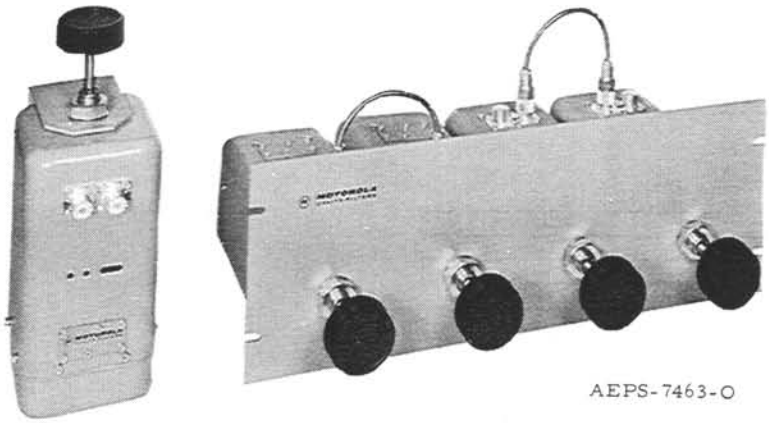
FILTERS AND DUPLEXERS

T1500A SERIES
406-512 MHz



AEPS-7463-O

1. INTRODUCTION

These filters and duplexers are for use with Motorola FM two-way radio communications equipment operating in the 406-512 MHz frequency range. The filters and duplexers use 1/4-wave cavity resonators which are temperature-compensated and tuned with an adjustable center conductor. The cavities contain unique loops or probes terminated in type UHF receptacle connectors with "Teflon" insulation.

These units may be used in the antenna circuit of a base station or repeater to eliminate or minimize receiver desensitization or intermodulation from strong local signals. Similarly, they may be used to reduce transmitter noise or intermodulation products.

2. INSTALLATION

a. Bracket-Mounted Filters

(1) Carefully unpack the unit and check for concealed damage.

(2) Select a mounting location near the associated equipment or inside the equipment cabinet that will permit using the shortest cabling between the filter and the equipment.

(3) Using the mounting bracket as a template, mark the locations of the desired mounting holes.

(4) Drill the mounting holes required by the type of mounting hardware to be used.

(5) Mount the filter using hardware supplied.

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PERFORMANCE SPECIFICATIONS

FILTERS

MODEL NUMBER	T1500A			T1501AL, AH			T1502A		
FREQUENCY BAND	406-512 MHz			406-430 MHz	430-470 MHz	470-512 MHz	406-430 MHz	430-470 MHz	470-512 MHz
INSERTION LOSS	0.5 dB	1.0 dB	2.5 dB	0.7 dB	0.6 dB	0.5 dB	1.5 dB	1.3 dB	1.2 dB
LOADED Q	350	725	1750	350			350		
MAXIMUM POWER INPUT	250 W	125 W	60 W	250 W			250 W		
MINIMUM PASS-REJECT SEPARATION				2 MHz		3 MHz	±2 MHz		±3 MHz
MINIMUM REJECT ATTENUATION				37 dB @ 2 MHz 52 dB @ 5 MHz		40 dB @ 3 MHz 48 dB @ 5 MHz	50 dB @ 2 MHz 72 dB @ 5 MHz		54 dB @ 3 MHz 67 dB @ 5 MHz
TEMPERATURE RANGE	-30° C to +60° C			-30° C to +60° C			-30° C to +60° C		
SIZE	12" x 4-1/2" x 5"			12" x 4-1/2" x 5"			7" x 19" x 12"		
TERMINATION	UHF Female			UHF Female			UHF Female		

MODEL NUMBER	T1505A	T1506A
INSERTION LOSS	1.0 - 5.0 dB	1.5 - 7.5 dB
SIZE (H x W x D)	5-1/4" x 19" x 12"	7" x 19" x 12"
POWER INPUT	250 watts - 60 watts (depending on insertion loss)	
ISOLATION (WHEN USED AS DUPLEXER)	See Isolation Curve: Figure 16	
TEMPERATURE RANGE	-30°C to +60°C	
TERMINATION	UHF Female	

DUPLEXERS

MODEL NUMBER	T1503A, AF		T1504A, AF			T1507A
FREQUENCY BAND	406-430 MHz	430-470 MHz	406-430 MHz	430-470 MHz	470-512 MHz	406-512 MHz
MINIMUM FREQUENCY SEPARATION	5 MHz		2 MHz		3 MHz	5 MHz
RECEIVER ISOLATION AT TRANSMIT FREQUENCY	55 dB		80 dB		85 dB	55 dB
TRANSMITTER NOISE SUPPRESSION AT RECEIVE FREQUENCY	55 dB		80 dB		85 dB	55 dB
MINIMUM TRANSMITTER RECEIVER ISOLATION	45 dB		60 dB		70 dB	55 dB
RECEIVER INSERTION LOSS	0.8 dB	0.7 dB	1.6 dB	1.4 dB	1.3 dB	2.0 dB
TRANSMITTER INSERTION LOSS	0.8 dB	0.7 dB	1.6 dB	1.4 dB	1.3 dB	2.0 dB
VSWR MAXIMUM	1.5: 1		1.5: 1			1.5: 1
MAXIMUM POWER INPUT	250 W		250 W			125 W
TEMPERATURE RANGE	-30°C to +60°C		-30°C to +60°C			-30°C to +60°C
SIZE	7" x 19" x 12"		7" x 19" x 12"			7" x 19" x 12"
TERMINATION	UHF Female		UHF Female			UHF Female

MOTOROLA

MODEL CHART

FOR

FILTERS AND DUPLEXERS

406-512 MHz

CODE:

- [X] = ONE ITEM SUPPLIED.
- [2] = NUMBER INDICATES QUANTITY OF ITEMS SUPPLIED.
- / = ONE ITEM SUPPLIED WHEN FREQUENCY SPACING IS LESS THAN 5.0 MHz
- ◢ = ONE ITEM SUPPLIED WHEN FREQUENCY SPACING IS GREATER THAN 5.0 MHz
- O = TWO ITEMS SUPPLIED WHEN FREQUENCY SPACING IS LESS THAN 5.0 MHz
- ■ = TWO ITEMS SUPPLIED WHEN FREQUENCY SPACING IS GREATER THAN 5.0 MHz

MODEL	DESCRIPTION	CAVITY FILTER KIT	PASSBAND COUPLING LOOP KIT	COUPLING LOOP KIT	COUPLING PROBE KIT	CABLE KIT	CABLE KIT	CABLE KIT	CABLE KIT	CABLE KIT	CABLE KIT	CABLE KIT	MOUNTING BRACKET KIT	RACK PANEL KIT	MISCELLANEOUS PARTS KIT	MISCELLANEOUS PARTS KIT	COUPLING LOOP KIT
KIT 470-512 MHz		TLE6420A	TLE6883A	TLE6432A	TLE6433A	TKN6537A	TKN6540A	TKN6543A	TKN6546A	TKN6551A	TKN6431A	TKN6432A	TLN4031A	TLN4066A	TLN4104A	TLN4202A	TLE6434A
KIT 430-470 MHz		TLE6420A	TLE6882A	TLE6432A	TLE6433A	TKN6536A	TKN6539A	TKN6542A	TKN6545A	TKN6550A	TKN6431A	TKN6432A	TLN4031A	TLN4066A	TLN4104A	TLN4202A	TLE6434A
KIT 406-430 MHz		TLE6420A	TLE6881A	TLE6432A	TLE6433A	TKN6535A	TKN6538A	TKN6541A	TKN6544A	TKN6549A	TKN6431A	TKN6432A	TLN4031A	TLN4066A	TLN4104A	TLN4202A	TLE6434A
T1500A	PASSBAND CAVITY FILTER	X	X										X				
T1501AH	PASS-REJECT CAVITY FILTER (REJECT FREQUENCY HIGHER THAN PASS FREQUENCY)	X		/									X				◢
T1501AL	PASS-REJECT CAVITY FILTER (REJECT FREQUENCY LOWER THAN PASS FREQUENCY)	X			X								X				
T1502A	TWO-CAVITY PASS-REJECT FILTER	2		/	X	X								X			◢
T1503A	TWO-CAVITY PASS-REJECT DUPLEXER	2		/	X		X							X	X		◢
T1503AF	FACTORY INSTALLED TWO-CAVITY PASS-REJECT DUPLEXER	2		/	X		X				2	2		X		X	◢
T1504A	FOUR-CAVITY PASS-REJECT DUPLEXER	4		O	2			X						X	X		■
T1504AF	FACTORY INSTALLED FOUR-CAVITY PASS-REJECT DUPLEXER	4		O	2			X			2	2		X		X	■
T1505A	TWO-CAVITY PASSBAND FILTER	2	2						X					X			
T1506A	THREE-CAVITY PASSBAND FILTER	3	3						2					X			
T1507A	FOUR-CAVITY PASSBAND DUPLEXER	4	4							X				X		X	
T1507AF	FACTORY INSTALLED FOUR-CAVITY PASSBAND DUPLEXER	4	4							X				X		X	

EPS-7461-A

(6) Connect the filter to the transmitter or receiver. Cables external to the filter are not of a critical length and may be shortened if required.

b. Rack Panel Mounted Units

(1) Carefully unpack the unit and check for concealed damage.

(2) The units are designed to mount on any standard 19-inch relay rack. Hardware is supplied for mounting units into Motorola outdoor base station cabinets.

(3) Select position in rack for best location of unit, i.e., closest proximity to associated equipment inputs and outputs.

(4) Mount unit in place in rack with appropriate mounting hardware. The hardware supplied is intended for use with Motorola base stations.

(5) Connect the filter and duplexer to the transmitter and receiver.

(6) Duplexers and filters must be installed with appropriate lengths of 50 ohm coaxial cable (not supplied) to fit the individual installation.

3. THEORY OF OPERATION

Each resonant cavity, technically a re-entrant quarter-wave resonator, is a very high-Q (low-loss) tunable tank circuit. The dimensions of each resonator are designed for minimum loss. The cavities are tuned to the required pass frequency by an adjustment which changes the length of the center conductor. Lower frequencies have more of the center conductor inside the cavity, higher frequencies have correspondingly less. Invar, a material with a very low temperature coefficient of expansion, is used for the tuning shaft to minimize detuning due to ambient temperature changes.

Each resonant cavity is fitted with a specially designed pair of coupling elements (loops or probes). These loops and probes efficiently convert energy from the 50 ohm coaxial cable to the correct mode inside the resonant structure.

When the cavity is not tuned to resonance, most of the energy is reflected. Only a small portion is able to excite the correct mode and reach the output element.

a. Passband Filters

Each passband cavity filter is provided with a set of adjustable coupling loops to supply varying degrees of selectivity. Coupling loop positions which provide a higher degree of selectivity also result in a higher insertion loss.

b. Pass-Reject Filters and Duplexers

The input and output coupling elements are placed very close to each other, to take advantage of mutual coupling. That is, a small amount of energy is always being transferred between coupling elements because of their proximity. At one frequency, the energy transferred by mutual coupling cancels the energy transferred across by the resonant mode within the cavity. Thus, at one frequency, there is a reject notch in addition to the selectivity of the cavity. When coupling loops are used, the notch occurs above the pass frequency; when coupling probes are used, the notch is below the pass frequency. The notch frequency is adjusted by changing the physical spacing between the coupling elements.

Cavities are used on each side of a duplexer. The cavities tuned to the lower carrier frequency use the coupling loops to notch out the higher carrier frequency, while the cavities tuned to the higher carrier frequency use coupling probes to notch out the lower carrier frequency. Odd quarter-wave coupling is used between cavities to obtain minimum pass frequency bandwidth and insertion loss.

4. INSTALLATION OF COUPLING ELEMENTS

Coupling elements are factory-installed in all T1500A Series Cavity Filters and Duplexers. There are three coupling element types: passband loops, notch loops, and notch probes (refer to Figures 2, 3, and 4). If it becomes necessary to change or install coupling elements, use the following procedure.

a. Passband Coupling Loops (Kits TLE6881A, TLE6882A and TLE6883A)

Models T1500A, T1505A, T1506A and T1507A employ passband loops. Unless otherwise specified on the factory order, the loops will be set for 1/2 dB insertion loss. The loops in the T1507A duplexer will be set for 1.0 dB.

Insertion loss of the filter is determined by the position in which the coupling loops are installed

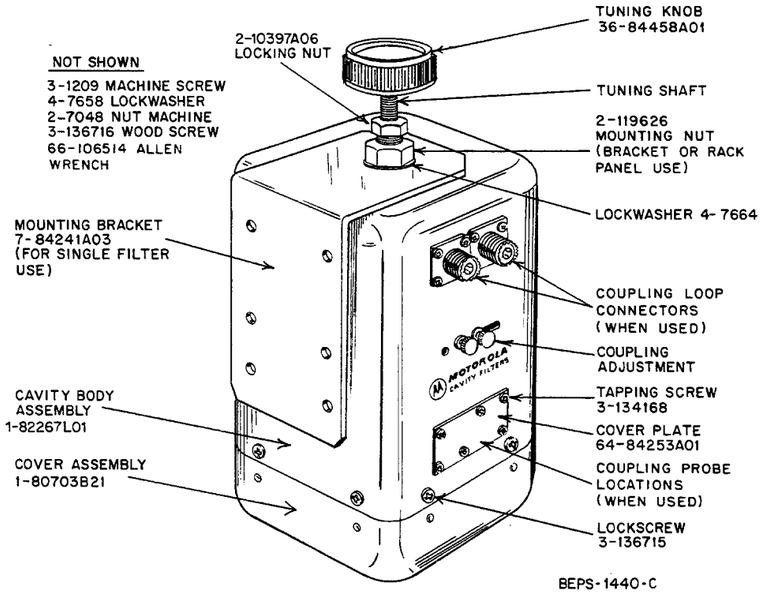


Figure 1.
Cavity Filter Parts Location Detail

PARTS LIST

TLE6420A Filter Cavity — PL-385-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	1-82267L01	CAVITY BODY ASSEMBLY:
	1-80703B21	COVER ASSEMBLY, cavity
	47-84255A01	PLUNGER
	47-84254A03	TUNING SHAFT
	41-84247A01	SPRING
	4-84250A01	WASHER (2 req'd)
	4-84251A01	WASHER
	64-84253A01	COVER PLATE, hole
	3-400356	SCREW, tapping: 4-24 x 1/4"; plain hex head; 6 req'd
	3-3375	SCREW, tapping: 6-20 x 5/16"; plain hex head; 8 req'd
	4-9777	LOCKWASHER, split: No. 4; 6 req'd
	2-119626	NUT, machine: 3/4-16 x 1-1/8" hex
	4-7664	LOCKWASHER: 3/4" internal
	36-84458A01	KNOB, tuning
	42-82388C05	RETAINING RING: "E" type
	2-10397A06	NUT, locking: #2-20

TLE6881A Passband Coupling Loop Kit (406-430 MHz) PL-1489-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	1-84448A03	COUPLING LOOP ASSEMBLY: fixed; right hand; coded GRN, RED (used for 1/2 and 1 dB insertion loss)
	1-84448A04	COUPLING LOOP ASSEMBLY: fixed; left hand; coded GRN, RED (used for 1/2 and 1 dB insertion loss)
	1-84448A07	COUPLING LOOP ASSEMBLY: fixed; right hand; coded BLK, GRN (used for 2.5 dB insertion loss)
	1-84448A08	COUPLING LOOP ASSEMBLY: fixed; left hand; coded BLK, GRN (used for 2.5 dB insertion loss)
	3-400356	SCREW, tapping: 4 x 1/4"; hex hd; 8 req'd.
	4-9777	LOCKWASHER, split: No. 4; 8 req'd.

TLE6882A Passband Coupling Loop Kit (430-470 MHz) PL-386-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	1-84448A01	COUPLING LOOP ASSEMBLY: fixed; right hand; coded BLK, RED (used for 1/2 and 1 dB insertion loss)
	1-84448A02	COUPLING LOOP ASSEMBLY: fixed; left hand; coded BLK, RED (used for 1/2 and 1 dB insertion loss)
	1-84448A09	COUPLING LOOP ASSEMBLY: fixed; right hand; coded RED, BLU (used for 2.5 dB insertion loss)
	1-84448A10	COUPLING LOOP ASSEMBLY: fixed; left hand; coded RED, BLU (used for 2.5 dB insertion loss)
	3-400356	SCREW, tapping: 4 x 1/4"; hex head; 8 req'd.
	4-9777	LOCKWASHER, split: No. 4; 8 req'd.

TLE6883A Passband Coupling Loop Kit (470-512 MHz) PL-1490-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	1-84448A05	COUPLING LOOP ASSEMBLY: fixed; right hand; coded BLK, BLU (used for 1/2 and 1 dB insertion loss)
	1-84448A06	COUPLING LOOP ASSEMBLY: fixed; left hand; coded BLK, BLU (used for 1/2 and 1 dB insertion loss)
	1-84448A11	COUPLING LOOP ASSEMBLY: fixed; right hand; coded BLU, GRN (used for 2.5 dB insertion loss)
	1-84448A12	COUPLING LOOP ASSEMBLY: fixed; left hand; coded BLU, GRN (used for 2.5 dB insertion loss)
	3-400356	SCREW, tapping: 4 x 1/4"; hex head; 8 req'd.
	4-9777	LOCKWASHER, split: No. 4; 8 req'd.

TLE6434A Notch Coupling Loop Kit — PL-387-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	9-82442E05	CONNECTOR, receptacle: 2 req'd.
	24-84238A01	LOOP, cavity (R.H.)
	24-84238A03	LOOP, cavity (L.H.)
	3-400356	SCREW, tapping: 4 x 1/4"; hex hd.; 8 req'd.
	4-9777	LOCKWASHER, split: No. 4; 8 req'd.
	4-82418B01	WASHER, nylon: 2 req'd.
	4-9746	LOCKWASHER: #8 med. split: 2 req'd.
	3-82245E04	SCREW, knurled head: 2 req'd. (TLE6432A)
	3-2949	SCREW, machine: 6-32 x 5/16" (TLE6434A)

TLE6433A Notch Coupling Probe Kit — PL-388-E

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	9-82442E05	CONNECTOR, receptacle: 2 req'd
	24-84239A01	PROBE, adjustable (R.H.)
	24-84239A03	PROBE, adjustable (L.H.)
	3-400356	SCREW, tapping: 4 x 1/4": hex hd.: 8 req'd.
	4-9777	LOCKWASHER, split: No. 4; 8 req'd.
	14-84240A01	INSULATOR, probe mounting: 2 req'd.
	4-9746	LOCKWASHER: #8 med. split: 2 req'd.
	2-84447A01	NUT, knurled: 2 req'd.
	4-82418B01	WASHER, insulating: 2 req'd.

TLN4031A Mounting Bracket Kit (1-Cavity) — PL-389-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	7-84241A03	BRACKET, cavity mtg
	3-1209	SCREW, machine: 10-32 x 1/2" slotted binder head (4 req'd)
	4-7658	LOCKWASHER: No. 10 internal (4 req'd)
	2-7048	NUT, machine: 10-32 x 5/16" hex (4 req'd)
	3-136716	SCREW, wood: No. 10 x 1-1/2" slotted round head (4 req'd)
	66-106514	WRENCH, ALLEN (#8)
	33-84002B01	NAMEPLATE, cavity

TLN4066A Mounting Panel Kit — PL-391-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	64-84242A03	PANEL, cavity mtg
	3-135038	SCREW, tapping: No. 14 x 3/4" Phillips pan head (4 req'd)
	2-82360B07	NUT, sheet spring: ("clip-on"); type "U" (4 req'd)
	4-812732	WASHER, cushion (4 req'd)
	66-106514	WRENCH, ALLEN (#8)
	33-84333B01	NAMEPLATE
	7-82537N01	BRACKET, duplexer cable
	42-10217A01	STRAP, tie

TLN4104A and TLN4202A Miscellaneous Parts Kit — PL-392-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	9-86150	CONNECTOR, adapter: uhf; "tee" type
	58-109152	CONNECTOR, adapter: uhf; "feed-through" type
	28-82021G01	CONNECTOR, plug: male; uhf; 4 req'd. (TLN4104A only)

CABLE KITS

PL-1491-C

CABLE KIT NUMBER	LOOSE CONNECTORS INCLUDED IN KIT		CABLE ASSEMBLIES INCLUDED IN KIT		ITEMS INCLUDED IN CABLE ASSEMBLY		
	CONNECTOR: COAXIAL; "TEE" TYPE; PART NO. 9-86150 (FOR QUANTITY REQUIRED, SEE BELOW)	CONNECTOR: COAXIAL; FEED-THRU TYPE; PART NO. 58-109152 (FOR QUANTITY REQUIRED, SEE BELOW)	PART NUMBER	COLOR CODE	CABLE, RF: COAXIAL; TYPE RG-142 B/U; PART NO. 30-83278B01 (FOR LENGTH REQUIRED, SEE BELOW)	CONNECTOR, MALE: COAXIAL; UHF TYPE; PART NO. 28-82021G01 (FOR QUANTITY REQUIRED, SEE BELOW)	ADAPTER, CABLE: PART NO. 58-854020 (FOR QUANTITY REQUIRED, SEE BELOW)
TKN6535A	--	--	1-84459A13	BLK, RED	14-1/4"	2	2
TKN6536A	--	--	1-84459A23	BLK	13-3/8"	2	2
TKN6537A	--	--	1-84459A19	BRN, GRN	11-3/4"	2	2
TKN6538A	--	--	1-84459A18	BRN, BLU	6-3/8"	2	2
			1-84459A04	ORG	9-3/4"	2	2
TKN6539A	--	--	1-84459A12	RED, YEL	5-3/4"	2	2
			1-84459A06	GRN	8-3/4"	2	2
TKN6540A	--	--	1-84459A05	YEL	5-1/4"	2	2
			1-84459A16	BLK, BLU	8"	2	2
TKN6541A	--	--	1-84459A18	BRN, BLU	6-3/8"	2	2
			1-84459A04	ORG	9-3/4"	2	2
			1-84459A14	BLK, YEL	10-1/2"	2	2
			1-84459A15	BLK, GRN	9-3/8"	2	2
TKN6542A	--	--	1-84459A12	RED, YEL	5-3/4"	2	2
			1-84459A06	GRN	8-3/4"	2	2
			1-84459A04	ORG	9-3/4"	2	2
			1-84459A07	BLU	8-1/2"	2	2
TKN6543A	--	--	1-84459A05	YEL	5-1/4"	2	2
			1-84459A16	BLK, BLU	8"	2	2
			1-84459A15	BLK, GRN	9-3/8"	2	2
			1-84459A20	BRN, YEL	7-7/8"	2	2
TKN6544A	--	--	*1-84459A15	BLK, GRN	9-3/8"	2	2
TKN6545A	--	--	*1-84459A07	BLU	8-1/2"	2	2
TKN6546A	--	--	*1-84459A20	BRN, YEL	7-7/8"	2	2
TKN6549A	--	--	*1-84459A15	BLK, GRN	9-3/8"	2	2
			*1-84459A04	ORG	9-3/4"	2	2
TKN6550A	--	--	*1-84459A07	BLU	8-1/2"	2	2
			*1-84459A06	GRN	8-3/4"	2	2
TKN6551A	--	--	*1-84459A20	BRN, YEL	7-7/8"	2	2
			*1-84459A16	BLK, BLU	8"	2	2
TKN6552A	1	1	*1-84459A16	BLK, BLU	8"	2	2
TKN6553A	1	1	*1-84459A10	VIO	7-3/8"	2	2
TKN6554A	1	1	*1-84459A21	BRN, RED	6-7/8"	2	2
TKN6555A	1	1	*1-84459A17	BRN, GRA	17-3/4"	2	2
TKN6556A	1	1	*1-84459A11	GRA	15-3/4"	2	2
TKN6557A	1	1	*1-84459A22	RED, BLU	14-3/4"	2	2
TKN6558A	1	1	*1-84459A04	ORG	9-3/4"	2	2
TKN6559A	1	1	*1-84459A06	GRN	8-3/4"	2	2
TKN6560A	1	1	*1-84459A16	BLK, BLU	8"	2	2

* (2) SUPPLIED

TABLE I

MODEL T1502A

FREQ. RANGE	CABLE KIT	"E" CODE
406-430 MHz	TKN6535A	BLK-RED
430-470 MHz	TKN6536A	BLACK
470-512 MHz	TKN6537A	BRN-GRN

MODEL T1502A

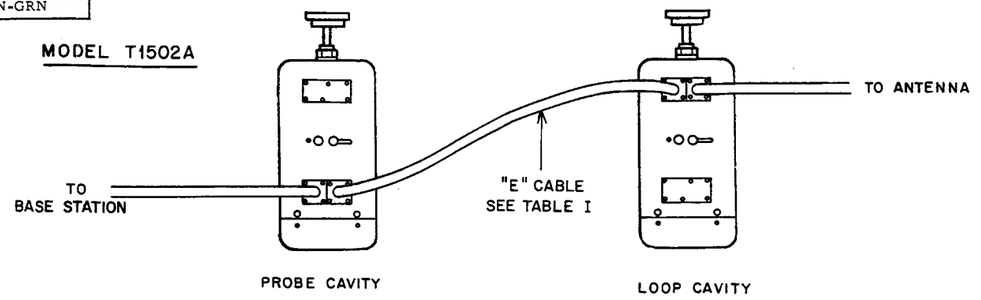


TABLE II

MODEL T1503A

FREQ. RANGE	CABLE KIT	"A" CODE	"B" CODE
406-430 MHz	TKN6538A	BRN-BLU	ORG
430-470 MHz	TKN6539A	RED-YEL	GRN
470-512 MHz	TKN6540A	YEL	BLK-BLU

MODEL T1503A

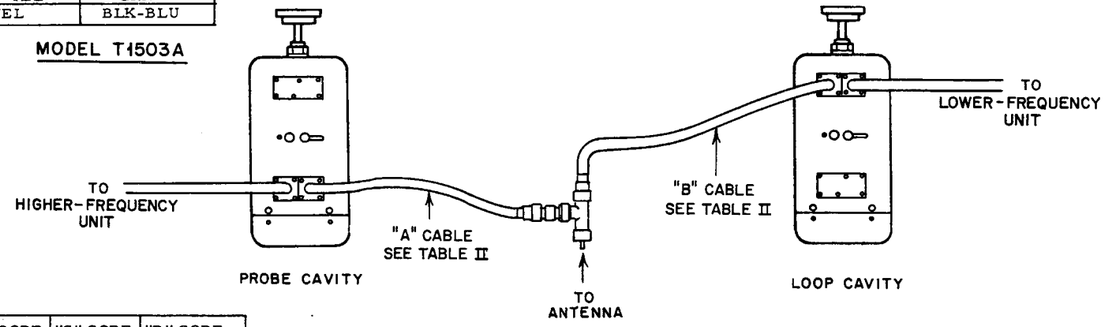
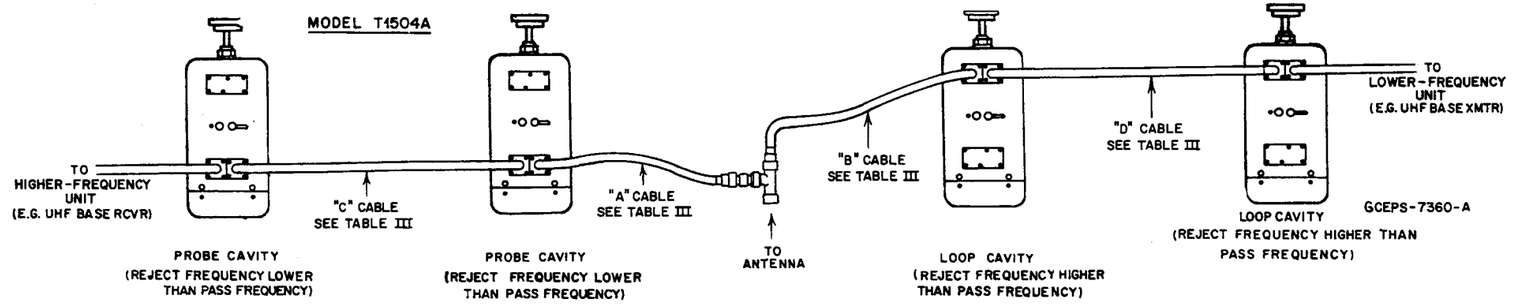


TABLE III

MODEL T1504A

FREQ. RANGE	CABLE KIT	"A" CODE	"B" CODE	"C" CODE	"D" CODE
406-430 MHz	TKN6541A	BRN-BLU	ORG	BLK-YEL	BLK-GRN
430-470 MHz	TKN6542A	RED-YEL	GRN	ORG	BLU
470-512 MHz	TKN6543A	YEL	BLK-BLU	BLK-GRN	BRN-YEL

MODEL T1504A



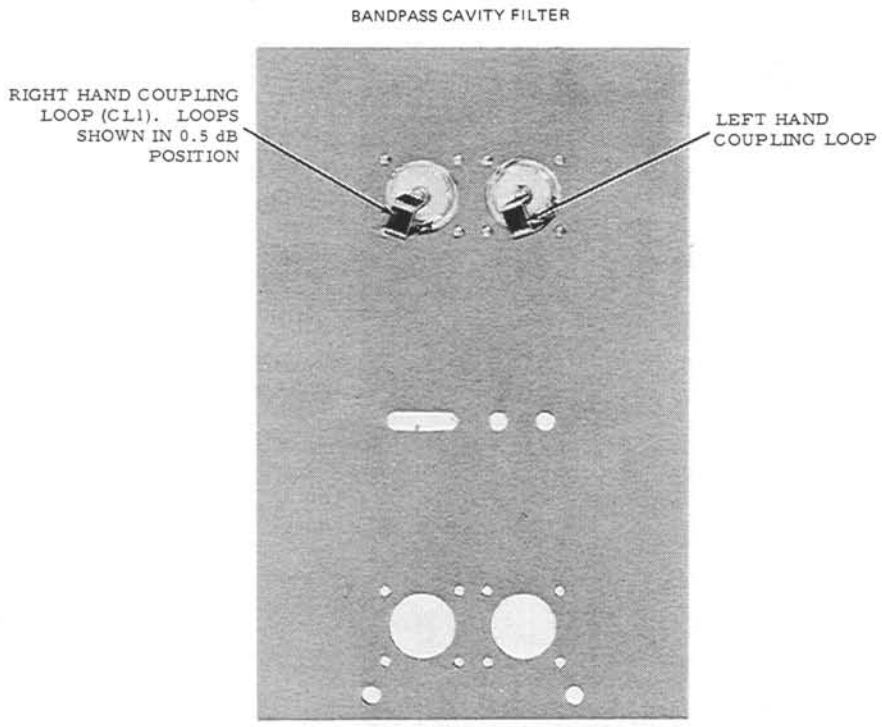


Figure 2. FAEPS-2623-A
Passband Coupling Loop Kit
(TLE6881A, TLE6882A, & TLE6883A)
(Interior View)

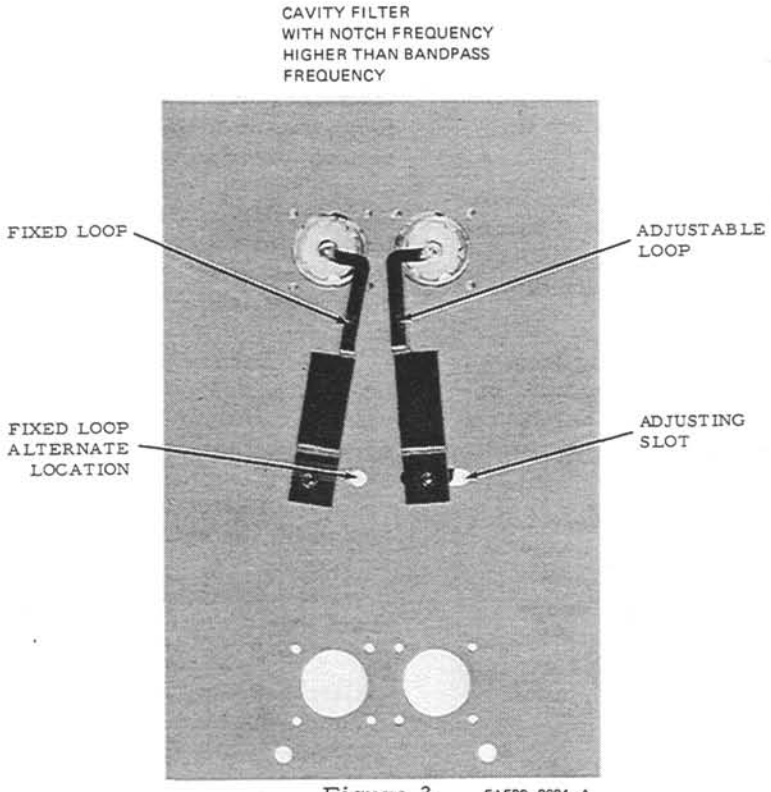


Figure 3. FAEPS-2624-A
TLE6432A (Loops Coded YEL, BLU)
TLE6434A (Loops Coded GRAY, VIOLET)
Notch Coupling Loop Kit
(Interior View)

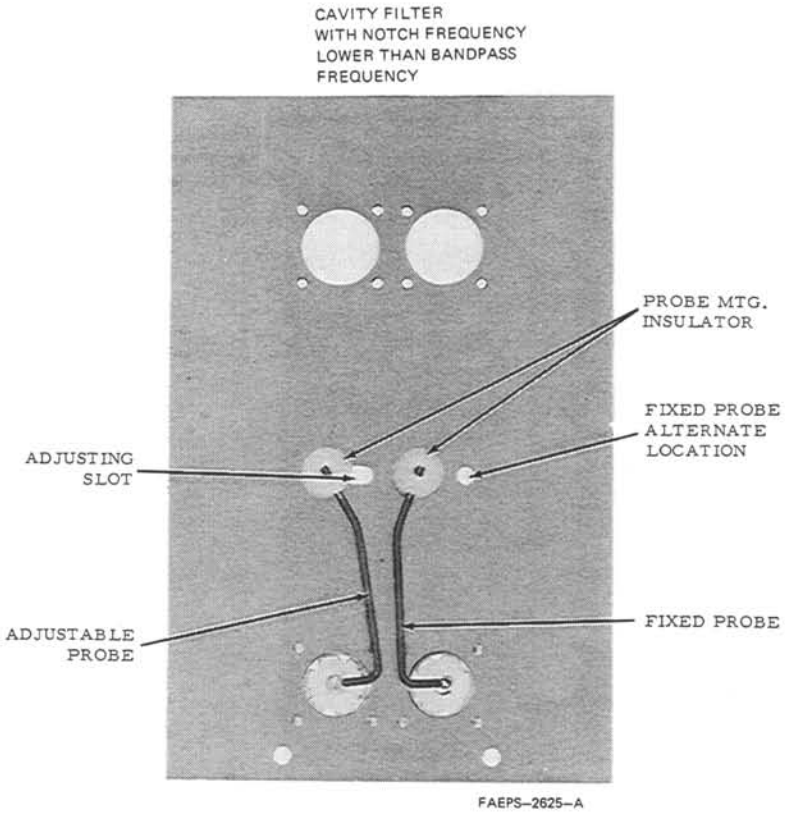


Figure 4.
TLE6433A Notch Coupling Probe Kit
(Interior View)

in the filter cavity. The loops may be properly oriented by referring to Figure 5. Select the desired insertion loss configuration.

(1) Place the left-hand coupling loop in the left coupling loop opening in the cavity. Position the loop with the dots in the proper position as shown in Figure 5. Fasten in place with the mounting hardware supplied.

(2) Install the right-hand coupling loop, properly oriented, in the right-hand opening of the cavity. Secure with the mounting hardware provided.

NOTE

When changing from 0.5 dB to either 1.0 or 2.5 dB settings, CL1 must be removed from the cavity and exchanged with the other coupling loop, rotating both loops to the correct position as shown in Figure 5. In the 2.5 dB insertion loss position, use the auxiliary set of loops supplied with the cavity.

b. Notch Coupling Loops (Kit TLE6432A)

Models T1501AH, T1502A, T1503A and T1504A employ notch coupling loops. These have a fixed insertion loss of 0.5 - 0.7 dB when correctly installed. Refer to Figure 3. The notch coupling loops can be installed without removing the cavity bottom cover assembly.

(1) Place the adjustable loop in the right-hand position so that the extruded and tapped hole in the loop lines up with the adjusting slot in the cavity body assembly.

(2) Secure the adjustable loop to the cavity body with a knurled machine screw provided, using a lockwasher and plastic washer under the screw head.

(3) Fasten the UHF connector to the cavity body with the self-tapping hardware provided.

(4) Determine the correct location for the fixed loop.

If the required separation between the filter pass and reject frequencies is greater than 2 and less than 5 MHz, use the fixed location closest to the adjusting slot.

If the required separation is greater than 5 MHz and less than 8 MHz, use the fixed location furthest from the adjusting slot, and use loop kit Model TLE6434A.

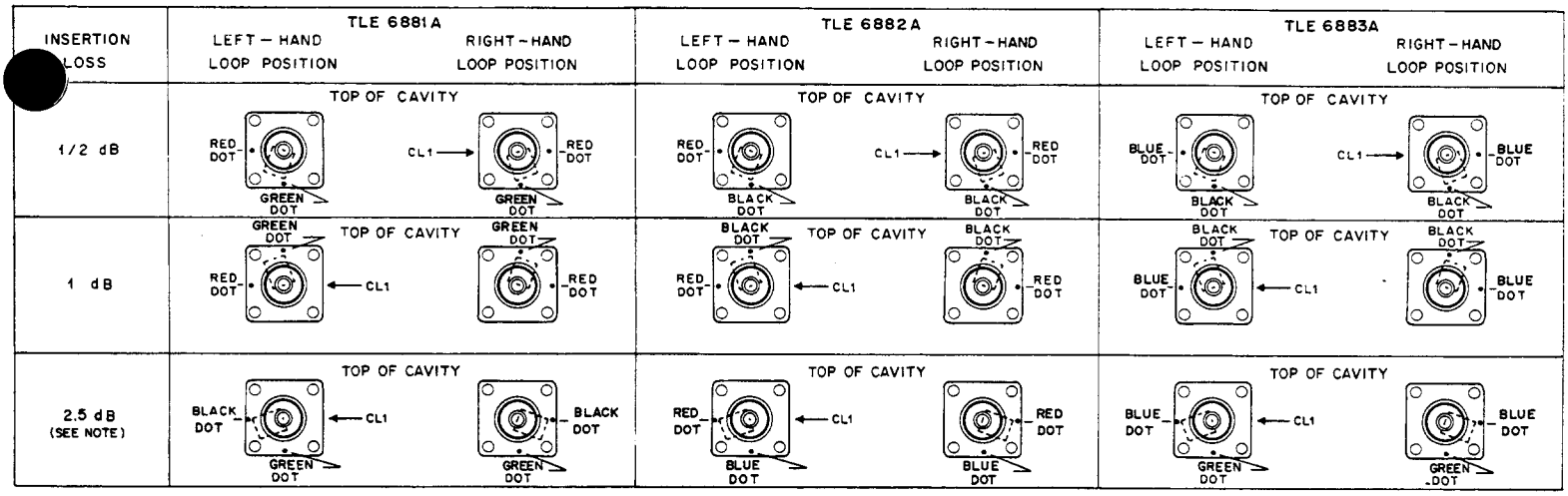


Figure 5.
Passband Coupling Loop Positions
(Exterior View)

(5) Place the fixed loop in the left-hand position so that the extruded and tapped hole in the loop lines up with the desired fixed hold location in the cavity body.

(6) Secure the fixed loop to the cavity body with a knurled machine screw provided, using a lockwasher and plastic washer under the screw head.

(7) Fasten the UHF connector to the cavity body with the self-tapping hardware provided.

c. Notch Coupling Probes (Kit TLE6433A)

Models T1501AL, T1502A, T1503A and T1504A employ notch coupling probes. These have a fixed insertion loss of 0.5-0.7 dB when correctly installed. Refer to Figure 4.

(1) Remove the cavity bottom cover assembly.

(2) Place a mounting insulator on the adjustable probe.

(3) Insert the adjustable probe and the mounting insulator into the right-hand loop position so that the copper threaded stem of the mounting insulator extends through the adjusting slot in the cavity body.

(4) Secure the adjustable probe to the cavity body with a knurled nut provided, using a lockwasher and plastic washer under the nut.

(5) Fasten the UHF connector to the cavity body with the self-tapping hardware provided.

(6) Determine the correct location for the fixed probe.

If the required separation between filter pass and reject frequencies is greater than 2 MHz and less than or equal to 5 MHz, use the fixed location closest to the adjusting slot.

If the required separation is greater than 5 MHz and less than 8 MHz, use the fixed location furthest from the adjusting slot.

(7) Place the fixed probe in the left-hand position so that the mounting insulator stud extends through the desired fixed hole location in the cavity body.

(8) Secure the fixed probe to the cavity body with a knurled nut provided, using a lockwasher and plastic washer under the nut.

(9) Fasten the UHF connector to the cavity body with the self-tapping hardware provided.

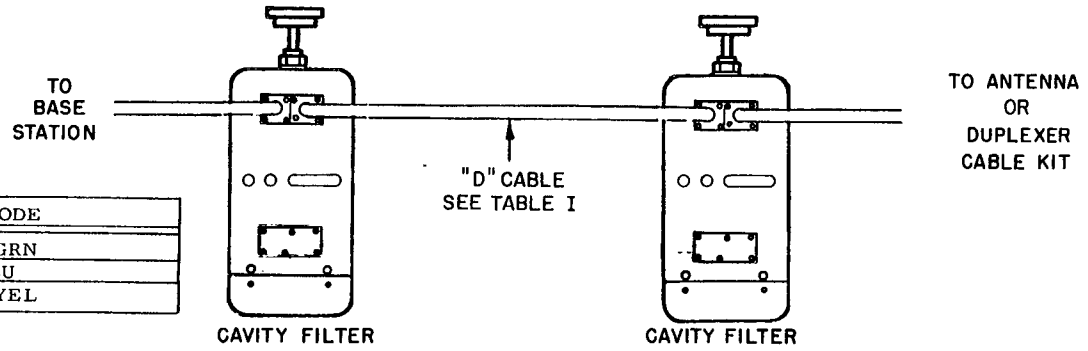
(10) Replace the cavity bottom cover assembly.

MODEL T1505A

TABLE I

MODELS T1505A & T1506A

FREQ. RANGE	CABLE KIT	"D" CODE
406-430 MHz	TKN6544A	BLK-GRN
430-470 MHz	TKN6545A	BLU
470-512 MHz	TKN6546A	BRN-YEL



MODEL T1506A

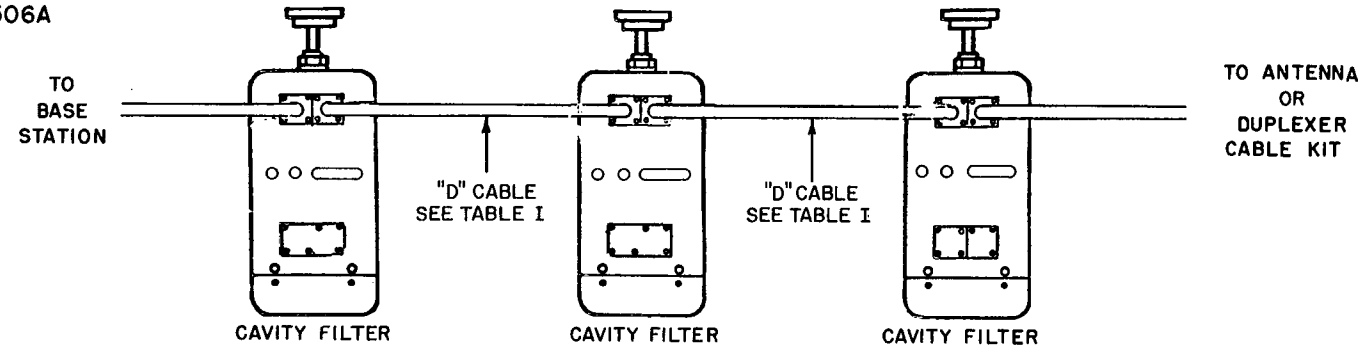
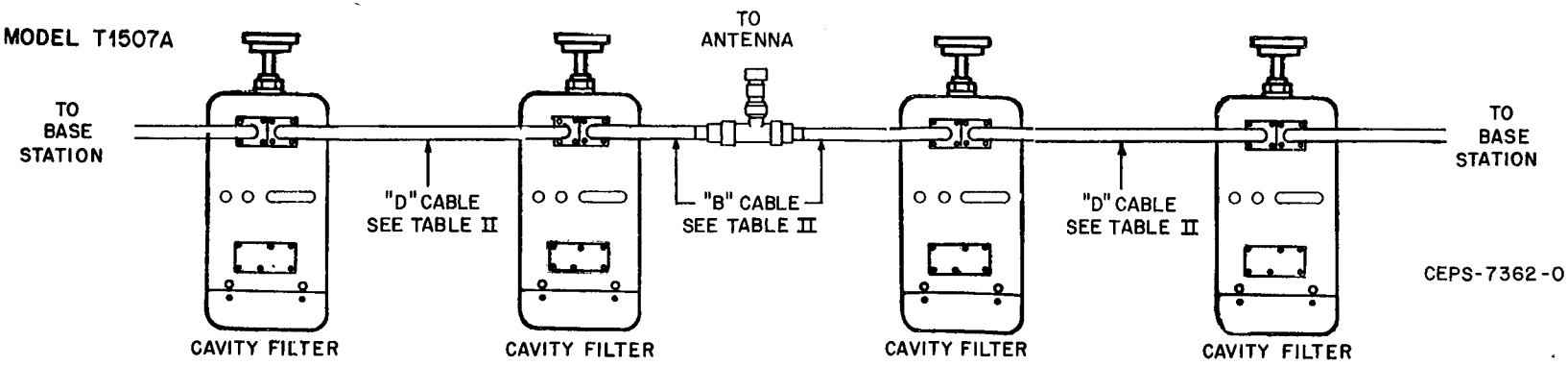


TABLE II

MODEL T1507A

FREQ. RANGE	CABLE KIT	"D" CODE	"B" CODE
406-430 MHz	TKN6549A	BLK-GRN	ORG
430-470 MHz	TKN6550A	BLU	GRN
470-512 MHz	TKN6551A	BRN-YEL	BLK-BLU

MODEL T1507A



CEPS-7362-0

Figure 6. Passband Filter and Duplexer Cabling Details

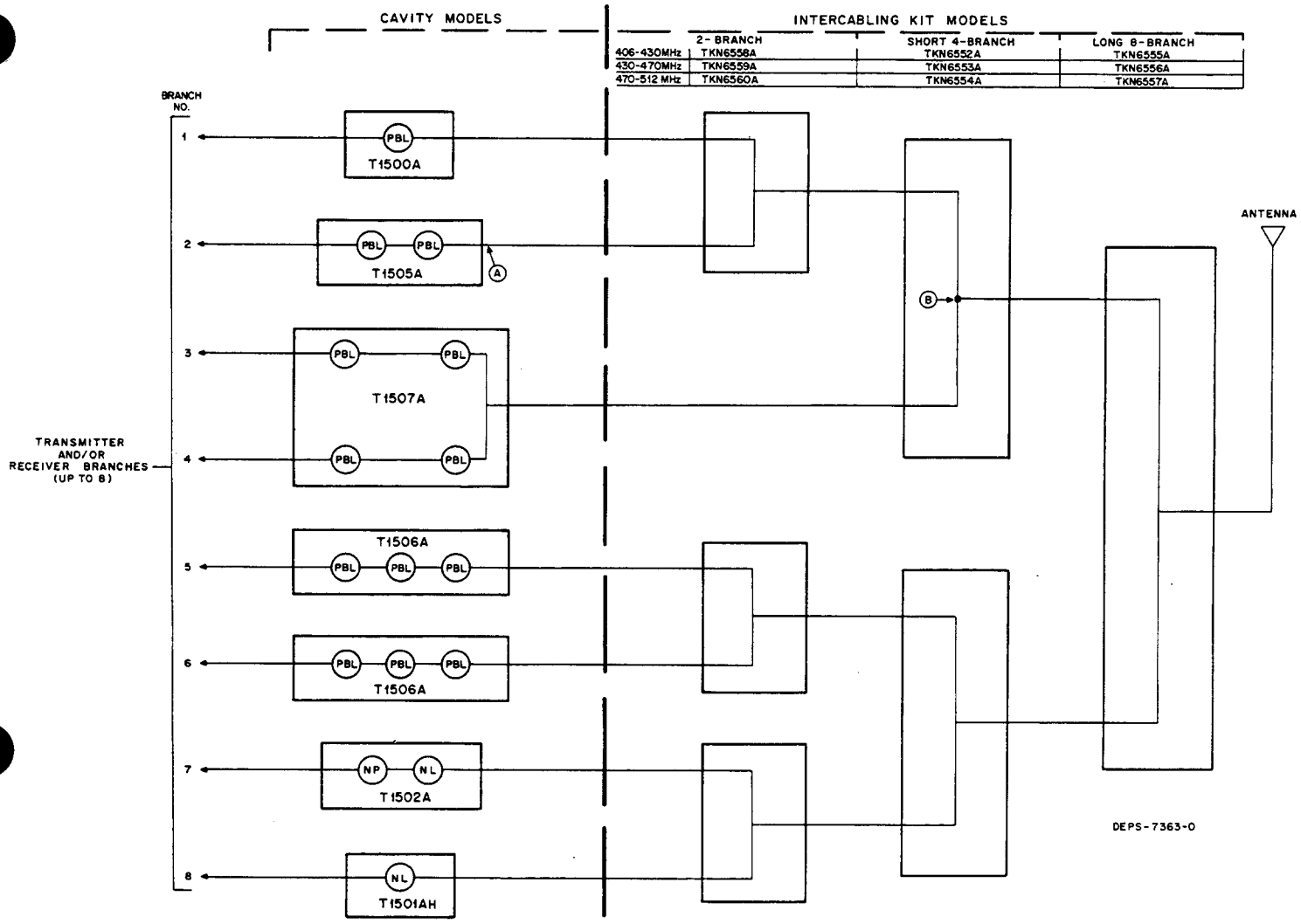


Figure 7.
Intercabling Diagram for Multiplexing Applications

NOTES:

1. PBL = PASSBAND LOOP; NP = NOTCH PROBE; NL = NOTCH LOOP
2. IF A T1502A CAVITY FILTER IS USED, AS IN BRANCH NO. 7, THE NOTCH COUPLING LOOP MUST BE CONNECTED TO THE INTER-CABLING KIT.
3. IF A T1501AL CAVITY FILTER IS USED INSTEAD OF A T1501AH CAVITY FILTER IN BRANCH NO. 8, ONE OF THE FOLLOWING CABLE KITS IS REQUIRED.

406-430 MHz	TKN6538A
430-470 MHz	TKN6539A
470-512 MHz	TKN6540A

4. IF AN ODD NUMBER OF BRANCHES ARE REQUIRED (FOR EXAMPLE, IF BRANCH NO. 1 IS NOT REQUIRED), THEN POINT (A) ON BRANCH NO. 2 MUST BE CONNECTED TO THE 4-BRANCH CABLE KIT (POINT (B)) WITH ONE OF THE FOLLOWING CABLE ASSEMBLIES:

406-430 MHz	1-84459A04
430-470 MHz	1-84459A06
470-512 MHz	1-84459A16

EPS-7367-O

5. MULTIPLEXING

a. Applications

Motorola offers three duplexer packages, Models T1503A, T1504A and T1507A for use with repeaters. For systems requiring more than two inputs to a common antenna, T1500A Series Motorola Cavity Filters may be converted to a multiplexer configuration with three optional intercabling kits.

Figure 6 illustrates two models of passband filters and a passband duplexer and Figure 7 shows a possible multiplexing application involving eight inputs (branches).

Figure 7 constitutes only one of several thousand possible networks, each one highly dependent upon the base station equipment and frequencies used. Consult your Motorola Area Systems Engineering Department for assistance with your particular requirements.

b. Isolation

The Passband Filter Isolation Curves in Figure 16 are included for your reference. These curves show the typical isolations provided by each filter model, when used in a duplexer or multiplexer configuration.

Figure 14 details the kits and insertion loss settings available from the factory. Isolation in Figure 16 is measured between points #1 and #2 as shown in Figure 14.

6. RECOMMENDED TUNING PROCEDURES

All filters and duplexers are tuned to the customer-specified frequencies prior to shipment from the factory. If system performance indicates the duplexer is detuned, one of the following procedures may be used. Do not attempt to retune unless the following procedures have been read, and do not attempt to "touch-up" the tuning unless the complete tuning procedure is going to be followed.

a. Method 1 (Models T1503A, AF and T1504A, AF)

(1) Recommended Test Equipment

(a) "Motorola" Model S1341A or S1342A Signal Generator.

(b) Tunable receiver or two "Motorola" receivers, one tuned to each of the frequencies to be duplexed.

(2) Tuning Procedure (refer to Figure 8)

(a) With the signal generator and the receiver tuned to the pass frequency, adjust the center conductor of the cavity for minimum signal loss through the cavity.

(b) With the signal generator and the receiver tuned to the reject frequency, adjust the movable loop for maximum signal loss through the cavity. To do this, loosen the knurled screw slightly. Move the screw until minimum signal is received and then re-tighten the screw. The screw may move slightly when it is tightened, so it is advisable to have the screw tight enough so that the screw can barely be moved when adjusting.

(c) Steps (1) and (2) should be repeated for every cavity in the duplexer.

(d) Connect the duplexer to the transmitter, receiver and antenna with 50-ohm coaxial cable (not supplied). Adjust the transmitter final amplifier for rated power into the duplexer. After all tuning is complete, the tuning knobs may be removed to prevent accidental detuning or tampering by unauthorized personnel.

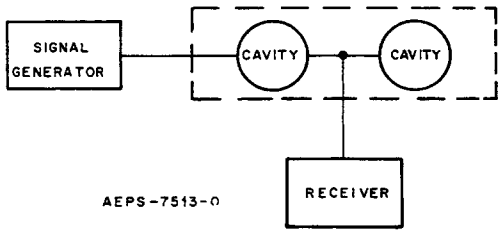


Figure 8.
Method 1 Test Set-Up

b. Method 2 (Models T1503A, AF and T1504A, AF)

(1) Recommended Test Equipment

(a) Mixer circuit constructed as shown in Figure 9.

(b) "Motorola" Model S1341A, S1342A or R1201A Signal Generator.

(c) IF output from an S1318A or R1201A Signal Generator equal to the duplex frequency separation or a "Motorola" S1056A/B Portable Test Set with a crystal frequency equal to the duplex frequency separation.

(d) "Motorola Wattmeter with appropriate elements.

(e) "Motorola" T1013A RF Load Resistor.

(f) Isolated Tee connector (construct this by removing the Tee port of a UHF Tee connector). This provides 30 to 40 dB of isolation between the shunt path and the direct path through the Tee to protect the receiver when the transmitter is keyed.

(g) Transmitter and receiver from the station to be duplexed

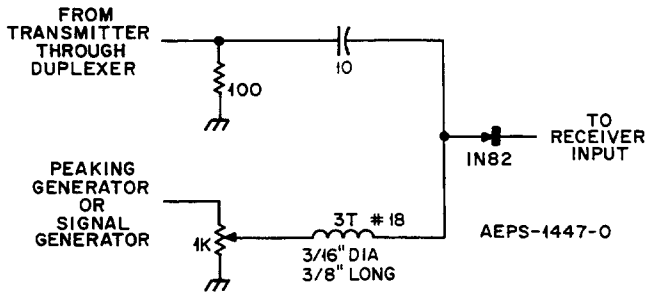


Figure 9.
Mixer Circuit

(2) Operation of the Mixer Circuit

Alignment of the duplexers can be simplified by using the mixer circuit shown in Figure 9. The mixer receives inputs from the transmitter and a low frequency source. The outputs from the mixer are frequencies above and below the transmitter frequencies at separations equal to the output of the low frequency generator.

The receiver will respond to one of the mixer products and thus can be used indirectly to detect the transmitter frequency.

(3) Tuning Procedure for Transmitter Branch of the Duplexer

(a) Connect the equipment as shown in Figure 10.

(b) Adjust the center conductors of the transmitter cavities for maximum wattmeter readings.

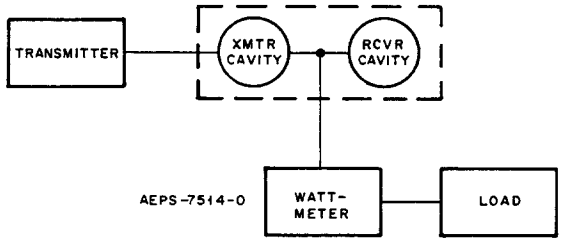


Figure 10.
Method 2 Transmitter Branch Pass Test Set-Up

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

(d) Tune the signal generator to the exact receiver frequency. Adjust the movable loop for maximum loss through the cavity. Refer to Method 1 for adjustment aids.

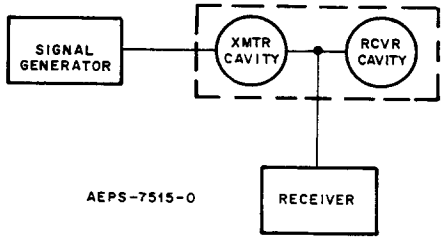


Figure 11.
Method 2 Transmitter Branch Reject Test Set-Up

(4) Tuning Procedure for Receiver Branch of the Duplexer

(a) Connect the equipment as shown in Figure 12.

(b) Tune the signal generator to the exact receiver frequency. Adjust the center conductors of the receiver cavities for minimum loss through the cavities (maximum receiver signal).

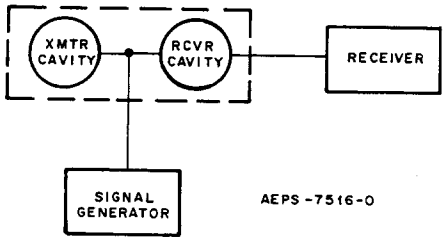


Figure 12.
Method 2 Receiver Branch Pass Test Set-Up

(c) Connect the equipment as shown in Figure 13.

(d) Set the local oscillator source to the exact duplex frequency separation. Adjust the movable loop for maximum loss through the cavity (minimum signal to the receiver). Refer to Method 1 for adjustment aids.

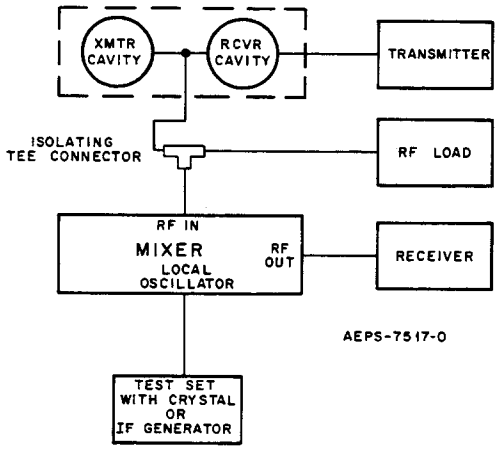


Figure 13.
Method 2 Receiver Branch Reject Test Set-Up

(5) Connect the duplexer to the transmitter, receiver and antenna with 50-ohm coaxial cable (not supplied). Adjust the transmitter final amplifier for rated power into the duplexer. After all tuning is complete, the tuning knobs may be removed to prevent accidental detuning or tampering by unauthorized personnel.

c. Tuning Procedures for all other Models

(1) Models T1501AH and T1501AL may be tuned by Method 1 or Method 2 using only the single cavity instead of a duplexer. Depending on the method used, omit either step (d) -- Method 1 -- or step (5) -- Method 2.

(2) Models T1500A, T1505A, T1506A and T1507A have only passband loops but no notch loops and probes. They may be tuned by using only steps (3) (a) and (b), and steps (4) (a) and (b) of Method 2.

(3) Model T1502A may be tuned by tuning each center conductor for minimum loss through the cavities. This should be adequate unless the reject frequencies also require retuning. If this is the case, use Method 1 with a tunable receiver but omit step (d).

7. ALTERNATE TUNING PROCEDURE

If the preceding methods can not be used, all models may be tuned using the following methods.

a. Cavity Tuning in Receiver Applications

Tuning cavities for receiver branch circuits entails individual tuning of each cavity in a multiple-cavity setup followed by repeaking of the group of cavities connected in their normal configuration. Individual tuning of each cavity requires disconnection of the cavity from its associated cabling, and connection to a signal generator and receiver. After each cavity is tuned, the intercabling must be reconnected and the final adjustment is made to the combined set of cavity resonators, using the same test equipment.

(1) Passband Tuning-Receiver Applications

(a) Connect the test set cable to the receiver meter socket. Set the test set to read meter position 4.

(b) Connect the signal generator to the receiver input. Set the signal generator "on-frequency" by adjusting the signal generator frequency for zero reading on meter position 4 (discriminator).

(c) Disconnect the signal generator from the receiver input and connect it to the input of the cavity to be tuned.

(d) Connect the output of the cavity to the receiver input.

(e) Set the test set to read meter position 1.

(f) Adjust the signal generator output to produce a usable reading on test set meter position 1. Keep the level below saturation.

(g) Tune cavity for maximum meter reading by adjusting the tuning knob on top of the cavity. One turn of the tuning knob will change the resonance point approximately 1.8 MHz. Keep

the meter reading below the point of saturation by reducing generator output as necessary.

(h) After the cavity is tuned for a peak reading, disconnect the test cables and reconnect the proper operating cables.

(2) Rejection Notch Tuning - Receiver Applications

(a) Connect the dummy load to the antenna receptacle.

(b) Loosely couple the signal generator to the receiver by proximity radiation to the front end, or with an isolating tee connector inserted in the antenna line.

CAUTION

This isolation must be used to protect the signal source from destruction by transmitter rf power.

(c) With the transmitter off, measure the quieting sensitivity of the receiver.

(d) With the transmitter keyed, repeat the quieting sensitivity measurement.

(e) Adjust the loops or probes for maximum quieting sensitivity as measured with the transmitter keyed. Turn transmitter off when making adjustments. As a general guide, the spacing of the loops or probes will be directly proportional to the spacing of the transmit and receive frequencies; i.e., if the transmit and receive frequencies are widely separated, the loops or probes will be widely spaced near the end of their mechanical limit; if the frequencies are close together, the loops or probes will be relatively close together.

(f) After the loops or probes are properly adjusted, lock them in place by tightening the knurled knob.

(g) Adjust the tuning shaft a maximum of 10-15° to peak up the notch.

b. Cavity Tuning in Transmitter Applications

Tuning transmitter branch cavity circuits entails individual tuning of each cavity in a multiple-cavity setup followed by repeaking of the group of cavities connected in their normal configuration. Individual cavity tuning requires disconnection of the cavity from its associated cabling, and connection to the transmitter and wattmeter for passband tuning, or to the signal generator and receiver for notch tuning. After each cavity is tuned, the intercabling must be reconnected and final adjustment must be made to the combined set of cavity resonators, using the same test equipment.

(1) Passband Tuning - Transmitter Applications

(a) Connect the transmitter to the wattmeter. Connect the wattmeter to the rf load resistor.

(b) Key the transmitter and adjust the transmitter tuning according to the alignment procedure given in the appropriate instruction manual.

(c) After the transmitter is correctly tuned, unkey the transmitter and disconnect the wattmeter from the transmitter.

(d) Connect the transmitter to the cavity input. Connect the wattmeter to the cavity output. Leave the rf load resistor connected to the wattmeter.

(e) If the transmitter is equipped with a TUNE-OPERATE switch, HIGH-LOW switch, or other means of reducing power, set the transmitter to this low-power position.

(f) Key the transmitter, and adjust the tuning knob on the top of the cavity for maximum forward power. One turn of the tuning knob will change the resonance point approximately 1.8 MHz. After the cavity tuning is peaked, switch the transmitter to its full power position and repeak the cavity, if necessary.

(g) Repeat the tuning procedure for each cavity in multiple-cavity setups.

(h) After each cavity has been tuned individually, connect all cavities in a multiple-cavity setup for normal use and check the tuning of the entire group.

(i) Remove the rf load resistor and connect the antenna. Adjust the transmitter final amplifier slightly for rated power output into the cavity filter.

(2) Rejection Notch Tuning - Transmitter Applications

Cavities connected in the transmitter branch lines must be tuned individually. Presuming that the cavities are to be tuned for rejection on

the receiver frequency, the associated receiver may be employed in the tuning process.

(a) Disconnect the cavity to be tuned from its normal cabling.

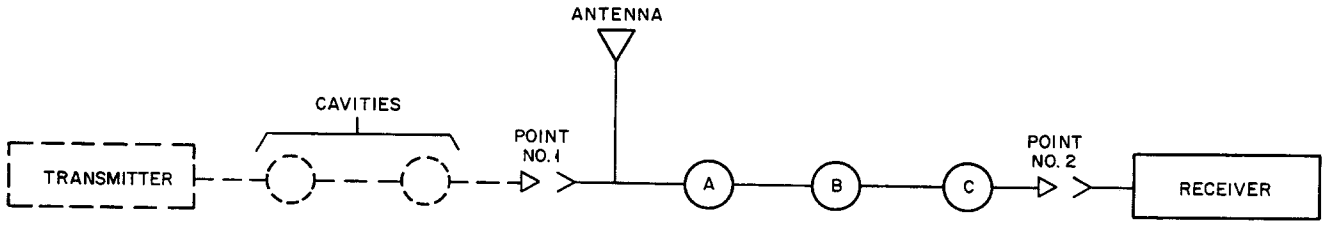
(b) Connect the signal generator to the cavity input; connect the cavity output to the receiver input.

(c) With the signal generator set on the desired frequency, adjust the cavity loop or probe for maximum attenuation of the injected signal. To adjust a loop or probe, loosen the knurled knob on the side of the cavity and move the knob in the slot in the housing.

(d) When the loop or probe is properly positioned for maximum attenuation of the test signal, lock it in place.

(e) Adjust the tuning shaft a maximum of 10-15° to peak up the notch.

(f) In multiple-cavity installations, repeat the tuning procedure for each cavity in the chain.



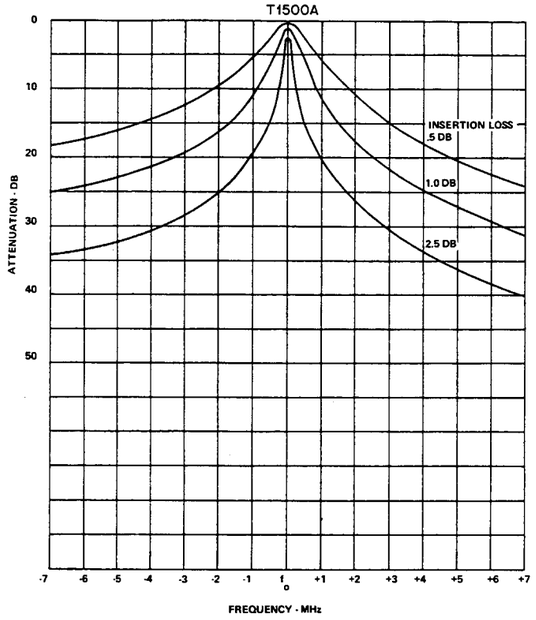
BEPS-7364-A

MODEL	COUPLING LOOPS			TOTAL INSERTION LOSS
	A	B	C	
T1500A	0.5			0.5
	1.0			1.0
	2.5*			2.5
T1505A	0.5	0.5		1.0
	1.0	1.0		2.0
	2.5*	1.0		3.5
T1506A	0.5	0.5	0.5	1.5
	1.0	1.0	1.0	3.0
	2.5*	1.0	1.0	4.5
T1507A	SAME VALUES AS T1505A FOR EACH LEG			

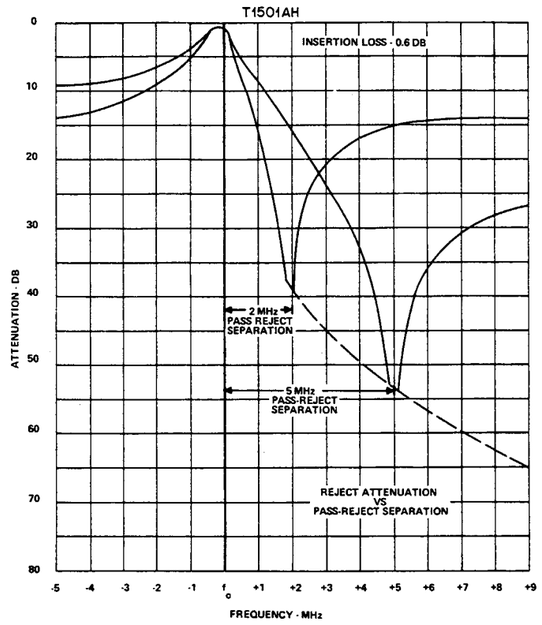
NOTE: ALL VALUES ARE IN DB'S
* USE AUXILIARY LOOPS IN THIS APPLICATION.

Figure 14.
Isolation Measurement Diagram

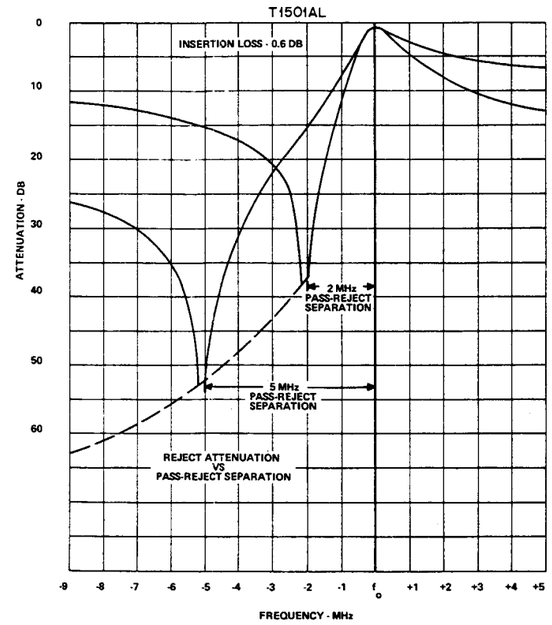
PASSBAND COUPLING
LOOP FILTER
T1500A



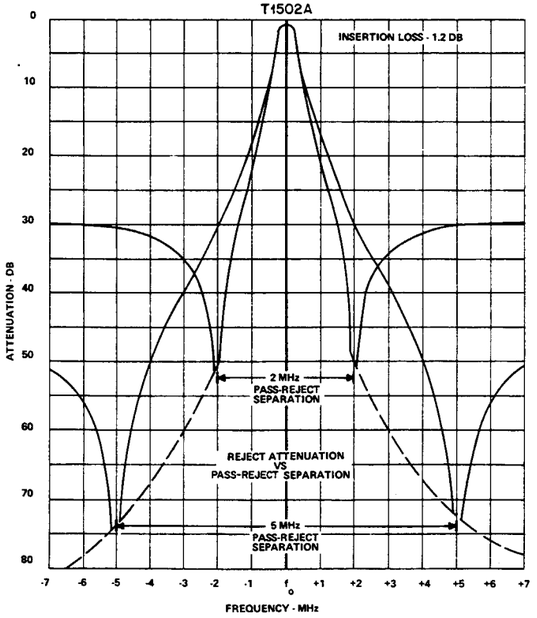
NOTCH LOOP FILTER
T1501AH



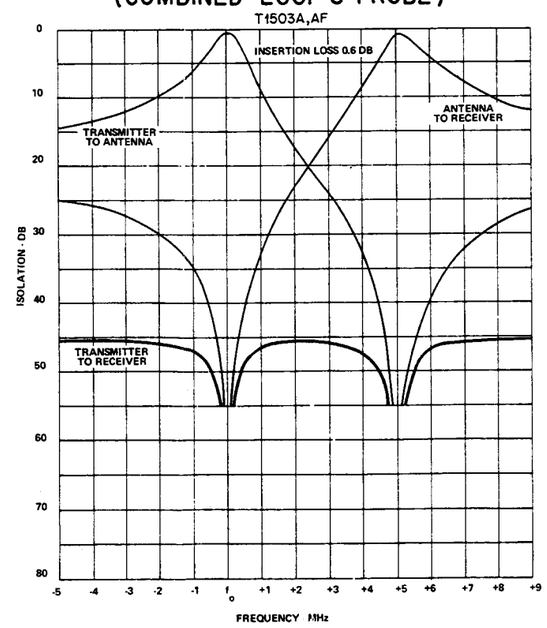
NOTCH PROBE FILTER
T1501AL



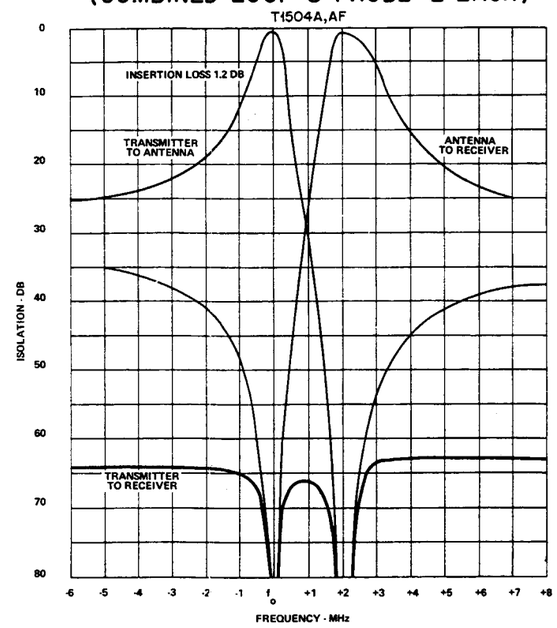
COMBINED LOOP 8
PROBE FILTER
T1502A



PASS-REJECT DUPLEXER
(COMBINED LOOP 8 PROBE)
T1503A,AF

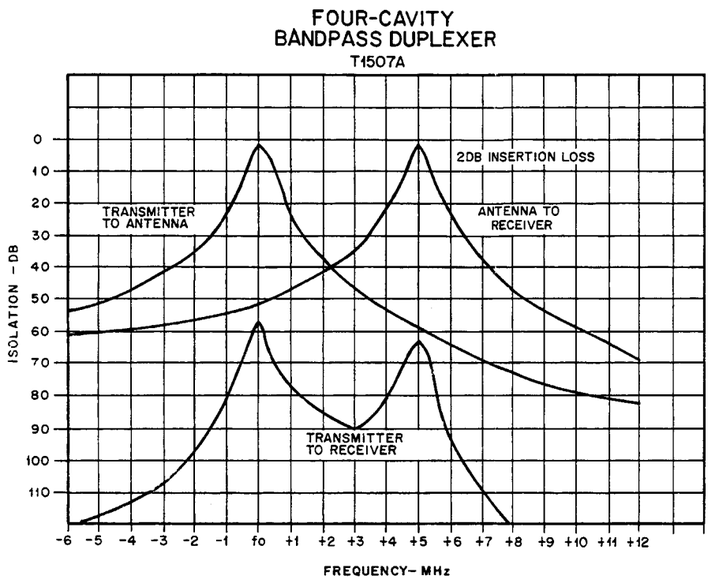


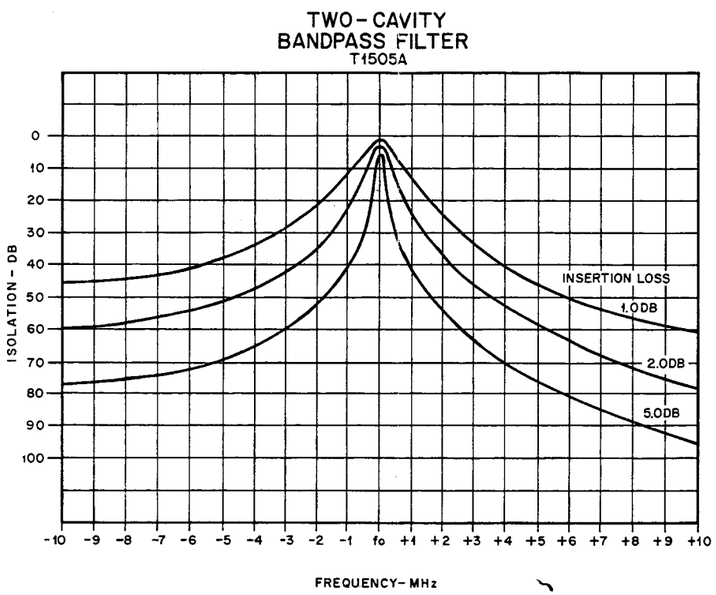
PASS-REJECT DUPLEXER
(COMBINED LOOP 8 PROBE-2 EACH)
T1504A,AF



EEPS-7365-0

Figure 15.
Filter and Duplexer Selectivity Curves
Typical for 430-470 MHz Range





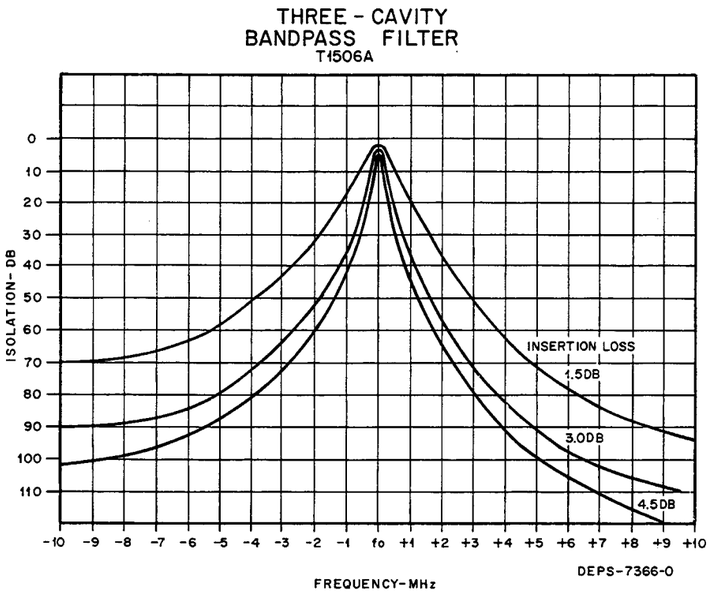


Figure 16.
Isolation Curves
Bandpass Filters and Duplexer T1505A, T1506A
& T1507A Typical for 430-470 MHz Range