divided by the resistance of R1. A very easy method is available for determining the value of R1. Look at the exact center of the ohmmeter scale. Your reading is the value of R1 on the Rx1 range.

The only other unknown required to calculate the short circuit current of an ohmmeter is the internal battery voltage. Let's take a well known meter that has a center scale reading on the ohms scale of 4.62 and a battery voltage of 1.5 volts. Its short circuit current can be calculated by using Ohm's Law. Dividing 1.5 volts by 4.62 ohms equals a short circuit current of 325 mA on the RX1 range. Obviously, the Rx1 range of this meter cannot be used to measure the resistance of semiconductors.

When the value of R1 is known for the Rx1 range it can then be determined for any range by multiplying R1 by the multiplier value of the range. The value of R1 for the Rx10 range of a meter with an R1 value on the Rx1 range of 4.62 ohms is 4.62 x 10 or 46.2 ohms. The short circuit current on the Rx10 range can then be calculated: 1.5 volts divided by 46.2 ohms equals 32.5 mA. By using this method, the lowest safe range for measuring semiconductor resistance may be determined for any ohmmeter.

The following chart indicates the results that should be obtained from operational transistors measured out of the circuit.

Transistor Type		Ohmmeter Connections		Resistance in ohms
		+ lead	- lead	
Germanium PNP	Power	Emitter	Base	30 to 50 ohms
		Emitter	Collector	Several hundred
	Small Signal	Emitter	Base	200 to 250 ohms
		Emitter	Collector	10 k to 100 k ohms
Silicon PNP	Small Signal	Emitter	Base	10 k to 100 k ohms
		Emitter	Collector	Very high (Might read open)
Silicon NPN	Power	Base	Emitter	200 to 1000 ohms
		Collector	Emitter	High often greater than 1 Megohm
	Small Signal	Base	Emitter	1 k to 3 k ohms
		Collector	Emitter	Very high (Might read open)

6.2 RECEIVER SERVICING

6.2.1 EQUIPMENT REQUIRED

Equivalent or superior equipment may be substituted.

Power Supply	Messenger 100 AC Power Supply - Cat. No. 239-125 or Hewlett Packard 6201A, 13.8 Volts DC, 1.5 amperes required.
Oscilloscope	Tektronix Model 561A
AC-VTVM	Heath Model AV-3
RF Generator	0.455 to 50 MHz with attenu-

	ated output of 1 microvolt to 0.1 volt capable of modulation at 1000 Hz at 30% - Hewlett Packard 606A.
Audio Generator	1000 Hz - Heath Model IG72
VTVM	Triplett Model 850 with RF Probe
6 dB Pad	Connect to output of RF signal generator for all trouble shooting and alignment procedures.
Tuning Tools	Radio Industries peaker tool-XA0378
	General Cement - 8606 Hex. tuning tool

6.2.2 TEST EQUIPMENT CONNECTIONS

a. The Messenger Transceiver is "floated" above ground and care must be exercised during test equipment connection. The test equipment called for in the equipment list will work satisfactorily if connected as shown in Figures 9 and 10. The AC-VTVM and oscilloscope connections may be made as shown in Figure 10.

b. If an audio generator or VTVM other than the ones described in the equipment list are used, they must be isolated from ground. It may be necessary in the use of the audio generator, to place a capacitor in series with the ground lead as well as the hot lead. The RF signal generator used for the receiver tests and alignment is connected to the receiver through a 6 dB pad for all measurements. In some instances the signal generator output may also be in series with a 0.1 μF capacitor. This will be indicated where appropriate. The test equipment connection to the receiver for trouble shooting and alignment will be as follows, except where noted in text.

c. Connect the test equipment to the receiver as shown in Figure 9.

d. The DC power supply is connected to J2 through a fused power lead. Ground the power supply to the Messenger chassis rail.

e. Connect the AC-VTVM and oscilloscope across the speaker leads.

f. Connect the RF signal generator to the transceiver antenna jack thru a 6 dB pad. Set the signal generator to receiver frequency. Remove the transmitter crystal. This will protect the signal generator in case the transmitter should be inadvertently keyed during receiver servicing.

6.2.3 PRELIMINARY RECEIVER TEST

a. Set RF output level from the signal generator at 1 microvolt into the 6 dB pad, and modulate with 1000 Hz at 30%. This can be internal modulation as in the case of a HP-606A, or external modulation from a separate audio generator.

b. Turn the receiver on and set the VOLUME control to maximum (cw); set the SQUELCH to minimum (ccw).

c. Check the receiver current drain, it should be approximately 210 mA at 13.8 volts DC.

d. The AC-VTVM across the speaker should indicate approximately 0.8 VAC (0 dB) of audio.

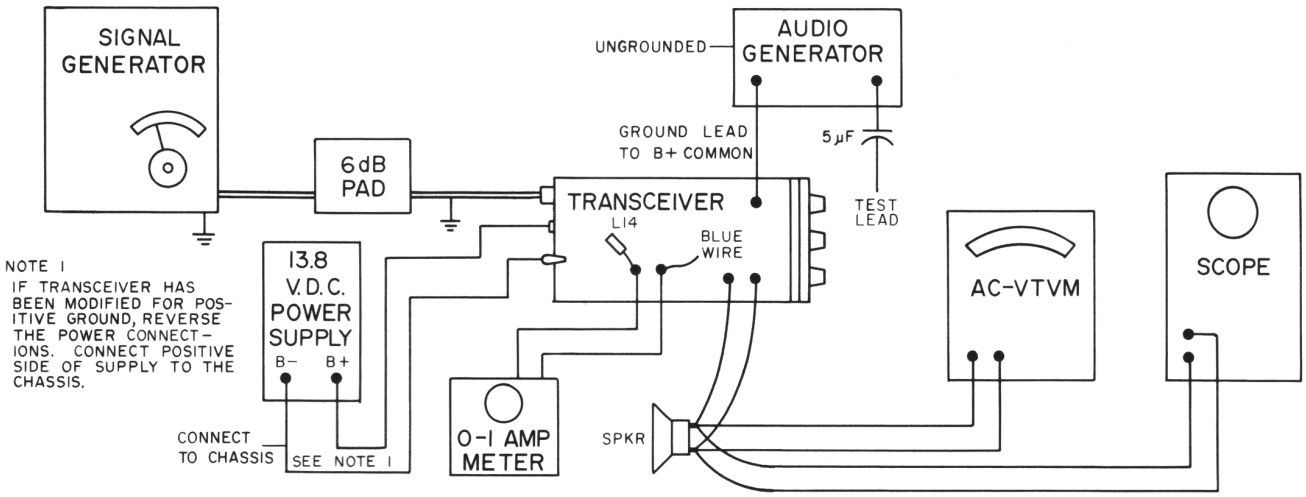
If the above conditions are not obtained, continue with the following receiver trouble shooting procedure.

NOTE:

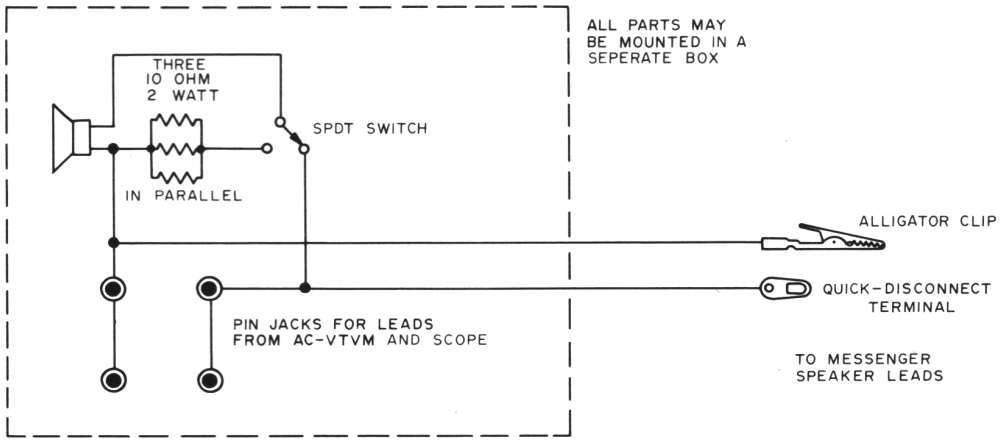
The first check for trouble shooting should be visual, then measure the bias voltages of the various stages. When performing DC voltage measurements the meter common must be connected to B+ as it is the reference point.

6.2.4 AGC

a. The Messenger utilizes a single AGC system. AGC is applied to the base of Q1 in the RF stage. Since AGC can affect many stages, it is important to make checks on this stage



RECEIVER TEST INSTRUMENT CONNECTIONS
FIGURE 9



TEST ASSEMBLY FOR
CONNECTING AC-VTVM AND SCOPE
FIGURE 10

first.

b. AGC problems will cause:

- receiver to be completely inoperative
- severe overloading on strong signals
- erroneous voltage readings at the bases of Q1, Q3 and Q4

c. To check the AGC stage:

- Connect test equipment as indicated in Section 6.2.2.
- Connect VTVM to the junction of R8, C13 and C14 - See Schematic
- Increase the output of the RF signal generator from 1 microvolt to 0.1 volt.
- The AGC voltage measured on the VTVM should go more positive as the signal is increased. See Figure 11 for a typical AGC curve (audio output vs. RF input).
- If the AGC voltage does not change, check the AGC detector, D1, and its associated network.

6.2.5 SQUELCH

a. Connect a VTVM (-15 volts DC range) to the emitter of Q8. Test equipment previously connected will not affect the SQUELCH and may be ignored during this check.

b. While monitoring the VTVM, rotate the SQUELCH control from minimum to maximum.

c. The voltage should vary from approximately -2.6 to -6.5 volts.

d. If the voltage does not change at Q8, check for an open diode, D5, by bridging it with

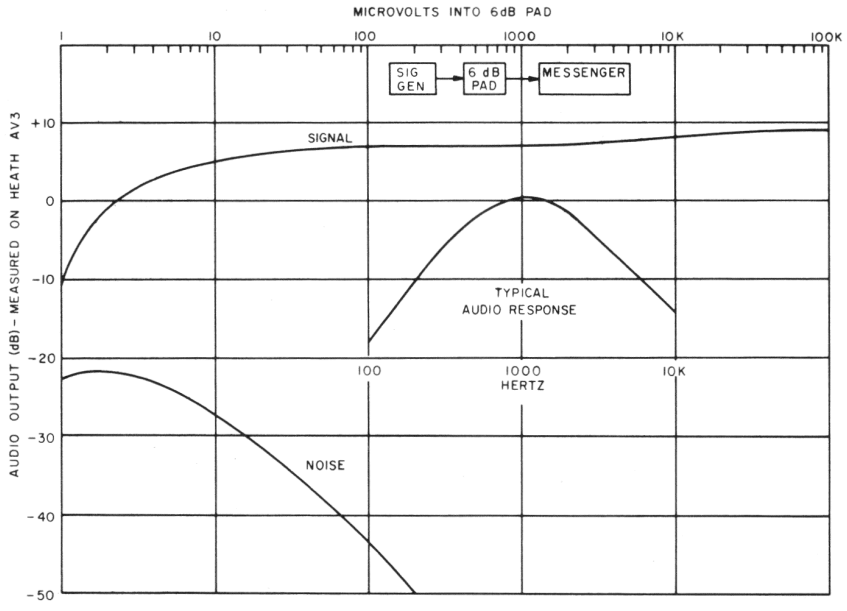


FIGURE 11

one known to be good.

e. If the diode is not open, disconnect one end and measure the front to back ratio with an ohmmeter. A normal diode will have a front to back ratio of approximately 10:1 or more.

f. Check the voltages on Q6 and Q7. If D5 is shorted, the voltage at Q7 will be normal and the squelch will operate very slowly. The emitter of Q8 in this case will read very low at minimum squelch.

6.2.6 AUDIO

a. Connect test equipment as indicated in Section 6.2.2.

b. Connect an audio generator through a 5 μF capacitor to the top of the VOLUME control.

c. Set the audio generator for an output of 0.0025 volts RMS ±10% at 1000 Hz. Connect the generator ground lead to the receiver B+.

d. Adjust the volume control for 2.5 VAC (+10 dB) indicated on the AC-VTVM and turn the squelch control to minimum (ccw).

e. The audio output as monitored on the oscilloscope should be 2.5 VAC (+10 dB) undistorted.

f. If these conditions are not met, check the bias of Q8, Q9, Q10 and Q11.

g. Check the voltages at the emitters and bases of the Class B audio transistors, Q10 and Q11. The voltages should be the same. If one of the transistors shows no voltage difference between emitter and base, it is probably defective.

6.2.7 IF STAGES

NOTE:
A shorted transistor in the Class B audio output stage will cause R20 to burn and possibly blow the fuse.

a. Connect test equipment as in Section 6.2.2, except connect RF signal generator through 6dB pad and a 0.1 μF capacitor to the base of the second IF transistor, Q5.

b. Set the signal generator to 455 kHz, modulated 30% at 1000 Hz.

c. Set the signal generator output to 0.01 volts RF.

d. The AC-VTVM should indicate approximately 0.8 volts AC. If this level is not reached, check voltages on Q5, L6 and associated circuitry. Replace defective components and refer to the receiver alignment chart for re-adjustment.

NOTE:
Move the signal generator from the base of Q5 to the base of Q4. Set the generator output level to 250 microvolts. The AC-VTVM should indicate circuitry if the level is abnormally low. Refer to the receiver alignment for adjustment.

Repeat the procedure in the above note with the signal generator connected to the base of Q3 and set for an output level of 30 microvolts.

6.2.8 RF AMPLIFIER - 1st MIXER

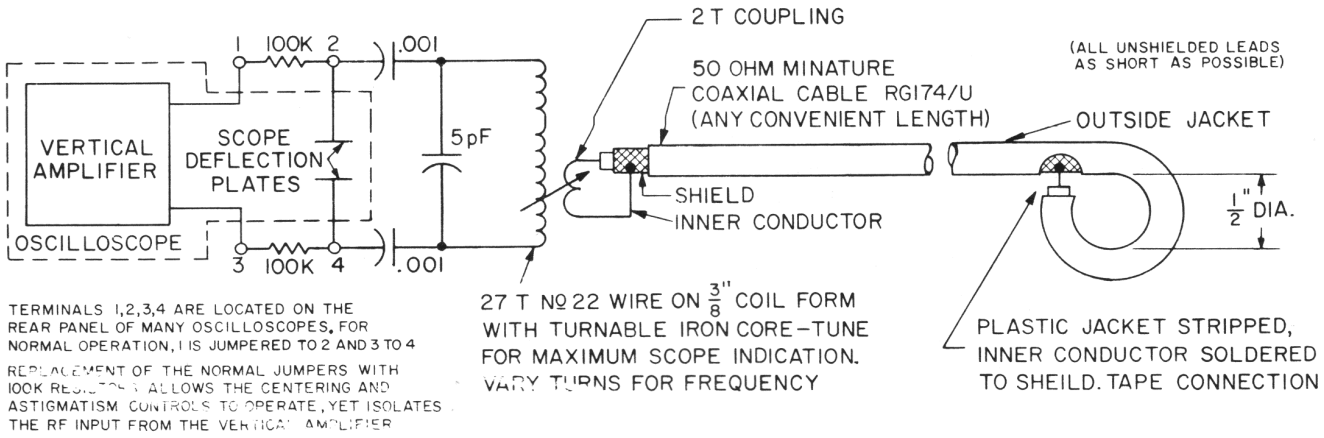
a. Connect test equipment as indicated in Section 6.2.2.

b. Set signal generator at the assigned frequency, 1 microvolt modulated with 1000 Hz at 30%.

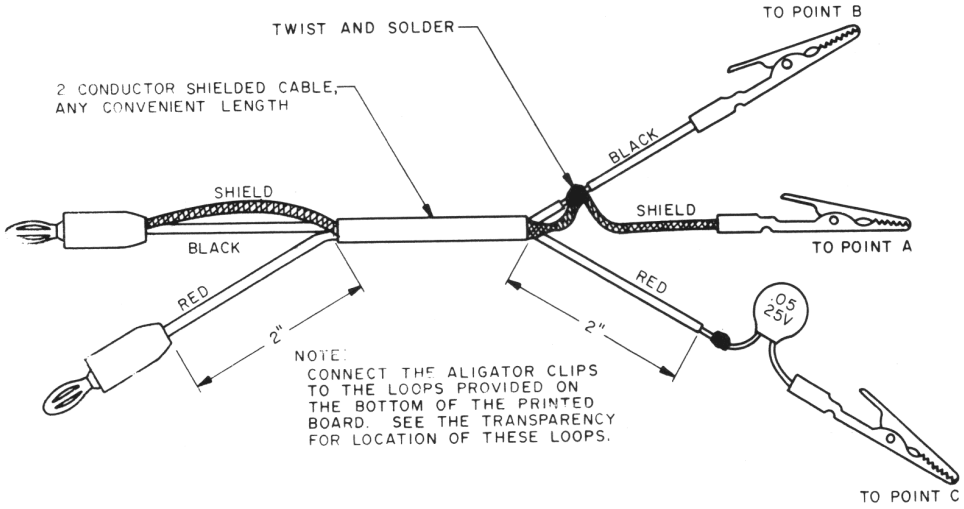
c. With the VOLUME control at maximum, the output across the speaker terminals is measured on the AC-VTVM and oscilloscope should be at least 0.8 VAC (0.5 dB) undistorted.

d. If the receiver output is not normal, check the emitter of the oscillator, Q2, with an RF probe (see Figure 16). The oscillator injection voltage at this point should be approximately 100 mV ±20 mV volts RMS.

e. If the oscillator output is normal, check the voltages at Q1 and Q3.



OSCILLOSCOPE RF PICK-UP LOOP
AND METHOD OF CONNECTION
FIGURE 12



AUDIO GENERATOR CABLE
FIGURE 13

f. If it is necessary to replace either L2, L3 or L4, re-align the stage as outlined in the receiver alignment chart.

6.3 TRANSMITTER SERVICING

6.3.1 EQUIPMENT REQUIRED

Power Supply	Messenger AC Power Supply-Model No. 250-823-2, or Hewlett Packard 6201A, 1.5A.
Frequency Meter	
Oscilloscope	Tektronix Model 561A or equivalent with RF pick-up loop capable of direct connection to the vertical plates of the oscilloscope (Figure 12 illustrates a simple RF pick-up loop which may be fabricated from spare parts.)
0-1 Amp DC Ammeter	Triplett 630
Dummy Antenna	50 ohms, 5 watts (with RF power indicator).
Sine-Wave Generator	1000 Hz, 0.01 Volts

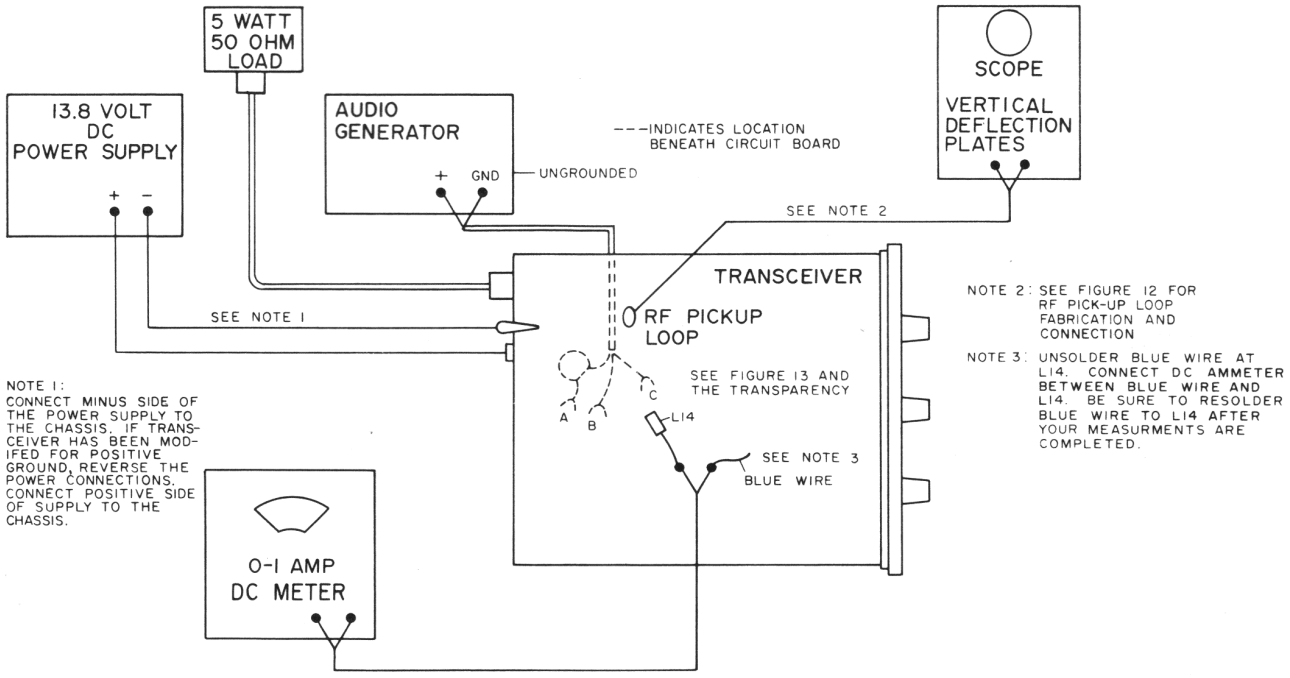
6.3.2 TEST EQUIPMENT CONNECTIONS

a. Connect the test equipment as shown in Figure 14. Be sure to connect the 50 ohm load.

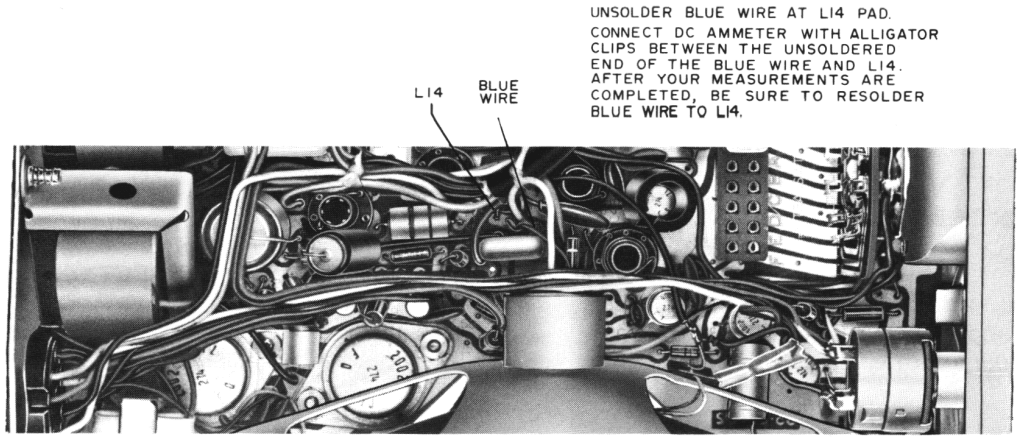
b. Connect the audio generator to points A, B and C. Figure 13 shows the audio generator test cable. Set the generator at zero output.

c. Couple RF pick-up loop from the oscilloscope to L16 of the power amplifier stage.

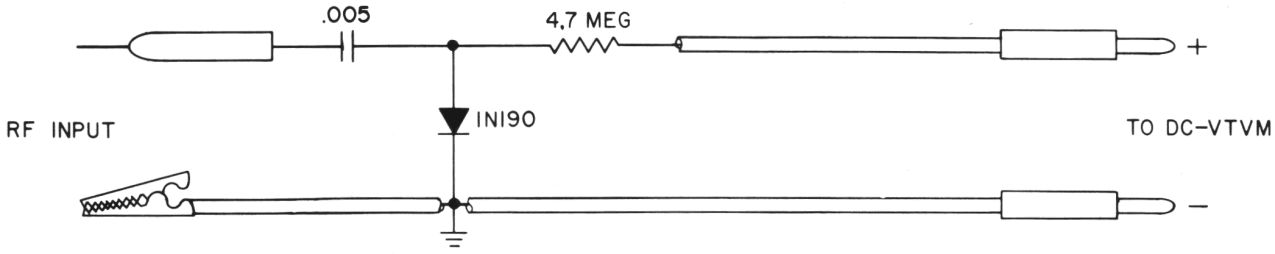
d. Monitor the transmitter frequency with the frequency meter.



TRANSMTTER TEST INSTRUMENT CONNECTIONS
FIGURE 14



DC AMMETER METER CONNECTIONS
FIGURE 15



CONNECTIONS SHOULD BE MADE AS SHORT AS POSSIBLE TO AVOID STRAY CAPACITANCE WHICH WILL AFFECT THE FREQUENCY RESPONSE OF THE PROBE

THE MAXIMUM INPUT MUST NOT EXCEED 30 VOLTS OF RF. THE OUTPUT OF THE PROBE IS NEGATIVE DC AND THE VTVM FUNCTION SHOULD BE SET ACCORDINGLY

RF PROBE FOR DC-VTVM
FIGURE 16

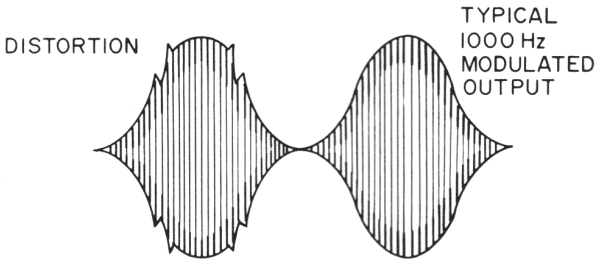
6.3.3 PRELIMINARY TRANSMITTER TEST

a. Turn the transceiver on and key the transmitter.

b. Measure the power output. See the specifications for minimum accepted power output. (Make sure RF pick-up loop is not affecting the reading.)

c. Set the audio generator for 1000 Hz. While monitoring the oscilloscope, increase the audio generator output level to obtain maximum modulation.

d. The modulated waveform should be symmetrical and undistorted. A mis-aligned or defective transmitter may cause distortion as shown in Figure 17. If distortion occurs, refer to the transmitter alignment chart for adjustment.



MODULATED
RF WAVEFORM DISTORTION
FIGURE 17

6.3.4 OSCILLATOR TROUBLE SHOOTING

a. A defective or mis-aligned oscillator stage can result in:

- loss of transmitter output
- intermittent operation on some channels
- distorted modulation
- spurious or adjacent channel "splatter".

b. To check the oscillator stage:

- key the transmitter and check for oscillator starting. If the oscillator does not start, check the bias of Q12 and replace defective components as necessary.

c. Check the modulated RF waveform for distortion or unsymmetrical waveform. If distortion exists, check oscillator adjustments - see Transmitter Alignment Chart.

d. Check the transmitter carrier frequency. If out of tolerance, refer to transmitter alignment section.

If the above conditions are not obtained, continue with the following transmitter trouble shooting procedure.

6.3.5 DRIVER AND POWER AMPLIFIER TROUBLE SHOOTING

a. A defective or mis-aligned driver or power amplifier will result in:

- reduced power output
- excessive current drain at reduced power
- distorted modulation

b. Check the bias of Q13 and Q14. Replace defective components as necessary and refer to Transmitter Alignment Section for adjustments.

6.3.6 RESISTANCE MEASUREMENTS

	Winding	Lead	DC Resistance
Transformer T1 (audio driver)	Primary	Blue to Red	200 ohms maximum
	Secondary	Orange Yellow	25 ohms maximum
Transformer T2 (audio output modulation)	Primary	Blue to Brown	2.4 ohms maximum
	Secondary #1	Yellow to Orange	1.4 ohms maximum
	Secondary #2	Green to Black	0.22 ohms maximum
Relay	Coil		195 ohms +0%, -20%