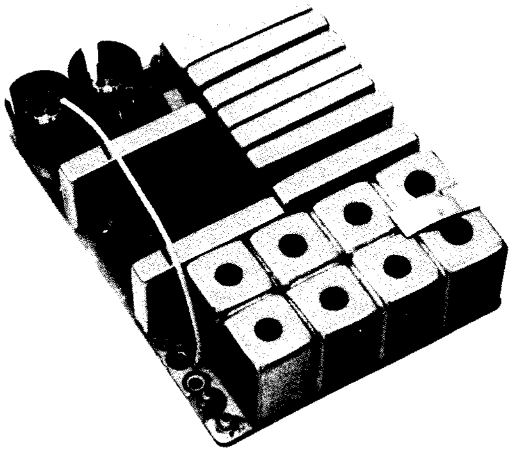
GE MOBILE RADIO

406-470 MHz RECEIVER

ER-60-A FOR PE MODELS AND Porta·Mobil II™



SPECIFICATIONS *

Type Number	ER-60-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 deemphasis curve from 300 to 3000 Hz (1000-Hz reference)	
Modulation Acceptance	±7.0 kHz	
Squelch Sensitivity		
Critical Squelch	0.20 µV	
Maximum Squelch	Greater than 20-dB Quieting	
Maximum Frequency Spacing Frequency Range	No Degradation (Sensitivity)	1 dB Degradation (Sensitivity)
406-420 MHz	1.62 MHz	3.25 MHz
450-460 MHz	1.80 MHz	3.60 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.

ER-60-A

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 4ER60A10-13 are single conversion, superheterodyne FM receivers for operation on the 406-420 and 450-470 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	Number of Freqs.	Tone Option
4ER60A10	406-420 MHz	1 or 2	
4ER60A11	450-470 MHz	1 or 2	
4ER60A12	406-420 MHz	1 or 2	Chan.Gd.
4ER60A13	450-470 MHz	1 or 2	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) 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.

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.

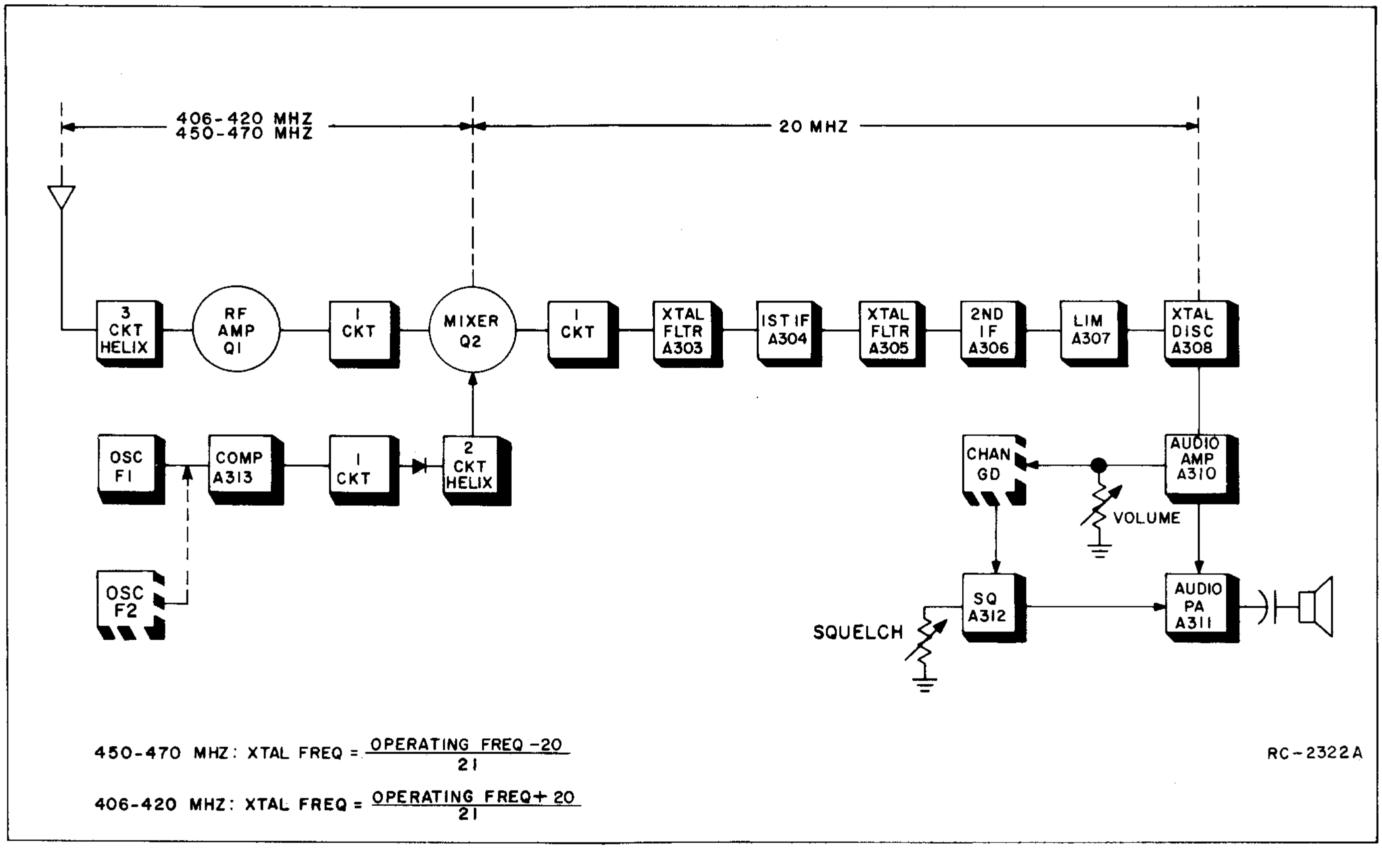


Figure 1 - Receiver Block Diagram

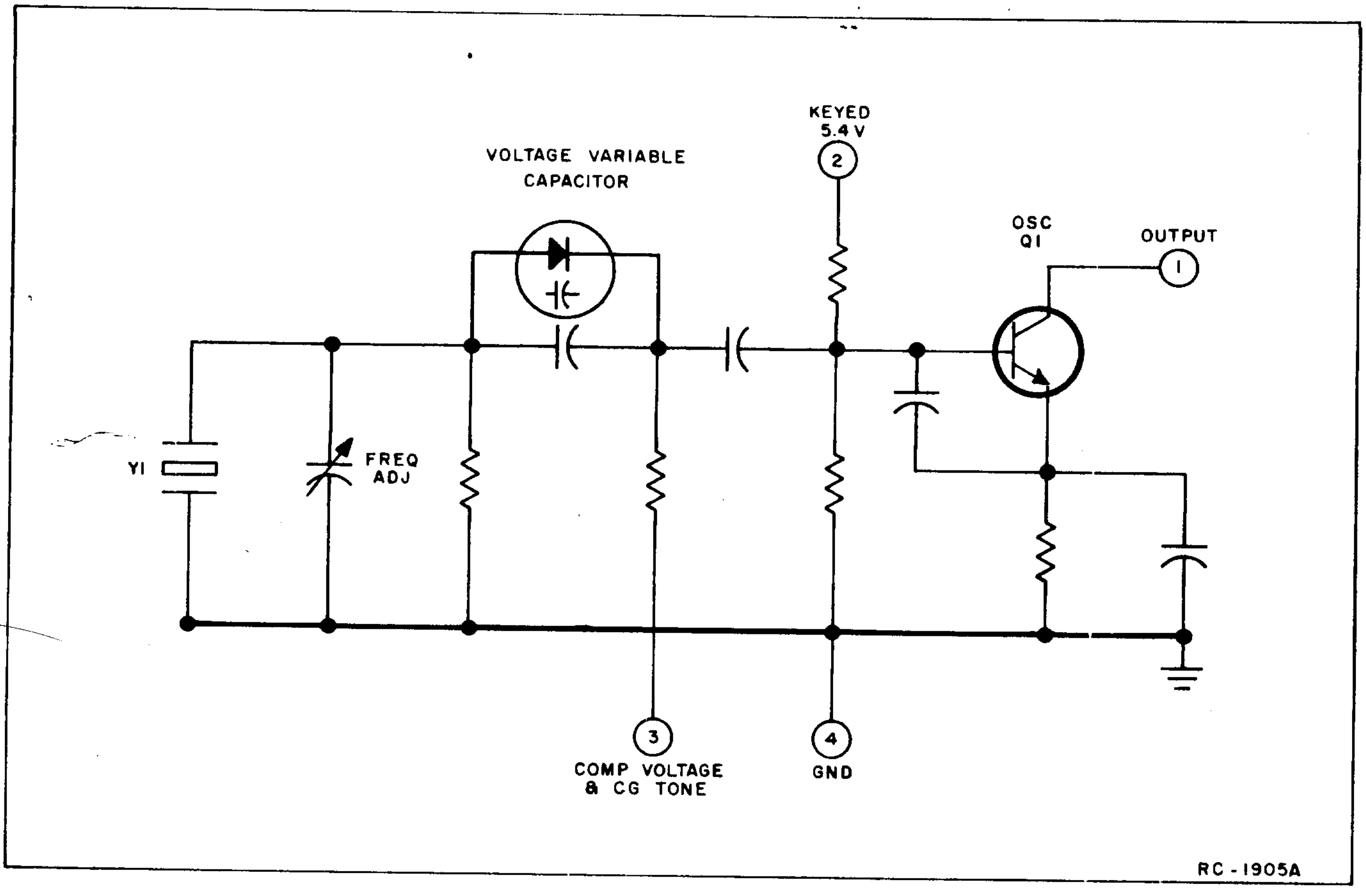


Figure 2 - Typical Oscillator Circuit

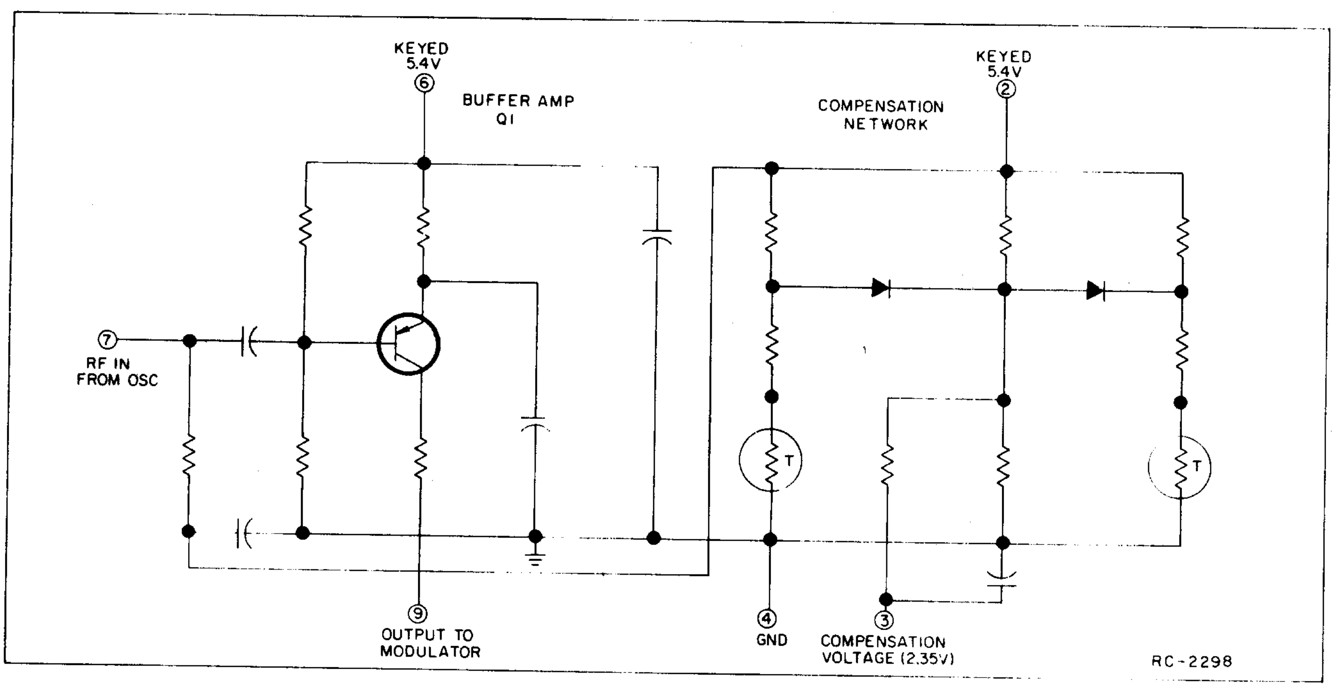


Figure 3 - Typical Compensator Circuit

In single frequency receivers, a jumper from H10 to H11 on System Board A702 connects the oscillator module to the continuous 5.4 volt supply voltage. The oscillator output is applied to Compensator A313.

In two-frequency receivers, an additional oscillator module is 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.

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 2, 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.

FRONT END A316/A317

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. The tap is positioned to provide the proper impedance match to the antenna. RF energy is coupled to the third coil (L13/L18) through openings in the sides of the cans. RF is then coupled from a tap on L13/L18 through C8 to the base of RF amplifier Q1. The output of Q1 is developed across tuned circuit C9/C10 and L3, and is applied to the base of the mixer.

MULTIPLIER & MIXER

The output of the Compensator module is applied to L1 in the Multiplier assembly. L1 is tuned to three times the crystal frequency and is metered at the Mult Test Point (H8) on the receiver board. The output of L1 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 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 Q1 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 Filter 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 the DC series-connected for reduced drain. The two IF modules provide a total gain of approximately 85 dB.

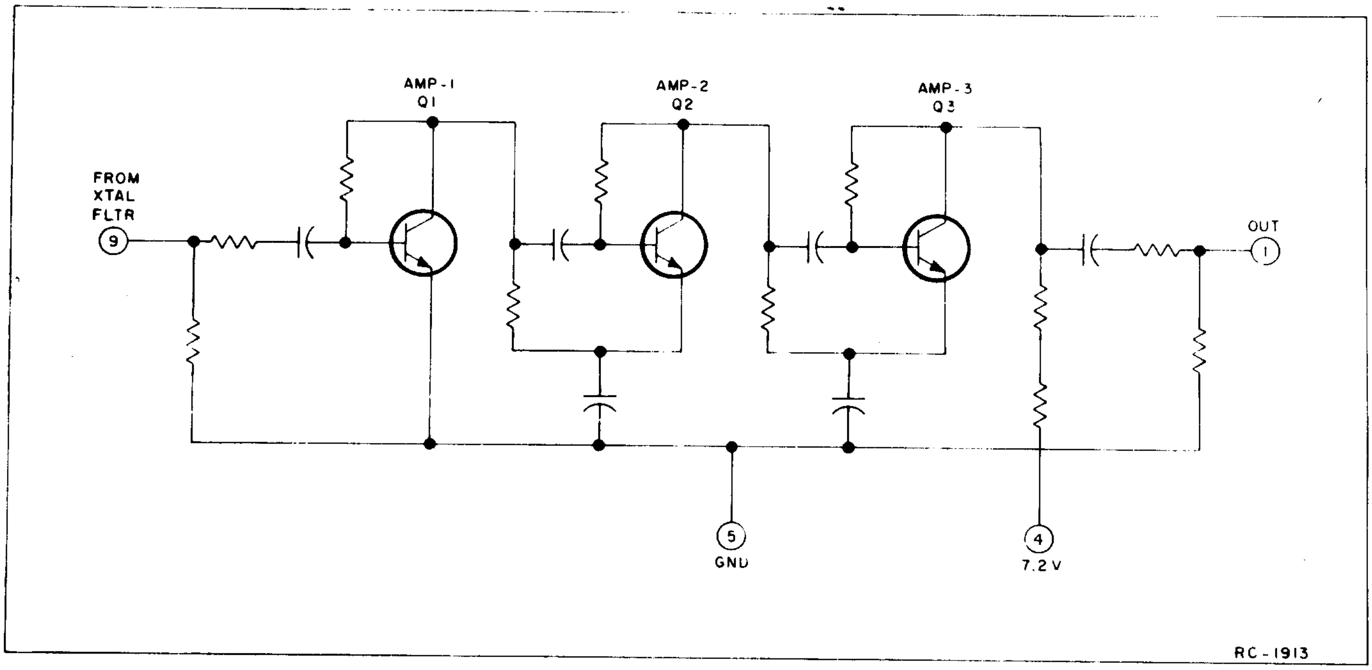


Figure 4 - Typical IF Amplifier Circuit

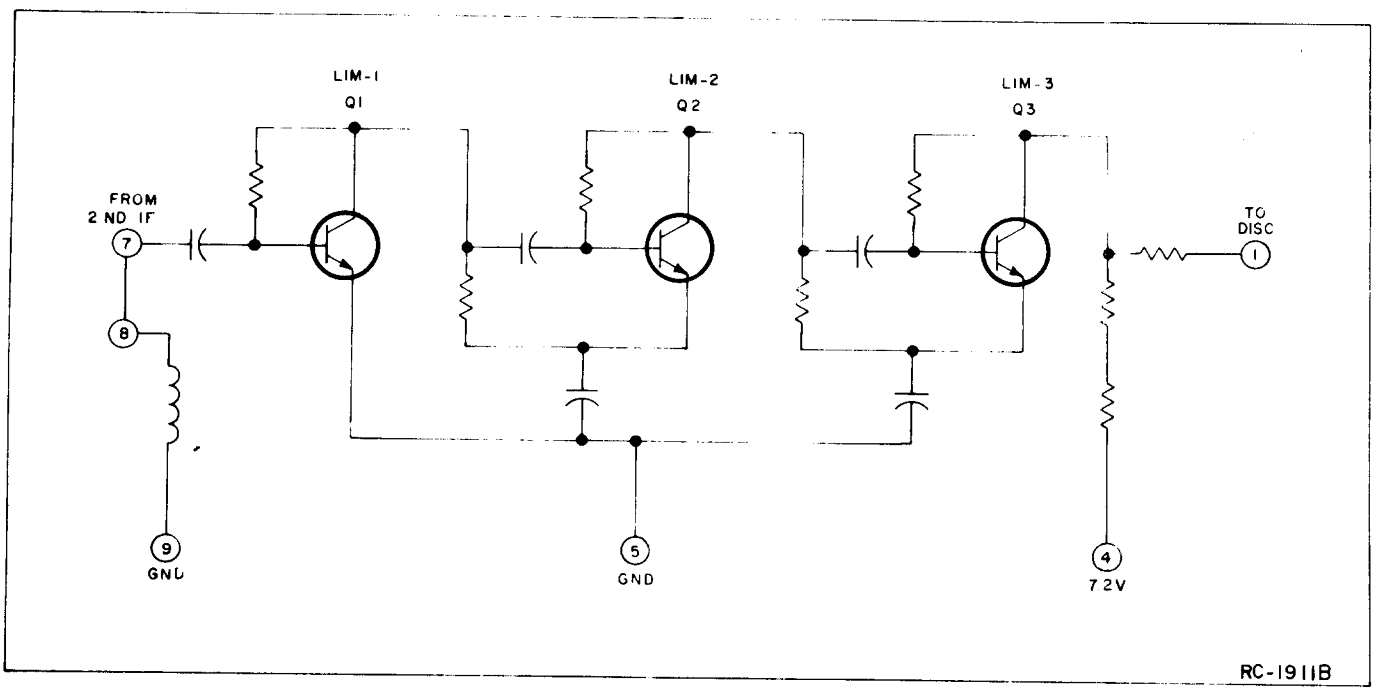


Figure 5 - Typical Limiter Circuit

LIMITER A307 & DISCRIMINATOR A308

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

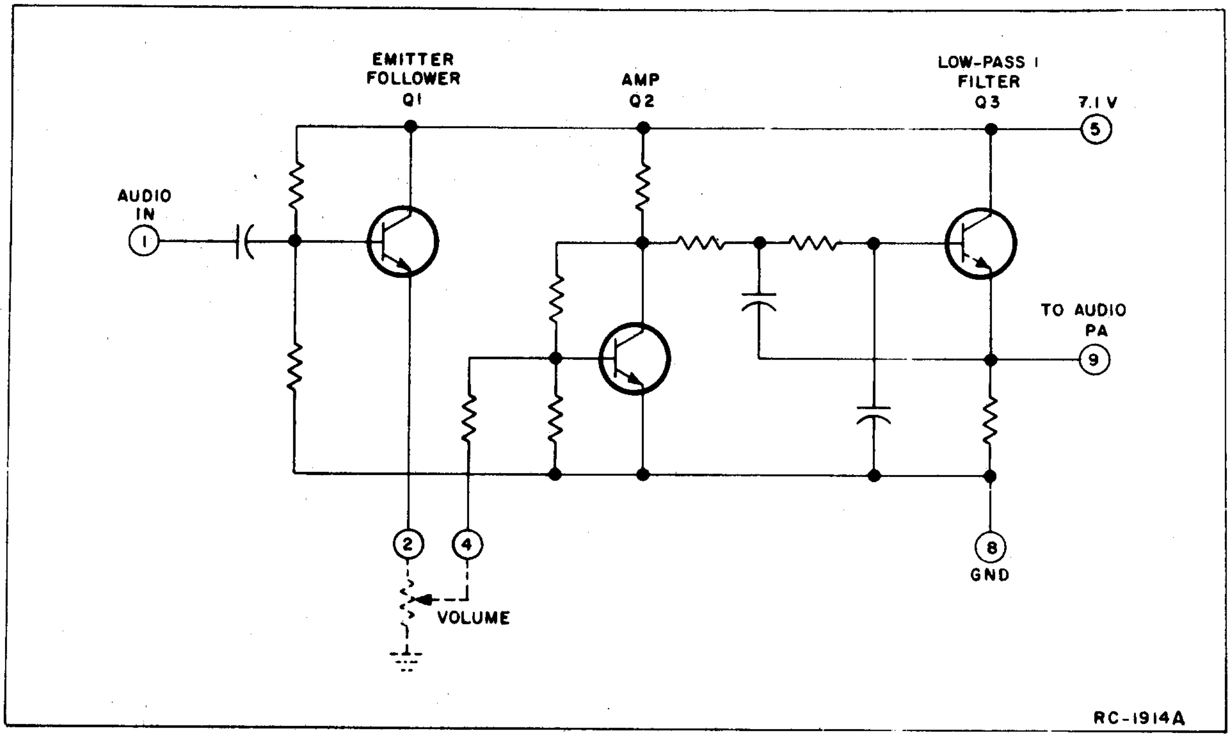


Figure 6 - Typical Audio Amplifier Circuit

AUDIO AMPLIFIER A310

Audio and noise from the discriminator is applied to Audio Amplifier module A310. 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 amplifier 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 a 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 A310 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 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.

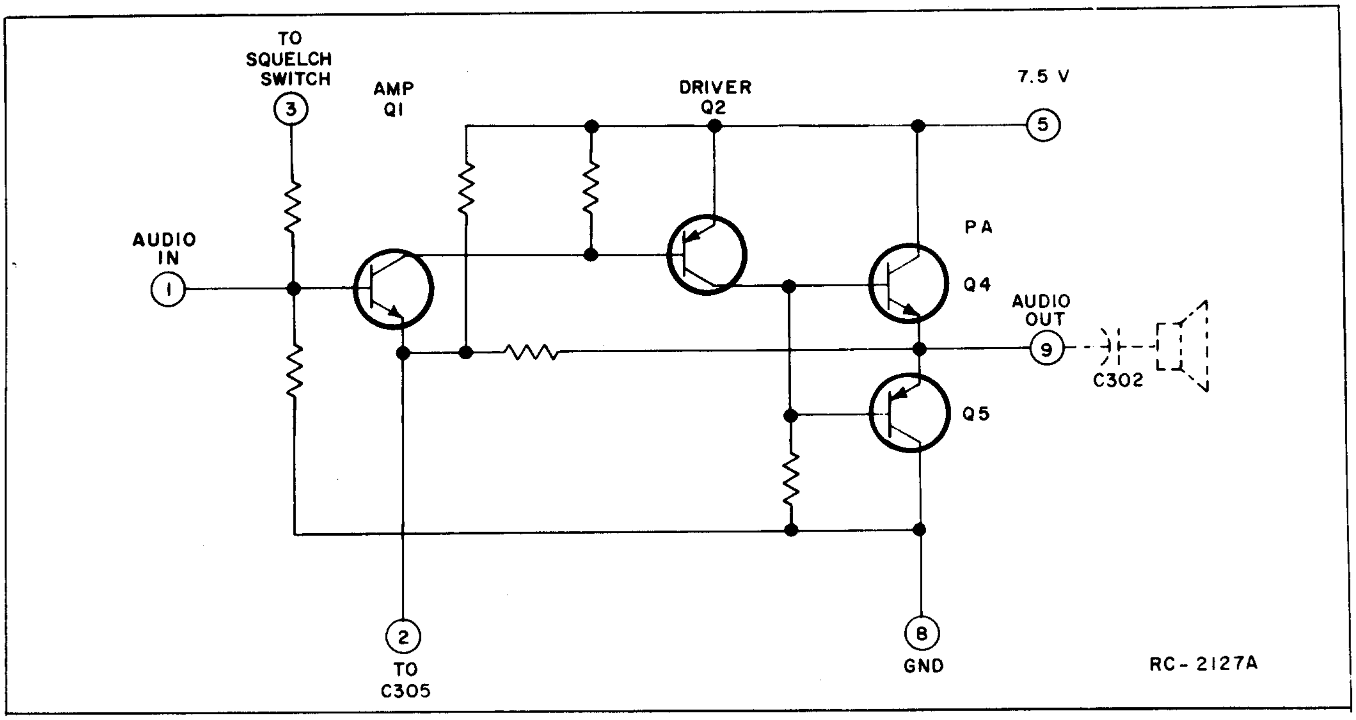


Figure 7 - Typical Audio PA Circuit

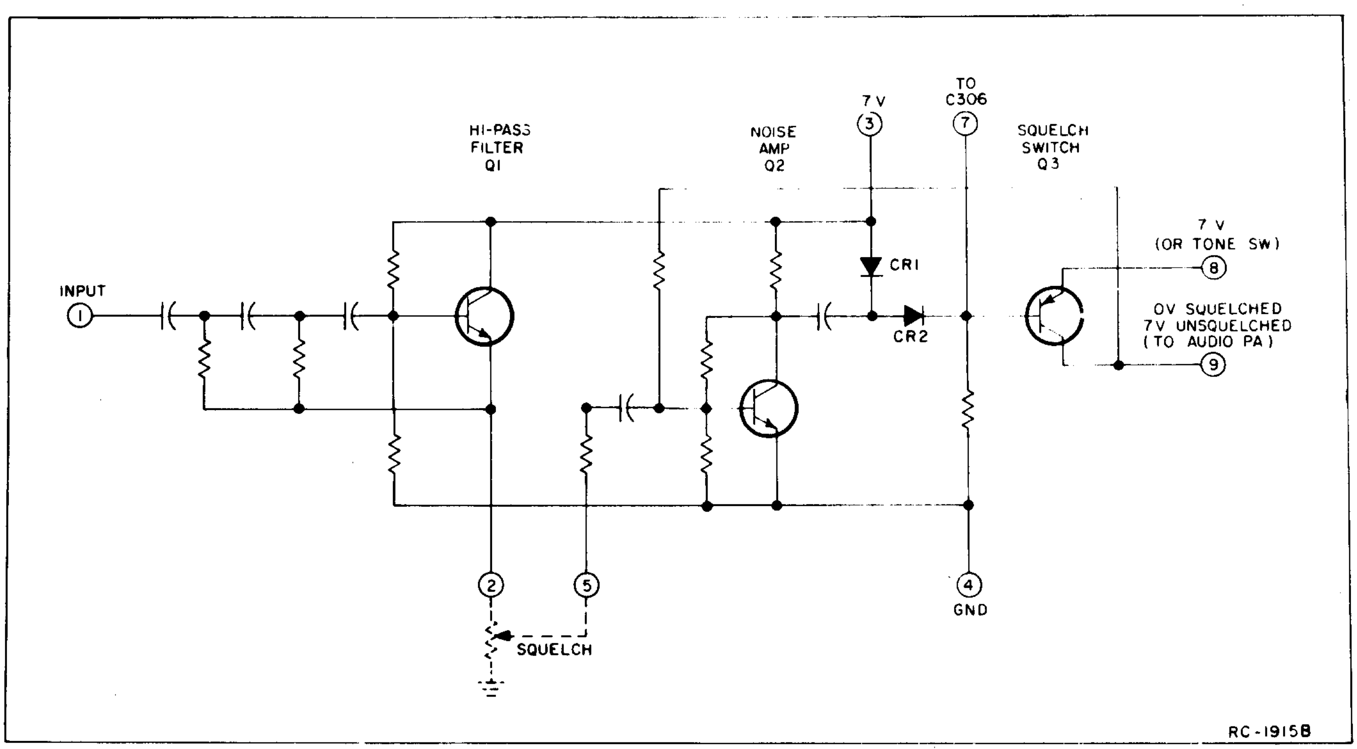


Figure 8 - Typical Squelch Circuit

When the receiver is quieted by a signal, squelch switch Q3 turns on. This applies +7 Volts to the base of amplifier Q1 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.

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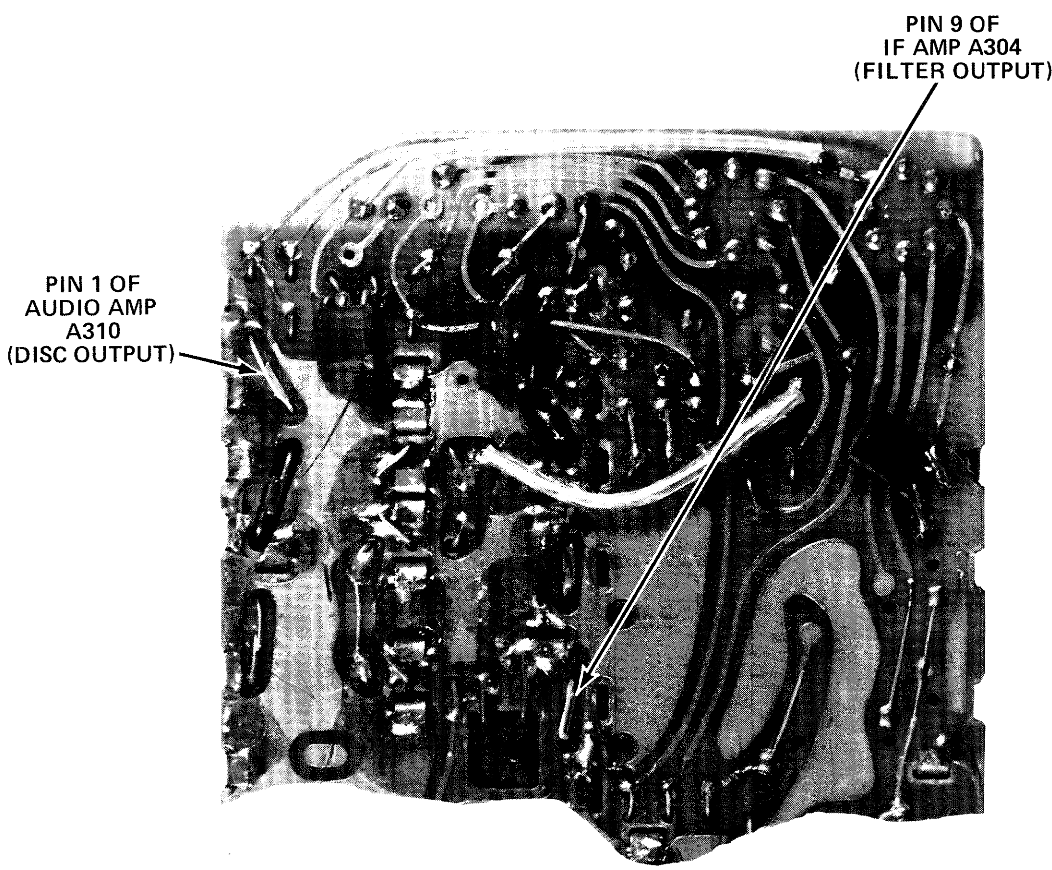
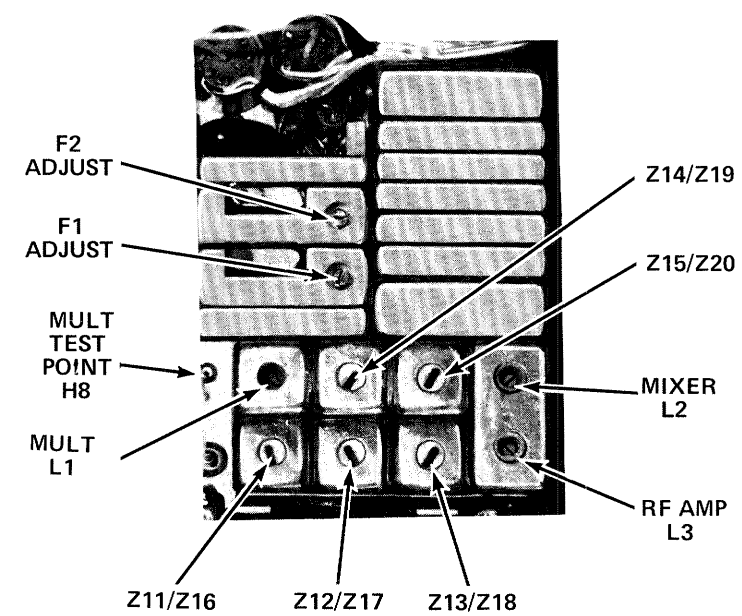
SOLDER SIDE



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 thru Z15/Z20 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 and Z15/Z20	Adjust Z14/Z19 and then Z15/Z20 for slight change in meter reading.
3.	Z11/Z16 thru Z13/Z18 and RF Amp L3	Apply an on-frequency signal to J702 and adjust Z11/Z16, Z12/Z17, Z13/Z18, 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 and Z15/Z20	De-tune L1. Next, increase the on-frequency input signal and tune Z14/Z19 and Z15/Z20 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. Alternate Method: Apply a strong 20 MHz signal to the Mixer. Measure the output of the Discriminator with a DC-VTVM at Pin 1 of 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 A310.

ALIGNMENT PROCEDURE

406—470 MHz RECEIVER
MODELS 4ER60A10-13

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.

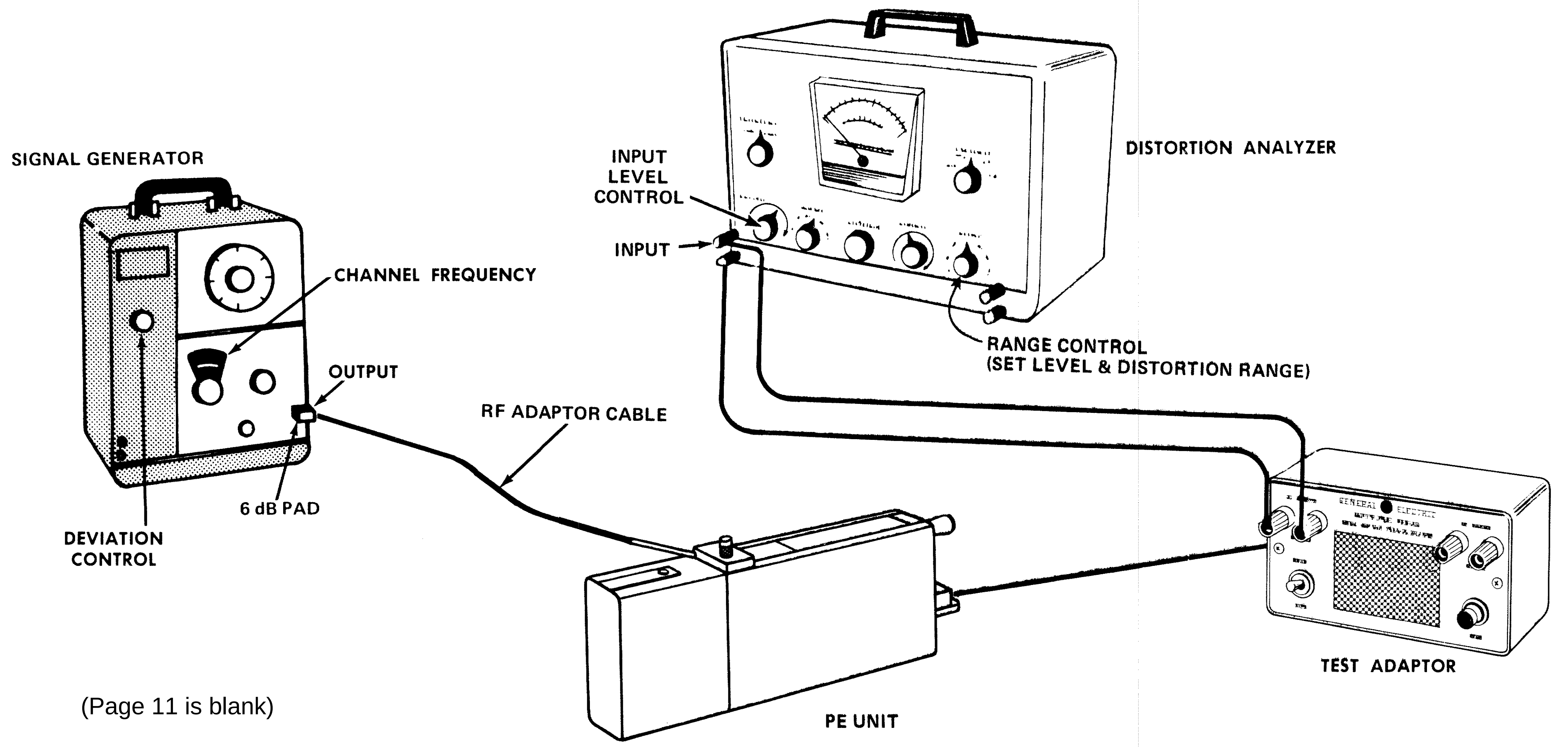
Once the defective stage is pin-pointed, refer to the "Service Check" listed to correct the problem. Additional corrective measures are included in the Troubleshooting Procedure. Before starting with the Receiver Test Procedures, be sure the receiver is tuned and aligned to the proper operating frequency.

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.



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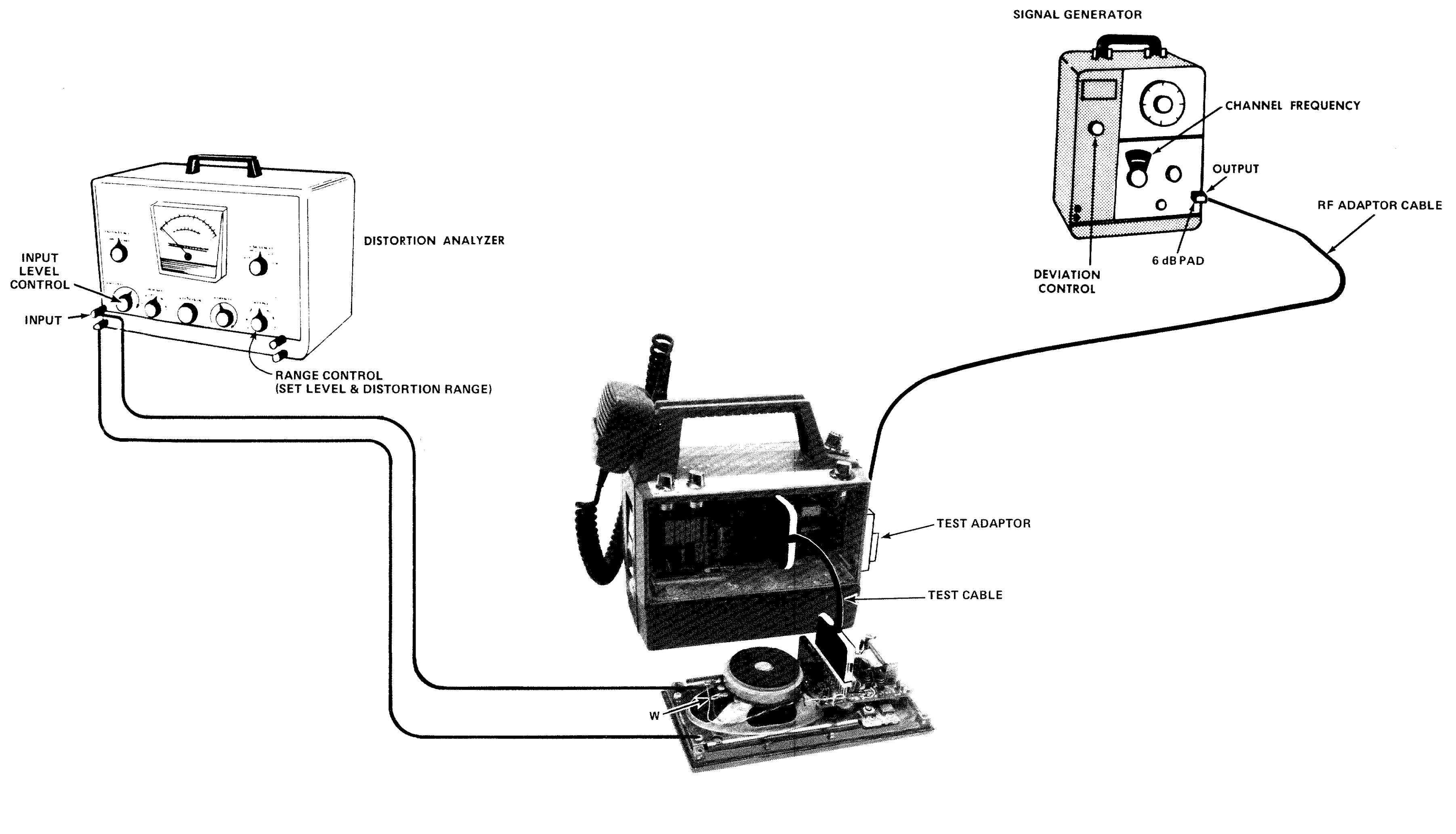


STEP 1

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).

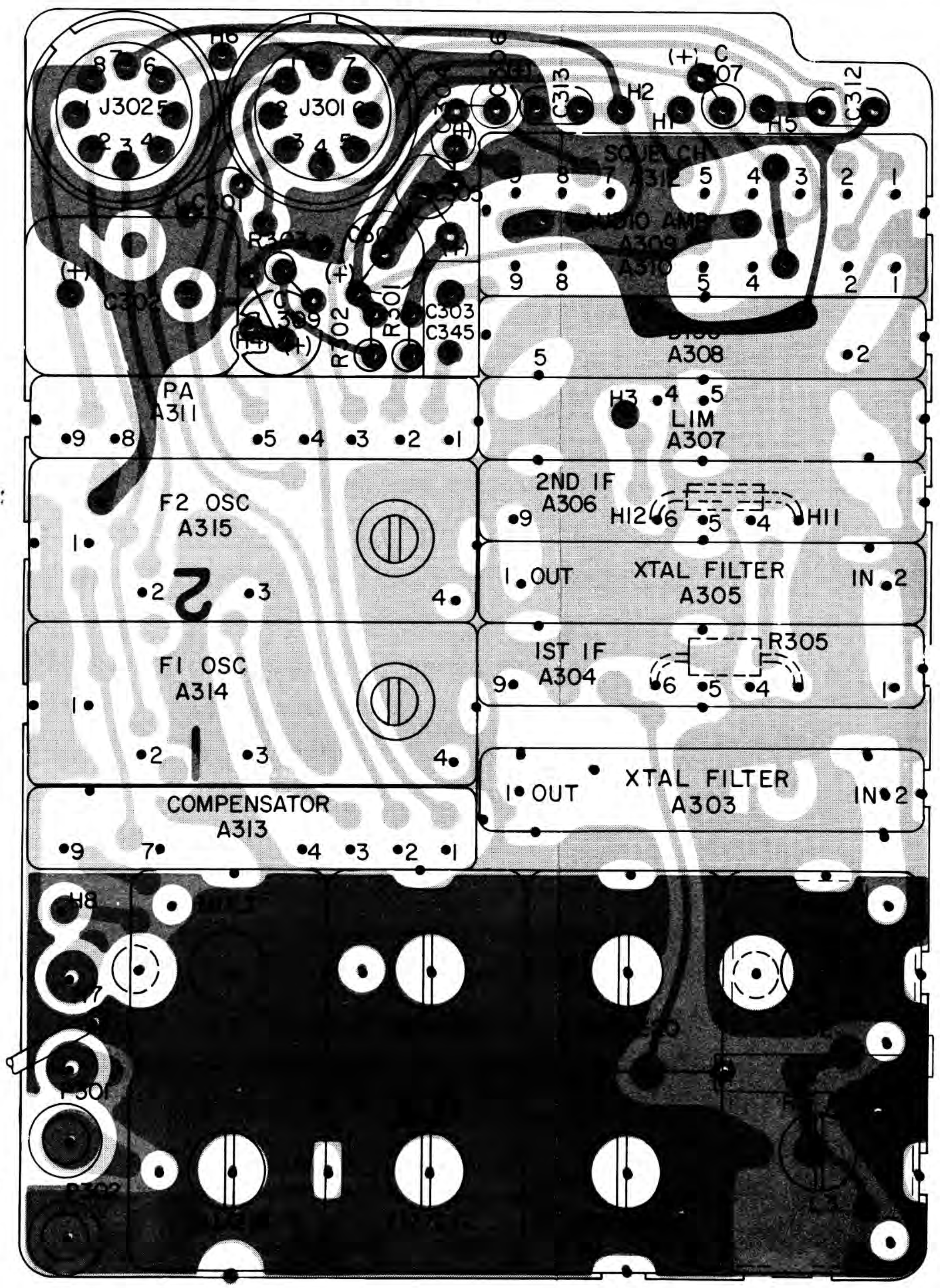
D. The deviation control reading for the 12-dB difference is the Modulation Acceptance Bandwidth of the receiver. It should be more than ±7 kHz (but less than ±9 kHz).

SERVICE CHECK

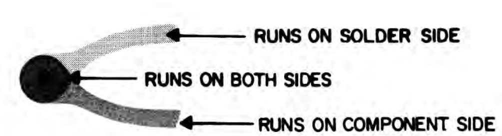
If the Modulation Acceptance Bandwidth test does not indicate the proper width, make gain measurements as shown on the Receiver Troubleshooting Procedure.

	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

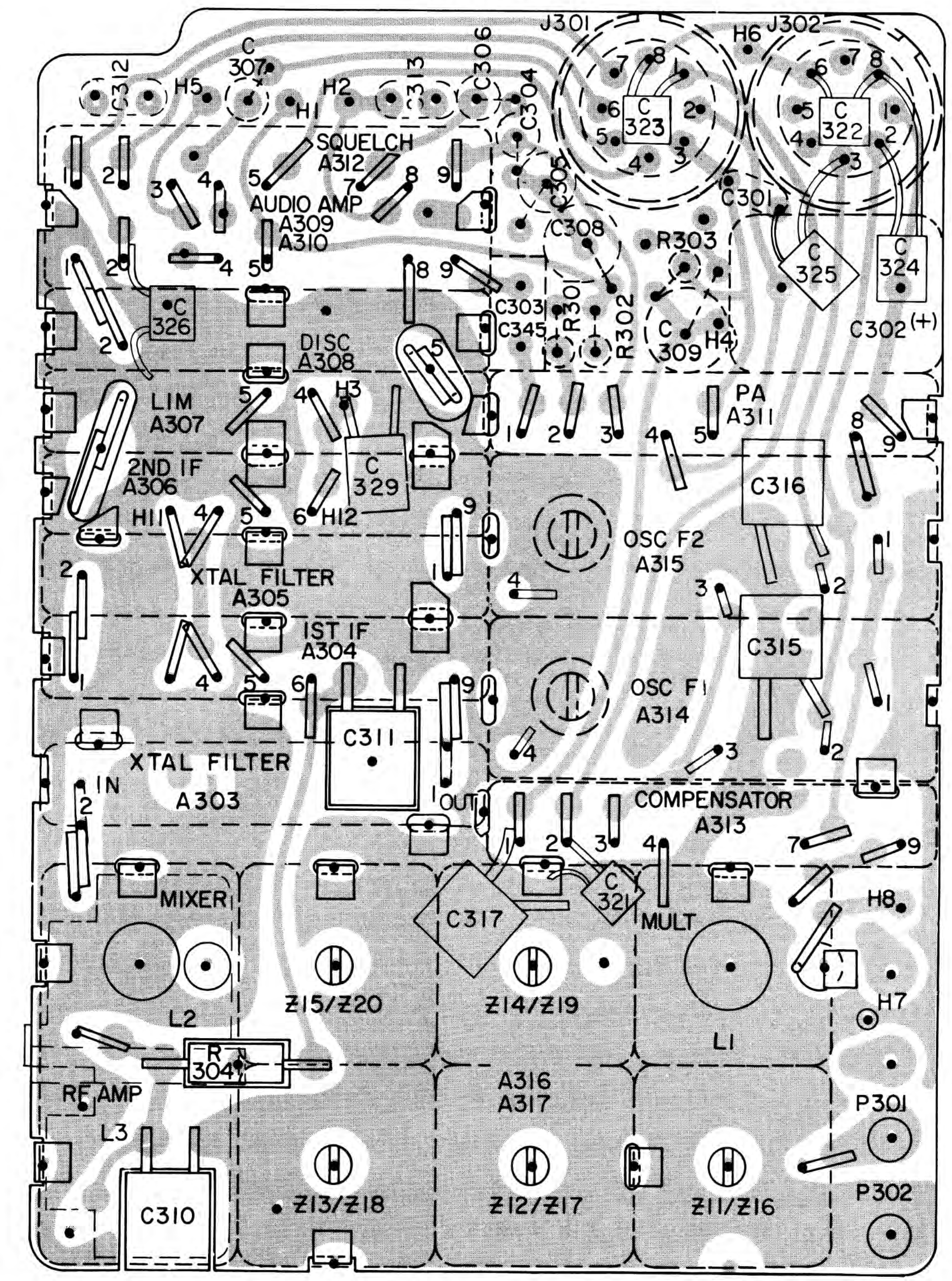
COMPONENT SIDE



RF IN



SOLDER SIDE



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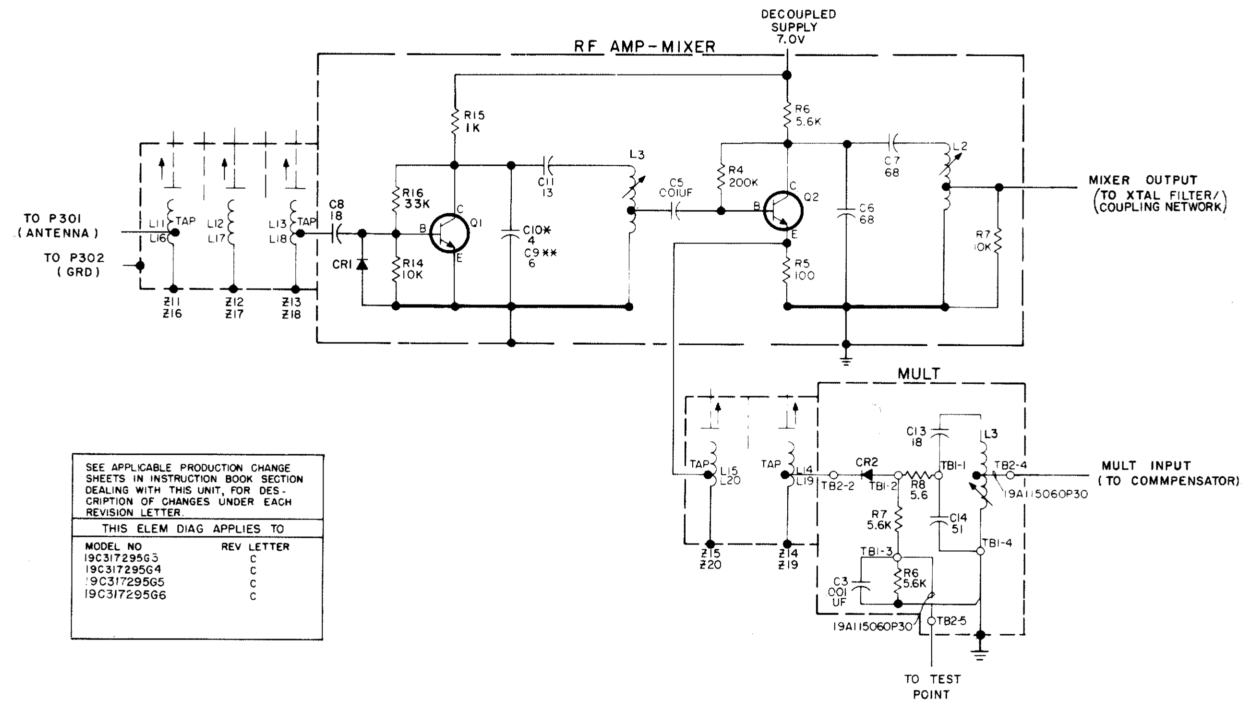
(19D416852, Sh. 2, Rev. 5)
(19D416852, Sh. 3, Rev. 6)

(19D416913, Rev. 8)
(19D416852, Sh. 2, Rev. 5)

OUTLINE DIAGRAM

406—470 MHz RECEIVER
MODELS 4ER60A10-13



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.

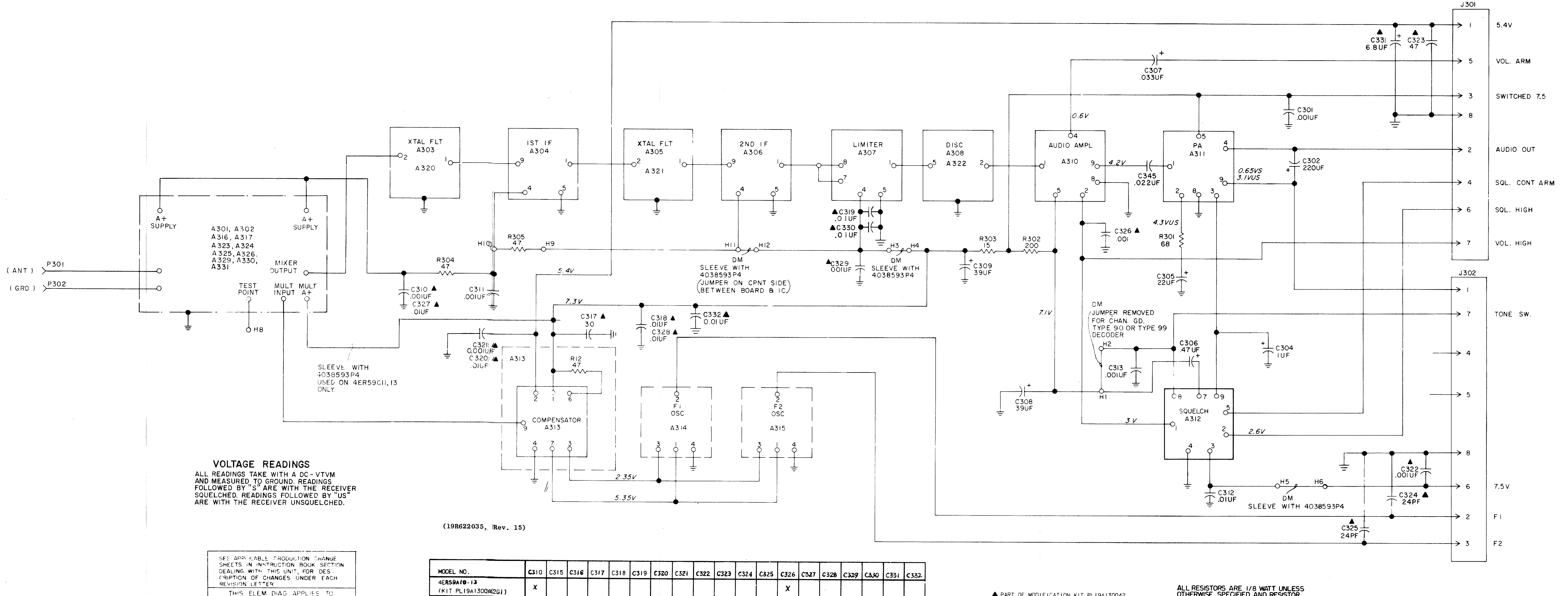
* HI SPLIT (450-470)

** LO SPLIT (406-420)

(19C320887, Rev. 5)

SCHEMATIC DIAGRAM

406-470 MHz RECEIVER FRONT END (A316/317)
MODELS 4ER60A10-13



VOLTAGE READINGS

ALL READINGS TAKE 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.

(19R622035, Rev. 15)

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
PL19D417490G1	H
PL19D417490G2	G
PL19D417490G3	G
PL19A130042G1	A
PL19A130042G2	A
PL19A130042G3	A
PL19A130042G4	A
PL19A130042G5	A
PL19A130042G6	A

MODEL NO.	C310	C315	C316	C317	C318	C319	C320	C321	C322	C323	C324	C325	C326	C327	C328	C329	C330	C331	C332
4ER59A10-13 (KIT PL19A130042G1)	X												X						
4ER60A10-13 (KIT PL19A130042G2)	X			X				X	X	X	X	X	X			X			
4ER61A11-13-15-17 (KIT PL19A30042G3)						X	X						X	X	X				
4ER62A10-11 (KIT PL19A130042G4)	X			X	X		X						X						
4ER59C11,13 (KIT PL19A130042G5)	X					X		X					X		X		X	X	X
4ER87A10-13 (KIT PL19A130042G6)						X	X						X	X	X				

▲ PART OF MODIFICATION KIT PL19A130042 SEE CHART BELOW FOR SELECTION OF PROPER PARTS FOR APPLICABLE MODEL NO.

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.

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.

SCHEMATIC DIAGRAM

406—470 MHz RECEIVER
MODELS 4ER60A10-13

PARTS LIST

LBI-4381F
406-470 MHz RECEIVER
4ER60A10 406-420 MHz
4ER60A11 450-470 MHz
4ER60A12 406-420 MHz CG
4ER60A13 450-470 MHz CG

SYMBOL	GE PART NO.	DESCRIPTION
A316* and A317*		FRONT END 19C317295G5 406-420 MHz 19C317295G6 450-470 MHz (Added by REV A)
A5* and A6*		RF AMPLIFIER A5 19C327300G3 406-450 MHz A6 19C327300G4 450-470 MHz (Added by REV C)
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C5	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C6 and C7	19A116114P4059	Ceramic: 68 pf ±5%, 100 VDCW; temp coef -220 PPM.
C8	19A116114P6038	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	19A116114P2035	Ceramic: 13 pf ±5%, 100 VDCW; temp coef -80 PPM.
		- - - - - - - - DIODES AND RECTIFIERS - - - - - - - -
CR1*	19A116052P1	Silicon. 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: 0.20 megohm ±5%, 1/8 w.
R5	3R151P101J	Composition: 100 ohms ±5%, 1/8 w.
R6	3R151P562J	Composition: 5600 ohms ±5%, 1/8 w.
R7	3R151P103J	Composition: 10,000 ohms ±5%, 1/8 w.
R14	3R151P103J	Composition: 10,000 ohms ±5%, 1/8 w.
R15	3R151P102J	Composition: 1000 ohms ±5%, 1/8 w.
R16	3R151P333J	Composition: 33,000 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: .001 µf +100% -20%, 75 VDCW.
C6 and C7	19A116114P4059	Ceramic: 68 pf ±5%, 100 VDCW; temp coef -220 PPM.
C8	19A116114P6038	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	19A116114P2035	Ceramic: 13 pf ±5%, 100 VDCW; temp coef -80 PPM.
		- - - - - - - - DIODES AND RECTIFIERS - - - - - - - -
CR1*	19A116052P1	Silicon. Added by REV B.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L2	19B216948G1	Coil.
L3	19A128005G1	Coil. Includes:
	19B209436P1	Tuning slug.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1 and Q2	19A116159P1	Silicon, NPN.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R4	3R151P204J	Composition: 0.20 megohm ±5%, 1/8 w.
R5	3R151P101J	Composition: 100 ohms ±5%, 1/8 w.
R6	3R151P562J	Composition: 5600 ohms ±5%, 1/8 w.
R7	3R151P103J	Composition: 10,000 ohms ±5%, 1/8 w.
R14	3R151P103J	Composition: 10,000 ohms ±5%, 1/8 w.
R15	3R151P102J	Composition: 1000 ohms ±5%, 1/8 w.
R16	3R151P333J	Composition: 33,000 ohms ±5%, 1/8 w.
A10		MULTIPLIER 19C311873G7
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C3	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C13	19A116114P2038	Ceramic: 18 pf ±5%, 100 VDCW; temp coef -80 PPM.
C14	19A116114P2054	Ceramic: 51 pf ±5%, 100 VDCW; temp coef -80 PPM.
		- - - - - - - - DIODES AND RECTIFIERS - - - - - - - -
CR2	19A116809P1	Silicon.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L3	19B216296P3	Coil.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R6*	3R151P562J	Composition: 5600 ohms ±5%, 1/8 w. Deleted by REV A.
R7	3R151P562J	Composition: 5600 ohms ±5%, 1/8 w.
R8	3R151P5R6J	Composition: 5.6 ohms ±5%, 1/8 w.
R10*	3R151P562J	Composition: 5600 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:
	19C311750P1	Tuning slug.
L12	19B216439G6	Helical resonator. (Part of Z12). Includes:
	19C311750P1	Tuning slug.
L13	19B216439G19	Helical resonator. (Part of Z13). Includes:
	19C311750P1	Tuning slug.
L14	19B216439G4	Helical resonator. (Part of Z14). Includes:
	19C311750P1	Tuning slug.
L15	19B216439G3	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.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - HELICAL RESONATORS - - - - - - - -
Z11		Consists of L11 and 19D413132P24 can.
Z12		Consists of L12 and 19D413132P3 can.
Z13		Consists of L13 and 19D413132P25 can.
Z14		Consists of L14 and 19D413132P19 can.
Z15		Consists of L15 and 19D413132P20 can.
Z16		Consists of L16 and 19D413132P24 can.
Z17		Consists of L17 and 19D413132P3 can.
Z18		Consists of L18 and 19D413132P25 can.
Z19		Consists of L19 and 19D413132P19 can.
Z20		Consists of L20 and 19D413132P20 can.
A316* and A317*		FRONT END 19C317295G3 406-420 MHz 19C317295G4 450-470 MHz (Deleted by REV A)
A5 and A6		RF AMPLIFIER A5 19C317445G3 A6 19C317445G4
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C5	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C6 and C7	19A116114P4059	Ceramic: 68 pf ±5%, 100 VDCW; temp coef -220 PPM.
C8	19A116114P6038	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	19A116114P2035	Ceramic: 13 pf ±5%, 100 VDCW; temp coef -80 PPM.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L2	19B216948G1	Coil.
L3	19A128005G1	Coil. Includes:
	19B209436P1	Tuning slug.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1 and Q2	19A116159P1	Silicon, NPN.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	3R151P184J	Composition: 0.18 megohm ±5%, 1/8 w.
R2	3R151P302J	Composition: 3000 ohms ±5%, 1/8 w.
R4	3R151P204J	Composition: 0.20 megohm ±5%, 1/8 w.
R5	3R151P101J	Composition: 100 ohms ±5%, 1/8 w.
R6	3R151P562J	Composition: 5600 ohms ±5%, 1/8 w.
R7	3R151P103J	Composition: 10,000 ohms ±5%, 1/8 w.
A7		MULTIPLIER 19C311873G6
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C3	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C4	19A116114P2050	Ceramic: 39 pf ±5%, 100 VDCW; temp coef -80 PPM.
C5	19A116114P7065	Ceramic: 100 pf ±5%, 100 VDCW; temp coef -750 PPM.
		- - - - - - - - DIODES AND RECTIFIERS - - - - - - - -
CR1	19A116081P1	Silicon.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L1	19B216296P1	Coil.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1 and R2	3R151P432J	Composition: 4300 ohms ±5%, 1/8 w.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
	19B200497P5	Tuning slug.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L11	19B216439G8	Helical resonator. (Part of Z11). Includes:
	19C311750P1	Tuning slug.
L12	19B216439G6	Helical resonator. (Part of Z12). Includes:
	19C311750P1	Tuning slug.
L13	19B216439G19	Helical resonator. (Part of Z13). Includes:
	19C311750P1	Tuning slug.
L14	19B216439G4	Helical resonator. (Part of Z14). Includes:
	19C311750P1	Tuning slug.
L15	19B216439G3	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.
		- - - - - - - - HELICAL RESONATORS - - - - - - - -
Z11		Consists of L11 and 19D413132P24 can.
Z12		Consists of L12 and 19D413132P3 can.
Z13		Consists of L13 and 19D413132P25 can.
Z14		Consists of L14 and 19D413132P19 can.
Z15		Consists of L15 and 19D413132P20 can.
Z16		Consists of L16 and 19D413132P24 can.
Z17		Consists of L17 and 19D413132P3 can.
Z18		Conssts of L18 and 19D413132P25 can.
Z19		Consists of L19 and 19D413132P19 can.
Z20		Consists of L20 and 19D413132P20 can.
		RECEIVER BOARD 19D417490G1
A303*	19C304824G1	Crystal Filter.
		In REV C and earlier:
	19C304516G3	Crystal Filter.
A304	19C311879G3	1st IF Amplifier.
A305*	19C304824G1	Crystal Filter.
		In REV A and earlier:
	19C304508G3	Crystal Filter.
A306	19C311879G4	2nd IF Amplifier.
A307	19C311876G4	Limiter.
A308	19C304504G3	Discriminator.
A309*	19C311878G2	Audio Amplifier. Deleted by REV H.
A310*	19C311995G4	Audio Amplifier.
		In REV G and earlier:
	19C311995G2	Audio Amplifier. (Includes Tone Filter).
A311*	19C311877G3	PA.
		In REV F and earlier:
	19C311877G2	PA.
A312	19C311880G4	Squelch.

SYMBOL	GE PART NO.	DESCRIPTION
A313*	19C320061G1	Compensator.
		In REV B and earlier:
	19C311891G5	Compensator.
		- - - - - - - - - - OSCILLATORS - - - - - - - - - -
A314 and A315		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. $Fx = \frac{Fo - 20}{21}$
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C301	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C302	19A116178P7	Tantalum: 220 µf ±20%, 6 VDCW.
C303*	19A116089P1	Ceramic: 0.1 µf ±20%, 50 VDCW, temp range -55 to +85°C. Deleted by REV H.
C304	5491674P28	Tantalum: 1.0 µf ±20%, 25 VDCW; sim to Sprague Type 162D.
C305	5491674P35	Tantalum: 22 µf ±20%, 4 VDCW; sim to Sprague Type 162D.
C306	5491674P27	Tantalum: .47 µf ±20%, 35 VDCW; sim to Sprague Type 162D.
C307	5491674P31	Tantalum: .033 µf ±20%, 35 VDCW; sim to Sprague Type 162D.
C308 and C309	5491674P30	Tantalum: 39 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C311	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C312*	19A116192P1	Ceramic: 0.01 µf ±20%, 50 VDCW; sim to Erie 8121 SPECIAL.
		In REV A and earlier:
	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C313	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C314*	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW. Deleted by REV E.
C345*	19A116192P6	Ceramic: 0.022 µf ±20%, 50 VDCW; sim to Erie 8131-M050-W5R-223M. Added by REV H.
		- - - - - - - JACKS AND RECEPTACLES - - - - - - -
J301 and J302	19A116122P1	Feed-thru: sim to Warren Co 1-B-2994-4.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P301 and P302	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R301*	3R151P680J	Composition: 68 ohms ±5%, 1/8 w.
		In REV A-D:
	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.
R304 and R305	3R151P470J	Composition: 47 ohms ±5%, 1/8 w.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
	19A129132P1	Shield. (Used with A5-A7).
	19B216316P1	Insulator. (Used with J301 and J302).

SYMBOL	GE PART NO.	DESCRIPTION
		CAPACITOR KIT 19A130042G2
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C310	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C315* and C316*	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW. Deleted by REV A.
C317	19A116114P7045	Ceramic: 30 pf ±5%, 100 VDCW; temp coef -750 PPM.
C321 and C322	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C323	19A116114P8053	Ceramic: 47 pf ±5%, 100 VDCW; temp coef -1500 PPM.
C324 and C325	19A116114P2042	Ceramic: 24 pf ±5%, 100 VDCW; temp coef -80 PPM.
C326	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C329	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

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 - 4ER60A10-13
To improve design.
Changed A316 and A317.

REV. B - To improve squelch action.
Changed A305.

REV. C - To suppress harmonics from IF limiter.
Added C329.

REV. A - Receiver Board 19D417490G1
To increase audio sensitivity.
Changed R301.

REV. A - Receiver Front End 19C317295G5 & 6
To improve receiver spurious response.
Deleted R2 and R6. Added shield.

REV. B - Receiver Board 19D417490G1
To improve critical squelch operation.
Changed C312.

REV. C - To eliminate spurious when keyed.
Changed A313.

REV. B - Receiver Front End 19C317295G5 & 6
To add base protection for transistor Q1.
Added CR1.

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

REV. D - Receiver Board 19D417490G1
To improve factory producibility.
Changed A303.

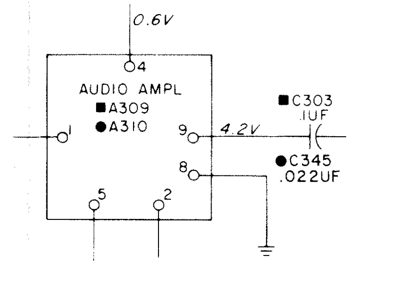
REV. E - To improve audio sensitivity and stability.
Deleted C314 and changed R301.

REV. F - To improve audio frequency response and attack time. Add C345 to be used with Channel Guard.

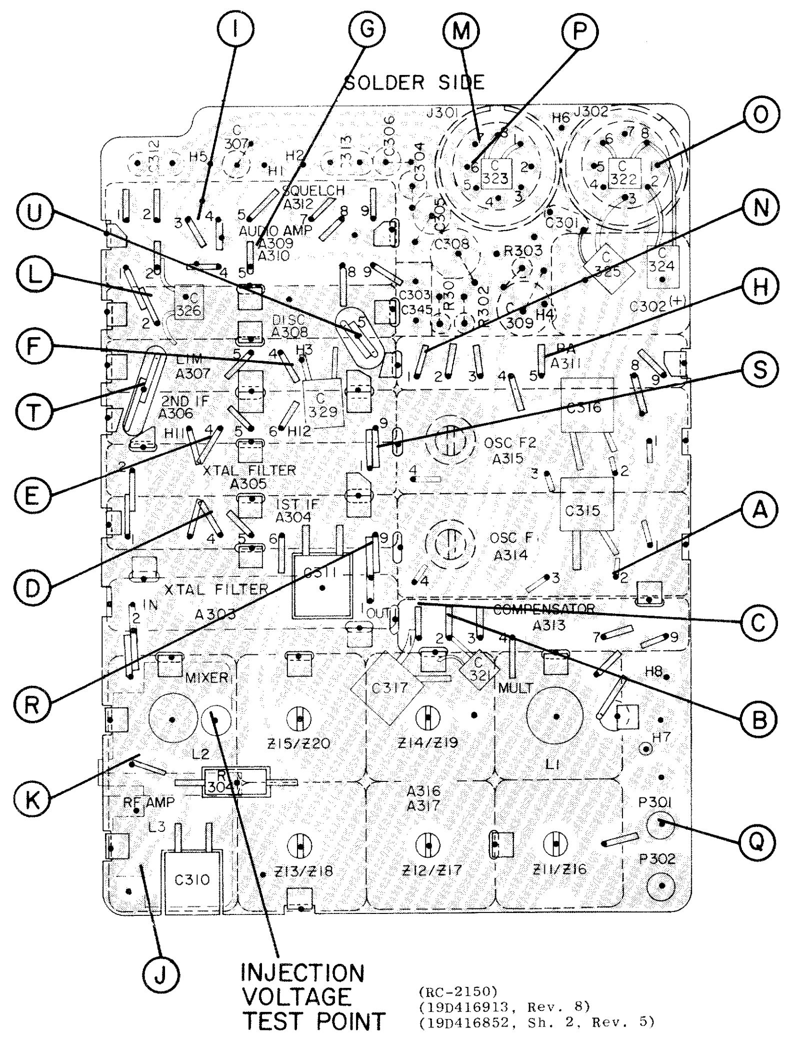
REV. G - To improve audio quality. Changed A311.

REV. H - To eliminate Non-Channel Guard receiver boards. Deleted callout of ■A309 and circle (●) in front of A310. Deleted callout of ■C303 and circle (●) for C345.
Deleted Notes: ■Use for Non-Channel Guard receivers and ● use for Channel Guard receivers.

Schematic Diagram Was:



REV. A - Receiver Kit 19A130042G2
To improve reliability. Deleted C315 and C316.



(RC-2150)
(19D416913, Rev. 8)
(19D416852, Sh. 2, Rev. 5)

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.

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

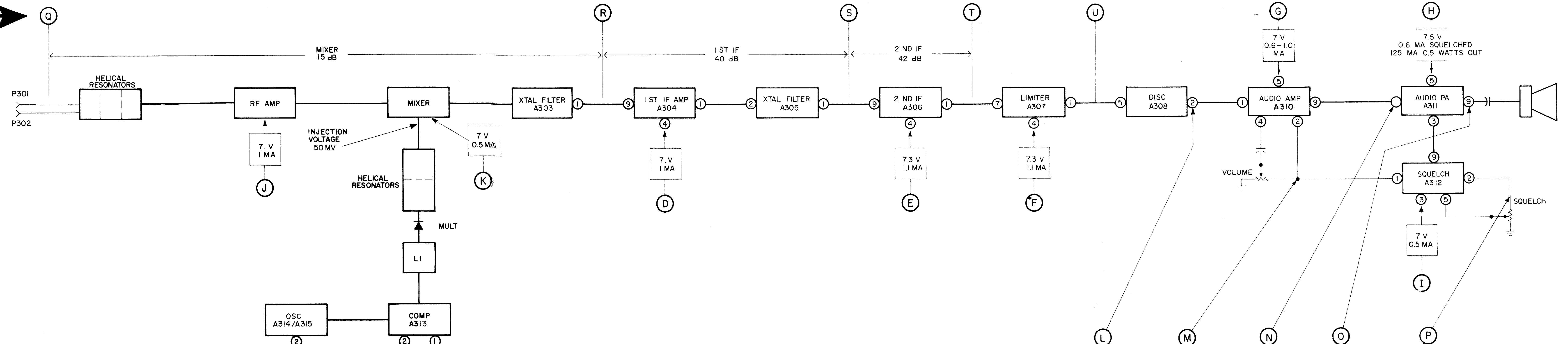
PROCEDURE FOR 2ND IF:

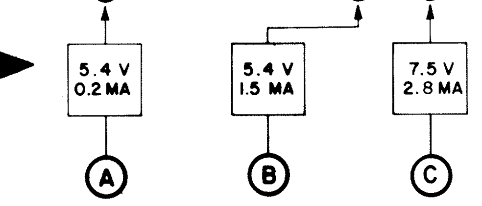
1. With no signal in, connect the RF probe to the output of the 2nd IF module. Increase the signal generator output until the Test Set reading increases by approximately 0.2 volt. Note Test Set and signal generator reading (dB2).
2. Connect the probe to the input of the 2nd IF module. Increase the signal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

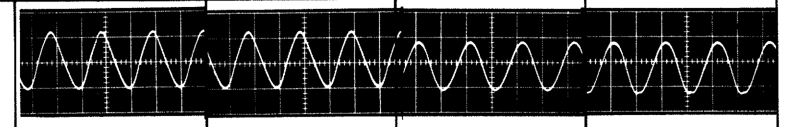
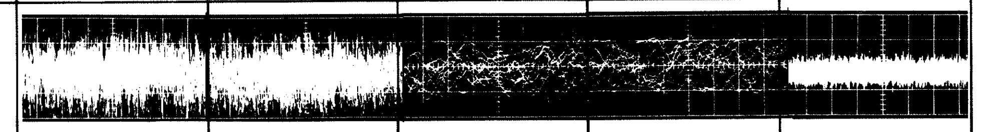
EQUIPMENT REQUIRED:

- 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	2.5 V	5.6 V	
	NOISE	0.9 V	0.9 V	2.5 V	5.6 V	0.7 V
STANDARD SIGNAL						
NOISE WAVEFORM						

RC- 2326A

END OF DOCUMENT

TROUBLESHOOTING PROCEDURE
406—470 MHz RECEIVER
MODELS 4ER60A10-13