FIELD TUNING INSTRUCTIONS

4-CAVITY BpBr CIRCUIT DUPLEXER

WP-604 WP-609 WP-612 WP-621 WP-629 WP-639 WP-641 WP-652

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.

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

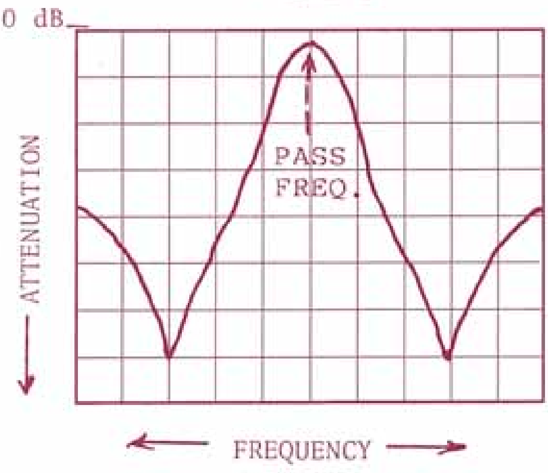
PREPARE THE CAVITIES FOR REALIGNMENT

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

(2) Loosen the hose clamps on each of the four 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.

(3) Pre-set the stubs on each BpBr Circuit Cavity by positioning the rexolite rod at the appropriate position. The "appropriate pre-set position" of the rexolite rods for your particular duplexer can be found on the Duplexer Check Sheet supplied with your duplexer; or you can call the factory for details. With rexolite rods properly set at the pre-set position, the frequency response curve of each BpBr Circuit Filter should be similar to the illustration in Fig. 1, if viewed on a spectrum analyzer with sweep equipment.

FIGURE 1



TUNE "PASS" FREQUENCY OF CAVITIES 1 & 2

(3) Connect the equipment to the duplexer as shown in Figure 1.

(4) Set the signal generator to 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.

(5) Rotate the threaded tuning rods of Cavities 1 & 2 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 from the signal generator. Tune each cavity several times because of interaction between cavities.

TUNE "PASS"FREQUENCY OF CAVITIES 3 & 4

(6) Leave the equipment connected as shown in Figure 1 and set the signal generator to the higher of the two duplex frequencies. Check the discriminator of Receiver #2 to determine that the signal generator is exactly on the desired frequency.

(7) Rotate the threaded tuning rods of Cavities 3 & 4 for maximum reading at the metering point of Receiver #2. Keep the metering point below saturation. Tune each cavity several times.

(8) Tighten the hex nuts which lock the tuning rods of Cavities 3 & 4.

RE-TUNE "PASS" FREQUENCY OF CAVITIES 1 & 2

(9) Repeat Steps 3, 4 & 5. This is a precautionary step to insure that Cavities 1 & 2 are properly tuned. This Step 9 is not necessary if the duplexer is being re-tuned to new frequencies that are close to the old frequencies. Step 9 is mandatory if the new "pass" frequency of Cavities 1 & 2 is close to the old "pass" frequency of Cavities 3 & 4.

(10) Tighten the hex nuts which lock the tuning rods of Cavities 1 & 2.

TUNE "REJECT" FREQUENCY OF CAVITIES 1 & 2

(11) Connect the equipment as shown in Figure 2.

(12) Set the signal generator to the higher duplex frequency and check the discriminator of Receiver #2 to make sure 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.

(13) Adjust the rexolite rod of stubs A & B (Cavities 1 & 2) 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.

(14) Tighten the clamps of stubs A & B.

TUNE "REJECT" FREQUENCY OF CAVITIES 3 & 4

(15) Connect the equipment as shown in Figure 3.

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

(17) Adjust the rexolite rod of stubs C & D (Cavities 3 & 4) 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 must be avoided.

(18) Tighten the clamps of stubs C & D. The duplexer is now ready for use.

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:

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

(2) 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.

(3) 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.

(4) 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:

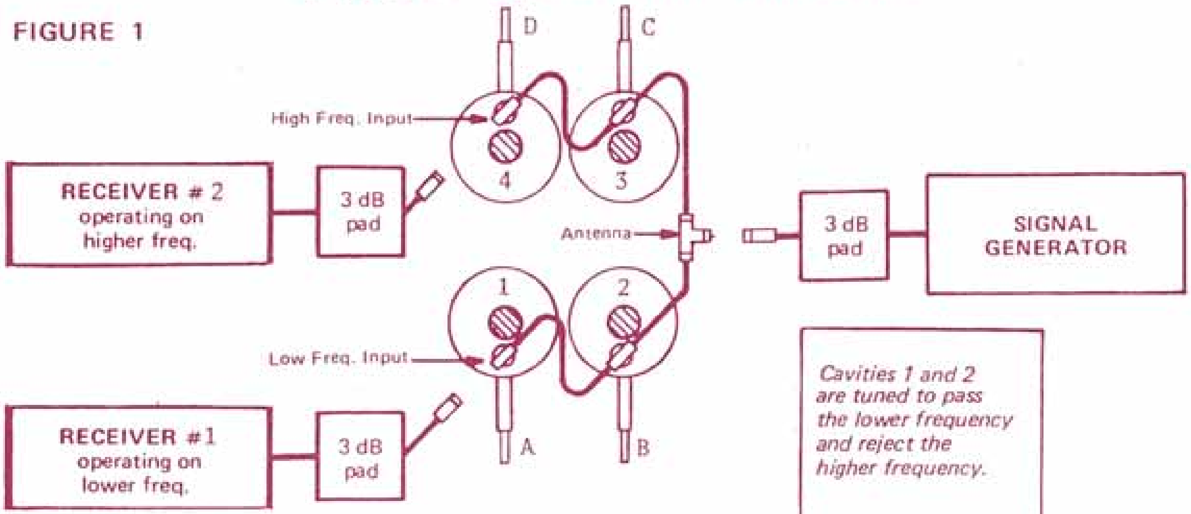
Length (in inches) of ½ wavelength = $\frac{3894}{\text{Freq. in MHz}}$

Example: At 152.03 MHz, ½ wavelength (cable equals 25.61 inches. Therefore, the random length of cable (above paragraph 3) 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.

(5) When the proper cable length is found, replace the longer cable length (paragraph 3) and the short lengths of cable and the UG646 elbows (paragraph 4) with one continuous length of cable of equivalent electrical length. The cable length is now optimized.

FIELD TUNING INSTRUCTIONS
for
4 CAVITY BpBr Circuit™ DUPLEXER

FIGURE 1



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

Cavities 3 and 4 are tuned to pass the higher frequency and reject the lower frequency.

FIGURE 2

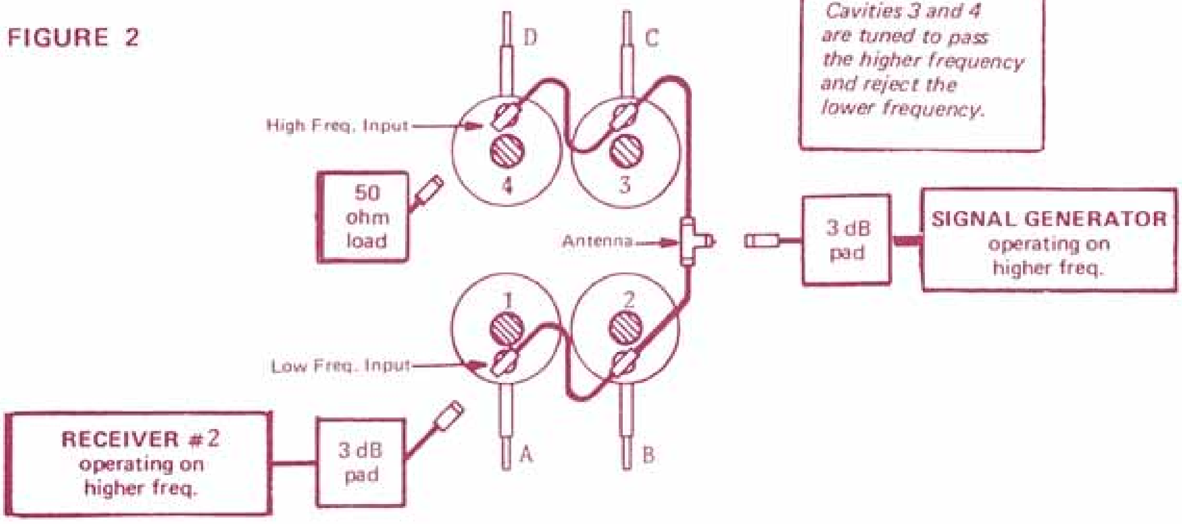
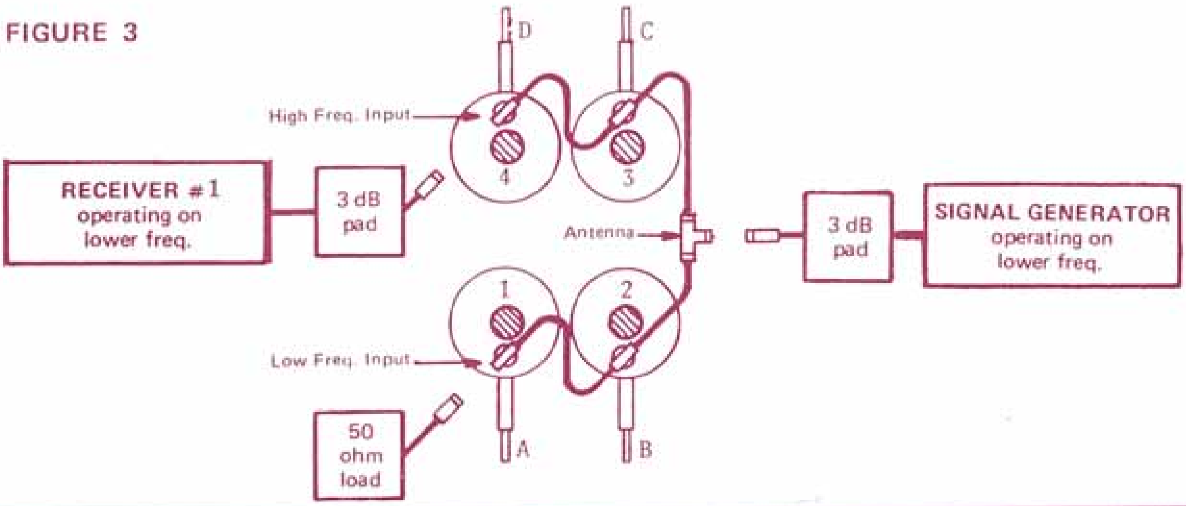


FIGURE 3



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WP-641
144-174 MHz
WP-621
118-144 MHz

WACOM PRODUCTS

BpBr Circuit®
BANDPASS-REJECT DUPLEXERS

MIN. FREQ. SPACING: 500 KHz POWER: TO 350 WATTS

U. S. PATENT
No. 4,080,601

THESE BpBr CIRCUIT® DUPLEXERS include the use of an exclusive circuit developed by Wacom Products which provides superior suppression of spurious sideband noise between and adjacent to the duplex frequencies. When used with a high Q cavity, the BpBr Circuit provides frequency response curves with bandpass cavity characteristics at the frequency to be passed and band-reject cavity characteristics at the frequency to be attenuated. Performance characteristics improve as the frequency separation is increased. Frequency stability of the BpBr Circuit duplexer is excellent—an important factor at close frequency spacing. Each model will handle transmitter powers up to 350 watts and all models are supplied with complete cable harness and mounting frame.

ADVANTAGES OF THE BpBr CIRCUIT®: Assuming a given insertion loss at the pass frequency, comparison of the performance of the BpBr Circuit filter versus other types of bandpass-reject filters will reveal the BpBr Circuit filter provides superior bandpass characteristics near the pass frequency and a significantly wider notch at the frequencies to be attenuated. These features result in superior transmitter to receiver isolation, superior protection to and from other nearby radio systems, and greater stability over a wide temperature range. In addition field tuning of a BpBr Circuit filter is considerably easier than field tuning of most other types of bandpass-reject filters.


Model WP-641

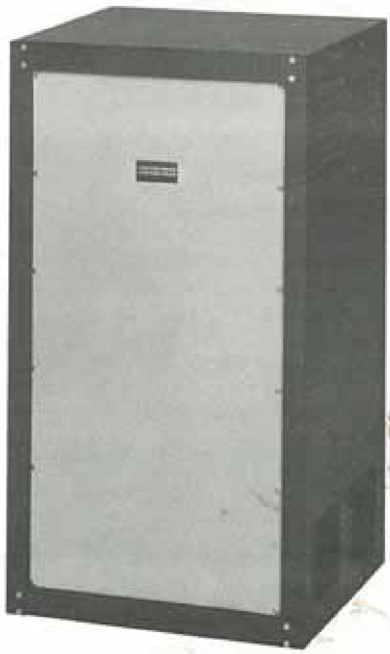
MODEL WP-641 is designed for use with duplex stations operating in the 144-174 MHz band when the separation between transmit and receive frequencies is 500 KHz or more. It consists of four 8" OD cavities interconnected with double shielded coaxial cable in a bandpass-reject configuration. It is generally suitable for use with all types of duplex stations, particularly the latest solid state types which require attenuation of transmitter sideband noise over a wide portion of the spectrum. Model WP-205 cabinet is available as an optional item.

MODEL WP-621 is identical to the above model but designed for use with duplex stations operating in the 118-144 MHz band when the Tx and Rx frequency separation is 500 KHz or more.

CONSTRUCTION: The top end-plate and outer conductor, made of chromated aluminum, are heliarc welded for improved conductivity. Coupling loops are made of copper; both sections of the cavity center conductor are made of silver plated copper. The tuning rod is made of Invar. Quality materials are used throughout the duplexer to assure top performance and long life. Galvanic corrosion is minimized by the use of similar materials and by passivating dissimilar materials which are in contact.

TUNING: The duplexer is factory tuned to the exact transmit and receive frequencies prior to shipment from the factory. No further field adjustment is normally required. If desired, the duplexer can be field tuned to new frequencies within its operating band by rotating the threaded tuning rod ("pass" frequency alignment) and adjusting the length of the adjustable stub ("reject" frequency alignment) of each filter.

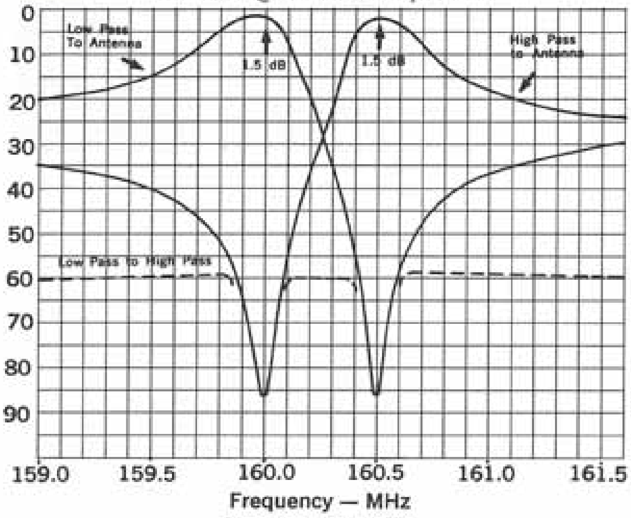
INSTALLATION: The duplexer can be mounted in any position but is normally mounted vertically, with the tuning rods up. Double-shielded coaxial cable (such as RG-214 or RG-142) must be used to interconnect the duplexer to the transmitter and receiver chassis if maximum isolation is to be maintained. A suitable duplexer installation cable kit (Part No. 30090) is available as an optional item.


Optional Model WP-205
Indoor Cabinet

Printed in U.S.A.—1-89

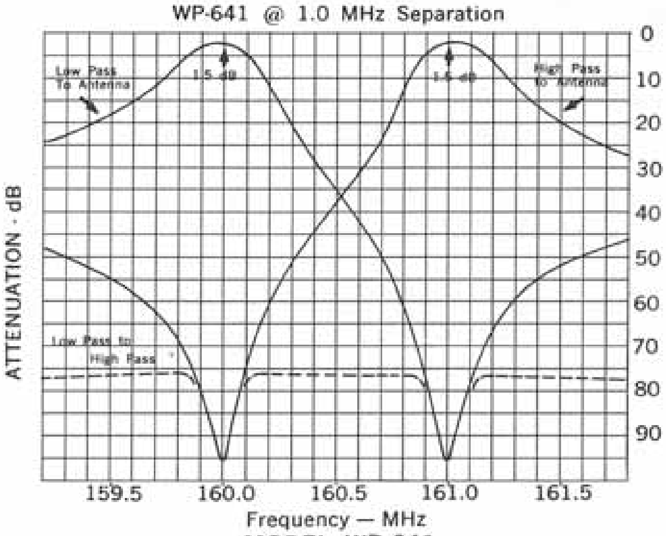
TYPICAL DUPLEX RESPONSE CURVES

WP-641 @ 0.5 MHz Separation



MODEL WP-641

WP-641 @ 1.0 MHz Separation



MODEL WP-641

ELECTRICAL DATA

	Model WP-621	Model WP-641
Tuning Range A Range	118-136 MHz	144-174 MHz
B Range	130-144 MHz	
Minimum Frequency Separation	0.5 MHz or more	0.5 MHz or more
Maximum Power Input (continuous duty)	350 watts	350 watts
Insertion Loss (Tx and Rx to antenna)		
at 0.5 MHz separation	1.5 dB	1.5 dB
at 1.0 MHz separation	1.5 dB	1.5 dB
Attenuation at Tx Freq. and Rx Freq.		
at 0.5 MHz separation	85 dB	85 dB
at 1.0 MHz or more separation	95 dB	95 dB
Isolation (midway between channels)		
with 0.5 MHz separation	55 dB	55 dB
with 1.0 MHz separation	75 dB	75 dB
Maximum VSWR (Ref. 50 ohms)	1.3 to 1	1.3 to 1
Temperature Range	−30° to +60°C	−30° to +60°C
Number of Cavity Filters	4	4

MECHANICAL DATA

	Model WP-621	Model WP-641
Dimensions:		
Individual Cavity (not incl. tuning rod)	8" OD x 29"	8" OD x 25"
Duplexer (D x W x H) with tuning rods fully extended	17" x 19" x 36"	17" x 19" x 33"
Connector Terminations (Tx, Rx, Ant)	UHF Female (Type N optional)	UHF Female (Type N optional)
Finish	Gray enamel	Gray enamel
Net Weight	42 lbs.	40 lbs.
Shipping Weight	50 lbs.	48 lbs.
Optional Cabinet	WP-205	WP-205
Dimensions, cabinet, (D x W x H)	18½" x 22½" x 41"	18½" x 22½" x 41"
Shipping Weight (Cabinet & Duplexer)	130 lbs.	128 lbs.

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ORDERING INFORMATION

Model WP-621 Duplexer with Tx on_____MHz and Rx on_____MHz
Model WP-641 Duplexer with Tx on_____MHz and Rx on_____MHz
Model WP-205 Optional Cabinet

When ordering specify exact Tx and Rx frequency.

Tx Frequency 145.725 Rx Frequency 145.125

INSERTION LOSS:

Tx to Ant. 1.5 dB Rx to Ant. 1.5 dB

Tx to Rx ISOLATION:

At Tx Freq. 92 dB At Rx Freq. 92+ dB

When retuning this duplexer at some future date, the stubs should be pre-set to specific positions during the initial tuning of the "Pass" frequency adjustment. After the pass frequency adjustment is completed, the stubs will be changed to new positions during the reject frequency adjustment. But it is helpful always to start the tuning procedure with the stubs of this particular duplexer pre-set at the following positions:

A. For frequency band of 144 - 148 MHz.

B. On "low pass" cavities, pull the rexolite rod OUT so that 4¼" inches of rod is exposed.

C. On "high pass" cavities, push the rexolite rod IN so that 1⅛" inches of rod is exposed.

INSPECTOR: John R Elliott DATE: Aug 4, 1993

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