MOBILE RADIO

DESCRIPTION AND MAINTENANCE

851—870 MHz CUSTOM MVP RECEIVER

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DESCRIPTION

Custom MVP 851 to 870 megahertz receivers are double conversion, superheterodyne FM receivers designed for one-through four-frequency 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 75 dB selectivity and maximum protection from desensitization 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 may be monitored at J1-3 (HI) and J1-4 (LOW).

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, remove the wing nut at the rear of the radio and pull the radio out of the case assembly.

To remove the RF Assembly:

1. Carefully disconnect the two leads connected to Pins J606 and J607 on the IF Detector board.
2. Unplug receiver input cable at P952 and unplug receiver injection cable at P302.
3. Remove the panhead screw holding the oscillator board to the receiver. (For a 4-frequency radio, remove the two (2) panhead screws holding the top oscillator board and one spacer holding the bottom oscillator board to the receiver).
4. Remove the two countersunk flat head screws on each side of the system frame assembly and lift out RF Assembly.

To remove the IF-Det board:

1. Carefully disconnect the two leads connected to Pins J606 and J607 on the IF-Det board.
2. Disconnect plug P903 from the IF-Det board.
3. Remove the five screws securing the board and lift the board out.

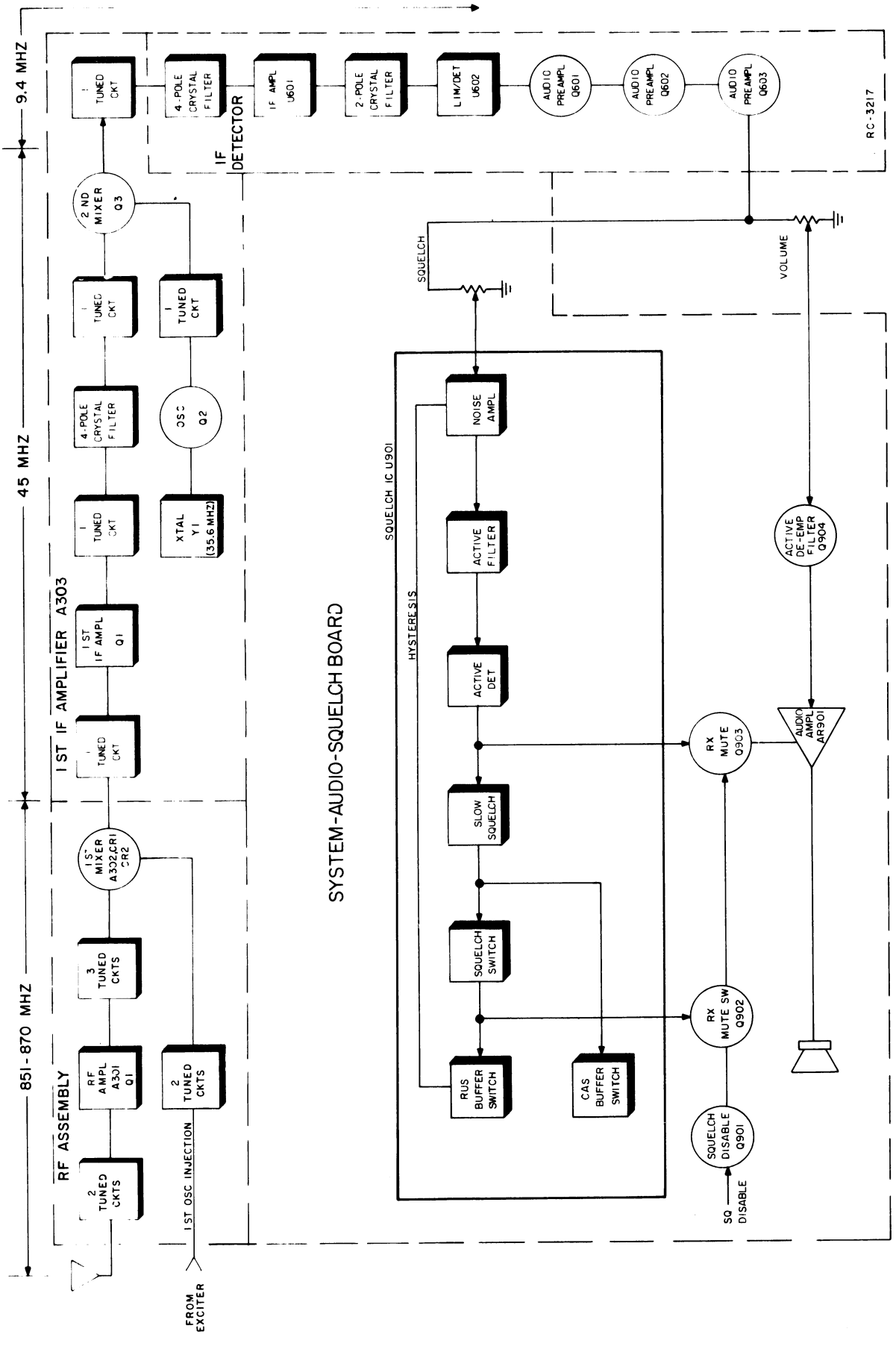


Figure 1 - Receiver Block Diagram

FRONT END ALIGNMENT

EQUIPMENT

1. GE Test Set Models 4EX3A11, 4EX8K12, or 20,000 ohms-per-Volt multimeter with a 1-Volt scale.
2. An 851-870 MHz signal source (Cushman CE-6A or equivalent).

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Connect black plug from Test Set to Receiver Centralized Metering Jack J601. Set meter sensitivity switch to the TEST 1 position (or 1-Volt position on 4EX8K12).
2. For multi-frequency receivers with a frequency spacing up to 0.80 MHz, align the receiver on the channel nearest center frequency.

   For multi-frequency receivers with a frequency spacing exceeding the above but no greater than 1.6 MHz, align the receiver using a center frequency tune-up ICOM on the exciter module. These limits can be extended to 2.0 MHz with 3 dB degradation in standard receiver specifications.
3. With Test Set in Position G, check for regulated +10 Volts. If using multimeter, measure between J601-6 (+) and J601-9 (-).
4. If using multimeter, connect the negative lead to J601-9 (A-).
5. Disable Channel Guard.

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
		OSCILLATOR INJECTION			
1.	A (REL PWR OUT)	Pin 2 (on J103)	C307, C306	See Procedure	Connect the black Test Set metering plug to J103 on the exciter. Then tune C307 for minimum meter reading and C306 for maximum meter reading.
		RF SELECTIVITY			
2.	B (IF AMPL)	Pin 1	C301 thru C305 & L1	Maximum	Connect the black Test Set plug to J601. Apply an on-frequency signal to the antenna jack, keeping the signal below saturation. Then tune C301 through C305 and L1 for maximum meter reading.
3.	B (IF AMPL)	Pin 1	C301 thru C305 and L1	Maximum	Apply an on-frequency signal to the antenna jack and slightly tune C301 through C305 and L1 for best quieting sensitivity.

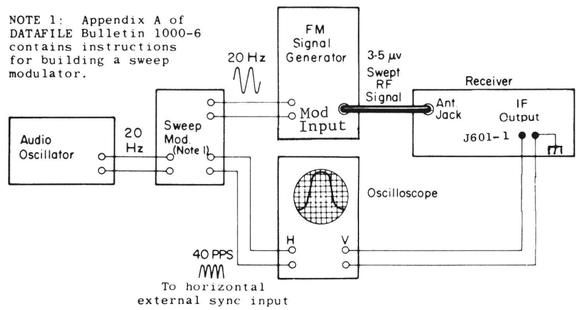
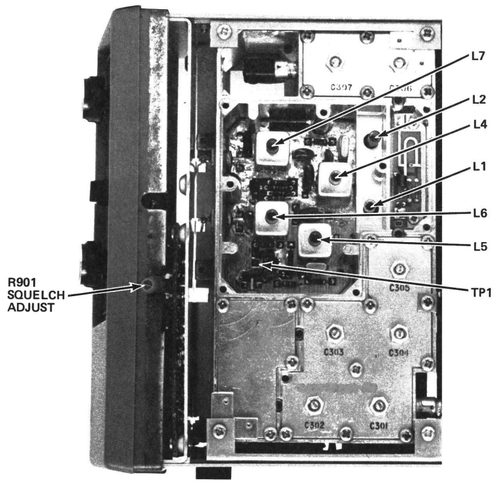
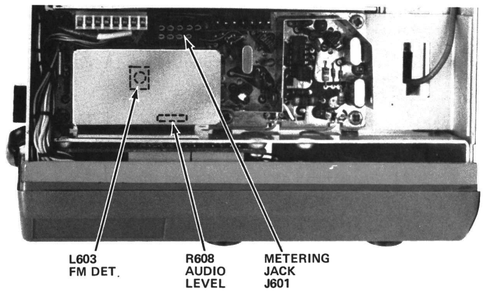


Figure 2 - Test Setup for 20-Hz Double-Trace Sweep Alignment





COMPLETE RECEIVER ALIGNMENT

EQUIPMENT REQUIRED

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

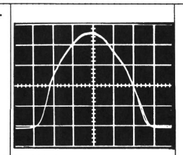
PRELIMINARY CHECKS AND ADJUSTMENTS

1. Connect the black plug from the Test Set to receiver metering jack J601. Set the meter sensitivity switch to the Test 1 (or 1-Volt position on the 4EX8K12).
2. For multi-frequency receivers with a frequency spacing up to 0.80 MHz, align the receiver on the channel nearest center frequency. For multi-frequency receivers with a frequency spacing exceeding the above but no greater than 1.6 MHz, align the receiver using a center frequency tune-up ICOM on the exciter module. These limits can be extended to 2.0 MHz with a 3 dB degradation in standard receiver specifications.
3. With the Test Set in Position G, check for regulated +10 Volts. With multimeter, measure from J601-6 (+) to J601-9 (-).
4. If using multimeter, connect the negative lead to J601-9 (A-).
5. Disable the Channel Guard.

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.	A (REL PWR OUT)	Pin 2 (on J103)	C307, C306	See Procedure	Connect the black Test Set metering plug to J103 on the exciter. Then tune C307 for minimum meter reading and C306 for maximum meter reading.
		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.	B (IF AMPL)	Pin 1	C301 thru C305 & L1	Maximum	Connect the black Test Set plug to J601. Apply an on-frequency signal to the antenna jack, keeping the signal below saturation. Then tune C301 through C305 and L1 for maximum meter reading.
6.	B (IF AMPL)	Pin 1	C301 thru C305 & L1	Maximum	Apply an on-frequency signal to the antenna jack and slightly tune C301 through C305 and L1 for best quieting sensitivity.
7.			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 9.					
		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.			
8.			L2, L4 and L7		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, L4 and L7 for double trace as shown on scope pattern.
9.				See Procedure	Check to see that modulation acceptance bandwidth is greater than ±7 kHz.
		SQUELCH ADJUST			
10.			R901		Set SQUELCH ADJUST control (R901) to open with a 6 dB SINAD signal. (Approximately 30° counterclockwise of critical squelch position).

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 similar to:

  Heath IM-12

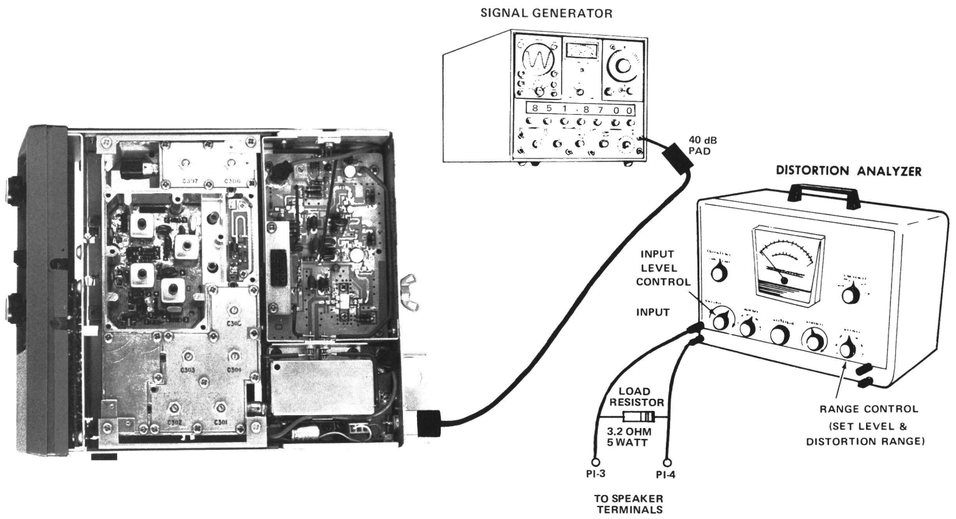
- Signal Generator similar to:

  Cushman CE-6A

- 40 -dB attenuation pad, and 3.2-ohm, 5-Watt resistor

PRELIMINARY ADJUSTMENTS

1. Connect the test equipment 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 the antenna jack.

B. With 5-Watt Speaker:

Disconnect speaker and connect a 3.2-ohm, 5-Watt load resistor from P1-3 (speaker HI) to P1-4 (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 P1-3 to P1-4.

C. Adjust the VOLUME control for 3-Watt output using the Distortion Analyzer as a VTVM (3.1 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 3.0 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 the antenna jack.

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 1.5 Watts (2.2 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. Reduce the audio output to 0.3 Watts (0.98 Vrms across the 3.2-ohm receiver load).

C. 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.

D. 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).

E. 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.

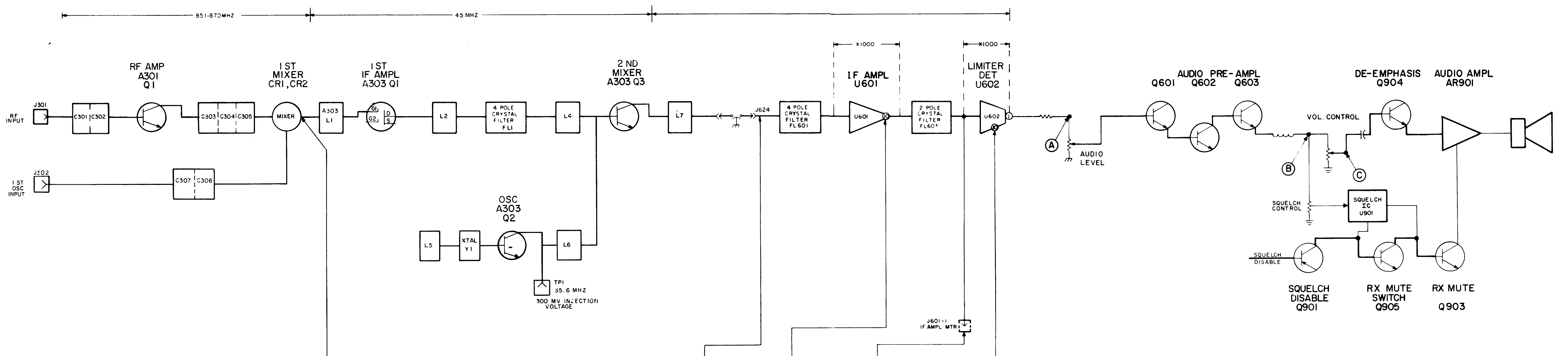
STEP 4-VOLT GE RATIO READINGS →

EQUIPMENT REQUIRED
1. RF VOLTMETER (SIMILAR TO BOONTON MODEL 91-CA OR MILLIVAC TYPE MV-18C.
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.

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

4. CHECK RESULTS WITH TYPICAL VOLTAGE RATIOS SHOWN ON DIAGRAM



STEP 2-SIMPLIFIED GAIN CHECKS →

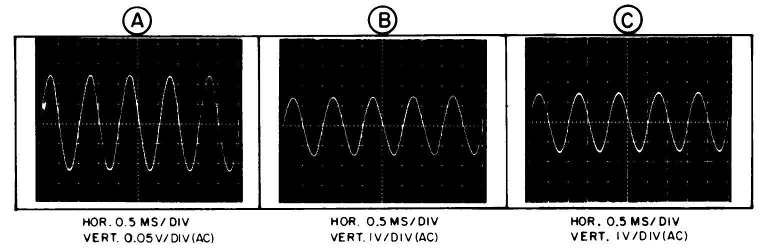
EQUIPMENT REQUIRED
1. VTVM AC & DC
2. SIGNAL GENERATOR (MEASUREMENTS 803 OR EQUIVALENT)
3. RF VOLTMETER

PRELIMINARY STEPS
1. SET VOLUME CONTROL FOR 3.1 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.

SET SIGNAL GENERATOR TO CORRECT RF FREQUENCY AND APPLY TO A301-J1.	UNMODULATED			UNMODULATED	UNMODULATED	UNMODULATED	NO SIGNAL INPUT
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	VTVM READING SHOULD BE APPROX 0.54 VDC	RF VOLTMETER READING SHOULD BE APPROX 0.6V RMS

AUDIO WAVEFORMS

STANDARD SIGNAL
1. 1MV OF RF
2. 1KHz MOD.
3. 3 KHz DEV.
4. VOLUME CONT SET FOR RATED OUTPUT (3.1 VRM ACROSS 3.2 ohm LOAD.)



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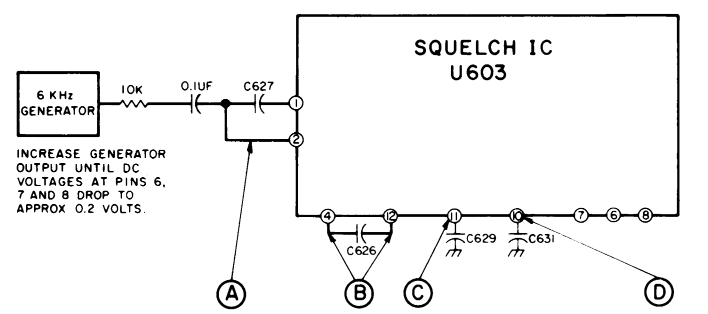
STEP 3-AUDIO & SQUELCH WAVEFORMS

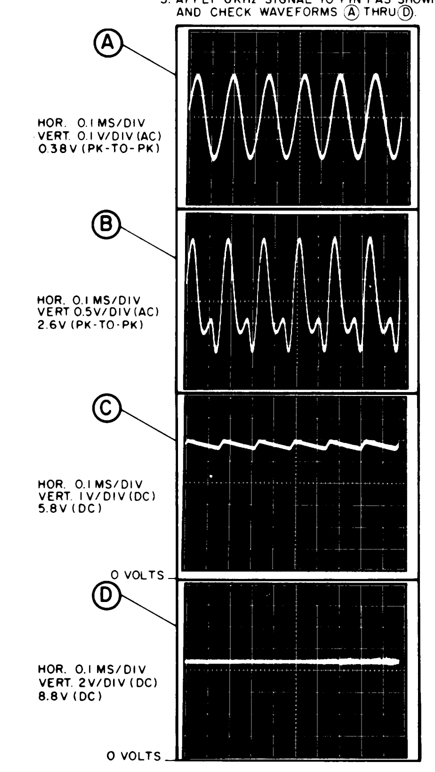
EQUIPMENT REQUIRED:
1. OSCILLOSCOPE CONNECTED BETWEEN A- AND POINTS INDICATED BY ARROW.
2. SIGNAL GENERATOR (MEASUREMENTS M803 OR EQUIVALENT.
3. 6 KHz GENERATOR



INCREASE GENERATOR OUTPUT UNTIL DC VOLTAGES AT PINS 6, 7 AND 8 DROP TO APPROX 0.2 VOLTS.

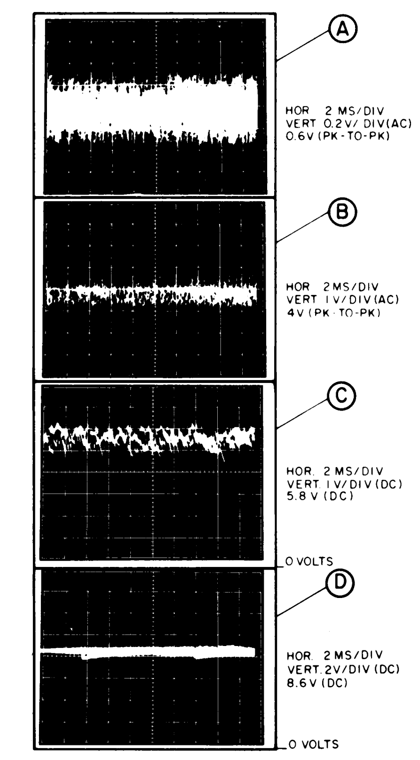
SQUELCH CIRCUIT CHECKS WITH 6 KHz SIGNAL:

PRELIMINARY STEPS
1. QUIET RECEIVER WITH A 1000 MICROVOLT, UNMODULATED SIGNAL.
2. SET SQUELCH CONTROL TO APPROX MID-RANGE.
3. APPLY 6KHz SIGNAL TO PIN 1 AS SHOWN, AND CHECK WAVEFORMS (A) THRU (D).



SQUELCH CIRCUIT CHECK WITH NOISE:

PRELIMINARY STEPS
1. NO INPUT SIGNAL APPLIED.
2. SET SQUELCH CONTROL FOR CRITICAL SQUELCH.
3. CHECK WAVEFORMS (A) THRU (D).



TROUBLESHOOTING PROCEDURE

851—870 MHz CUSTOM MVP RECEIVER