MOBILE RADIO

LBI30949B

DESCRIPTION AND MAINTENANCE
851—870 MHz, GE-MARC V™ RECEIVER

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DESCRIPTION

GE-MARC V,™ 851 to 870 Megahertz receivers are double conversion, superheterodyne FM receivers designed for up to 20 channel operation.

The solid state receiver utilizes integrated circuits (ICs), monolithic crystal filters and discrete components with each of the crystal filters located between gain stages to provide 70 dB selectivity and maximum protection from de-sensitization and intermodulation.

The receiver consists of the following modules:

- RF Assembly
- IF Detector (IF Det)
- Audio and Squelch circuits (part of System-Audio & Squelch (SAS) board)

Audio, supply voltages and control functions are connected to the system board through P903 on the IF Det board. The regulated +10 Volts is used for all receiver stages except the audio PA stage which operates from the A+ system supply.

Centralized metering jack J601 on the IF Det board is provided for use with GE Test Set 4EX3A11 or Test Kit 4EX8K12. The test set meters the FM Detector and IF Amplifier stages. Speaker high and low are metered on the system board metering jack.

A Block Diagram of the complete receiver is shown in Figure 1.

Refer to the appropriate Maintenance Manual for complete details on each receiver module as listed in the Table of Contents.

MAINTENANCE

DISASSEMBLY

To gain access to the receiver for servicing, unlock the radio and remove the two retaining screws in the front cover. Then pull the radio out of the mounting frame. To remove the receiver modules from the radio:

1. Remove all power to the radio.
2. Remove the three countersunk Phillips head screws in the siderail of the radio near the RF casting.

NOTE

Do not remove the two screws in the bracket along the top edge of the RF casting.

3. Loosen the screws in the two locking tabs on the corners of the RF casting and release the tabs.
4. Remove the two screws securing the IF-Det board to the mounting frame.
5. Unplug the 1st oscillator input cable from the synthesizer and then disconnect the plug from receiver input jack J302.
6. Lift up the RF assembly enough to unplug the antenna cable from J301.
7. Lift the receiver modules out of the radio with a gentle rocking motion. If desired, remove the three screws on the bottom of the IF Det board to detach it from the RF assembly.

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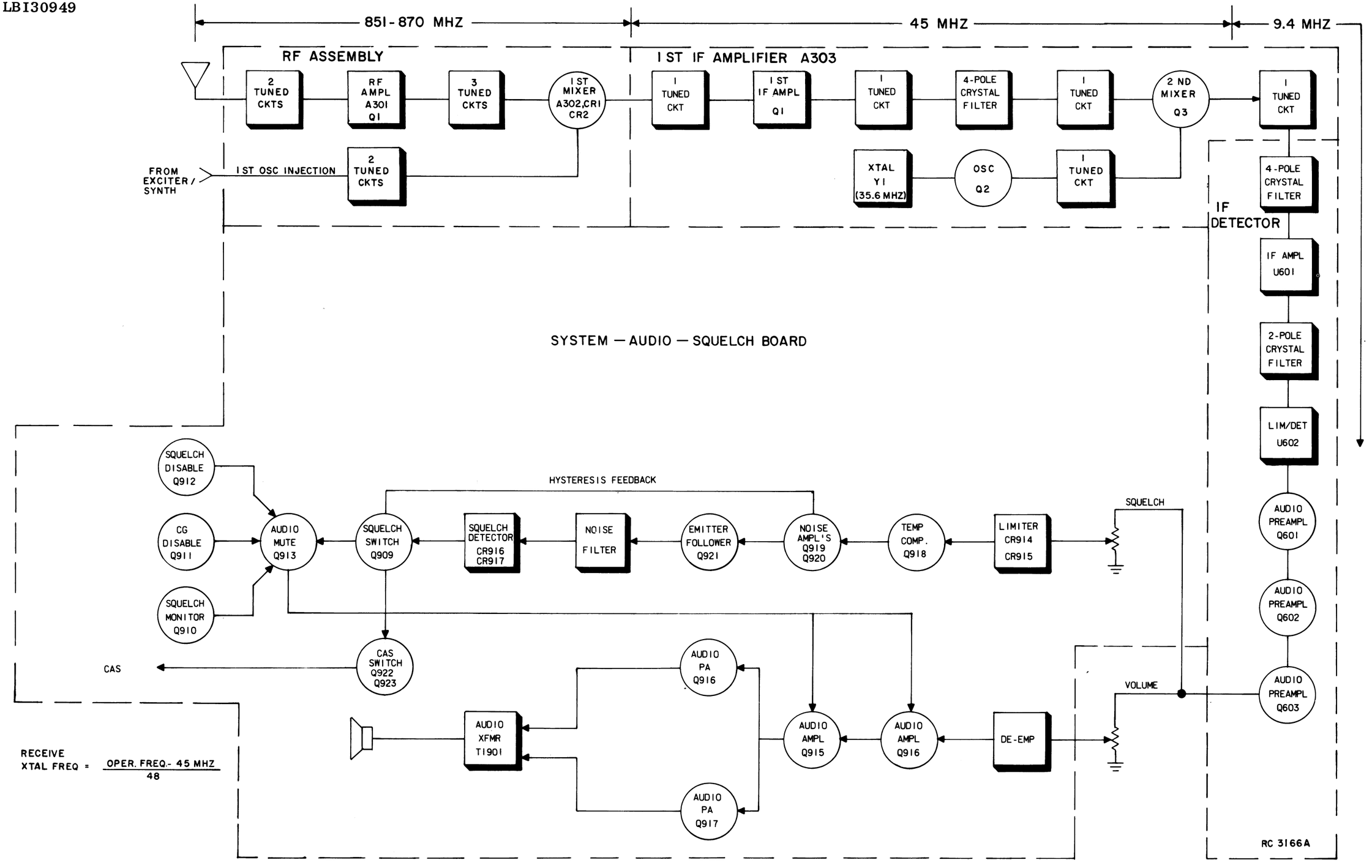
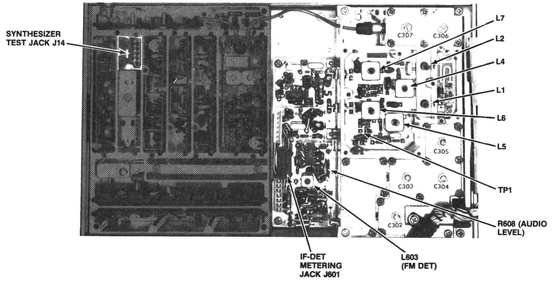
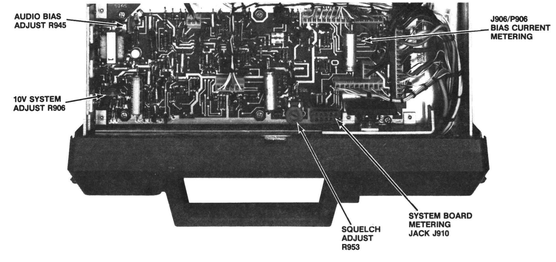


Figure 1 - Receiver Block Diagram





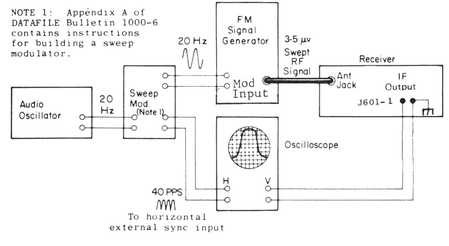


Figure 2 - Test Setup for 20-Hz Double-Trace Sweep Alignment

COMPLETE RECEIVER ALIGNMENT

EQUIPMENT REQUIRED

1. GE-MARC V Test Set TL59.
2. GE Test Models 4EX3A11, 4EX8K12 (or 20,000 ohms-per-Volt multimeter with a 1 Volt scale).
3. An 851-870 MHz signal source (Cushman CE-6A or equivalent).
4. A VTVM.
5. Ammeter (capable of measuring 20 milliamperes).
6. Distortion Analyzer (see following page for connections).
7. An RF Voltmeter.
8. Frequency Counter (capable of counting 35.600 MHz).

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Connect the black plug from the Test Set to IF-DET metering jack J601, and the red plug to SAS board metering jack J910. Set the meter sensitivity switch to the Test 1 (or 1 Volt position on the 4EX8K12).
2. Connect Test Set TL59 to the system harness as shown in the Test Set Maintenance Manual. Then select the center frequency on the TL59.
3. With the 4EX3A11 in Position J, check for regulated +10 Volts. With multimeter, measure from J910-3 (+) to J910-9 (-).
4. Set SQUELCH ADJUST R953 to unmute the receiver and VOLUME control to minimum. Disconnect J908 on the SAS board and connect the milliammeter in series with J906 (+) and P906 (-). Adjust audio BIAS control on SAS board for 20 milliamperes.
5. If using multimeter, connect the negative lead to J601-9 (A-).

NOTE

MAKE SURE THE TRANSMITTER IS PROPERLY ALIGNED BEFORE ALIGNING THE RECEIVER.

ALIGNMENT PROCEDURE

STEP	METERING POSITION: GE TEST SET	METERING POSITION: Multimeter (-) at J601-9	TUNING CONTROL	METER READING	PROCEDURE
			FM DETECTOR		
1.	A (FM DET)	Pin 2	L603	0.38 Volt	With no signal applied, adjust L603 for a meter reading of approximately 0.38 Volt.
			OSCILLATOR INJECTION		
2.	F (REL PWR OUT)	Pin 2 (on J14)	C307, C306	See Procedure	Connect the black Test Set metering plug to J14 on the synthesizer. Then tune C307 for minimum meter reading. Carefully tune C306 for an increase in meter reading. This peak may be relatively small.
			RF SELECTIVITY		
3.			L6	See Procedure	Connect RF voltmeter to TP1. Adjust L6 for maximum meter reading.
4.			L5	See Procedure	Connect counter to TP1. Adjust L5 for 35.600 MHz (±100 Hz).
5.					If center frequency tuning is required, set signal generator to the center frequency of the customer frequency spread. Connect signal generator to mobile radio antenna jack. Adjust output level of signal generator to obtain approximately 10 dB of quieting.
6.	B (IF AMPL)	Pin 1	C301-C305	See Procedure	Connect black Test Set plug to J601. Tune C301-C305 for best quieting decreasing the output level of the signal generator to maintain 10-20 dB of noise quieting.
7.	B (IF AMPL)	Pin 1	C301-C305	See Procedure	Retune C301-C305 until no further improvement in noise quieting can be obtained. Then adjust L1 for best quieting.
8.					If rated sensitivity is not obtained, carefully retune for center frequency and/or adjust C301 through C305 for equal sensitivity on the lowest and highest frequency channels until receiver sensitivity specification are met.
9.			L7	See Procedure	Modulate the signal generator with 1 kHz at ±3 kHz, and set the level to 1 millivolt. Monitor the audio distortion and adjust L7 for minimum distortion.
10.			L603, R608	See Procedure	Remove the Test set metering plug from J601. Apply a 100 microvolt signal with 1 kHz modulation and 3 kHz deviation to the antenna jack. Tune L603 for maximum voltage at 1.0 kHz and adjust R608 for 1 Volt RMS measured with a VTVM at P903-1 (VOL/SQ HI) and P903-6 (A-).
			IF CIRCUITS		
The IF circuits have been aligned at the factory and will normally require no further adjustment. If adjustment is necessary, use the procedure outlined in STEP 11.					
			NOTE		
REFER TO DATAFILE BULLETIN 1000-6 (IF ALIGNMENT OF TWO-WAY RADIO FM RECEIVERS) FOR HELPFUL SUGGESTIONS ON HOW TO DETERMINE WHEN IF ALIGNMENT IS REQUIRED.					
11.			L2 and 4		Connect scope, signal generator and probe as shown in Figure 2. Set signal generator level for 3 to 5 µV and modulate with 10 kHz at 20 Hz. With probe between J601-1 and A-, tune L2 and L4 for double trace as shown on scope pattern.
12.				See Procedure	Check to see that modulation acceptance bandwidth is greater than ±7 kHz.
			SQUELCH ADJUST		
13.			R953		Turn the SQUELCH control (on System Board) fully clockwise (unsquelched). Adjust signal generator for a 12 dB SINAD signal. Turn the SQUELCH control counter-clockwise until the receiver squelches, and then carefully turn SQUELCH control clockwise until receiver just unsquelches.

TEST PROCEDURES

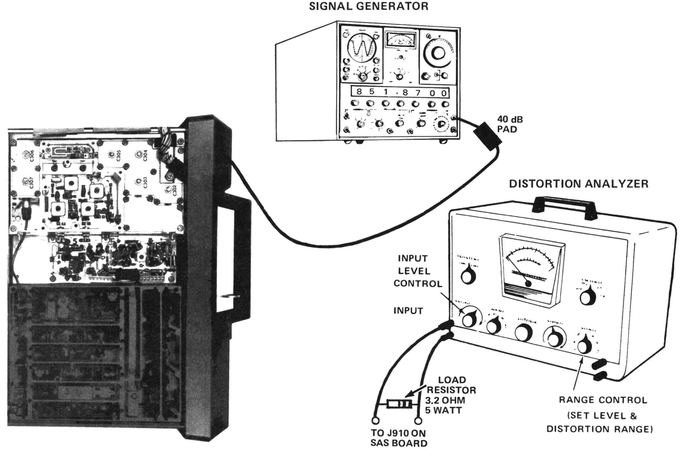
These Test Procedures are designed to help you to service a receiver that is operating---but not properly. The problems encountered could be low power, poor sensitivity, distortion, limiter not operating properly, and low gain. By following the sequence of test steps starting with Step 1, the defect can be quickly localized. Once the defective stage is pin-pointed, refer to the "Service Check" listed to correct the problem. Additional corrective measures are included in the Troubleshooting Procedure. Before starting with the Receiver Test Procedures, be sure the receiver is tuned and aligned to the proper operating frequency.

TEST EQUIPMENT REQUIRED

- Distortion Analyzer
- Signal Generator
- 40-dB attenuation pad, and 3.2 ohm, 5-Watt resistor

PRELIMINARY ADJUSTMENTS

1. Connect the test equipment to the receiver as shown for all steps of the receiver Test Procedure.
2. Turn the SQUELCH control fully clockwise for all steps of the Test Procedure.
3. Turn on all of the equipment and let it warm up for 20 minutes.



STEP 1
AUDIO POWER OUTPUT AND DISTORTION

TEST PROCEDURE

Measure Audio Power Output as follows:

A. Apply a 1,000-microvolt, on-frequency test signal modulated by 1,000 hertz with ±3.0 kHz deviation to antenna jack A301-J1.

B. With 5-Watt Speaker

Disconnect speaker and connect a 3.2-ohm 5-Watt load resistor from J910-1 (speaker H1) to J910-2 (A-). Connect The Distortion Analyzer input across the resistor as shown.

OR

With Handset:

Lift the handset off of the hookswitch. Connect the Distortion Analyzer input from J910-1 to J910-2.

C. Adjust the VOLUME control for 5-Watt output using the Distortion Analyzer as a Voltmeter (4 Vrms).

D. Make distortion measurements according to manufacturer's instructions. Reading should be less than 5%. If the receiver sensitivity is to be measured, leave all controls and equipment as they are.

SERVICE CHECK

If the distortion is more than 5%, or maximum audio output is less than 5.0 Watts, make the following checks:

E. Battery and regulator voltage---low voltage will cause distortion. (Refer to Receiver Schematic Diagram for voltages.)

F. Audio Gain (Refer to Receiver Troubleshooting Procedure.)

G. FM Detector adjustment (Refer to Receiver Alignment on reverse side of page).

STEP 2
USABLE SENSITIVITY (12-dB SINAD)

If STEP 1 checks out properly, measure the receiver sensitivity as follows:

A. Apply a 1000-microvolt, on-frequency signal modulated by 1000 Hz with 3.0-kHz deviation to A301-J1.

B. Place the RANGE switch on the Distortion Analyzer in the 200 to 2000-Hz distortion range position (1000-Hz filter in the circuit). Tune the filter for minimum reading or null on the lowest possible scale (100%, 30%, etc.)

C. Place the RANGE switch to the SET LEVEL position (filter out of the circuit) and adjust the input LEVEL control for a +2 dB reading on a mid range (30%).

D. While reducing the signal generator output, switch the RANGE control from SET LEVEL to the distortion range until a 12-dB difference (+2 dB to -10 dB) is obtained between the SET LEVEL and distortion range positions (filter out and filter in).

E. The 12-dB difference (Signal plus Noise and Distortion to noise plus distortion ratio) is the "usable" sensitivity level. The sensitivity should be less than rated 12 dB SINAD specifications with an audio output of at least 2.5 Watts (2.8 Volts RMS across the 3.2-ohm receiver load using the Distortion Analyzer as a VTVM).

F. Leave all controls as they are and all equipment connected if the Modulation Acceptance Bandwidth test is to be performed.

SERVICE CHECK

If the sensitivity level is more than rated 12 dB SINAD, check the alignment of the RF stages as directed in the Alignment Procedure, and make the gain measurements as shown on the Troubleshooting Procedure.

STEP 3
MODULATION ACCEPTANCE BANDWIDTH (IF BANDWIDTH)

If STEPS 1 and 2 check out properly, measure the bandwidth as follows:

A. Set the Signal Generator output for twice the microvolt reading obtained in the 12-dB SINAD measurement.

B. Set the RANGE control on the Distortion Analyzer in the SET LEVEL position (1000-Hz filter out of the circuit), and adjust the input LEVEL control for a +2 dB reading on the 30% range.

C. While increasing the deviation of the Signal Generator, switch the RANGE control from SET LEVEL to distortion range until a 12-dB difference is obtained between the SET LEVEL and distortion range readings (from +2 dB to -10 dB).

D. The deviation control reading for the 12-dB difference is the Modulation Acceptance Bandwidth of the receiver. It should be more than ±7 kHz.

SERVICE CHECK

If the Modulation Acceptance Bandwidth test does not indicate the proper width, make gain measurements as shown on the Receiver Troubleshooting Procedure.

STEP 1 - QUICK CHECKS

TEST SET CHECKS

These checks are typical voltage readings measured with GE Test Set Model 4EX3A11 in the Test 1 position, or Model 4EX8K12 in the 1-Volt position.

Metering Position	Reading With No Signal In	Reading with 5-Microvolts Unmodulated
A (FM DET)	0.35-0.50 VDC	
B (IF AMP)		0.2 VDC
J (Reg. +10 Volts at System Metering jack)	+10 VDC	

SYMPTOM CHECKS

SYMPTOM	PROCEDURE
NO SUPPLY VOLTAGE	• Check power connections and continuity of supply leads, and check fuse in power supply. If fuse is blown, check receiver for short circuits.
NO REGULATED 10-VOLTS	• Check the 12-Volt supply. Then check 10-Volt regulator circuit. (See Troubleshooting Procedure for 10-Volt Regulator).
LOW RECEIVER SENSITIVITY	• Check Front End Alignment. (Refer to Receiver Alignment Procedure). • Check antenna connections, cable and antenna switch. • Check Oscillator injection voltage (Pos. A on Exciter). • Check voltage readings of IF Amplifiers. • Make SIMPLIFIED GAIN CHECKS (STEP 2).
IMPROPER SQUELCH OPERATION	• Check voltages on Schematic Diagram. • Make gain and waveform checks with noise. • Make gain and waveform checks with 6 kHz signal. • Check discrete components in the squelch circuit on SAS board.
LOW OR DISTORTED AUDIO	• Check voltages on Schematic Diagram. • Make gain and waveform checks. • Check receiver and alignment and FM-DET output. • Check Q601, Q602, Q603 and other discrete components. • Check audio circuit on SAS board.

STEP 4-VOLTAGE RATIO READING

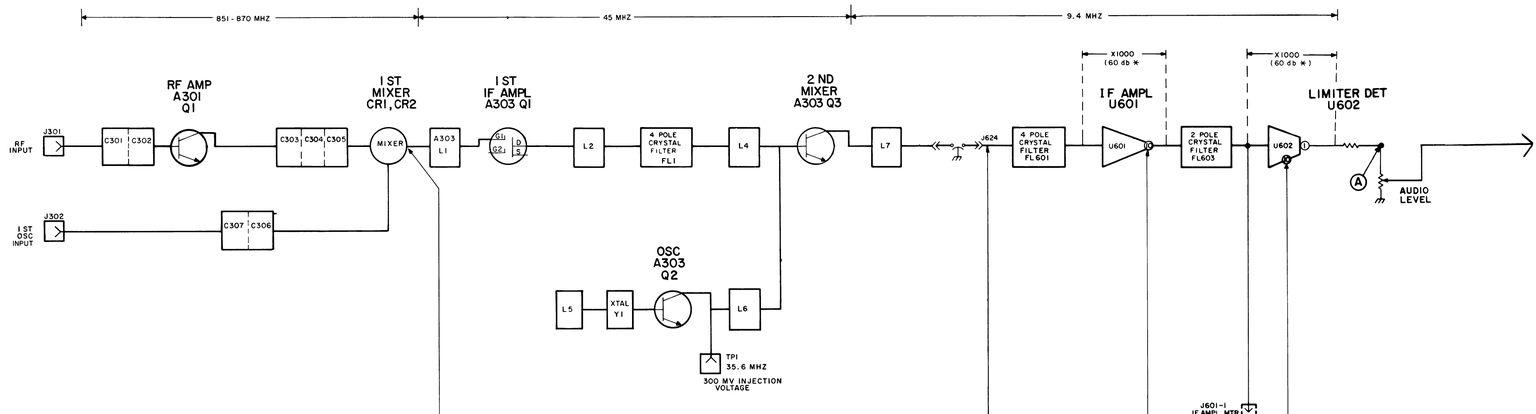
EQUIPMENT REQUIRED
1. RF VOLTMETER
2. SIGNAL ON RECEIVER FREQUENCY (BELOW SATURATION). USE 1000 HERTZ SIGNAL WITH 3.0 KHz DEVIATION.

PROCEDURE:
1. APPLY PROBE TO INPUT OF STAGE (FOR EXAMPLE, SOURCE OF RF AMP). PEAK RESONANT CIRCUIT OF STAGE BEING MEASURED AND TAKE VOLTAGE READING (E_1).
2. MOVE PROBE TO INPUT OF FOLLOWING STAGE (MIXER). REPEAK FIRST RESONANT CIRCUIT THEN PEAK CIRCUIT BEING MEASURED AND TAKE READING (E_2).
3. CONVERT READINGS BY MEANS OF THE FOLLOWING FORMULA.

$$\text{VOLTAGE RATIO} = \frac{E_2}{E_1}$$

4. CHECK RESULTS WITH TYPICAL VOLTAGE RATIOS SHOWN ON DIAGRAM.

* DIFFERENCE BETWEEN INPUT AND OUTPUT READING ON db SCALE OF RF VOLTMETER. NOT ACTUAL POWER GAIN.



STEP 2-SIMPLIFIED GAIN CHECKS

EQUIPMENT REQUIRED:
1. VOLTMETER AC & DC
2. SIGNAL GENERATOR
3. RF VOLTMETER

PRELIMINARY STEPS:
1. SET VOLUME CONTROL FOR 4.0 VOLTS ACROSS 3.2-OHM LOAD. IF THIS CANNOT BE OBTAINED, SET TO APPROX. 70% OF MAX. ROTATION.
2. SET SQUELCH CONTROL FULLY COUNTERCLOCKWISE.
3. RECEIVER SHOULD BE PROPERLY ALIGNED.
4. CONNECT METER BETWEEN A- AND POINTS INDICATED BY ARROW.

APPLIED TO J301	UNMODULATED			UNMODULATED	UNMODULATED	UNMODULATED	NONE
PROCEDURE	SET GENERATOR OUTPUT AT 30 MV.			SET GENERATOR OUTPUT AT 1000 MICROVOLTS	INCREASE GENERATOR OUTPUT FROM ZERO UNTIL U601 SATURATES AS MEASURED WITH RF VOLTMETER	INCREASE GENERATOR OUTPUT FROM ZERO TO 40 MICROVOLTS	SHOULD BE IN SATURATION AT ALL TIMES
READING	RF VOLTMETER READING SHOULD BE APPROX. 100 MV.			RF VOLTMETER READING SHOULD BE APPROX 200 MILLIVOLTS	GENERATOR OUTPUT SHOULD BE APPROX 20 MICROVOLTS	VOLTMETER READING SHOULD BE APPROX. 0.54 VDC	RF VOLTMETER READING SHOULD BE APPROX 0.6 V RMS

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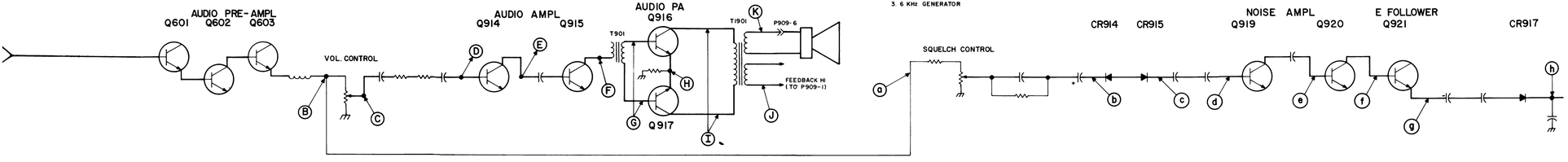
STEP 3-AUDIO & SQUELCH WAVEFORMS

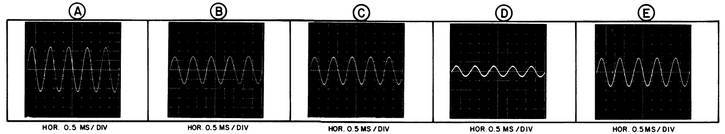
EQUIPMENT REQUIRED
1. OSCILLOSCOPE CONNECTED BETWEEN A- AND POINTS INDICATED BY ARROW.
2. SIGNAL GENERATOR
3. 6 KHz GENERATOR

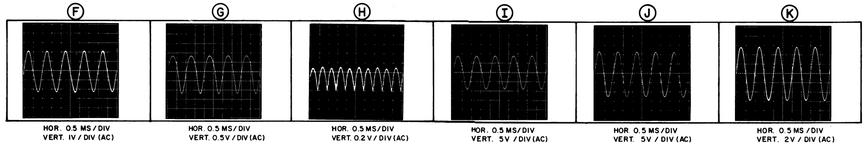


AUDIO WAVEFORMS

STANDARD SIGNAL

1. 1000 MICROVOLTS OF RF
2. 1 KHz MOD.
3. 3 KHz DEV.
4. VOLUME CONT SET FOR RATED OUTPUT (4 VRMS).

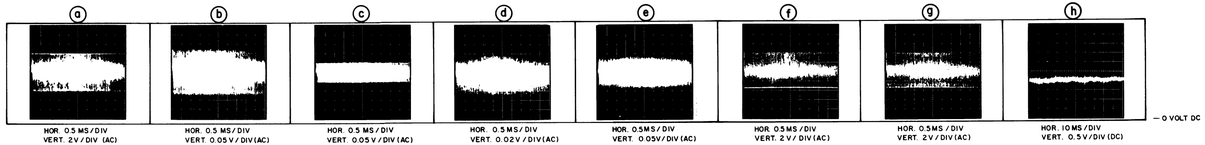




SQUELCH WAVEFORMS

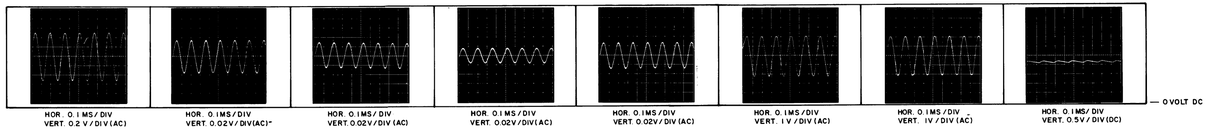
(WITH NOISE)

1. NO RF
2. SET SQUELCH CONTROL TO CRITICAL.



(WITH 6KHz SIGNAL)

1. 1 MV RF.
2. 6KHz MOD
3. 3KHz DEV.
4. SET SQUELCH CONTROL FOR CRITICAL (TP901 JUST FALLS TO 0VDC.)



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