MOBILE RADIO

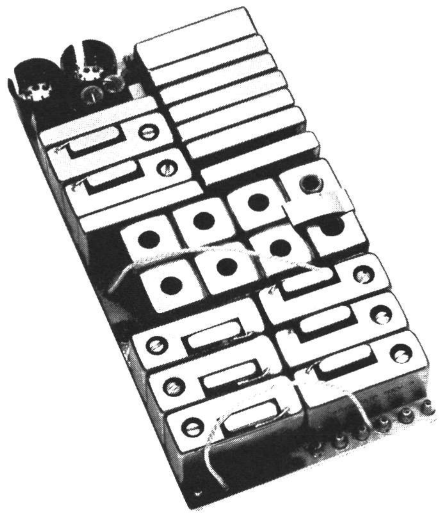
MASTR® *Personal Series*
PROGRESS LINE

Maintenance Manual LBI4639J

DATAFILE FOLDER - DF 1116

PE/MPE MODELS

406-420 MHz & 450-470 MHz RECEIVER TYPE ER-60-B AND 420-450 MHz RECEIVER TYPE ER-131-A



ER-60-B & ER-131-A

SPECIFICATIONS *

Type number 5	ER-60-B & ER-131-A
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	0.5 µV
Selectivity	
EIA Two Signal	-65 dB at ±25 kHz
20 dB Quieting Method	-90 dB at ±25 kHz
Spurious Response	-60 dB
Intermodulation (EIA)	-65 dB
Audio Response	+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	0.20 µV
Maximum Squelch	Greater than 20 dB quieting
Maximum Frequency Spacing	

Frequency Range	Full Performance	1 dB Degradation in Sensitivity
406-420 MHz	1.62 MHz	3.24 MHz
420-450 MHz	1.62 MHz	3.24 MHz
450-460 MHz	1.80 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.

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

Receiver Models 4ER60B10 through 4ER60B13 and receiver type ER131A are single conversion, superheterodyne FM receivers for one through eight frequency operation on the 406-470 MHz bands. The complete receiver mounts on a single printed wiring board, and utilizes both discrete components and Integrated Circuit modules. The application of each model receiver is shown in the following chart:

Model No.	Freq. Range	Tone Option
4ER60B10	406-420 MHz	
4ER60B11	450-470 MHz	
4ER60B12	406-420 MHz	Chan. Gd.
4ER60B13	450-470 MHz	Chan. Gd.
ER131A	420-450 MHz	Chan. Gd.

References to symbol numbers mentioned in the following text 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 regulated 5.4 Volts for the compensator module, 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 4EG28A12 (406-420 MHz), 4EG28A38 (420-450 MHz) and 4EG28A13 (450-470 MHz) consists of a crystal-controlled Colpitts oscillator similar to the Oscillator module used in the transmitter (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 19.33 to 22.38 MHz, and the crystal frequency is multiplied 21 times.

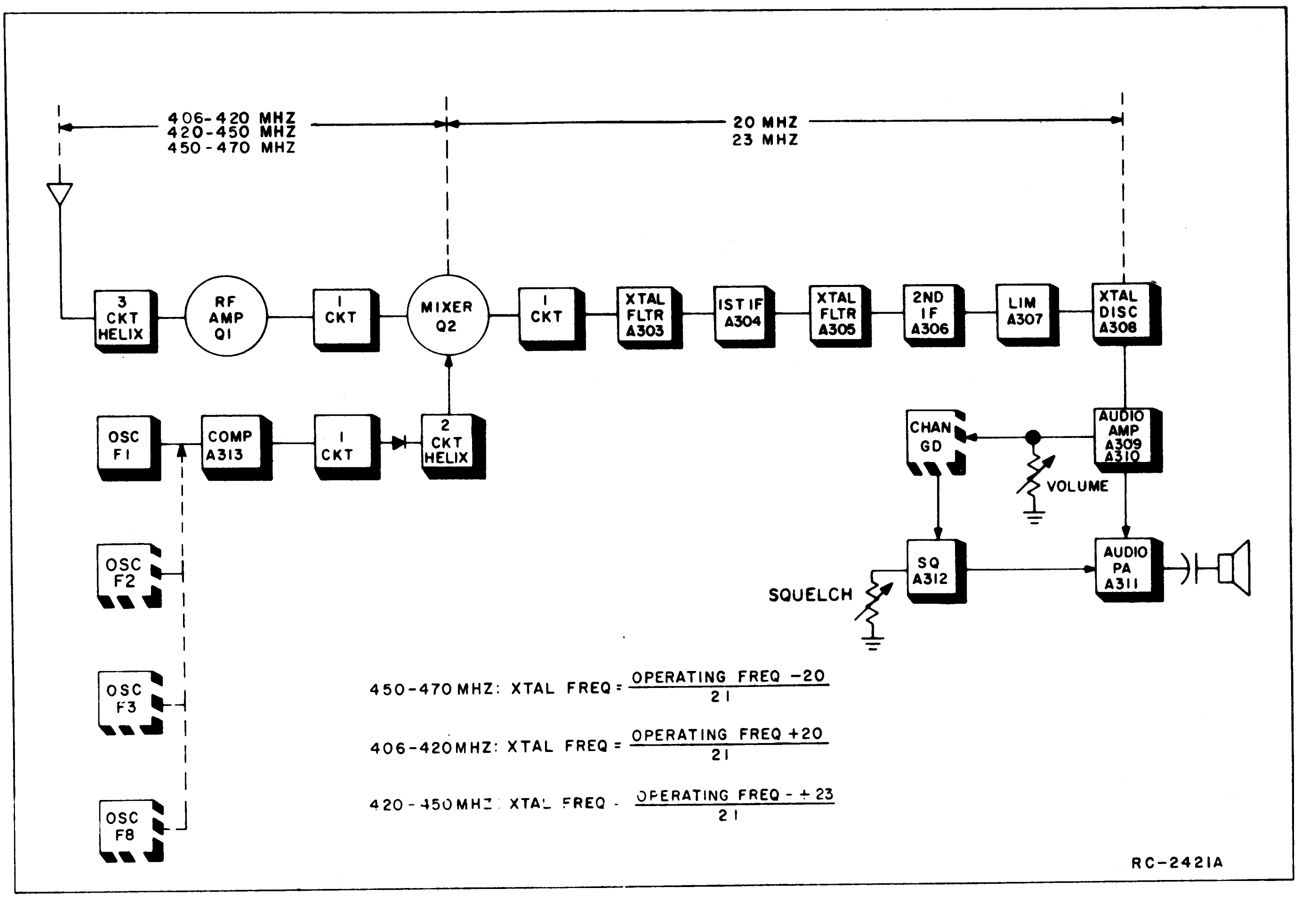


Figure 1 - Receiver Block Diagram

The oscillator frequency is temperature compensated to provide instant frequency compensation, with a frequency stability of ±.0002% from 0°C to +55°C and ±.0005% from -30°C to +60°C. The temperature compensation network is contained in Compensator Module A313.

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 modifications are contained in the Multi-Frequency Modification Diagram (see Table of Contents).

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 A313

Compensator module A313 contains a buffer-amplifier stage, and the temperature compensation network for the oscillator (see Figure 3).

RF from the oscillator is coupled through a DC blocking capacitor to the base of Q1. The output of Q1 connects to multiplier coil L1 on the Multiplier assembly.

In the compensation network, 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 voltage 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.

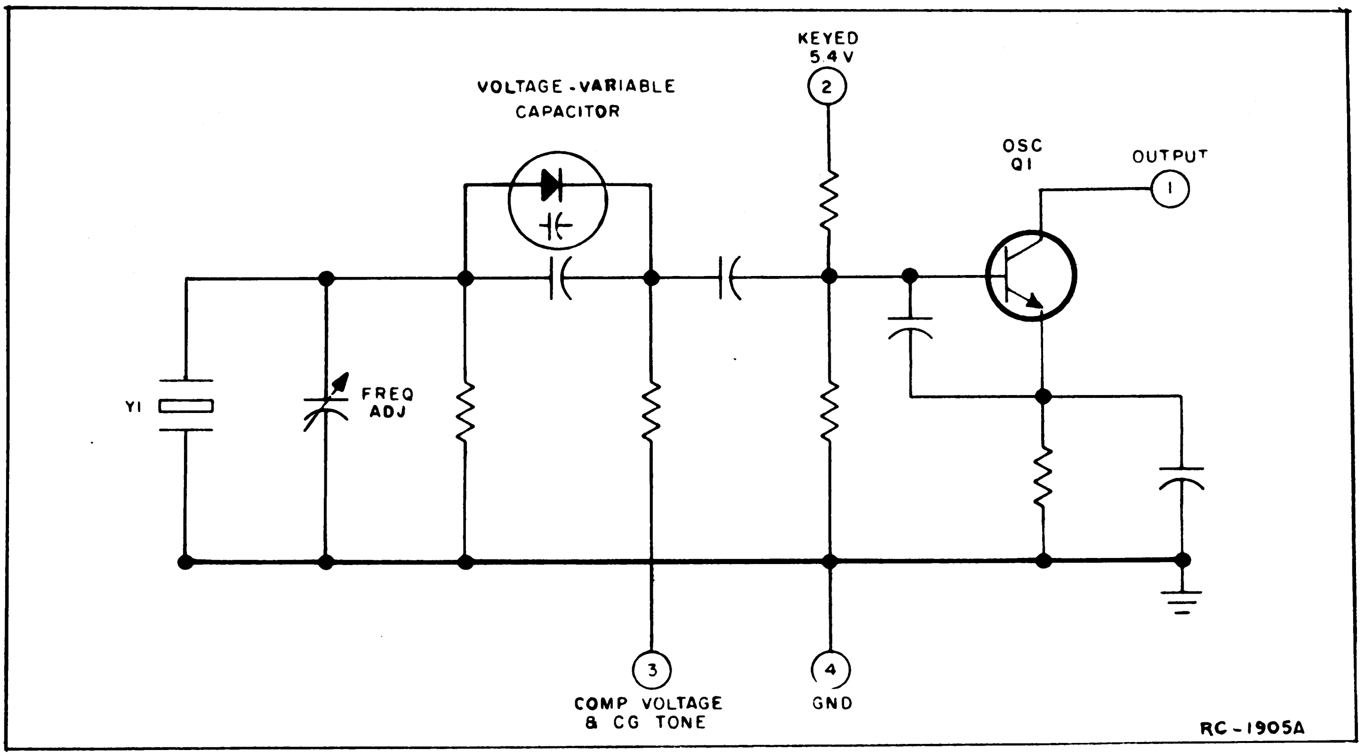


Figure 2 - Typical Oscillator Circuit

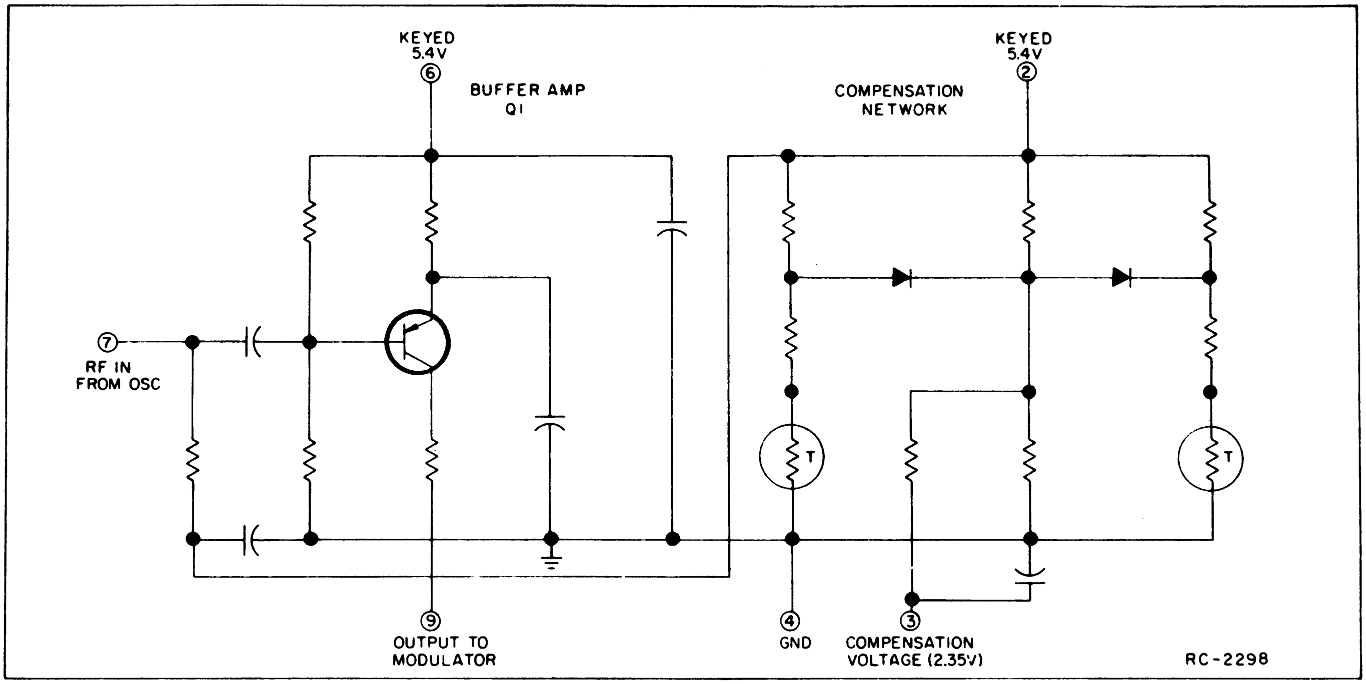


Figure 3 - Typical Compensator Circuit

FRONT END A316/A317/A339

The receiver Front End consists of three tuned helical resonators and an RF amplifier stage. The RF signal from the antenna is coupled through RF cable W301 to a tap on L11/L16/L28. The tap is positioned to provide the proper impedance match to the antenna. RF energy is coupled to the third coil (L13/L18/L30) through openings in the sides of the cans. RF is then coupled from a tap on L13/L18/L30 through C8 to the base of RF amplifier Q1. The output of Q1 is developed across tuned circuit C9/C10 and L1, and is applied to the base of the mixer.

MULTIPLIER & MIXER

The output of the Compensator module is applied to L3 in the Multiplier assembly. L3 is tuned to three times the crystal frequency and is metered at the Mult Test Point (H8) on the receiver board. The output of L3 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. In 406-420 and 420-450 MHz receivers, a high side injection frequency is used. In 450-470 MHz receivers, a low side injection frequency is used.

The RF signal from the RF amplifier is applied to the base of mixer Q2 and the high or low side injection voltage from the multiplier assembly is applied to the emitter. The resultant 20 MHz IF frequency is coupled through the mixer collector tank (L2 & C6) to Crystal Filter A303. The collector tank also provides impedance matching to the crystal filter.

CRYSTAL FILTERS A303 & A305

Filter A303 follows the Multiplier-Mixer stage, and its output is applied to the 1st IF amplifier module. Filter A305 follows the IF Amplifier Module. The two Crystal Filters provide the major selectivity for the receiver. A303 provides a minimum of 40 dB stop-band attenuation, while A305 provides a minimum of 20 dB stop-band attenuation.

IF AMPS A304 & A306

An IF Amplifier module follows each of the crystal filters, and contain the resistor-matching networks for the filters. A typical IF amplifier circuit is shown in Figure 4.

Each of the IF Amplifier modules consists of three R-C coupled amplifier stages that are DC series-connected for reduced drain. The two IF modules provide a total gain of approximately 85 dB.

LIMITER A307 & DISCRIMINATOR A308

Limiter A307 consists of three R-C coupled limiter stages that are DC series connected for reduced drain. The Limiter

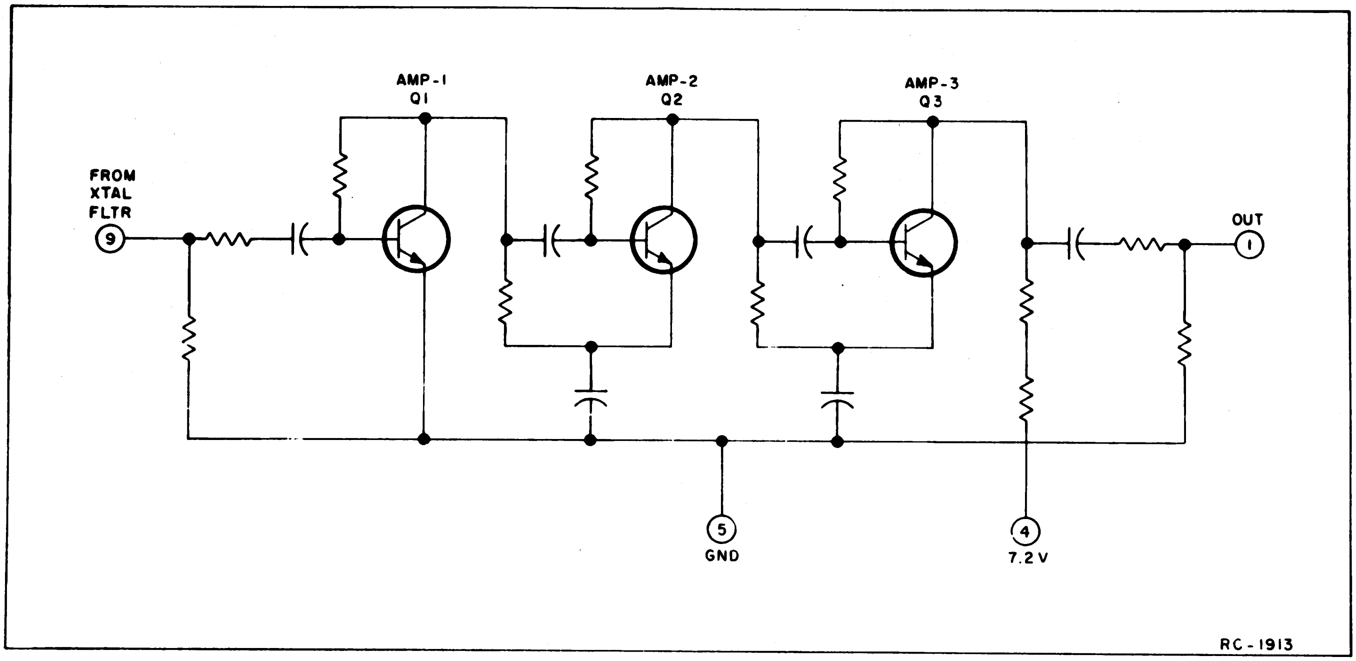


Figure 4 - Typical IF Amplifier Circuit

module also provides some gain. The output of the Limiter is applied to the discriminator. A typical Limiter circuit is shown in Figure 5.

The receiver uses a 20 MHz, fixed-tuned crystal discriminator (A308) to recover the audio from the IF signal. The Discriminator output is applied to the Audio Amplifier module.

AUDIO AMPLIFIER A309/A310

Audio and noise from the discriminator is applied to Audio Amplifier module A309 (A310 in Channel Guard applications). A typical audio amplifier circuit is shown in Figure 6.

Audio and noise is applied to the base of Q1. This stage operates as an emitter-follower for matching the impedance of the discriminator to the amplifier stage (Q2) and the VOLUME control. 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 the Squelch module.

Following amplifier Q2 is an active low-pass filter (Q3). Audio from the filter is connected from Pin 9 to the Audio PA module. In Audio Amplifier module A310, an active high-pass filter is added in series with the low-pass filter to provide the required tone frequency roll-off.

AUDIO PA A311

When the receiver is quieted by a signal, audio from the active filter is connected to Pin 1 of Audio PA module A311, and then to the base of amplifer Q1. Q1 feeds the audio signal to the base of Q2, which drives PA transistors Q4 and Q5. A typical audio PA circuit is shown in Figure 7.

PA transistors Q4 and Q5 operate as complementary emitter-followers, providing a 500 milliwatt output into an 8 ohm load. Audio from Pin 9 is coupled through capacitor C302 on the receiver board to the loudspeaker.

SQUELCH A312

Noise from Audio Amplifier A309/A310 operates the squelch circuit. A typical squelch 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 R708. R708 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 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 Q1 in the Audio PA module, turning off Q3 also turns off Q1, 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 Q1

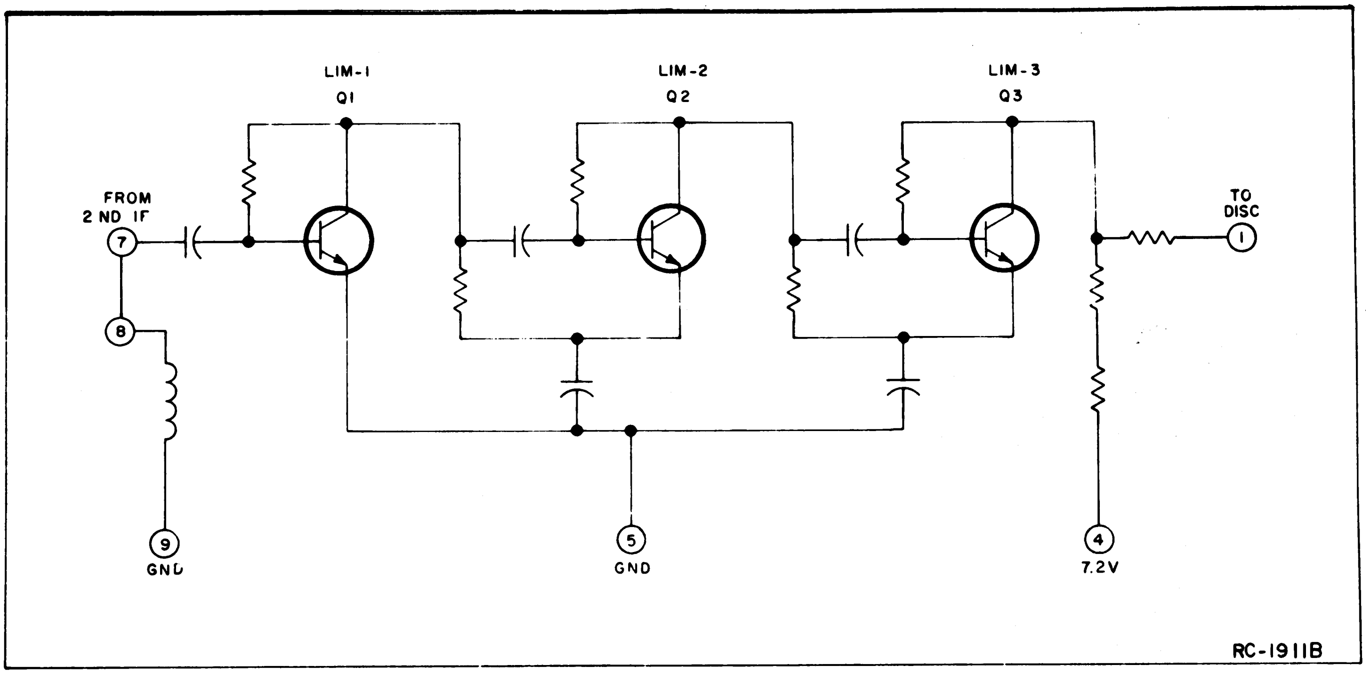


Figure 5 - Typical Limiter Circuit

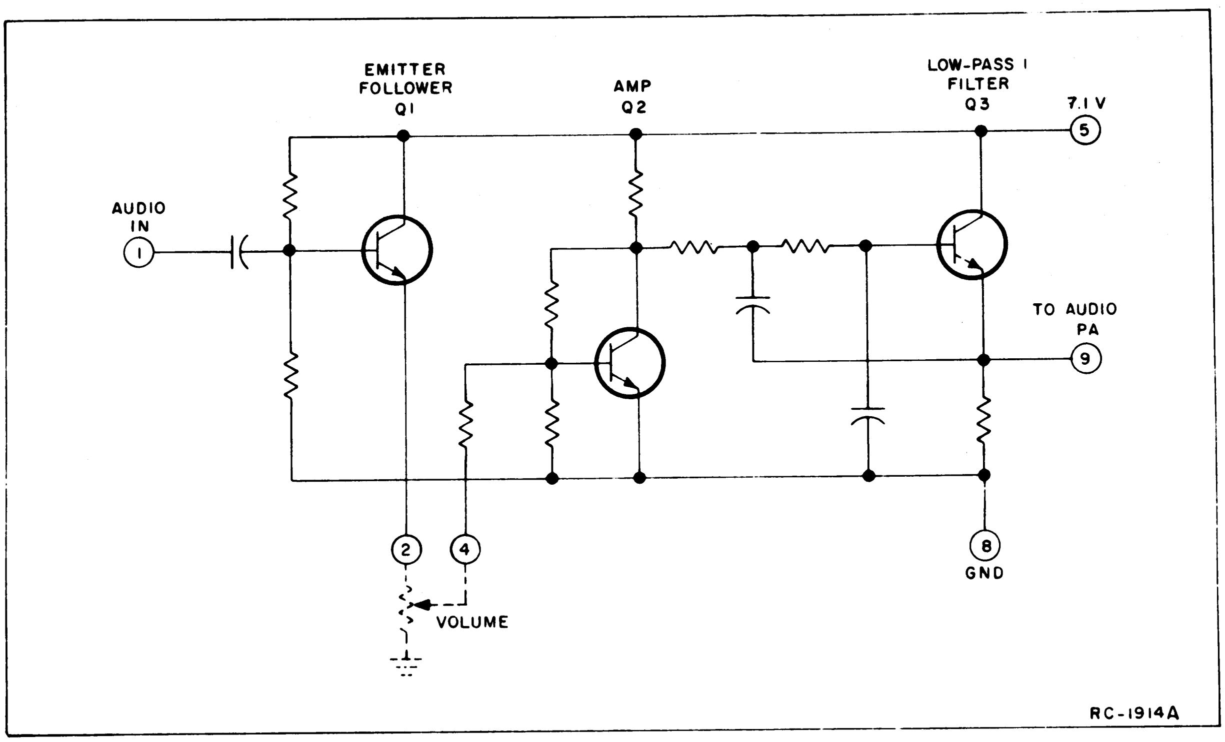


Figure 6 - Typical Audio Amplifier Circuit

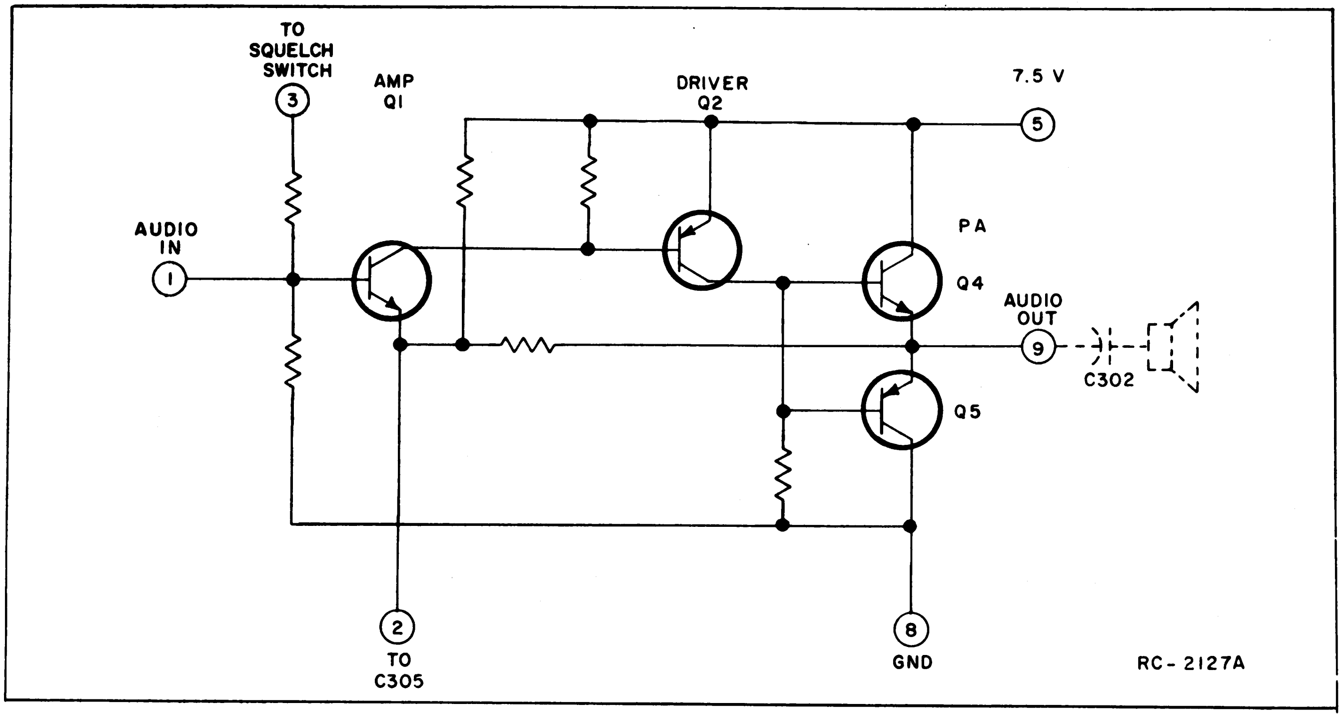


Figure 7 - Typical Audio PA Circuit

in the Audio PA module, 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.

An RF adaptor cable is available for connecting the receiver to a signal generator. Connecting the RF adaptor cable to J702 opens a set of contacts on the antenna strip line assembly. This disconnects the antenna and connects the receiver input to J702-1. Connection to chassis ground is made at J702-4.

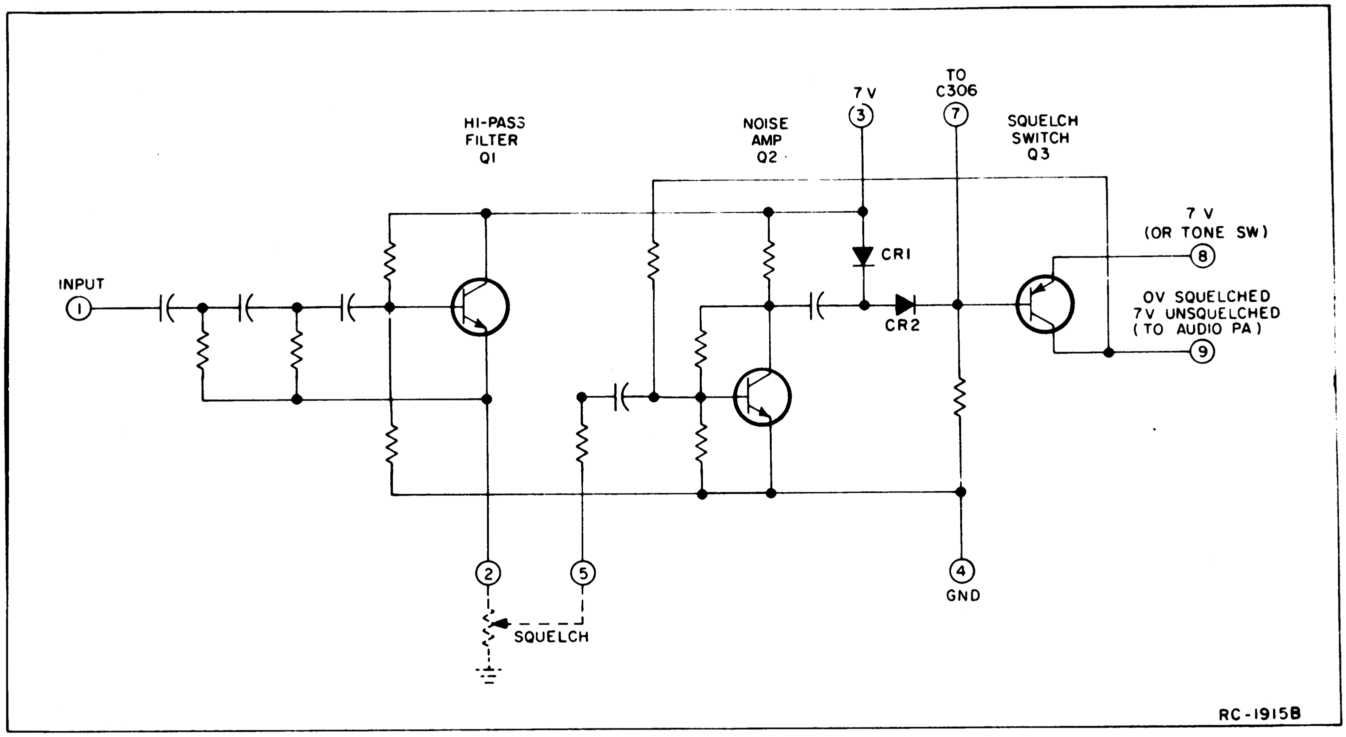


Figure 8 - Typical Squelch Circuit

MOBILE DETECTOR APPLICATIONS

PE receiver types ER60B are used as Mobile Detector boards used in Vehicular Repeater applications. Detector boards 19D417493G4 & G5 are similar to PE receiver boards except that PA module A311, C302, C305, C345 and R301 are not used. Also, R306 (3R151P103J) is added.

The Mobile Detector monitors the mobile radio transmit frequencies to determine if a second vehicular repeater is repeating portable-to-base station transmissions. If a portable-to-base transmission is in progress, the mobile detector prevents the Vehicular Repeater from becoming the priority unit.

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

GENERAL ELECTRIC*
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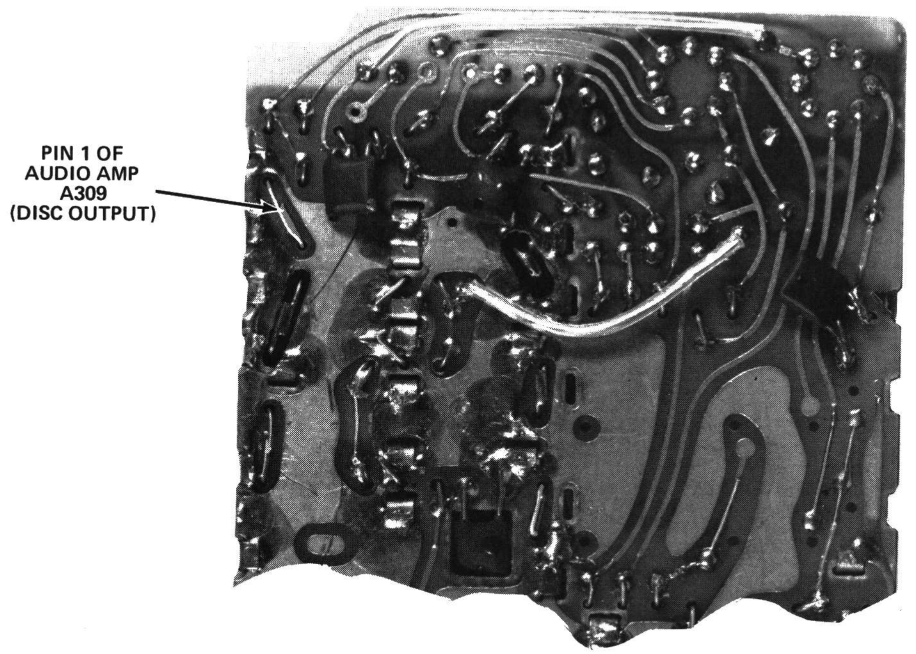
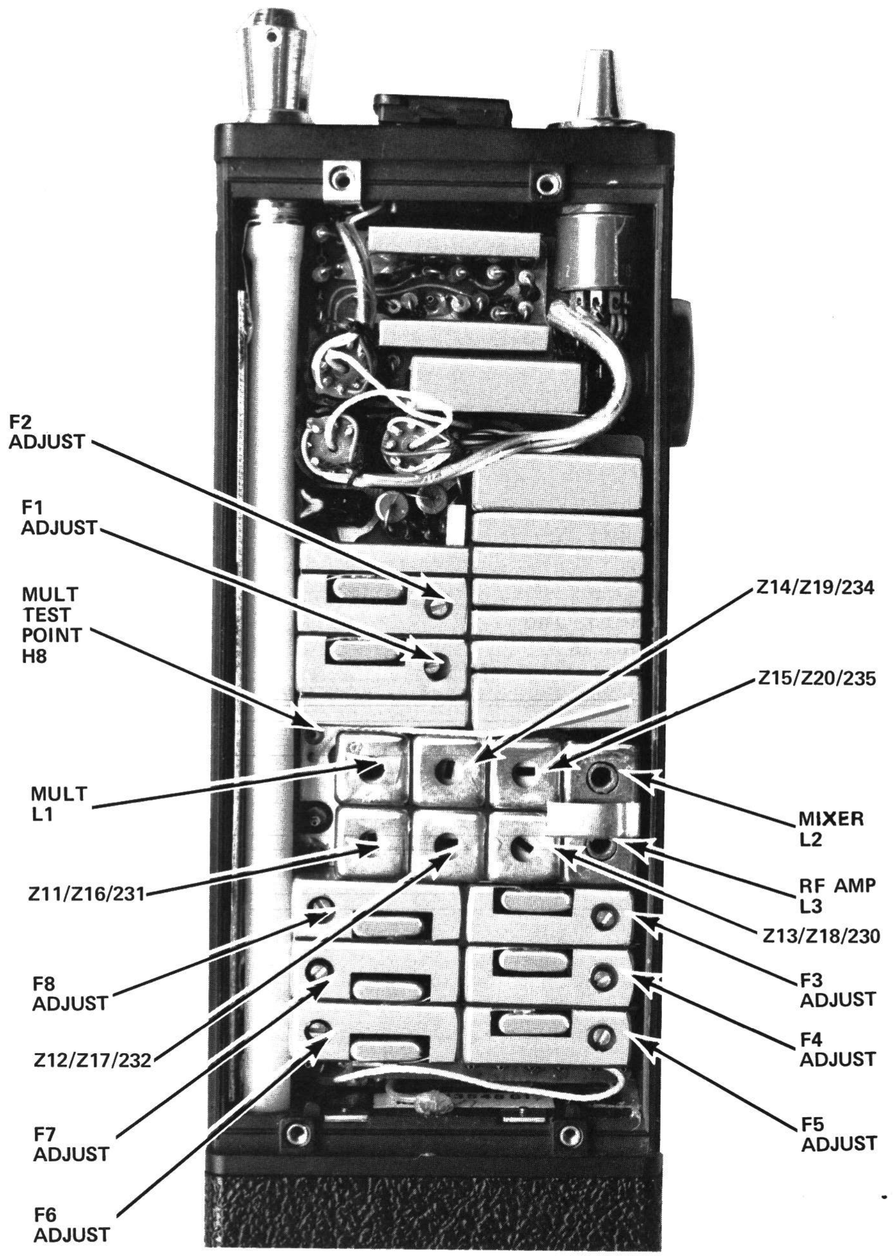
SOLDER SIDE



COMPONENT SIDE



RECEIVER ALIGNMENT

EQUIPMENT

1. A 20 MHz signal source (GE IF Generator Model 4EX9A10 or equivalent) and a 406-470 MHz source connected to Antenna Switch J702 by Receiver Test Cable 19C317633G1.
2. GE Test Set Model 4EX3A10 or 4EX8K11 or voltmeter with equivalent sensitivity.
3. GE Test Amplifier Model 4EX16A10 and RF probe 19C311370G1, or equivalent RF voltmeter.
4. Distortion Analyzer or AC-VTVM.

PRELIMINARY CHECKS AND ADJUSTMENTS

1. In multi-frequency receivers where the maximum frequency spacing is less than one MHz, align the receiver of the F1 channel. Where the frequency spacing is more than one MHz, align the receiver on the center frequency.
2. Set the slugs in Z11/Z16/Z31/Z15/Z20/Z35 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.
4. Connect the negative lead of the DC Test Set to the Mult Test Point (H8), and the positive lead to ground. Connect the Distortion Analyzer or AC-VTVM across the speaker leads.

ALIGNMENT PROCEDURE

STEP NO.	TUNING CONTROL	PROCEDURE
1	MULT L1	Adjust L1 for maximum meter reading.
2	Z14/Z19/Z34 and Z15/Z20/Z35	Adjust Z14/Z19/Z34 and then Z15/Z20/Z35 for slight change in meter reading.
3	Z11/Z16/Z31 thru Z13/Z18/Z33 and RF AMP L3	Apply an on-frequency signal to J702 and adjust Z11/Z16/Z31, Z12/Z17/Z32, Z13/Z18/Z33, and L3 for best quieting sensitivity.
4	Mixer L2	Apply an on-frequency signal as above. With the RF probe on Pin 9 of IF Amp A304, tune L2 for maximum meter reading.
5	MULT L1 Z14/Z19/Z34 and Z15/Z20/Z35	De-tune L1. Next, increase the on-frequency input signal and tune Z14/Z19/Z34 and Z15/Z20/Z35 for best quieting sensitivity. No re-adjust L1 for maximum meter reading.
		FREQUENCY ADJUSTMENT
6		While applying an on-frequency signal to J702, loosely couple a 20 MHz signal to the Mixer. Adjust the Oscillator trimmer(s) for a zero beat frequency between the two signals. <u>Alternate Method</u>: Apply a strong 20 MHz signal to the Mixer. Measure the output of the Discriminator with a DC-VTVM at Pin 1 of A309/A310. Note the reading. Next, remove the 20 MHz signal and apply a strong on-frequency signal to J702. Then tune the oscillator trimmer(s) for the meter reading obtained at Pin 1 of A309/A310.

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.

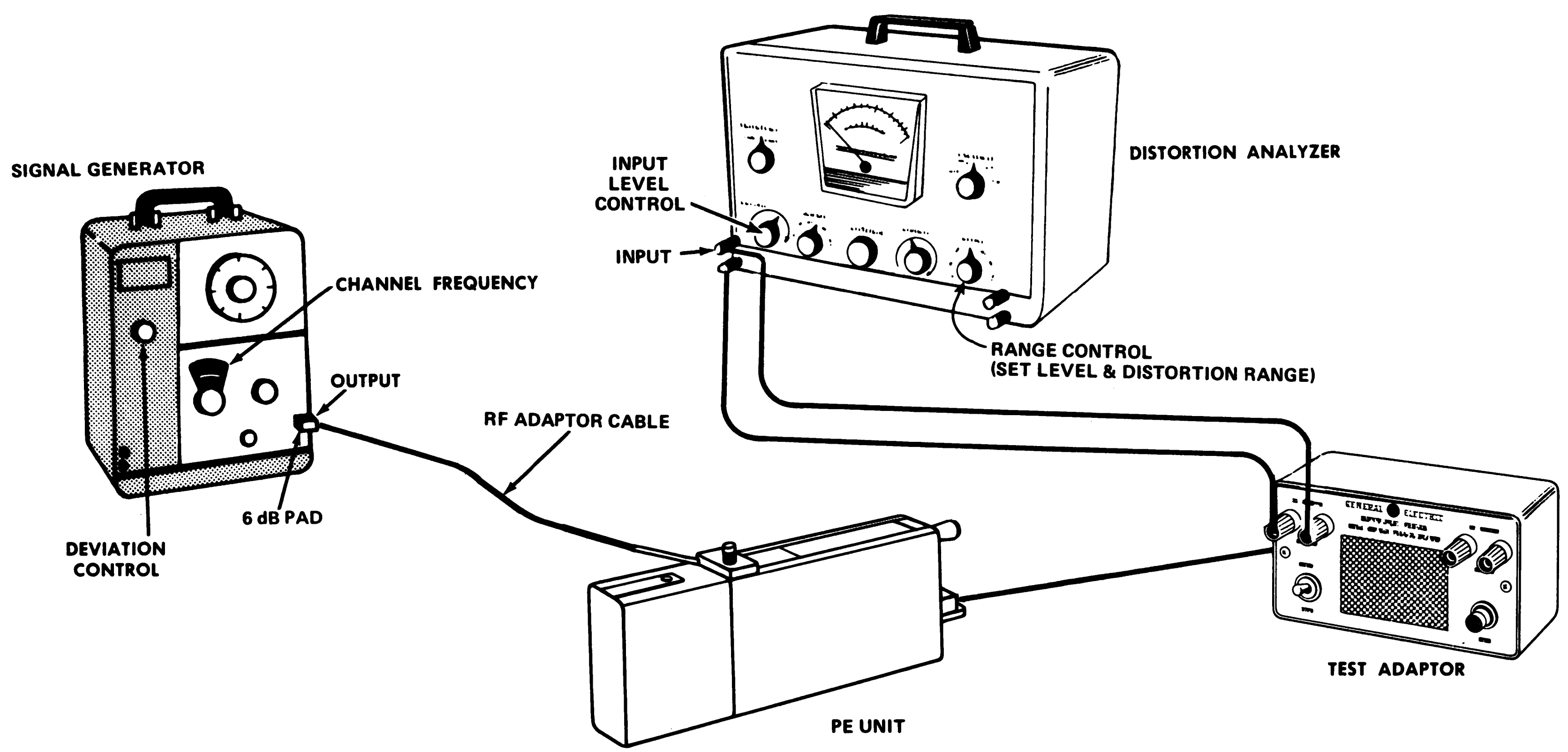
Once the defective stage is pin-pointed, refer to the "Service Check" listed to correct the problem. Additional corrective measures are included in the Troubleshooting Procedure. Before starting with the Receiver Test Procedures, be sure the receiver is tuned and aligned to the proper operating frequency.

TEST EQUIPMENT REQUIRED

- Distortion Analyzer similar to: Heath IM-12
- Signal Generator similar to: Measurements M-803
- 6-dB attenuation pad
- Test Adaptor Model 4EX12A10
- RF Adaptor Cable 19C317633G1

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. Connect a 1,000-microvolt test signal modulated by 1,000 hertz ±3.0 kHz deviation to the Antenna Switch J702.

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 J702.

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).

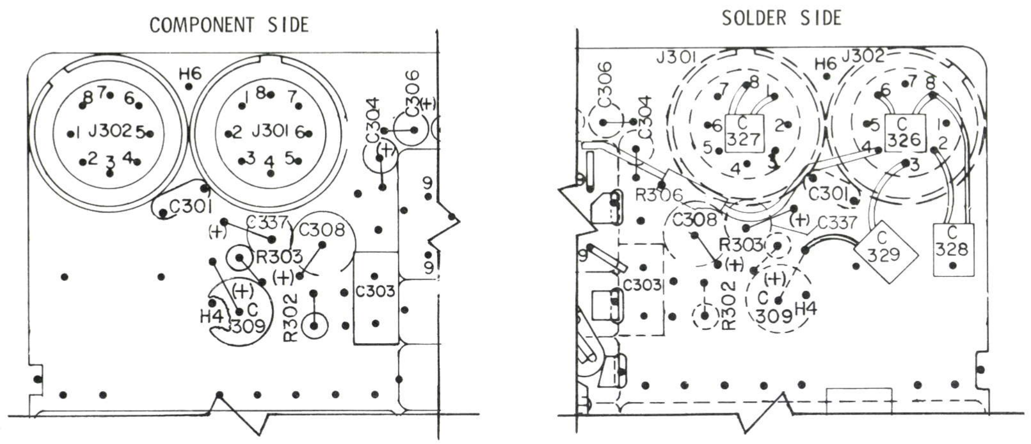
D. The deviation control reading for the 12-dB difference is the Modulation Acceptance Bandwidth of the receiver. It should be more than ±7 kHz (but less than ±9 kHz).

SERVICE CHECK

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

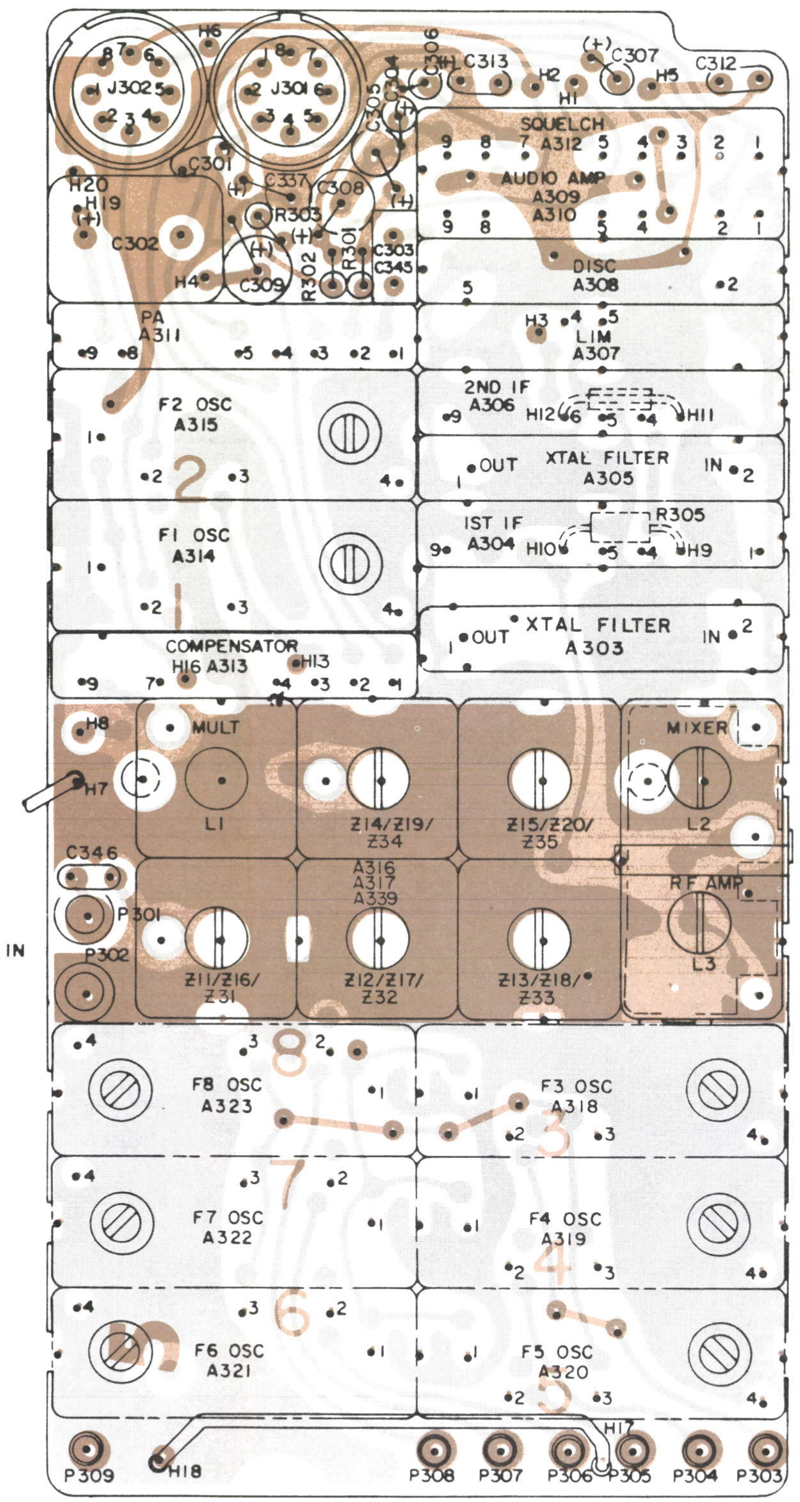
	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8
J301	5.4V	AUDIO OUT	SWITCHED 7.5V	SQ ARM	VOL ARM	SQ HI	VOL HI	GND
J302		FREQ 1	FREQ 2			7.5V	TONE SWITCH	GND

MOBILE DETECTOR APPLICATIONS



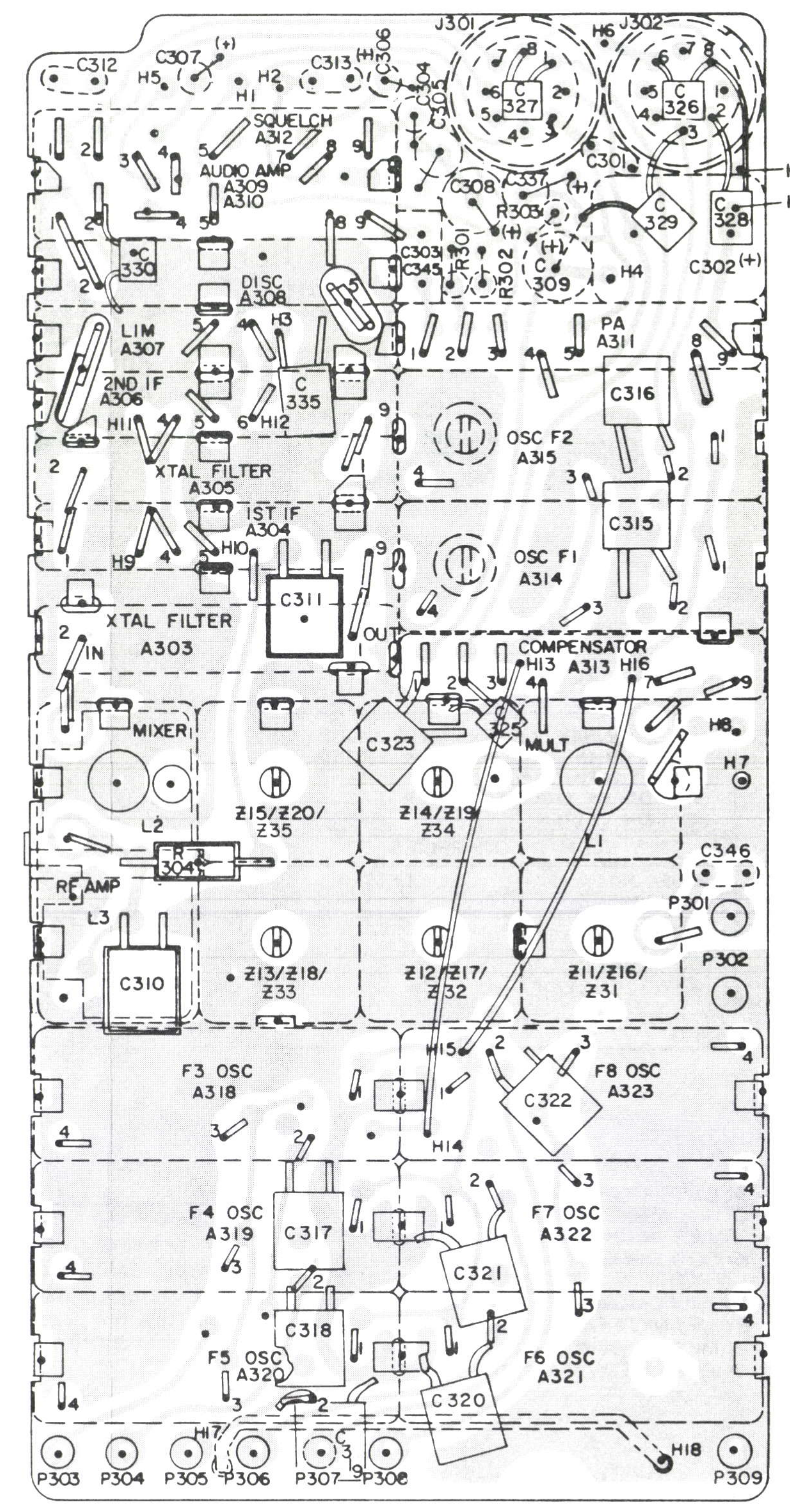
(19D430368, Rev. 0)

COMPONENT SIDE



(19D417292, Rev. 11)
(19D424861, Sh. 2, Rev. 6)
(19D424861, Sh. 3, Rev. 5)

SOLDER SIDE



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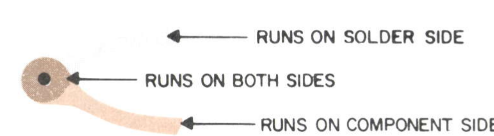
(19D424861, Sh. 2, Rev. 6)

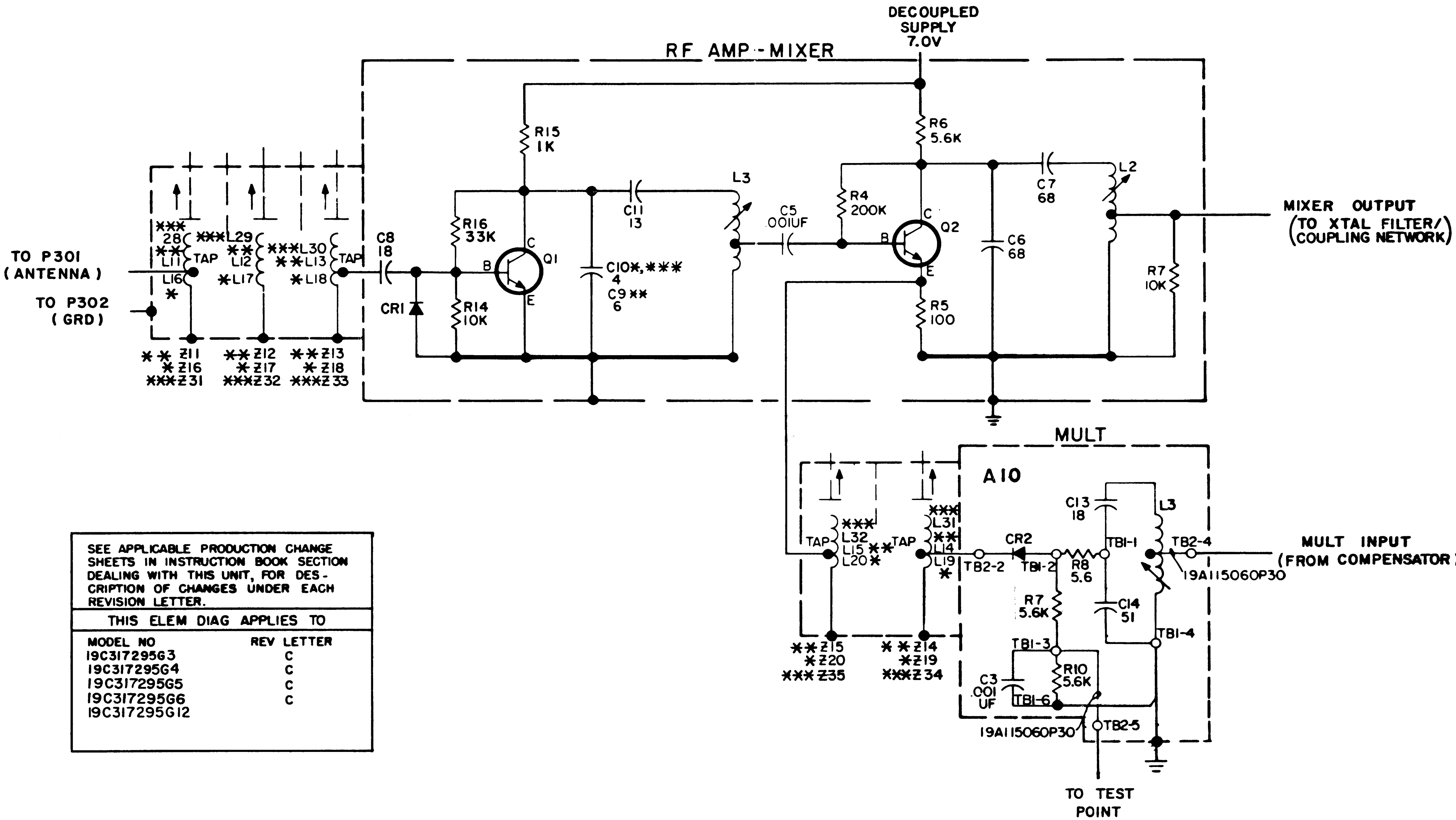


OUTLINE DIAGRAM

406—470 MHz RECEIVER

Types ER60-B & ER131B

Issue 6



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
19C317295G12	

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.

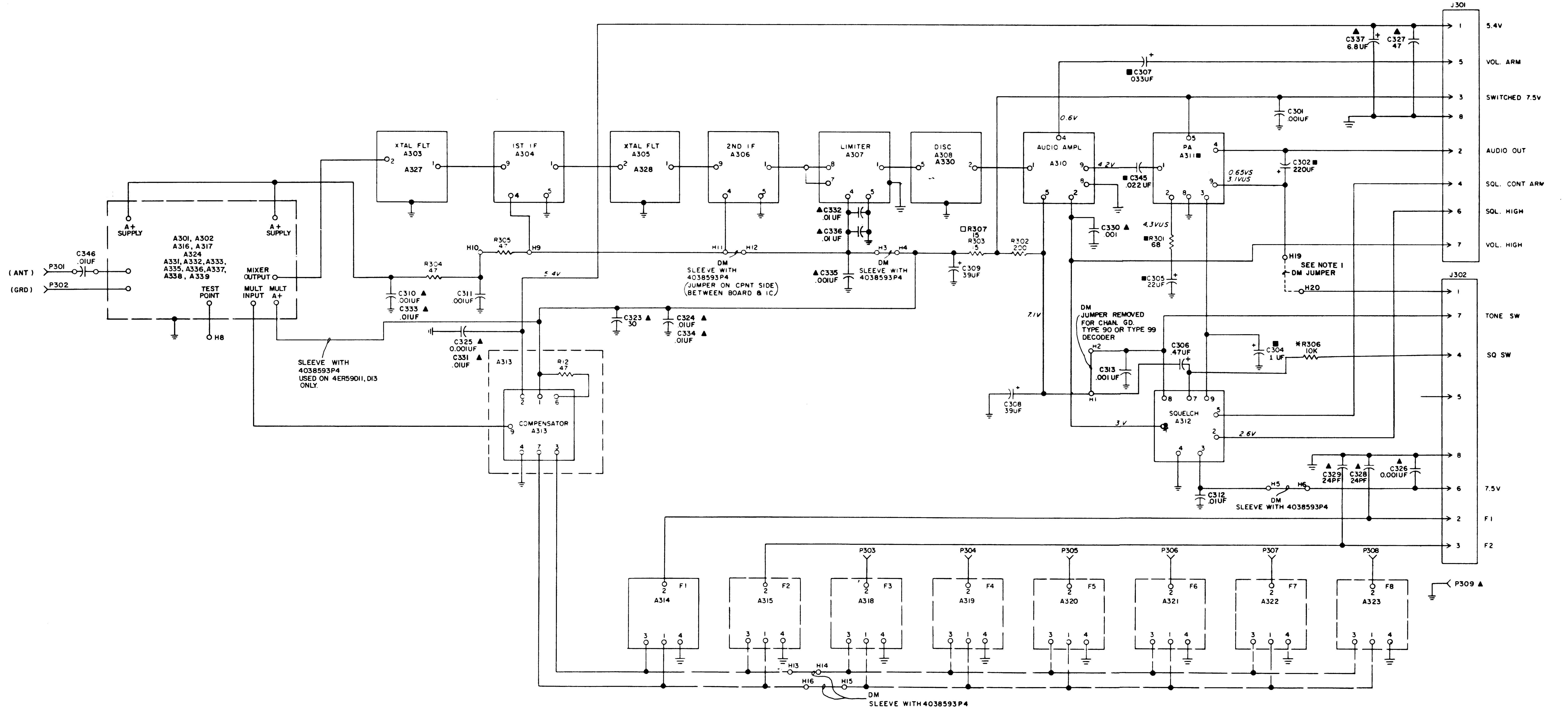
IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

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

(19C320887, Rev. 9)

SCHEMATIC DIAGRAM

406—470 MHZ RECEIVER
FRONT END (A316/A317/A339)



NOTE 1: DM JUMPER ON SOLDER SIDE H19 TO H20. PRESENT IN PM II APPLICATIONS ONLY.

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

THIS ELEM DIAG APPLIES TO

MODEL NO	REV LETTER
PL19D417493G1	P
PL19D417493G2	K
PL19D417493G3	M
PL19A130043G1	A
PL19A130043G2	A
PL19A130043G3	A
PL19A130043G4	A
PL19A130043G5	B
PL19A130043G6	A
PL19D417493G4	F
PL19D417493G5	F

* PRESENT ONLY IN GROUPS 4 & 5

■ NOT PRESENT IN GROUPS 4 & 5

▲ PART OF MODIFICATION KIT PL19A130043 SEE CHART BELOW FOR SELECTION OF PROPER PARTS FOR APPLICABLE MODEL NO.

□ USED ONLY WITH PL19D417493G1

MODEL NO.	C310	C315	C316	C317	C318	C319	C320	C321	C322	C323	C324	[illegible]	C326	C327	C328	C329	C330	C331	C332	C333	C334	C335	C336	C337	C339	P309
4ER59B10-13 (KIT PL19A130043G1)	X																X									
4ER60B10-13 (KIT PL19A130043G2)	X									X		X	X	X	X	X	X					X				X
4ER61B11-13, 15-17 (KIT PL19A130043G3)																	X	X	X	X	X					
4ER62B10, 11 (KIT PL19A130043G4)	X									X	X						X	X								X
4ER59D11, 13 (KIT PL19A130043G5)	X											X					X		X		X		X	X		
4ER87B10-13 (KIT PL19A130043G6)																	X	X	X	X	X					

VOLTAGE READINGS

ALL READINGS TAKEN WITH A DC-VTVM AND MEASURED TO GROUND. READINGS FOLLOWED BY "S" ARE WITH THE RECEIVER SQUELCHED. READINGS FOLLOWED BY "US" ARE WITH THE RECEIVER UNSQUELCHED.

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.

(19R622036, Rev. 27)

SCHEMATIC DIAGRAM

406—470 MHz RECEIVER

Types ER60B & ER131B

PARTS LIST

LBI4447G

406-470 MHz RECEIVER
ER-60-B
ER-131-A

SYMBOL	GE PART NO.	DESCRIPTION
A316, A317, A339		FRONT END A316 19C317295G5 406-420 MHz A317 19C317295G5 450-470 MHz A339 19C317295G12 420-450 MHz
A5* and A6*		RF AMPLIFIER A5 19C327300G3 406-450 MHz A6 19C327300G4 450-470 MHz (Added by REV C)
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C5	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW.
C6 and C7	19A700223P59	Ceramic: 6.8 pF ±5%, 100 VDCW, temp coef -220 PPM.
C8	19A700225P38	Ceramic: 18 pF ±5%, 100 VDCW, temp coef -470 PPM.
C9	19A116114P2020	Ceramic: 6 pF ±5%, 100 VDCW; temp coef -80 PPM.
C10	19A116114P2014	Ceramic: 4 pF ±5%, 100 VDCW; temp coef -80 PPM.
C11	19A700221P32	Ceramic: 13 pF ±5%, 100 VDCW, temp coef -80 PPM.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1*	19A116052P1	Silicon, hot carrier: Fwd drop .350 volts max. Added by REV B.
		- - - - - - - - - - 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.
A5* and A6*		RF AMPLIFIER A5 19C317445G3 406-450 MHz A6 19C317445G4 450-470 MHz (Deleted by REV C)
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C5	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW.
C6 and C7	19A700223P59	Ceramic: 6.8 pF ±5%, 100 VDCW, temp coef -220 PPM.
C8	19A700225P38	Ceramic: 18 pF ±5%, 100 VDCW, temp coef -470 PPM.
C9	19A116114P2020	Ceramic: 6 pF ±5%, 100 VDCW; temp coef -80 PPM.
C10	19A116114P2014	Ceramic: 4 pF ±5%, 100 VDCW; temp coef -80 PPM.
C11	19A700221P32	Ceramic: 13 pF ±5%, 100 VDCW, temp coef -80 PPM.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1*	19A116052P1	Silicon, hot carrier: Fwd drop .350 volts max. Added by REV B.
		- - - - - - - - - - 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: 0.001 uF +100% -20%, 75 VDCW.
C13	19A700221P38	Ceramic: 18 pF ±5%, 100 VDCW, temp coef -80 PPM.
C14	19A700221P54	Ceramic: 51 pF ±5%, 100 VDCW, temp coef -80 PPM.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR2	19A116809P1	Silicon; sim to HP Step Recovery 5082-0180.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L3	19B216296P3	Coil.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R6*	3R151P562J	Composition: 5.6K ohms ±5%, 1/8 w. Deleted by REV A.
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. Added by REV A.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
	19B200497P5	Tuning slug. (Used with L3).
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L11	19B216439G8	Helical resonator. (Part of Z11). Includes:
	19C3311750P1	Tuning slug.
L12	19B216439G6	Helical resonator. (Part of Z12). Includes:
	19C331750P1	Tuning slug.
L13	19B216439G19	Helical resonator. (Part of Z13). Includes:
	19C311750P1	Tuning slug.
L14	19B216439G22	Helical resonator. (Part of Z14). Includes:
	19C311750P1	Tuning slug.
L15	19B216439G21	Helical resonator. (Part of Z15). Includes:
	19C311750P1	Tuning slug.
L16	19B216439G7	Helical resonator. (Part of Z16). Includes:
	19C311750P1	Tuning slug.
L17	19B216439G2	Helical resonator. (Part of Z17). Includes:
	19C311750P1	Tuning slug.
L18	19B216439G1	Helical resonator. (Part of Z18). Includes:
	19C311750P1	Tuning slug.
L19	19B216439G4	Helical resonator. (Part of Z19). Includes:
	19C311750P1	Tuning slug.
L20	19B216439G3	Helical resonator. (Part of Z20). Includes:
	19C311750P1	Tuning slug.
L28	19B216439G2	Helical resonator. (420-450 MHz).
L29	19B233677G3	Helical resonator. (420-450 MHz).
L30	19B233677G1	Helical resonator. (420-450 MHz).
L31	19B216439G15	Helical resonator. (Part of Z31).
L32	19B216439G14	Helical resonator. (Part of Z32).
		- - - - - - - - HELICAL RESONATORS - - - - - - -
Z11		Consists of L11 & 19D413132G24 can.
Z12		Consists of L12 & 19D413132G3 can.
Z13		Consists of L13 & 19D413132G25 can.
Z14		Consists of L14 & 19D413132G19 can.
Z15		Consists of L15 & 19D413132G20 can.
Z16		Consists of L16 & 19D413132G24 can.
Z17		Consists of L17 & 19D413132G3 can.
Z18		Consists of L18 & 19D413132G25 can.
Z19		Consists of L19 & 19D413132G19 can.
Z20		Consists of L20 & 12D413132G20 can.
Z31		Consists of L28 & 19D413132G24 can
Z32		Consists of L29 & 19D413132G3 can.
Z33		Consists of L30 & 19D413132G25 can.
Z34		Consists of L31 & 19D413132G19 can.
Z35		Consists of L32 & 19D413132G20 can.
		RECEIVER BOARD 19D417493G1 406-420, 450-470 MHz 19D417493G3 420-450 MHz 19D417493G4 406-420,450-470 MHz VEHICLE REPEATER 19D417493G5 420-450 MHz VEHICLE REPEATER
A303*	19C304824G1	Crystal filter.
		In REV B & earlier:
	19C304516G3	Crystal filter.
A304	19C311879G3	1st IF Amplifier.
A305	19C304824G1	Crystal filter.
A306	19C311879G4	2nd IF Amplifier.
A307	19C311876G4	Limiter.
A308	19C304504G3	Discriminator.
A309*	19C311878G2	Audio Amplifier. Deleted by REV G.
A310*	19C330341G1	Audio Amplifier. (Includes Tone Filter).
		In G1 of REV G-K, In G4 & G5 of REV B & earlier:
	19C311995G4	Audio Amplifier.
		In REV F & earlier:
	19C311995G2	Audio Amplifier. (Includes Tone Filter).
A311*	19C330710G1	PA.
		In REV F-K:
	19C331877G4	PA.
		In REV E & earlier:
	19C311877G2	PA.
A312*	19C330342G1	Squelch.
		In G1 of REV K & earlier: In G4 & G5 of REV B & earlier:
	19C311880G4	Squelch.
A313	19C320061G1	Compensator.
A327 and A328	19C304824G3	Band Pass Filter.
A330	19C304504G6	Discriminator.
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C301	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW.
C302	19A116178P7	Tantalum: 220 uF ±20%, 6 VDCW.
C303*	19A116089P1	Ceramic: 0.1 uF ±20%, 50 VDCW, temp range -55 to +85°C. Deleted by REV G.
C304	5491674P28	Tantalum: 1 uF ±20%, 25 VDCW; sim to Sprague Type 162D.
C305	5491674P35	Tantalum: 22 uF ±20%, 4 VDCW; sim to Sprague Type 162D.
C306	5491674P27	Tantalum: 0.47 uF ±20%, 35 VDCW; sim to Sprague Type 162D.
C307	5491674P31	Tantalum: 0.033 uF ±20%, 35 VDCW; sim to Sprague Type 162D.
C308 and C309	5491674P30	Tantalum: 39 uF ±20%, 10 VDCW; sim to Sprague Type 162D.
C311	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW.
C312*	19A116192P1	Ceramic: 0.01 uF ±20%, 50 VDCW; sim to Erie 8121 SPECIAL.
		In REV A & earlier:
	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW.
C313	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW.
C314*	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW. Deleted by REV B.
C345*	19A116192P6	Ceramic: 0.022 uF ±20%, 50 VDCW; sim to Erie 8131-M050-W5R-223M. Added by REV G.
C346*	19A116192P1	Ceramic: 0.01 uF ±20%, 50 VDCW; sim to Erie 8121 SPECIAL. Added to G1 by REV J, G4 & G5 by REV B.
		- - - - - - - JACKS AND RECEPTACLES - - - - - - -
J301 and J302	19C331182P1	Terminal, feed-thru: sim to Warren 1-B-2994-4.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P301 thru P308	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R301*	3R151P680J	Composition: 68 ohms ±5%, 1/8 w.
		In REV A-C:
	3R151P101J	Composition: 100 ohms ±5%, 1/8 w.
		Earlier than REV A:
	3R151P470J	Composition: 47 ohms ±5%, 1/8 w.
R302	3R151P201J	Composition: 200 ohms ±5%, 1/8 w.
R303*	3R151P150J	Composition: 15 ohms ±5%, 1/8 w. Deleted in G1 by REV K.
R304	19A134231P470J	Deposited carbon: 47 ohms ±5%, 1/8 w.
R305	3R151P470J	Composition: 47 ohms ±5%, 1/8 w.
R306	3R151P103J	Composition: 10K ohms ±5%, 1/8 w.
R307*	19A134564P1	Metal film: 15 ohms ±5%, 1/4 w. Added to G1 by REV K.
		ASSOCIATED ASSEMBLIES
		- - - - - - - - - - OSCILLATORS - - - - - - - - - -
A314, A315, A318 thru A323		NOTE: When reordering, give GE Part Number and specify exact frequency needed.
	4EG28A12	Oscillator Module. 406-420 MHz. $Fx = \frac{Fo + 20}{21}$
	4EG28A13	Oscillator Module. 450-470 MHz. $Fx = \frac{Fo - 20}{21}$
	4EG28A38	Oscillator Module. 420-450 MHz. $Fx = \frac{Fo + 20}{21}$
		RECEIVER KIT 19A130043G2 19A130043G3
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C310	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW.
C323	19A700221P45	Ceramic: 30 pF ±5%, 100 VDCW, temp coef -80 PPM.
C325 and C326	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW.
C327	19A700227P53	Ceramic: 47 pF ±5%, 100 VDCW, temp coef -1500 PPM.
C328 and C329	19A700221P42	Ceramic: 24 pF ±5%, 100 VDCW, temp coef -80 PPM.
C330*	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW. Added by REV A.
C331 thru C334	19A116192P1	Ceramic: 0.01 uF ±20%, 50 VDCW; sim to Erie 8121 SPECIAL.
C335	5495323P12	Ceramic: 0.001 uF +100% -20%, 75 VDCW.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P309	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.

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 - Receiver Front End 19C317295G5 & G6
To reduce receiver spurious response.
Deleted R2 and added R9.

REV. A - Receiver Board 19D417493G1
To increase audio sensitivity.
Changed R301.

REV. B - To improve squelch operation.
Changed C312.

REV. B - Receiver Front End 19C317295G5 & G6
To improve operation. Added CR1.

REV. C - To improve ease of assembly, troubleshooting and repair. Changed A5 and A6.

REV. C - Receiver Board 19D417493G1
To improve producibility. Changed A303.

REV. D - To improve audio sensitivity and stability.
Deleted C314 and changed R301.

REV. E - To improve audio frequency response.
Added C345.

REV. F - To improve audio quality.
Changed A311.

REV. G - To eliminate non Channel Guard receiver boards.
Deleted from schematic diagram callout ■ A309 and circle (●) in front of C345. Deleted callout ■C303 and circle (●) for C345. Deleted NOTES:
■Use for non channel guard receivers.
●Use for channel guard receivers.

REV. A - Receiver Kit 19A130043G2
To improve 20 MHz IF filtering.
Added C330.

REV. A - Receiver Board 19D417493G4 & G5.

VOID
REV. B - To provide DC isolation of relay contacts from antenna circuit.
Added C346.

REV. C - To implement improved hybrid packaging technique.
Changed A310, A311 and A312.

REV. J - Receiver Board 19D417493G1

To provide DC isolation of relay contacts from antenna circuit.
Added C346.

REV. K - To incorporate flame proof resistor. Deleted R303 added R307

REV. L - To implement improved hybrid packaging technique.
Changed A310, A311 and A312.

REV. M - Receiver Board - 19D417493G1
REV. K - Receiver Board - 19D417493G3
REV. D - Receiver Board - 19D417493G4,G5

To improve squelch switch. Changed C304.
C304 was:

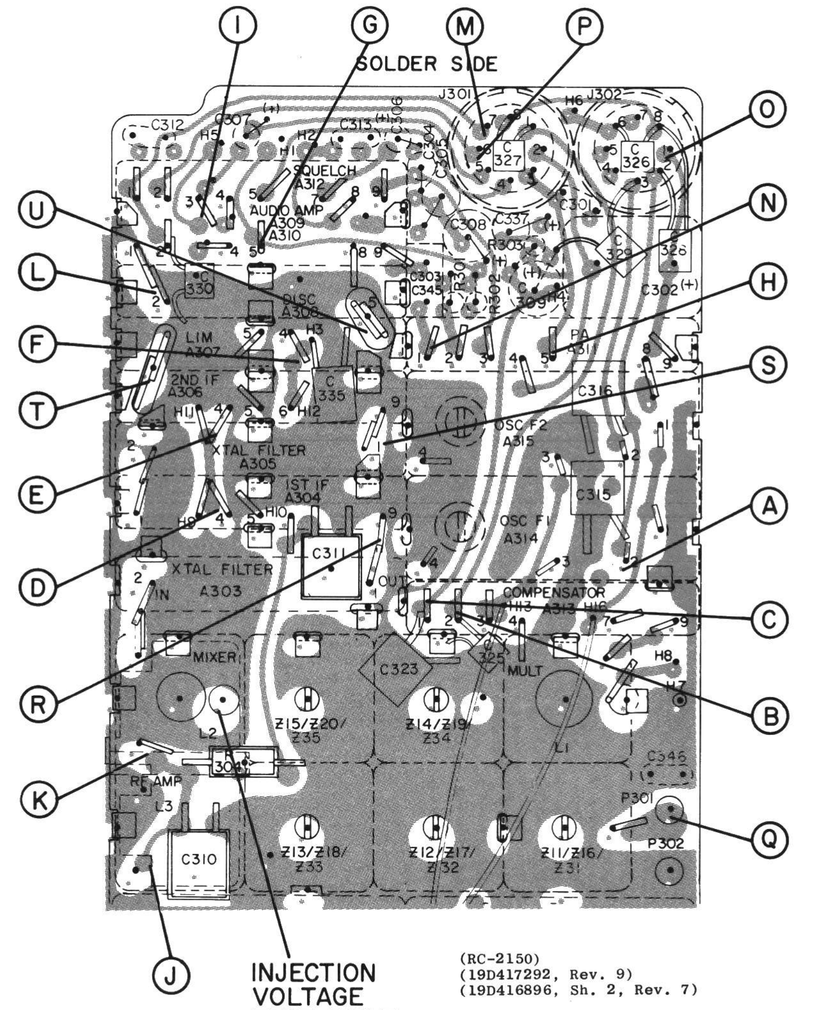
5491674P28: tanlalum 1.0μf ± 20%, 25 VDCW; sim to Sprague Type 162D.

REV. N - Receiver Board - 19D417493G1
REV. L - Receiver Board - 19D417493G3
REV. E - Receiver Board - 19D417493G4,G5

To eliminate "bubbling" at critical squelch.
Changed C304.
C304 was:
19B800650P15; tantalum, 3.3 μf ± 20% 10 VDCW.

REV. P - Receiver Board - 19D417493G1
REV. M - Receiver Board - 19D417493G3
REV. F - Receiver Board - 19D417493G4,G5

To improve test and troubleshooting. Added H17 and H18, and changed connection of A304 from H10 to H9.



(RC-2150)
(19D417292, Rev. 9)
(19D416894, Sh. 2, Rev. 7)

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).

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

STEP 3 - RF GAIN CHECKS

EQUIPMENT REQUIRED:

1. RF probe and Test Amplifier Model 4EX16A10 connected to GE Test Set Model 4EX3A10, or an RF voltmeter.
2. A signal generator (M-800 or equivalent) connected to P301 (High) and P302 (Low).

PROCEDURE FOR MIXER & 1ST IF:

1. Switch the Test Set to the Test 1 position and the Test Amplifier to the X50 position.
2. Connect the RF probe across the input of the stage to be measured as shown on the diagram. Increase the signal generator output to obtain a reference reading on Test Set 4EX3A10. Note the Test Set reading and the dB reading on the generator (dB1).
3. Connect the RF probe to the output of the stage to be measured as shown on the diagram. Decrease the generator output until the Test Set reference reading in Step 2 is obtained. Note the dB reading on the generator (dB2).
4. 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

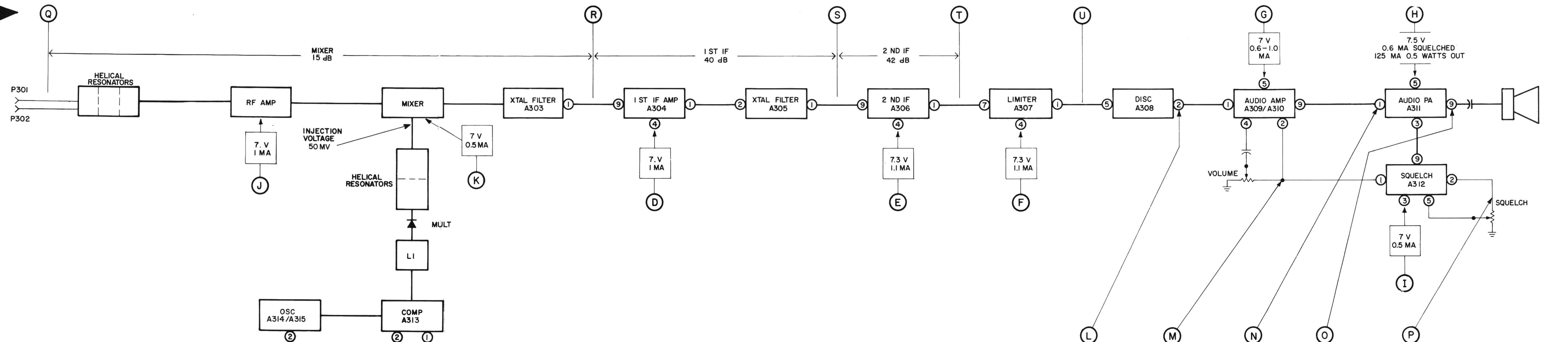
PROCEDURE FOR 2ND IF:

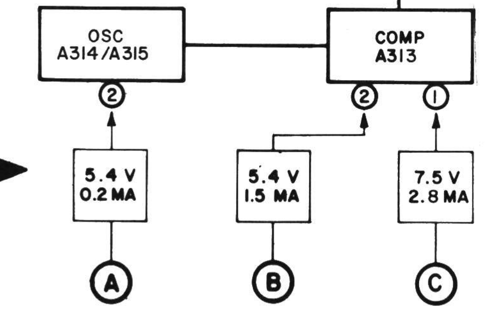
1. With no signal in, connect the RF probe to the output of the 2nd IF module. Increase the signal generator output until the Test Set reading increases by approximately 0.2 volt. Note Test Set and signal generator reading (dB2).
2. Connect the probe to the input of the 2nd IF module. Increase the signal 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 IF amplifier module.

LIMITER CHECK

The Limiter module limits on noise so tha 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 and check for a reading of approximately 0.4 volt.
2. Increase the signal generator output. There should be no appreciable increase in the limiter output meter reading.





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

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.

CAUTION

When checking the current of Audio PA module A311, do not short Pin 4 to ground or to + (Pin 5). To do so will destroy the Audio PA module.

STEP 2 - AUDIO & SQUELCH WAVEFORMS
(STEPS L THRU P)

STEP 2 - AUDIO & SQUELCH WAVEFORMS

EQUIPMENT REQUIRED:

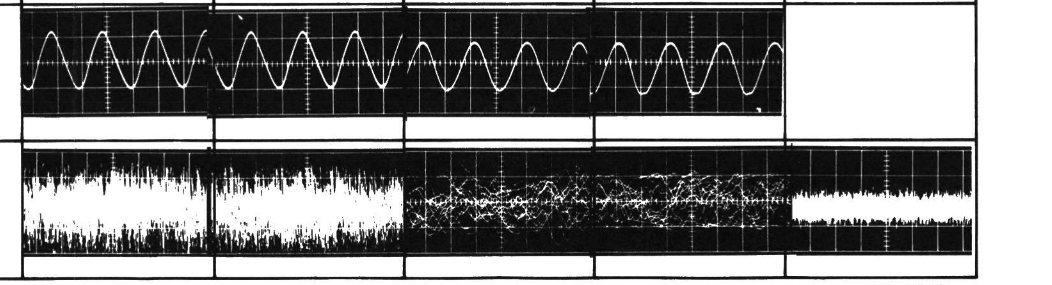
- Oscilloscope connected between the points shown and ground.
- Signal Generator (Measurements M-800 or equivalent).

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.

SCOPE SETTINGS

		L	M	N	O	P
PEAK-TO-PEAK READINGS	SIGNAL	0.35 V	0.35 V	0.25 V	5.6 V	
	NOISE	0.9 V	0.9 V	0.25 V	5.6 V	0.7 V
STANDARD SIGNAL						
NOISE WAVEFORM						



RC- 2326

TROUBLESHOOTING PROCEDURE

406—470 MHz RECEIVER

Types ER 60-B & ER131A