**RECEIVER**

MODEL SERIES TRD6170A, TRD6180A, AND TRD6190A

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**Receiver Model Table**

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency (MHz)</th>
<th>Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRD6171A</td>
<td>132-150.8</td>
<td>Multi-Frequency 10.7 MHz I-F, Non-Filtered</td>
<td>Used with Single Receiver Stations</td>
</tr>
<tr>
<td>TRD6172A</td>
<td>146-174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRD6181A</td>
<td>132-150.8</td>
<td>Multi-Frequency 10.7 MHz I-F, Filtered</td>
<td>Used with 2-Receiver Stations and Repeater Stations</td>
</tr>
<tr>
<td>TRD6182A</td>
<td>146-174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRD6191A</td>
<td>132-150.8</td>
<td>Multi-Frequency 10.8 MHz I-F, Filtered</td>
<td>Used with 2 Receiver Stations Where Shifted I-F is Required.</td>
</tr>
<tr>
<td>TRD6192A</td>
<td>146-174</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Impedance</td>
<td>50 ohms</td>
</tr>
<tr>
<td>Number of Channels</td>
<td>1, 2, 3, or 4</td>
</tr>
<tr>
<td>Frequency Separation</td>
<td>2.0 MHz</td>
</tr>
<tr>
<td>I-F Frequency</td>
<td>10.7 MHz or 10.8 MHz</td>
</tr>
<tr>
<td>EIA Modulation Acceptance</td>
<td>±7 kHz Minimum</td>
</tr>
<tr>
<td>Frequency Stability</td>
<td>± .0005% from −30°C to +60°C ambient (+25°C reference) ± .0002% Optional*</td>
</tr>
<tr>
<td>Channel Spacing</td>
<td>20 kHz, 25/30 kHz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sensitivity:</th>
<th>With Preamp**</th>
<th>Without Preamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 dB Quieting</td>
<td>.25 uV</td>
<td>.50 uV</td>
</tr>
<tr>
<td>EIA SINAD</td>
<td>.20 uV</td>
<td>.35 uV</td>
</tr>
<tr>
<td>Selectivity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EIA SINAD</td>
<td>20 kHz Channel</td>
<td>85 dB</td>
</tr>
<tr>
<td>25/30 kHz Channel</td>
<td>95 dB</td>
<td>100 dB</td>
</tr>
</tbody>
</table>

| Intermodulation:            |                                            |                                         |
| EIA SINAD                   | 20 kHz Channel                             | 75 dB (Minimum)                         |
| 25/30 kHz Channel           | 80 dB (Minimum)                            | 85 dB (Minimum)                         |

| Spurious and Image Rejection| 100 dB (Minimum)                           | 100 dB (Minimum)                        |

* Available with option C621, C622, C623, C624.
** Optional Model HLD4050A RF Preamp.

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1. **DESCRIPTION**

1.1 These receivers are fully transistorized units that receive FM signals on one to four crystal-controlled frequencies. In a multi-frequency receiver, only one frequency can be received at a time.

1.2 Each receiver includes an rf preselector, mixer, local oscillator injection circuitry, high gain selective i-f stages, quadrature detector, audio preamplifier, and a low-ripple 9.5 volt regulator. The receiver develops a low noise audio signal from a frequency modulated "on-channel" rf carrier in the 132-174 MHz range. An optional rf preamplifier may be used with any of these receivers.

1.3 All circuits are constructed on a single plug-in circuit board which is easily accessible for servicing. The receiver plugs into the backplane interconnect board which provides all dc, audio, and rf connections thereby eliminating all interconnecting wiring. All alignment points are accessible through the top of the rf compartment cover.
2. THEORY OF OPERATION

2.1 PI FILTER, RF PRESELECTOR, OPTIONAL PREAMPLIFIER

The receive port of the antenna switch is connected to the 5 cavity helical resonator rf preselector through the input “pi” filter. The “pi” filter, consisting of C135, C136, and L112, provides additional filtering for higher frequency spurious responses. The steep skirted rf preselector filter has a bandwidth of 2.0 MHz and ultimate rejection of 100 dB. To provide additional front-end selectivity while minimizing loss, the optional rf preamplifier is inserted in the housing between the second and third cavities. The output of the preselector (L5) is connected to the gate of N-channel JFET mixer, Q103.

2.2 LOCAL OSCILLATOR INJECTION CIRCUITRY

Plug in crystal oscillator modules (channel elements) provide a stable, temperature compensated frequency which is applied to injection amplifier Q101. Each receiver is capable of receiving up to four distinct frequencies. The output of Q101 (typical gain of 15 dB) passes through a two pole bandpass filter which attenuates unwanted harmonics of the injection frequency. The injection level of +12 dBm (typical) is coupled to the source of mixer Q103.

2.3 MIXER

Excellent intermodulation immunity is provided by a JFET mixer, Q103. The filtered receive input and injection signal are applied to the gate and source respectively. The output at the drain is applied to impedance matching circuitry which emphasizes the difference frequency applied to the i-f circuitry. Both the mixer and the following impedance matching circuitry are shielded.

2.4 I-F CIRCUITRY

2.4.1 Several stages of filtering and amplification are employed in the i-f circuitry. Selective i-f filtering is accomplished using dual-resonator, mode coupled monolithic crystals cut to a fundamental frequency of 10.7 MHz or 10.8 MHz. Due to the inherent piezoelectric properties of the crystal material, input signals selectively produce mechanical vibrations which propagate through the device. At the output the same piezoelectric property selectively converts the mechanical vibrations into the i-f electrical signal.

2.4.2 Refer to Figure 1. The high “Q” of the crystals create steep skirts which result in excellent on-channel intelligibility and off-channel signal rejection. The i-f circuitry requires no tuning and makes extensive use of shielding.

![Diagram](Image)

Figure 1. Simplified Piezoelectric Coupling Diagram
2.4.3 The first crystal filter is a single 2-pole device, Y201. This stage is followed by a matching network, 16 dB discrete amplifier Q201, additional matching, and 4-pole filter Y202-Y203. The output of the first 4-pole filter is applied to a matching network and then to high gain (approximately 50 dB) 2nd i-f amplifier U201. The output of U201 is applied to matching circuitry, a 2nd 4-pole filter Y204-Y205, final matching circuitry, and limiter/detector U202.

2.5 LIMITER/DETECTOR

Limiter/Detector U202 is a 16-pin monolithic integrated circuit that internally includes three stages of i-f amplification for limiting, a quadrature fm detector, audio preamplifier, and alignment metering output. The recovered audio output of approximately 80 mV is applied to discrete audio preamplifier Q202-Q203, which provides the 250 mV receiver detected audio level required by the R1 (or R2) audio board in the control package. Adjustment of the quadrature detector is provided by L201.

2.6 9.5 VOLT REGULATOR

The regulated 9.5 volts and 13.8 volts provided to the receiver from the station power supply are applied to Q104 and Q105, resulting in a highly regulated and filtered 9.5 volts. This highly regulated 9.5 volts is supplied to the receiver channel elements, quadrature detector U202, and audio preamplifier Q202 to assure good receiver hum and noise performance.

2.7 DELAYED KEYED A+

This circuit (Q102) provides for disabling of the receiver channel element while the base station is in the transmit mode and prevents audio feed back to the receiver.

3. MAINTENANCE

Malfunctions in the receiver can be localized by using the optional built-in station metering kit or connecting a Motorola portable test set to the receiver metering receptacle and making stage measurements. The meter readings may be compared to the values shown on the receiver functional diagram, but preferably, a log of readings should be maintained for reference. Each new set of readings should then be compared to previous readings. An abrupt change in a meter reading indicates a circuit failure while a gradual change in a reading may indicate an impending failure which can be corrected before operation becomes marginal. Refer to the Receiver Maintenance section for further information.

4. RECEIVER FUNCTIONAL TESTS

4.1 AUDIO AND SQUELCH TEST

The receiver and R1 audio board should provide 1.0 watts of audio when the VOLUME control on the R1 audio board is set fully clockwise and a strong carrier signal is received that is modulated ± 3.0 kHz deviation with a 1000 Hz tone. When the rf input signal is reduced to minimum and the SQUELCH control on the R1 audio board is set at threshold, the speaker should be quieted. Increasing the rf input signal a small amount should again produce noise in the speaker. On Private-Line models, no signal should be heard from the speaker unless the signal has the proper PL tone modulation. These circuits may be checked as follows:

Step 1. PL disable station. Connect speaker to test connector on mother board. Adjust the signal generator for 1000 uV input to the receiver modulated with 1000 Hz tone for ± 3.0 kHz deviation.

Step 2. Connect an ac voltmeter to measure the voltage between pins 1 and 2 of the control metering socket.

Step 3. Set the VOLUME control on the R1 audio board fully clockwise. The ac voltmeter should indicate at least 2.8 volts rms.

Step 4. Decrease the signal generator output to minimum. Remove modulation from signal generator.

Step 5. Set the SQUELCH control at threshold, that is, clockwise until the noise just quiets.

Step 6. Increase the signal generator output slightly until the noise is again heard in the speaker. No more than .125 uV should be required.

Step 7. On Private-Line radios, enable the PL function. No noise should be heard in the speaker.

Step 8. Modulate the rf signal with the proper Private-Line tone with ±500 Hz deviation. Adjust signal generator output until noise is again heard in speaker. (See audio section for PL squelch specifications).

4.2 20 DB QUIETING TEST

With no signal input and the receiver unsquelched, noise should be heard in the speaker or indicated on position 11 of the portable test set (function selector switch in RCVR position). When a carrier frequency signal is injected, the noise should decrease. No more than 0.5 uV (.25 uV if radio is equipped with rf preamplifier) should be required to decrease the noise 20 dB. This may be checked as follows:

Step 1. Unselquel receiver by turning the SQUELCH control on the R1 audio board fully counterclockwise. PL disable the receiver.

Step 2. Set the function selector switch on the portable test set to the RCVR position and the selector switch to position 11.
Step 3. Adjust VOLUME control on the R1 audio board for noise in the speaker and a reading on the test set meter. A reading of 1.5 V ac is a convenient reference value to use.

Step 4. Connect an rf signal generator (set to the receiver carrier frequency) to the antenna input connector.

Step 5. Beginning with minimum signal level, increase the signal generator output until the meter 11 reading drops to 1/10 the reference value in Step 3, that is 0.15 V ac. No more than 0.5 microvolt output from the signal generator should be required to quiet the receiver.

4.3 RECEIVER GAIN MEASUREMENTS

NOTE
Before making any receiver gain measurements, make sure the case of every crystal filter has a good conductive path to ground. A continuity test should indicate less than 1 ohm between the crystal filter case and the receiver circuit board ground plating. A bad ground connection may cause errors in gain measurements.

Step 1. Proper receiver alignment is essential to this procedure portion of the Station Alignment. Perform a complete receiver alignment as given in the “Receiver Alignment” section of this manual.

Step 2. Refer to the Receiver Functional Block Diagram, receiver schematic diagram, and the receiver circuit board detail diagram while performing this procedure.

Step 3. Adjust the rf signal generator output frequency to the receive channel frequency. Adjust the rf signal generator output to provide the required receiver input voltage for a particular test point. Then, using an rf ac voltmeter, measure the rf signal voltage between the test point and a nearby chassis ground point. At every test point, the measured voltage should be within ±6 dB of the given value.

5. TROUBLESHOOTING TECHNIQUES

5.1 VISUAL INSPECTION

The first step in the troubleshooting procedure should be a thorough visual inspection of the receiver and, in particular, the receiver board. Corrosion, burned or damaged components are usually easily seen and may be the cause or a symptom of the receiver malfunction. An improperly installed receiver shield can cause a degradation in receiver performance.

After the “obvious” problems have been corrected, repeat the receiver board performance tests. If the tests still produce unsatisfactory results, refer to the receiver troubleshooting chart in this section. The troubleshooting chart provides a systematic procedure for isolation of the defective stage and component.

As much information as possible has been included on the troubleshooting chart. However, it will be necessary to occasionally refer to the receiver schematic diagram and circuit board detail. Detailed procedures regarding alignment as a troubleshooting technique, integrated circuit troubleshooting, receiver gain measurements, and crystal troubleshooting follow in the remaining paragraphs of this section.

5.2 ALIGNMENT AS A TROUBLESHOOTING TECHNIQUE

Low meter readings, and otherwise abnormal performance of the receiver are very often corrected by realignment. Therefore, alignment should be one of the first troubleshooting steps performed for these symptoms.

5.3 TROUBLESHOOTING INTEGRATED CIRCUITS

Integrated circuits (IC) are very reliable components and should not be replaced unless it is definitely indicated that the IC is the defective component. Before replacing an IC, make sure that the external components in the circuit are normal. The IC’s on the receiver board may be checked by dc voltage measurements. Refer to schematic diagram for correct voltages.

5.4 TROUBLESHOOTING CRYSTALS

A defective filter crystal can best be found by performing an i-f gain check per the schematic diagram. A defective crystal will show an abnormally high insertion loss. If the crystal is found to be defective because of high insertion loss or an ungrounded case, it should be replaced.
The tuning procedure should be performed with the receiver in a position so that the Coax connector fitting is at the bottom left of the instrument panel. Place the A-PAD unit in the A position and the FUNCTION switch in the WREND mode and the antenna switch in the position. If using the K-100A or an equivalent BPR through the TES-50 antenna cables, put the function switch in the position C and the M-L switch to the normal position. If using the optional back-up meter, put the REVERSE switch to the 0 position.

For axes containing two receiver digi, set each receiver individually using the same procedure.

**NOTE**

All axes containing the word "gain" should also be set after the receiver has been removed from the instrument. Tuning using multiple Receivers is the fastest, but it may be necessary to tune each axis individually.

**RECEIVER FREQUENCY CALCULATIONS**

1. \( f_{coax} \) = carrier frequency (frequency to be measured)
2. \( f_{inj} \) = injection frequency
3. \( f_{rd} \) = frequency to be measured

**REFERENCES**


**Figure 2: Receiver Alignment Adjustments Location**