4.3.6 Automatic Gain Control (AGC)

The AGC circuit consisting of an AGC Detector, CR4, and three AGC Amplifiers, Q7, Q21 and Q22, functions to maintain a constant receiver gain with fluctuating RF input levels. AGC voltage is applied to three stages, Q1, Q2 and Q5 in the receiver and to Q10 and Q11 in the Noise Blanker circuit so that the Noise Blanker action will be decreased when a large signal is received and noise reduction is not necessary.

An IF sample is coupled from the secondary of T10 to the AGC Detector diode, CR4, through C33. If, for example, a large signal is received, a large sample will be rectified by CR4 resulting in a large reverse bias voltage on the base of Q7. As the conduction of Q7 decreases, the voltage drop across the emitter resistor, R36, decreases. This negative going AGC voltage is connected to the base of Q21 and Q22 simultaneously causing their rate of conduction to decrease. Thus Q21 and Q22 act as variable resistors in the emitter circuits of Q1 and Q2 respectively. Therefore Q1, the RF Amplifier, and Q2, the Receive Mixer, provide less gain to the received signal. The AGC voltage is also applied to the base of the Second IF Amplifier, Q5, which reduces the IF gain and prevents receiver overloading.

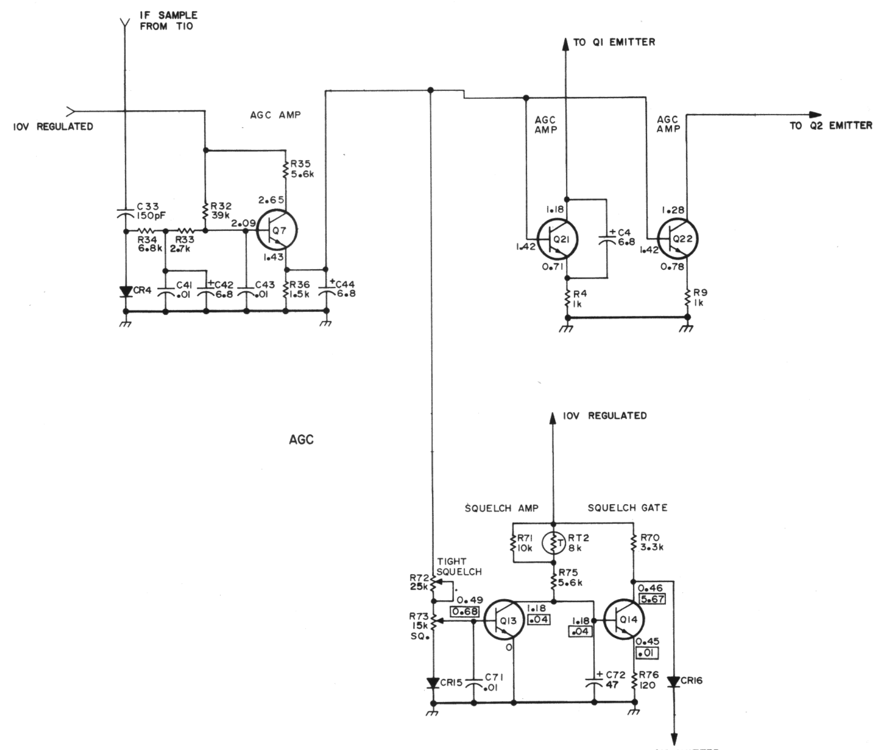
The AGC voltage is also applied to the base of the Noise Blanker First IF Amplifier, Q10, and the Noise Blanker Second IF Amplifier, Q11. This negative voltage acts as reverse bias to decrease the conduction and the stage gain of Q10 and Q11 to reduce the gating pulse amplitude when strong signals are received.

4.3.7 Squelch

The squelch circuit is designed to disable the Audio Preamplifier when no "on frequency" signal is present at the receiver.

When an "on frequency" signal is received, an AGC voltage is developed on the emitter of Q7 which is applied to the base of the Squelch Amplifier, Q13, at a level set by the Squelch control, R73. This negative voltage causes Q13 conduction to decrease and Q13 collector voltage to increase. The positive going collector voltage is applied to the base of the Squelch Gate, Q14, as forward bias. When Q14 conducts, it allows the Audio Preamplifier, Q15, to conduct and pass the audio signals.

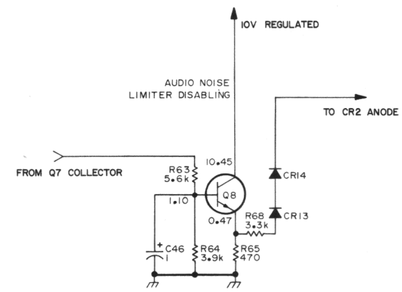
When there is no "on frequency" signal at the receiver, the AGC voltage goes positive which is felt as forward bias on Q13. As Q13 conducts, Q14 cuts off due to the negative voltage on the base. With Q14 cut off the collector voltage goes positive, reverse biasing Q15 which disables the receiver audio.



4.3.8 Audio Noise Limiter Disabling

The Audio Noise Limiter Disabling circuit places a positive voltage on the anode of the Audio Noise Limiter diode, CR2, which turns on the diode to prevent clipping distortion.

When a large signal is received (larger than 30μV), the collector voltage of the AGC Amplifier, Q7, goes positive, which provides forward bias for the Audio Noise Limiter Disabler, Q8. When Q8 turns on, a positive voltage is developed across R65 causing CR13 and CR14 to conduct. The positive voltage at R65 causes CR2 to stay in conduction, which disables its limiting function. CR13 and CR14 also prevent loading of the audio circuits by Q8 circuitry during normal noise limiter operation.

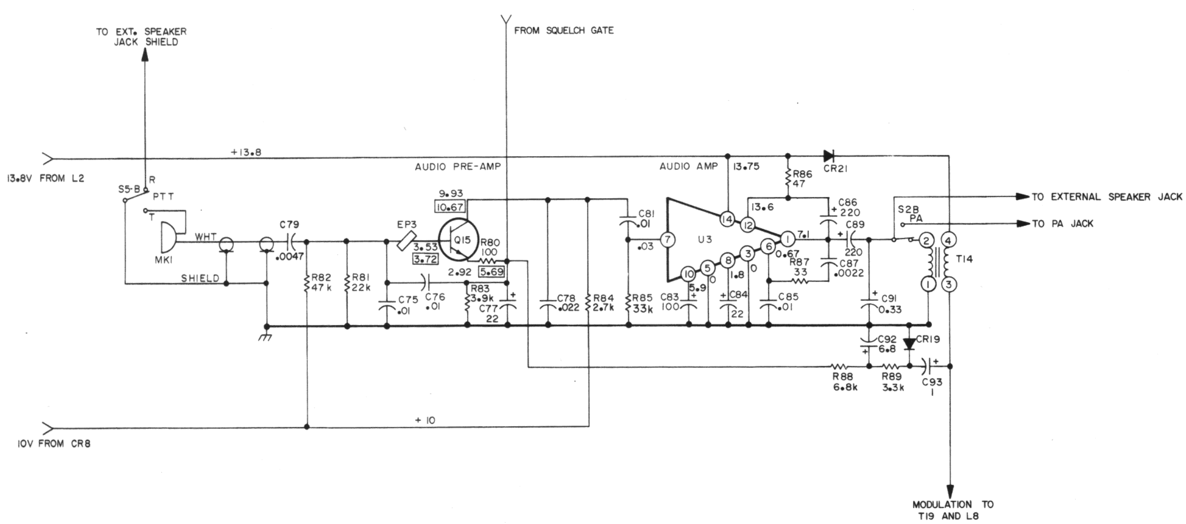


4.4 TRANSMIT

4.4.1 Audio

When the push to talk (PTT) button on the microphone is depressed, the 13.8V B+ is switched from the receive circuits and applied to the transmit circuits along with DS203 (red transmit indicator). The PTT switch also switches the common line from the speaker to the microphone.

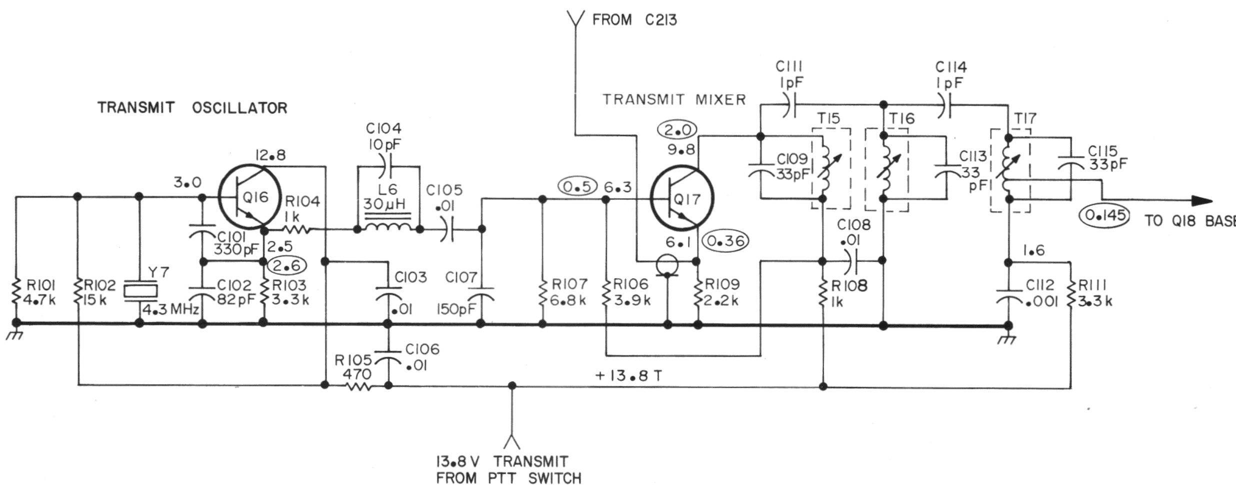
The audio from the microphone is amplified by the Audio Preamplifier, Q15, and coupled from Q15 collector through C81 to the input of the Audio Power Amplifier, pin 7 of U3. The amplified audio from pin 1 of U3 is coupled through C89, the PA switch, to T14, the modulation transformer. The audio is coupled through T14 and modulates Q19 and Q20 collectors. An audio sample is coupled from T14 secondary through C93 to the compressor diode CR19. CR19 rectifies the audio and the resultant positive voltage is applied to Q15 emitter as reverse bias. Therefore, the stronger the audio signal at T14, the larger the reverse bias voltage at Q15 emitter to reduce the audio gain.



4.4.2 Transmit Oscillator and Transmit Mixer

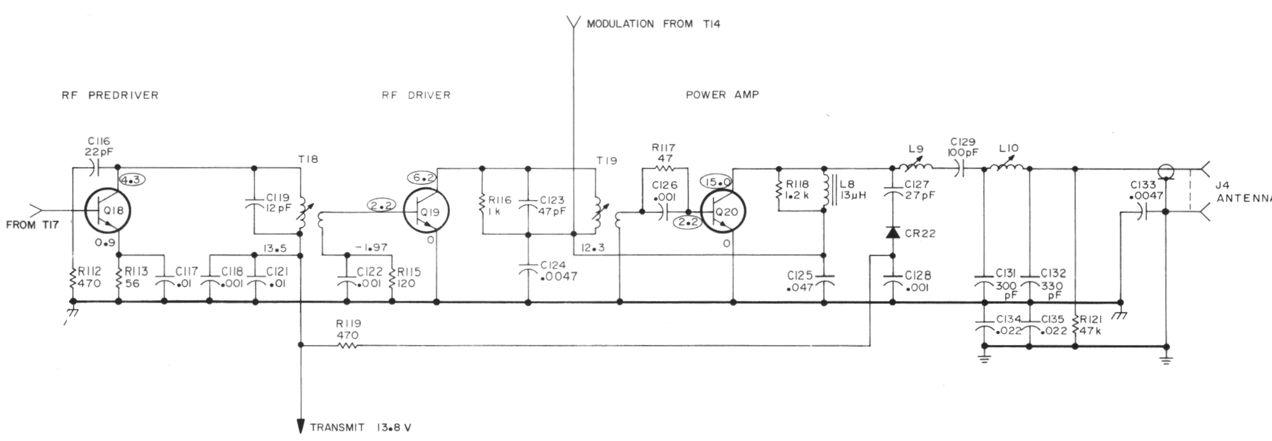
The output of the frequency synthesizer is always 4.3 MHz below the channel frequency so the channel frequencies are derived by mixing the synthesizer frequency with 4.3 MHz from the Transmit Oscillator, Q16.

The oscillator is a Modified Colpitts oscillator utilizing a parallel resonant crystal operating on its fundamental frequency to produce 4.3 MHz. The 4.3 MHz signal is coupled from the emitter of Q16 through C106 to the base of the Transmit Mixer, Q17. The synthesizer output is coupled from the synthesizer switch to the emitter of Q17 to be mixed with the 4.3 MHz. The output of the mixer is the sum of the two input frequencies. For example on channel 1, the 4.3 MHz is mixed with 22.665 MHz from the synthesizer to produce 26.965 MHz. The Q17 output circuitry of T15, T16, T17, C109, C111, C113, C114 and C115 is tuned to pass the band of frequencies between 26.965 MHz and 27.255 MHz.



4.4.3 Transmit RF

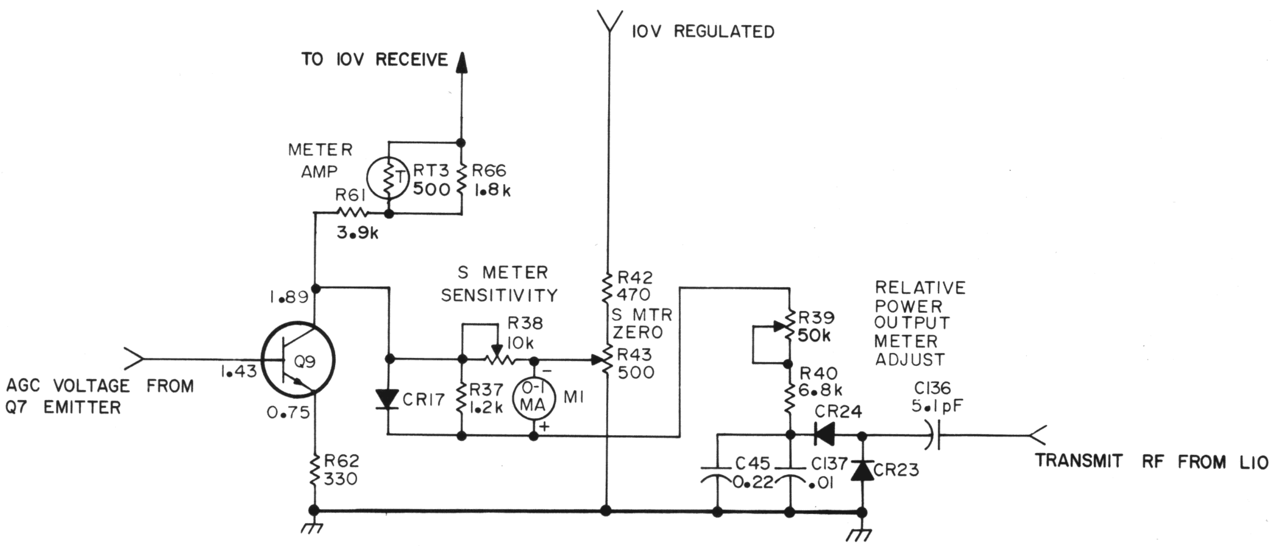
The output of the Transmit Mixer is coupled to two RF amplifier stages, Q18 and Q19, the RF Predriver and the RF Driver. The output of these stages is coupled to the input of the Power Amplifier, Q20. The output of Q20, a maximum power output of 4 watts RF, is coupled through L9, C129 and L10 to the antenna. The carrier signal is modulated by the audio signals from terminal 3 of modulation transformer T14 and applied to the collectors of Q19 and Q20.



4.4.4 S/RFO Meter

In the transmit mode, a sample of the RF voltage at the antenna jack, J4, is coupled through C136 and rectified by CR23 and CR24. The resultant positive DC voltage causes current to flow through the meter and through the Relative Power Output meter adjust, R39. R39 is adjusted to read 4 with an unmodulated RF carrier and will deflect up scale with modulation.

In the receive mode, the AGC voltage controls the Meter Amplifier, Q9, which is part of a balanced bridge circuit. The meter is connected across equal voltage points on the arms of the bridge when there is no received signal. When a signal is received, an AGC voltage is applied to the base of Q9, causing its conduction to decrease and the collector voltage to increase. This voltage causes an unbalanced condition in the bridge circuit and current flows through the meter. CR17 and R37 provide for a more linear meter action.



SECTION 5
SERVICE

5.1 GENERAL

The Messenger 323A contains two printed circuit boards; one for the frequency synthesizer and one for the transceiver. Also included is a speaker which is mounted on a detachable bracket and the front panel assembly which contains the S/RFO meter, Squelch and Volume controls, the Channel Selector switch, the PA switch and the Noise Blanker switch.

5.1.1 Preventive Maintenance

The transceiver should be put on a regular maintenance schedule and an accurate performance record should be maintained. Important checks are receiver sensitivity and transmitter frequency and power output.

5.1.2 Visual Inspection

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 in color.

5.1.3 Components Layout

A components layout sheet is located at the back of this manual. The view is from the solder side of the board. Locating components, measuring voltages and making signal injections are simplified by locating the desired component on the components layout sheet and noting the location on the actual circuit board.

5.1.4 Replacement Parts List

A replacement parts list is located at the back of this manual. For easy location, the parts are listed alphabetically and numerically.

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, replace defective transistors with the type listed in the parts list.

5.1.5 Test Instruments

Refer to Table 5-1 for the recommended test instruments used for transceiver service and alignment. Test instruments with equivalent specifications can be substituted.

5.1.6 Integrated Circuit Handling

There are two heat sinks on the audio integrated circuit (IC), one is part of the IC and the other is added for this particular application. When replacing the audio IC, the external heat sink should be removed first by removing the two screws that fasten it to the IC. Then unsolder the IC heat sink and finally unsolder the IC pins. Completely remove the solder from the heat sink and IC pins using solder wick or other desoldering device before attempting to remove the IC. The replacement IC has preformed leads to facilitate orientation and installation.

5.2 TRANSISTOR TROUBLE-SHOOTING

5.2.1 General

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

It is important to remember that even though a transistor checks good on a transistor tester, it might not function properly in the circuit. Transistor substitution should then be the final judge of the transistor condition. Because of the excellent history of transistor reliability, do not 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 before substitution. Refer to the schematic diagram.

5.2.2 Transistor Operating Characteristics

The key to most bipolar transistor troubleshooting is the bias voltage on the base-emitter junction. For the transistor to conduct, the base-emitter junction must be forward biased in the same manner as a conventional diode. The base-emitter voltage differential (bias) for a typical silicon transistor is between 0.5 to 0.7 volts. During high collector current conditions the bias voltage will increase to 0.7 to 0.9 volts.

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 test can be performed using a sensitive voltmeter and a shorting device, as outlined in the following tests. The circuit shown is that of the Audio Noise Limiter Disabling.

1. Measure the emitter voltage. Compare your reading with 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 tests.

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

TABLE 5-1
RECOMMENDED TEST EQUIPMENT

TEST INSTRUMENT	SPECIFICATIONS	USE	INSTRUMENT TYPE
1. RF Signal Generator	26 to 30 MHz internal or external modulation capability	Receiver service and alignment	Hewlett Packard 606B
2. VTVM	-40 to +30 dB range	Measure AC voltages	Heath IM-38
3. Audio Generator	6 Hz to 3 kHz at 0 to 10 volts	Alignment and performance tests	Heath IG-72
4. Frequency Counter	30 MHz, 50 mV sensitivity	Alignment and performance tests	Heath IB-1102
5. Wattmeter	26-30 MHz, 0-5 watts 50 ohms	Measure power output	Bird Model 43 with 5 watt element
6. Oscilloscope	Direct connection to vertical plates, or 30 MHz bandwidth	Signal tracing and audio checks	Telequipment S54A
7. RF Voltmeter	Frequency Range 26-30 MHz 5 mV to 3V RMS	Measure RF voltages	Boonton 91H
8. AC Power Supply	0-20 volts, 2 amps	Transceiver operating voltages	Harrison Labs 6284A
9. VOM	10 megohm input Z	Alignment and performance tests	Triplett 600, Type 2
10. Pulse Generator	100 Hz, P.W. 1µsec, 0.1 volt amplitude	Noise Blanker alignment and performance tests	Refer to Figure 6-1
11. Speaker Load	3.2 ohm speaker and resistive load with switch	Receiver alignment and performance tests	Assembled or commercial type

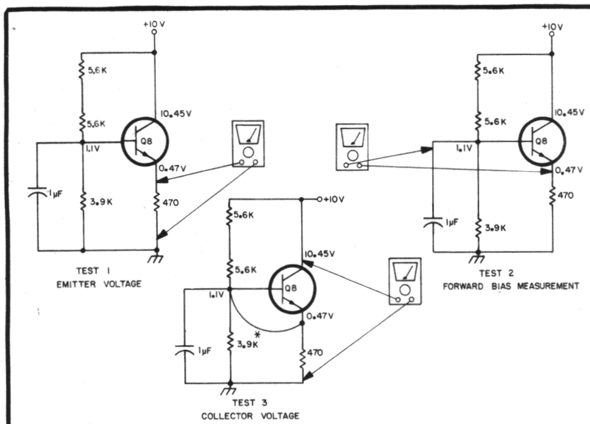
* Instruments with equivalent specifications may be substituted.

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 transistor leakage. 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 the ohmmeter or a transistor tester.

* Not recommended for high level stages under driving conditions.

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.



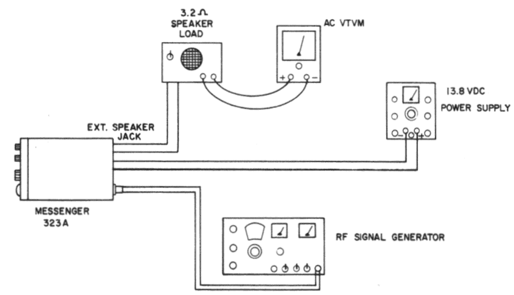
IN-CIRCUIT TRANSISTOR TESTING
FIGURE 5-1

5.3 RECEIVER TROUBLESHOOTING

If any of the performance tests indicate a malfunction, use the half-split troubleshooting technique to locate the defective component. The following procedure assumes there is no output from the receiver or transmitter. The voltage readings are what can be expected from a properly functioning transceiver. The readings listed are averaged from several transceivers; therefore they may differ slightly from the voltages of any one specific transceiver.

Refer to the suggested test setup in Figure 5-2 and set the controls as follows:

Squelch	-	fully counterclockwise
Volume	-	fully clockwise
Channel Selector	-	Channel 11
Noise Blanker	-	OFF
PA	-	OFF



RECEIVER TEST SETUP
FIGURE 5-2

5.3.1 Audio Stages

a. Connect the audio generator, set to 1 kHz, to the cathode of CR2 through a 0.01µF capacitor.

b. Connect an AC VTVM across the speaker and adjust the generator level for 1.5V RMS as read on the AC VTVM.

c. Use an oscilloscope to measure stage voltages and check for audio distortion.

d. Refer to Table 5-2 for voltage readings.

TABLE 5-2
AUDIO LEVELS

Test Point	Peak to Peak Volts
Q15 B	0.17
Q15 C	0.15
U3 pin 7	0.13
U3 pin 1	5.0
Speaker	4.6

Measurements taken with an Telequipment S5AA oscilloscope with 1 kHz signal at a level to produce 1.5V RMS audio output.

5.3.2 IF and RF Stages

a. Connect the RF signal generator to the collector of Q3 through a 0.01µF capacitor. Set the generator output for 4.3 MHz modulated 30% with 1 kHz at a level of 30µV.

b. Refer to Table 5-3 for IF voltage levels.

TABLE 5-3
IF LEVELS

Test Point	RMS Volts
Q4 B	0.0006
Q4 C	0.0009
Q5 B	0.0008
Q5 C	0.0023
Q6 B	0.001
Q6 C	0.039

Measurements taken with a Boonton 91H with an RF signal level input of 30μV.

NOTE

If Q5 or Q6 is replaced, the IF alignment should be checked carefully and realigned because of critical adjustment of T8, T9, and T10.

c. If the IF stages check good, make DC voltage measurements at Q1 and Q2 and compare the readings with those listed on the schematic diagram.

5.3.3 Frequency Synthesizer

a. Measure the DC voltage at CR8. A reading of 10 ±0.5 VDC should be measured.

b. Measure the receiver injection voltage. The synthesizer output voltage should be 80mV RMS at the base of Q2.

c. Loop couple a frequency counter to T202 and count the synthesizer output frequency which is 4.3 MHz below the channel frequency.

5.3.4 Noise Blanker

a. Connect a pulse generator to the antenna connector and set the output for a squarewave with an amplitude of 0.1 volt, pulse repetition rate of 100 Hz and pulse width of 1 microsecond. Refer to paragraph 6.4.6.

b. Turn the noise blanker "ON" and, using the oscilloscope, observe the waveform and amplitude as shown on the schematic diagram.

c. If the waveform or amplitude is incorrect, measure the DC voltages to isolate the defective component.

5.3.5 Automatic Gain Control (AGC)

a. Connect an RF signal generator to the antenna connector and measure the voltage at the junction of R36 and C44. A voltage of 1.4V should be measured with no signal input.

b. Set the volume control for 2.5V RMS audio output with 500μV input signal level. Increase the signal generator output level from 0.5μV to 50,000μV while observing the Q7 emitter voltage; refer to Table 5-4 for AGC voltages.

TABLE 5-4
AGC LEVELS

RF Input in Microvolts	AGC Voltage
0.0	1.4
0.5	1.38
1.5	1.20
5.0	1.05
15.0	0.95
50.0	0.83
150.0	0.76
500.0	0.70
1,500.0	0.68
5,000.0	0.65
15,000.0	0.63
50,000.0	0.62

Measurements made with Heath IM-38.

5.3.6 Squelch

a. The Squelch Amplifier, Q13, receives control voltage from the AGC amplifier, Q7; therefore check the AGC circuit before troubleshooting the squelch circuit.

b. If the AGC circuit is operating properly, connect a DC voltmeter to the emitter of the Audio Preamplifier. Rotate the squelch control from minimum to maximum; the voltmeter should indicate between 3.0 to 5.5 volts.

c. If the squelch voltage is incorrect measure the DC voltages at Q13 and Q14 and check diode CR16.

5.3.7 Audio Noise Limiter Disabling

a. The Audio Noise Limiter Disabling works in conjunction with the AGC Amplifier; therefore the AGC Amplifier, Q7, should be checked if audio distortion is a problem before troubleshooting the Audio Noise Limiter Disabling circuit.

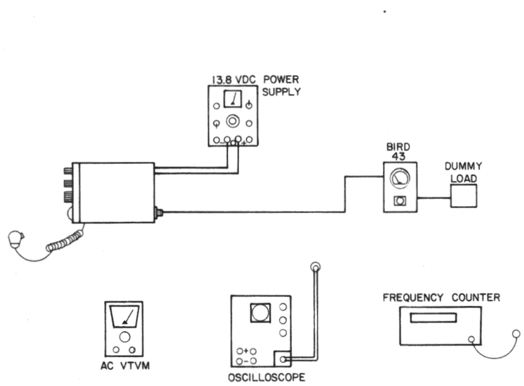
b. If Q7 checks good, connect an RF signal generator to the antenna connector and set the output for 27.085 MHz modulated with 1 kHz at a level of 50μV.

c. Measure the DC voltage at CR2 anode; a properly operating disabling circuit will provide approximately 0.3V.

5.4 TRANSMITTER TROUBLE-SHOOTING

Refer to the suggested test setup in Figure 5-3 and set the controls as follows:

Squelch	-	fully counterclockwise
Volume	-	fully clockwise
Channel Selector	-	Channel 11
Noise Blanker	-	OFF
PA	-	OFF



TRANSMITTER TEST SETUP
FIGURE 5-3

5.4.1 Transmitter Current Drain

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

b. Normal current drain should be 970 milliamperes maximum with 3.8 watts RF power output no modulation and 1.6 amperes with full modulation.

5.4.2 RF Stages

a. Connect a dummy load to the antenna connector, apply 13.8 VDC to the transmitter and loop couple a frequency counter to L10.

TABLE 5-5
TRANSMITTER RF AND DC LEVELS

Test Point	RF	DC
Q16 E	2.6	2.5
Q17 B	0.5	6.3
Q17 C	0.4	9.8
Q18 B	0.2	
Q18 C	4.3	
Q19 B	2.2	
Q19 C	6.2	
Q20 B	2.2	
Q20 C	15.0	

RF measurements taken with a Boonton 91H.

b. Key the transmitter and count the transmitter frequency on channels 1, 6, 11, 16, 20 and 23. If the output frequency is good, measure the DC and RF voltages in the transmitter stages to locate the defective component. Refer to Table 5-5 for the transmitter voltage levels.

c. If the transmitter carrier frequency is out of tolerance as shown in Table 6-2, count the frequency synthesizer frequency and compare with those listed in Table 4-1, the Crystal Synthesizer Scheme. Measure the synthesizer injection voltage which should be approximately 200 mV RMS and the emitter of Q17.

d. If the synthesizer output is good, check the Transmit Oscillator frequency (4.3 MHz).

e. Check the transmitter modulated waveform, refer to paragraph 6.6.3. If the waveform is overmodulated or distorted check the compressor circuit consisting of C93, CR19, C82, R89 and R88.

SECTION 6
ALIGNMENT

6.1 GENERAL

Refer to Figure 5-1 for the suggested test setup for the receiver alignment.

6.2 FREQUENCY SYNTHESIZER

a. Connect the RF Voltmeter probe to the junction of C211 and C212. Set the channel selector to channel 23.

b. Adjust T203 1/4 turn clockwise past the peak meter reading.

c. Set the channel selector to channel 12 and adjust T201 and T202 for a maximum meter reading, approximately 200 mV.

d. Loop couple a frequency counter to T202 and count the synthesizer frequency to be sure it is within tolerance.

6.3 RECEIVER ALIGNMENT

6.3.1 IF Alignment

a. Set R20 to approximately mid range and the NB switch "off".

b. Connect 4.3 MHz to the base of Q2 through a 0.01μF coupling capacitor.

c. Adjust T10, T9, T8, T7, T6, T5, T4, T11 and T3 for maximum audio output while decreasing the generator output level.

6.3.2 RF Alignment

a. Connect the RF generator to the antenna connector and set the generator output level to 0.5μV, modulated 30% with 1 kHz on channel 11 frequency (27.085 MHz).

b. Adjust T1, T2, T11 and T3 for maximum audio output.

6.3.3 Noise Blanker

a. Connect the RF signal generator to the antenna connector and set the output to channel 11 (27.085 MHz) modulated 30% with 1 kHz at a level of 0.5μV.

b. Connect the DC voltmeter to the cathode of CR9 and adjust T13 and T12 for a minimum DC voltage, approximately 0.02 volt.

6.3.4 Receive Meter Adjust

a. With no signal input, adjust R43 for a zero meter reading.

b. Connect the RF signal generator to the antenna connector and set the output to channel 11 (27.085 MHz) at a level of 50μV unmodulated.

c. Adjust R38 for an S9 meter reading.

6.4 RECEIVER PERFORMANCE TEST

The following tests can be performed to determine the general condition of the receiver.

6.4.1 Test Equipment Required

Refer to Table 5-1 for a complete description of the required test equipment. Refer to Figure 5-1 for the suggested test setup.

6.4.2 Automatic Gain Control (AGC)

a. Measure the AGC voltage at the emitter of Q7. With no signal input, the AGC voltage should be 1.4 volts.

b. Check the AGC rolloff as follows. Set the channel selector switch to channel 11 and the Squelch control fully counterclockwise.

c. Set the signal generator output level to 500μV modulated 30% with 1 kHz on channel 11 (27.085 MHz). Set the Volume control for a 0 dB reference level as read on the VTVM.

d. Reduce the signal generator output level to 0.5μV. The VTVM reading should decrease 15 dB ±8 dB. Adjust R20 and repeat steps b and c if unable to obtain 15 dB ±8 dB rolloff.

CAUTION

Be careful not to disturb the adjustment of R20 when installing the speaker mounting bracket.

6.4.3 Sensitivity (S+N)/N and Receiver Current Drain

a. Set the Squelch control fully counterclockwise and set the channel selector switch to channel 11.

b. Set the signal generator output to 0.5μV, modulated 30% with 1 kHz on channel 11 (27.085 MHz).

c. Adjust the transceiver Volume control for a 0 dB indication on the AC VTVM.

d. Switch the signal generator audio off, the VTVM indication should decrease 8 dB or more.

e. Adjust the Volume control for maximum (fully clockwise).