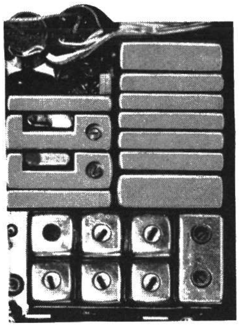
MOBILE RADIO

MASTR® *Personal Series*
PROGRESS LINE

PE HIGH SENSITIVITY MODELS
150.8-174 MHz, RECEIVER MODELS 4ER59A11 & 13
(Includes Options 4226 and 4227)

Maintenance Manual LBI4665C

DATAFILE FOLDER - DF1102



SPECIFICATIONS *

Type Number	ER-59-A
Audio Output (EIA)	500 milliwatts at less than 5% distortion
Channel Spacing	30 kHz
Sensitivity	
12-dB SINAD (EIA Method)	0.25 uV
20-dB Quieting Method	0.35 uV
Selectivity	
EIA Two-Signal	-75 dB at ±30 kHz
20-dB Quieting Method	-110 dB at ±30 kHz
Spurious Response	-70 dB
Intermodulation (EIA)	-60 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	0.15 uV
Maximum Squelch	Greater than 20-dB Quieting
Maximum Frequency Spacing	0.60 MHz with no degradation in Rec. Sensitivity
	1.20 MHz with 1 dB degradation in Rec. Sensitivity

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

ER-59-A

GENERAL ELECTRIC

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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 4ER59A11 and 4ER59A13 are high sensitivity, single conversion, superheterodyne FM receivers for operation on the 150.8-174 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.	Option No.	Freq. Range	Number of Freq.	Tone Option
4ER59A11	4226	150.8-174 MHz	1 or 2	
4ER59A13	4227	150.8-174 MHz	1 or 2	Channel Guard

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 4EG28A11 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 14.53 to 17.11 MHz, and the crystal frequency is multiplied 9 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.

In single frequency receivers, a jumper from H10 to H11 on System Board A701 connects the oscillator module to the continuous 5.4 Volt supply voltage. The oscillator output is applied to Compensator A313.

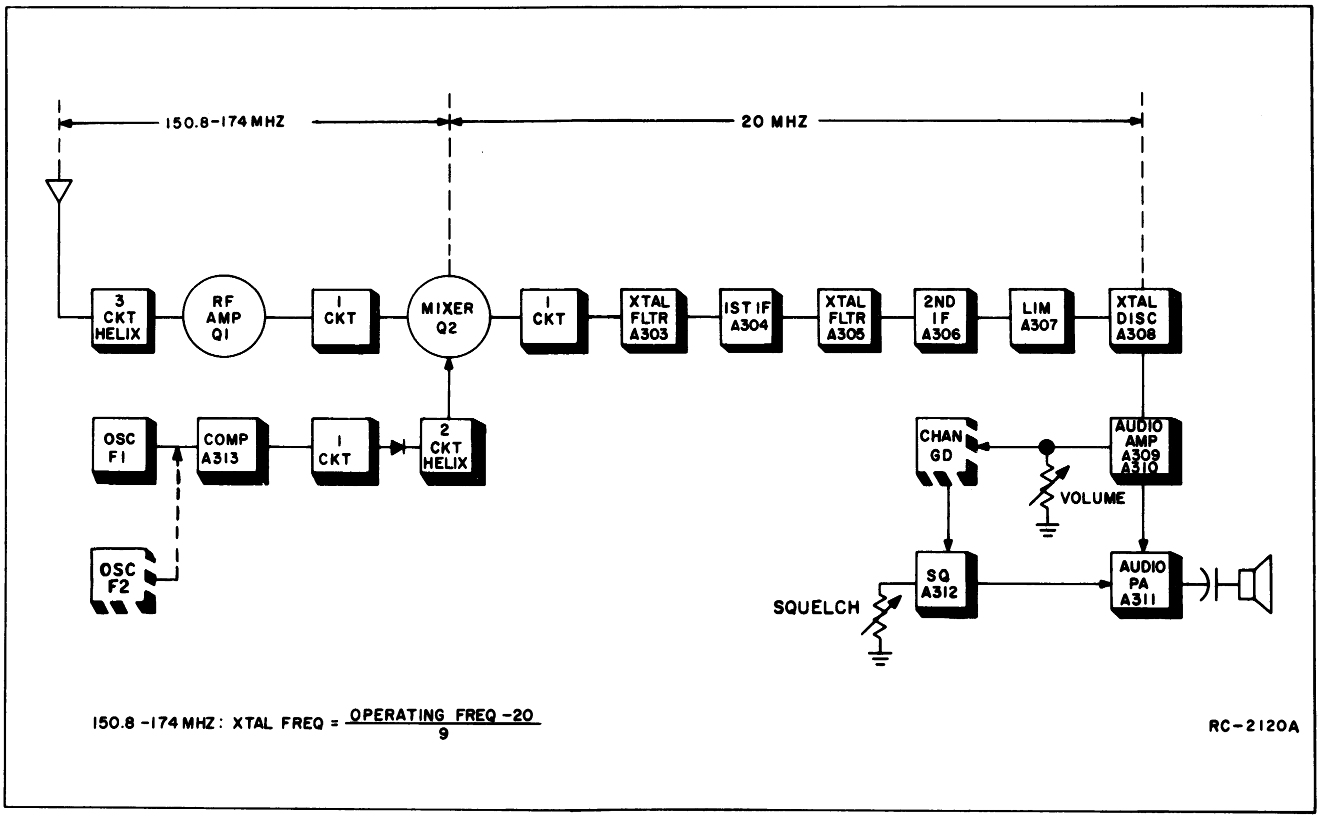


Figure 1 - Receiver Block Diagram

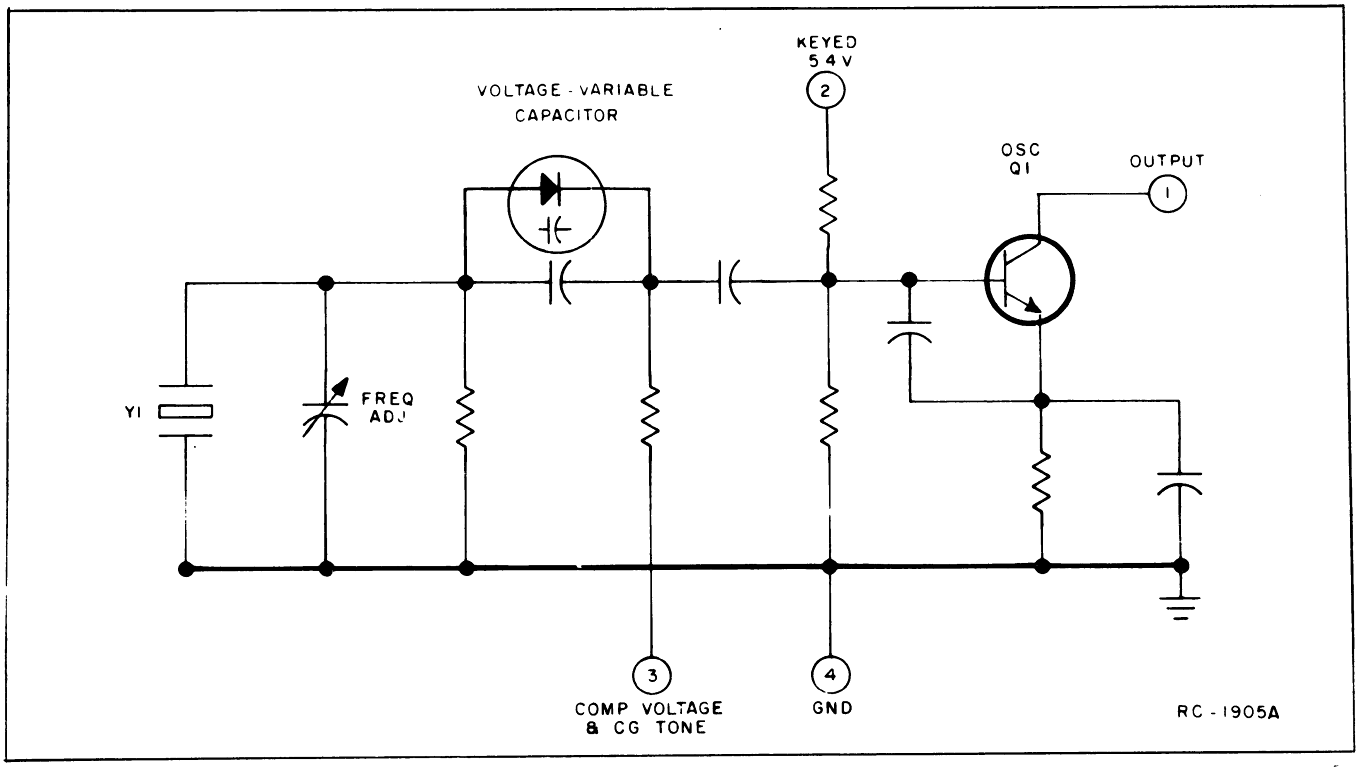


Figure 2 - Typical Oscillator Circuit

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 indivdually compendated 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 similar to the Compensator used in the transmitter (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.

FRONT END A302

The receiver High Sensitivity 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 L6. The tap is positioned to provide the proper impedance match to the antenna. RF energy is coupled to the third coil (L8) through openings in the sides of the cans. RF is then coupled from a tap on L8

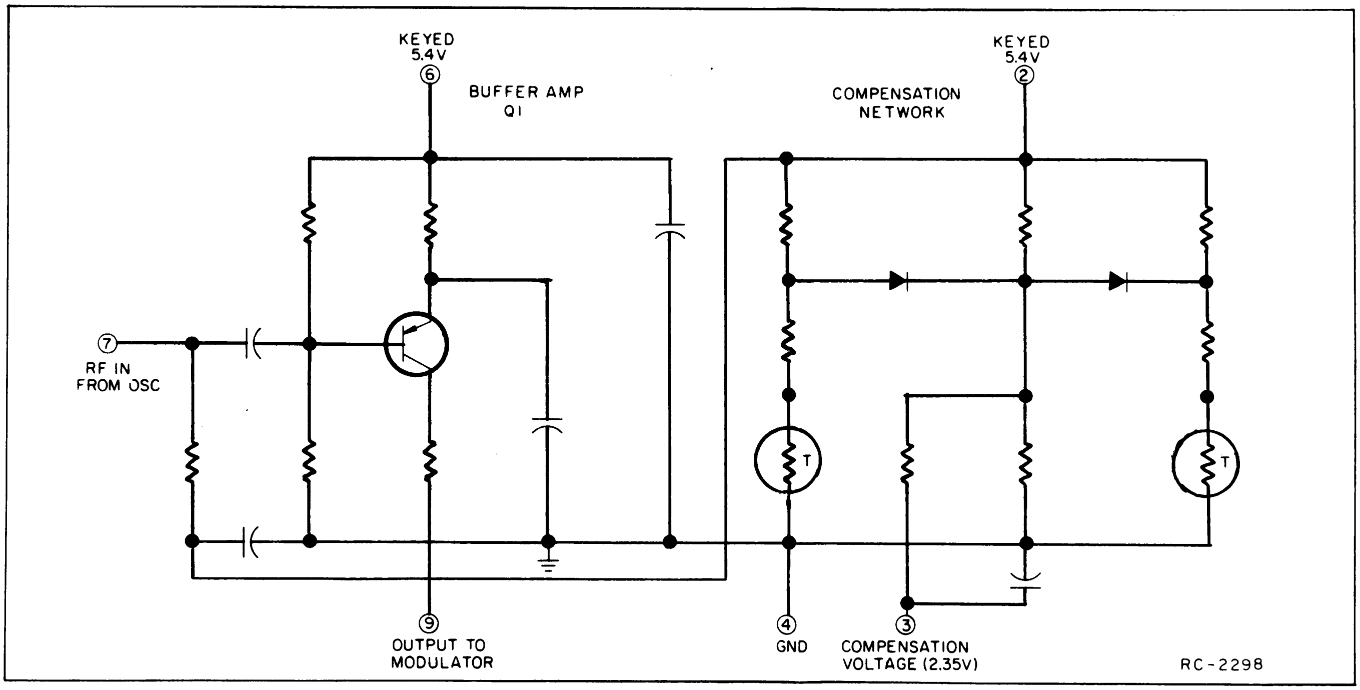


Figure 3 - Typical Compensator Circuit

through C1 to the base of RF amplifier Q1. The output of Q1 is developed across tuned circuit C2/L1 and is applied to the base of the mixer.

MULTIPLIER & MIXER A302

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 three times the first multiplier frequency for a total multiplication of 9 times. The output of the helical resonators is direct-coupled to the emitter of the mixer transistor.

The RF signal from the RF amplifier is applied to the base of mixer Q2 and the 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 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.

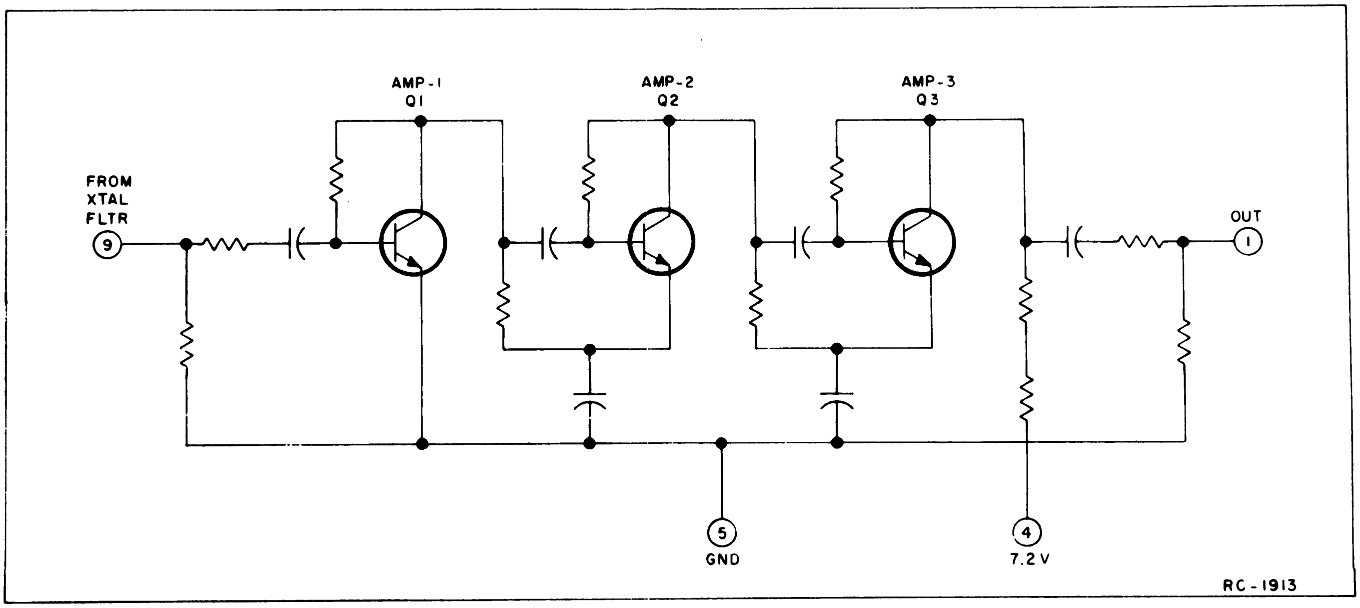


Figure 4 - Typical IF Amplifier Circuit

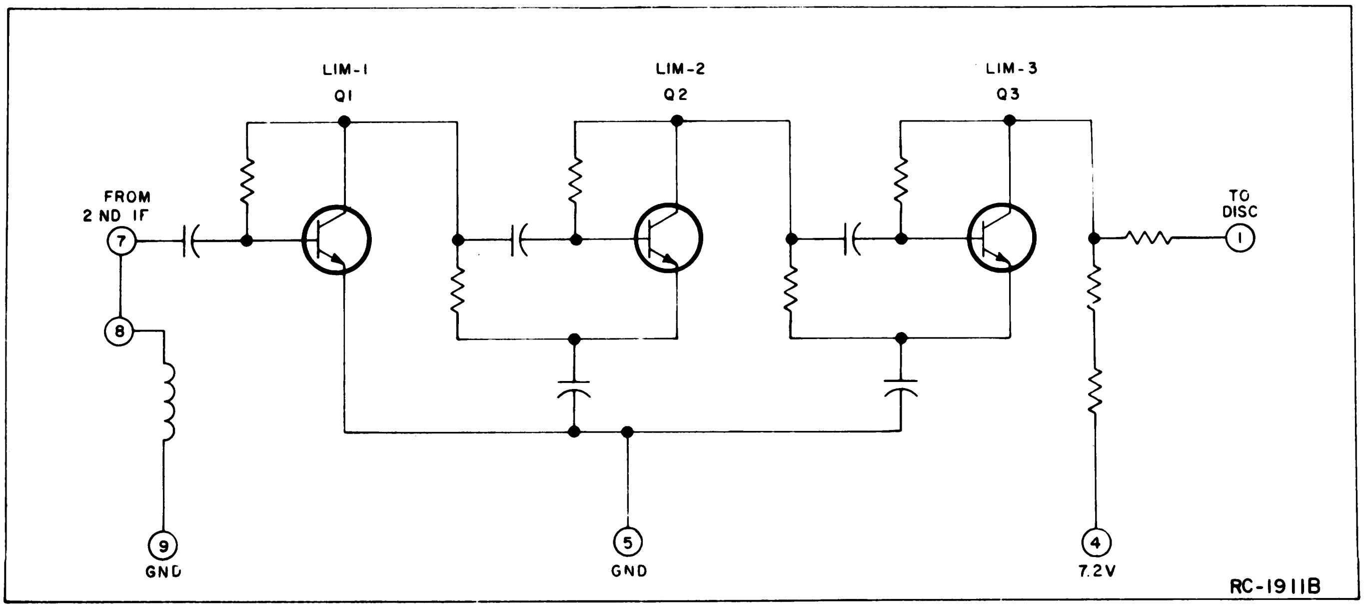


Figure 5 - Typical Limiter Circuit

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 A323, 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 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 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.

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.

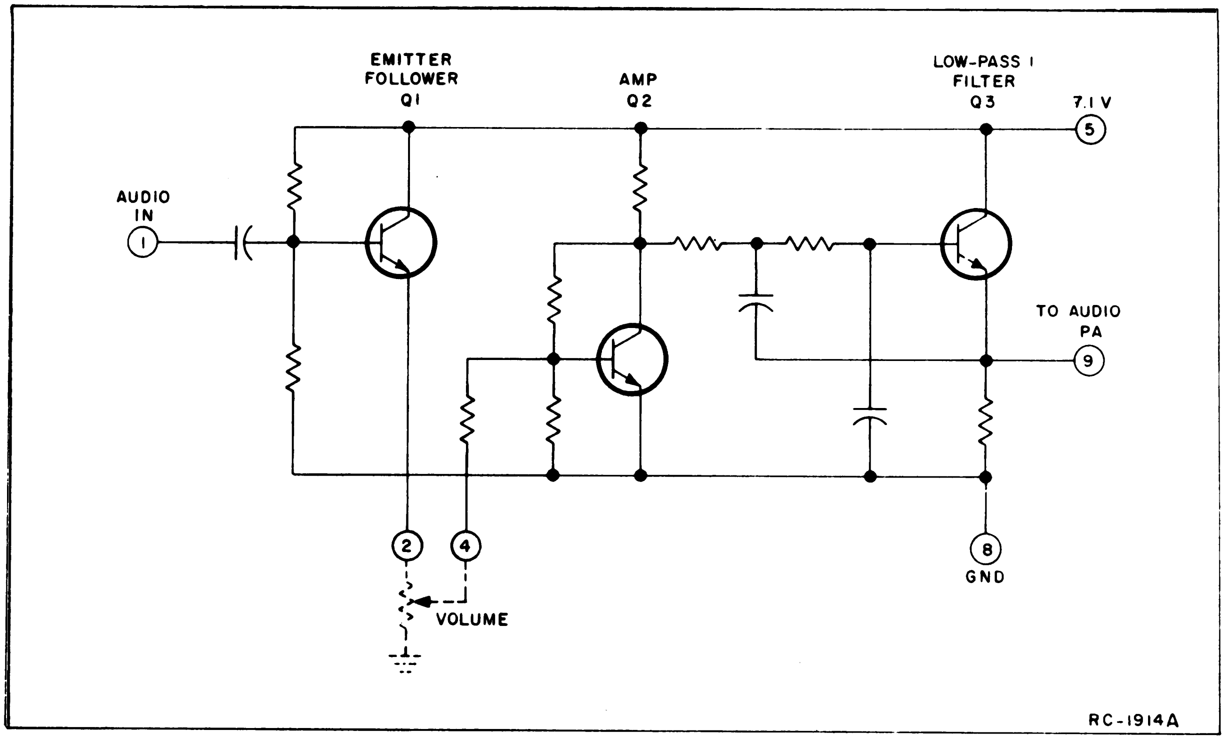


Figure 6 - Typical Audio Amplifier Circuit

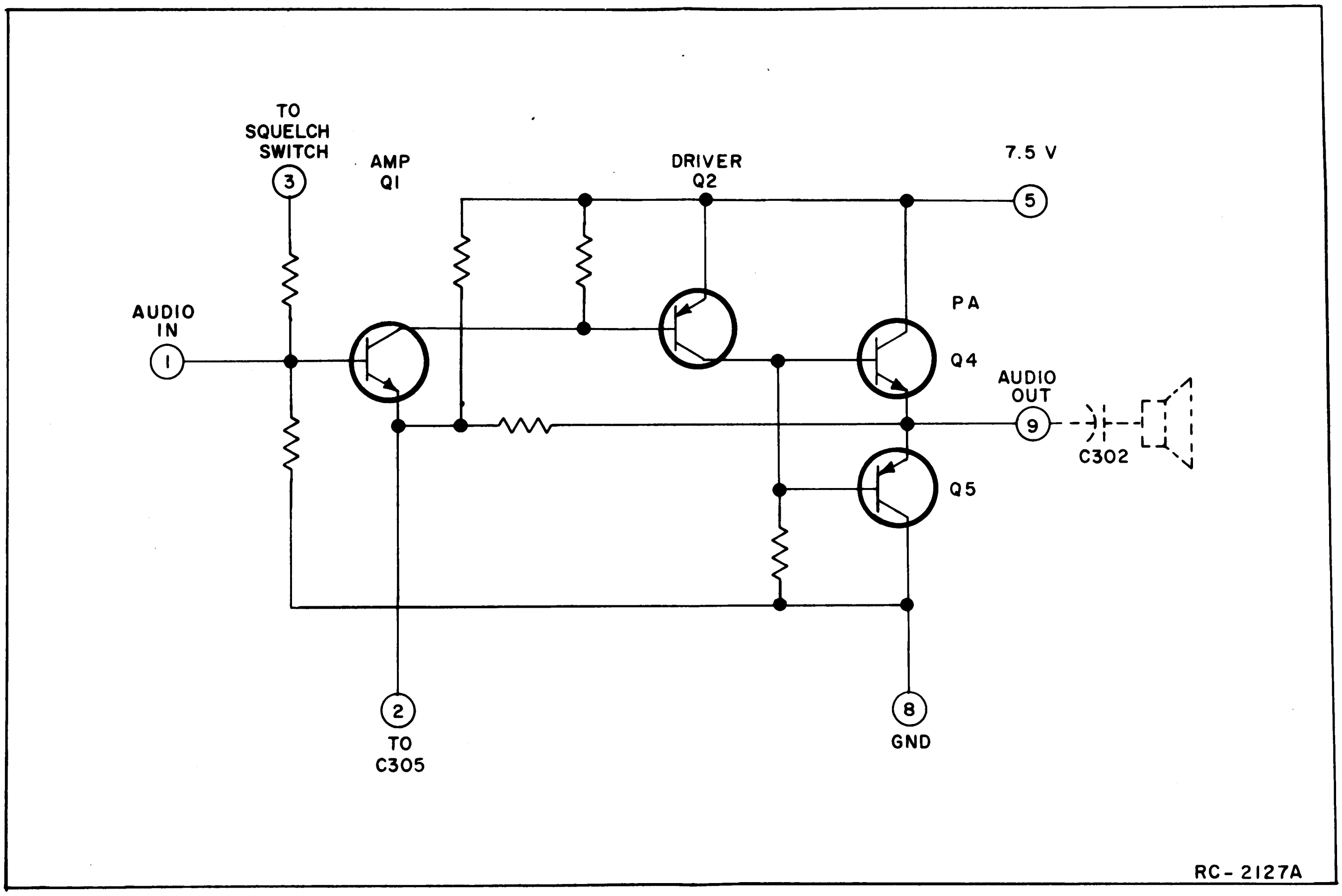


Figure 7 - Typical Audio PA Circuit

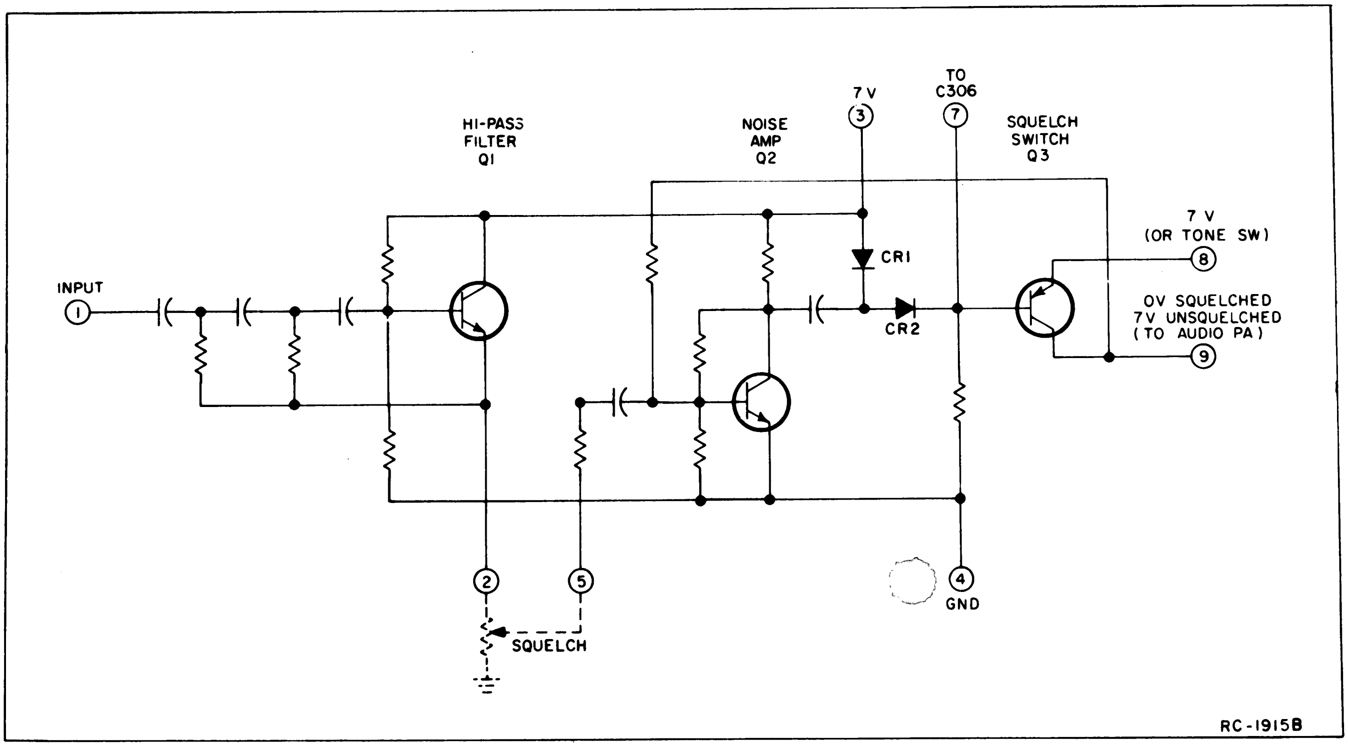
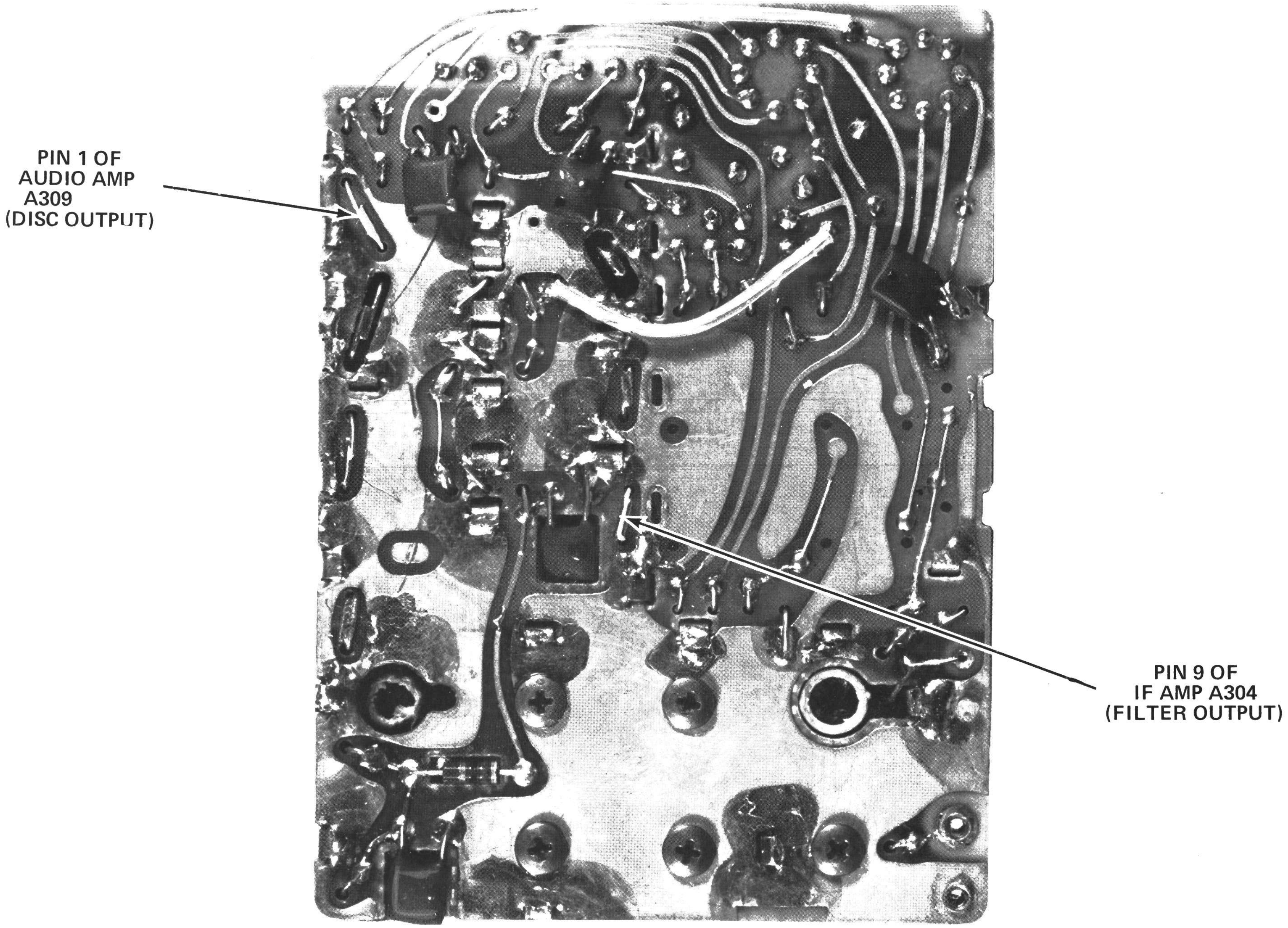


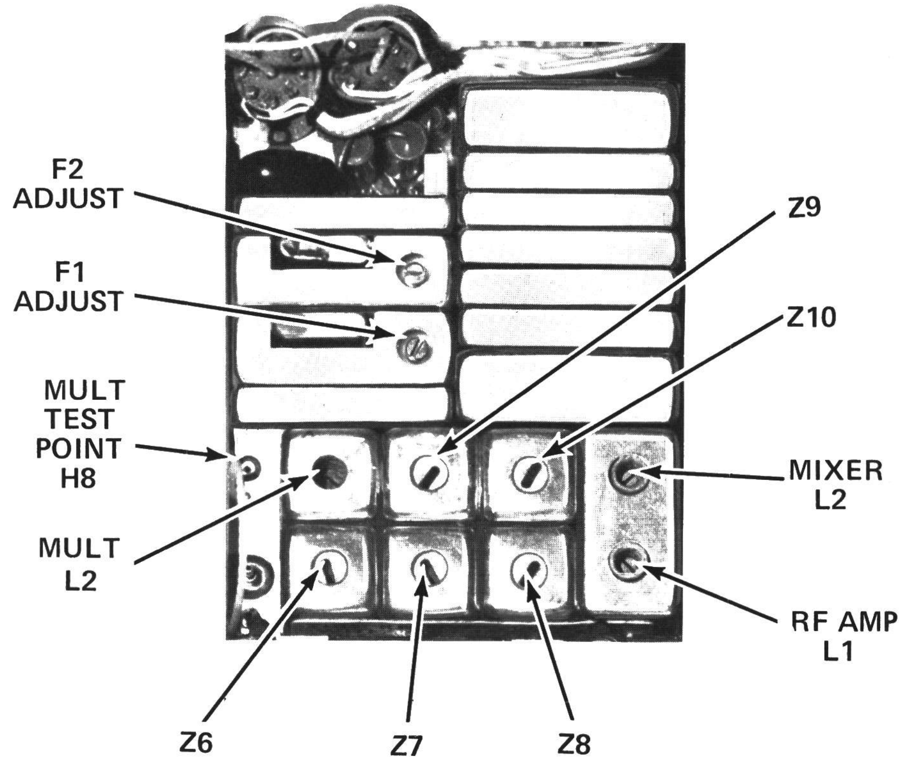
Figure 8 - Typical Squelch Circuit

RECEIVER ALIGNMENT

SOLDER SIDE



COMPONENT SIDE



EQUIPMENT

1. A 20-MHz signal source (GE IF Generator Model 4EX9A10 or equivalent) and a 150.8-174 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 Z6 thru Z9 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 L1 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 L2	Adjust L2 for maximum meter reading.
2.	Z9 and Z10	Adjust Z9 and then Z10 for slight change in meter reading.
3.	Z6 thru Z8 and RF Amp L1	Apply an on-frequency signal to J702 and adjust Z6, Z7, Z8, and L1 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 L2, Z9, and Z10	De-tune L2. Next, increase the on-frequency input signal and tune Z9 and Z10 for best quieting sensitivity. Now re-adjust L2 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.

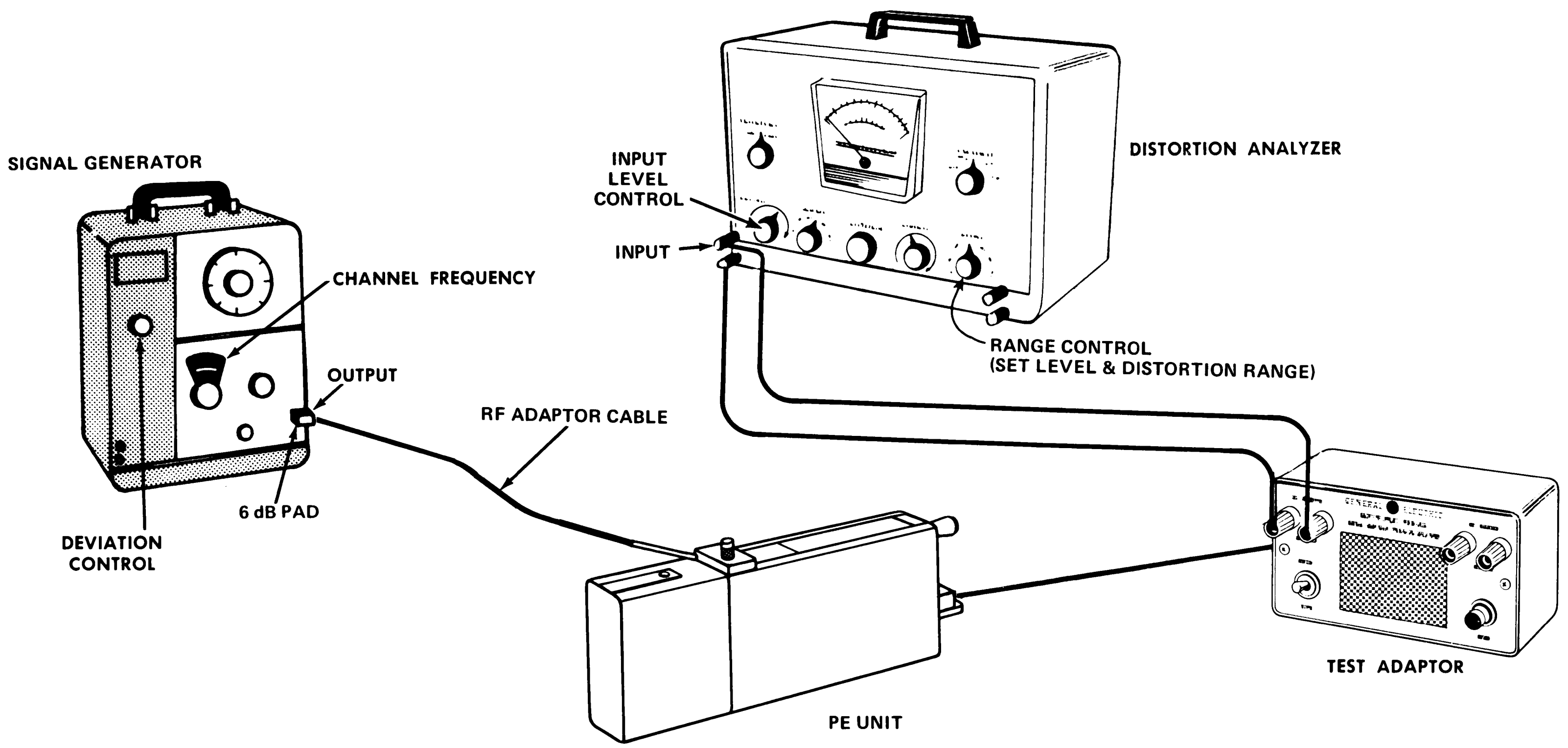
Once the defective stage is pin-pointed, refer to the "Service Check" listed to correct the problem. Additional corrective measures are included in the Troubleshooting Procedure. Before starting with the Receiver Test Procedures, be sure the receiver is tuned and aligned to the proper operating frequency.

TEST EQUIPMENT REQUIRED

- Distortion Analyzer similar to: Heath IM-12
- Signal Generator similar to: Measurements M-800
- 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).

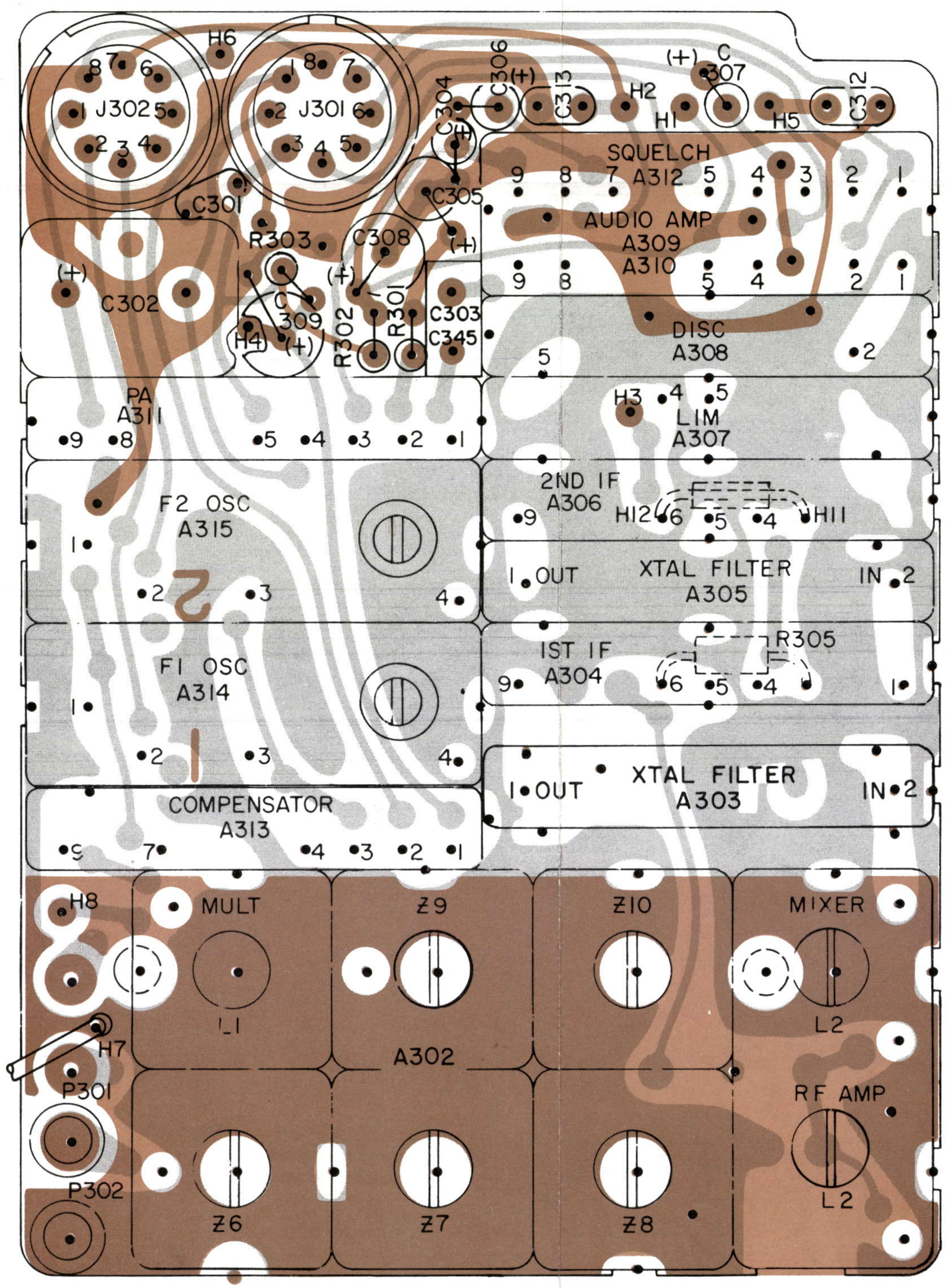
D. The deviation control reading for the 12-dB difference is the Modulation Acceptance Bandwidth of the receiver. It should be more than ±7 kHz (but less than ±9 kHz).

SERVICE CHECK

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

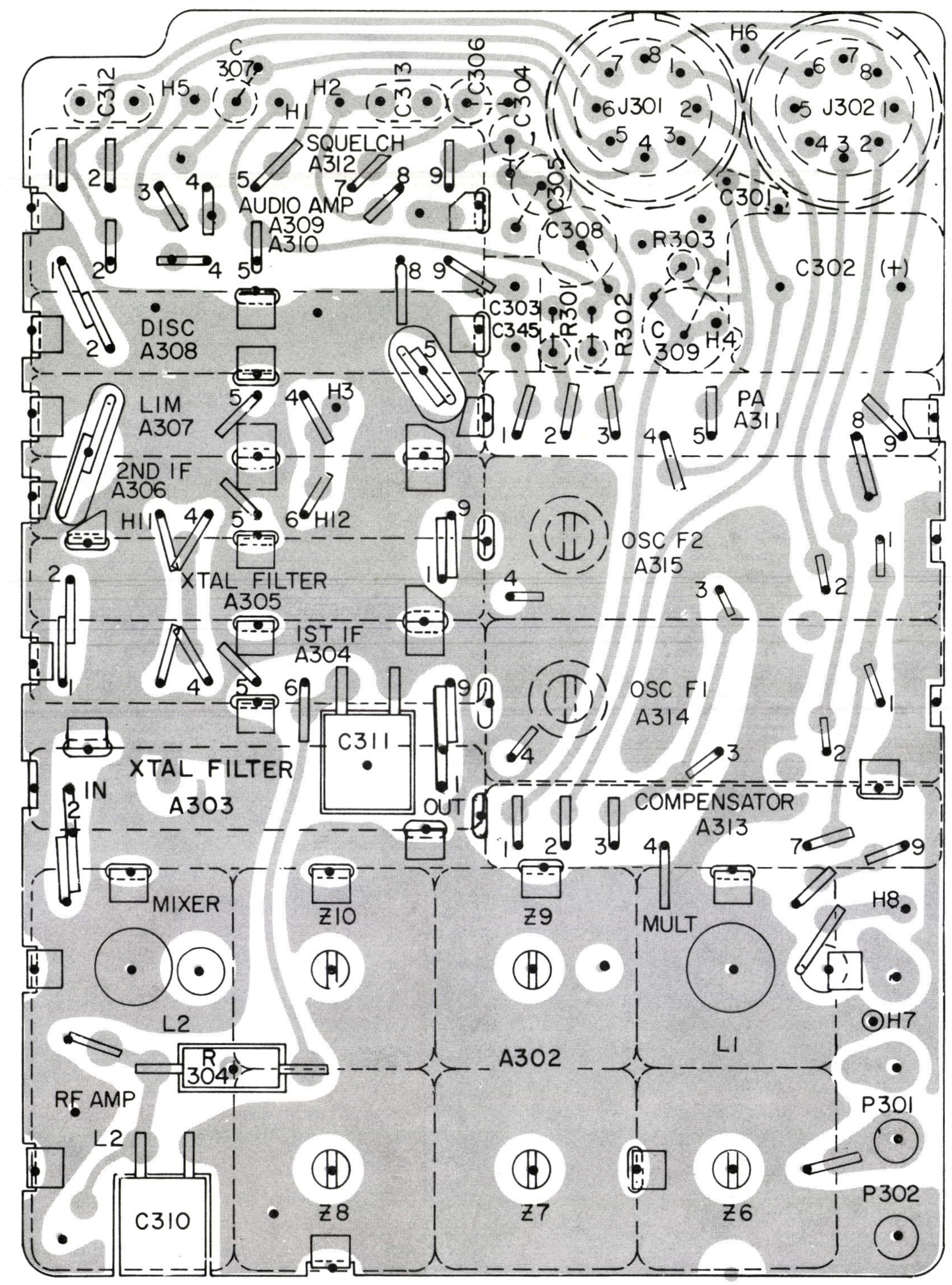
	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8
J301	5.4V	AUDIO OUT	SWITCHED 7.5V	SQ ARM	VOL ARM	SQ HI	VOL HI	GND
J302		FREQ 1	FREQ 2			7.5V	TONE SWITCH	GND

COMPONENT SIDE



RF IN

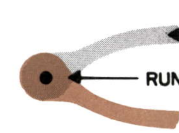
SOLDER SIDE



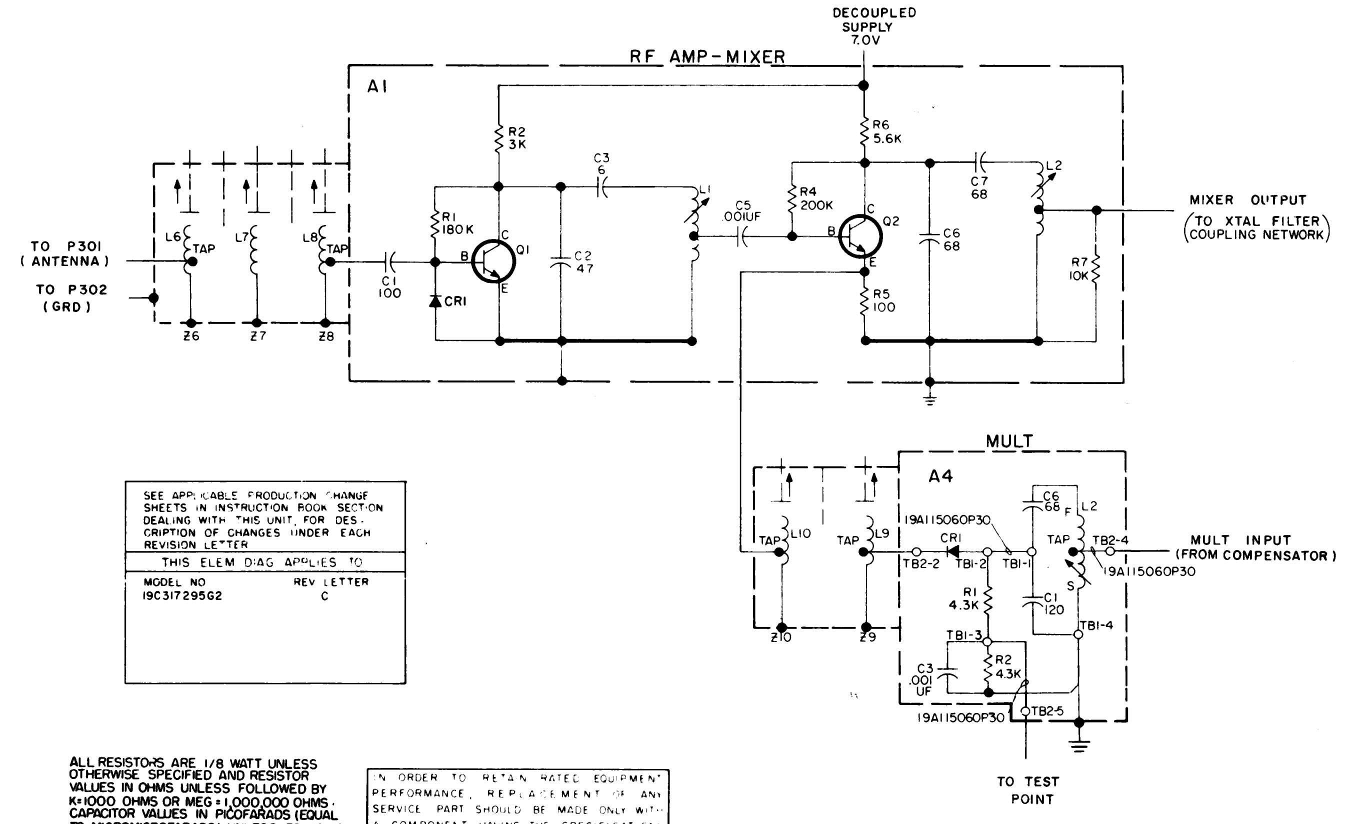
OUTLINE DIAGRAM

150.8—174 MHz RECEIVER
MODELS 4ER59A11 & 13

(19D416196, Rev. 11)
(19D416852, Sh. 2, Rev. 5)
(19D416852, Sh. 3, Rev. 6)



(19D416196, Rev. 11)
(19D416852, Sh. 3, Rev. 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
19C317295G2	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.

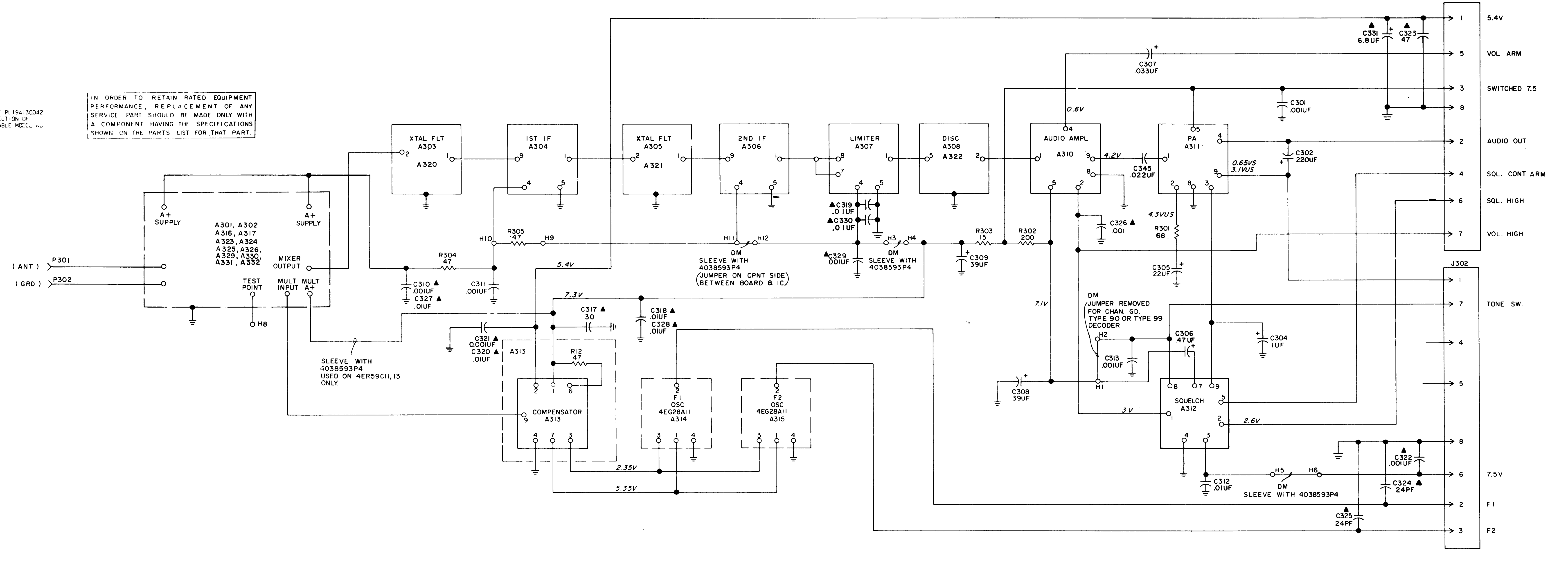
(19C320888, Rev. 5)

SCHEMATIC DIAGRAM

150.8—174 MHz RECEIVER HIGH SENSITIVITY FRONT END (A302) MODELS 4ER59A11 & 13

▲ 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.



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	B
PL19A130042G6	A

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. 16)

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

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

150.8—174 MHz RECEIVER
MODELS 4ER59A11 & 13

PARTS LIST

LBI4232E

150.8-174 MHz RECEIVER
MODEL 4ER59A11 STD
MODEL 4ER59A13 CG

SYMBOL	GE PART NO.	DESCRIPTION
A302		FRONT END 19C317295G2 150.8-174 MHz
A1*		RF AMPLIFIER 19C327300G1 (Added by REV C)
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1	19A116114P11064	Ceramic: 100 pf ±10%, 100 VDCW; temp coef -4200 PPM.
C2	19A116114P8053	Ceramic: 47 pf ±5%, 100 VDCW; temp coef -1500 PPM.
C3	19A116114P2020	Ceramic: 6 pf ±5%, 100 VDCW; temp coef -80 PPM.
C5	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C6 and C7	19A116114P4059	Ceramic: 68 pf ±5%, 100 VDCW; temp coef -220 PPM.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1	19A116052P1	Silicon.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L1	19B216950G1	Coil.
L2	19B216948G1	Coil.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1 and Q2	19A116159P1	Silicon, NPN.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	3R151P184J	Composition: 180K ohms ±5%, 1/8 w.
R2	3R151P302J	Composition: 3K ohms ±5%, 1/8 w.
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.
A1*		RF AMPLIFIER 19C317445G1 (Deleted by REV C)
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1*	19A116114P11064	Ceramic: 100 pf ±10%, 100 VDCW; temp coef -4200 PPM.
		In REV A:
	19A116114P7068	Ceramic: 120 pf ±5%, 100 VDCW; temp coef -750 PPM.
		Earlier than REV A:
	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C2*	19A116114P8053	Ceramic: 47 pf ±5%, 100 VDCW; temp coef -1500 PPM.
		In REV A and earlier:
	19A116114P8041	Ceramic: 22 pf ±5%, 100 VDCW; temp coef -1500 PPM.
C3*	19A116114P2020	Ceramic: 6 pf ±5%, 100 VDCW; temp coef -80 PPM.
		In REV A and earlier:
	19A116114P2024	Ceramic: 7 pf ±5%, 100 VDCW; temp coef -80 PPM.
C5	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C6 and C7	19A116114P4059	Ceramic: 68 pf ±5%, 100 VDCW; temp coef -220 PPM.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1*	19A116052P1	Silicon. Added by REV B.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L1	19B216950G1	Coil.
L2	19B216948G1	Coil.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1 and Q2	19A116159P1	Silicon, NPN.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	3R151P184J	Composition: 180K ohms ±5%, 1/8 w.
R2	3R151P302J	Composition: 3K ohms ±5%, 1/8 w.
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.
A4		MULTIPLIER 19C311873G5
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1*	19A116114P7068	Ceramic: 120 pf ±5%, 100 VDCW; temp coef -750 PPM. Added by REV B.
C3	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C6*	19A116114P4059	Ceramic: 68 pf ±5%, 100 VDCW; temp coef -220 PPM. Added by REV B.
C8*	19A116114P7074	Ceramic: 180 pf ±5%, 100 VDCW; temp coef -750 PPM. Deleted by REV B.
C9*	19A116114P4057	Ceramic: 62 pf ±5%, 100 VDCW; temp coef -220 PPM. Deleted by REV B.
C10*	19A116114P3053	Ceramic: 47 pf ±5%, 100 VDCW; temp coef -150 PPM. Deleted by REV B.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1	19A116081P1	Silicon.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L1*	19B216296P1	Coil. Includes: Deleted in G5 by REV B.
	19B200495P5	Tuning slug.
L2*	19B216296P2	Coil. Includes: Added in G5 by REV B.
	19B200495P5	Tuning slug.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	3R151P432J	Composition: 4.3K ohms ±5%, 1/8 w.
R2*	3R151P432J	Composition: 4.3K ohms ±5%, 1/8 w. Deleted by REV A.
R9*	3R151P432J	Composition: 4.3K ohms ±5%, 1/8 w. Added by REV A.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L6	19B216441G2	Helical resonator. (Part of Z6). Includes:
	19C311727P1	Tuning slug.
L7	19B216441G3	Helical resonator. (Part of Z7). Includes:
	19C311727P1	Tuning slug.
L8*	19B216441G12	Helical resonator. (Part of Z8). Includes:
	19C311727P1	Tuning slug.
		In REV A and earlier:
	19B216441G1	Helical resonator. (Part of Z8). Includes:
	19C311727P1	Tuning slug.
L9 and L10	19B216441G4	Helical resonator. (Part of Z9, Z10). Includes:
	19C311727P1	Tuning slug.
		- - - - - - - HELICAL RESONATORS - - - - - - -
Z6		Consists of L6 and 19D413132P16 can.
Z7		Consists of L7 and 19D413132P3 can.
Z8		Consists of L8 and 19D413132P17 can.
Z9		Consists of L9 and 19D413132P19 can.
Z10		Consists of L10 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.
A306	19C311879G4	2nd IF Amplifier.
A307	19C311876G4	Limiter.
A308	19C304504G3	Discriminator.
A309*	19C311878G2	Audio Amplifier. Deleted by REV H.
A310	19C311995G4	Audio Amplifier. (Includes Tone Filter).
A311*	19C311877G4	PA.
		In REV F and earlier:
	19C311877G2	PA.
A312	19C311880G4	Squelch.
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.
	4EG28A11	Oscillator Module. 150.8-174 MHz. $Fx = \frac{Fo - 20}{9}$
		- - - - - - - - - - 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.
		RECEIVER KIT 19A130042G1
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C310	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C326*	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW. Added by REV A.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
	19B200497P5	Tuning slug. (Used with L2 on A4).
	19B219801P2	Shield. (Used with Z6 of Front End).
	19B216316P1	Insulator. (Used with J301, J302 on Receiver Board).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

PRODUCTION CHANGES

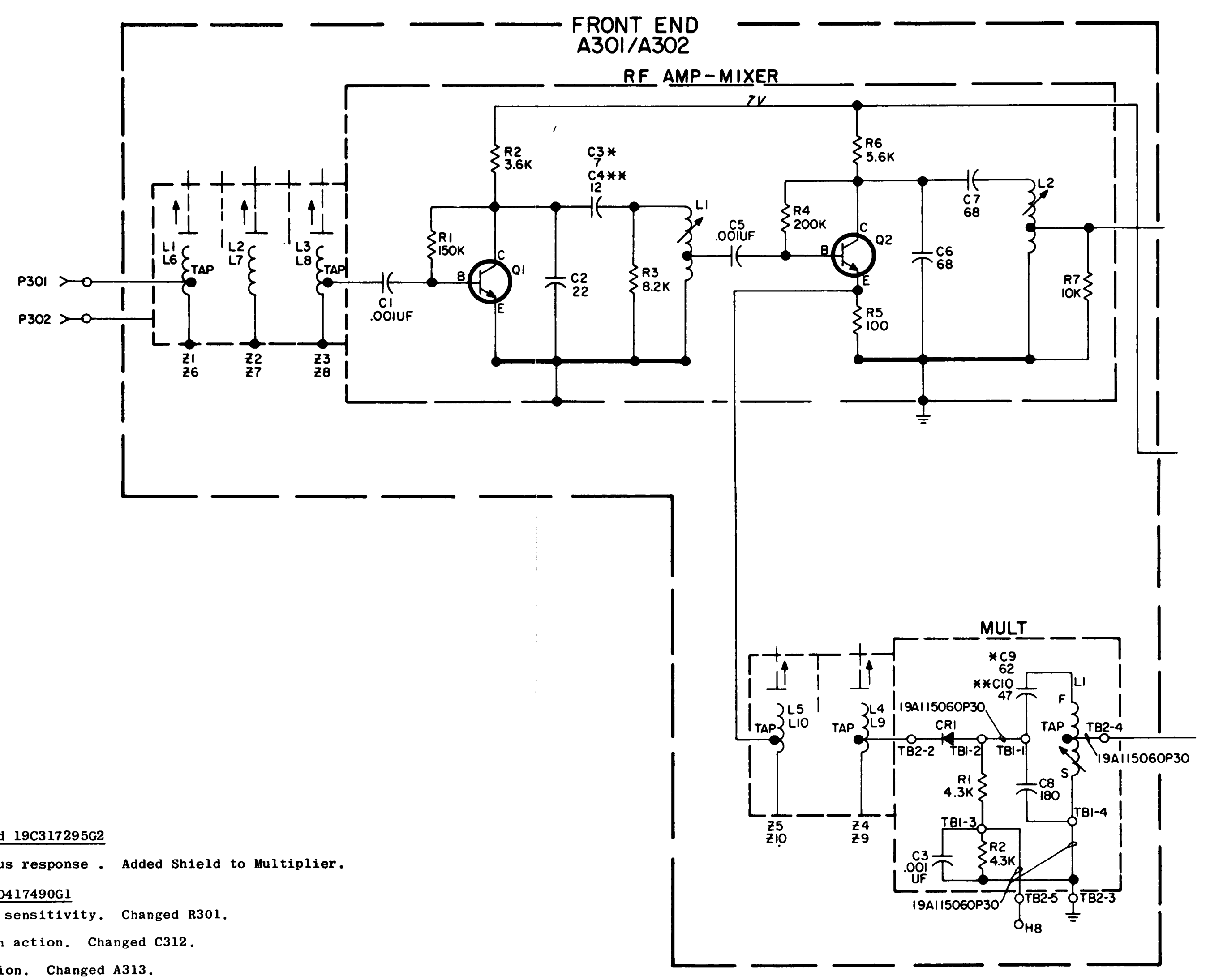
Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

4ER59A10-13

REV. A - To improve performance. Changed C1 and R3.

REV. B - To simplify manufacturing test. Changed L3 and L8 in the Front End. Changed C1 thru C4 and deleted R3 in the RF Amplifier. Replaced C8 with C1, C9 with C6, C10 with C7 and added L2 to the Multiplier.

SCHEMATIC DIAGRAM WAS:



REV. A - Receiver Front End 19C317295G2

To improve Spurious response . Added Shield to Multiplier.

REV. A - Receiver Board 19D417490G1

To increase audio sensitivity. Changed R301.

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

REV. C - To improve operation. Changed A313.

REV. D - To improve producibility. Changed A303.

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

REV. F - To improve frequency response. Added C345.

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, .1 µf and the circle (●) for C345. Deleted NOTES: ■ Use for non Channel Guard Receivers. ● Use for Channel Guard Receivers.

REV. B - Receiver Front End 19C317295G2

To protect RF Amp transistor and mixer transistors. Added CR1.

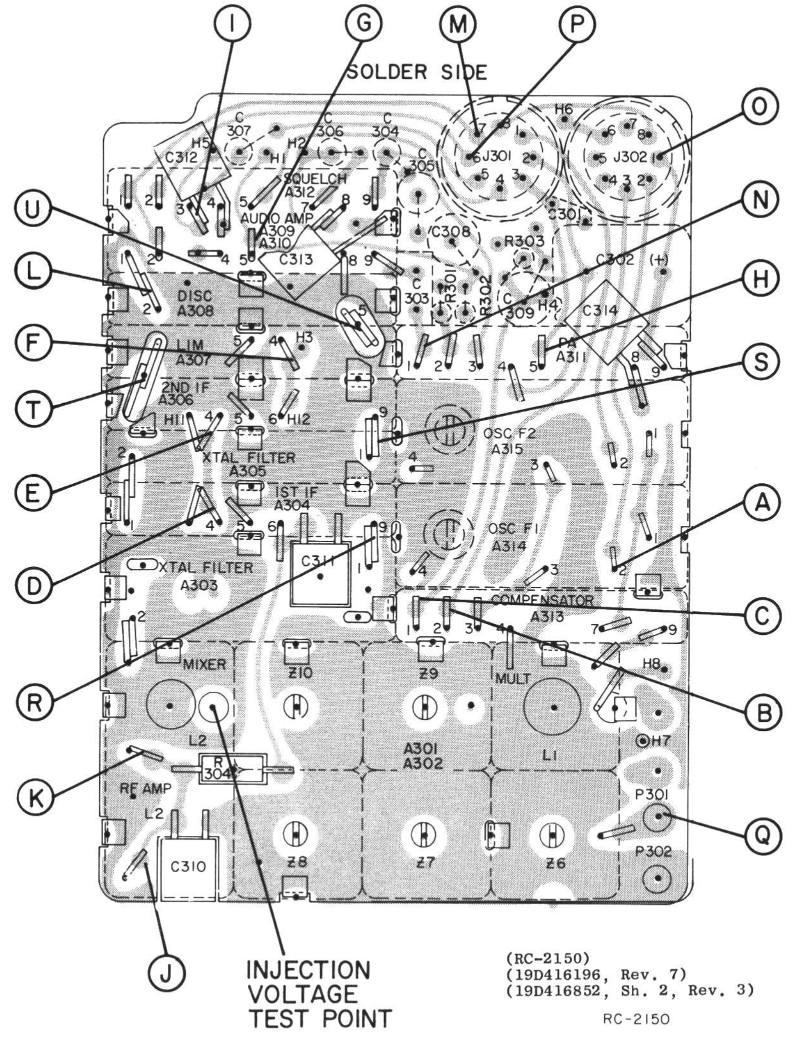
REV. C - To improve ease of assembly, troubleshooting and repair. Changed RF Amplifier/Mixer A1.

REV. A - Receiver Kit 19A130042G1

To improve IF filtering. Added C326.

QUICK CHECKS

SYMPTON	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 injection voltage for a minimum level of 30 millivolts. If the reading is low, check the output of the Oscillator and Compensator modules with an RF voltmeter. 2. 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-2150)
(19D416196, Rev. 7)
(19D416852, Sh. 2, Rev. 3)

RC-2150

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
```

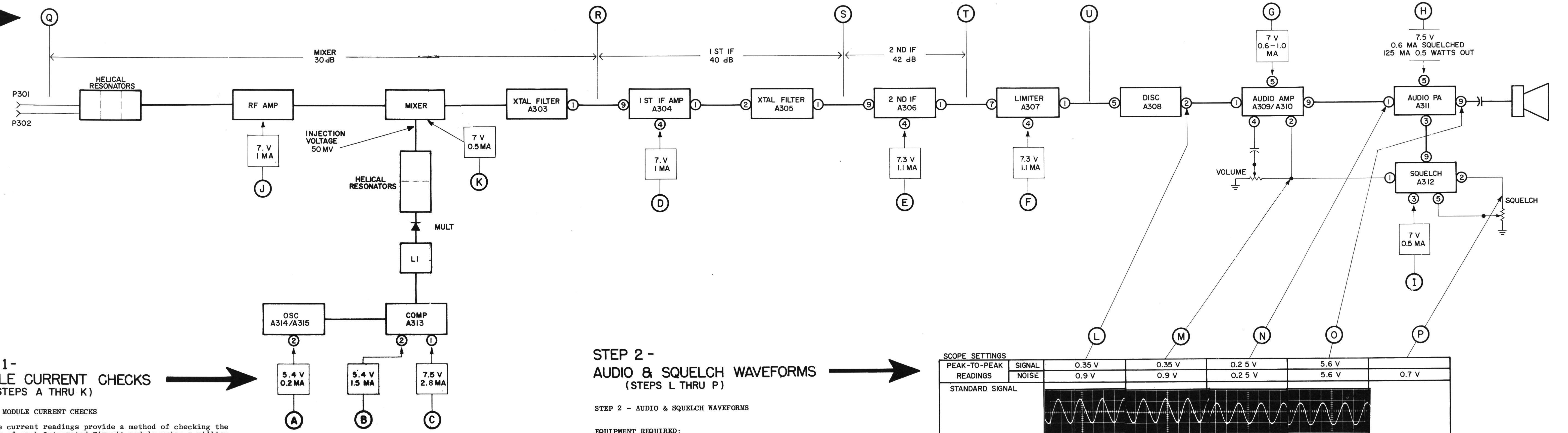
PROCEDURE FOR 2ND IF:

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:

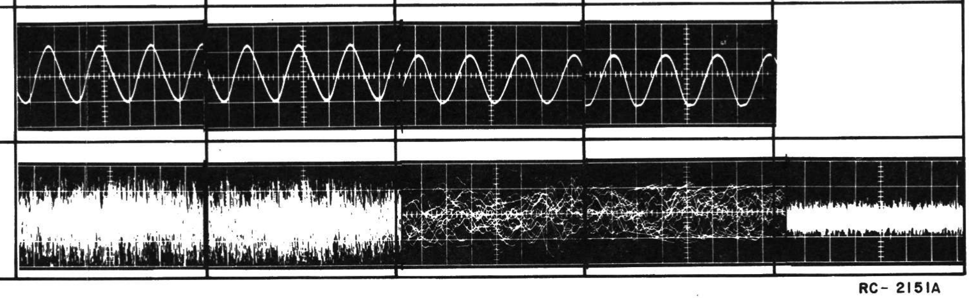
- Oscilloscope connected between the points shown and ground.
- Signal Generator (Measurements M-800 or equivalent).

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	0.2 5 V	5.6 V	
	NOISE	0.9 V	0.9 V	0.2 5 V	5.6 V	0.7 V
STANDARD SIGNAL						
NOISE WAVEFORM						



RC- 2151A

TROUBLESHOOTING PROCEDURE

150.8—174 MHz RECEIVER
MODELS 4ER59A11 & 13