RF Measurement and Management in Your World

Installation and Operation Manual for Channelized Signal Booster Model 611-70

Manual Part Number

7-9469

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Warranty

This warranty applies for one year from shipping date.

TX RX Systems Inc. warrants its products to be free from defect in material and workmanship at the time of shipment. Our obligation under warranty is limited to replacement or repair, at our option, of any such products that shall have been defective at the time of manufacture. **TX RX Systems Inc.** reserves the right to replace with merchandise of equal performance although not identical in every way to that originally sold. **TX RX Systems Inc.** is not liable for damage caused by lightning or other natural disasters. No product will be accepted for repair or replacement without our prior written approval. The purchaser must prepay all shipping charges on returned products. **TX RX Systems Inc.** shall in no event be liable for consequential damages, installation costs or expense of any nature resulting from the purchase or use of products, whether or not they are used in accordance with instructions. This warranty is in lieu of all other warranties, either expressed or implied, including any implied warranty or merchantability of fitness. No representative is authorized to assume for **TX RX Systems Inc.** any other liability or warranty than set forth above in connection with our products or services.

TERMS AND CONDITIONS OF SALE

PRICES AND TERMS:
Prices are FOB seller's plant in Angola, NY domestic packaging only, and are subject to change without notice. Federal, State and local sales or excise taxes are not included in prices. When Net 30 terms are applicable, payment is due within 30 days of invoice date. All orders are subject to a $100.00 net minimum.

QUOTATIONS:
Only written quotations are valid.

ACCEPTANCE OF ORDERS:
Acceptance of orders is valid only when so acknowledged in writing by the seller.

SHIPPING:
Unless otherwise agreed at the time the order is placed, seller reserves the right to make partial shipments for which payment shall be made in accordance with seller's stated terms. Shipments are made with transportation charges collect unless otherwise specified by the buyer. Seller's best judgement will be used in routing, except that buyer's routing is used where practicable. The seller is not responsible for selection of most economical or timeliest routing.

CLAIMS:
All claims for damage or loss in transit must be made promptly by the buyer against the carrier. All claims for shortages must be made within 30 days after date of shipment of material from the seller's plant.

SPECIFICATION CHANGES OR MODIFICATIONS:
All designs and specifications of seller's products are subject to change without notice provided the changes or modifications do not affect performance.

RETURN MATERIAL:
Product or material may be returned for credit only after written authorization from the seller, as to which seller shall have sole discretion. In the event of such authorization, credit given shall not exceed 80 percent of the original purchase. In no case will Seller authorize return of material more than 90 days after shipment from Seller's plant. Credit for returned material is issued by the Seller only to the original purchaser.

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Cancellation or alteration of acknowledged orders by the buyer will be accepted only on terms that protect the seller against loss.

NON WARRANTY REPAIRS AND RETURN WORK:
Consult seller's plant for pricing. Buyer must prepay all transportation charges to seller's plant. Standard shipping policy set forth above shall apply with respect to return shipment from TX RX Systems Inc. to buyer.

DISCLAIMER

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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First Printing: March 2009

Version Number	Version Date
1	03/30/09
1.1	06/10/09

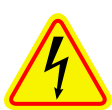
Symbols Commonly Used

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 resonable 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.

Table of Contents

Figures and Tables

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

Sales Support at 716-549-4700 extension 5043

Customer Service at 716-549-4700 extension 5044

Technical Publications at 716-549-4700 extension 5019

OVERVIEW

Signal boosters extend radio coverage into areas where abrupt propagation losses prevent reliable communication. The system receives an RF signal, raises its power level, and couples it to an antenna so that it can be re-radiated. The input signal may be derived from a receiving antenna or a long run of radiating coax.

The TXRX model 611-70 channelized signal booster is designed to operate in the 450 to 470 MHz range. The system is based on a module design with each module capable of handling one uplink and one downlink channel simultaneously. The size of the system can be tailored to the customers needs by increasing or decreasing the number of modules used. Each module is bi-directional with one downlink and one uplink signal branch. Each of the two branches in a module are independently tunable to their required pass frequency via software interface.

The systems part number is used to describe the configuration of the product. The first three digits are always 611 and describe the channelized signal booster product group. The second group of two digits describe the frequency range (450 to 470 MHz). The next two digit group describes the number of channel modules while the last letter describes the mounting method used (the letter “A” represents rack mounted). Specifications for the 611-70 family of channelized signal boosters are listed in **Table1**.

Frequency Range	450 - 470 MHz
Number of Carriers per Channel	1 Uplink 1 Downlink
Nominal Passband Gain	120 dB
Channel Bandwidth	Standard 25 KHz; can be programmed to meet group delay requirements (User Selectable)
Output Power per Channel	+ 37 dBm ERP
Maximum Input Level	-40 dBm
RF In/Out Impedance	50 Ohms
Alarms	Form-C Contacts Module LED’s
Power	90 - 250 VAC, 50/60 Hz or 28 VDC (+/- 5%)
Operating Temperature Range	-30°C to +60°C

Table 1: Specifications

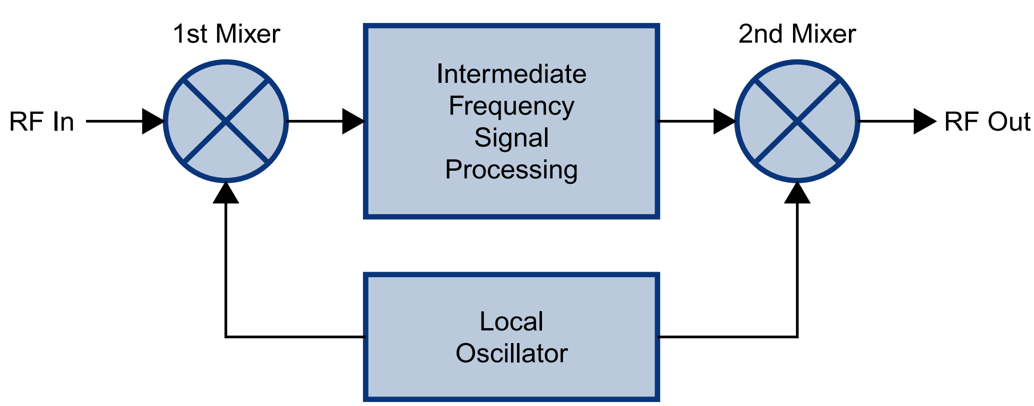


Figure 1: The down converter / up converter process.

Down / Up Conversion

A channelized signal booster has much in common with a superheterodyne (superhet) receiver. The incoming signal is converted to a lower frequency so that single channel selectivity can be obtained. It is then filtered. Unlike the superhet receiver however, the signal is not demodulated. Instead, it is up-converted back to its original frequency where it is further amplified to reach a useful power level.

Figure 1 shows a simplified block diagram that illustrates the down/up conversion principle. An incoming signal at (Freq IN) is applied to the first mixer along with a signal from a local oscillator (Freq LO). A third signal at an intermediate frequency (Freq IF) is produced as a result of the mixing. The intermediate frequency is given by the following relationship:

(1) Freq IF = Freq IN - Freq LO

The IF signal from the mixer then passes through filtering with single channel bandwidth before being amplified and passed on to the second mixer. The second mixer also receives the same local oscillator signal (Freq LO). The result is a mixing product frequency at the output of mixer 2. The output frequency (Freq OUT) is given by the following relationship:

(2) Freq OUT = Freq IF + Freq LO

Substituting equation (1) for the “Freq IF” term in equation (2) allows the “Freq LO” terms to be canceled yielding:

(3) Freq Out = Freq IN

The implication of equation (3) is that the frequency stability of the signal that is processed by this type of signal booster is not affected by the frequency stability of the signal booster itself. Frequency stability depends only on the stability of the signal source producing the signal to be boosted. A shift in the LO frequency of the signal booster will only cause a shift in the IF frequency with a possible loss of signal amplitude but no change in the output signal frequency.

UNPACKING

It is important to report any visible damage to the carrier immediately. It is the customers responsibility to file damage claims with the carrier within a short period of time (1 to 5 days). Care should be taken when removing the unit from the packing box to avoid damage to the unit.

INSTALLATION

The following sub-sections of the manual discuss general considerations for installing the booster. All work should be performed by qualified personnel and 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 for any reason.

The booster needs to be installed such that there can be unobstructed air flow over and around the subassemblies. The various subassemblies will stay warm to the touch during normal operation so in the interest of equipment longevity, avoid locations that carry hot exhaust air or are continually hot.

Antenna Isolation

Antenna isolation between uplink and downlink 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.

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.

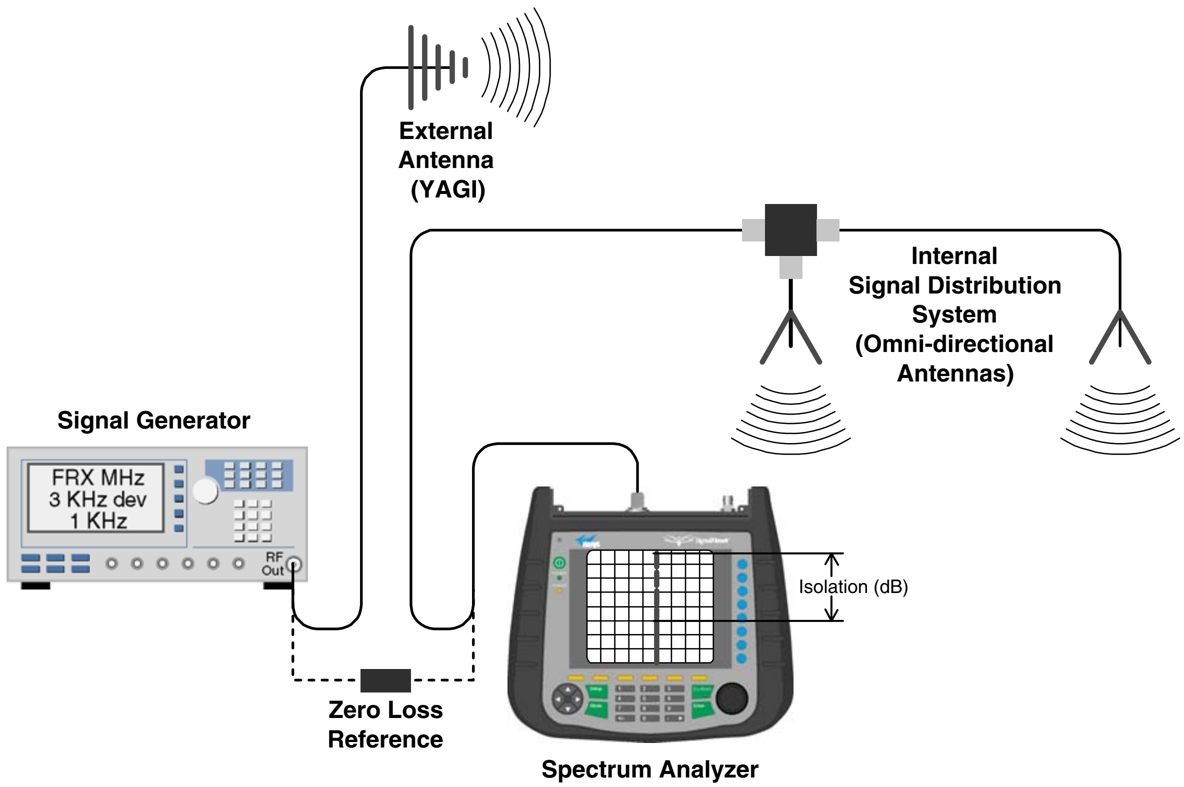


Figure 2: Typical test equipment interconnection for measuring antenna isolation.

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 the boosters passband.

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 2**. 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 2, 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 the 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 it's input attenuation reduced. The isolation value measured should exceed the signal booster's gain figure by at least 15 dB.

5) Repeat step 4 again with the signal generator set at the passband edges in order to see if the

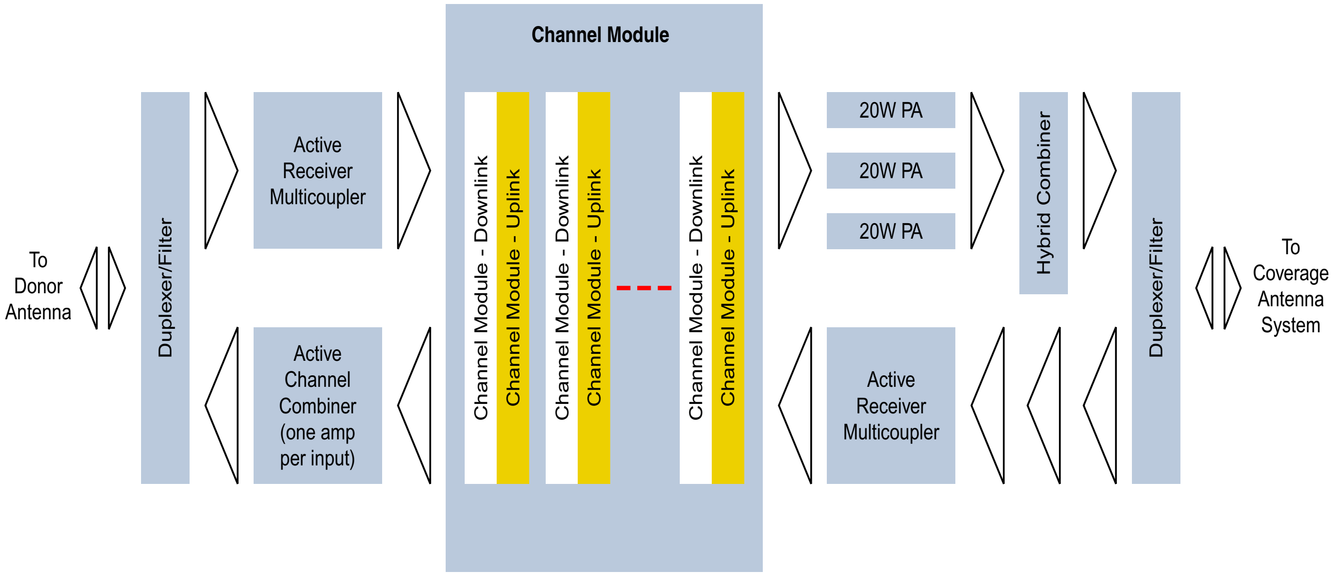


Figure 3: Functional block diagram of the channelized signal booster.

isolation is remaining relatively constant over the complete width of the passband.

6) Repeat the isolation measurements if necessary at 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.

FUNCTIONAL BLOCK DIAGRAM DISCUSSION

Figure 3 is the functional block diagram of the channelized signal booster model 611-70. **Figure 4A and 4B** show the front and rear views of the module housing.

Downlink / Uplink Input Signals

Downlink and Uplink input signals are applied to a distribution amplifier 3-22340. This is an ultra-low noise high linearity amplifier with a gain of 18.9 dB. Refer to schematic 3-22341. Following the distribution amp is a 6-way power divider which is used to distribute the signal to individual channel modules. Downlink signals are applied to the down converter board of a downlink branch while uplink signals are applied to the down converter board of an uplink branch. Any unused output ports of the 6-Way should be terminated with a 50 ohm load. Signal processing within the channel module is discussed in the Channel module section below.

Downlink / Uplink Output Signals

Downlink signals leave the channel module at the DL OUT connector and are applied to a power amplifier 8-22290 which has a typical gain of 35 dB. After amplification, signals from multiple modules are combined by a Hybrid Combiner 3-18317-1 and fed into combline filtering before being applied to an antenna. Uplink output signals leave the channel module at the UL OUT connector and are applied to an active combiner 3-22319. The active combiner amplifies and combines signals from multiple modules. Following the active combiner is combline filtering.

Channel Module 3-22322

The channel modules are bi-directional with each module containing one downlink branch and one uplink branch. The branches are functionally identical because the same set of circuit boards are used in each branch. The uplink and downlink branches can work on different frequencies within the modules passband (450 to 470 MHz) but for either branch the input and output signals will be the same frequency. **Figure 5** is the block diagram of the channel module.

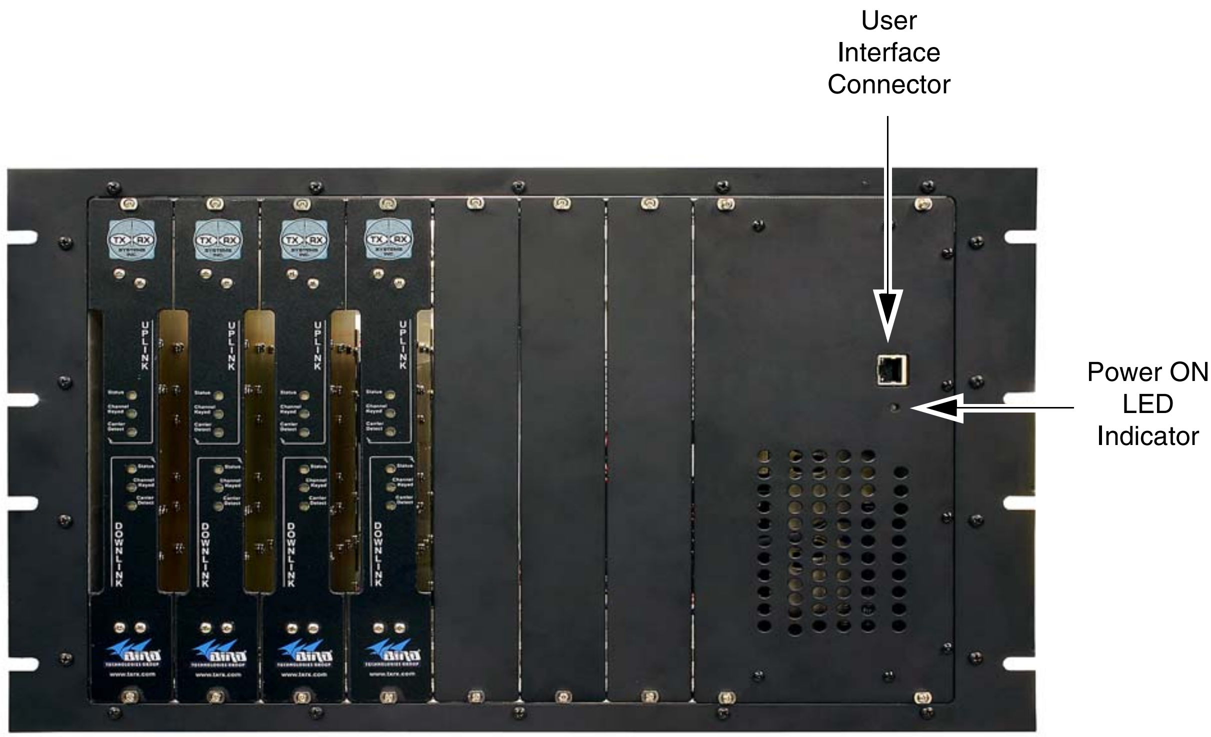


Figure 4A: Module housing front view.

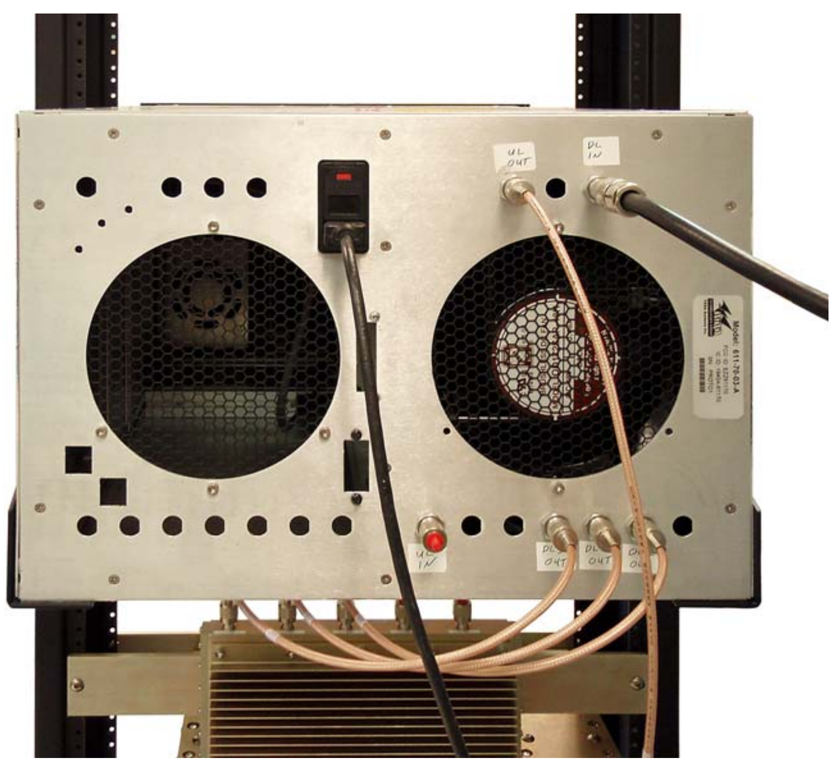


Figure 4B: Module housing rear view.

Each branch consists of four boards; Digital, Local Oscillator, Down Converter, and Up Converter. RF signals enter the branch at the down converter board where they are filtered, amplified, and converted into a 70 MHz intermediate frequency. The digital board digitizes the IF signal with an ADC. The digitized samples are applied to a programmable gated array for digital filtering. The filtered signals from the array are converted back into analog by a DAC and output to the up converter board. The up converter board converts the IF back into the original UHF signal and outputs it from the module. The Local Oscillator board generates the reference signals for mixing and sampling. The mixing frequency can range from 380 to 400 MHz and is determined by the user via interface with the micro controller on the digital board.

OPERATION

Power is applied to the unit by plugging in the AC power cord. There is a Power-ON LED located on the front of the unit (near the computer interface connector) which will illuminate when power is applied.

Module LED's

There are six LED indicators on the front of each channel module, 3 for the uplink branch and 3 for the downlink branch. The function of indicator LED's are listed in **Table 2**.

RF EXPOSURE

To comply with FCC RF exposure compliance requirements, a separation distance of at least 100 cm must be maintained between the antenna of this device and all persons. This device must not be co-located or operating in conjunction with any other antenna or transmitter.

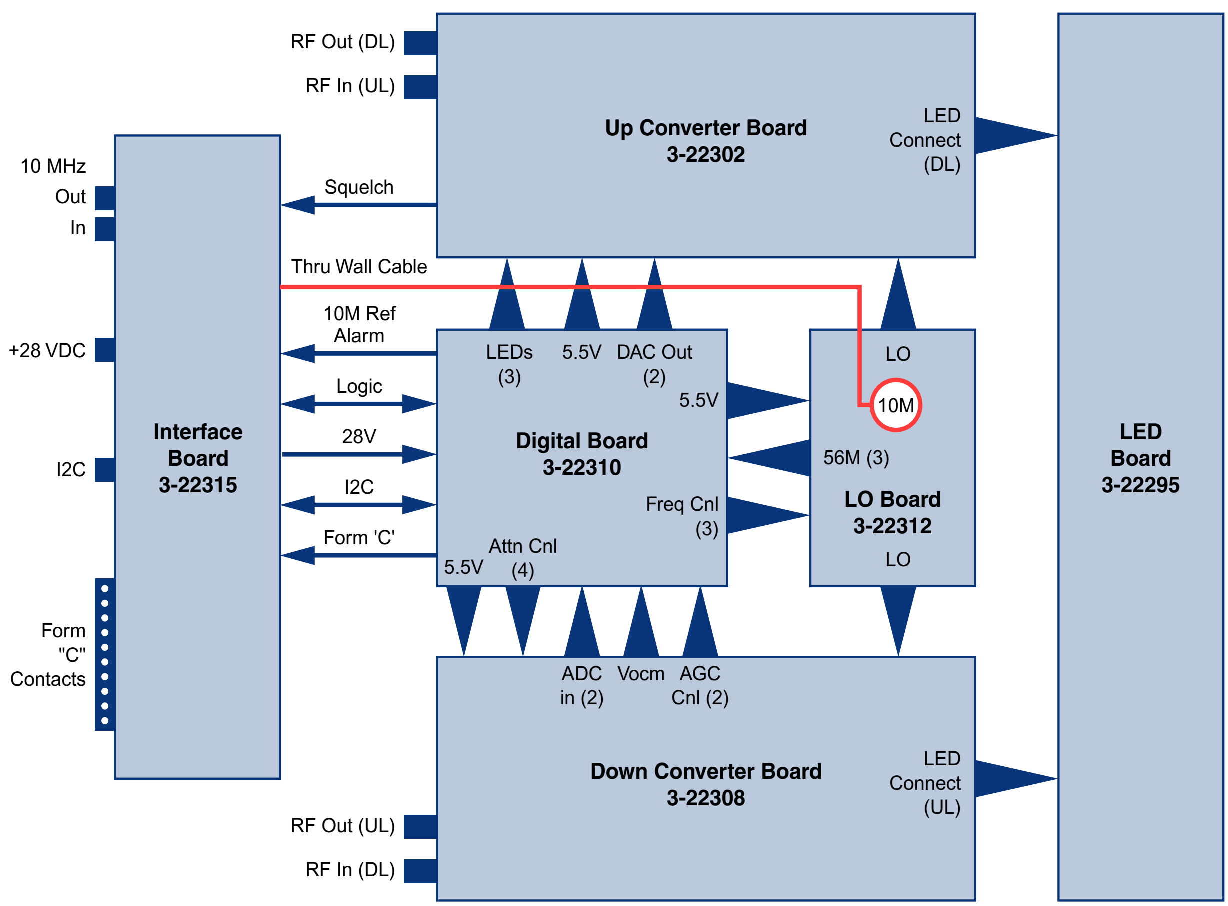


Figure 5: Channel Module block diagram.

Status LED	
Green (flashing fast)	Unit Identification (for several seconds only on command from User Interface)
Orange (slow flash)	Unprogrammed unit (no settings set)
Off	Unit disabled (no output from module)
Red (slow flash)	External reference selected but is absent or not locked
Red (solid ON)	Alarm of some kind (current or temp out of limits, LO not locked, filter not set)
Green (solid ON)	all is OK
Channel Keyed	
Slow Flash	Unprogrammed unit (no settings set)
ON	Unit will transmit signal if CTCSS and DCS disabled then signal present on input above carrier squelch threshold Else if one is enabled then it means that the selected CTCSS or DCS code has been detected
OFF	Unit will not transmit signal
Carrier Detect	
Slow Flash	Unprogrammed Unit (no settings set)
ON	Signal present on input above carrier squelch threshold
OFF	No signal present on input above carrier squelch threshold

Table 2: Channel Module Indicator LED's

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