nected to pin 4. Relay K1 is de-energized when the AC power supply is off.

PERFORMANCE SURVEY

It is a good idea to document the performance of the system after installation so that a reference exists for future comparisons. This information can make troubleshooting an interference problem or investigation of a complaint about system performance much easier. If there are coverage problems with a system, this survey will usually reveal them allowing corrective measures to be taken before the system is put into routine use. The following is an outline of how to do such a survey. Because the nature of each installation can be quite different, only a broad outline is given.

1) Measure the gain of the signal booster being careful not to exceed the maximum input level. **Figure 9** shows this being done using a signal generator and spectrum analyzer. This is basically a substitution measurement. Record the measured values for each passband.

2) Each branch of the signal booster system is equipped with a -50 dB signal sampler port following the final output amp (part of the OLC assembly). This port is for the connection of test equipment such as a spectrum analyzer and will allow the observation of the amplifier output at a considerably reduced output level. This decoupling figure needs to be added to a measured signal value in order to arrive at the actual signal level. OLC assemblies appear in schematic representation on the specification drawings.

3) With a spectrum analyzer connected to the signal sampler port for the branch under test (see **Figure 10**), have personnel with handheld radios move to predetermined points and key their radios. Record the level of these signals as observed on the analyzer and also record the location of the person transmitting. In this way, a map of the systems performance can be generated.

4) For branches that amplify signals coming from a fixed antenna or station, record the level of all the desired incoming signals for future reference.

FIELD ADJUSTMENTS

The following information is provided in support of field support activities, including routine maintenance, repairs, adjustments and tuning. It is

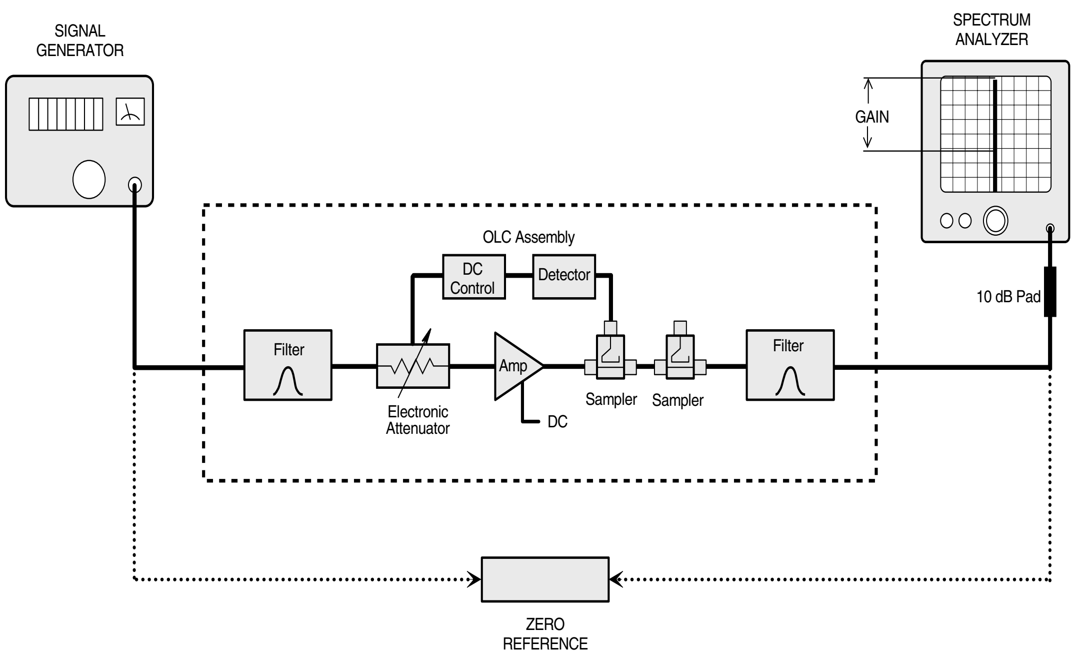

Figure 9: Test equipment interconnection for measuring signal booster gain.

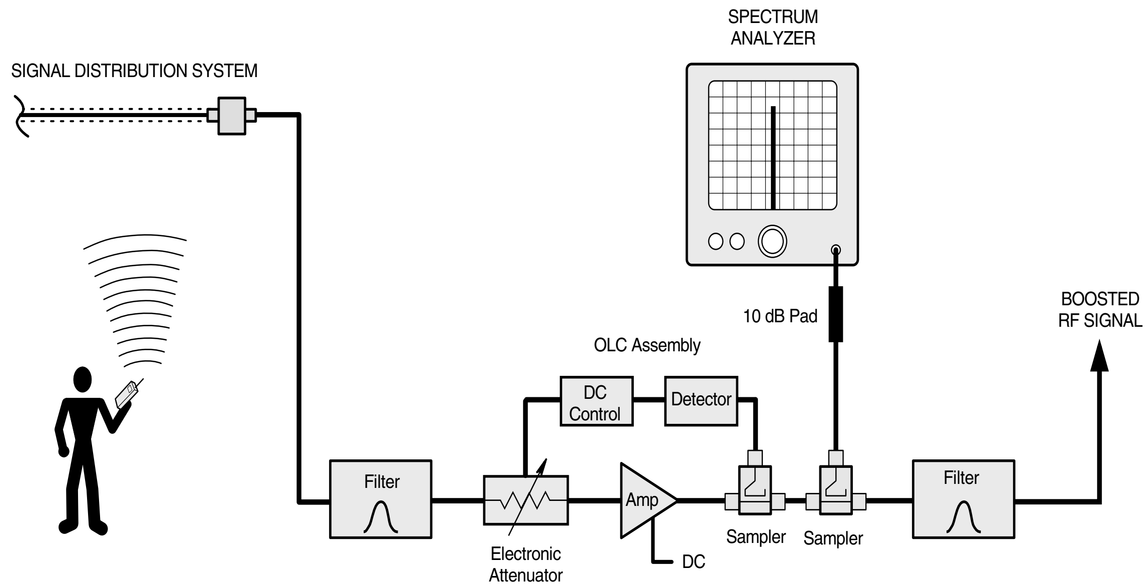

Figure 10: Test equipment interconnection for surveying performance.

assumed that the procedures will be carried out by a qualified electronics technician observing all standard safety practices.

Filter Tuning

Filters used in TX RX Systems' signal boosters are passive devices of rugged electrical and mechanical design. They are tuned at the factory for the original design requirements and require no adjustment or maintenance. These devices will stay properly tuned unless they have been physically damaged or are tampered with. Filter tuning falls into two categories; retuning to the original frequency such as when a filter is being repaired or replaced, or tuning to new frequencies.

A number of points need to be considered before attempting to tune a signal booster to frequencies different from the original.

1) The Frequency Range Specification for the 61-38-05 signal booster family does not mean that an individual signal booster is field tunable over the entire indicated frequency range. This specification only indicates the frequency range for which the 61-38-05 components are intended. Many of the filter assemblies used in a particular booster maintain reasonable performance over a range that is within ± 2% of the original frequency. For greater changes in frequency, the performance of the filters may degrade severely. Therefore some filters may need to be replaced or modified when large frequency changes are made.

2) In a bidirectional system, will the new inbound and outbound channels have the same frequency separation from each other as the original ones? Frequency separation in bidirectional designs is one of the prime design criteria. If the frequency separation decreases from the original, the filters will provide less isolation so the gain may also have to be reduced to prevent the signal booster from oscillating. Increases in frequency separation are more easily accommodated.

3) If the bandwidth requirement increases, the bandpass filters may not pass all of the new frequencies. In most cases, the bandwidth of the bandpass filters cannot be changed by the customer.

4) The amplifier assemblies may have to be retuned.

5) The length sensitive interconnect cables may need to be changed.

If you are not sure about tuning the signal booster system to new frequencies then contact your TX RX Systems, Inc. representative. Our knowledgeable engineering and sales staff are happy to discuss what it will take to tune your system to the new frequencies.

Helical Preselectors

The helical preselectors are composed of four cascaded individual helical cavities. The cavities are interconnected with critical length cables to synthesize a shaped response. This filter assembly can not be tuned by tuning the individual cavities, the assembly must be tuned as a whole. The bandwidth of the filter is determined by the critical alignment of internal "reactive" components. Bandwidth is therefore fixed by construction in this type of filter The helical preselectors are pretuned at the factory for a specific bandwidth and no attempt should be made to adjust the bandwidth.

REQUIRED EQUIPMENT

A two channel network analyzer that simultaneously displays both transmission and reflection is best for properly tuning a preselector. A single channel tracking generator / spectrum analyzer combination may be adequate but insure that it is accurate enough to verify factory specifications. A return loss bridge would also be required when using a tracking generator / spectrum analyzer. Skill and experience are also needed and the personnel doing the work should be thoroughly familiar with the test equipment.

TUNING PROCEDURE

The following is an outline of the general procedure.

1) Connect test equipment as shown in **Figure 11**.

2) Set the analyzer to the desired center frequency and desired bandwidth.

3) Loosen the tuning rod locking nuts.

4) If the preselector is severely out of tune, set the analyzer for 10 dB/div vertical scale and alternately adjust the tuning rods in pairs working from the center to the end rods for maximum signal at the center frequency. Start with the center rods and then move to the outer rods.

5) Repeat step 4 tuning to maximize the signal at the center frequency. The response should start to take on the desired shape and symmetry. Setup the analyzer for 2 dB/div and then re-adjust the rods in the same fashion. Make sure that the response is relatively symmetrical. Fine adjust the tuning rods as necessary to adjust symmetry.

6) When using the spectrum analyzer/tracking generator, the equipment must be connected as shown in **Figure 12** in order to check the return loss curve. The network analyzer will show the return loss curve as a matter of course.

7) Lock all tuning rods after the desired response is obtained. Note that a slight dissymmetry in

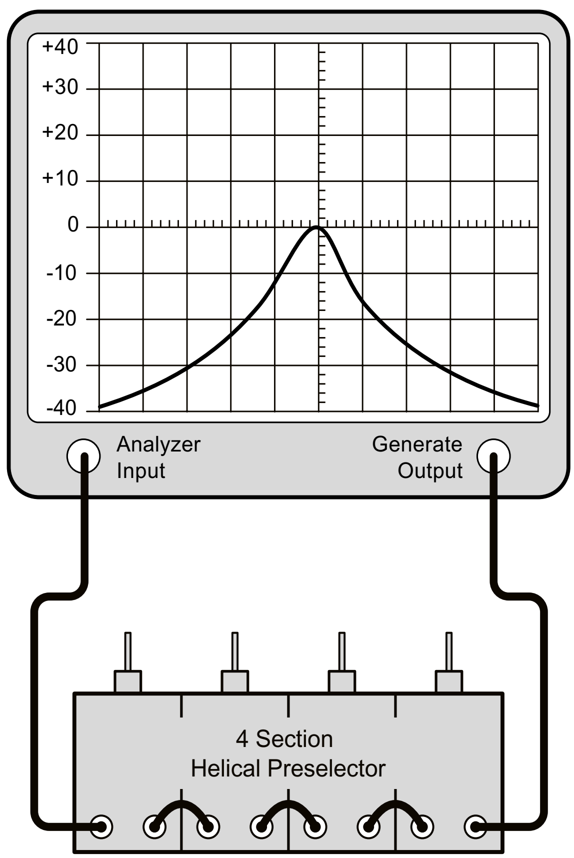

Figure 11: Preselector tuning.

either the transmission or reflection response may be unavoidable.

Bandpass Filters
The bandpass filters pass one narrow band of frequencies (the passband) and attenuate all others with increasing attenuation above and below the pass frequencies. The insertion loss setting determines the filters selectivity and maximum power handling capability. Insertion loss is set at the factory.

Cavity tuning follows a two step process. First the cavity is temporarily disconnected from the system and rough tuned, this will ensure the response curve is very close to it's ideal. Next the cavity is reconnected to the system and fine tuned. This is done in large systems such as the model 61-38-05 in order to eliminate any slight distortions which could result from interactions with other cavities.

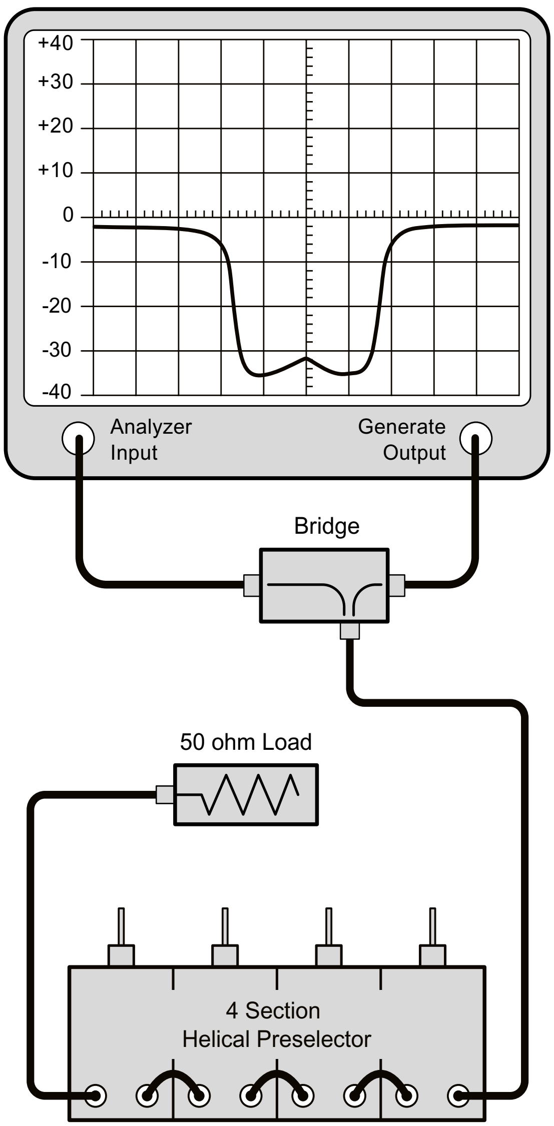

Figure 12: Observing preselector return loss.

The *pass frequency* is the only field adjustable parameter found in the individual Bandpass resonant cavity filters. Adjustment of the tuning rod on these filters will allow the passband to be centered at the desired frequency. The insertion loss of each cavity is not field adjustable.

REQUIRED EQUIPMENT
Due to the sensitivity of the adjustments, it is strongly recommended that the proper equipment be used when tuning the individual filters, otherwise the filter should be sent to the factory or an authorized representative for retuning. The following equipment or it's equivalent is recommended in order to properly perform the tuning adjustments.

1. IFR A-7550 spectrum analyzer with optional tracking generator installed.

2. 7/16" wrench.

3. Double shielded coaxial cable test leads (RG142 B/U or RG223/U).

4. Female union (UG29-N or UG914-BNC).

TUNING PROCEDURE
The following is an outline of the general procedure.

1. Turn off the system power and disconnect the cables that are attached to the cavity.

2. Setup the analyzer / generator for the desired frequency and bandwidth (center of display) and also a vertical scale of 2 dB/div. Set the sweep width of the display to 100 KHz.

4. A zero reference must first be established at the IFR A-7550 before making measurements. This is accomplished by temporarily placing a "female union" between the generator output and the analyzer input.

5. The flat line across the screen is the generator's output with no attenuation, this value will become our reference value by selecting the

"MODE" main menu item and choosing the "STORE" command. This will store the flat-line value in the analyzer's internal memory.

6. Next select the "DISPLAY" main menu item and choose the "REFERENCE" command. This will cause the stored value to be displayed on the screen as the 0 dB reference value.

7. The resonant frequency of the filter is checked by connecting the tracking generator to the input of the cavity filter assembly while the spectrum analyzer is connected to the output, as shown in **Figure 13**.

8. Insure the IFR A-7550 menu's are set as follows:

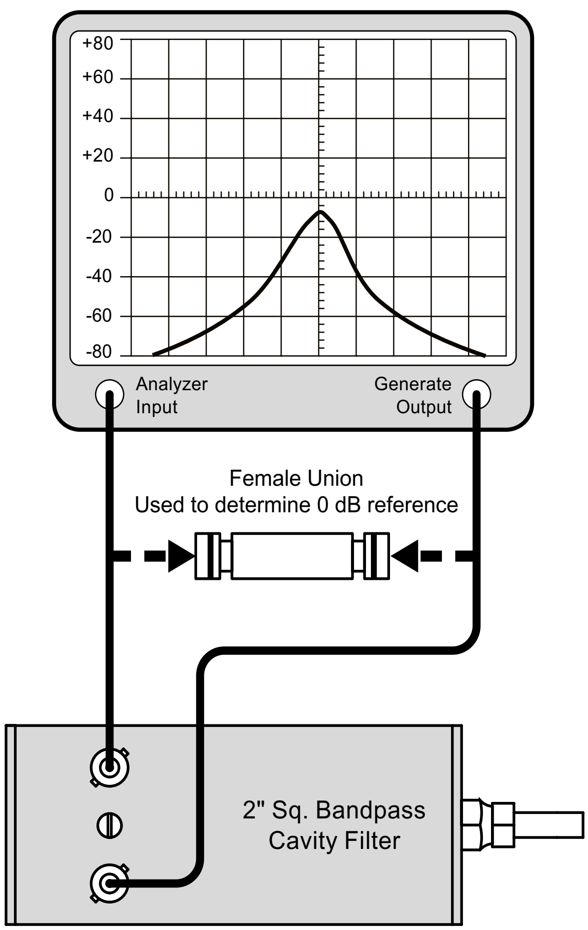

Figure 13: Bandpass filter tuning.

DISPLAY - line
MODE - live
FILTER - none
SETUP - 50 ohm/dBm/gen1.

9. Adjust the pass frequency by setting the peak (minimum loss value) of the response curve to the desired frequency (should be the center-vertical graticule line on the IFR A-7550's display). The resonant frequency is adjusted by adjusting the tuning rod, which is a sliding adjustment (invar rod) that rapidly tunes the filter's response curve.

Pseudo-Bandpass Filters

The pseudo-bandpass filter passes a relatively narrow band of frequencies and rejects (notches out) a relatively wide frequency band. These cavity filters are two inch square, helical type resonators that include a tunable notching section, refer to **Figure 14**. These filters are pretuned and require no adjustment unless they have been damaged and repaired or tampered with in some way. They are passive devices that require no maintenance.

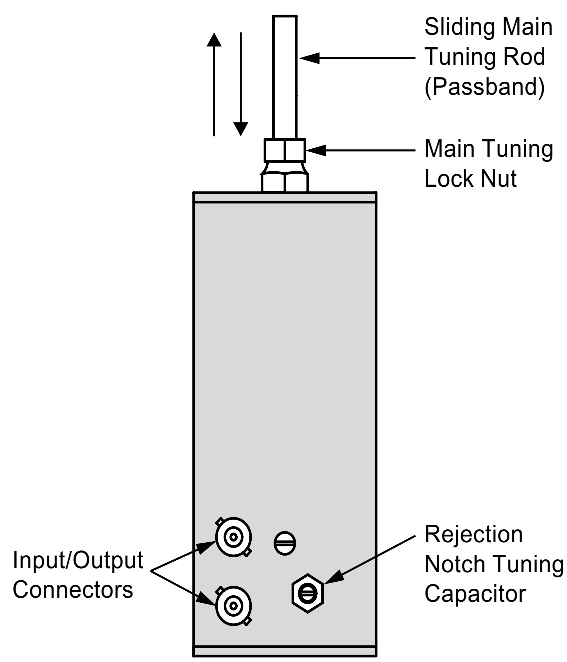

Figure 14: The Pseudo-bandpass filter.

REQUIRED EQUIPMENT
Due to the sensitivity of the adjustments, it is strongly recommended that the proper equipment be used when tuning the individual filters, otherwise the filter should be sent to the factory or an authorized representative for retuning. The following equipment or it's equivalent is recommended in order to properly perform the tuning adjustments.

1) IFR A-7550 Spectrum Analyzer / Tracking Generator combination.

2) Eagle Model RLB150BN3 Return Loss Bridge (35 dB directivity).

3) Double shielded coaxial cable test leads (RG142 B\U or RG223/U).

4) 50 Ohm load with at least -35 dB return loss (1.10:1 VSWR).

5) Insulated metal blade tuning tool for adjusting ceramic and/or piston variable capacitors.

Similar equipment from other manufacturers should yield acceptable results.

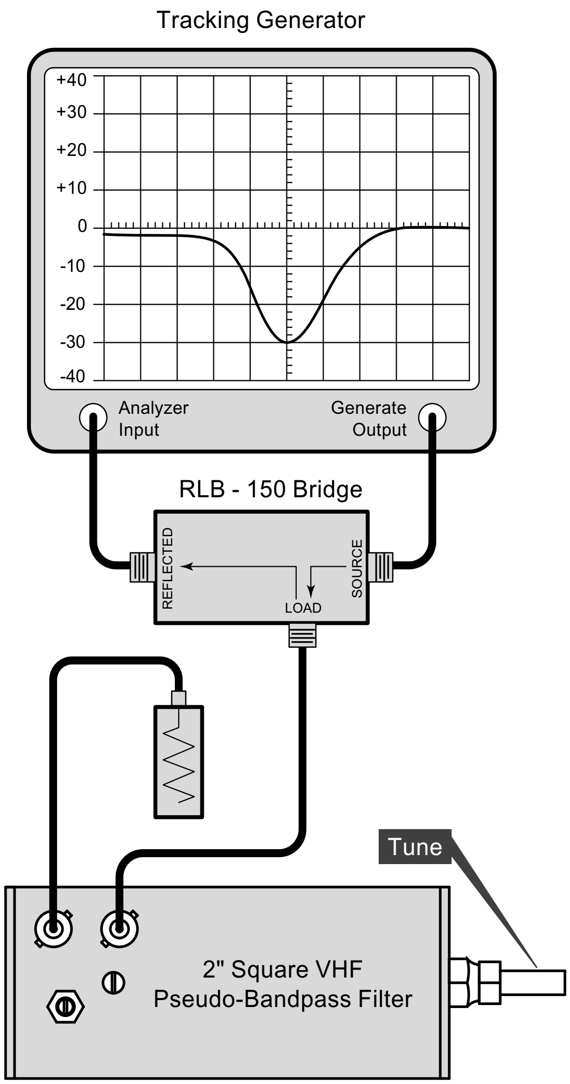

Figure 15: Tuning the Pseudo-bandpass filter for maximum return loss.

TUNING PROCEDURE
The following general procedure assumes familiarity with the use of a tracking generator.

1) Set the tracking generator to a center frequency of the filter to be tuned. Set the tracking generator for 0 dBm output and a 10 dB/div scale. Connect the equipment as shown in **Figure 15** but leave the load port of the bridge unconnected.

2) Set a 0 dB return loss reference. For the IFR A-7550 perform the following procedure:

a) Make sure that the unit is in "LIVE" mode when performing step 7.

b) From the **Mode Menu**, "STORE" the above trace.

c) Switch to the **Display Menu** and select "REF". The trace should appear at the 0 dB level.

3) Connect the load port of the bridge to the filter as shown in figure 15.

4) Adjust the cavity main tuning rod for maximum return loss at the center frequency.

5) Set the tracking generator for the center frequency of the filter and connect the test leads as shown in **Figure 16** but first temporarily connect the leads together through a female barrel connector and set a zero dB loss reference. On the IFR A-7550 proceed as follows:

a) Make sure that the unit is in "LIVE" mode when performing step 2.

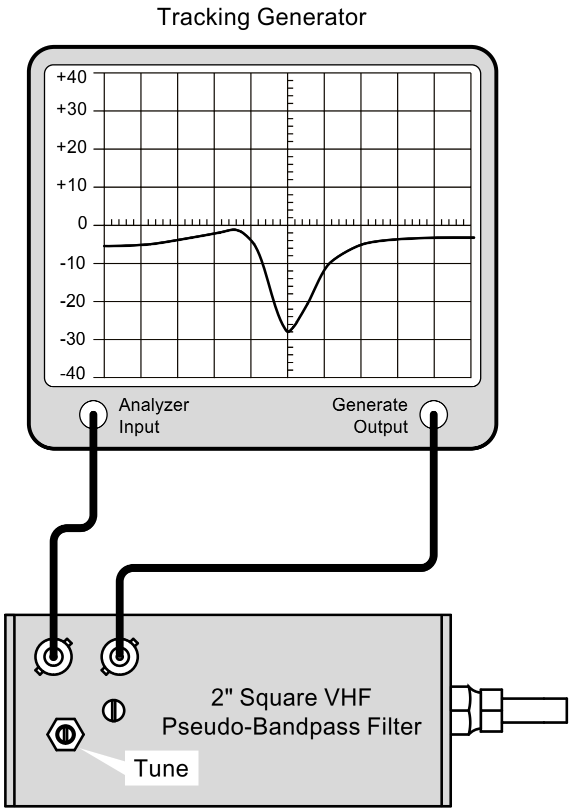

Figure 16: Tuning the Pseudo-bandpass filter for maximum attenuation.

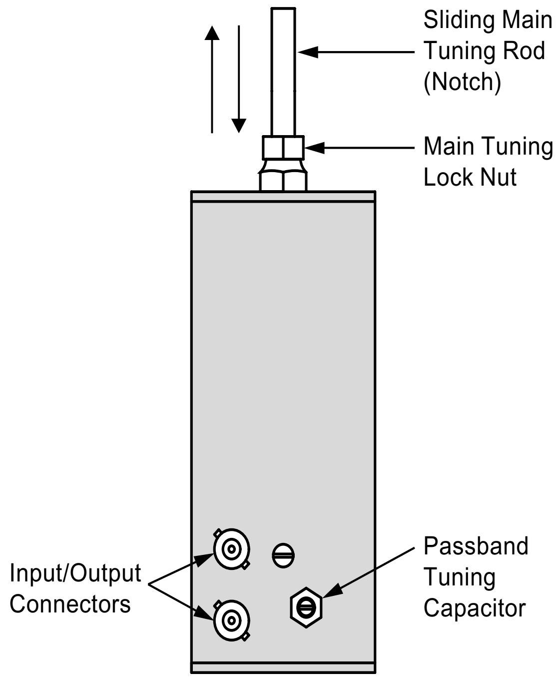

Figure 17: The Notch filter.

b) From the **Mode Menu**, "STORE" the above trace.

c) Switch to the **Display Menu** and select "REF".

6) Connect the leads to the cavity as shown in figure 16 and use a tuning tool or small screw driver to engage the notch tuning capacitor and rotate it to obtain maximum attenuation at the notch frequency.

7) Tighten the cavity main tuning locking nuts.

The cavity may be put back into the repeater amplifier.

Notch Filters

The notch filter passes a relatively wide band of frequencies while rejecting (notches out) a very narrow band of frequencies. They are used to improve the skirt selectivity of associated band-pass filters. These cavity filters are two inch square, helical type resonators that include a tunable notching section, refer to **Figure 17**. These filters are pretuned and require no adjustment unless they have been damaged and repaired or tampered with in some way. They are passive devices that require no maintenance.

REQUIRED EQUIPMENT

Due to the sensitivity of the adjustments, it is strongly recommended that the proper equipment be used when tuning the individual filters, otherwise the filter should be sent to the factory or an authorized representative for retuning. The following equipment or it's equivalent is recommended in order to properly perform the tuning adjustments.

1) IFR A-7550 Spectrum Analyzer / Tracking Generator combination.

2) Eagle Model RLB150BN3 Return Loss Bridge (35 dB directivity).

3) Double shielded coaxial cable test leads (RG142 B\U or RG223/U).

4) 50 Ohm load with at least -35 dB return loss (1.10:1 VSWR).

5) Insulated metal blade tuning tool for adjusting ceramic and/or piston variable capacitors.

Similar equipment from other manufacturers should yield acceptable results.

TUNING PROCEDURE
The following general procedure assumes familiarity with the use of a tracking generator.

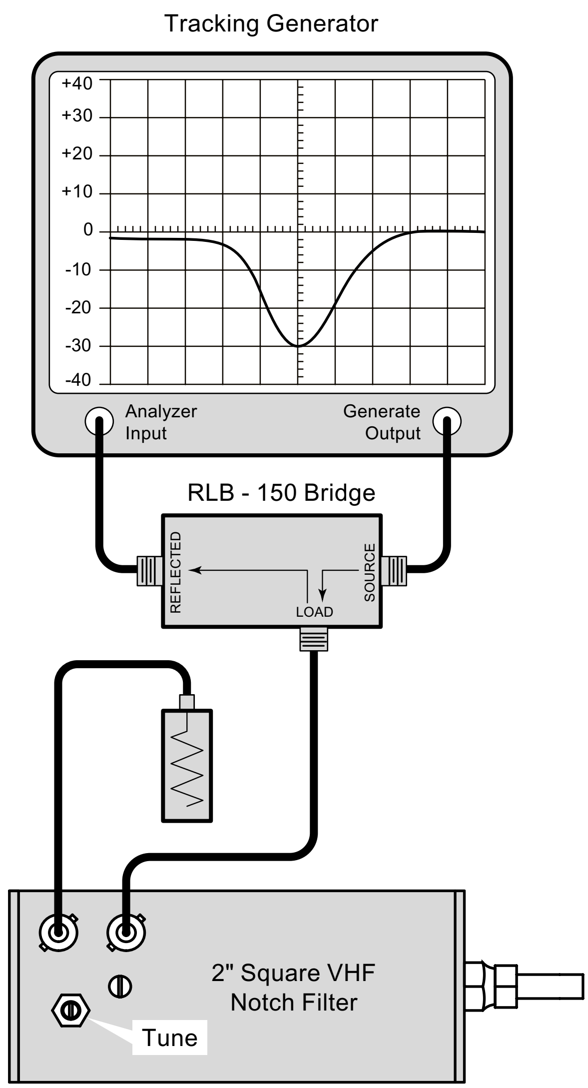

Figure 18: Tuning the Notch filter for maximum return loss.

1) Set the tracking generator to a center frequency of the filter to be tuned. Set the tracking generator for 0 dBm output and a 10 dB/div scale. Connect the equipment as shown in **Figure 18** but leave the load port of the bridge unconnected.

2) Set a 0 dB return loss reference. For the IFR A-7550 perform the following procedure:

   a) Make sure that the unit is in "LIVE" mode when performing step 7.

   b) From the **Mode Menu**, "STORE" the above trace.

   c) Switch to the **Display Menu** and select "REF". The trace should appear at the 0 dB level.

3) Connect the load port of the bridge to the filter as shown in figure 18.

4) Adjust the cavity main tuning rod for maximum attenuation at the notch frequency.

5) Set the tracking generator for the center frequency of the filter and connect the test leads as shown in **Figure 19** but first temporarily connect the leads together through a female barrel connector and set a zero dB loss reference. On the IFR A-7550 proceed as follows:

a) Make sure that the unit is in "LIVE" mode when performing step 2.

b) From the **Mode Menu**, "STORE" the above trace.

c) Switch to the **Display Menu** and select "REF".

6) Connect the leads to the cavity as shown in figure 19 and use a tuning tool or small screw driver to engage the notch tuning capacitor and rotate it to obtain maximum return loss at the center frequency.

7) Tighten the cavity main tuning locking nuts.

The cavity may be put back into the repeater amplifier.

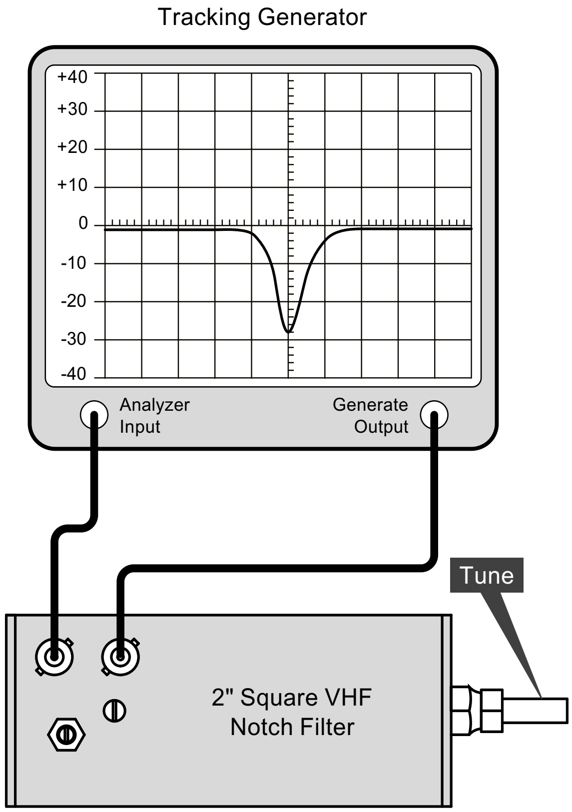

Figure 19: Tuning the Notch filter for max attenuation.

Single Section Amplifier Subassemblies

Amplifiers with 400 Milliwatt RF power output ratings are manufactured by TX RX Systems, Inc. for use in the model 61-38-05 family of signal boosters. These amplifiers utilize bi-polar transistors operating as class-A linear amplifiers with varying RF power output capability. They offer a good compromise between low noise figure and low levels of intermodulation distortion. In addition, these amplifiers use narrow band impedance matching circuitry which offers significant improvements in noise figure compared to broadband designs. However, narrow band circuits necessitate having to tune the matching networks to obtain best performance. This tuning procedure needs to be done when the RF transistor and/or matching network components are replaced.

Each single amplifier section (see **Figure 20**) uses a bias regulator circuit to keep the RF transistor biased for constant collector current with changes in temperature. The collector current remains constant when these amplifiers are running properly. The actual value of bias current will be different for different types of amplifiers but can also vary slightly if the power supply voltage varies. All versions of the current production bias regulators are designed for fixed values of RF transistor collector current.

The multi section amplifier assembly 3-11423 is a combination of individual single section subassemblies (part # 3-8089) which have a 400 Milliwatt output power rating per section. These single section subassemblies are interconnected with short lengths of double shielded coaxial cable for the RF interconnection. The individual sections are mounted on a common bracket with a DC distribution wire running internally between sections. A multi section amplifier is tuned on a per section basis. Never attempt to tune the interconnected sections.

AMPLIFIER TUNING

Field repair and tuning of our amplifiers is supported by TX RX Systems Inc. and the following procedure will allow satisfactory operation to be obtained. At the factory, TX RX amplifiers are tuned using two channel network analyzers that allow adjustment of both gain, input/output return loss and verification of reverse isolation. After this tuning, the amplifiers are checked with an advanced noise figure measurement system and are fine tuned to obtain best noise figure. Because this equipment is rarely available in even the most well equipped service centers, we recommend returning the amplifier to the factory for repair and retuning if the specified noise figure has to be obtained. In actual practice, most of the amplifiers retuned in the field will exhibit noise figures that range from being equal to the published specification or exceed it by 0.5 to 2 dB. Low noise figure may be of minimal importance in any system where very weak signal sensitivity is not an issue.

REQUIRED EQUIPMENT

The following procedure was developed to be practical as a field bench service procedure. This procedure is intended for single sections only. All multi section TX RX amplifiers are composed of cascaded single sections interconnected with short lengths of double shielded coaxial cable. Individually tuned single sections do not require any further adjustment when they are connected together forming a multi-section subassembly. This procedure requires the following equipment:

1) IFR A-7550 Spectrum Analyzer / Tracking Generator combination.

2) Eagle RLB150N3 Return Loss Bridge or equivalent (35 dB directivity).

3) Double shielded coaxial cable test leads (RG142 B\U or RG223/U).

4) 50 Ohm load with at least -35 dB return loss (1.10:1 VSWR). JFW Industries model 50T-007 or equivalent.

5) Regulated DC power supply at the required voltage.

6) Insulated metal blade tuning tool for adjusting ceramic and/or piston variable capacitors.

Similar equipment from other manufacturers should yield acceptable results.

ADJUSTMENT PROCEDURE

1) Set the tracking generator output level to -20 dBm, the desired center frequency and sweep width of 20 MHz.

2) Connect the test lead together through a female barrel connector to obtain a zero dB reference level. On the IFR A-7550 proceed as follows:

   a) Make sure that the unit is in "LIVE" mode when performing step 2.

   b) From the Mode Menu, "STORE" the above trace.

   c) Switch to the Display Menu and select "REF". A display with a vertically centered trace should be visible.

3) Connect the equipment as shown in **Figure 21**.

4) Remove the amplifier top cover. Engage the Output Tuning Capacitors one at a time and rotate them for maximum gain.

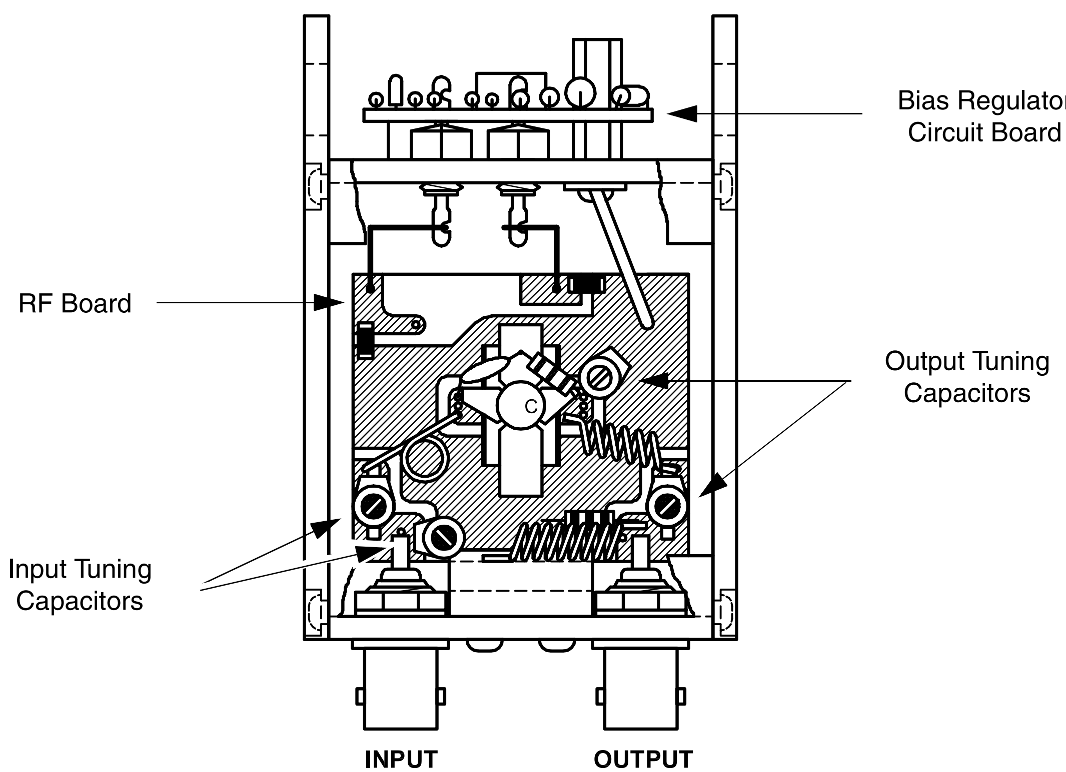

Figure 20: Mechanical layout of a single section amplifier subassembly.

5) Engage the Input Tuning Capacitors one at a time and rotate them for maximum gain.

NOTE

NOTE: If the gain peaks at a level about 60% of maximum, one of the variable capacitors should be rotated 180° and steps 4 and 5 repeated.

6)Connect the return loss bridge to the tracking generator as shown in **Figure 22** but do not connect it to the amplifier. Leave the test port on the bridge open.

7) Set up the 0 dB return loss reference. For the IFR A-7550 do the following procedure:

a) Make sure that the unit is in "LIVE" mode when performing step 7.

b) From the Mode Menu, "STORE" the above trace.

c) Switch to the Display Menu and select "REF". The trace should appear at the 0 dB level.

8) Connect the bridge and load to the amplifier as shown in figure 22 and see if the input return loss is down -16 dB or more. If it is, skip to step 10.

9) Alternately adjust the input tuning capacitors for increased return loss. A return loss of -20 to -30 dB loss should be obtained with maximum loss at the center frequency.

10) Reverse the connections as shown in **Figure 23** and see if the output return loss is -16 dB or more. If it is, skip to step 12.

11) Alternately adjust the output tuning capacitors for increased return loss. It should be possible to obtain -20 to -30 dB loss with maximum loss at the center frequency.

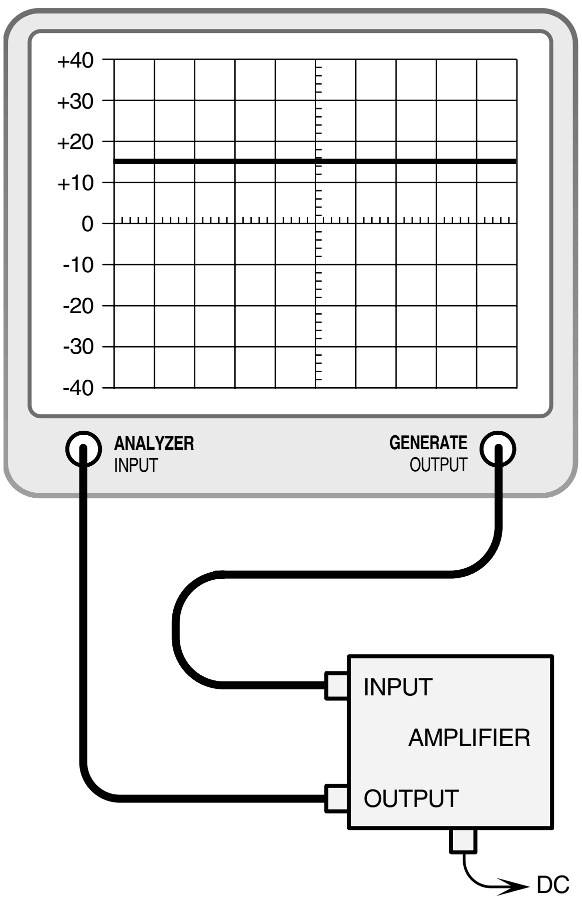

Figure 21: Measuring amplifier gain.

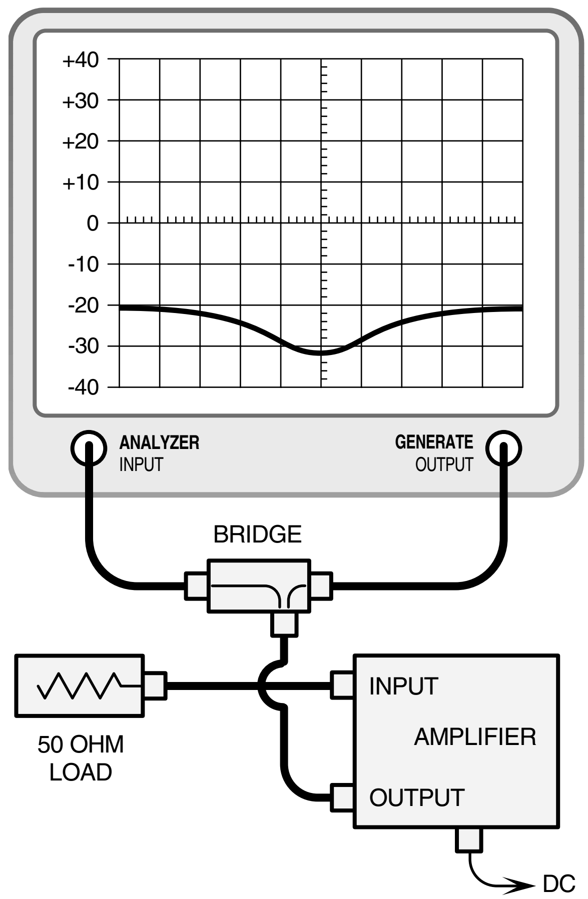

Figure 22: Measuring input return loss.

12) Due to interaction, tuning the output circuitry affects the input tuning and vise-versa. Repeat steps 8 through 11 until acceptable input and output return loss occurs without further tuning.

13) Connect the equipment as shown in **Figure 24** but connect the test leads together through a female barrel connector and repeat the zero reference procedure of step 2.

14) Using the figure 24 connection, verify that the reverse isolation is at least -20 to -22 dB. This value will occur normally as the result of proper tuning.

The greater the reverse isolation the better as this value must exceed the gain of the amplifier or oscillation may occur. If after proper tuning this value remains low, it may indicate a bad bypass capacitor or defective RF transistor.

Output Level Control (OLC)
The OLC circuits are preset at the factory to limit the RF power output of the signal booster branch to the maximum two-carrier level as indicated on the specification drawing. **DO NOT attempt to adjust or change this setting.** This setting will be adequate for protecting the final amplifier stage and limiting intermodulation products.

OLC voltage data sheets are included with the equipment shipment and list the actual OLC voltage values in relation to the degree of overload detected for your unit. These sheets also record the measured 1 dB compression point for the branch and the calculated output intercept point based on this compression point data.

CHECKING FOR OVERLOAD
Measurement of the DC voltage developed by the OLC circuitry is a way to determine the degree of input signal overload. In normal operation, up to 10 dB of overload on an intermittent basis is considered acceptable in most installations. Higher levels

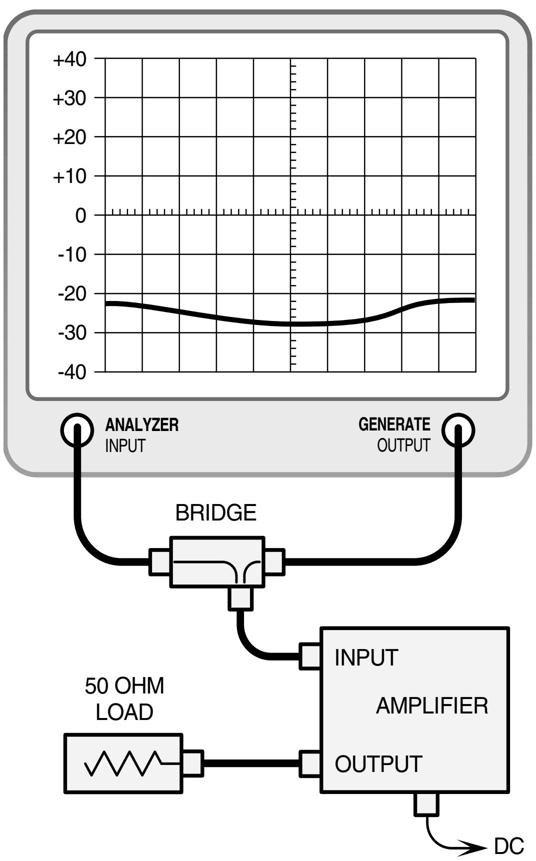

Figure 23: Measuring output return loss.

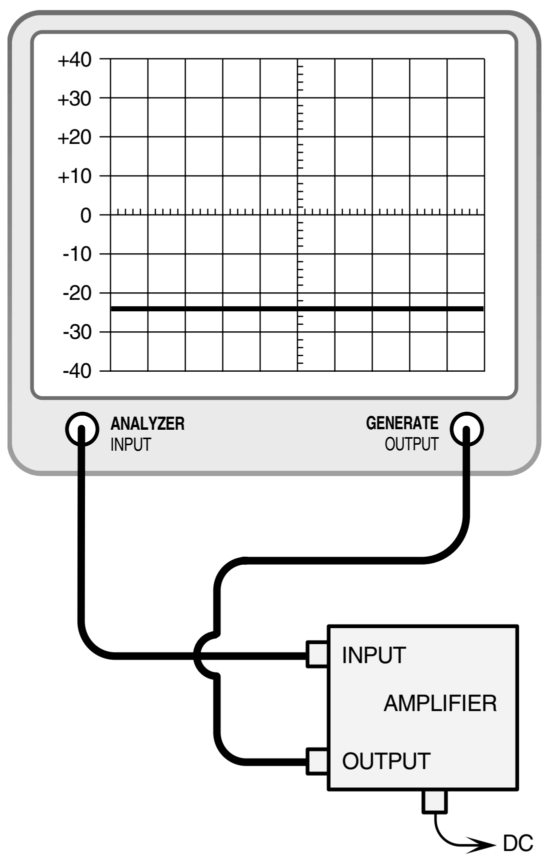

Figure 24: Measuring reverse isolation.