SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

The Messenger 122 and 123A are solid state 23 channel citizens radio transceivers which incorporate 14 crystal frequency synthesizers to generate the receiver and transmitter channel frequencies. A front panel mounted meter on the Messenger 123A indicates received signal strength and relative power output.

Refer to the block diagram and the transceiver schematics, located at the back of this manual, when following the circuit description.

4.2 FREQUENCY SYNTHESIZER

4.2.1 GENERAL

The synthesizer consists of three crystal banks, two oscillators, a mixer, a diode switch driver and two diode switching networks. The synthesizer receiver output is 455 kHz below the received frequency and the synthesizer transmitter output is the channel frequency. This is accomplished by two oscillators and one mixer operating in a single side-step operation. There is no frequency multiplication in the synthesizer or in other circuits.

4.2.2 LF OSCILLATOR

The low frequency oscillator is made up of Q5 and its associated circuitry and crystals Y1 through Y8 which operate at their fundamental frequency. Switch S2B selects one of these crystals. Refer to the schematic synthesizer scheme, for the low frequency crystals. The signal from the selected crystal is applied to the base of Q5, which has a common collector to provide a high input impedance. The signal from the emitter of Q5 is coupled through C47 to the base of the synthesizer mixer, Q14. Capacitive voltage divider, C47 and C48, reduces the voltage at the base of Q14 and provides the proper impedance match.

4.2.3 HF OSCILLATOR

The high frequency oscillator, Q13, operates with third overtone crystals, Y9 through Y14. Switch S2A selects one of the HF crystals at the same time as S2B selects a LF crystal. Refer to the synthesizer scheme for the high frequency crystal frequencies. The signal from the selected series resonant crystal is applied directly to the base of the HF oscillator, Q13. The signal from the collector of Q13 is coupled through the oscillator transformer, T7, to the emitter of the synthesizer mixer, Q14.

4.2.4 SYNTHESIZER MIXER

The signal from the low frequency (LF) oscillator, Q5, is coupled to the base of the mixer, Q14, by C47. The signal from the high frequency (HF) oscillator is coupled by T7 to the emitter of the mixer. The mixer output transformer, T8, is tuned for the difference frequency, (HF oscillator output minus the LF oscillator output). On channel 1 receive this would be: 32.700 MHz - 6.190 MHz = 26.510 MHz. While referring to the crystal chart, notice that in the receive condition the synthesizer output is always 455 kHz below the channel frequency. In transmit the synthesizer output is the channel frequency.

4.2.5 DIODE SWITCHING

The synthesizer contains two diode switching networks. Diodes CR7 and CR8 switch transmit and receive LF crystals respectively. CR14 switches the synthesizer output in receive and CR15 switches the output in transmit.

In the receive condition, DC switch Q6 is cut off, allowing receive crystal switch CR8 and receive output switch CR14 to conduct.

The synthesizer is switched to the transmit condition when the microphone push-to-talk switch is depressed. This action allows DC switch Q6 to conduct, which in turn cuts off CR8 and CR14, and turns on transmit crystal switch CR7 and transmit output switch CR15.

4.3 RECEIVER

4.3.1 RF AMPLIFIER

The incoming signal is coupled to the base of the RF amplifier, Q1, through RF input transformer T1. The signal is amplified by Q1 and coupled by T2 to the base of mixer stage Q2.

4.3.2 RECEIVER MIXER AND CERAMIC FILTER

The output of the synthesizer, operating 455 kHz below the signal from the RF amplifier, is coupled through T9, C56, CR14, C37 and C5 to the base of the receiver mixer, Q2. The mixer output is coupled to the ceramic filter, Z1, which passes only the difference frequency of 455 kHz.

Note: The 123A mixer emitter resistor, R4, is shown in the meter circuitry, located below Q15 on the schematic diagram.

4.3.3 IF AMPLIFIER, DETECTOR AND NOISE LIMITER

After the 455 kHz signal is filtered by Z1, it is then amplified by IF amplifiers Q3 and Q4. IF gain control R7 adjusts the gain of Q3. Refer to the alignment section for proper R7 adjustment.

The amplified 455 kHz IF signal is detected by CR4 and noise limiting is accomplished by CR5 and associated components.

The resulting detected and noise limited audio signal is coupled by coupling capacitor C16 to the volume control, R13.

4.3.4 AUTOMATIC GAIN CONTROL (AGC)

When the received signal level increases, a sample output voltage from Q3 is rectified by AGC rectifier CR3, and the resulting negative going AGC-1 voltage is applied to the base of RF amplifier Q1. This negative going voltage appearing at the base of Q1 decreases stage gain, and the emitter voltage of Q1 also goes in a negative direction. Since the emitter of Q1 is connected to the base of mixer Q2, base of IF amplifier Q3 and diode CR2, this applied voltage effectively reduces the overall receiver gain and prevents overloading. Diode CR2 delays the application of AGC-2 voltage to the base of Q2, allowing positive squelch gate operation with weak received signal levels.

When the received signal level decreases, Q1 gain increases, which in turn increases Q2, Q3 and Q4 conduction.

The end result of AGC-1 and AGC-2 action is a relatively constant audio output with varying receiver signal inputs.

4.3.5 AUDIO

The audio signal is coupled from the wiper arm of volume control R13 by coupling capacitor C18 to audio switch CR6, which is biased "on" in the receive condition. From CR6, the audio signal is coupled by coupling capacitor C19 to the base of audio amplifier Q9. The audio is then amplified by audio amplifier Q9, audio driver Q10 and coupled by audio driver transformer T5 to the Class B audio output stage, Q11 and Q12. The amplified audio output from Q11 and Q12 is coupled by audio output transformer T6 to the 8 ohm speaker, LS1.

4.3.6 SQUELCH

The squelch circuitry consists of squelch control R27, squelch gate Q7, squelch amplifier Q8, squelch diode CR9 and associated components. Squelch gate Q7 is normally cut off and squelch amplifier Q8 is normally conducting, which reverse biases squelch diode CR9.

When squelch control R27 is adjusted to forward bias squelch gate Q7, the transistor conducts and a negative going collector voltage cuts off normally conducting Q8. When Q8 cuts off, squelch diode CR9 is forward biased and cuts off audio amplifier Q9, disabling audio output.

When an RF signal is received, Q1 emitter voltage goes in a negative direction because of AGC action. With sufficient signal, this voltage reverse biases squelch gate Q7, forward biases squelch amplifier Q8 and reverse biases squelch diode CR9, enabling audio output.

4.4 TRANSMITTER

4.4.1 SYNTHESIZER MIXER AND RF STAGES

The synthesizer mixer Q14 output is coupled through C56, CR15, C57 and double tuned transformer T10-T11 to the base of the predriver stage, Q15. The predriver stage increases the RF power to a sufficient level to drive the driver stage, Q16, and transformer T13 couples the driver output to the base of power amplifier Q17.

Power amplifier stage Q17 is operated Class C and is designed to operate with a 5 watt DC power input for a power output range of 3 to 4 watts. The antenna is switched from receive to transmit operation by diode CR16, and the power output is coupled through a low pass filter network to the antenna.

4.4.2 MODULATOR AND AUDIO COMPRESSOR

Audio switching diode CR6 is biased "off" in the transmit condition, and effectively isolates the receiver circuitry from the audio amplifier input.

Audio signals from the microphone are coupled to the base of audio amplifier Q9. Amplified audio output from the collector of Q9 are coupled to audio driver Q10 stage where the audio is again amplified, then coupled by driver transformer T5 to the Class B audio output stage, Q11 and Q12. The audio output from Q11 and Q12 is coupled by transformer T6 to RF driver Q16 and power amplifier Q17, where the audio modulates the RF carrier.

Audio compression is provided by sampling the audio output at the T6 secondary. This audio sample is coupled by C32 to the compressor rectifier diode, CR11. After rectification, the audio sample is filtered by RC filter R34 and C29, then applied to the emitter of Q9, which reduces the gain of Q9.

The end result is a relatively constant modulation level with a varying microphone audio input level.

4.5 METER CIRCUITRY

In the receive condition with no signal input, S meter zero control R81 is adjusted for an electrical meter zero. Therefore, when a significant input signal is coupled to Q2 base, Q2 emitter and meter current decrease (due to AGC action), allowing the meter to indicate a signal strength reading which is proportional to the input signal level.

In the transmit condition, some of the RF carrier leaks through CR16 and is coupled through T1 and Q1 to Q2 where it is rectified, causing a meter indication.

The LED meter circuit (123SJ) operates similar to the mechanical meter. In the receive condition, a received signal is rectified by the base-emitter junction of Q2 and applied to the base of Q201, allowing Q201 to conduct and Q202 to cut off. The positive voltage on the collector of Q202 causes Q203 to conduct from ground through one or more of the LED's to B+. The number of LED's that turn on depends on the amplitude of the received signal at Q2.

When the transmitter is modulated, a sample modulation voltage level biases Q203, allowing the appropriate LED display indication.

SECTION 5
SERVICING

5.1 GENERAL

The information in this section serves as a guide for servicing the Messenger 122 and 123A Citizens Radio transceivers. Carefully read this information before attempting to isolate transceiver malfunctions.

Refer to the circuit description, block diagram and schematic to familiarize yourself with the transceiver circuitry.

Always give a defective transceiver a quick visual check before attempting to isolate troubles. Look for overheated or discolored components and cold solder joints. Be suspicious of solder joints that appear to have excessive solder, too little solder, or dull and uneven color.

5.1.1 PREVENTIVE MAINTENANCE

The transceiver should be put on a regular maintenance schedule and an accurate record of its performance should be maintained. Important checks are receiver signal-to-noise and transmitter power output and frequency. Use the performance tests in the alignment section as guides.

5.1.2 SOLDERING PRACTICES

The same basic soldering practices used on other printed circuit boards can be used on the Messenger 122 and 123A printed circuit board. Avoid using small wattage soldering irons and apply the amount of heat that will cause the solder to flow quickly. No soldering iron smaller than 47 watts should be used. Use desoldering devices such as a solder sipper or solder wick to remove solder from the printed circuit board.

5.1.3 COMPONENTS LAYOUT

A components layout sheet is located at the back of this service manual. The view is from the bottom of the printed circuit board and is printed on a transparent page. It can be referenced to the actual printed circuit board when locating components, measuring voltages and performing signal injections.

5.1.4 REPLACEMENT PARTS LIST

A replacement parts list has been included at the back of this service manual. The parts are listed in alphabetical and numerical order for ease of location.

The transistors used in this transceiver are specially selected for specific parameters and are listed with E. F. Johnson part numbers. To obtain peak transceiver performance, replacement transistors should be the type listed in the parts list section.

5.1.5 OSCILLOSCOPE WAVEFORMS

When servicing the audio section, it is recommended that an oscilloscope be used to isolate defective components.

5.2 TRANSISTOR TROUBLESHOOTING

5.2.1 GENERAL

The following information is intended to aid troubleshooting through the isolation or elimination of transistor malfunctions.

It should be pointed out that a transistor which checks good, even with an expensive tester, might not function properly in the circuit. Transistor substitution should then be the final judge of transistor condition. However, because of the excellent history of transistor reliability, don't substitute a transistor before being certain that other components are not causing the problem.

Transistor lead placement is not always consistent. Therefore, transistor base diagrams should be consulted when there is doubt.

5.2.2 TRANSISTOR OPERATING CHARACTERISTICS

For all practical purposes the transistor base-emitter junction and the transistor base-collector junction can be considered to be diodes. For the transistor to conduct, its base-emitter junction must be forward biased in the same manner as a conventional diode. In a germanium transistor the typical forward biased junction voltage is 0.2 to 0.4 volts. A typical silicon transistor will have a forward biased junction voltage of 0.5 to 0.7 volts. When collector current is high the base-emitter voltage of both germanium and silicon transistors increases from 0.1 to 0.2 volts. The base-emitter bias voltage in the forward biased condition is then 0.4 to 0.5 volts for a germanium transistor and 0.7 to 0.9 volts for a silicon transistor. High current silicon transistors may go up to 2 volts under load.

5.2.3 IN-CIRCUIT TRANSISTOR TESTING

An in-circuit transistor tester should be used if one is available. If one is not available, an in-circuit transistor test can be performed using a sensitive voltmeter, a soldering aid and, sometimes, a 100 ohm resistor.

Refer to Figure 5-1 for the correct voltmeter connections and proceed with the following tests:

1. Measure the emitter voltage. Compare your measurement to the voltage listed on the schematic diagram. A correct emitter voltage reading generally indicates that the transistor is working properly. If you are in doubt as to the condition of the transistor after measuring the emitter voltage, proceed with the following test.

2. Measure the base-emitter junction bias. The voltage measured across a forward biased junction should be approximately 0.3 volts for a germanium transistor and 0.6 volts for a small signal silicon transistor.

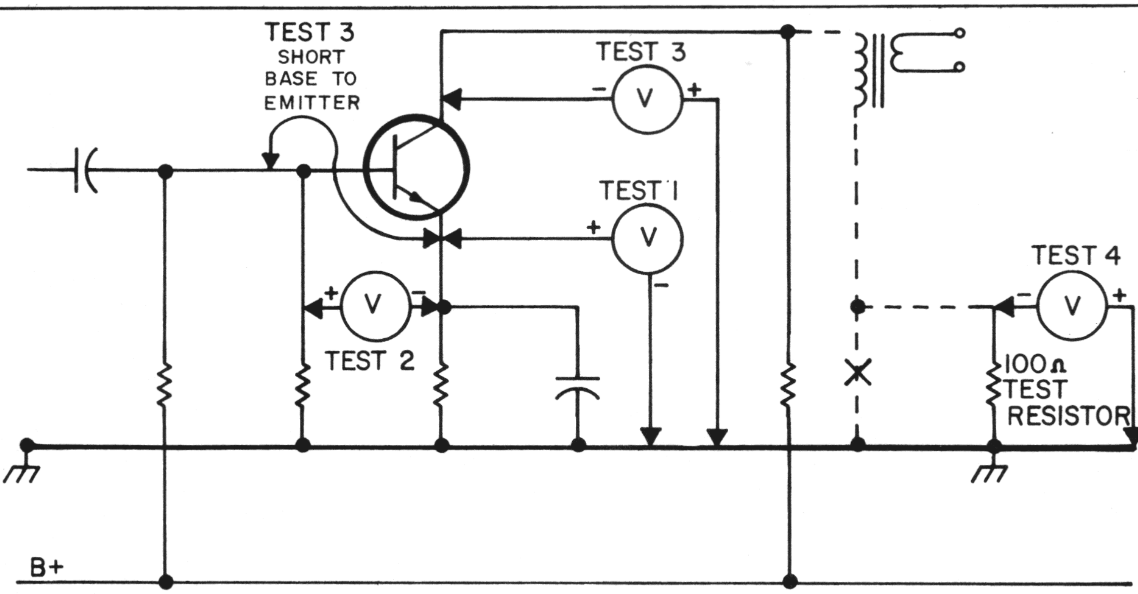
3. Check for amplifier action by shorting the base to the emitter with a soldering aid while monitoring the collector voltage.* The transistor should cut off (not conduct emitter to collector) because the base-emitter bias is removed. The collector voltage should rise to near the supply level. Any difference is the result of leakage current through the transistor. Generally, the smaller the leakage current the better the transistor. If no change occurs in the collector voltage when the base-emitter junction is shorted the transistor should be removed from the circuit and checked with an ohmmeter or a transistor tester.

4. Use a 100 ohm load resistor if the collector DC resistance is too low to develop much DC voltage. This 100 ohm value does not affect the stage characteristics and by measuring the voltage developed across it, the collector current is indirectly measured.

CAUTION

Be careful when connecting test leads to in-circuit transistors. Operating transistors can be ruined by shorting the base to the collector and, in some circuit configurations, the emitter to ground.

*Not recommended for high level stages under driving conditions.



IN CIRCUIT TRANSISTOR TESTING
FIGURE 5-1

5.2.4 OHMMETER REQUIREMENTS FOR OUT OF CIRCUIT TRANSISTOR TESTING

Only high quality ohmmeters should be used to measure the resistance of transistors. Many ohmmeters of both VOM and electronic types have short circuit current capabilities in their lower ranges that can be damaging to semiconductor devices. A good "rule of thumb" is to never measure the resistance of a semiconductor on any ohmmeter range that produces more than 3 milliamperes of short circuit current. Also, it is not advisable to use an ohmmeter that has an open circuit voltage of more than 1.5 volts.

The following steps should be performed to determine the ohmmeter short circuit current:

1. When the ohmmeter test probes are shorted together (measuring the forward resistance of a diode or the base-emitter junction of a transistor amounts to the same thing) the meter deflects full scale and the entire battery voltage appears across a resistance that we will designate as R1. The current through the probes is the battery voltage 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.

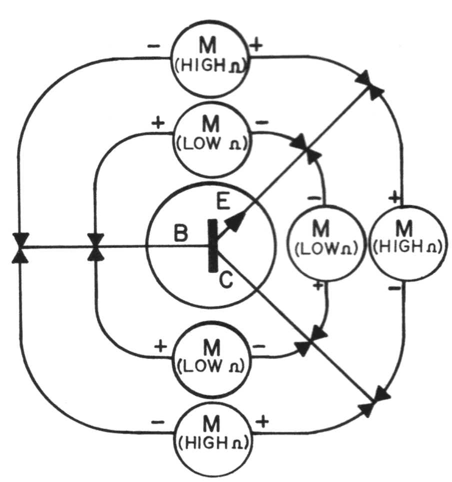
2. The only other unknown required to calculate the short circuit current of an ohmmeter is the internal battery voltage. Let's take a well known meter that has a center scale reading on the ohms scale of 4.62 and a battery voltage of 1.5 volts. Its short circuit current can be calculated by using Ohm's Law. Dividing 1.5 volts by 4.62 ohms equals a short circuit current of 324 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 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.

   Remember that you should not measure any semiconductor resistance on any ohmmeter range which produces more than three milliamperes of short circuit current.

5.2.5 OUT OF CIRCUIT TRANSISTOR TESTING

Turn the transceiver voltage off, disconnect at least two of the three element leads on the suspected defective transistor and refer to Figure 5-2.

Polarities shown in Figure 5-2 are for NPN transistor types. For PNP transistor types, reverse the meter lead polarity.



OUT OF CIRCUIT TRANSISTOR RESISTANCE MEASUREMENTS
FIGURE 5-2

Note: Germanium transistor information is included for reference only.

Silicon

Connect the negative meter lead to the emitter and the positive lead to the base. Approximately 500 to 2K ohms should be measured. Move the positive meter lead to the collector. Approximately 25K to infinity should be measured. If the emitter to base reading is near zero or infinity, the transistor can be considered defective. If the emitter to collector reading is near zero, the transistor can be considered defective. It is sometimes difficult to determine if an open exists from emitter to collector, since normal readings are near infinity.

Small Signal Germanium (PNP)

Connect the positive meter lead to the emitter and the negative lead to the base. Approximately 300 to 400 ohms should be measured. Move the negative meter lead to the collector. Approximately 5K to 50K ohms should be measured. If either meter reading is near zero or infinity, the transistor can be considered defective.

Power Germanium (PNP)

Connect the positive meter lead to the emitter and the negative lead to the base. Approximately 20 to 50 ohms should be measured. Move the negative meter lead to the collector. Approximately 30 to 500 ohms should be measured. If either meter reading is near zero or infinity, the transistor can be considered defective.

5.3 RECEIVER TROUBLESHOOTING

5.3.1 RECEIVER CURRENT DRAIN

a. Connect a 1.5 ampere current meter in series with the positive voltage lead.

b. Set the volume control for maximum volume and the squelch control for minimum squelch.

c. Check the total receiver current drain.

   1. Typical receiver current drain should measure approximately 400 mA with no signal input.

5.3.2 RECEIVER OVERALL GAIN TEST

a. The relative receiver condition can be quickly checked by performing a receiver overall gain test.

b. Proceed as follows to perform a receiver overall gain test:

   1. Connect the RF signal generator to the antenna connector through a 6dB pad. Set the RF signal generator output for 1 μV, modulated with 1 kHz at 30%.

   2. Set the RF signal generator frequency for 27.085 MHz (channel 11) and the transceiver volume control full on with channel 11 selected.

3. With an audio voltmeter connected across the speaker terminals, a voltmeter indication of at least 0.775 volts (0 dB) should be indicated. A typical reading of +12 dB is common.

4. If the preceding test indicates problems, use the following information to systematically troubleshoot the receiver.

5.3.3 OSCILLATOR, MIXER AND CERAMIC FILTER

a. Measure the RF injection voltage at the base and emitter of Q14 in both receive and transmit condition.

  1. A typical reading of approximately 0.3 VRF should be measured at Q14 base.

  2. A typical reading of approximately 0.8 VRF should be measured at Q14 emitter.

b. Measure the synthesizer mixer output in both receive and transmit condition.

  1. In the receive condition, a typical reading of approximately 0.07 VRF should be measured at Q2 base.

  2. In the transmit condition, a typical reading of approximately 0.36 VRF should be measured at Q15 base.

c. The condition of ceramic filter Z1 can be checked by connecting a 455 kHz signal to the base of Q2 and monitoring the response curve after detector diode CR4 with an oscilloscope.

  1. Be sure to carefully check associated components before substituting Z1.

  2. Ceramic filter Z1 normally does not require realignment when replaced. If alignment is necessary, do so while monitoring the response curve.

5.3.4 AUTOMATIC GAIN CONTROL (AGC)

a. Receiver performance can be evaluated by checking AGC characteristics and levels.

  1. Refer to receiver test setup, Figure 6-2, in the alignment section.

  2. Set the RF signal generator output for 1000μV on 27.085 MHz (channel 11), modulated with 1 kHz at 30%.

  3. Set the transceiver to channel 11 and adjust the volume control for a 0 dB audio VTVM indication.

  4. Reduce the RF signal generator output to 1 μV. The audio VTVM should drop 15 dB ±2 dB. If this requirement is not met, adjust R7 and repeat steps 3 and 4.

  5. If the audio reading still does not meet the preceding requirement, proceed with AGC troubleshooting.

b. AGC Troubleshooting

  1. Measure the no signal input AGC-1 voltage at the junction of R9 and C12. The reading should be approximately 0.9 V.

  2. Measure the no signal input AGC-2 voltage at the cathode of CR2. The reading should be approximately 1.6 V.

  3. Increase the RF signal generator output from 1 μV to 100,000 μV while observing the audio output meter indication. Refer to Table 5-1 for typical AGC levels.

  4. Isolate the AGC circuitry from the squelch stage by disconnecting the interconnecting lead from squelch control R7. This will separate squelch problems from defective AGC indications.

  5. If the audio output meter indication does not follow the general trend of the data shown in Table 5-1, check CR3, Q1 and associated circuitry.

TABLE 5-1
TYPICAL AGC LEVELS

RF Input to 6 dB pad (In Microvolts)	Relative Audio Output (In dB)
1	-16.0
3	- 8.5
10	- 4.6
30	- 2.5
100	- 1.3
300	- 0.9
1,000	- 0.8
3,000	- 0.9
10,000	- 1.1
30,000	- 0 (+10 dB ref)
100,000	+ 3.0

Test Conditions: Connect the RF signal generator through a 6 dB pad to the transceiver antenna connector, and set the frequency to 27.085 MHz. (channel 11), modulated with 1 kHz at 30%.

Set the volume control for a 10 dB reference level as measured across the speaker terminal with a 30,000 μV RF signal generator input.

TABLE 5-2
TYPICAL RECEIVER SIGNAL LEVELS

Test Point	Input Frequency	Input Voltage Level to 6 dB Pad
Antenna Connector	27.105 MHz	1.0 μV
Q1 Base	27.105 MHz	1.7 μV
Q1 Collector	27.105 MHz	19.0 μV
Q2 Base	27.105 MHz	16.0 μV
Q2 Collector	455 kHz	2.4 mV
Q3 Base	455 kHz	0.4 mV
Q3 Collector	455 kHz	4.5 mV
Q4 Base	455 kHz	2.2 mV
Q4 Collector	455 kHz	340.0 mV
CR4 Anode	1 kHz	95.0 mV
CR5 Cathode	1 kHz	9.5 mV
C16 (vol. side)	1 kHz	8.9 mV
CR6 Cathode	1 kHz	0.6 mV
Q9 Base	1 kHz	0.3 mV
Q9 Collector	1 kHz	4.7 mV
Q10 Base	1 kHz	4.8 mV
Q10 Collector	1 kHz	400.0 mV
Q11, Q12 Base	1 kHz	350.0 mV

Test Conditions: Set the volume control for a 0 dB audio output with 1 μV into 6 dB pad RF input. Set the squelch control for minimum squelch.

Connect the RF and audio signal generators through a 1.0 μF capacitor to the listed test points, and set the generator output levels for a 0 dB reference level as measured across the speaker terminals.

Modulate the RF signal generator with a 1 kHz tone at 30% modulation.

5.3.5 RF AND IF STAGES

Proper RF and IF stage operation can be quickly checked by injecting calibrated signals at various points and measuring for a reference output voltage level (signal injection method).

a. Refer to Table 5-2 for test conditions, test points, frequencies and voltage levels.

b. Connect the RF or IF signal generator through a 1.0 μF capacitor to indicated test points, and compare readings with those listed.

c. Half split troubleshoot.

   1. First connect the generator to Q9 base. If there is audio output, work towards the receiver front end until the defective stage is isolated.

   2. If there is no audio output, proceed with audio troubleshooting.

5.3.6 AUDIO TROUBLESHOOTING

a. Refer to Table 5-2 for test conditions, test points, frequency and voltage levels.

b. Connect the audio signal generator through a 1.0 μF capacitor to indicated test points, and compare readings with those listed.

c. First connect the generator to Q11 and Q12 collector. If there is audio output, work toward CR4 until the defective stage is isolated.

d. If audio distortion is apparent, use an oscilloscope to trace trouble to defective stage and component.

e. Severe audio distortion can be the result of an open Q11 or Q12. A shorted Q11 or Q12 can cause R42 to burn and possibly blow the line fuse.

5.3.7 SQUELCH

a. Squelch operation can be checked by performing a tight squelch test. Proceed as follows to perform this test:

   1. Connect the RF signal generator to the antenna connector and adjust the squelch control full clockwise.

   2. Set the RF signal generator to 30 μV, modulated with 1 kHz at 30% (channel 11 frequency). Squelch should not open.

   3. Set the RF signal generator to 3000 μV. The squelch should open, allowing audio output to be heard.

   4. If the preceeding requirements are not met, proceed with squelch troubleshooting.

b. Squelch Troubleshooting

   1. Measure the emitter voltage of audio amplifier Q9 while adjusting the squelch control from minimum to maximum squelch. The voltage indication should go from approximately +2.9 to 5.3 VDC.

   2. Since squelch gate Q7 receives its control voltage from the amplified AGC line (AGC2), the AGC circuitry should be checked before proceeding with squelch troubleshooting.

   3. After determining that the AGC circuitry is not defective, check squelch gate Q7, squelch amplifier Q8, squelch diode CR9 and associated circuitry.

   4. Measure Q7 and Q8 DC voltages and compare with those indicated on the schematic.

5.3.8 NOISE LIMITER

The noise limiter condition should be checked by using signal injections and resistance measurements.

1. If signal injections indicate a defective noise limiter circuit, unsolder CR5 and substitute with a known good diode. Check associated components.

2. The front-to-back resistance ratio should measure approximately 1:10 for a typical noise limiter diode.

5.4 TRANSMITTER TROUBLESHOOTING

Refer to the alignment section for test setup details, and Table 5-3 for typical transmitter RF voltage readings.

5.4.1 TRANSMITTER CURRENT DRAIN

a. Connect a current meter in series with the positive voltage lead and key the transmitter.

b. Normal current drain should measure between approximately 970 mA with 3.8 watts power output, no modulation, or 1.2 A maximum with full modulation.

5.4.2 OSCILLATOR, PREDRIVER AND DRIVER

a. Refer to section 5.3.3 for oscillator injection voltage readings. If the injection voltages are abnormal, check the appropriate crystals (as referenced on the schematic synthesizer scheme) and other associated components.

b. Measure the predriver (Q15) collector RF voltage. A typical reading of approximately 4.5 VRF should be measured.

c. Measure driver Q16 base and collector RF voltages. A typical reading of approximately 2.0 VRF and 8.0 VRF should be measured.

d. If stage RF voltage readings are abnormal, measure the DC voltages and compare with those listed on the schematic.

5.4.3 POWER AMPLIFIER, ANTENNA SWITCHING DIODE AND LOW PASS FILTER

a. Measure power amplifier Q17 base and collector RF voltages. A typical reading of approximately 1.8 VRF and 12.8 VRF should be measured.

b. Measure the RF voltage across R68. A typical reading of approximately 13.5 VRF should be measured.

1. If no RF voltage is developed across R68, check antenna switching diode CR16.

2. Check low pass filter tuning (L6-L7), and check associated components.

5.4.4 MODULATOR AND AUDIO COMPRESSOR

a. Couple an oscilloscope pickup loop to L7. Refer to Figure 5-4 for pickup loop fabrication and oscilloscope connection.

b. Key the transmitter and observe the unmodulated RF carrier oscilloscope waveform. The waveform should be free from noise. Refer to Figure 5-3 (1) for normal waveform.

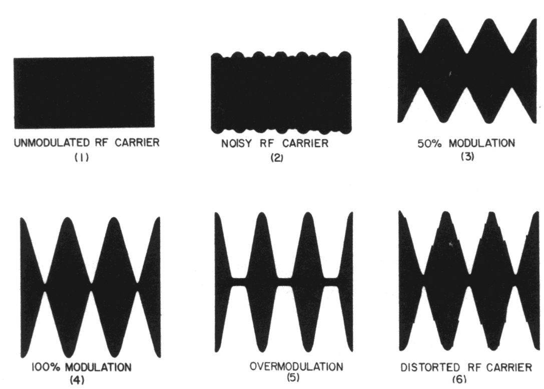
1. If noise is riding on top of the waveform, check for a noisy Q9 or Q10 and other associated defective components. Refer to Figure 5-3 (2) for noisy RF carrier waveform.

TABLE 5-3
TYPICAL TRANSMITTER RF VOLTAGE READINGS

Test Point	RF Voltage Reading
Q15 Collector	4.5 VRF
Q16 Base	2.0 VRF
Q16 Collector	8.0 VRF
Q17 Base	1.8 VRF
Q17 Collector	12.8 VRF
Antenna Connector	15.4 VRF

Test Conditions:
RF voltage readings were measured with a Boonton 91C RF voltmeter using a 100:1 RF probe.

Measurements were made on an unmodulated transmitter which had an RF power output of 3.7 watts.



TRANSMITTER RF WAVEFORMS
FIGURE 5-3

c. Connect the audio generator through a 6800 pF capacitor to the base of Q9.

1. Set the audio generator frequency to 1 kHz and the output level to 10 mV (-38 dB). The oscilloscope should indicate at least 50% modulation. Refer to Figure 5-3 (3) for normal waveform.

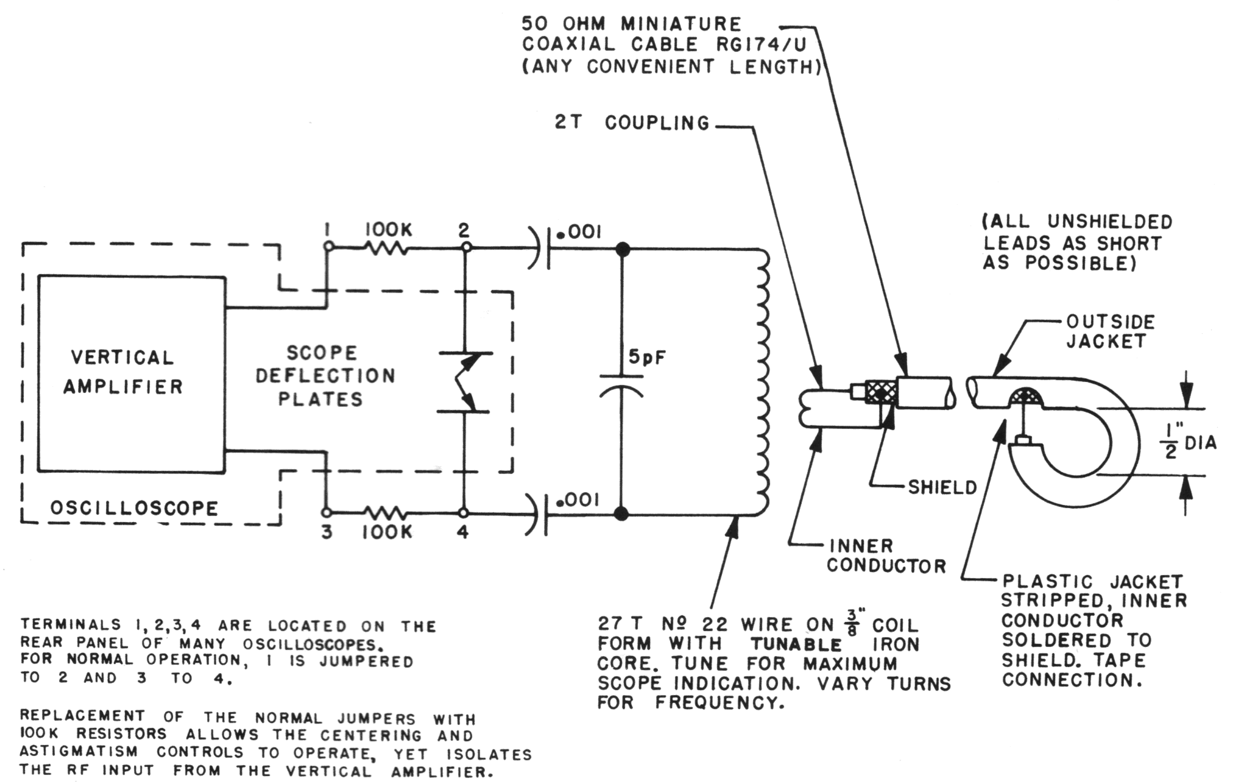
2. Increase the audio generator output level to 63 mV (-22 dB). The oscilloscope should indicate not less than 80% and not more than 100% modulation on negative and positive peaks. Refer to Figure 5-3 (4) for 100% modulation oscilloscope waveform.

d. Check for modulation waveform distortion and correct if present.

1. When the audio compressor is functioning properly, the transmitter cannot be overmodulated with a 1 kHz microphone input. If upward or downward overmodulation is apparent, suspect audio compressor trouble. Refer to Figure 5-3 (5) for overmodulation waveform.

2. Check C32, CR11, C29 and associated components.

3. The waveform should be clean and free of RF distortion. If RF distortion is present, try to eliminate by retuning the transmitter, then check C68, C69, C71 and C72. Refer to Figure 5-3(6) for distorted RF carrier waveform.



OSCILLOSCOPE RF PICK-UP LOOP FABRICATION AND METHOD OF CONNECTION

FIGURE 5-4

5.5 FREQUENCY SYNTHESIZER

The following information including Tables 5-4, 5-5 and 5-6 should be helpful in isolating frequency synthesizer troubles.

a. Connect the RF voltmeter probe to the CR14-CR15 junction, and check each channel for crystal starting and uniform injection voltage levels.

b. Couple an unmodulated transmitter power output sample to a frequency meter or electronic counter.

c. Measure the frequency of channels 1, 6, 11, 16, 20 and 23. Refer to Table 5-5 for transmitter channel frequency limits.

d. If the synthesizer fails to meet the limits listed in Table 5-5, refer to Table 5-4, 5-6 and proceed with frequency synthesizer trouble isolation.

TABLE 5-4
FREQUENCY SYNTHESIZER TROUBLE ANALYSIS

Trouble	Probable Cause
Receiver and transmitter completely inoperative. No apparent synthesizer output.	Synthesizer mixer Q14
Receiver completely inoperative.	CR8 or CR14
Transmitter inoperative.	CR7 or CR15
Transceiver operation intermittent.	Dirty selector switch.
Transceiver inoperative on some channels, operates normally on others.	Defective crystal. Refer to Table 5-8.

TABLE 5-5
TRANSMITTER CHANNEL FREQUENCY LIMITS
(at +25°C - 72°F)

CHANNEL NO.	FREQUENCY, kHz	+0.004% HIGH LIMIT, kHz	-0.004% LOW LIMIT, kHz
1	26,965.000	26,966.079	26,963.921
6	27,025.000	27,026.081	27,023.919
11	27,085.000	27,086.083	27,083.917
16	27,155.000	27,156.086	27,153.914
20	27,205.000	27,206.088	27,203.912
23	27,255.000	27,256.090	27,253.910

TABLE 5-6
FREQUENCY SYNTHESIZER CRYSTAL TROUBLE ANALYSIS

Channels Inoperative	Receive Inoperative	Transmit Inoperative	Faulty Crystal
1, 2, 3 and 4	X	X	Y9
5, 6, 7 and 8	X	X	Y10
9, 10, 11 and 12	X	X	Y11
13, 14, 15 and 16	X	X	Y12
17, 18, 19 and 20	X	X	Y13
21, 22 and 23	X	X	Y14
1, 5, 9, 13, 17 and 21	X		Y5
2, 6, 10, 14, 18 and 22	X		Y6
3, 7, 11, 15 and 19	X		Y7
4, 8, 12, 16, 20, 23	X		Y8
1, 5, 9, 13, 17 and 21		X	Y1
2, 6, 10, 14, 18 and 22		X	Y2
3, 7, 11, 15, 19		X	Y3
4, 8, 12, 16, 20 and 23		X	Y4