1. INTRODUCTION

These filters and duplexers are for use with "Motorola" FM two-way radio communications equipment operating in the 148-174 MHz frequency range. They utilize cavity resonators with a special internal loading construction to achieve a size much less than one-quarter wavelength and are tuned with an adjustable center conductor. The resonators use a unique temperature compensating mechanism and uniquely adjustable coupling loops. Specially designed low-profile cable connectors are used to obtain an extremely compact package.

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 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 the hardware supplied.

(6) Connect the filter to the transmitter or receiver. Cables external to the filter are not of a critical length.
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. Select position in rack for best location of unit, i.e., closest proximity to associated equipment inputs and outputs.

3. Mount unit in place in rack with appropriate mounting hardware. The hardware supplied is intended for use with "Motorola" base stations.

4. Connect the filter or duplexer to the transmitter and receiver.

5. 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. A special internal construction uses two different characteristic impedances for the center conductor to achieve an overall length considerably less than a quarter-wavelength. The dimensions 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. Special bimeial washers are used for temperature compensation to minimize detuning due to ambient temperature changes.

Each resonant cavity is fitted with a specially designed pair of coupling elements (loops). These loops 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.

The input and output coupling loops are placed very close to each other, to take advantage of mutual coupling. A small amount of energy is always being transferred between coupling loops 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 normal selectivity of the cavity. The proximity of the loops provides inductive coupling. In addition, a precision high Q trimmer capacitor is connected across the loops. This capacitor can adjust the net coupling to be inductive or capacitive. When the net coupling is inductive, the notch occurs above the pass frequency. When the net coupling is capacitive, the notch occurs below the pass frequency.

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

4. **REMOVAL/REPLACEMENT OF COUPLING LOOPS**

Coupling loops are factory-installed in all T1480A Series Cavity Filters and Duplexers. If it becomes necessary to change coupling loops, refer to Figure 1 and PEP5-8095 and use the following procedure.

a. **Removal Procedure**

The cable shields are soldered to the connector portion of the loops. These shields must first be unsoldered before the loops can be removed. The shields cannot be unsoldered while the connectors are attached to the cavity body because the cavity body acts as a heat sink.

1. Remove the eight screws securing the connectors to the cavity body.

2. The two coupling loops are internally connected and must be removed together. Using a 150-watt soldering iron, first unsolder and remove the connector covers from the two connectors.

3. Grasp the center conductor of the cable (at the point where it enters the center pin of the connector) with long nose pliers. Melt the solder around the cable shield and pull the cable off the connector. Do the same for the other connector.

4. Remove the two knurled adjusting knobs taking care not to lose the washers. Now the loops are completely free and can be removed from the can.
from the factor. If system performance indicates that 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 it is certain that performance does not meet specifications.

The following tuning procedures assume that the entire duplexer is to be retuned. If it is desired to perform a minor "touch-up", refer to paragraphs of this tuning procedure. When left and right are used in the following procedures, this shall mean facing the tuning shaft end and with the connectors facing up.

(a) **Method I (Models T1485A, AF and T1487A, AF)**

1. **Recommended Test Equipment**
   b. Tunable receiver or two "Motorola" receivers, one tuned to each of the frequencies to be duplexed.

2. **Tuning Procedure**
   a. Move sliding screws as far apart as possible on each cavity and then tighten the screws.
   b. Turn trimmer capacitors fully counterclockwise.
   c. Tune the signal generator and the receiver to the duplex receive frequency.
   d. Connect the signal generator to the antenna port and the receiver to the right-hand port.
   e. Tune the right-hand cavity(s) for minimum insertion loss by adjusting the tuning rod screw.
   f. Tune the signal generator and the receiver to the duplex transmit frequency.
   g. Connect the receiver to the left-hand port.
   h. Tune the left-hand cavity(s) for minimum insertion loss by adjusting the tuning rod screw.
   i. Connect the receiver to the right-hand port.
   j. Tune the right-hand cavity(s) for maximum attenuation by using procedure 5.f., "Tuning the Notch".

---

5. **RECOMMENDED TUNING PROCEDURE**

All filters and duplexers are tuned to the customer-specified frequencies prior to shipment.
(k) Tune the signal generator and the receiver to the duplex receive frequency.

(l) Connect the receiver to the left-hand port.

(m) Tune the left-hand cavity(s) for maximum attenuation by using procedure 5.f.

(n) Repeat steps (c) through (m), but only tune the trimmer capacitors when tuning the notches.

b. Method 2 (Models T1485A, AF and T1487A, AF)

(1) Recommended Test Equipment

(a) Mixer circuit constructed as shown in Figure 4.

(b) "Motorola" R1201 Series Signal Generator.

(c) IF output from R1201 Series Signal Generator equal to the duplex frequency separation or a "Motorola" S1056B Portable Test Set with a crystal frequency equal to the duplex frequency separation.

(d) "Motorola" S1350A Wattmeter.

(e) "Motorola" T1013A RF Load Resistor.

(f) Isolated Tee connector (construct this by removing the Tee port center pin 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.

(2) Operation of the Mixer Circuit

Alignment of the duplexers can be simplified by using the mixer circuit shown in Figure 4. The mixer receives inputs from the transmitter and a low frequency source. The outputs from the mixer are frequencies above and below the transmitter frequency 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

(a) Move sliding screws as far apart as possible on each cavity and then tighten the screws.

(b) Turn trimmer capacitors fully counterclockwise.

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

Figure 3. Method 2 Transmitter Branch Pass Test Set-Up

(d) Tune the left-hand cavity(s) for a maximum power reading on the wattmeter by adjusting the tuning rod screw.

(e) Connect the equipment as shown in Figure 4.

Figure 4. Method 2 Receiver Branch Pass Test Set-Up

(f) Tune the signal generator to the receive frequency.
(g) Tune the right-hand cavity(s) for a minimum insertion loss (maximum signal at the receiver) by adjusting the tuning rod screw.

(h) Connect the equipment as shown in Figure 5.

![Diagram](AEPS-8164-0)

**Figure 5.**
Method 2 Transmitter Branch Reject Test Set-Up

(i) Tune the left-hand cavity(s) for maximum attenuation by using procedure 5.f., "Tuning the Notch".

(j) Connect the equipment as shown in Figure 6.

(k) Set the local oscillator source to the exact duplex frequency separation.

(l) Tune the right-hand cavity(s) for maximum attenuation by using procedure 5.f.

(m) Repeat steps (c) through (l) but only tune the trimmer capacitors when tuning the notches.

(4) Connect the duplexer to the transmitter, receiver and antenna with 50-ohm coaxial cable. Adjust the transmitter final amplifier for rated power into the duplexer.

c. **Model T1481A**

This model may be tuned by using only steps (1) and steps (2)(a) through (e) and (j) and (k) of Method 1.

d. **Model T1482A**

1. **Recommended Test Equipment**
   b. Tunable receiver.

2. **Tuning Procedure**
   a. Move sliding screws as far apart as possible on each cavity and then tighten the screws.
   b. Turn the trimmer capacitors fully counterclockwise.
   c. Tune the signal generator and the receiver to the pass frequency.
   d. Connect the equipment as shown in Figure 7.

![Diagram](AEPS-8165-0)

**Figure 6.**
Method 2 Receiver Branch Reject Test Set-Up

![Diagram](AEPS-8166-0)

**Figure 7.**
Model T1482A Test Set-Up
(e) Tune both cavities for minimum insertion loss by adjusting the tuning rod screw.

(f) Tune the signal generator and the receiver to the lower notch frequency.

(g) Tune the left-hand cavity for maximum attenuation by using procedure 5.f.

(h) Tune the signal generator and the receiver to the higher notch frequency.

(i) Tune the right-hand cavity for maximum attenuation by using procedure 5.f.

(j) Repeat steps (c) through (i) but only tune the trimmer capacitors when tuning the notches.

e. Minor "Touch-Up" Procedures (Models T1485A, AF and T1487A, AF)

(1) Method A

(a) Using the Recommended Test Equipment given for Method 1, tune the signal generator and the receiver to the duplex receive frequency.

(b) Connect the signal generator to the antenna port and the receiver to the right-hand port.

(c) Tune the right-hand cavity(s) for minimum insertion loss by adjusting the tuning rod screw.

(d) Tune the signal generator and the receiver to the duplex transmit frequency.

(e) Connect the receiver to the left-hand port.

(f) Tune the left-hand cavity(s) for minimum insertion loss by adjusting the tuning rod screw.

(g) Connect the receiver to the right-hand port.

(h) Tune the trimmer capacitor(s) on the right-hand cavity(s) for maximum attenuation.

(i) Tune the signal generator and the receiver to the duplex receive frequency.

(j) Connect the receiver to the left-hand port.

(k) Tune the trimmer capacitor(s) on the left-hand cavity(s) for maximum attenuation.

(2) Method B

(a) Using the Recommended Test Equipment given for Method 2, connect the equipment as shown in Figure 3.

(b) Tune the left-hand cavity(s) for a maximum power reading on the wattmeter by adjusting the tuning rod screw.

(c) Connect the equipment as shown in Figure 4.

(d) Tune the signal generator to the receive frequency.

(e) Tune the right-hand cavity(s) for a minimum insertion loss (maximum signal at the receiver) by adjusting the tuning rod screw.

(f) Connect the equipment as shown in Figure 5.

(g) Tune the trimmer capacitor(s) on the left-hand cavity(s) for maximum attenuation.

(h) Connect the equipment as shown in Figure 6.

(i) Set the local oscillator source to the exact duplex frequency separation.

(j) Tune the trimmer capacitor(s) on the right-hand cavity(s) for maximum attenuation.

f. Tuning the Notch

(1) If the Notch (Reject) Frequency is Below the Pass Frequency:

(a) Move the sliding screws as far apart as possible and then tighten the screws.

(b) Tune the trimmer capacitor for maximum attenuation at the notch frequency.

(2) If the Notch (Reject) Frequency is Above the Pass Frequency:

(a) Turn the trimmer capacitor completely counterclockwise and then clockwise two full turns.

(b) Adjust the sliding screws for maximum attenuation at the notch frequency and then tighten the screws.

(c) Tune the trimmer capacitor for maximum attenuation at the notch frequency.
# MOTOROLA

MODEL CHART
FOR
FILTERS AND DUPLEXERS
148-174 MHz

**CODE:**

- **X** = ONE ITEM SUPPLIED.
- **2** = NUMBER INDICATES QUANTITY OF ITEMS SUPPLIED.

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<thead>
<tr>
<th>MODEL</th>
<th>DESCRIPTION</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>T1481A</td>
<td>PASS-REJECT FILTER</td>
<td>X</td>
</tr>
<tr>
<td>T1482A</td>
<td>DUAL-REJECT FILTER</td>
<td>X</td>
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<td>T1485A</td>
<td>TWO-CAVITY PASS-REJECT DUPLEXER</td>
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<tr>
<td>T1485AF</td>
<td>TWO-CAVITY PASS-REJECT DUPLEXER (FACTORY-INSTALLED)</td>
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<td>T1487A</td>
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### PERFORMANCE SPECIFICATIONS

#### FILTERS

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<td>T1482A</td>
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<td><strong>MINIMUM PASS-REJECT SEPARATION</strong></td>
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<td><strong>MINIMUM REJECT ATTENUATION</strong></td>
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<td>42 dB @ 1.5 MHz</td>
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#### DUPLEXERS

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<th>T1485AF</th>
<th>T1487A</th>
<th>T1487AF</th>
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<td>T1487A</td>
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<tr>
<td><strong>ISOLATION AT RECEIVER FREQUENCY</strong></td>
<td>52 dB</td>
<td>82 dB</td>
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<tr>
<td><strong>MINIMUM TRANSMITTER RECEIVER ISOLATION</strong></td>
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<td>125 W</td>
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<td>-30°C to +60°C</td>
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<td><strong>SIZE</strong></td>
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SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

EPS-8409-O
## Parts List

### TL0608A Cavity Filter

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<th>DESCRIPTION</th>
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<td>3-3075</td>
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<td>2</td>
<td>1961310101</td>
<td>WASHERS, flat 3/16&quot; (2 reqs)</td>
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<td>3</td>
<td>196708101</td>
<td>SCREW, 3-40 x 3/8&quot; Phillips hex head (1 req)</td>
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<td>4</td>
<td>4344010301</td>
<td>WASHERS, flat 3/16&quot; (2 reqs)</td>
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<td>5</td>
<td>3-154166</td>
<td>SCREW, tapping 4-40 x 1/4&quot; Phillips hex head, internal lockwasher (2 reqs)</td>
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<td>3022520104</td>
<td>SCREW, 3-40 x 3/8&quot; Phillips hex head, internal lockwasher (2 reqs)</td>
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<td>WASHERS, flat 3/16&quot; (2 reqs)</td>
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<td>WASHERS, flat 3/16&quot; (2 reqs)</td>
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<td>4344010301</td>
<td>COVER, locking (4 reqs)</td>
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<td>11</td>
<td>4344840301</td>
<td>COVER, temperature compensating (1/4&quot; stamped on concave side)</td>
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<td>12</td>
<td>4344840301</td>
<td>COVER, temperature compensating (1/4&quot; stamped on concave side)</td>
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<td>14</td>
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### TLN4565A Mounting Hardware Kit (1-Cavity)

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### TLN4566A Mounting Hardware Kit (2 or 4-Cavities)

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<td>BRACKET, cavity mfg (top)</td>
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<td>2</td>
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<td>NAMEPLATE</td>
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<td>8</td>
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<td>TOOL, testing</td>
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**Cavity Filter**

**Parts Location Detail and Parts List**

Motorola No. PEP8-8095-A

7/3/85-NPC