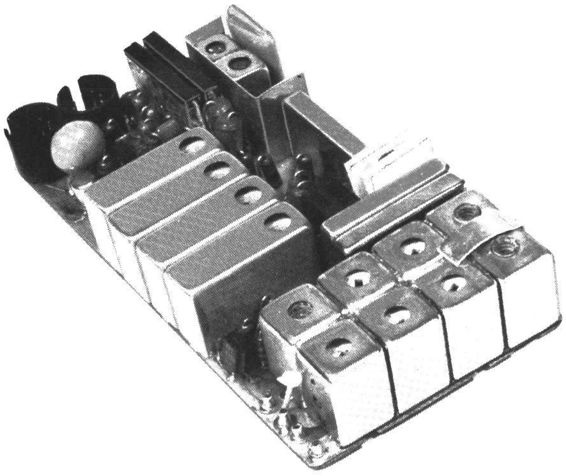
MOBILE RADIO

MASTR®

MVP *Personal*

450-470 MHz, RECEIVER TYPE ER-72-A



SPECIFICATIONS *

Audio Output (EIA)	500 milliwatts at less than 5% distortion
Channel Spacing	25 kHz
Sensitivity	
12 dB SINAD (EIA Method)	0.35 µV
20 dB Quieting Method	0.50 µV
Selectivity	
EIA Two-Signal	-70 dB at ±30 kHz
20 dB Quieting Method	-110 dB at ±30 kHz
Spurious Response	-60 dB
Intermodulation (EIA)	-60 dB
Audio Response	Within +2 and -10 dB of a standard 6 dB per octave de-emphasis curve from 300 to 3000 Hz (1000 Hz reference)
Modulation Acceptance	±7.5 kHz
Squelch Sensitivity	
Critical Squelch	0.25 µV
Maximum Squelch	Greater than 20 dB Quieting

Maximum Frequency Spacing

Frequency Range	Full Performance	1 dB Degradation in Sensitivity
450 - 460 MHz	1.8 MHz	3.6 MHz
460 - 470 MHz	1.84 MHz	3.68 MHz

*These specifications are intended primarily for the use of the serviceman. Refer to the appropriate **Specification Sheet** for the complete specifications.

Maintenance Manual LBI30591D

DATAFILE FOLDER — DF-1111

ER-72-A

GENERAL ELECTRIC

TABLE OF CONTENTS

ILLUSTRATIONS

WARNING

No one should be permitted to handle any portion of the equipment that is supplied with high voltage; or to connect any external apparatus to the units while the units are supplied with power. KEEP AWAY FROM LIVE CIRCUITS!

DESCRIPTION

General Electric MVP Personal Receiver Type ER-72-A, is a one through six-frequency, dual conversion FM receiver for operation in the 450 MHz to 470 MHz range. The receiver is constructed on a single printed wire board and utilizes both discrete components and Integrated Circuit Modules.

References to symbol numbers mentioned in the following test are found on the Schematic Diagram, Outline Diagram and Parts List (See Table of Contents). The typical circuit diagrams used in the text are representative of the circuits used in the Integrated Circuit Modules. A block diagram of the receiver is shown in Figure 1.

Supply voltage for the receiver includes a continuous 7.5 Volts for the squelch module, and a switched 7.5 Volts for the remaining receiver stages.

CIRCUIT ANALYSIS

OSCILLATOR MODULE

Oscillator Model 4EG28A28 (450-470 MHz) is a crystal-controlled Colpitts oscillator (see Figure 2). The entire oscillator is contained in a metal can with the receiver operating frequency printed on the top. The crystal frequency ranges from 20.48 to 22.38 MHz, and the crystal frequency is multiplied 21 times.

In multi-frequency receivers, additional oscillator modules are mounted on the receiver board. The single-frequency supply jumper is removed, and the proper frequency is selected by connecting the 5.4 Volts to the selected oscillator module through frequency selector switch S1 on the control unit.

Complete instructions for multi-frequency Modification Diagram (Refer to LBI-4900).

NOTE

All oscillator modules are individually compensated at the factory and cannot be repaired in the field. Any attempt to remove the oscillator cover will void the warranty.

COMPENSATOR

Compensator module A3 contains the temperature compensation network for the oscillator (see Figure 3).

The regulated 5.4 Volts at Pin 2 is applied to a thermistor-compensated voltage divider. The output at Pin 3 (2.35 Volts measured with a VTVM) is applied to Pin 3 and to the varactor in the Oscillator module. At temperatures below -10°C, the compensated voltages increases to maintain the proper voltage on the oscillator voltage-variable capacitor.

SERVICE NOTE

An abnormally low VTVM reading (or no reading) at Pin 3 may indicate a short or leakage path in the oscillator. This can be checked by unsoldering Pin 3, raising it off of the printed board, and taking another reading. If this reading is normal, the problem is in the Oscillator module. If the reading remains low (or zero), the problem is in the Compensator.

BUFFER/TRIPLER

RF from the oscillator module is coupled to the base of Buffer/Tripler transistor Q301. Q301 prevents loading of the oscillator modules by the receiver Front End. L3 in the multiplier circuit of the receiver Front End, is part of the collector circuit of Q301 and is tuned to three times the oscillator frequency. Three times the oscillator frequency is metered at Mult-Test Point (TP5) on the receiver board.

RECEIVER FRONT END

The receiver Front End consists of three tuned helical resonators, an RF amplifier stage, a mixer stage and a multiplier circuit. RF from the antenna is coupled to a tap on L16. The tap is positioned to provide the proper impedance match to the antenna. RF energy is coupled to the third coil L18 through openings in the sides of the cans. RF is then coupled from a tap on L18 through C8 to the base of RF amplifier transistor Q1. The output of Q1 is developed across tuned circuit C10 and L3, and is applied to the base of the mixer transistor Q2 to be beat against the low-side injection frequency from the Multiplier Circuit.

The output of L3 in the multiplier circuit is applied to the anode of multiplier diode CR1. The two helical resonators following CR1 are tuned to seven times the first multiplier frequency for a total multiplication of 21 times. The output of the helical resonators is direct-coupled to the emitter of the mixer transistor Q2. With the RF signal from the RF amplifier applied to the base of mixer Q2 and the low side injection frequency from the multiplier circuit applied to the emitter, the resultant 23-MHz IF frequency is coupled through the mixer collector tuned circuit (L2 & C6) to Crystal Filter FL303.

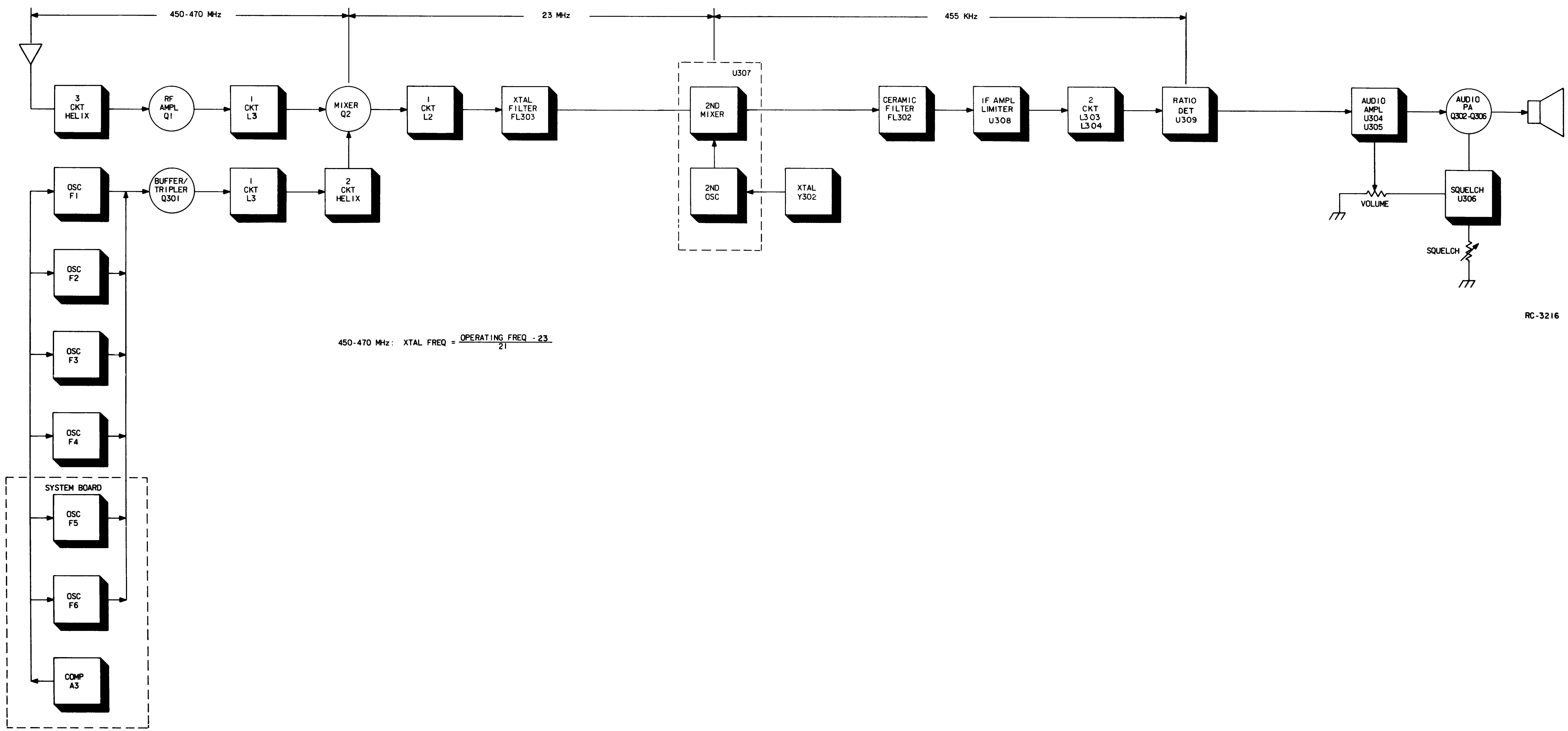


Figure 1 - Receiver Block Diagram

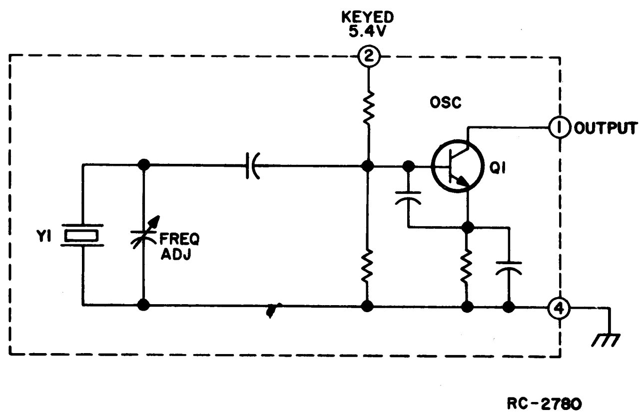


Figure 2 - Typical Oscillator Circuit

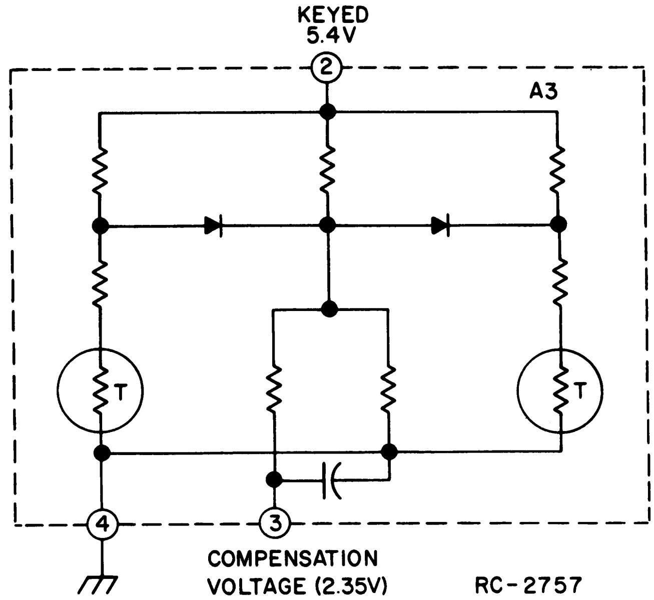


Figure 3 - Typical Compensator Circuit

CRYSTAL FILTER

Crystal Filter FL303 follows the receive Front End mixer stage and provides a minimum of 40 dB stop-band attenuation at 23 MHz. The output of FL303 is connected to 2nd Mixer and Oscillator Module U307-3.

2ND MIXER AND OSCILLATOR

The 23 megahertz signal coupled to 2nd Mixer and Oscillator Module U307-3 is connected to the base of amplifier transistor Q3. The output of Q3 is coupled to the base of 2nd Mixer Transistor Q2. Also coupled to the base of Q2 is a 23.455 megahertz high side injection frequency from Colpitts oscillator Q1. The 23 megahertz High-IF signal and 23.455 megaherts high side injection frequency, produce a 455 kilohertz Low-IF output at U307-4. A typical 2nd mixer and oscillator circuit is shown in Figure 4.

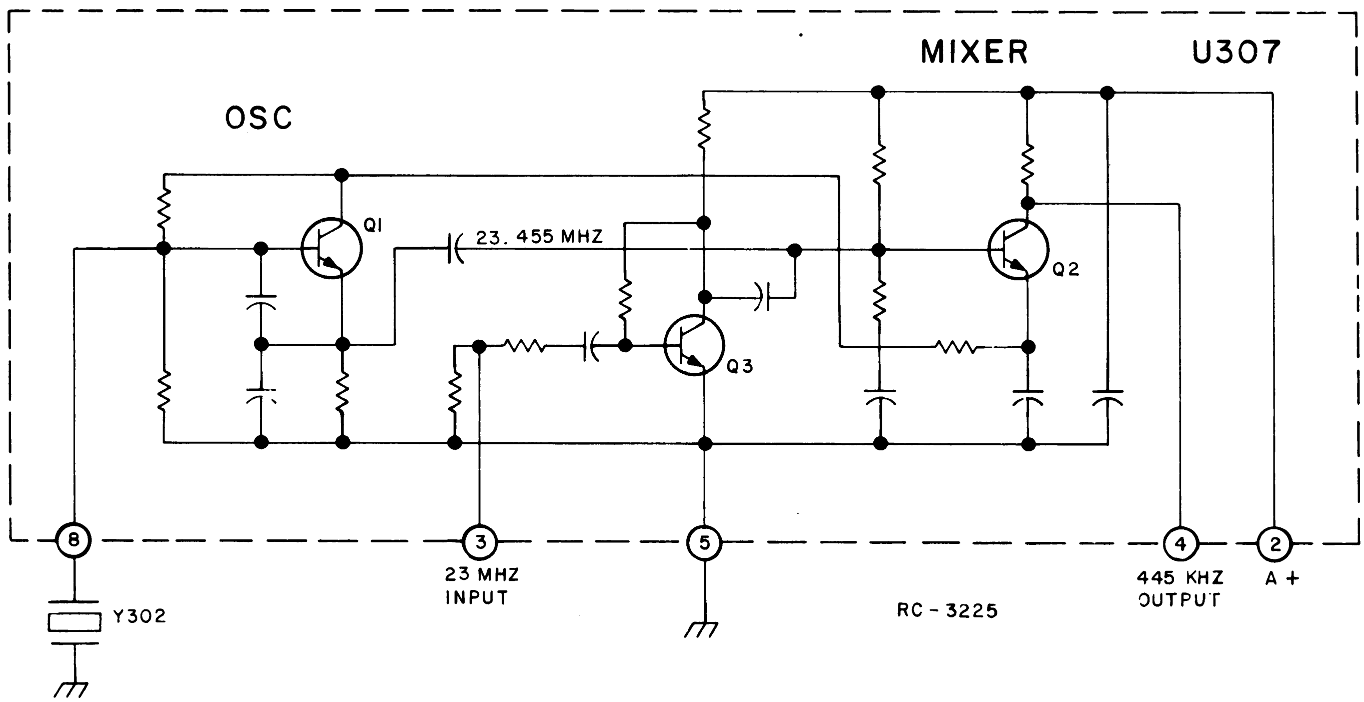


Figure 4 - Typical 2nd Mixer and Oscillator Circuit

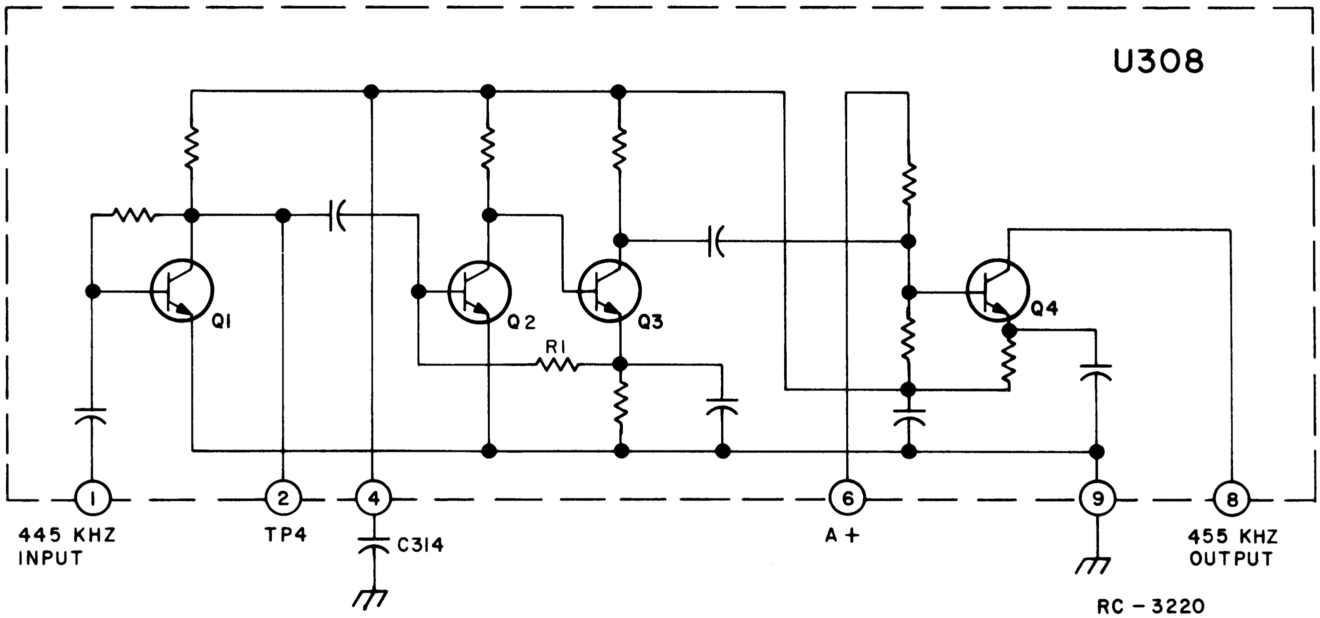


Figure 5 - Typical IF Amplifier/Limiter Circuit

The 455 Kilohertz Low-IF from 2nd Mixer and Oscillator Module U307-4 is coupled through Low-IF Ceramic Filter FL302. FL302 provides additional selectivity for the receiver. The output from FL302 is coupled to Low-IF Amplifier/Limiter U308-1.

IF AMPLIFIER/LIMITER

The 455 Kilohertz Low-IF, coupled to IF Amplifier/Limiter U308-1, is applied to the base of amplifier transistor Q1. A typical IF amplifier/limiter circuit is shown in Figure 5. The output of Q1 is measurable at TP4 and is coupled to the base of first limiter transistor Q2.

As the amplitude of the AC signal on the base of Q2 increases, Q2 conducts harder and the DC voltage on the collector of Q2 drops. The collector of Q2 is direct coupled to the base of transistor Q3. The DC voltage on the collector of Q2 dropping causes Q3 to conduct less. Transistor Q3 conducting less causes the DC voltage on the emitter of Q3 to decrease. The decreasing voltage on the emitter of Q3, fed back through R1 to the base of Q2, causes transistor Q2 to conduct less. Similarly, when transistor Q2 conducts less, the DC collector voltage of Q2 increases causing Q3 to conduct harder. The emitter voltage of Q3 increases and transistor Q2 conducts harder keeping the output of transistor Q3 constant.

The output of transistor Q3 is coupled to the base of output transistor Q4. The collector of Q4 is connected to Pin 8.

RATIO DETECTOR

The 455 kHz Low-If output from Amplifier/Limiter U308-8 is coupled through L303 and L304 to Ratio Detector U309. A typical ratio circuit is shown in Figure 6. The Low-IF is applied to the bases of transistors Q1 and Q2. Transistors Q1 and Q2 rectify the Low-IF. Voltages, the sum of which always remain constant, develop across resistors R1 and R2. Audio is developed as a result of the varying ratio of the voltages across R1 and R2. Capacitor C320 stabilizes the circuit and keeps the sum of the voltages across R1 and R2 constant.

AUDIO AMPLIFIER

Audio and noise from the ratio detector circuit is applied to Audio Amplifier module U305-1. A typical audio amplifier circuit is shown in Figure 7.

Audio and noise is applied to the base of Q1. This stage operates as an emitter-follower for matching the impedance of the ratio detector to amplifier transistor Q2 and VOLUME control R701. The output of Q1 connects from Pin 2 to the base of amplifier Q2 (Pin 4) through the VOLUME control. The output of Q1 is also applied to the input of Squelch module U306.

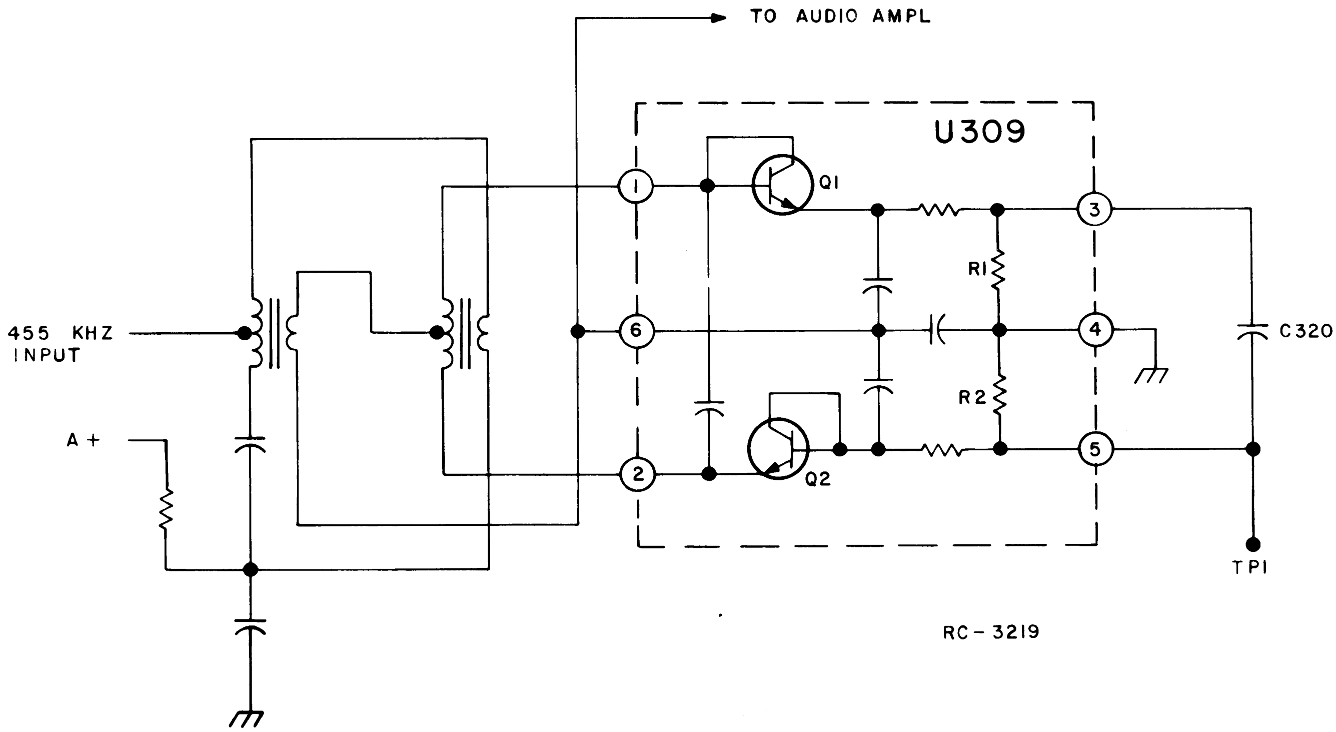


Figure 6 - Typical Ratio Detector Circuit

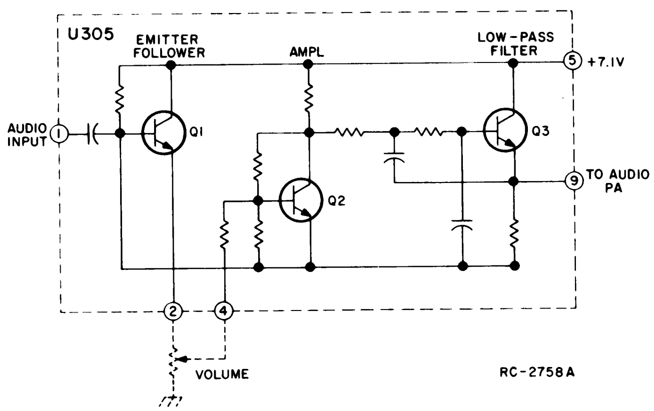


Figure 7 - Typical Audio Amplifier Circuit

Following amplifier Q2 is active low-pass filter Q3. Audio from the filter is connected from Pin 9 to Audio PA transistor Q302. In audio Amplifier module U305, an active high-pass filter is added in series with the low-pass filter to provide the required tone frequency roll-off.

AUDIO PA

When the receiver is quieted by a signal, audio from the active filter, in Audio Amplifier Module U305, is coupled to the base of amplifier transistor Q302. The output of Q302 is direct coupled to the base of Drive transistor Q303. Q303 supplies drive for PA transistors Q304 and Q306. Q304 is driven direct from the collector of Q303. Drive from the collector of Q303 is applied to the base of bootstrap transistor Q305. The emitter of Q305 is direct coupled to Q306.

PA transistors Q304 and Q306 operate as complementary emitter-followers, providing a 500 milliwatt output into an 8-ohm load. Audio is coupled through capacitor C329 on the receiver board to speaker LS1.

SQUELCH

Noise from Audio Amplifier U305 operates the squelch circuit. A typical squelch circuit is shown in Figure 8.

When no carrier is present in the receiver, the noise output of active high-pass filter Q1 is coupled to the base of noise amplifier Q2 through SQUELCH control R702. R702 controls the gain of the noise amplifier.

The output of noise amplifier Q2 is detected by diodes CR1 and CR2, and the resultant positive voltage turns off the PNP

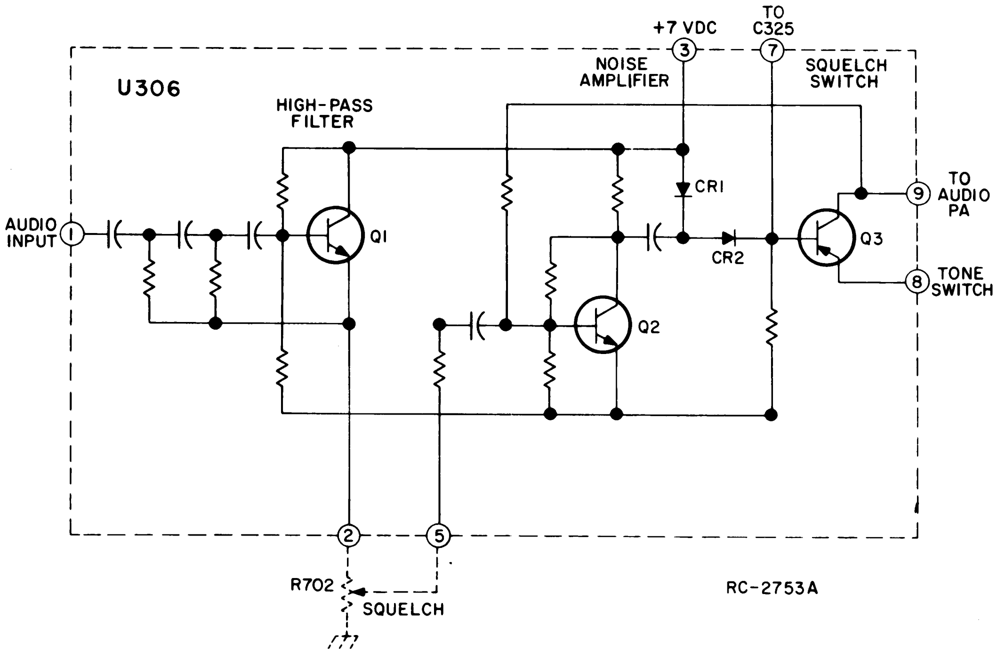


Figure 8 - Typical Squelch Circuit

squelch switch Q3. In standard radios, the emitter of Q3 is connected to +7 Volts by means of a jumper from H1 to H2. When noise turns off Q3, its collector drops to ground potential. As the collector of Q3 is connected to the base of amplifier Q302 in the Audio PA circuit, turning off Q3 also turns off Q302, keeping the audio PA turned off.

When the receiver is quieted by a signal, squelch switch Q3 turns on. This applied +7 Volts to the base of amplifier Q302 in the Audio PA circuit, turning the Audio PA circuit on so that sound is heard at the speaker.

In tone decoder applications, the 7-Volt jumper from H1 to H2 is removed. The emitter of squelch switch Q3 is connected to 7.5 Volts by a DC switch on the decoder board.

GENERAL ELECTRIC COMPANY • MOBILE COMMUNICATIONS DIVISION
WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

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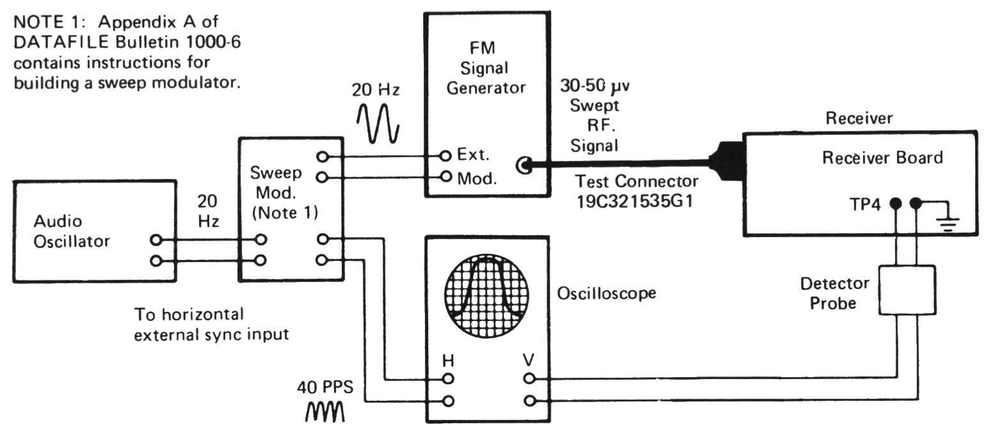


Figure 9 - Test Setup for 20-Hz Double-Trace Sweep Alignment

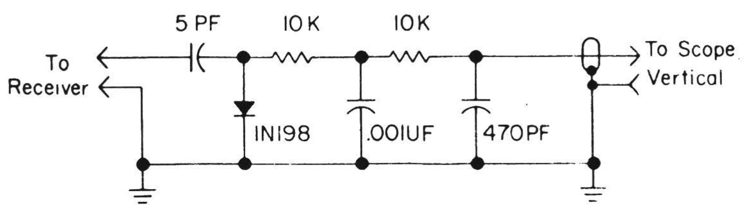
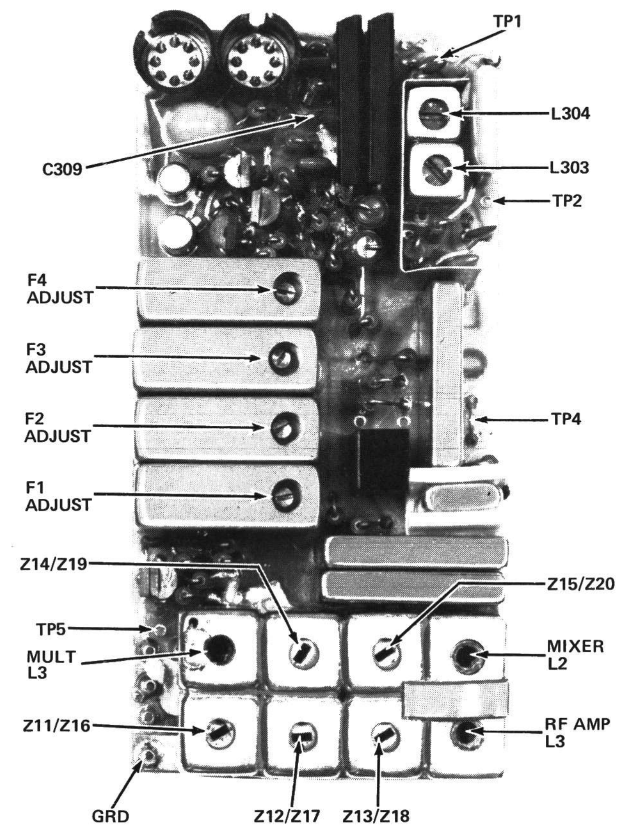


Figure 10 - Detector Probe for Sweep Alignment



RECEIVER ALIGNMENT

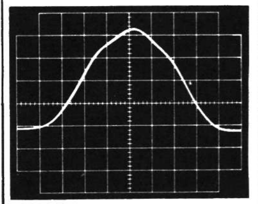
EQUIPMENT

1. A 23 MHz signal source, a 455 kHz signal source (GE IF Generator Model 4EX7A10 or equivalent), and a 450-470 MHz source connected to the receiver through Receiver Test Connector 19C321535G1 inserted into antenna tube 19A127779G8.
2. GE Test Set Model 4EX3A11 or 4EX8K11 or voltmeter with equivalent sensitivity.
3. GE Test Amplifier Model 4EX6A10 and RF probe 19C311370G1, or equivalent RF voltmeter.
4. Distortion Analyzer or AC-VTVM.
5. Oscilloscope, 50 MV/DIV or better.

PRELIMINARY CHECKS AND ADJUSTMENTS

1. In multi-frequency receivers where the maximum frequency spacing is less than one MHz, align the receiver on the F1 channel. Where the frequency spacing is more than one MHz, align the receiver on the center frequency.
2. Set the slugs in Z16 thru A20 to the bottom of the coil form for frequencies in the low end of the band. Set the slugs near the top of the coil form for frequencies near the high end of the band.
3. Set the slug in RF AMP L3 to the top of the coil form for frequencies in the low end of the band, and near the bottom of the coil form for frequencies near the high end of the band. Set Mixer Output coil L2 near the middle of the coil form.
4. Connect the negative lead of the DC Test Set to TP1 and the positive lead to ground. Connect the Distortion Analyzer or AC-VTVM across the speaker leads.

ALIGNMENT PROCEDURE

STEP	TUNING CONTROL	PROCEDURE
		RATIO DETECTOR
1.	L302	Lightly couple a 455 kHz signal to TP4. Adjust input for a slight increase at (TP1) Tune L303 for a peak.
2.	L304	Adjust L304 to zero volts ±10 mV at TP2. Repeat steps 1 and 2. Disconnect 455 kHz generator.
		FRONT END MULTIPLIER
3.	MULT L3	Adjust L3 for maximum meter reading at TP5.
4.	Z19 and Z20	Adjust Z19 and then Z20 for slight change in meter reading at TP5.
		HIGH AND LOW IF
		The IF Circuits have been aligned at the factory and will normally require no further adjustment. Should alignment become necessary, use the procedure outlined in Steps 5 and 6.
5.	See Procedure	Connect the scope, signal generator and detector as shown in Figures 9 and 10. Apply an on-frequency signal using the lowest possible input level to avoid limiting. Modulate the generator with 20 Hz at 10 to 16 kHz deviation. NOTE An on-frequency signal is easily determined by zero beating the channel signal with the 455 kHz market generator signal. Loosely couple the 455 kHz generator to U301-4 and adjust the RF level of the RF signal generator to 20 dB quieting level
6.	L2 	Tune L2 of the mixer for the best response and for flatness. Retune L2 for the best shape on scope as shown on scope wave form, keeping the signal below saturation.
		FRONT END
7.	Z16 thru Z18 and RF. Amp L3	Apply an on-frequency signal and adjust Z16, Z17, Z18, and L3 for best quieting sensitivity.
8.	MULT L3, Z19 & Z20	De-tune L3. Increase the on-frequency input signal and tune Z19 and Z20 for best quieting sensitivity. Now re-adjust L3 for maximum meter reading at TP5.
9.	L303, L304	Re-tune the ratio detector on noise. Peak L303 at TP1. Zero TP2 by tuning L304. Detector idling should be zero volts ±10 mV.
		FREQUENCY ADJUSTMENT
10.		While applying an on-frequency signal, loosely couple a 455 kHz signal to the receiver. Adjust the oscillator trimmers for zero beat frequency between the two signals. Alternate Method: With no signal, measure and record the output of the ratio-detector with a DC-VTVM at TP2. Apply a strong on-frequency signal and tune the oscillator trimmers for the meter reading obtained at TP2.

ALIGNMENT PROCEDURE

450—470 MHz MVP PERSONAL RECEIVER
TYPE ER-72-A

TEST PROCEDURES

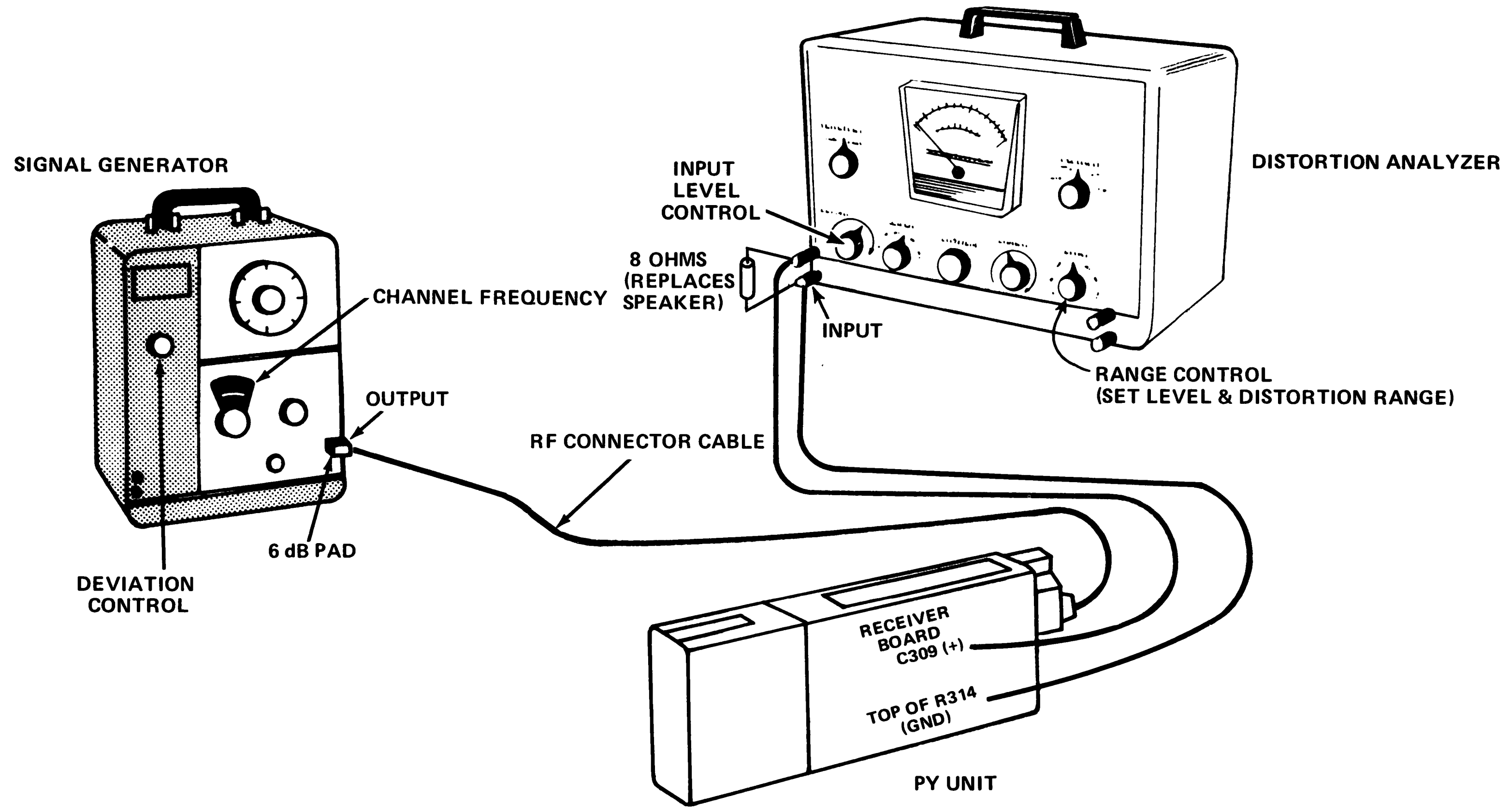
These Test Procedures are designed to help you to service a receiver that is operating --- but not properly. The problems encountered could be low power, poor sensitivity, distortion, and low gain. By following the sequence of test steps starting with Step 1, the defect can be quickly localized. Once 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: Measurements M-803
- 6-dB attenuation pad
- 8 ohm, 1 watt resistor
- RF Connector Cable 19C321535G1

PRELIMINARY ADJUSTMENTS

1. Connect the test equipment to the receiver as shown for all steps of the receiver Test Procedure. Refer to page 7 for connection points.
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. Connect a 1,000-microvolt test signal modulated by 1,000 hertz ±3.0 kHz deviation to the Antenna Connector.

B. Set the Volume Control for a 500 milliwatt output (2 volts RMS).

C. Make distortion measurements according to manufacturer's instructions. Reading should be less than 5%-10% (5% is typical). 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 0.5 watt, make the following checks:

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

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

STEP 2

USABLE SENSITIVITY (12 dB SINAD)

TEST PROCEDURE

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 Connector.

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 specification with an audio output of at least 250 milliwatts.

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)

TEST PROCEDURE

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.

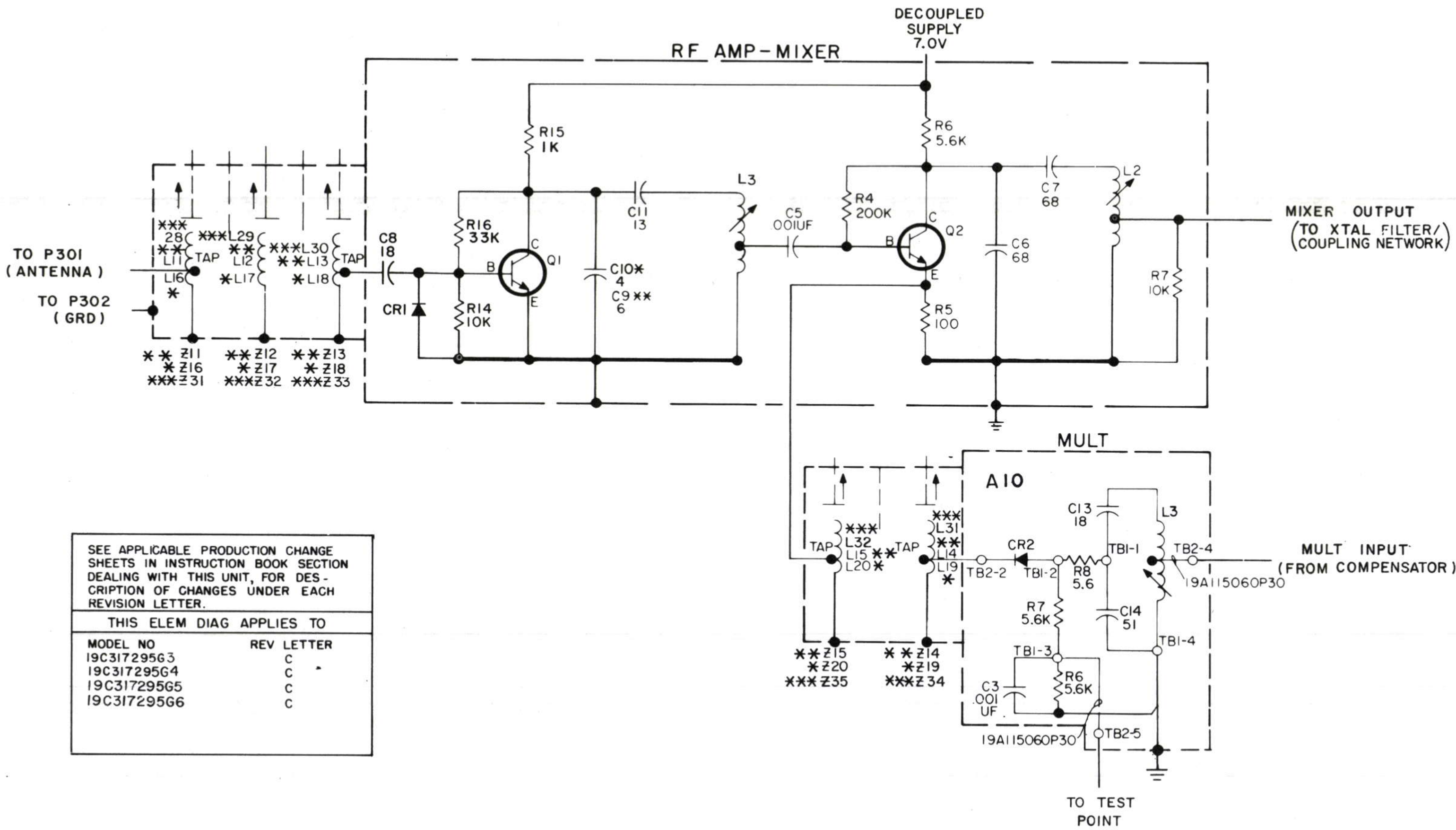
C. While increasing the deviation of the Signal Generator, switch the RANGE control from SET LEVEL to distortion range until a 12-dB difference is obtained between the SET LEVEL and distortion range readings (from +2 dB to -10 dB).

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 (but less than ±9 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.

SCHEMATIC DIAGRAM



SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.	
THIS ELEM DIAG APPLIES TO	
MODEL NO	REV LETTER
19C317295G3	C
19C317295G4	C
19C317295G5	C
19C317295G6	C

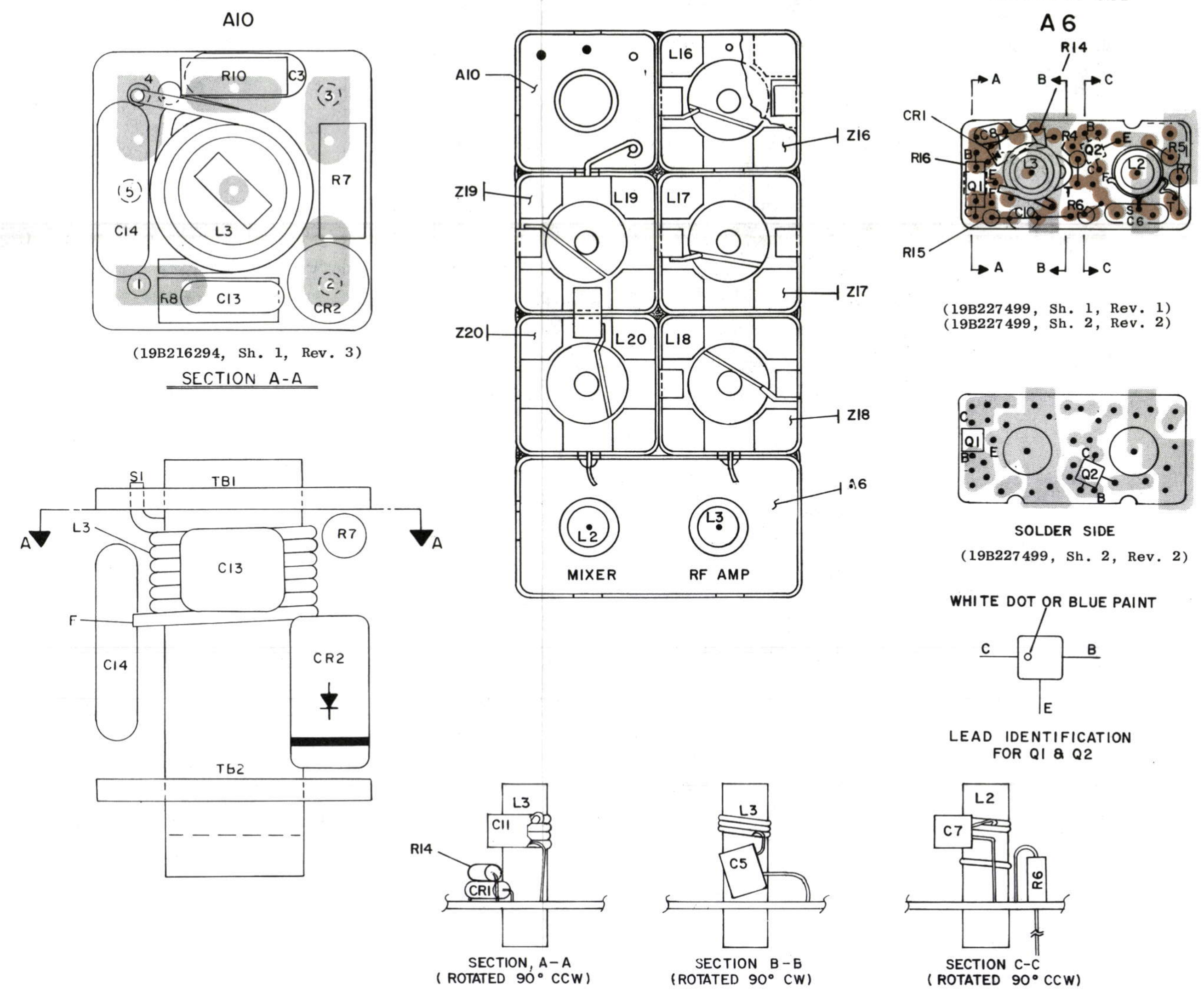
ALL RESISTORS ARE 1/8 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR H=HENRYS.

IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

* HI SPLIT (450-470)
** LO SPLIT (406-420)
*** MID SPLIT (420-450)

(19C320887, Rev. 9)

OUTLINE DIAGRAM



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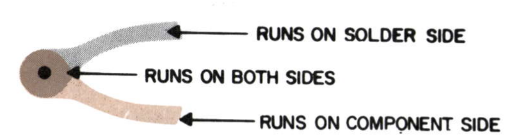
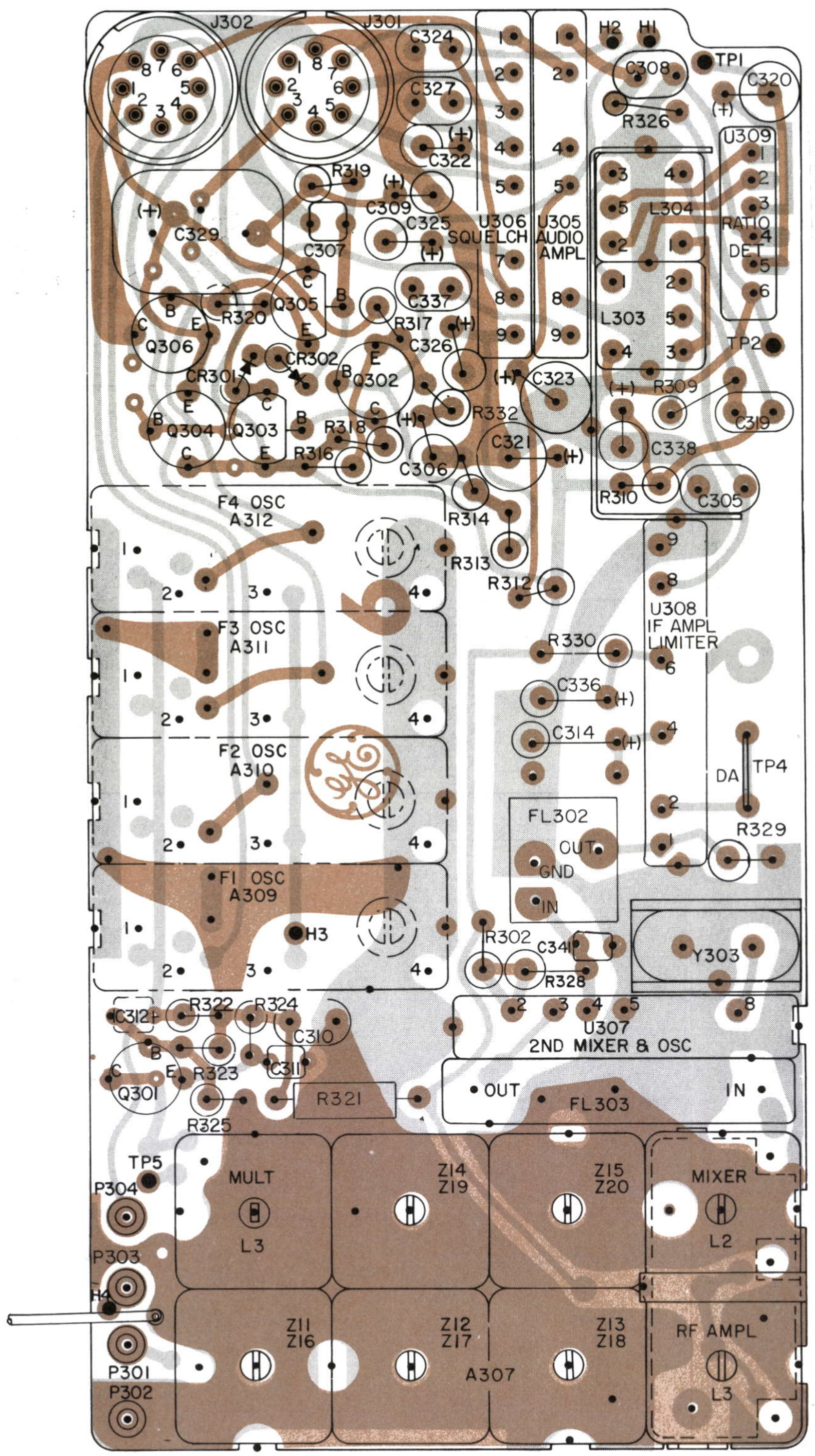
(19C321537, Rev. 5)



SCHEMATIC & OUTLINE DIAGRAM

450—470 MHz RECEIVER FRONT END
TYPE ER-72-A

COMPONENT SIDE



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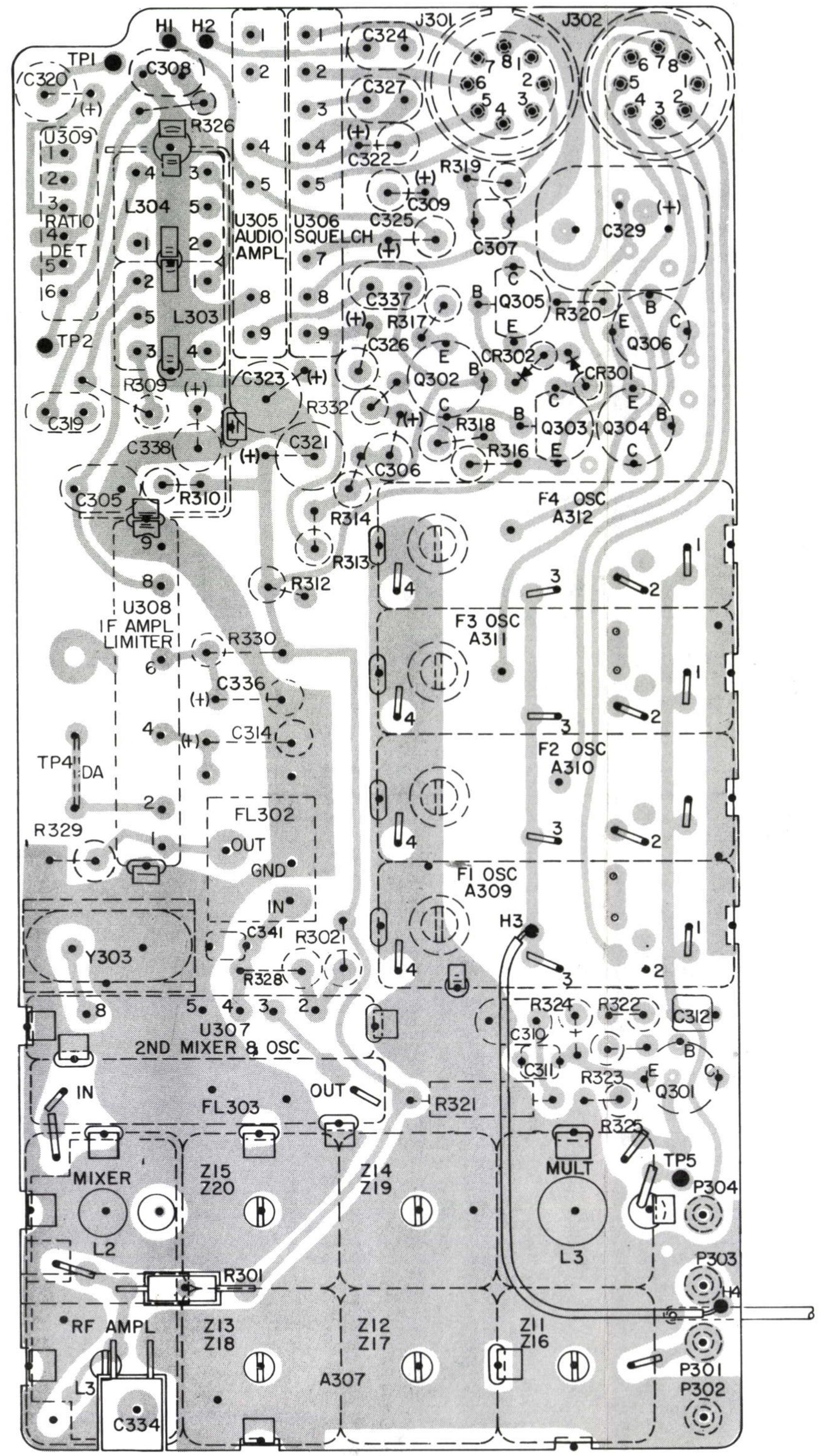
(19D429044, Sh. 3, Rev. 6)

SOLDER SIDE



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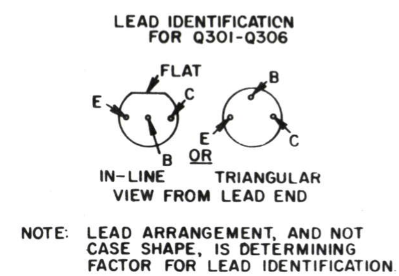

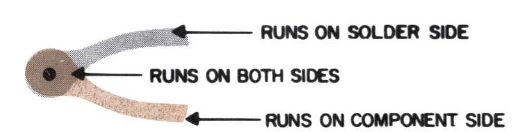

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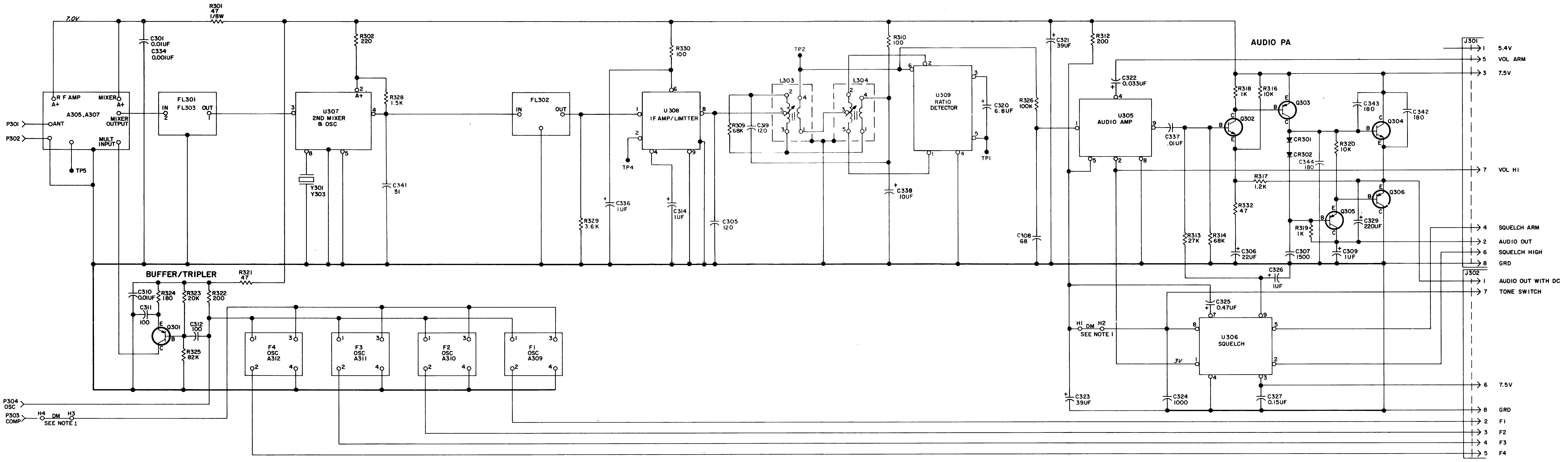
OUTLINE DIAGRAM

450—470 MHz MVP PERSONAL RECEIVER
TYPE ER-72-A



ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR H=HENRYS.

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NOTES:
1. JUMPER PRESENT IN G5 AND G6 ONLY.

SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER

THIS ELEM DIAG APPLIES TO

MODEL NO	REV LETTER
PL19D423091G5	H
PL19D423091G6	G

(19R622324, Rev. 12)

SCHEMATIC DIAGRAM

450—470 MHz MVP PERSONAL RECEIVER
TYPE ER-72-A

PARTS LIST

LBI30584C

450-470 MHz RECEIVER ER-72-A

SYMBOL	GE PART NO.	DESCRIPTION
A307		FRONT END ASSEMBLY 19C317295G6
A6		RF AMPLIFIER 19C327300G4
		- - - - - - - - - - CAPACITORS - - - - - - - - -
C5	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C6 and C7	19A700223P59	Ceramic: 68 pf ±5%, 100 VDCW; temp coef -220 PPM/°C.
C8	19A700225P38	Ceramic: 18 pf ±5%, 100 VDCW; temp coef -470 PPM/°C.
C10	19A116114P2014	Ceramic: 4 pf ±5%, 100 VDCW; temp coef -80 PPM.
C11	19A700221P32	Ceramic: 13 pf ±5%, 100 VDCW; temp coef -80 PPM/°C.
		- - - - - - - DIODES AND RECTIFIERS - - - - - -
CR1	19A116052P1	Silicon, hot carrier: Fwd. drop .350 volts max.
		- - - - - - - - - - INDUCTORS - - - - - - - - -
L2	19B216948G1	Coil.
L3	19A128005G1	Coil. Includes:
	19B209436P1	Tuning slug.
		- - - - - - - - - - TRANSISTORS - - - - - - -
Q1 and Q2	19A116159P1	Silicon, NPN.
		- - - - - - - - - - RESISTORS - - - - - - - - -
R4	3R151P204J	Composition: 200K ohms ±5%, 1/8 w.
R5	3R151P101J	Composition: 100 ohms ±5%, 1/8 w.
R6	3R151P562J	Composition: 5.6K ohms ±5%, 1/8 w.
R7	3R151P103J	Composition: 10K ohms ±5%, 1/8 w.
R14	3R151P103J	Composition: 10K ohms ±5%, 1/8 w.
R15	3R151P102J	Composition: 1K ohms ±5%, 1/8 w.
R16	3R151P333J	Composition: 33K ohms ±5%, 1/8 w.
A10		MULTIPLIER 19C311873G7
		- - - - - - - - - - CAPACITORS - - - - - - - - -
C3	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C13	19A700221P38	Ceramic: 18 pf ±5%, 100 VDCW; temp coef -80 PPM/°C.
C14	19A700221P54	Ceramic: 51 pf ±5%, 100 VDCW; temp coef -80 PPM/°C.
		- - - - - - - DIODES AND RECTIFIERS - - - - - -
CR2	19A116809P1	Diode, silicon; sim to HP Step Recovery 5082-0180.
		- - - - - - - - - - INDUCTORS - - - - - - - - -
L3	19B216296P3	Coil.
		- - - - - - - - - - RESISTORS - - - - - - - - -
R7	3R151P562J	Composition: 5.6K ohms ±5%, 1/8 w.
R8	3R151P5R6J	Composition: 5.6 ohms ±5%, 1/8 w.
R10	3R151P562J	Composition: 5.6K ohms ±5%, 1/8 w.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - INDUCTORS - - - - - - - - -
L16	19B216439G7	Helical resonator. (Part of Z16).
L17	19B216439G2	Helical resonator. (Part of Z17).
L18	19B216439G1	Helical resonator. (Part of Z18).
L19	19B216439G4	Helical resonator. (Part of Z19).
L20	19B216439G3	Helical resonator. (Part of Z20).
		- - - - - - - HELICAL RESONATORS - - - - - -
Z16		Consists of L16 & 19D413132P24 can.
Z17		Consists of L17 & 19D413132P3 can.
Z18		Consists of L18 & 19D413132P25 can.
Z19		Consists of L19 & 19D413132P19 can.
Z20		Consists of L20 & 19D413132P20 can.
		RECEIVER BOARD 19D423091G6 (19D423091G6 replaces 19D423091G3)
		- - - - - - - - - - CAPACITORS - - - - - - - - -
C305	19A116288P9	Ceramic: 120 pf ±5%, 100 VDCW; sim to Erie 8121-A100-U2J-121J.
C306	5491674P35	Tantalum: 22 µf ±20%, 4 VDCW; sim to Sprague Type 162D.
C307	19A116192P10	Ceramic: 1500 pf ±20%, 50 VDCW; sim to Erie 8121-050-W5R.
C308	19A700225P59	Ceramic: 68 pf ±5%, 100 VDCW; temp coef -470 PPM/°C.
C309	5491674P28	Tantalum: 1.0 µf ±20%, 25 VDCW; sim to Sprague Type 162D.
C310	19A116192P1	Ceramic: 0.01 µf ±20%, 50 VDCW; sim to Erie 8121 SPECIAL.
C311 and C312	19A700232P64	Ceramic: 100 pf ±10%, 100 VDCW; temp coef -5600 PPM/°C.
C314	5491674P28	Tantalum: 1.0 µf ±20%, 25 VDCW; sim to Sprague Type 162D.
C318*	5491674P37	Tantalum: 10 µf 20%, 10 VDCW; sim to Sprague Type 162D. Deleted by REV B.
C319	19A700226P68	Ceramic: 120 pf ±5%, 100 VDCW; temp coef -750 PPM/°C.
C320	5496267P1	Tantalum: 6.8 µf ±20%, 6 VDCW; sim to Sprague Type 150D.
C321	5491674P30	Tantalum: 39 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C322	5491674P31	Tantalum: .033 µf ±20%, 35 VDCW; sim to Sprague Type 162D.
C323	5491674P30	Tantalum: 39 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C324	19A116192P13	Ceramic: 1000 pf ±10%, 50 VDCW; sim to Erie 8121-A050-W5R.
C325	5491674P27	Tantalum: .47 µf ±20%, 35 VDCW; sim to Sprague Type 162D.
C326	5491674P28	Tantalum: 1.0 µf ±20%, 25 VDCW; sim to Sprague Type 162D.
C327	19A116244P4	Ceramic: 0.15 µf ±20%, 50 VDCW.
C329	19A116178P7	Tantalum: 220 µf ±20%, 6 VDCW.
C334	19A116192P13	Ceramic: 1000 pf ±10%, 50 VDCW; sim to Erie 8121-A050-W5R-102K.
C335*	19A116192P1	Ceramic: 0.01 µf ±20%, 50 VDCW; sim to Erie 8121 SPECIAL. Deleted by REV B.
C336	5491674P28	Tantalum: 1.0 µf ±20%, 25 VDCW; sim to Sprague Type 162D.
C337	19A116192P1	Ceramic: 0.01 µf ±20%, 50 VDCW; sim to Erie 8121 SPECIAL.
C338	5491674P37	Tantalum: 10 µf 20%, 10 VDCW; sim to Sprague Type 162D.
C341*	19A700221P54	Ceramic: 51 pf ±5%, 100 VDCW; temp coef -80 PPM. Added by REV E.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR301 and CR302	19A115250P1	Silicon, fast recovery, 225 mA, 50 PIV.
		- - - - - - - - - - - FILTERS - - - - - - - - -
FL302	19A134199P1	Bandpass: 455 KHz.
FL303	19C304824G3	Bandpass: 23 MHz.
		- - - - - - - JACKS AND RECEPTACLES - - - - - - -
J301 and J302	19A116122P1	Terminal, feed-thru.
		- - - - - - - - - - INDUCTORS - - - - - - - - -
L303	19A116308P1	IF Transformer: sim to Toko, Inc. LSN4816VE2.
L304	19A116308P2	IF Transformer: sim to Toko, Inc. LSN4817YM2.
		- - - - - - - - - - - PLUGS - - - - - - - - - -
P301 thru P304	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.
		- - - - - - - - - - TRANSISTORS - - - - - - - -
Q301	19A116223P1	Silicon, PNP; sim to Type 2N3640.
Q302	19A116774P1	Silicon, NPN; sim to Type 2N5210.
Q303	19A115852P1	Silicon, PNP; sim to Type 2N3906.
Q304	19A115720P1	Silicon, NPN; sim to Type 2N2222.
Q305	19A115852P1	Silicon, PNP; sim to Type 2N3906.
Q306	19A134165P1	Silicon, PNP; sim to Type 2N2906A.
		- - - - - - - - - - RESISTORS - - - - - - - - -
R301	3R151P470J	Composition: 47 ohms ±5%, 1/8 w.
R302	19A700019P29	Deposited carbon: 220 ohms ±5%, 1/4 w.
R309	19A700019P59	Deposited carbon: 68K ohms ±5%, 1/4 w.
R310	19A700019P25	Deposited carbon: 100 ohms ±5%, 1/4 w.
R312	19A143400P28	Deposited carbon: 200 ohms ±5%, 1/4 w.
R313	19A700019P54	Deposited carbon: 27K ohms ±5%, 1/4 w.
R314	19A700019P59	Deposited carbon: 68K ohms ±5%, 1/4 w.
R315*	3R152P560J	Composition: 56 ohms ±5%, 1/4 w. Deleted by REV B.
R316	19A700019P49	Deposited carbon: 10K ohms ±5%, 1/4 w.
R317	19A700019P38	Deposited carbon: 1.2K ohms ±5%, 1/4 w.
R318 and R319	19A700019P37	Deposited carbon: 1K ohms ±5%, 1/4 w.
R320	19A700019P49	Deposited carbon: 10K ohms ±5%, 1/4 w.
R321	19A700019P21	Deposited carbon: 47 ohms ±5%, 1/4 w.
R322	19A700019P29	Deposited carbon: 220 ohms ±5%, 1/4 w.
R323	19A143400P52	Deposited carbon: 20K ohms ±5%, 1/4 w.
R324	19A700019P28	Deposited carbon: 180 ohms ±5%, 1/4 w.
R325	19A700019P60	Deposited carbon: 82K ohms ±5%, 1/4 w.
R326*	19A700019P61	Deposited carbon: 0.1 megohm ±5%, 1/4 w.
		In REV B & earlier:
	3R152P154J	Composition: 150K ohms ±5%, 1/4 w.
R328	19A700019P39	Deposited carbon: 1.5K ohms ±5%, 1/4 w.
R329	19A143400P43	Deposited carbon: 3.6K ohms ±5%, 1/4 w.
R330	19A700019P25	Deposited carbon: 100 ohms ±5%, 1/4 w.
R332	19A700019P21	Deposited carbon: 47 ohms ±5%, 1/4 w.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - INTEGRATED CIRCUITS - - - - - -
U305*	19C330341G1	Audio Amplifier. (Includes Tone Filter).
		In REV F & earlier:
	19C311995G4	Audio Amplifier. (Includes Tone Filter).
U306*	19C330342G1	Squelch.
		In REV F & earlier:
	19C311880G4	Squelch.
U307	19C327925G3	2nd Oscillator, Mixer.
U308	19C321351G3	455 Limiter.
U309	19C327981G1	Ratio Detector.
		- - - - - - - - - - - CRYSTALS - - - - - - - - -
		NOTE: When reordering, give GE Parts List Number and specify exact frequency needed.
		$Fx = \frac{Fo - 23}{21}$
Y303	19B206357G21	Quartz: 23.455 MHz, temp range -30°C to +85°C.
		- - - - - - - - - MISCELLANEOUS - - - - - - - -
	19B216316P1	Insulator. (Used with J301, J302).
	19B226696P1	Shield. (Located at L303, L304).
	19B227477P3	Pad. (Used with Y303).
	19A129811P2	Insulator. (Used with U307 & U308).
		ASSOCIATED PARTS
		- - - - - - - - - - OSCILLATORS - - - - - - - -
A309 thru A312		NOTE: When reordering, give GE Part Number and specify exact frequency needed.
	4EG28A28	Oscillator Module. 450-470 MHz. $Fx = \frac{Fo - 23}{21}$

PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A & B - Receiver Board 19D423091G6
Incorpated into initial shipment

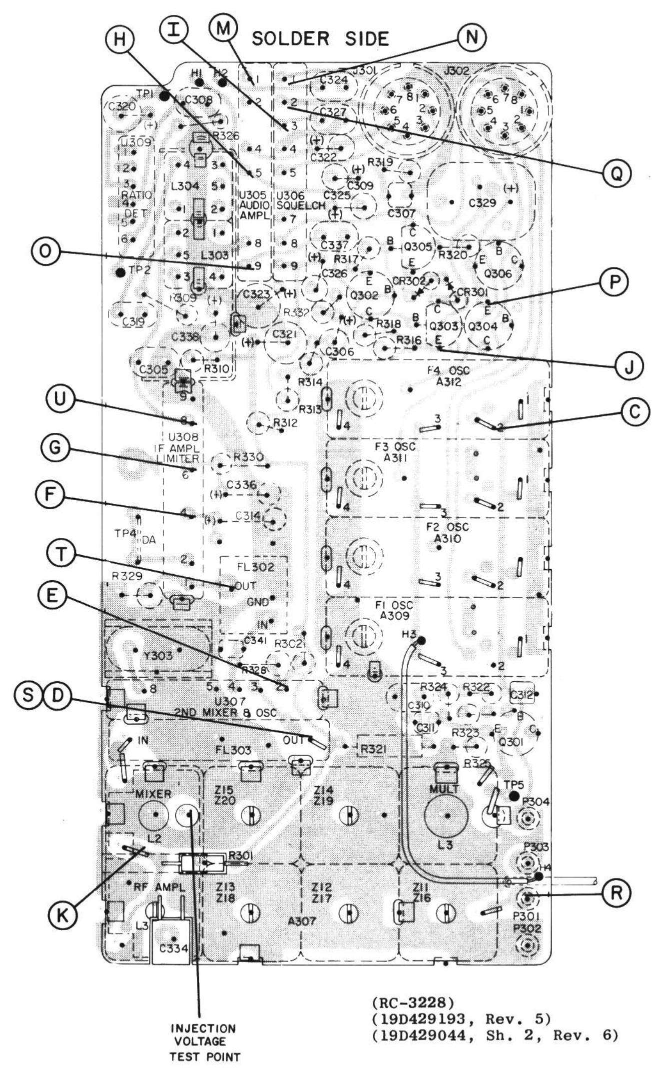
REV. C - To improve maximum squelch operation.
Changed R326.

REV. D - To update wiring and outline diagrams.
Deleted NOTE 2.
Added See Note 1.

REV. D - To improve stability of second oscillator/mixer.
Added C341.

QUICK CHECKS

SYMPTOM	PROCEDURE
No Audio	1. Check audio waveform at the top of the Volume Control (see Step 2). 2. If audio is present, check voltage readings of Audio and Squelch modules (see Schematic Diagram). 3. If audio is not present, check gain and current readings of Front End and IF modules (see Steps 1 & 3).
Poor Sensitivity	1. Measure the gain of the Mixer stage (see Step 3). If low, measure the gain of the RF amplifier and IF modules.
Improper Squelch Operation	1. Check the noise waveform at the input to the Squelch module and at Squelch Control high (see Step 2). 2. Measure the DC voltages for the Squelch module (squelched and unsquelched).



(RC-3228)
(19D429193, Rev. 5)
(19D429044, Sh. 2, Rev. 6)

STEP 3 - RF GAIN CHECKS

EQUIPMENT REQUIRED:

1. RF probe and Test Amplifier Model 4EX16A10 connected to GE Test Set Model 4EX3A11, or an RF voltmeter.
2. A signal generator (M-800 or equivalent) connected to P301 (High) and P302 (Low).

PROCEDURE FOR MIXER AND 1ST IF:

1. Disable 2nd Oscillator by shorting Y303 with a .01 µf capacitor.
2. Switch the Test Set to the Test 1 position and the Test Amplifier to the X50 position.
3. Connect the RF probe across the input (R) as shown on the diagram. Increase the signal generator output to obtain a reference reading on Test Set 4EX3A11. Note the Test Set reading and the dB reading on the generator (dB1).
4. Connect the RF probe to the output (S) as shown on the diagram. Decrease the generator output until the Test Set reference reading in Step 3 is obtained. Note the dB reading on the generator (dB2).
5. Subtract the dB1 reading from the dB2 reading and check the results with the typical gains shown on the diagram.

Example:
  35 dB (dB2)
  -15 dB (dB1)
  20 dB gain

6. Remove .01 µf shorting capacitor.

PROCEDURE FOR 2ND MIXER:

1. With no signal in, connect the RF probe to the output of the 2nd IF filter FL302 at (T). Increase the signal generator output until the Test Set reading increases by approximately 0.2 volt. Note Test Set and signal generator reading (dB2).
2. Connect the probe to the input of the 2nd Mixer module at (S). Increase the signal generator until the Test Set reference reading is obtained, and note the dB reading (dB1).
3. Now subtract dB2 from dB1 to obtain the gain of the 2nd Mixer.

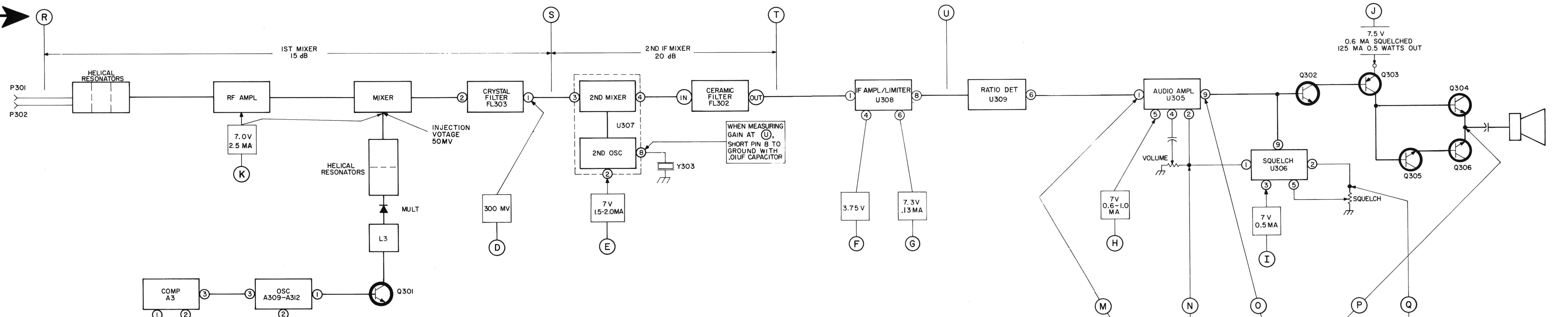
IF AMP/LIMITER CHECK:

The limiter module limits on noise so that the gain of the circuit cannot be measured. The following procedure provides a check to determine if the module is limiting.

1. Switch the Test Amplifier to the X1 position and the Test Set to the Test 1 position. Then connect the RF probe to the output of the Limiter module (U) and check for a reading of approximately 0.25 VDC.
2. Increase the signal generator output. There should be no appreciable increase in the limiter output meter reading.

STEP 3 - RF GAIN CHECKS
(STEPS R THRU U)

STEP 1 -
MODULE CURRENT CHECKS
(STEPS A THRU K)



STEP 2 - AUDIO & SQUELCH WAVEFORMS

EQUIPMENT REQUIRED:

- Oscilloscope connected between the points shown and ground.
- Signal Generator (Measurements M-800 or equivalent).

PRELIMINARY STEPS:

1. Apply a standard signal to P301. A standard signal is 1000 microvolts on the receiver frequency modulated by one kHz with 3.0-kHz deviation.
2. Set the Volume control for 0.5-watt output.

STEP 2 -
AUDIO & SQUELCH WAVEFORMS
(STEPS M THRU Q)

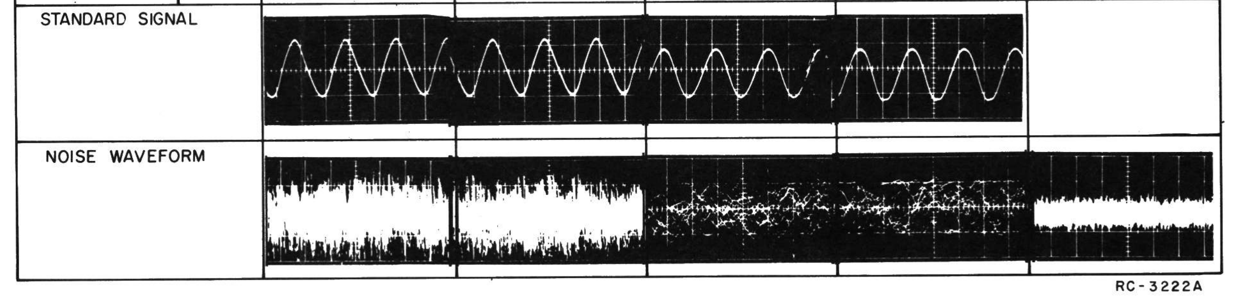
STEP 1 - MODULE CURRENT CHECKS

These current readings provide a method of checking the operation of each Integrated Circuit module using a milliammeter (Triplett 630 or equivalent).

1. Unsolder the + lead as shown in the Diagram of the module to be checked.
2. Connect the milliammeter in series with the + lead, and check for the indicated current drain and supply voltage. No current drain indicates that the module should be replaced.

SCOPE SETTINGS

PEAK-TO-PEAK READINGS		M	N	O	P	Q
	SIGNAL	0.26 V	0.26 V	0.29 V	5.6 V	
	NOISE	0.9 V	0.9 V	0.6 V	6.6 V	0.7 V



RC-3222A

TROUBLESHOOTING PROCEDURE

450—470 MHz MVP PERSONAL RECEIVER
TYPE ER-72-A