FIELD TUNING INSTRUCTIONS

6-CAVITY BpBr CIRCUIT DUPLEXER

HIGHLIGHTS

(1) The duplexer is factory tuned to the exact frequencies appearing on the decal with use of a spectrum analyzer/tracking generator and no further field tuning or "touching up" is required.

(2) To maintain maximum isolation, use double-shielded type cable (RG-142 or RG-214) to connect the duplexer to the transmitter and receiver chassis.

(3) The duplexer includes interconnecting cables between cavities which are critical in length. Do not change.

(4) With some transmitters, the length of the cable between the transmitter chassis and the duplexer might have to be optimized to obtain a proper impedance match (see instructions).

INSTALLATION

The three input connectors are marked "Low Freq. Input", "High Freq. Input" and "Antenna". If the transmit frequency is lower than the receive frequency, the transmitter should be connected to the connector marked "Low Freq. Input" and the receiver connected to the connector marked "High Freq. Input". If the transmit frequency is higher than the receive frequency, the transmitter should be connected to the connector marked "High Freq. Input" and the receiver connected to the input marked "Low Freq. Input".

EQUIPMENT REQUIRED FOR FIELD ALIGNMENT

The duplexer is factory-tuned to the exact operating frequencies prior to shipment from the factory. No further field tuning or adjustment is normally required. If it becomes necessary to change the operating frequencies of the duplexer, it can be field-tuned if the following equipment is available:

(1) A 50 ohm signal generator (with 3 dB or 6 dB pad) capable of producing a signal at the transmit and receive frequencies.

(2) A 50 ohm, crystal controlled receiver tuned to the desired transmit frequency.

(3) A 50 ohm, crystal controlled receiver tuned to the desired receive frequency.

(4) Two 50 ohm 3 dB (or 6 dB) pads.

(5) A 50 ohm load.

The 50 ohm pads are used during alignment to help isolate the duplexer from the signal generator and receivers. Signal generators and receivers are supposed to be 50 ohm devices but many are not. If the signal generator and/or receivers do not present a 50 ohm impedance at the ports of the duplexer, the impedance mismatch will tend to "pull" the signal off frequency and result in improper alignment of the cavities. As noted above, the 50 ohm pads will help minimize the effects of an impedance mismatch.

EXPLANATION OF TUNING ADJUSTMENTS

For proper alignment, each cavity filter in the duplexer must be tuned to two different frequencies: (1) the frequency to be passed by the cavity and (2) the frequency to be attenuated or rejected by the cavity. The threaded Invar tuning rod is the "pass" frequency adjustment and the stub is the "reject" frequency adjustment. The "reject" frequency adjustment (stub) must always be the last adjustment made to each cavity. Adjustment of the stub moves the notch (reject frequency) closer to, or farther from the pass frequency but does not change the pass frequency alignment. Rotation of the threaded tuning rod changes alignment of the "pass" frequency as desired, but also changes alignment of the notch to some unknown frequency. For this reason, the "pass" frequency adjustment is made first and the "reject" frequency adjustment is made last.

Cavities 1, 2 and 3 are always tuned to pass the lower of the two frequencies and reject the higher of the two frequencies. Cavities 4, 5 and 6 are always tuned to pass the higher frequency and reject the lower frequency. All six cavities have the same power handling capability therefore either section of the duplexer can be used for transmitter or receiver.

When three of the BpBr Circuit filters are connected in series, the combined attenuation at the "reject" frequency will easily exceed 100 dB and may be as much as 125 dB. This is beyond the dynamic range of most measuring devices. For this reason, the cavities must be tuned as single or dual cavity combinations. For the sake of simplicity, these instructions will deal with tuning the cavities one at a time. The interconnect cables must be removed from each cavity in order to tune each cavity individually.

PREPARE THE CAVITIES FOR REALIGNMENT

(1) Disconnect the interconnect cables from the Tee connectors on all of the cavities but leave the Tee connector on each cavity.

(2) Loosen the hex nut which locks the threaded tuning rod on each of the six cavities. The tuning rod should now be free to rotate in either direction.

(3) Loosen the hose clamps on each of the six stubs so the rexolite rod can be adjusted (in and out). Leave the clamp slightly tight to prevent the rexolite rod from sliding out of the stub.

(4) Pre-set stubs A, B and C on Cavities 1, 2 and 3 by positioning the rexolite rod so that 7" of the rod is exposed.

(5) Pre-set stubs D, E and F on Cavities 4, 5 and 6 by pushing the rexolite rod into the stub housing so that only ½" of the rod is exposed.

TUNE "PASS" FREQUENCY OF CAVITIES 1, 2 AND 3

(6) Refer to Figure 1. As explained in preceeding steps, all interconnect cables should be removed from all six cavities. Connect the signal generator (with pad on output) to one side of the Tee connector on Cavity #1. Connect Receiver #1 (operating on the lower frequency) through a pad to the other side of the Tee connector on Cavity #1.

(7) Set the signal generator to operate on the lower of the two duplex frequencies and check the discriminator of Receiver #1 to determine that the signal generator is exactly on the desired frequency. The output level should be near maximum at the start.

(8) Rotate the threaded tuning rod of Cavity #1 for maximum reading on an unsaturated relative signal strength metering point (such as first limiter or low IF amplifier) of Receiver #1. Keep the metering point below saturation by continuing to reduce the signal level from the signal generator. The output level required from the signal generator will probably be less than one microvolt when the cavity is properly tuned. "Rock" the tuning knob back and forth for maximum reading. Lock the tuning shaft of Cavity #1 by tightening the hex nut on the threaded shaft.

> NOTE: Clockwise rotation of the tuning shaft lowers the resonant frequency of the cavity and counter-clockwise rotation raises the resonant frequency.

(9) Tune Cavities 2 and 3 by following the procedures outlined in Steps 6, 7 and 8. Then lock the tuning shafts of the cavities.

TUNE "PASS" FREQUENCY OF CAVITIES 4, 5 AND 6

(10) Refer to Figure 1. Connect the signal generator (with pad on output) to one side of the Tee connector on Cavity #4. Connect Receiver #2 (operating on the higher frequency) through a pad to the other side of the Tee connector on Cavity #4.

(11) Set the Signal generator to operate on the higher frequency and check the discriminator of Receiver #2 to determine that the signal generator is exactly on the desired frequency. The output level should be near maximum at the start.

(12) Rotate the threaded tuning rod of Cavity #4 for maximum reading on an unsaturated relative signal strength metering point (such as first limiter or low IF amplifier) of Receiver #2. Keep the metering point below saturation by continuing to reduce the signal level from the signal generator. The output level required from the signal generator will probably be less than one microvolt when the cavity is properly tuned. "Rock" the tuning knob back and forth for maximum reading. Lock the tuning shaft of Cavity #4 by tightening the hex nut on the threaded shaft.

(13) Tune Cavities 5 and 6 by following the procedures outlined in Steps 10, 11 and 12. Then lock the tuning shafts of the cavities by tightening the lock shaft nuts.

TUNE "REJECT" FREQUENCY OF CAVITIES 1, 2 AND 3

(14) Refer to Figure 2. Connect the signal generator (with pad on output) to one side of the Tee connector on Cavity #1. Connect Receiver #2 (operating on the higher frequency) through a pad to the other side of the Tee connector on Cavity #1.

(15) Set the signal generator to operate on the higher frequency and check the discriminator of Receiver #2 to determine that the signal generator is exactly on the desired frequency. The output level from the signal generator will have to be increased in order to obtain a detectable reading on the next step.

(16) Adjust the rexolite rod of Stub A in or out for minimum reading at the metering point of Receiver #2. The output level of the signal generator will have to be continuously increased to obtain a detectable reading but saturation of the metering point must be avoided. "Rock" the rexolite dielectric rod in and out and note the definite increase and decrease of signal level. When minimum signal level is reached, lock the dielectric rod in place by tightening the locking clamp.

(17) Adjust the dielectric rod of Stubs B and C (Cavities 2 and 3) by following the procedures outlined in steps 14, 15 and 16. Lock the rods in place by tightening the clamps on Stubs B and C.

TUNE "REJECT" FREQUENCY OF CAVITIES 4, 5 AND 6

(18) Refer to Figure 3. Connect the signal generator (with pad on output) to one side of the Tee connector on Cavity #4. Connect Receiver #1 (operating on the lower frequency) through a pad to the other side of the Tee connector on Cavity #4.

(19) Set the signal generator to operate on the lower frequency and check the discriminator of Receiver #1 to determine that the signal generator is exactly on the desired frequency. The output level from the signal generator will have to be increased in order to obtain a detectable reading on the next step.

(20) Adjust the rexolite rod of Stub D in or out for minimum reading at the metering point of Receiver #1. The output level of the signal generator will have to be continuously increased to obtain a detectable reading but saturation of the metering point must be avoided. "Rock" the dielectric rod in and out and note the definite increase and decrease of signal level. When minimum signal level is reached, lock the dielectric rod in place by tightening the locking clamp.

(21) Adjust the dielectric rod of Stubs E and F (Cavities 5 and 6) by following the procedures outlined in steps 18, 19 and 20. Lock the rods in place by tightening the clamps on Stubs E and F.

(22) Reconnect all interconnect cables of the duplexer. The duplexer is now tuned to your new operating frequencies. Do not make any furthur adjustments to the duplexer.

CABLE LENGTH BETWEEN TRANSMITTER AND DUPLEXER

The length of the coaxial cable between the transmitter and the duplexer might be a critical length with some transmitters because of an impedance mismatch. (All transmitters do NOT have a 50 ohm output impedance)

In this event, the length of cable will have to be optimized. The need for this optimization will be apparent if the output power of the transmitter is reduced by more than the amount absorbed in the duplexer due to insertion loss. (Note that ½ dB insertion loss = transmitter power loss of 11%; 1 dB = 20%: 1.5 dB = 29%; 2 dB = 37%; 3 dB = 50%)

The optimum length of cable between the transmitter and the duplexer can be found by the following procedure:

(A) Tune the transmitter into a 50 ohm dummy load (or antenna) according to the instruction book.

(B) Connect the duplexer to the transmitter. The transmitter output signal should feed through the duplexer, then through a wattmeter, then into a dummy load (or antenna). If there is an impedance mismatch, the duplexer will detune the transmitter and the cable length should be optimized.

(C) Cut a length of RG8, RG9 or RG142 type cable to the approximate length that will be required to interconnect the transmitter to the duplexer. Attach connectors and connect to transmitter.

(D) Using short lengths of coaxial cable (approximately 2" @ 450 MHz; 4" @ 150 MHz; 8" @ 70 MHz), or UG646 right elbow connectors, gradually increase the length of the above coaxial cable between the transmitter and duplexer over a half-wavelength (at the operating frequency) until the optimum length (no de-tuning effect) is found. (Note: a UG646 elbow is equal to approximately 1½" of RG8 or RG9 type cable). A half-wavelength (cable) at the operating frequency can be found by:

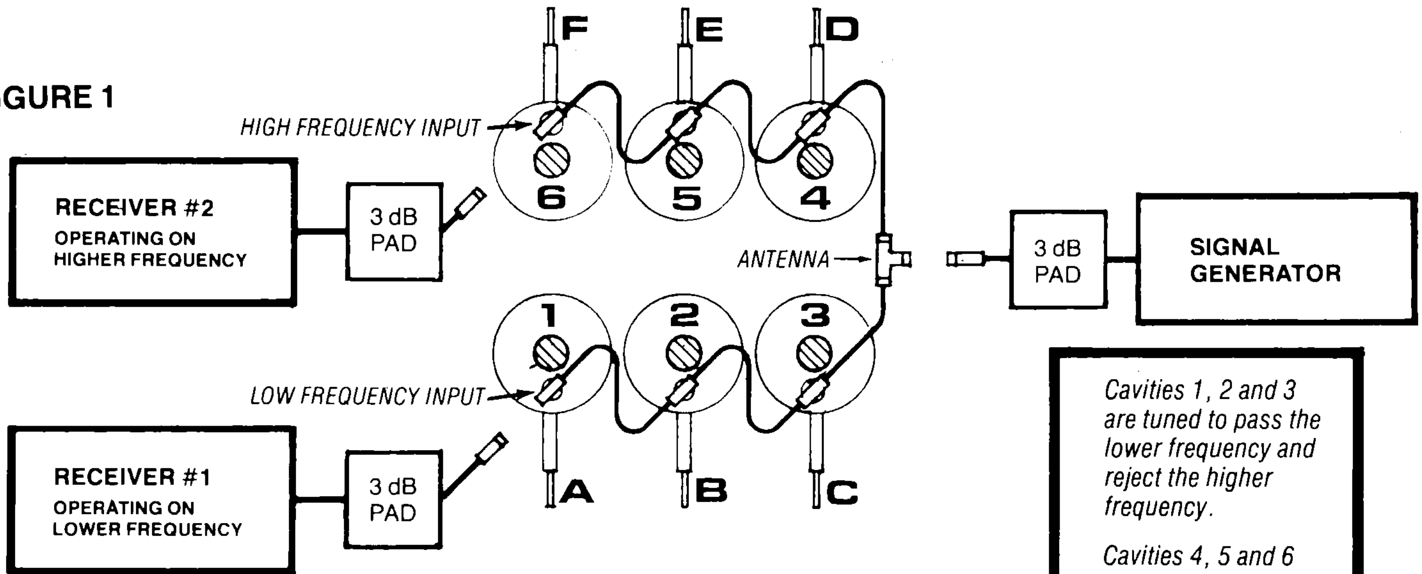
$$\text{Length (in inches) of } \tfrac{1}{2} \text{ wavelength} = \frac{3894}{\text{Freq. in MHz}}$$

Example: At 152.03 MHz, ½ wavelength (cable equals 25.61 inches. Therefore, the random length of cable (above paragraph C) should be increased approximately 4" at a time, and the transmitter-filter match checked at each length, until a total of 26" of additional cable has been tried. At some length within this 26", the match will be optimized and that length should be noted.

(E) When the proper cable length is found, replace the longer cable length (paragraph C) and the short lengths of cable and the UG646 elbows (paragraph D) with one continuous length of cable of equivalent electrical length. The cable length is now optimized.

FIELD TUNING INSTRUCTIONS

FIGURE 1



Cavities 1, 2 and 3 are tuned to pass the lower frequency and reject the higher frequency.

Cavities 4, 5 and 6 are tuned to pass the higher frequency and reject the lower frequency.

FIGURE 2

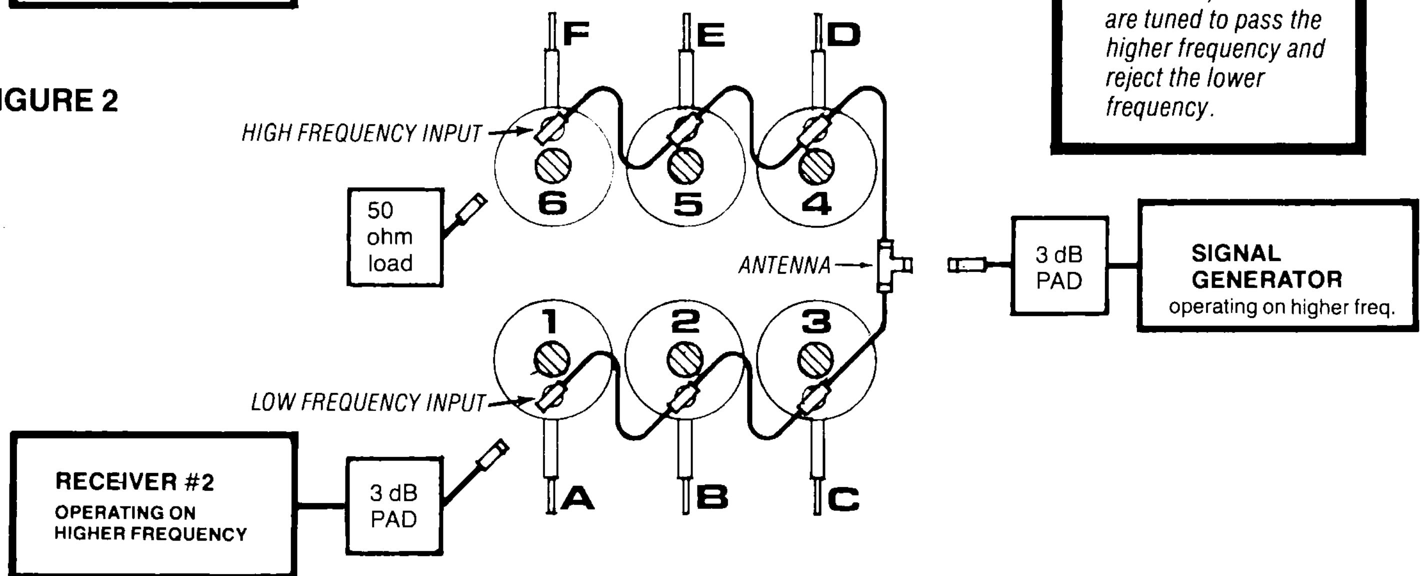
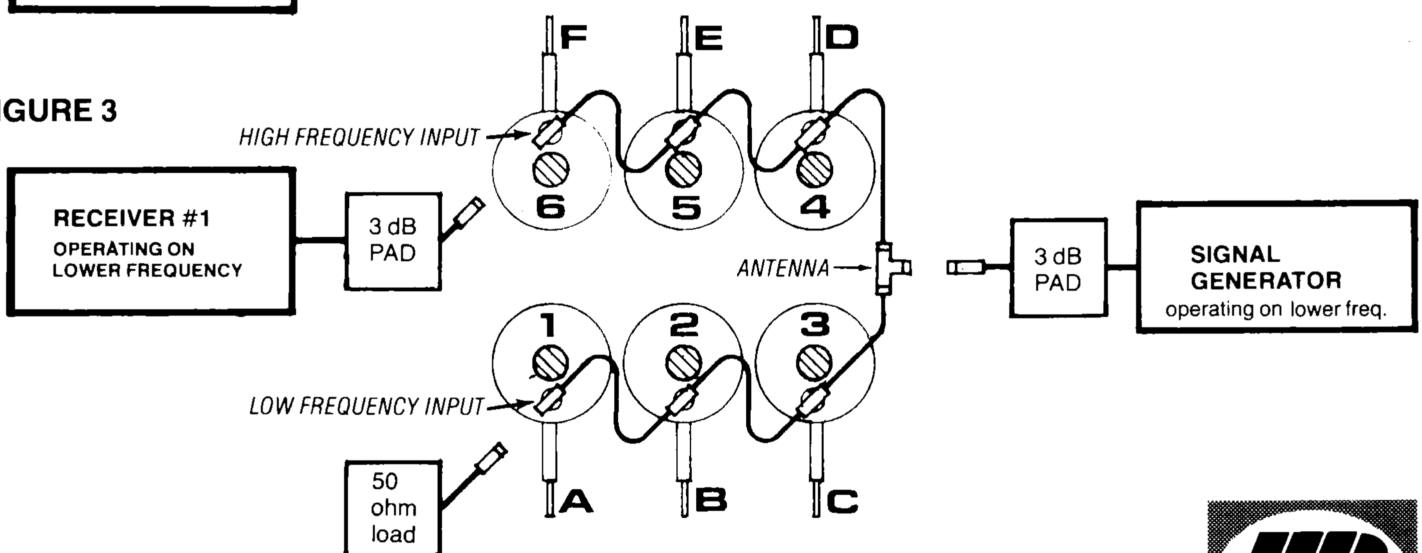


FIGURE 3



WACOM PRODUCTS, INC.

WACO, TEXAS