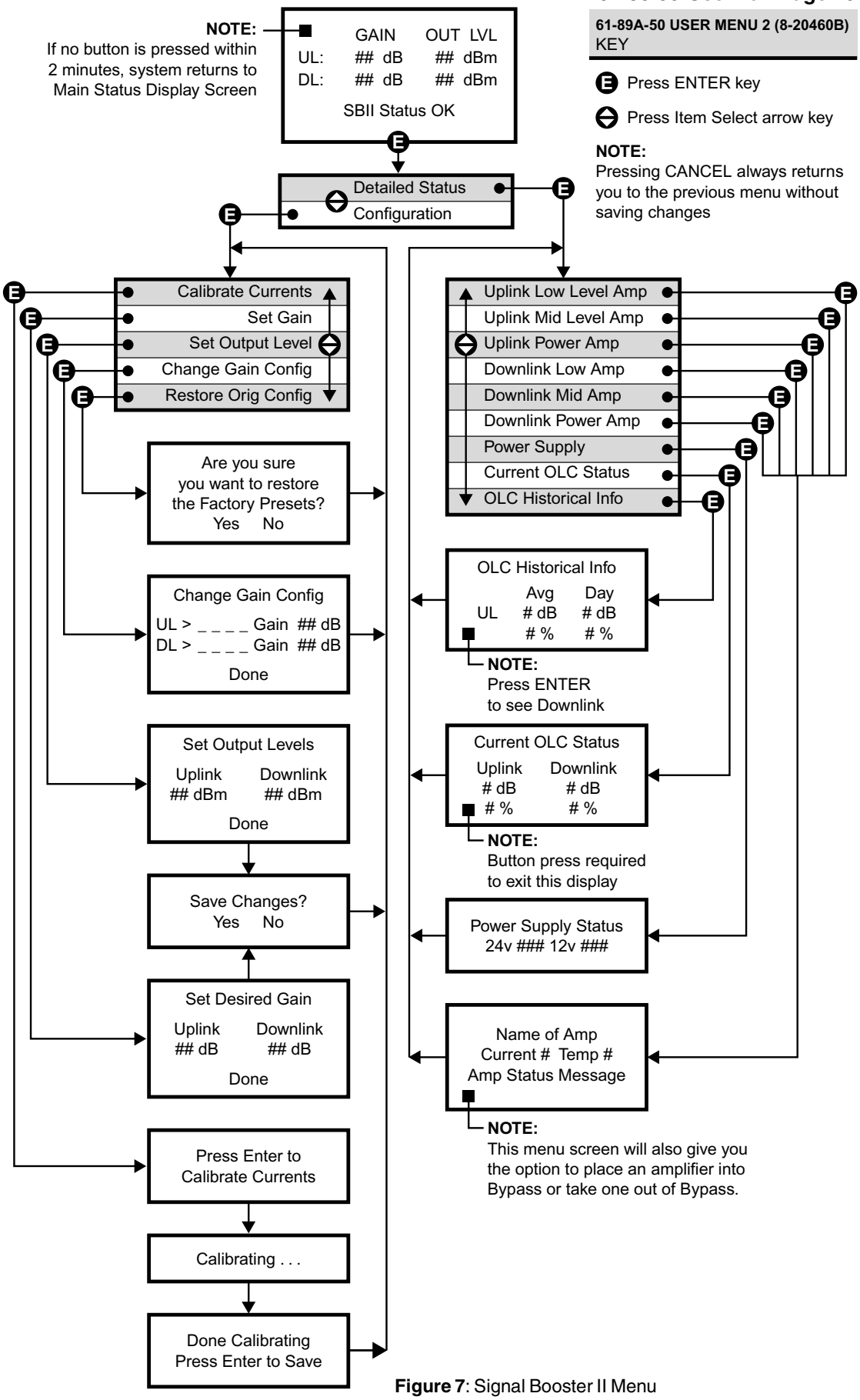

Figure 7: Signal Booster II Menu