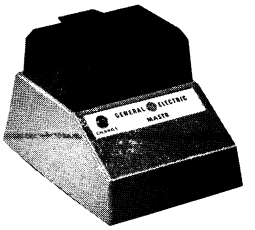
MOBILE RADIO

MASTR
PROGRESS LINE
Personal Series
MAINTENANCE MANUAL

PE MODEL

EXTERNAL MICROPHONE

406–470 MHz
8-FREQUENCY
PE MODEL RADIO
TWO-WAY
PERSONAL
FM RADIO
LBI-4445
DF-9029



DESK CHARGER

GENERAL ELECTRIC

TABLE OF CONTENTS

SPECIFICATIONS

GENERAL

Frequency Range	406-420 and 450-470
Battery Drain (@7.5 Volts)	
Standby	14.5 milliamps
Receive	140 milliamps
Transmit	680 milliamps
Operable Temperature Range	
Transmitter-Receiver	-30°C to +60°C (-22°F to +140°F)
Rechargeable Battery Pack	-20°C to +45°C (-4°F to +113°F)
Frequency Stability	
-30°C to +60°C	±.0005%
0°C to +55°C	±.0002%

TRANSMITTER

Type Number	KT-22-A
Power Output	1 Watt
Modulation Deviation	0 to ±5 kHz
Spurious	
Radiated	-43 dB
Conducted	-43 dB
Audio Response	Within +1 and -3 dB of a 6-dB/octave pre-emphasis from 300 to 3000 Hz except for an additional 6-dB/octave roll-off from 2500 to 3000 Hz per EIA.
Audio Distortion	Less than 8%
Crystal Multiplication Factor	24
RF Load Impedance	50 ohms
Modulation Sensitivity	0.8 to 3 millivolts
Maximum Frequency Spacing	
450-470 MHz	0.4% of highest frequency with no degradation 5.5 MHz with less than 1 dB degradation
406-420 MHz	0.4% of highest frequency with no degradation 0.8% of highest frequency with less than 1 dB degradation

RECEIVER

Type Number	ER-60-B
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)	-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	0.20 µV
Maximum Squelch	Greater than 20-dB Quieting
Maximum Frequency Spacing	0.4% of highest frequency with no degradation
	0.8% of highest frequency with less than 1 dB degradation

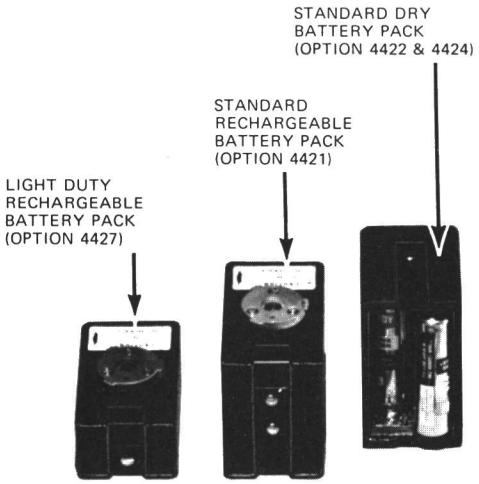
*These specifications are intended primarily for the use of the servicemen. Refer to the appropriate Specification Sheet for the complete specifications.

COMBINATION NOMENCLATURE

1st & 2nd Digits	3rd Digit	4th Digit	5th Digit	6th Digit	7th Digit	8th & 9th Digits
Product Line	RF Power Output Range	Channel Spacing	Control	Number of Freq.	Options	Frequency Range
PE Personal Series	**4** 1 Watt	**5** 25 kHz	**K** Extended	**A** 1-Freq.Xmit 1-Freq.Rec	**S** Standard	**77** 406-420 MHz
				B 2-Freq.Xmit 1-Freq.Rec	**U** Channel Guard Encoder/Decoder	**88** 450-470 MHz
				C 2-Freq.Xmit 2-Freq.Rec	**R** 2-Tone Channel Guard Encoder	
				D 1-Freq.Xmit 2-Freq.Rec	**B** Type 90 Encoder/Decoder	
				E 3-Freq.Xmit 3-Freq.Rec	**C** Type 90 2-Tone Encoder	
				F 4-Freq.Xmit 4-Freq.Rec		
				G 5-Freq.Xmit 5-Freq.Rec		
				H 6-Freq.Xmit 6-Freq.Rec		
				J 7-Freq.Xmit 7-Freq.Rec		
				K 8-Freq.Xmit 8-Freq.Rec		

ACCESSORIES

BATTERY PACKS

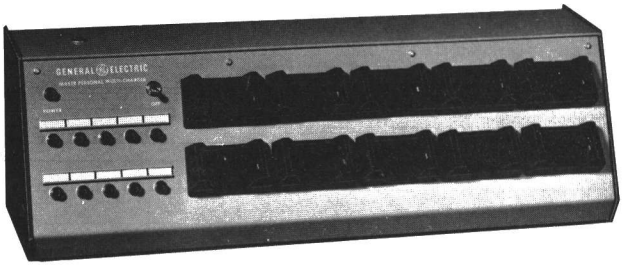


DESK CHARGER
MODEL 4EP71A10 (Option 4436)

FAST CHARGER
MODEL 4EP73A10 (Option 4440)

RF ADAPTER CABLE
(Option 4466)

MULTI-CHARGER
MODEL 4EP68A10 (Option 4445)

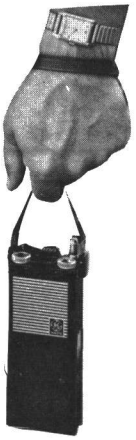


(Plug-in Slave Unit Option 4446)

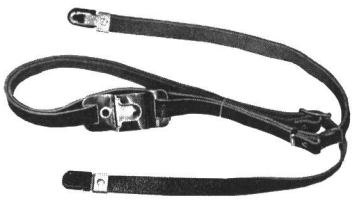
VEHICULAR CHARGER
MODEL 4EP72A10 &11
(Options 4451 thru 4456)

LEATHER CASE
(Option 4411)

HAND STRAP
(Option 4406)



SHOULDER STRAP
(Option 4407)



TEST EQUIPMENT

TEST ADAPTOR
MODEL 4EX12A10 (Option 4384)

Provides transmitter and receiver audio connections

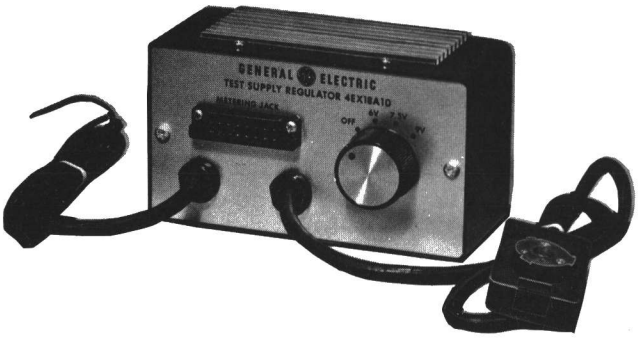
IF GENERATOR
MODEL 4EX9A10 (Option 4381)

For setting the receiver on frequency and for troubleshooting

TEST SET
MODEL 4EX3A10 (TM-11 & TM-12)

Used with Test Regulator for servicing

TEST REGULATOR
MODEL 4EX18A10 (Option 4465)



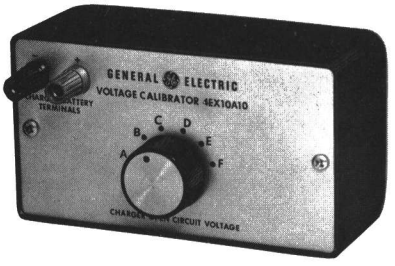
Extension cables for servicing the receiver out of the radio

Transmitter RF Adaptor Cable

TEST AMPLIFIER
MODEL 4EX16A10 &
RF PROBE 19C311370-G1 (Option 4382)

For receiver front end and IF gain measurements

VOLTAGE CALIBRATOR
MODEL 4EX10A10 (Option 4383)



For setting voltages on Personal Battery Chargers

DESCRIPTION

General Electric MASTR PE Model personal radios are extremely compact, high performance two-way FM radios designed for one-through eight-frequency operation in the 406-470 MHz range. The radios are fully transistorized -- utilizing both discrete components and Integrated Circuit modules (IC's).

The radio is contained in a ruggedly-constructed, weatherproof Lexan ® case with vinyl-covered, stainless steel front and back covers. All operating controls except the PTT switch are conveniently located on the top of the radio. The accessory jack on the top of the radio is provided for external microphones, earphones and other accessories.

Power for the radio is normally supplied by a rechargeable nickel-cadmium battery pack that quickly attaches to the bottom section of the case. The battery pack can be recharged either attached or removed from the radio.

A battery pack using dry batteries is available whenever the rechargeable battery pack is not required.

OPERATION

When using the collapsible antenna, make sure that the antenna is in the fully-extended position. If the radio is equipped with a tone option switch, disable the option before adjusting the radio by placing the switch in the OFF or M (Monitor) position. After adjusting the radio, place the option switch back in the ON or N (normal) position to enable the option. Refer to LBI-4229 for complete operating instructions.

TO RECEIVE A MESSAGE

1. Turn the OFF-VOLUME control about halfway to the right.
2. Turn the SQUELCH (SQ) control to the right as far as possible. A hissing sound will be heard from the speaker.
3. Adjust the VOLUME control until the hissing sound is easily heard but not annoyingly loud.
4. Turn the SQUELCH control slowly to the left until the hissing noise just fades out.

In multi-frequency units, select the proper frequency. You are now ready to receive messages from other radios in your system.

TO SEND A MESSAGE

1. Turn on the radio as directed in the "To Receive a Message" section.
2. In two-frequency units, select the proper frequency. Then listen to make sure that no one is using the channel.
3. While holding the radio so that the antenna is vertical, press the Push-to Talk (PTT) switch and speak directly into the local microphone (or across the face of an external microphone) in a normal tone of voice. Release the PTT switch as soon as you stop talking. You cannot receive messages when the PTT switch is pressed.

OPERATING TIPS

The following conditions tend to reduce the effective range of Two-Way Radios, and should be avoided whenever possible.

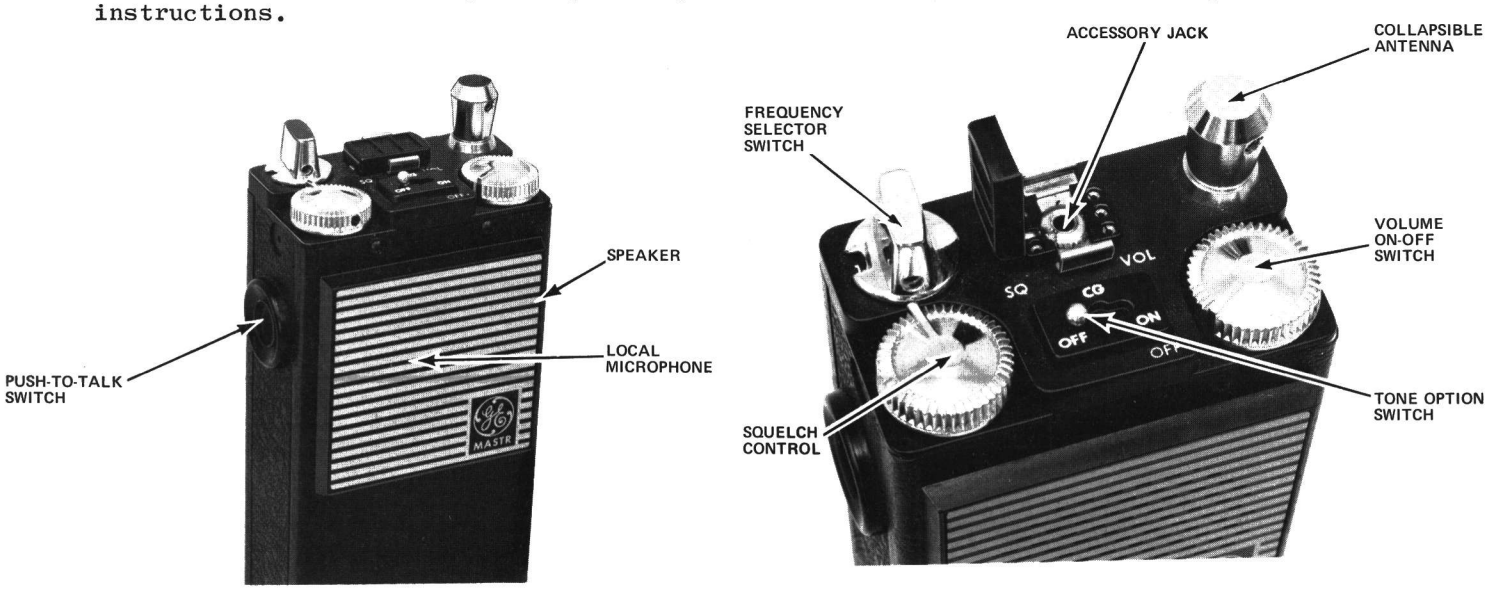


Figure 1 - Operating Controls

- Operating the radio in low areas of the terrain, or while under power lines or bridges.
- Operating the radio inside of a vehicle, or in a metal or steel-framed building unless using an external antenna.
- Obstructions such as mountains or buildings between the person sending and the person receiving the messages.

In areas where the transmission or reception is poor, check to see that the antenna is fully extended. Then hold the radio so that the antenna is vertical. If this doesn't help, move a few yards or turn a corner and head in another direction. Moving to a higher elevation can help considerably.

MAINTENANCE

SERVICING THE RADIO

A complete procedure is provided in this manual for disassembling the radio for servicing. The procedure also contains instructions for replacing the different assemblies, Integrated Circuit modules and transmitter PA transistors. Refer to the Disassembly Procedure as listed in the Table of Contents.

If the radio should begin to operate improperly (i.e., transmitted messages start getting weak and hard to understand, or the receiver won't squelch properly), the first thing to suspect is run-down batteries. If a freshly recharged battery pack or new dry batteries fail to restore the radio to its normal operating condition, refer to the appropriate Troubleshooting Procedure for help in isolating and correcting the problem.

TEST AND TROUBLESHOOTING PROCEDURES

Whenever difficult servicing problems occur, the Test Procedures for the transmitter and receiver can be used by the servicemen to compare the actual performance of the unit to the specifications met by the unit when shipped from the factory.

In addition, specific Troubleshooting Procedures are available for the transmitter, receiver and tone options. For best results, the Test Procedures should be used in conjunction with the Troubleshooting Procedures when servicing the radio. Refer to the Table of Contents for the applicable procedure.

CHANGING FREQUENCIES

To change the operating frequency of the transmitter and receiver, it is necessary to replace the entire oscillator module as directed in the Disassembly Procedure. Always give the model number of the module and the exact operating frequency required when ordering new oscillator modules.

After replacing the oscillator module, re-align the transmitter or receiver as directed in the applicable Alignment Procedure (see Table of Contents).

BATTERY INFORMATION

Two rechargeable battery packs and a dry battery pack are available for operating the radio. The different battery packs are shown in Table 1.

The rechargeable battery packs are shipped from the factory in a fully-charged condition -- ready for immediate use. If the radio has been stored for over 30 days, the battery pack should be fully recharged before using. When it is necessary to store the unit for over 30 days, it is recommended that the battery pack be kept in the appropriate battery charger.

All of the battery packs are directly interchangeable. However, the battery pack should be selected according to the

Battery Pack	Battery Pack	Battery Part Number	Equivalent
Standard 19D413522G1	Rechargeable	19D413522G1	None
Dry Battery Pack 19E500938G1	Carbon-zinc		Eveready 1015
Dry Battery Pack 19E500938G1	Alkaline (Package of 4)	19B200608P2	Eveready E91
Dry Battery Pack 19E500938G1	Mercury (Package of 4)	19A116522P2	Mallory RM15
Light Duty 19D413522G2	Rechargeable	19D413522G2	None

Table 1 - Battery Packs

power output and battery life required. Battery life for a 10% transmit, 10% receive and 80% standby duty cycle and for a 5% transmit, 5% receive and 90% standby are shown in Table II.

WARNING

Do not dispose of the rechargeable battery packs or mercury batteries by burning them. To do so may cause a battery to explode.

BATTERY PACK REPLACEMENT

To remove the battery pack from the radio:

1. Turn the radio OFF.
2. Press the battery retaining latch away from the battery pack as shown in Figure 2, and turn the battery pack one-quarter turn to the left. The battery pack can now be detached from the radio.

To reconnect the battery pack to the radio:

1. Hold the battery pack at a 90° angle to the radio as shown in Figure 2.
2. Align the large tab marked with an arrow on the battery pack connector with the large cut-out marked with an arrow on the radio socket.
3. Press the battery pack connector into the socket on the radio and turn the battery pack one-quarter turn to the right until the latch clicks.

STANDARD DRY BATTERY PACK

Standard battery pack 19E500938G1 is equipped with a removable bottom cover for use with dry batteries. To remove the batteries:

1. Remove the battery pack from the radio.

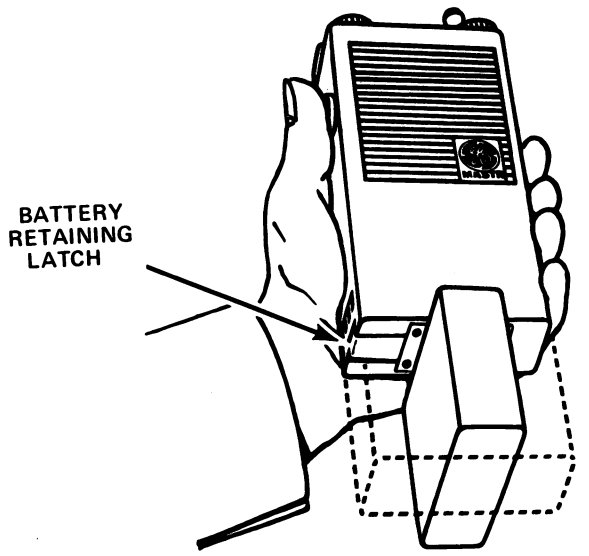


Figure 2 - Battery Pack Replacement

2. Press in and turn the captive screw one-quarter turn to the left to the OPEN position, and lift off the cover.
3. Rap the open end of the battery pack on the palm of one hand over a table or desk to dislodge the batteries.
4. Replace the batteries with the plus (+) end pointing away from the springs as shown on the decal in the battery compartment.
5. Replace the bottom cover with the white dot in corner of the cover over the white dot in the corner of the battery compartment.
6. Turn the locking screw one-quarter turn to the right to the LOCK position.

Duty Cycle	BATTERY LIFE IN HOURS			
	Standard Rechargeable	Standard Mercury	Standard Alkaline	Light Duty Rechargeable
10-10-80	5.8	22	2	0.7
5-5-90	10	39	3	1.3

Table II - Battery Life

BATTERY CHECKS

CHARGE LEVEL MEASUREMENT

The charge level of the battery packs can be accurately measured by connecting a voltmeter across the charging contacts and measuring the voltage with the transmitter keyed.

For the rechargeable battery packs, a fully charged battery pack should provide a reading of 7.5 to 8 Volts. A fully discharged battery pack should provide a reading of 6 to 5.6 Volts.

For dry battery packs, replace the batteries if the reading is 5.6 Volts or less.

RECHARGEABLE BATTERY CHECK

One of the best service checks for the PE series rechargeable battery packs can be easily obtained by measuring the ampere-hour capacity. The results of the measurement can then be compared with the rated capacity of the battery pack to determine the general condition of the rechargeable batteries.

First, it is necessary to find the percentage of rated capacity. This is obtained by measuring the time it takes to discharge a fully charged battery pack until the voltage drops to 6 Volts. The proper load resistor for each of the battery packs is shown in Table III.

Then use the formula $\frac{T}{60}$ = % where "T" is the time in minutes required to discharge the battery pack to 6 Volts and % is the percentage of rated capacity the battery delivered to a load. For example: assume the standard battery pack voltage dropped to 6 Volts in 50 minutes:

$$\frac{50}{60} = .83 \text{ (percentage of capacity)}$$

Now multiply the percentage of capacity by its rated capacity (see Table III):

$$.83 \times 500 \text{ mA} = 415 \text{ mA}$$

The 415 milliamperes is the actual capacity of the battery pack.

CAUTION

As the voltage drops very fast near the end of the discharge cycle, be very careful to avoid discharging the battery pack below 6 Volts.

BATTERY CHARGERS

Four different PE Series chargers are available for recharging the Standard and the Light Duty rechargeable battery packs. The charging times listed are the maximum times required. The charging time may be less, depending on the charge remaining in the battery pack. The different chargers are:

- DESK CHARGER - Charges one battery pack on or off of the radio from a 117-Volt, 50/60 Hz source in less than 16 hours.
- MULTI-CHARGER - Charges up to ten battery packs on or off the radio from a 117-Volt, 50/60 Hz source in 16 hours, or less. Three additional slave charging units can be connected to the multi-charger for charging up to 40 radios or battery packs simultaneously.
- FAST CHARGER - (Standard Battery Pack Only). Charges one radio or battery pack to 70% of capacity in 15 minutes (or less if the battery is not fully discharged). Fully recharges the battery pack in additional seven hours on trickle charge.
- VEHICULAR CHARGER - Charges one radio from the vehicle battery in less than 16 hours.

NOTE

Due to the temperature characteristics of the nickel-cadmium batteries, the batteries will not accept a full charge at temperature extremes. For maximum capacity, recharge the battery pack at a room temperature of from 65° to 85° Fahrenheit whenever possible.

All of the chargers are designed to prevent the battery pack from being over-charged. Whenever the CHARGE light goes out

RECHARGEABLE BATTERY PACK	RATED CAPACITY	DISCHARGE RATE (for 60 minutes	LOAD RESISTOR (R_L)	END VOLTAGE
STANDARD (6 cells) 19D413522G1	500 mA	500 mA	15 ohms, 8 Watts	6 VDC
LIGHT DUTY (6 cells)	150 mA	150 mA	50 ohms, 2 Watts	6 VDC

Table III - Capacity Measurement Data

(indicating 70% of charge), a trickle charge is applied to the battery pack for the remainder of the charging time, or until the battery pack is removed. The battery pack may be safely left on trickle charge as long as desired.

Refer to the applicable battery charger Maintenance Manual for complete instructions.

Desk Charger

To use the Desk Charger, plug the power cable into a 117-Volt AC, 50/60 Hz source. Next, place the radio into the charging insert with the speaker facing the front of the charger, or place the battery pack into the insert with the arrow on the yellow label pointing towards the rear of the charger. The red CHARGE light will glow when the battery is charging.

The radio can be used to send and receive messages while charging although it will probably take longer to recharge the battery. Simply leave the desk Charger turned on and use the radio as you normally would.

The Desk Charger is equipped with an antenna connector for connecting the unit to an external antenna. Simply placing the radio into the charging insert automatically connects the radio to the external antenna and disconnects the internal antenna. If the automatic external antenna connection is not desired, instructions for disabling the antenna connection are contained in the Desk Charger Maintenance Manual.

Multi-Charger

To use the Multi-Charger, plug the power cable into a 117-Volt AC, 50/60 Hz source. Next, place the radio(s) into the charging insert(s) with the speaker facing down, or place the battery pack(s) into the insert with the arrow on the yellow label pointing up. Then turn the OFF-ON switch to the ON position. The green CHARGE light will glow when the batteries are charging.

Fast Charger

The fast charger will recharge the Standard battery pack only. To use the Fast Charger, plug the power cable into a 117-Volt AC, 50/60 Hz source. Next, turn the OFF-ON switch to the ON position. Then place the radio into the charging insert with the speaker facing down, or place the Standard battery pack into the insert with the arrow on the yellow label pointing up. The red FAST CHARGE light will glow when the battery is charging.

The battery is charged to 70% of capacity when the FAST CHARGE light turns OFF and the amber Trickle Charge light turns ON.

The fast charge circuit will not start fast charging if the radio (or battery pack) is placed into the charging insert before the power is turned on, or if the 117-Volt power source goes off while the unit is charging. The charger will remain in the trickle charge mode. If this should occur, start the fast charge cycle by lifting the radio (or battery pack) off the bottom of the charging insert for a moment.

NOTE

If the fast charger will not start charging, the battery pack has either been excessively discharged or has a bad cell. Let the battery trickle charge for 15 minutes and then remove and replace the battery in the charger. The battery should start fast charging if a cell is not defective.

Vehicular Charger

To use the vehicle charger, place the radio into the charging insert with the speaker facing down. Then press in the radio against the bottom of the charging insert. Next, turn the OFF-ON switch to the ON position. The red Charge light will glow when the battery is charging.

Keying the microphone will cause the charger to switch to the high charge rate whenever the charger is in the trickle-charge mode.

Lock the charger to secure the radio. This also assures good contact with the external accessory pins during periods of severe vibration.

This charger is shipped with an external antenna. This permits the radio to be used to send and receive messages while charging -- although it will probably take longer to recharge the battery. An optional external microphone is required for this application.

To remove the radio from the charger, simply unlock the charger and pull the radio out of the charging insert.

CIRCUIT ANALYSIS

TRANSMITTER

Transmitter Type KT-22-A is a crystal controlled, phase modulated transmitter for one-through eight-frequency operation in the 406-470 MHz band. The transmitter utilizes both discrete components and Integrated Circuit Modules (IC-s).

The transmitter consist of the audio, voltage regulator, oscillator, compensator and modulator IC's, and plug-in Exciter/ PA module all of the transmitter modules are mounted on System Board A702. Supply voltages for the transmitter are provided by the battery and Regulator. The different transmitter voltages are shown in the following chart:

Voltage	Used For:
Continuous 7.5 Volts	Regulator module
Keyed 7.5 Volts	Regulator 5.4-Volt keying, Exciter and PA modules.
Keyed 5.4 Volts	Compensator, Oscillator, Audio and Modulator modules, and optional Compressor module.

References to symbol numbers mentioned in the following test are found on the Schematic Diagrams, Outline Diagrams and Parts Lists (see Table of Contents). The typical, simplifier circuit diagrams used in the text are representative of the circuits in the IC modules. A block diagram of the transmitter is shown in Figure 3.

REGULATOR A2

The Regulator module operates from the 7.5-Volt from the battery, and provides a continuous, regulated 5.4 Volts and a switched 5.4 Volts for operating the transmitter, receiver and tone options. A typical regulator circuit is shown in Figure 4.

Turning on the radio applies the battery voltage to Pin 2 of the Regulator, causing Q2 and then Q1 to conduct. When conducting, the continuous 5.4 Volts at the collector of Q1 is taken from Pin 4 and applied to the receiver Compensator and Oscillator module.

Regulation is provided by Q2 and Q3, which operate as a differential amplifier. If the output of Q1 starts to increase, Q3 conducts harder, causing Q2 to conduct less. This causes Q1 to conduct less, keeping its output at 5.4 Volts. If the output of Q1 starts to decrease, Q3 conducts less,

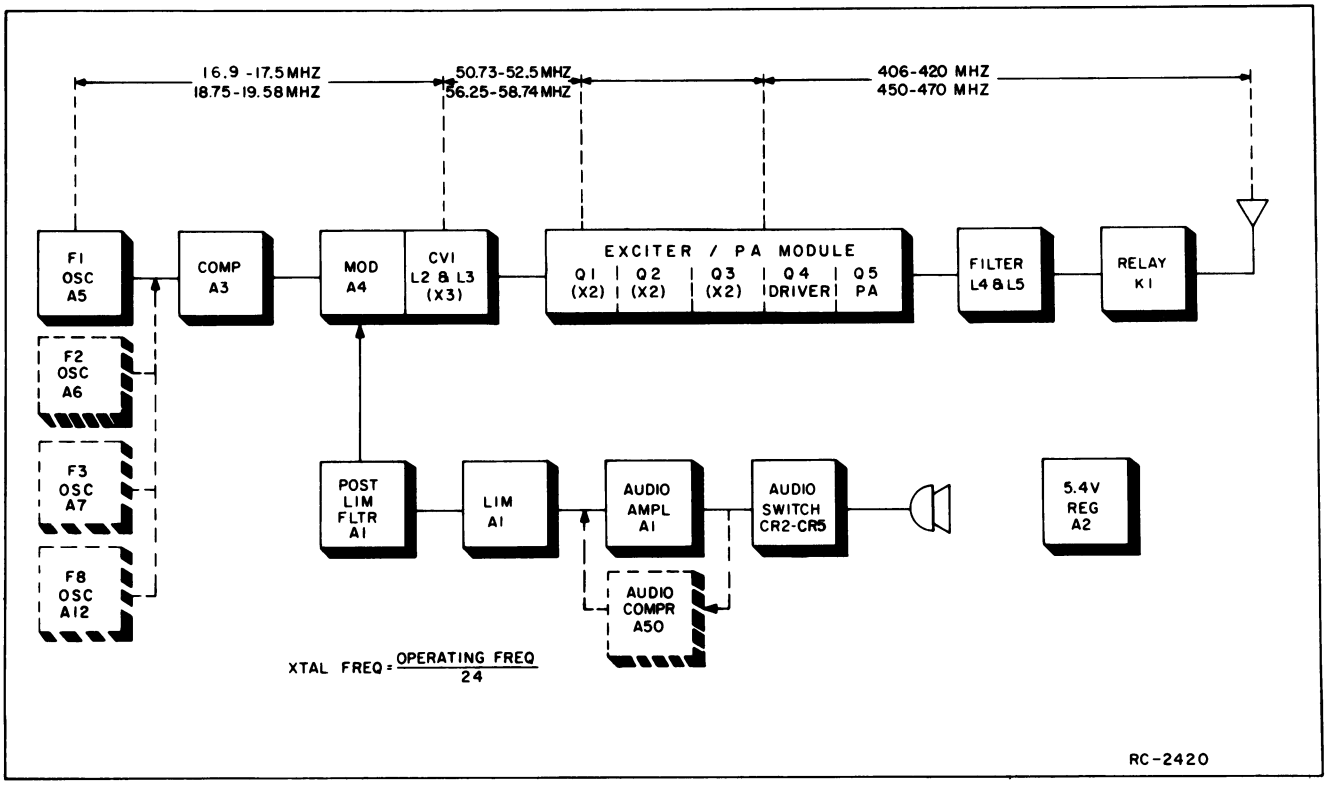


Figure 3 - Transmitter Block Diagram

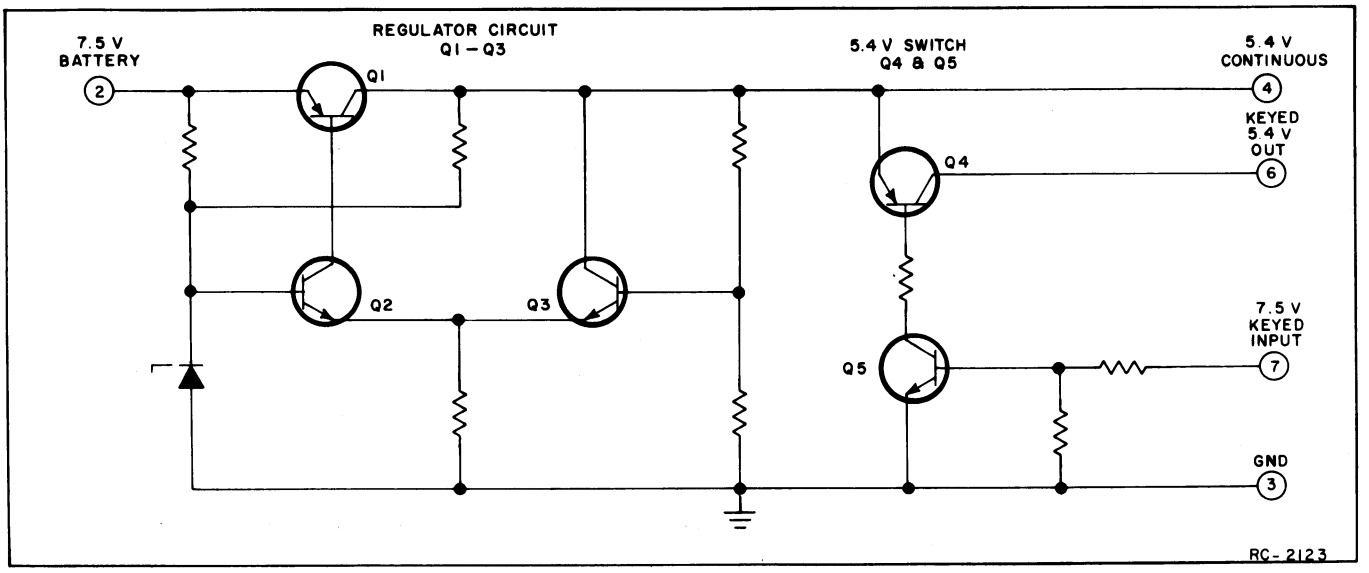


Figure 4 - Typical Regulator Circuit

causing Q2 to conduct harder. This causes Q1 to conduct harder, keeping the output constant.

Q4 and Q5 operate as a DC switch. Keying the transmitter applies the battery voltage to Pin 7 and to the base of Q5, turning it on. This turns on PNP transistor Q4, so that the regulated 5.4 Volts at Pin 6 is applied to the transmitter Compensator, Modulator, and audio module, and to the optional Compressor module and multi-frequency switch S1.

OSCILLATOR MODULE A5

Oscillator Model 4EG27A11 consists of a crystal-controlled Colpitts oscillator and a Channel Guard tone modulator. The entire oscillator is contained in a metal

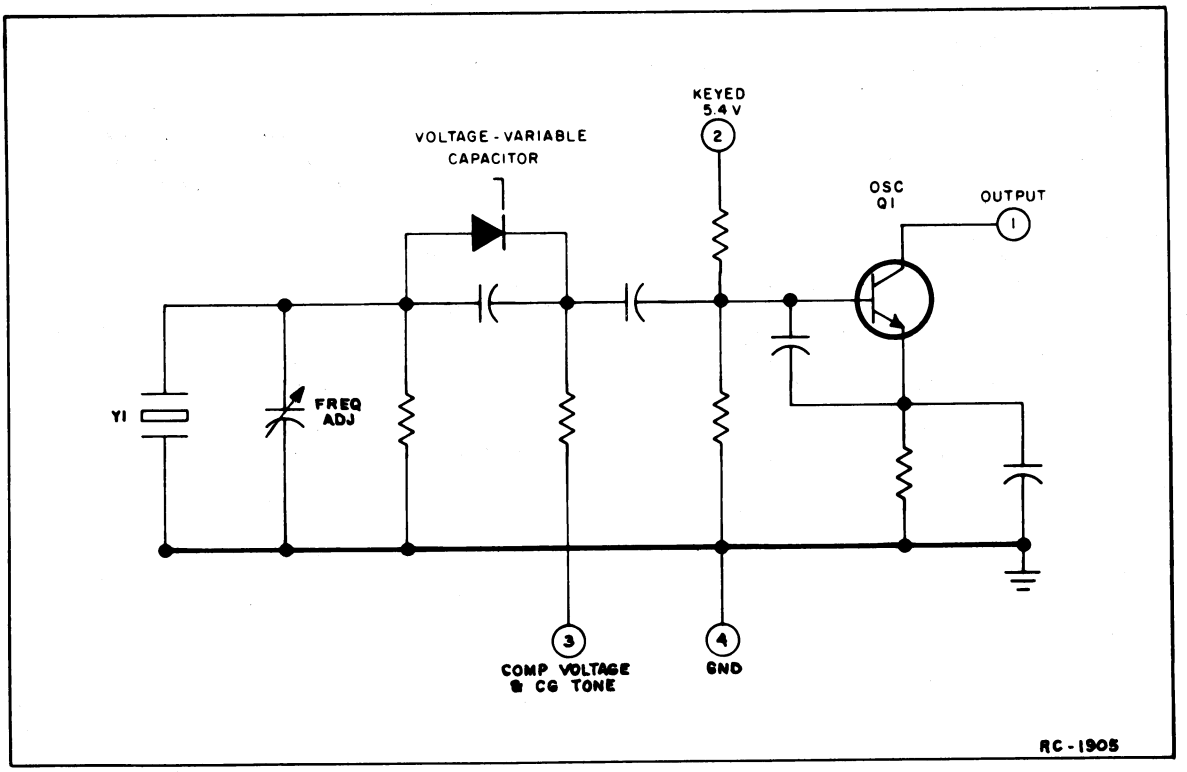


Figure 5 - Typical Oscillator Circuit

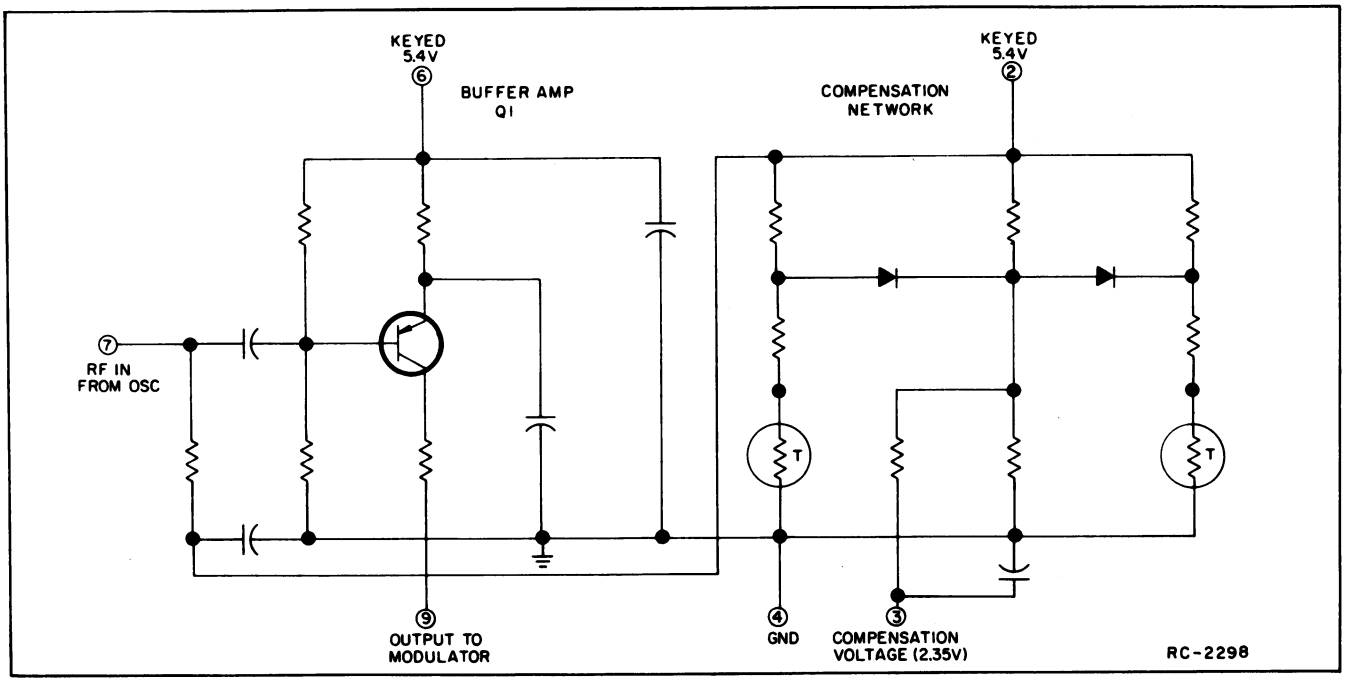


Figure 6 - Typical Compensator Circuit

can with the transmitter operating frequency printed on the top. The crystal frequency ranges from 16.9 to 19.6 MHz, and the crystal frequency is multiplied 24 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 A3.

A typical oscillator circuit is shown in Figure 5.

In single-frequency transmitters, a jumper from Hole 20 to Hole 21 on the System Board connects the keyed 5.4 Volt supply voltage to the oscillator module. Keying the transmitter applies the supply voltage to the oscillator, turning it on. The oscillator output is applied to Compensator A3.

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

For Channel Guard applications, tone from the Channel Guard encoder is applied to the oscillator module. The tone is applied through Pin 3 to the voltage-variable capacitor on the oscillator module, which frequency modulates the oscillator output.

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 A3

Compensator module A3 contains a buffer-amplifier, and the temperature compensating network for the oscillator. A typical Compensator circuit is shown in Figure 6.

RF from the oscillator at Pin 7 is coupled through a DC-blocking capacitor to the base of buffer-amplifier Q1. This stage isolates the oscillator from the modulator. The output of Q1 connects from Pin 9 to the modulator.

In the compensation network, the keyed 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 voltage-variable capacitor in the oscillator module. At temperatures below -10°C, the compensated voltage increases to maintain the proper voltage 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 the printed board and taking another reading. If this reading is normal

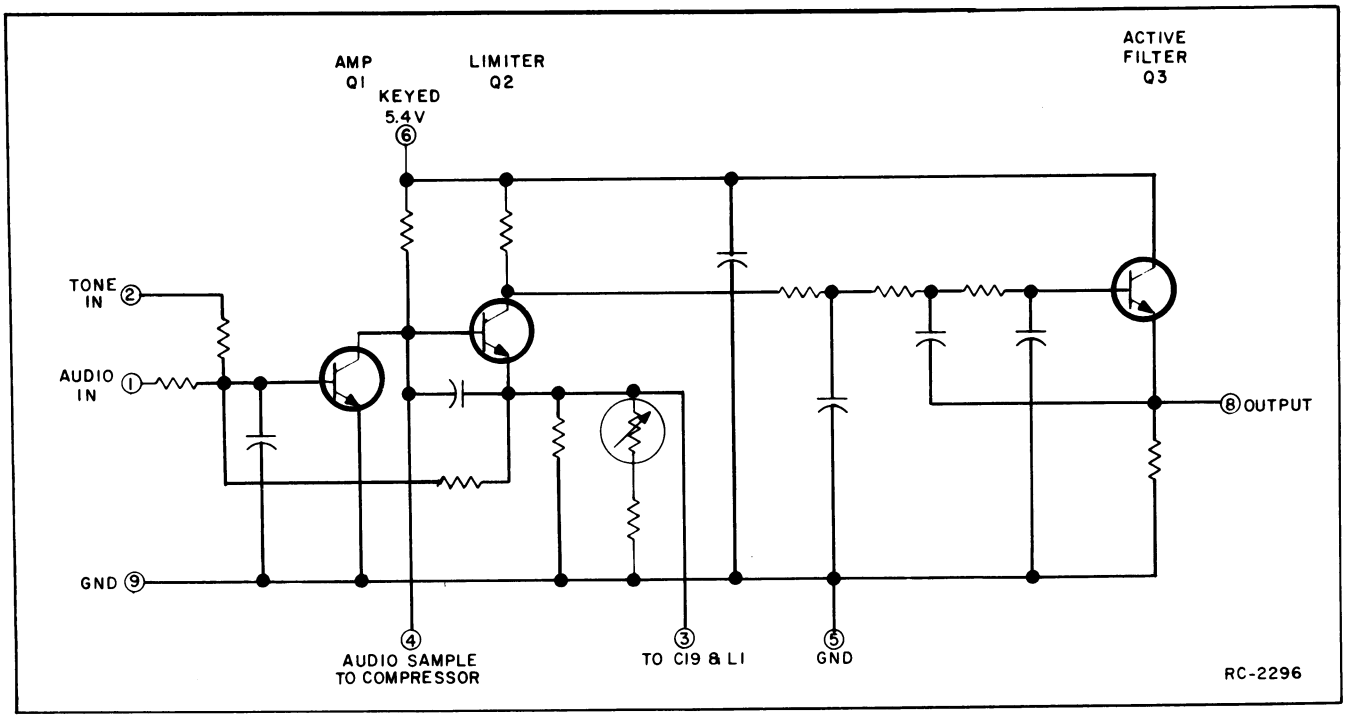


Figure 7 - Typical Audio Amplifier & Limiter Circuit

the problem is in the oscillator module. If the reading remains low (or zero) the problem is in the Compensator.

AUDIO AMPLIFIER AND LIMITER A1

Audio from the microphone is coupled through the audio switching circuit to Pin 1 and then to the base of audio amplifier Q1 (see Figure 7). In Type 90 encoder applications, the encode tone is applied to the amplifier at Pin 2.

The amplifier output is applied directly to the transistorized limiter stage (Q2). Following the limiter is a combined post-limiter filter and de-emphasis network. The filter output at Pin 8 is coupled through Mod Adjust potentiometer R8 to the Modulator module A4.

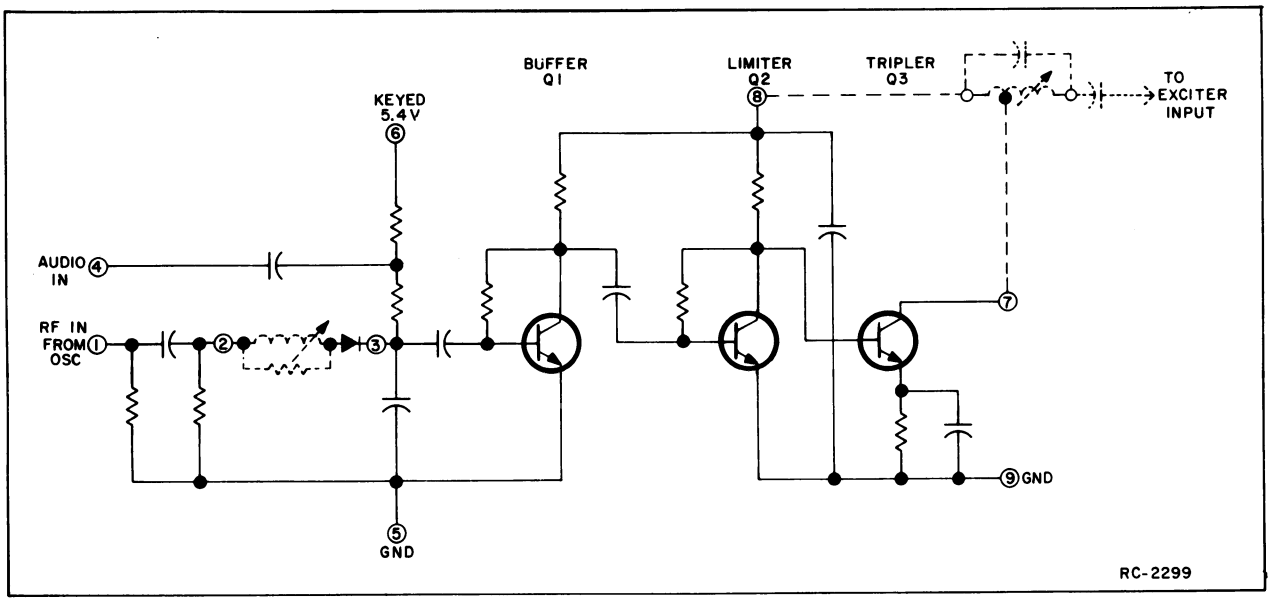


Figure 8 - Typical Phase Modulator Circuit

PHASE MODULATOR

The phase modulator circuit consists of Modulator A4, voltage-variable capacitor CV1 and tuneable coil L2. CV1 and L2 are mounted on System Board A702. A typical modulator circuit is shown in Figure 8.

With CV1 in series with L2, the network appears as a series-resonant circuit when RF from the oscillator is applied to Pin 1. Applying audio from Audio Limiter A1 to Pin 4 of Modulator A4 varies the bias of CV1, resulting in a phase modulated output.

Buffer Q1 isolates the modulator from the loading effects of the following multiplier stage, and also provides some amplification. Following the buffer stage is tripler Q2. The output of Q2 is coupled through L3 (on the System Board) to the exciter module. L3 is tuned to three times the crystal frequency.

EXCITER/PA MODULE

Exciter/PA Models 4EF41A10 (406-420 MHz) and 4EF41A11 (450-470 MHz) consists of three class C doubler stages, a class C driver stage and a class C power amplifier stage.

All of the stages are supplied by a type of constant-K, DC collector feed network.

Doubler Stages

The modulator output is coupled through T101 to the base of 1st doubler Q101. T101 is tuned to three times the crystal frequency. The modulator coils and the 1st doubler base circuit are metered at TP1. The 1st doubler collector circuit is metered at TP2.

The output of the 1st doubler is coupled through T102 (untuned) and T103 to the base of 2nd doubler Q102. T103 is tuned to six times the crystal frequency, and is metered at TP2.

An impedance-matching network couples the output of Q102 to the base of Q103. The network consists of C112, C113, L105/L121, C114/C136 and C115, and also provides some selectivity. L105/L121 is tuned to 12 times the crystal frequency.

3rd doubler Q103, driver Q104 and PA transistor Q105 are tuned by measuring the total current drain of the radio. An ammeter with a one ampere full scale meter is used in series with the radio's 7.5-Volt supply. GE Test Regulator Model 4EX18A10 and Test Set Model 4EX3A10 may be used in place of the ammeter.

Driver & PA

Following the third doubler is an impedance-matching network consisting of L107, C118, L108, C119 and C120/C140. The network matches the high impedance doubler output to the low impedance driver input. C119 is tuned to 24 times the crystal frequency.

The driver output is coupled through a similar impedance-matching network to the base of class C power amplifier Q105. The power amplifier output is applied to the low-pass filter through a series-tuned matching network (L115, L122/L113, C128, L114 and C129).

Low-Pass Filter

Low-pass filter L118, L119, C132, C113 and C134 provides for the suppression of harmonics. The filter output is applied to the antenna through system switching relay K1 mounted on the Systems Board.

An RF adaptor cable is available for connecting the transmitter RF output to a wattmeter. 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 transmitter output to J702-3. Connection to chassis ground is made at J702-4.

RECEIVER

Receiver Models 4ER60B10 through 4ER60B13 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.

References to symbol numbers mentioned in the following test are found on the Schematic Diagram, Outline Diagram and Parts List (see Table of Contents). The typical circuit diagrams used in the test are representative of the circuits used in the Integrated Circuit modules. A block diagram of the receiver is shown in Figure 9.

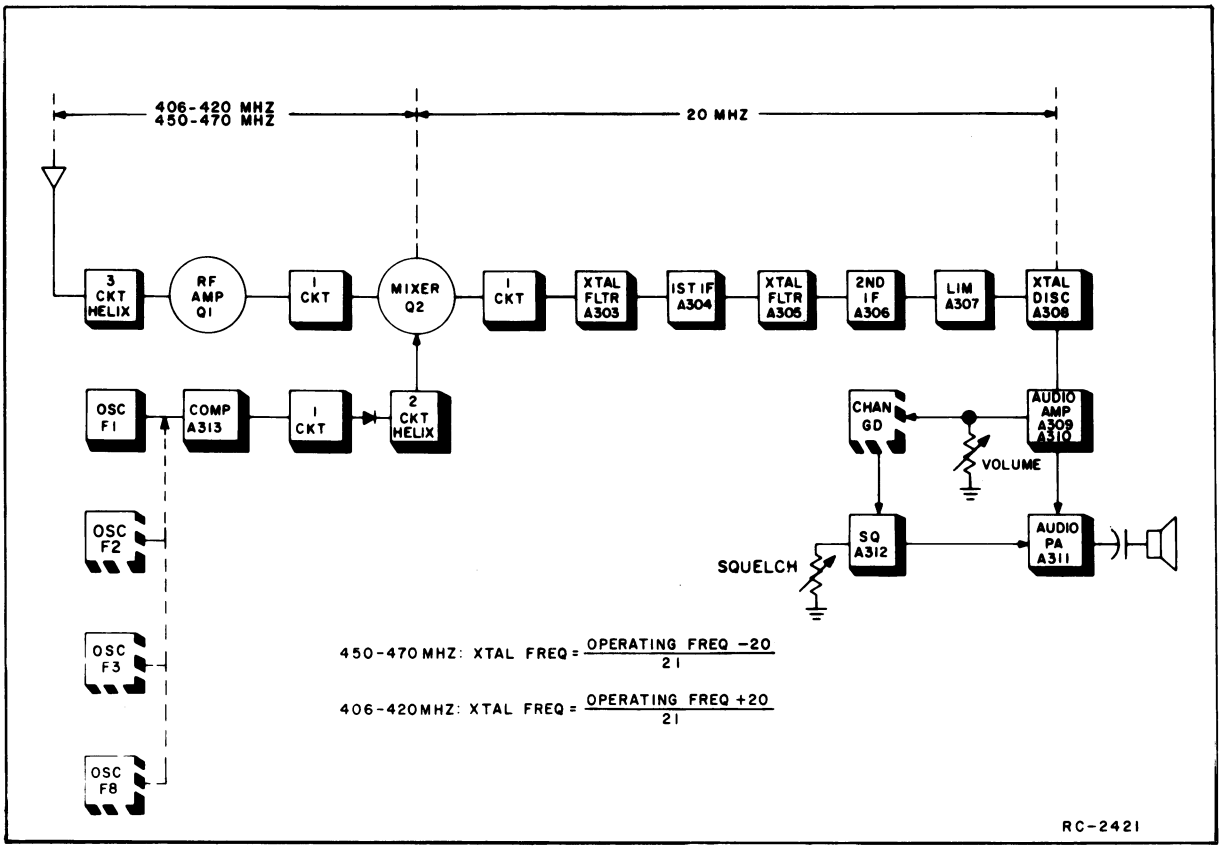


Figure 9 - Receiver Block Diagram

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.

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 6). 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.

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 similar to the Compensator used in the transmitter (see Figure 6).

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.

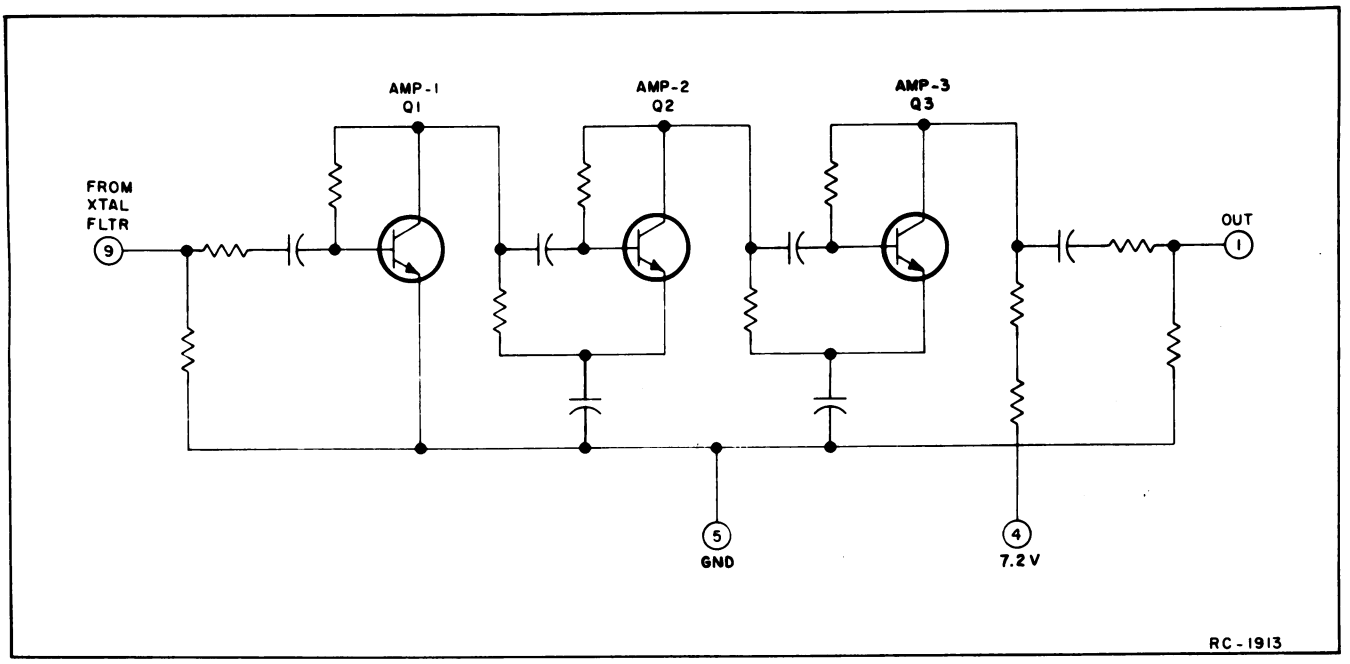


Figure 10 - Typical IF Amplifier Circuit

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 Filters provide the major selectivity

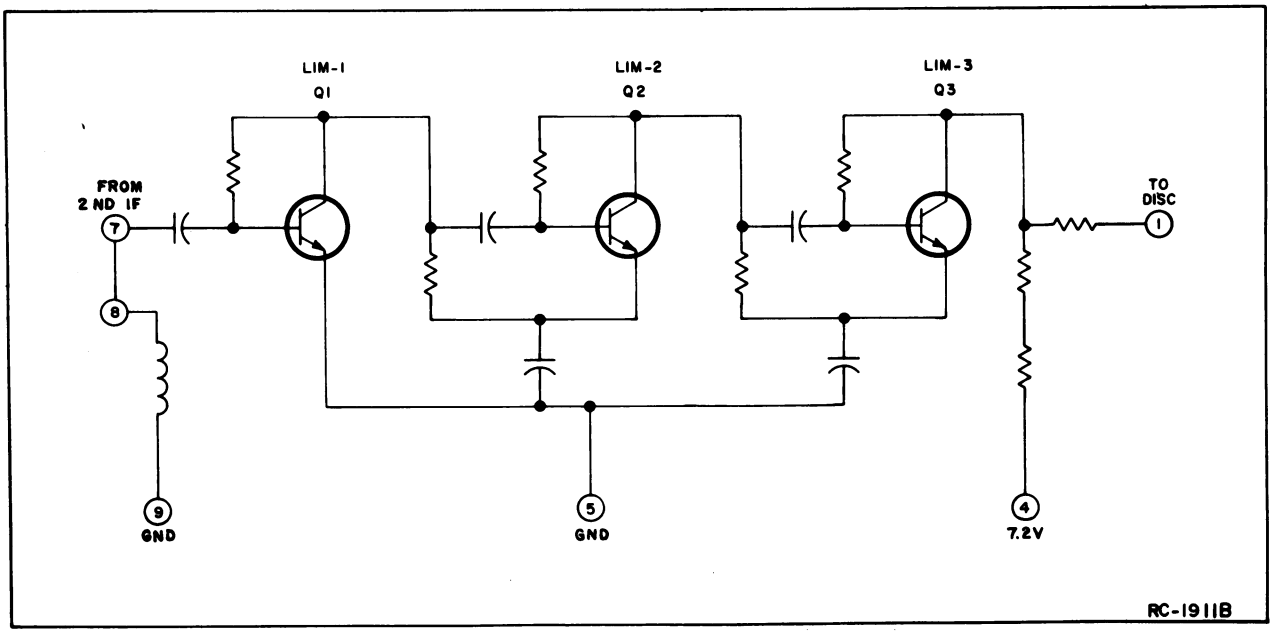


Figure 11 - Typical Limiter Circuit

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 10.

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 11.

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 12.

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 13.

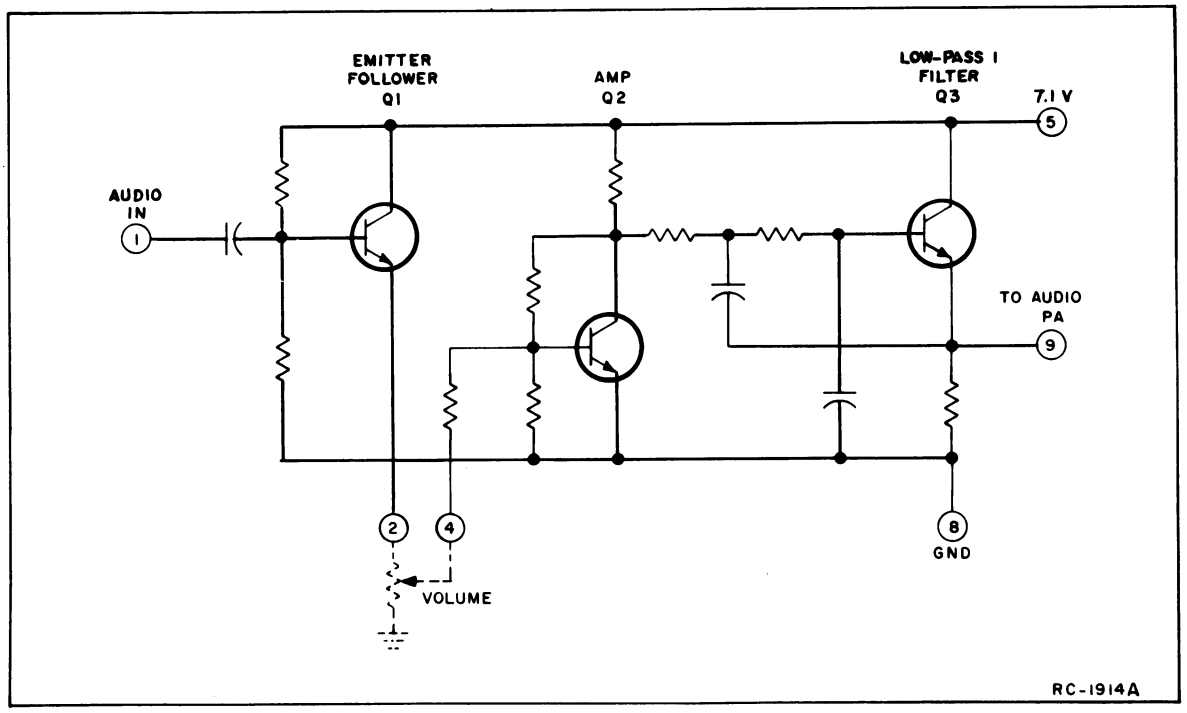


Figure 12 - Typical Audio Amplifier Circuit

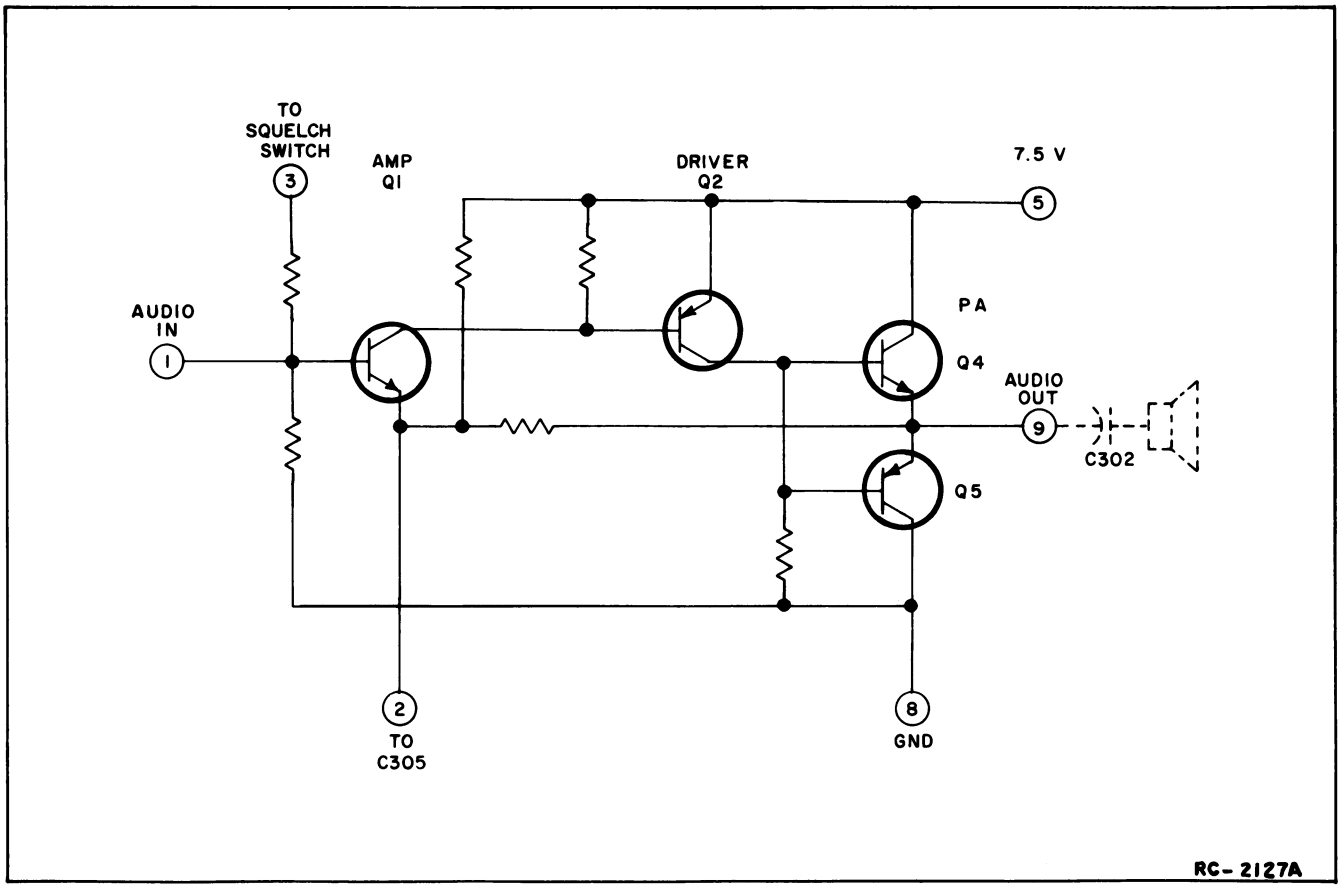


Figure 13 - Typical Audio PA Circuit

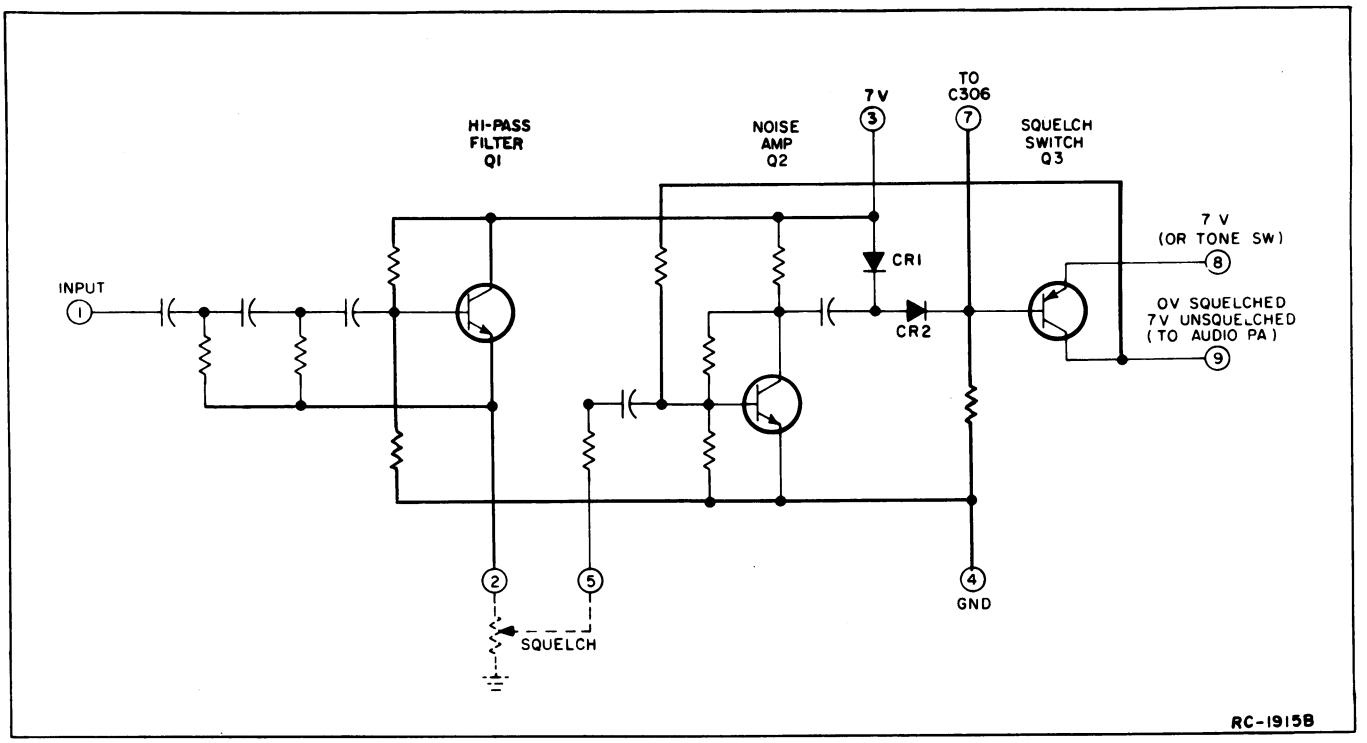


Figure 14 - Typical Squelch Circuit

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 14.

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.

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.

SYSTEM BOARD

System Board A702 provides system interconnections for the transmitter, receiver, tone options and operating controls. In addition to the transmitter modules, the system board contains the microphone, system relay, and the audio and DC switching circuitry.

Jacks J702 and J703 are connected to the system board and provide contacts for an external antenna, speaker, and microphone. J702 provides contacts for the external antenna and speaker, and J703 provides contacts for an external microphone. Placing the radio into the vehicular charger automatically connects the jack contacts

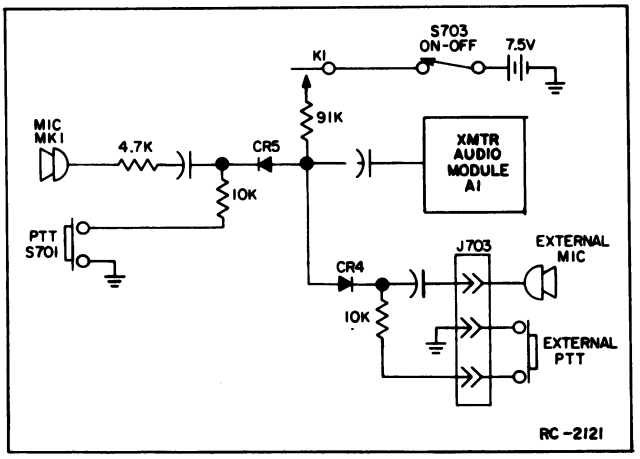


Figure 15 - Audio Switching Circuit

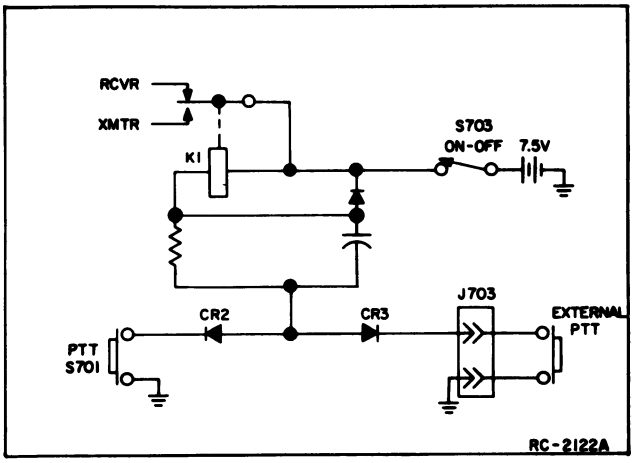


Figure 16 - DC Switching Circuit

to the external circuitry. The radio is also connected to the external antenna when placed in the desk charger.

AUDIO SWITCHING

Audio switching for local microphone MK1 and an external microphone is controlled by a diode network as shown in Figure 15.

Pressing P-T-T switch S701 forward biases diode CR5, permitting audio from MK1 to be applied to transmitter audio module A1.

Keying the external microphone forward biases diode CR4, permitting audio to be applied to the audio module.

DC SWITCHING

Operation of system relay K1 is also controlled by a diode network (see Figure 16).

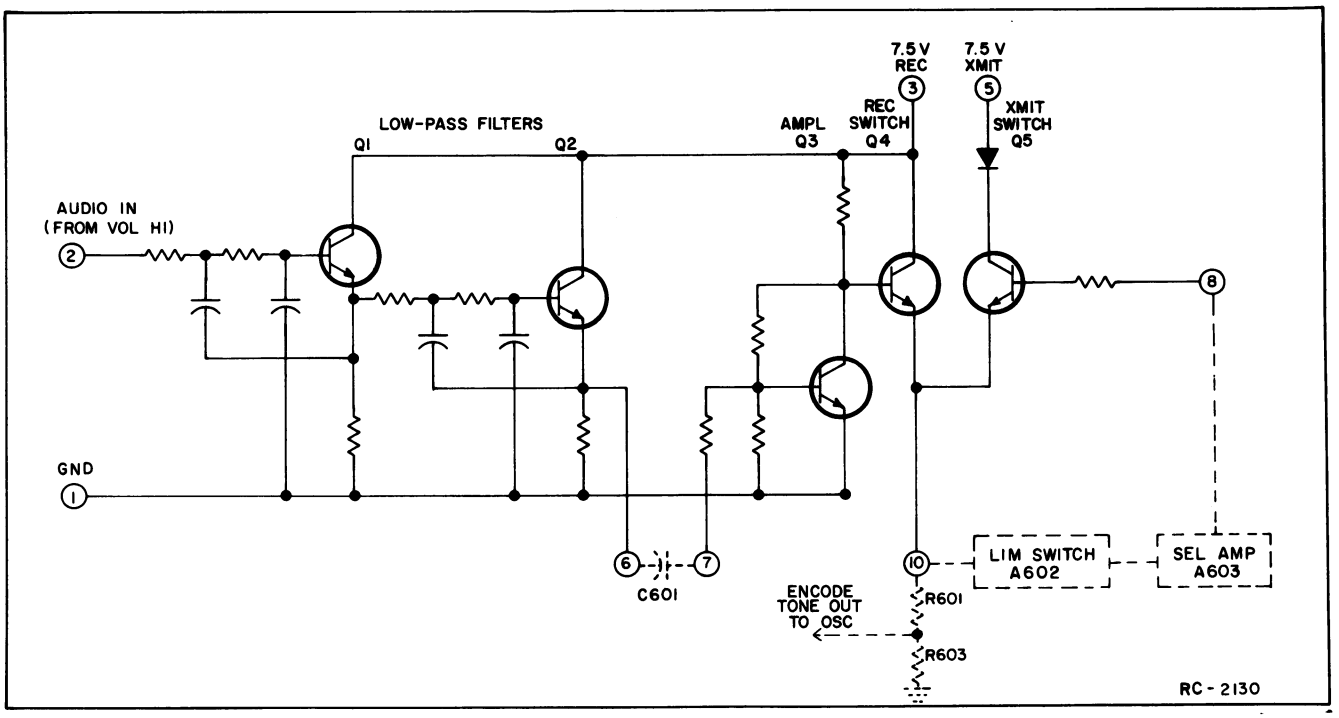


Figure 17 - Input Filter Circuit

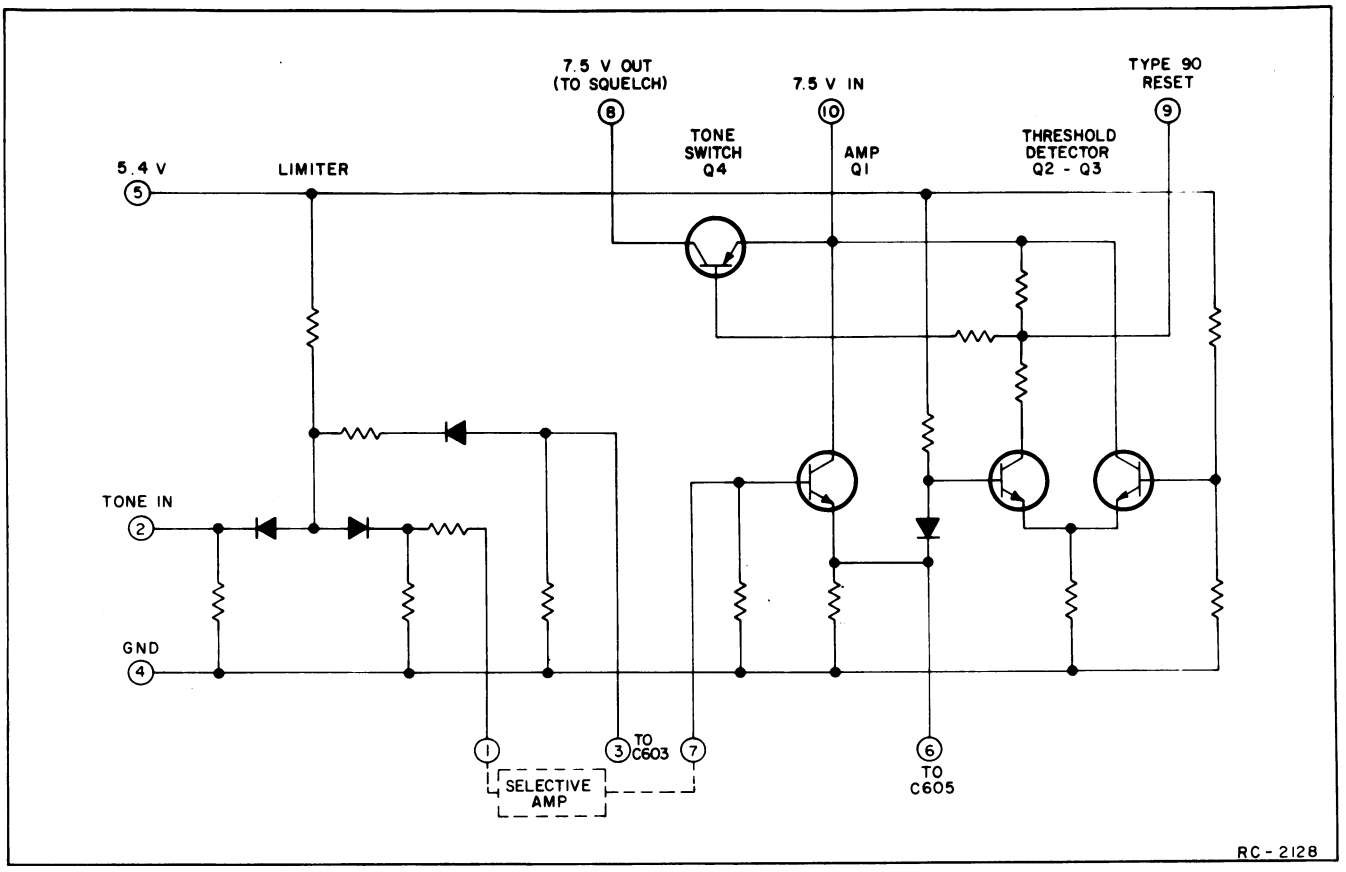


Figure 18 - Limiter Switch Circuit

Pressing S701 forward biases CR2, completing the relay path to ground. This energizes relay K1, and switches the battery voltage to the transmitter audio and regulator modules. Energizing K1 also connects the transmitter output to the antenna.

Keying the external microphone forward biases CR3 and energizes the relay.

TONE OPTIONS

The following tone options are available in the PE Model Combinations:

- Channel Guard Encoder/Decoder Model 4EK17A11
- Channel Guard Encoder Models 4EH21A10, 11
- Type 90 Encoder/Decoder Model 4EK18A11
- Type 90 Encoder Model 4EH20A10, 11

Both the Channel Guard and Type 90 Tone Options use Selective Amplifier IC's for the frequency (tone) selective circuit. The selective Amplifier consists of a Wien bridge circuit with an operational amplifier for controlling the encoder frequency stability and the decoder bandwidth.

CHANNEL GUARD ENCODER/DECODER

Encoder/Decoder Model 4EK17A11 is continuous-tone encoder and decoder for operation on tone frequencies in the 71.9 to 203.5 Hz range. Both the encoder and decoder operate on the same frequency. The Encoder/Decoder consists of a Tone Control board and three Integrated Circuit Modules mounted on a printed wiring board. The Integrated Circuit Modules include Input Filter A601, Limiter & Switch A602, and Selective Amplifier A603. Typical diagrams of the Input Filter and Limiter Switch circuits are shown in Figures 17 and 18.

The Channel Guard circuit is controlled by CG ON-OFF switch S2 and multi-frequency switch S1 on the control unit. Placing S2 in the OFF position disables the decoder circuits to permit monitoring all calls on the selected channel. Placing S2 in the ON position enables the Encoder/Decoder. Multi-frequency switch S1 selects the channel that will have Channel Guard, and also enables the Tone Control board circuitry.

TONE CONTROL BOARD

The Tone Control board consists of diodes CR1 through CR7, and a three-transistor switching circuit. Placing multi-frequency switch S1 on a frequency with Channel Guard applies 5.4 Volts to the Tone Control board. For example, placing S1 on the channel 1 frequency forward biases CR1 and applies supply voltage to pin 5 of the Limiter-Switch Module, and the Selective Amplifier. In addition, the 5.4 Volts are applied to the base of Q1, turning it on. Turning on Q1 turns on Q2 which turns off Q3. Turning off Q3 removes the 7.5 Volts applied to the receiver Audio PA module so that the radio operates in the Channel Guard mode.

Switching S1 to a non-Channel Guard position removes the 5.4 Volts to the Tone Control Board. This allows Q3 to conduct, applying 7.5 Volts to the squelch switching transistor on Audio PA module so that the receiver operates on noise squelch.

Whenever Channel Guard is not desired on a particular frequency, the lead to the Tone Control board can be removed from the appropriate frequency selector jack on the Systems Board (J25 through J31) and taped back, or the associated diode on the Tone Control board can be removed.

ENCODE

Keying the transmitter applies 7.5 Volts to Pin 5 of the Input Filter module, turning on encode switch Q5. This allows tone from Selective Amplifier A603 to be coupled through Q5 and applied to the transmitter oscillator module.

DECODE

Releasing the PTT switch removes the 7.5 Volts at Pin 5 and applies 7.5 Volts to Pin 3, turning on decode switch Q4. At the same time the signal from R707-3 (Volume HI) is coupled to Pin 2 of Input Filter A601, where it is applied to a two-stage, active low-pass filter (Q1 and Q2) for attenuating frequencies over 205 Hz. The output of A601 at Pin 10 is applied to Pin 2 of Limiter-Switch A602. When no tone is present in the signal, the random noise output of the filter will not operate the decoder circuitry.

Any tone present in the signal applied to A602 is limited by the limiter diodes and the output applied through Pin 1 to the Selective Amplifier module. If the incoming tone is of the proper frequency, the output of the Selective Amplifier will be just sufficient to operate the detector circuit (Q1 thru Q3).

The positive half cycles of the Selective Amplifier output turns on Q1, which over-rides the diode and turns on Q2. Turning on Q2 causes its collector to drop to ground potential, turning on the PNP tone switch Q4. When conducting, the 7.5 Volts at the collector of Q4 is applied to the squelch switching transistor on the Audio PA module. The receiver now operates on noise squelch, permitting the call to be monitored.

CHANNEL GUARD ENCODER

Encoder Models 4EH21A10 (one-tone) and 4EH21A11 (two-tone) operate on tone frequencies in the 71.9 to 203.5 Hz range. The two-tone encoder consists of Limiter module A601 and two Selective Amplifier modules A602 and A603. The single-tone encoder assembly utilizes a Limiter module and only one Selective Amplifier module.

The Encoder is controlled by a three position switch on the control unit. Placing the switch in the OFF position disables the Encoder so that no tone is applied to the transmitter oscillator module.

Placing the switch in the Tone A or Tone B position applies 5.4 Volts to the Limiter-Switch module and one of the Selective Amplifier modules, causing the modules to oscillate on the encode frequency. The Limiter Circuit keeps the input to the Selective Amplifier constant to maintain the required frequency and level stability.

Whenever the transmitter is keyed, the encoder tone at Pin 9 of the Limiter module is applied to the transmitter oscillator module.

TYPE 90 ENCODER/DECODER

Type 90 Encoder Model 4EK18A11 Decoder is a pulsed tone encoder/decoder assembly for operating on standard Type 90 tone frequencies of 1000 to 3000 Hz. The assembly consists of a Tone Control board and three Integrated Circuit modules mounted on a printed wiring board. The Integrated Circuit modules include Input Amplifier A601, Limiter-Switch A602, and Selective Amplifier A603. The Limiter Switch diagram is shown in Figure 18. A typical diagram of the Input Amplifier is shown in Figure 19.

The Type 90 circuit is controlled by Monitor-Normal-Reset switch S2 and multi-frequency switch S1 on the control unit.

Tone switch S2 is a three-position switch that must be in the Monitor position to transmit the encoder tone or to monitor the channel. The switch must be placed in the Reset and then the Normal position for the decoder to operate.

Multi-frequency switch S1 selects the Channel that will have Type 90 tone, and enables the Tone Control board circuitry.

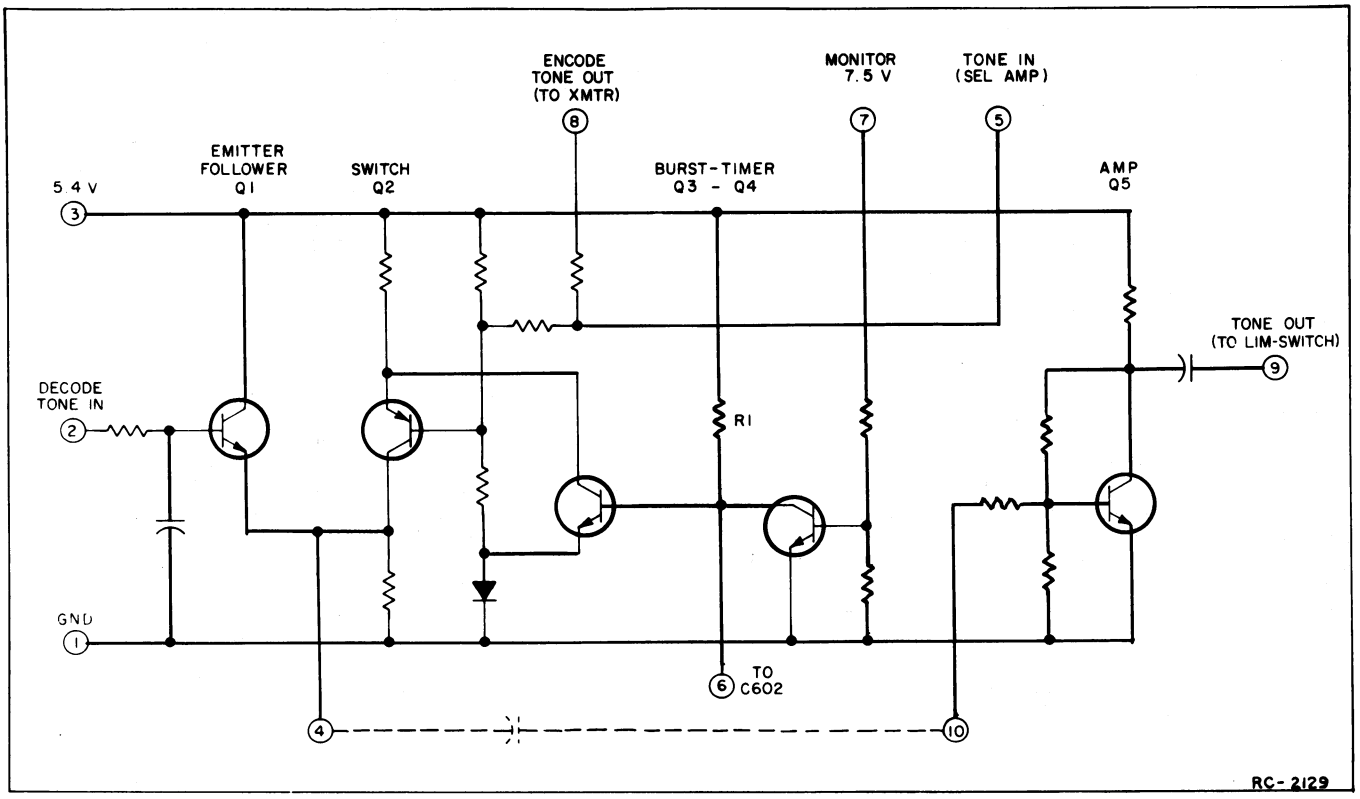


Figure 19 - Typical Input Amplifier Circuit

MONITOR

Placing S2 in the Monitor position applies 7.5 Volts to Pin 7 of the Input Amplifier module. This turns on Q4 in the burst-timer circuit, turning off Q3. This removes the ground on the emitter of Q2, allowing Q2 to turn on. Tone from the Selective Amplifier module is applied to Pin 5 of the Input Amplifier and is coupled through Q2 to Pin 4 where it is capacity coupled through C601 to amplifier Q5. The amplifier output is applied to Pin 2 of the Limiter-Switch module where it activates the tone switch (Q4), allowing the receiver to operate on noise squelch.

TONE CONTROL BOARD

The Tone Control board consists of diodes CR1 through CR7, and a three-transistor switching circuit.

Placing multi-frequency switch S1 on a channel with Type 90 tone applies 5.4 Volts to the Tone Control board. For example, placing S1 on the channel 1 frequency forward biases CR1 and applies supply voltage to the Input Amplifier and the Selective Amplifier. In addition, the 5.4 Volts is applied to the base of Q1, turning it on. Turning on Q1 turns on Q2 which turns off Q3. Turning off Q3 removes the 7.5 Volts applied to the receiver Audio PA module so that the radio operates in the encode/decode mode.

Switching S1 to a channel without tone removes the 5.4 Volts to the Tone Control Board. This allows Q3 to conduct, applying 7.5 Volts to the squelch switching transistor on the Audio PA module so that the receiver operates on noise squelch.

Whenever tone is not desired on a particular frequency, the lead to the Tone Control board can be removed from the appropriate frequency selector jack on the Systems board (J25 through J31) and taped back, or the associated diode on the Tone Control board can be removed.

ENCODE

Keying the transmitter removes the 7.5 Volts at Pin 7 of the Input Amplifier module, turning off Q4 in the burst-timer circuit. Capacitor C602 is kept discharged while Q4 is conducting. When Q4 turns off, Q3 also remains off until C602 charges through R1. While C602 is charging, Q2 operates and completes the feedback path for the Selective Amplifier, causing it to oscillate on the encode frequency. Tone is coupled through Encode Tone Adjust potentiometer R605 and applied to the Audio-Limiter module on the System Board. R605 is set for a tone output of ±3 kHz.

When C602 charges up, Q3 turns on which turns Q2 off, removing the tone to the transmitter. The burst-timer circuitry provides a pulsed tone output of approximately one second.

DECODE

When the switch is in the Normal position, the burst-timer circuit is disabled. Audio from R707-3 (Volume Hi) is applied to the base of emitter-follower Q1 on the Input Amplifier module. The output of Q1 is capacity-coupled to the base of amplifier Q5. The amplifier output is applied to the limiter circuit on the Limiter-Switch module.

Any tone present in the signal is limited by diodes CR1 and CR2, and the output applied through Pin 1 to the selective Amplifier module. If the incoming tone is of the proper frequency, the output of the Selective Amplifier will be just sufficient to operate the detector circuit (Q1 thru Q3).

The positive half cycles of the Selective Amplifier output turns on Q1, which over-rides the diode and turns on Q2. Turning on Q2 causes its collector to drop to ground potential, turning on the PNP tone switch Q4. When conducting, the 7.5 Volts at the collector of Q4 is applied to the squelch switch on the receiver squelch module. The voltage is connected through the squelch switching transistor to the Audio PA module. The receiver now operates on noise squelch so that all calls on the channel can be monitored.

TYPE 90 ENCODER

Type 90 Encoder Models 4EH20A10 (one-tone) and 4EH20A11 (two-tone) are pulsed tone encoders for operating on two tone frequencies in the 1000 to 3000 Hz range. The assembly consists of Limiter A601 and Selective Amplifiers A602 and A603. The single-tone encoder consists of the Limiter and a single selective Amplifier module. The Limiter module contains a Tone burst Timer circuit and a limiter circuit for each Selective Amplifier module. The limiter circuit keeps the input to the selective Amplifier modules constant to maintain the required frequency and level stability.

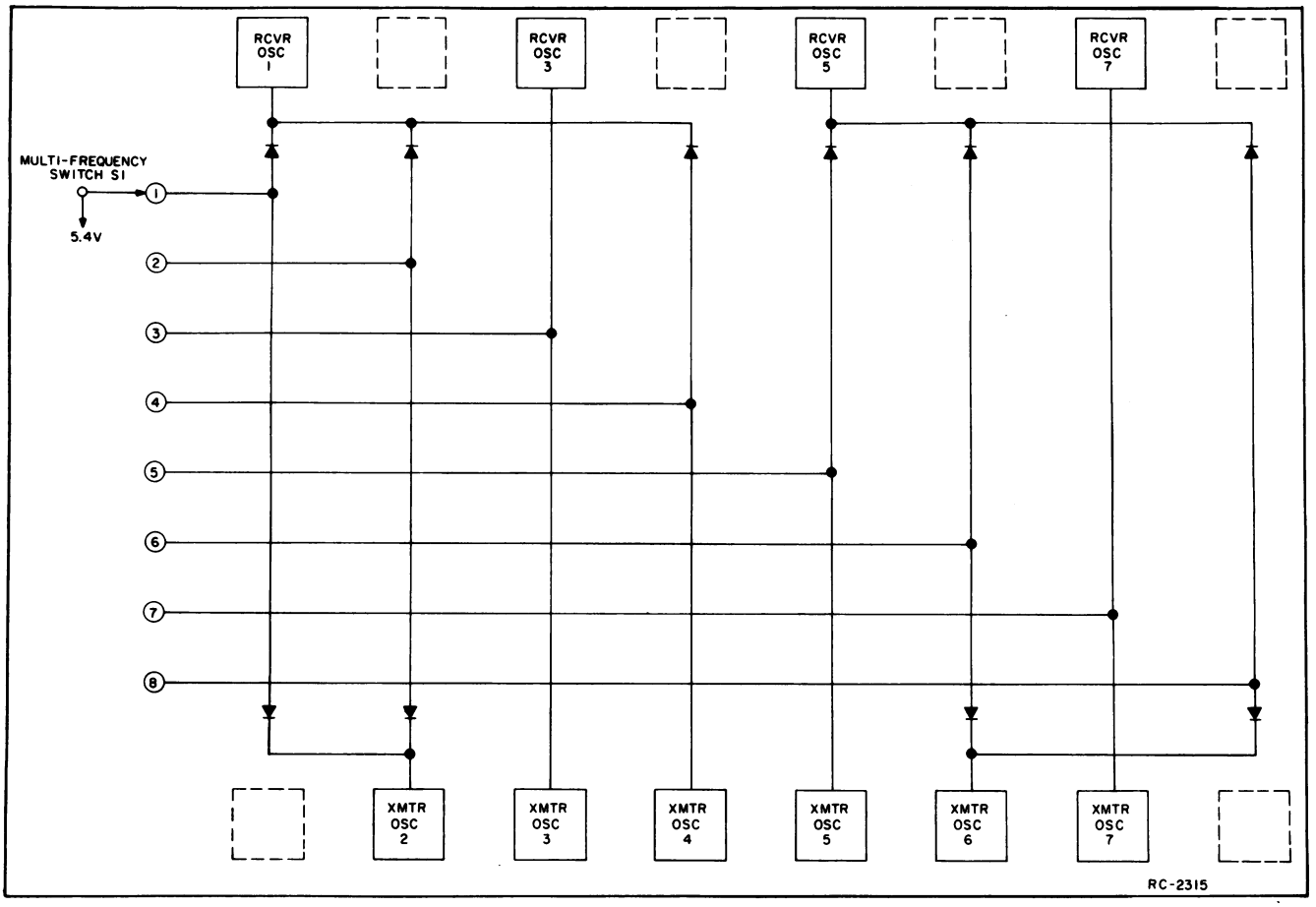


Figure 20 - Repeating Oscillator Modules

The Encoder is controlled by a three-position switch on the Control Unit. Placing the switch in the OFF position removes the 5.4-Volt supply voltage and disables the Encoder. With the switch in the Tone A or Tone B position, keying the transmitter applies 5.4 Volts to the Limiter module and to the selected Selective Amplifier module.

Applying power to the modules causes the Selective Amplifier to start oscillating at the desired tone frequency, and also starts the tone burst timer circuit. The burst timer provides a tone output for approximately one second. The encode tone is coupled through Encode Tone Adjust R603 to the transmitter Audio module on the System Board. R603 is set for ±3 kHz deviation.

REPEATING OSCILLATOR MODULES

Both the transmitter and receiver can be adapted to repeat the use of the same frequency without the use of additional Oscillator Modules. The Oscillator Module is replaced by a diode, allowing the frequency selector switch to have the same frequency on one or more switch positions even though only one Oscillator Module is used for each of the repeated channels. A typical diagram with repeated Oscillator Modules is shown in Figure 20.

Complete instructions for multi-frequency modifications are contained in the Multi-Frequency Modification diagram (see Table of Contents).

For radios equipped with Channel Guard or Type 90 Encoders/Decoders, repeating Oscillator Modules also permits switching or disabling tones on the same RF frequency with the multi-frequency switch. Also, the tone and RF frequency can be changed at the same time.

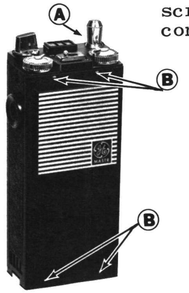
DISASSEMBLY PROCEDURE

Do not attempt to remove a module from the printed wiring board until troubleshooting indicates that the module is bad. Remove or replace the assemblies or modules as directed.

Caution: Always remove the battery before removing any component board to avoid blowing the fuse.

Equipment Required

- Small Phillips-head screwdriver.
- Pencil-type soldering iron (40-60 watts) with a fine tip for unsoldering module leads and component leads, and a medium tip for unsoldering module mounting tabs.
- Needlenose pliers for removing slotted nuts.
- Tuning tool 19B219079-P1 for removing Allen-head screws in the cover, and the set screws in the controls and antenna tip.

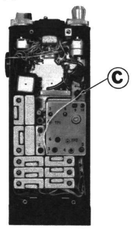


STEP 1.

To remove the antenna, unscrew the antenna nut (A) and pull out the antenna.

STEP 2.

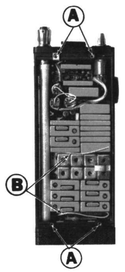
To gain access to the transmitter, remove the four Allen-head screws (B) with the tuning tool, and carefully lift off the front cover to avoid breaking the speaker leads.



The exciter and PA modules can be unplugged by pulling on lifting straps (C) .

STEP 3.

To gain access to the receiver and tone board, remove the four Allen-head screws (A) in the back cover with the tuning tool and lift off the cover. Lift the receiver board out of the case by lifting strap (B) . The tone board can also be lifted out of the case.



CAUTION

Do not place either board on metal or other conductive surface with power applied. To do so will damage the Integrated Circuit modules. A small "pancake" of Duxseal® provides an excellent insulated work surface for the receiver or tone board.

STEP 4.

To remove the Volume or Squelch Control, remove the set screw (A) in the side of the control with the tuning tool. Then unscrew the slotted nut and remove the control.

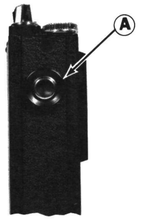
To remove the Multi-Frequency switch, remove the set screw (B) as directed above. Then remove the washer, unscrew the slotted nut and remove the control.

STEP 5.

To replace the accessory jack, first remove the tone board if present. Then unscrew the slotted nut (A) , and press down to the top of the jack to break the waterproof seal. Apply RTV-108 (GE Part No. 19A115153P2) around the shoulder on the new jack before inserting the jack into the mounting hole and replacing the slotted nut.

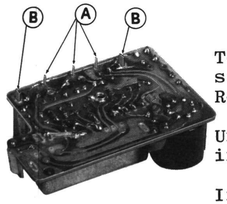
STEP 6.

To replace the speaker, remove the four Phillips-head screws (A) , and lift off the speaker cover. Then push the speaker out of its mounting hole and remove any of the sealant remaining around the edge of the mounting hole. Apply RTV-108 around the edge of the speaker mounting hole and replace the speaker in the hole aligned as shown. Then replace the speaker cover.



STEP 7.

To replace the PTT switch or clean the rubber diaphragm, use a 3/32-inch diameter blade flat-head screwdriver (GE Service Parts No. SPK-528) and remove the two screws holding the PTT ring (A) to the case. Remove the PTT ring and button. Remove the diaphragm, metal disk and spring.

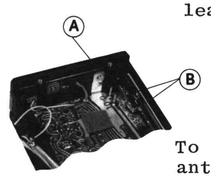


STEP 8.

To replace one of the modules, unsolder and straighten up the module wire leads (A) . Remove any solder accumulation from the leads.

Unsolder and straighten up the module mounting tabs (B) and remove any solder accumulation.

If replacing the receiver front end or mixer modules, also remove the small screws holding the helical resonators. Replace the module and solder down the mounting tabs and then the wire leads. Refer to the appropriate Outline Diagram (see Table of Contents) for the wire lead placement, if required.



STEP 9.

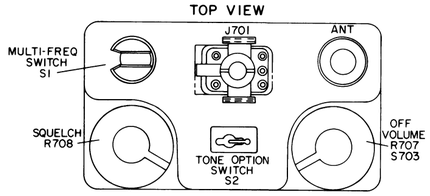
To replace the antenna switch, remove the antenna and the receiver and tone boards from the case. Next, remove the Phillips-head screw (A) and then unsolder the mounting tabs (B) .

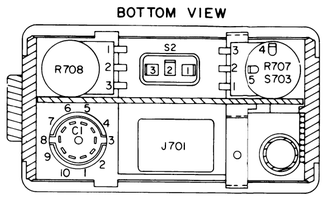
Install the new switch by replacing the Phillips-head screw (A) and then soldering the mounting tabs (B) .

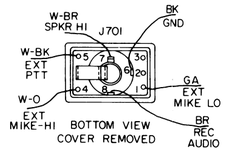
WARNING

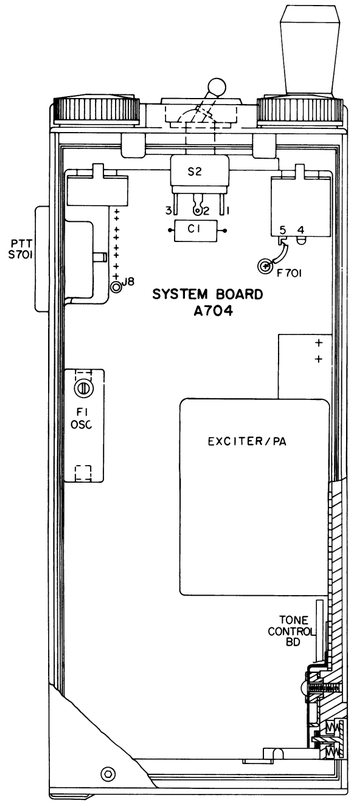
The stud mounted RF Power Transistor used in the PA Module contain Beryllium Oxide, a TOXIC substance. If the ceramic or other encapsulation is opened, crushed, broken or abraded, the dust may be hazardous if inhaled. Use care in replacing transistors of this type.

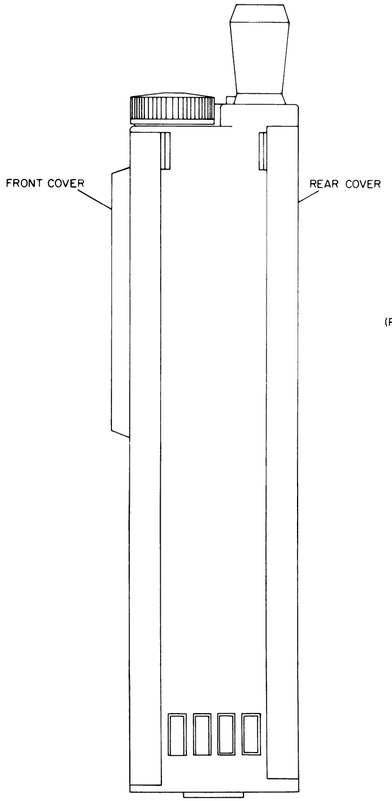
CONTROL UNIT

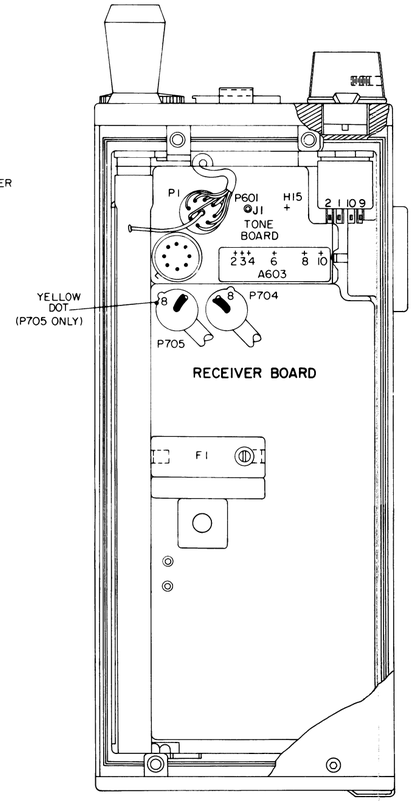


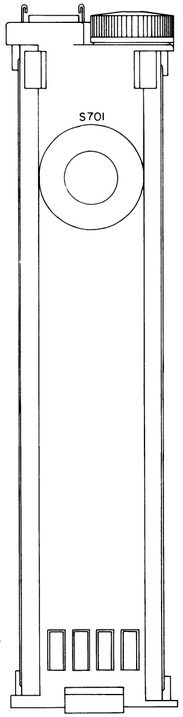












(19D417224, Rev. 0)

MODULE LAYOUT DIAGRAM

PE MODEL TWO-WAY FM RADIO

MODULATION LEVEL ADJUSTMENT

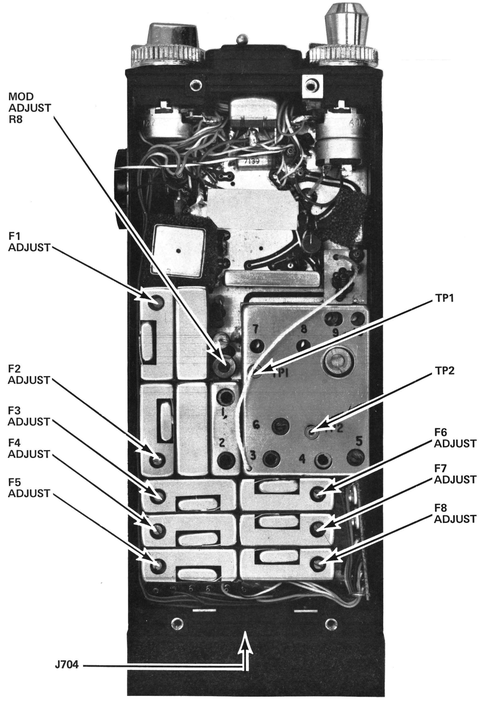
The MOD ADJUST (R8) was adjusted to the proper setting before shipment and should not normally require readjustment. This setting permits approximately 75% modulation for the average voice level. The audio peaks which would cause overmodulation are clipped by the modulation limiter. The limiter, in conjunction with the de-emphasis network, instantaneously limits the slope of the audio wave to the modulator, thereby preventing overmodulation while preserving intelligibility.

TEST EQUIPMENT

1. Audio oscillator Model 4EX6A10
2. A deviation meter
3. An output meter or a VTVM
4. Test Adaptor Model 4EX12A10

PROCEDURE

1. Connect the equipment as shown in the Test Procedure on the back of this page.
2. Apply a 140 millivolt signal at 1000 Hz to the Test Adaptor. If the Test Adaptor is not used, apply a 14 millivolt signal to Pin 4 (Mike Hi) and Pin 1 of Accessory Jack J701.
3. With the signal applied, adjust Tuning Control 1 for zero modulation symmetry on the lowest channel frequency.
4. For transmitters without Channel Guard, set MOD ADJUST R8 for a 4.5-kilohertz swing with the deviation polarity which gives the highest reading as indicated on the frequency modulation monitor.
5. For transmitters with Channel Guard, check the Channel Guard Modulation as shown in Step 2 of the transmitter Test Procedure. With Channel Guard tone applied, set the deviation as described in Step 4 above.
6. For multi-frequency transmitters, set the deviation as described in Step 4 on the channel producing the largest amount of deviation.



TRANSMITTER ALIGNMENT

EQUIPMENT REQUIRED:

- GE Test Set Model 4EX3A10 (or 4EX8K11) or equivalent 20,000 ohm-per-volt meter.
- GE Test Regulator Model 4EX18A10, or an ammeter capable of measuring one ampere.
- A 50-ohm, terminating wattmeter connected to external antenna jack J702 thru RF adaptor cable 19C317633G1 (Option 4466).
- A frequency counter.

PRELIMINARY CHECKS AND ADJUSTMENTS

1. In multi-frequency transmitters, set the channel selector switch to the lowest channel frequency.
2. Set the slugs in Tuning Controls 1 thru 6 even with the top of the can (there is no slug in Tuning Control 4). When properly aligned, the slugs will be between the top of the can and the coil.
3. If using Test Set 4EX3A10 and Test Regulator 4EX18A10, connect the Test Set to the metering jack on the Test Regulator. Then connect the Regulator output to J704 on the radio, and set the Regulator for 6 Volts. Switch the Test Set range to the Test 1 position. Place the test selector switch on position "I" to check the supply voltage (read on the 1-volt scale as 10-volts full scale). Switch to position "G" for current drain readings (read on the 1-volt scale as 1 ampere full scale).
4. Test Point meter reading made with the (+) meter lead to TP1 and TP2, and the (-) lead to system ground.
5. All adjustments made with the transmitter keyed.

ADJUSTMENT PROCEDURE

STEP	TUNING CONTROL	TYPICAL METER READING	PROCEDURE
1.	1, 2, and 3	Maximum (at TP1)	Adjust Tuning Controls 1, 2 and 3 for maximum meter reading at TP1. If no reading is obtained, adjust Tuning Controls 1, 2 and 3 for maximum transmitter current, and then re-adjust 1, 2 and 3 for maximum meter reading at TP1.
2.	5	Maximum (at TP2)	Adjust Tuning Control 5 for maximum meter reading at TP2.
3.	6, 7 and 8	Maximum mA	Adjust Tuning Controls 6, 7 and 8 for maximum transmitter current.
4.	9 and 10	Maximum Power Output	Adjust Tuning Controls 9 and 10 for maximum power output.
5.	2 thru 10	Maximum Power Output	Re-adjust Tuning Controls 2 thru 10 until no further increase in power output is obtained.
6.			Apply 7.5 Volts and check for a power output of one watt (minimum).
7.			With no modulation, adjust the F1 (and F2 thru F8) crystal trimmer for proper oscillator frequency. Next, refer to the Modulation Adjustment. NOTE: It is recommended that all frequency adjustments be made when the equipment is at a temperature of approximately 75°F. In no case should frequency adjustments be made when the equipment is outside the temperature range of 60°F to 90°F.

TEST PROCEDURES

These Test Procedures are designed to assist you in servicing a transmitter that is operating--but not properly. Problems encountered could be low power output, tone and voice deviation, defective audio sensitivity and modulator adjust control set too high. By following the sequence of test steps starting with Step 1, the defect can be quickly localized. Once a defect is pin-pointed, refer to the "Service Check" and the additional corrective measures included in the Transmitter Troubleshooting Procedure. Before starting with the Transmitter Test Procedures, be sure the transmitter is tuned and aligned to the proper operating frequency.

TEST EQUIPMENT REQUIRED

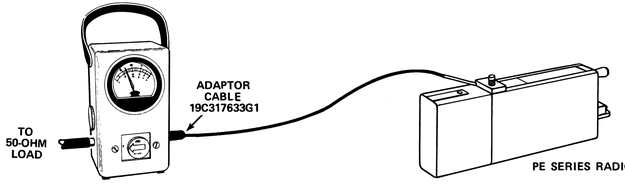
for test hookup shown:

1. Wattmeter similar to:
   Bird # 43
2. VTVM similar to:
   Triplett # 850
   Heath # 1M-21
3. Audio Generator similar to:
   GE Model 4EX6A10 or
   Heath # IG-72
4. Deviation Meter (with a .75 kHz scale) similar to:
   Measurements # 140
   Lampkin # 205A
5. GE Test Adaptor Model 4EX12A10.

STEP 1
POWER MEASUREMENT

TEST PROCEDURE

A. Connect transmitter output to wattmeter as shown below. GE adaptor cable 19C317633G1 is recommended for accurate power output readings.



B. Key transmitter and check wattmeter for desired power output..

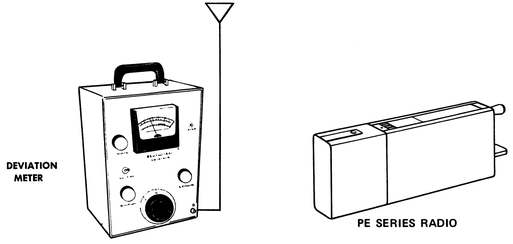
SERVICE CHECK

Refer to Service Hints on Transmitter Troubleshooting Procedure.

STEP 2
TONE DEVIATION WITH CHANNEL GUARD

TEST PROCEDURE

A. Set up Deviation Meter and monitor output of transmitter as shown below:



B. Set MOD ADJUST R8 fully counterclockwise.

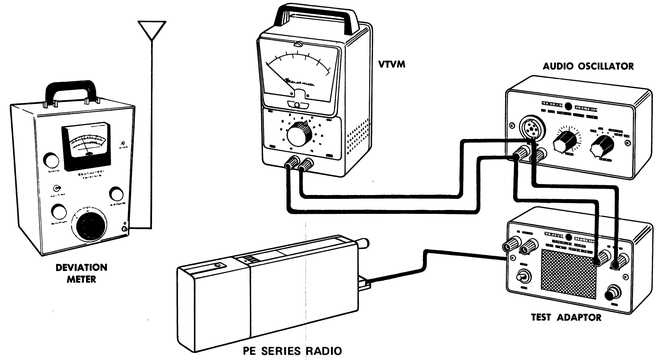
C. Key transmitter and check for approximately 0.75-kHz deviation. If reading is low or high, refer to the Channel Guard Troubleshooting Procedure (see Table of Contents)

NOTES--The Tone Deviation Test Procedures should be repeated every time the Tone Frequency is changed.

STEP 3
VOICE DEVIATION AND SYMMETRY

TEST PROCEDURE

A. Connect test equipment to transmitter as shown below:



B. Set the generator output to 140 millivolts RMS and frequency to 1 kHz. If the Test Adaptor is not used, set the generator output for 14 millivolts.

C. Key the transmitter and adjust Deviation Meter to carrier frequency.

D. Deviation reading should be ±4.5 kHz. If the deviation is not 4.5 kHz, set the deviation as directed on the Transmitter Alignment Procedure (see Table of Contents).

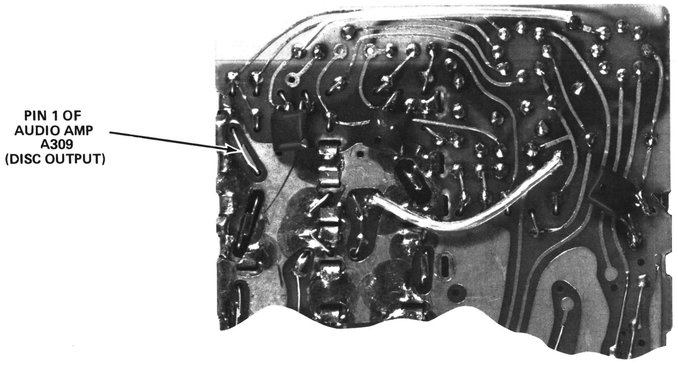
NOTES --These transmitters are adjusted for 4.5 kHz deviation at the factory. The factory adjustment will prevent the transmitter from deviating more than 5.0 kHz under the worst conditions of frequency, voltage and temperature.

If the deviation reading plus (+) or minus (-) differs by more than 0.5 kHz:

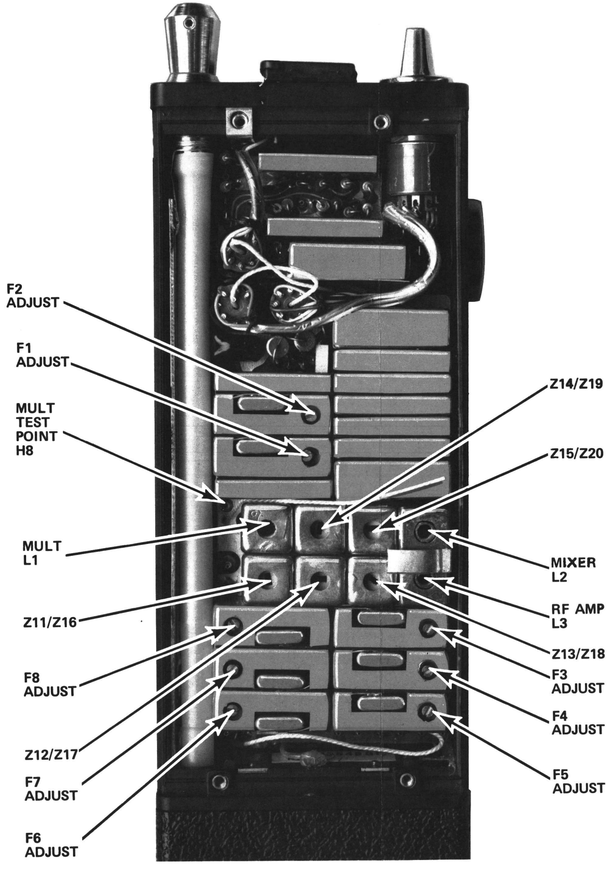
E. Refer to the Modulation Adjustment on the Transmitter Alignment Procedure.

F. Check Audio Sensitivity by reducing generator output until deviation falls to 3.3 kHz. Voltage should be LESS than 14 millivolts.

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 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.

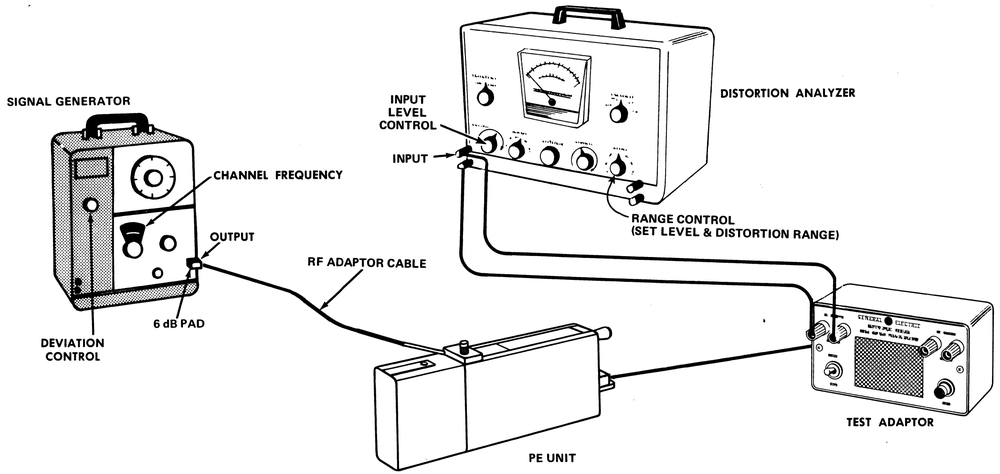
Once the defective stage is pin-pointed, refer to the "Service Check" listed to correct the problem. Additional corrective measures are included in the Troubleshooting Procedure. Before starting with the Receiver Test Procedures, be sure the receiver is tuned and aligned to the proper operating frequency.

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 ±3.3 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 3.3-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.

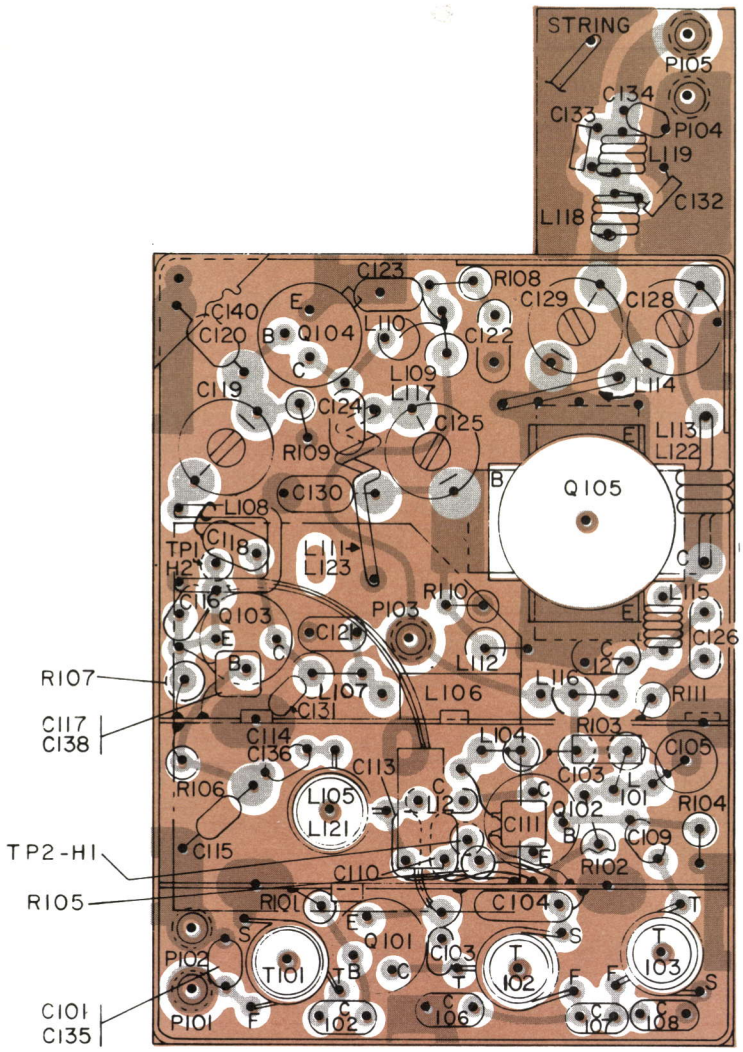
B. Set the RANGE control on the Distortion Analyzer in the SET LEVEL position (1000-Hz filter out of the circuit), and adjust the input LEVEL control for a +2 dB reading on the 30% range.

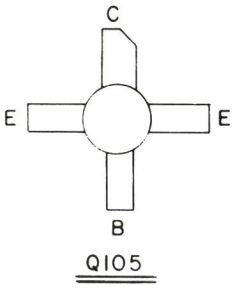
C. While increasing the deviation of the Signal Generator, switch the RANGE control from SET LEVEL to distortion range until a 12-dB difference is obtained between the SET LEVEL and distortion range readings (from +2 dB to -10 dB).

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).

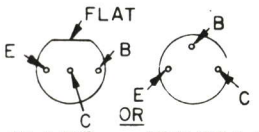
SERVICE CHECK

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





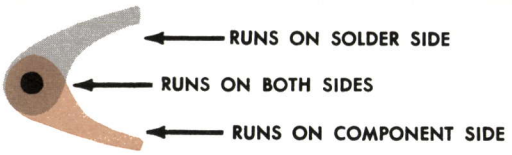
LEAD IDENTIFICATION
FOR Q101 THRU Q104



VIEW FROM LEAD END

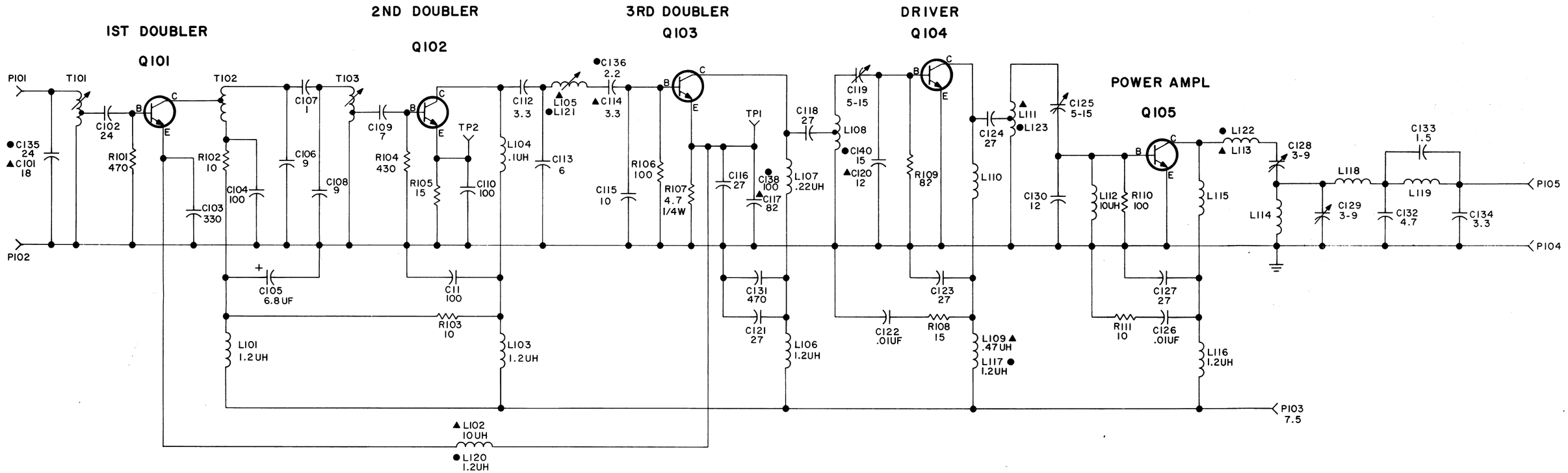
NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

(19C320437, Rev. 0)
(19C320138, Sh. 1, Rev. 0)
(19C320138, Sh. 2, Rev. 0)



OUTLINE DIAGRAM

406—470 MHz TRANSMITTER
EXCITER/PA ASSEMBLY



▲- HI SPLIT 4EF41A11 (450-470MHz)

●- LO SPLIT 4EF41A10 (406-420MHz)

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 1/10 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.

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

(19D416544, Rev. 4)

SCHEMATIC DIAGRAM

406—470 MHz TRANSMITTER EXCITER/PA ASSEMBLY

PARTS LIST

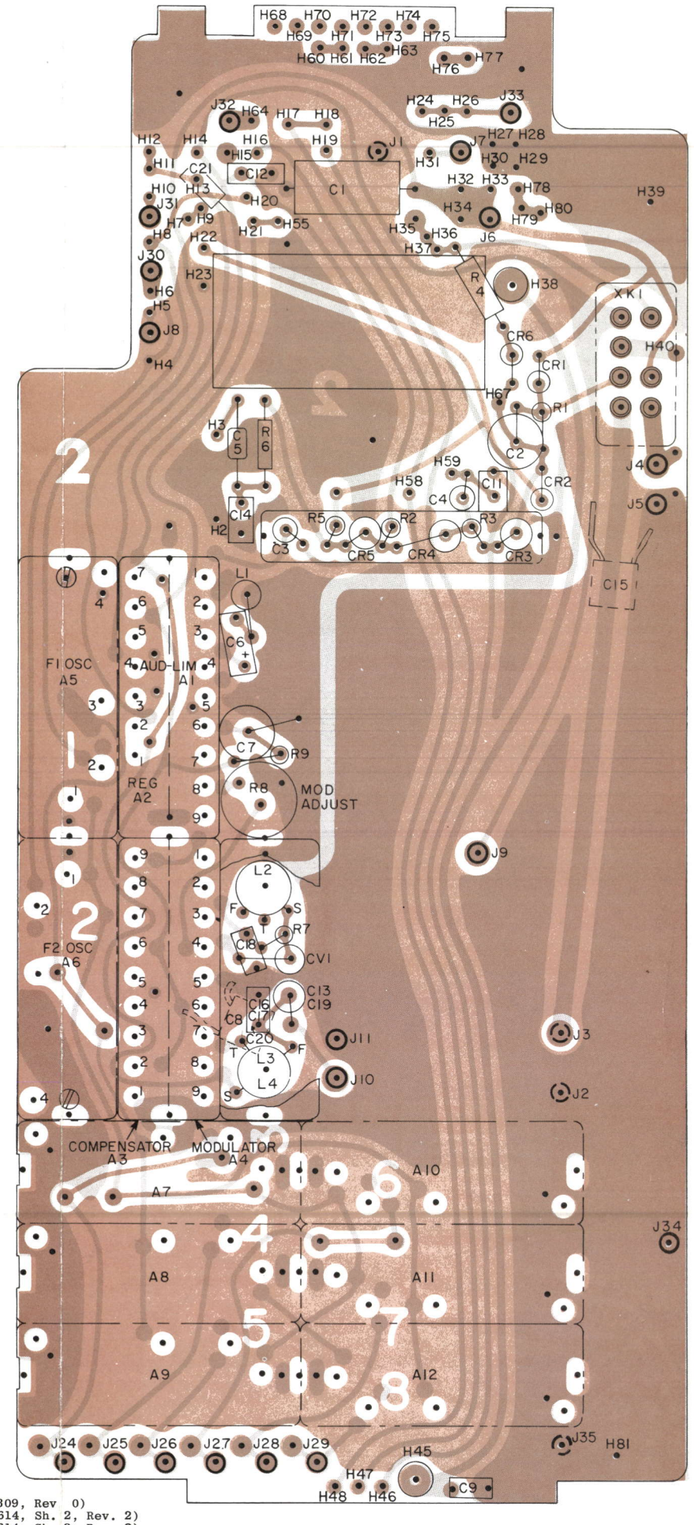
LBI-4382

EXCITER PA MODULE
4EF41A10 (406-420 MHz)
4EF41A11 (450-470 MHz)
19D416545G1, G2

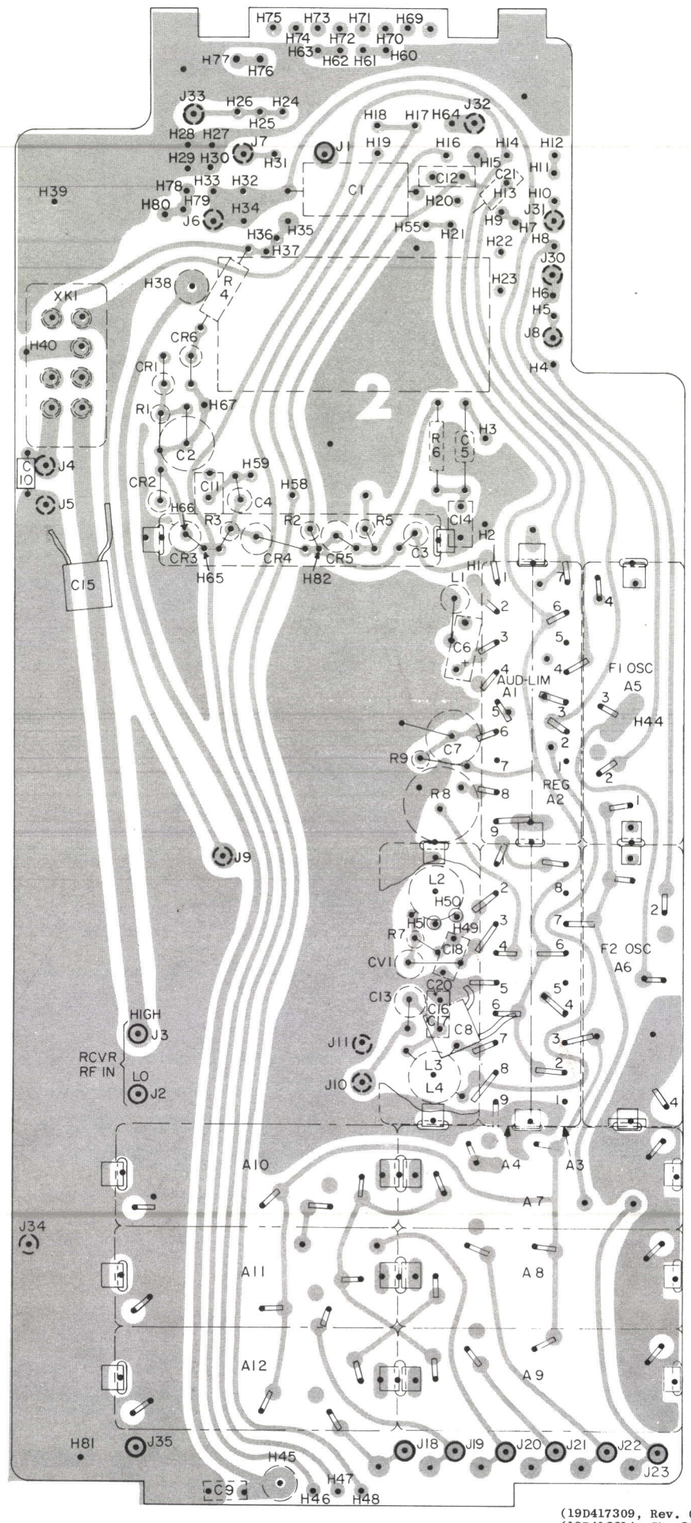
SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - CAPACITORS - - - - - - - - -
C101	19A116114P2038	Ceramic: 18 pf ±5%, 100 VDCW; temp coef -80 PPM.
C102	19A116114P2042	Ceramic: 24 pf ±5%, 100 VDCW; temp coef -80 PPM.
C103	19A116192P7	Ceramic: 330 pf ±20%, 50 VDCW; sim to Erie 8101-050-W5R.
C104	19A116114P8064	Ceramic: 100 pf ±10%, 100 VDCW; temp coef -1500 PPM.
C105	5491674P39	Tantalum: 6.8 µf ±20%, 15 VDCW; sim to Sprague Type 162D.
C106	19A116114P2030	Ceramic: 9 pf ±5%, 100 VDCW; temp coef -80 PPM.
C107	19A116114P2	Ceramic: 1 pf ±5%, 100 VDCW; temp coef 0 PPM.
C108	19A116114P2030	Ceramic: 9 pf ±5%, 100 VDCW; temp coef -80 PPM.
C109	19A116114P24	Ceramic: 7 pf ±5%, 100 VDCW; temp coef 0 PPM.
C110 and C111	19A116114P8064	Ceramic: 100 pf ±10%, 100 VDCW; temp coef -1500 PPM.
C112	19A116114P12	Ceramic: 3.3 pf ±5%, 100 VDCW; temp coef 0 PPM.
C113	19A116114P20	Ceramic: 6 pf ±5%, 100 VDCW; temp coef 0 PPM.
C114	19A116114P12	Ceramic: 3.3 pf ±5%, 100 VDCW; temp coef 0 PPM.
C115	19A116114P2032	Ceramic: 10 pf ±5%, 100 VDCW; temp coef -80 PPM.
C116	19A116114P2044	Ceramic: 27 pf ±5%, 100 VDCW; temp coef -80 PPM.
C117	19A116114P2062	Ceramic: 82 pf ±5%, 100 VDCW; temp coef -80 PPM.
C118	19A116114P2044	Ceramic: 27 pf ±5%, 100 VDCW; temp coef -80 PPM.
C119	19A116710P4	Variable, ceramic: 5 to 15 pf, 50 VDCW; sim to Erie Style 511-000.
C120	19A116114P2033	Ceramic: 12 pf ±5%, 100 VDCW; temp coef -80 PPM.
C121	19A116114P2044	Ceramic: 27 pf ±5%, 100 VDCW; temp coef -80 PPM.
C122	19A116192P1	Ceramic: 0.01 µf ±20%, 50 VDCW; sim to Erie 8121-050-W5R.
C123 and C124	19A116114P2044	Ceramic: 27 pf ±5%, 100 VDCW; temp coef -80 PPM.
C125	19A116710P4	Variable, ceramic: 5 to 15 pf, 50 VDCW; sim to Erie Style 511-000.
C126	19A116192P1	Ceramic: 0.01 µf ±20%, 50 VDCW; sim to Erie 8121-050-W5R.
C127	19A116114P2044	Ceramic: 27 pf ±5%, 100 VDCW; temp coef -80 PPM.
C128 and C129	19A116710P3	Variable, ceramic: 3 to 9 pf, 50 VDCW; sim to Erie Style 511-000.
C130	19A116114P2033	Ceramic: 12 pf ±5%, 100 VDCW; temp coef -80 PPM.
C131	19A116192P2	Ceramic: 470 pf ±20%, 50 VDCW; sim to Erie 8111-050-W5R.
C132	19A116114P16	Ceramic: 4.7 pf ±5%, 100 VDCW; temp coef 0 PPM.
C133	19A116114P4	Ceramic: 1.5 pf ±5%, 100 VDCW; temp coef 0 PPM.
C134	19A116114P12	Ceramic: 3.3 pf ±5%, 100 VDCW; temp coef 0 PPM.
C135	19A116114P2042	Ceramic: 24 pf ±5%, 100 VDCW; temp coef -80 PPM.
C136	19A116114P8	Ceramic: 2.2 pf ±5%, 100 VDCW; temp coef 0 PPM.
C138	19A116114P8064	Ceramic: 100 pf ±10%, 100 VDCW; temp coef -1500 PPM.
C140	19A116114P2036	Ceramic: 15 pf ±5%, 100 VDCW; temp coef -80 PPM.
		- - - - - - - - - - INDUCTORS - - - - - - - -
L101	19B209420P114	Coil, RF: 1.20 µh ±10%, 0.18 ohms DC res max; sim to Jeffers 4436-1.
L102	19B209420P125	Coil, RF: 10.0 µh ±10%, 3.10 ohms DC res max; sim to Jeffers 4446-4.
L103	19B209420P114	Coil, RF: 1.20 µh ±10%, 0.18 ohms DC res max; sim to Jeffers 4436-1.
L104	19B209420P101	Coil, RF: 0.10 µh ±10%, 0.08 ohms DC res max; sim to Jeffers 4416-1.
L105	19B219526G1	Coil. Includes:
	19A127805P1	Tuning slug.
L106	19B209420P114	Coil, RF: 1.20 µh ±10%, 0.18 ohms DC res max; sim to Jeffers 4436-1.
L107	19B209420P105	Coil, RF: 0.22 µh ±10%, 0.14 ohms DC res max; sim to Jeffers 4416-5.
L108	19B219524P1	Coil.
L109	19B209420P109	Coil, RF: 0.47 µh ±10%, 0.34 ohms DC res max; sim to Jeffers 4426-2.
L110	19A129251P1	Coil.
L111	19B219525P1	Coil.
L112	19B209420P125	Coil, RF: 10.0 µh ±10%, 3.10 ohms DC res max; sim to Jeffers 4446-4.
L113	19A129230G1	Coil.
L114	19A129250P1	Coil.
L115	19A129252P1	Coil.
L116 and L117	19B209420P114	Coil, RF: 1.20 µh ±10%, 0.18 ohms DC res max; sim to Jeffers 4436-1.
L118 and L119	19A129247P1	Coil.
L120	19B209420P114	Coil, RF: 1.20 µh ±10%, 0.18 ohms DC res max; sim to Jeffers 4436-1.
L121	19B219526G2	Coil. Includes:
	19B209436P1	Tuning slug.
L122	19A129230G2	Coil.
L123	19B219566P1	Coil.
		- - - - - - - - - - - PLUGS - - - - - - - - - -
P101 thru P105	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.
		- - - - - - - - - TRANSISTORS - - - - - - - - -
Q101 thru Q103	19A116201P3	Silicon, NPN.
Q104	19A116201P2	Silicon, NPN.
Q105	19A129165P1	Silicon, NPN.
		- - - - - - - - - - RESISTORS - - - - - - - - -
R101	3R151P471K	Composition: 470 ohms ±10%, 1/8 w.
R102 and R103	3R151P100K	Composition: 10 ohms ±10%, 1/8 w.
R104	3R151P431J	Composition: 430 ohms ±5%, 1/8 w.
R105	3R151P150K	Composition: 15 ohms ±10%, 1/8 w.
R106	3R151P101K	Composition: 100 ohms ±10%, 1/8 w.
R107	19A116670P16	Composition: 4.7 ohms ±5%, 1/4 w.
R108	3R151P150K	Composition: 15 ohms ±10%, 1/8 w.
R109	3R151P820K	Composition: 82 ohms ±10%, 1/8 w.
R110	3R151P101K	Composition: 100 ohms ±10%, 1/8 w.
R111	3R151P100K	Composition: 10 ohms ±10%, 1/8 w.
		- - - - - - - - - TRANSFORMERS - - - - - - - - -
T101	19B219527G2	Coil.
T102	19B219523G2	Coil.
T103	19B219523G1	Coil.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
	4035306P11	Washer: 1/8 dia. (Used with Q101-Q104).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

COMPONENT SIDE



SOLDER SIDE



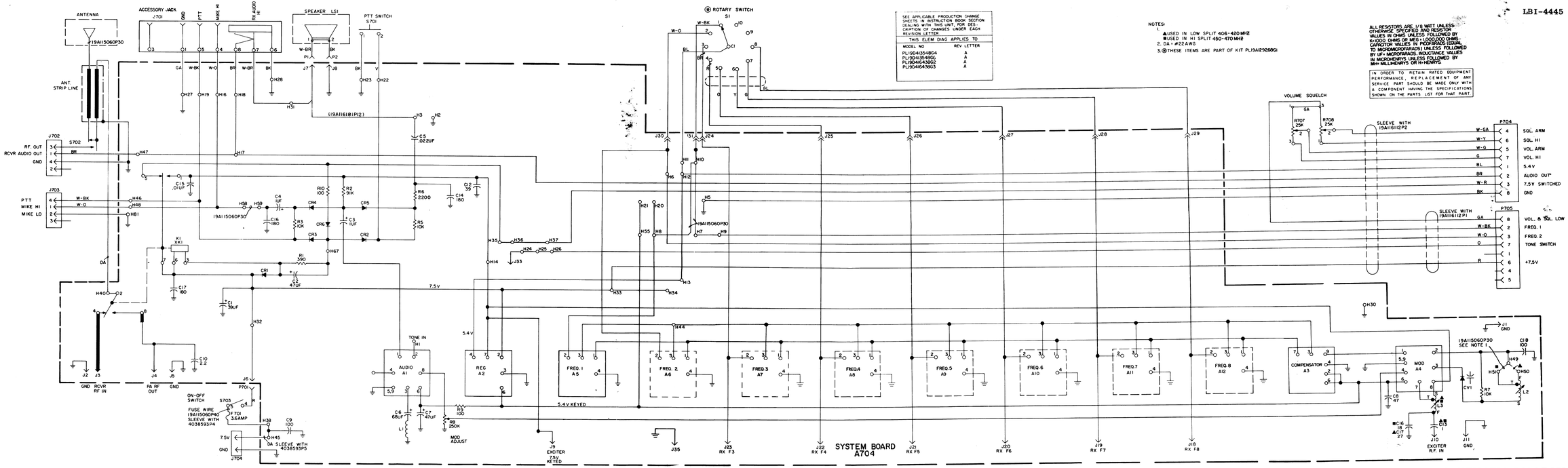
RUNS ON SOLDER SIDE
RUNS ON BOTH SIDES
RUNS ON COMPONENT SIDE

OUTLINE DIAGRAM

406—470 MHz SYSTEM BOARD

(19D417309, Rev 0)
(19D416614, Sh. 2, Rev. 2)
(19D416614, Sh. 3, Rev. 2)

(19D417309, Rev. 0)
(19D416614, Sh. 2, Rev. 2)



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
PLI904I3548G4	A
PLI904I3548G5	A
PLI904I6438G2	A
PLI904I6438G3	A

NOTES:
1. ▲USED IN LOW SPLIT 406-420 MHZ
■USED IN HI SPLIT 450-470 MHZ
2. DA = #22 AWG
3. ⊛THESE ITEMS ARE PART OF KIT PLI9A129268G1

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.

(19A821817, Rev. 3)

SCHEMATIC DIAGRAM

406—470 MHz SYSTEM BOARD

PARTS LIST

LBI-4446

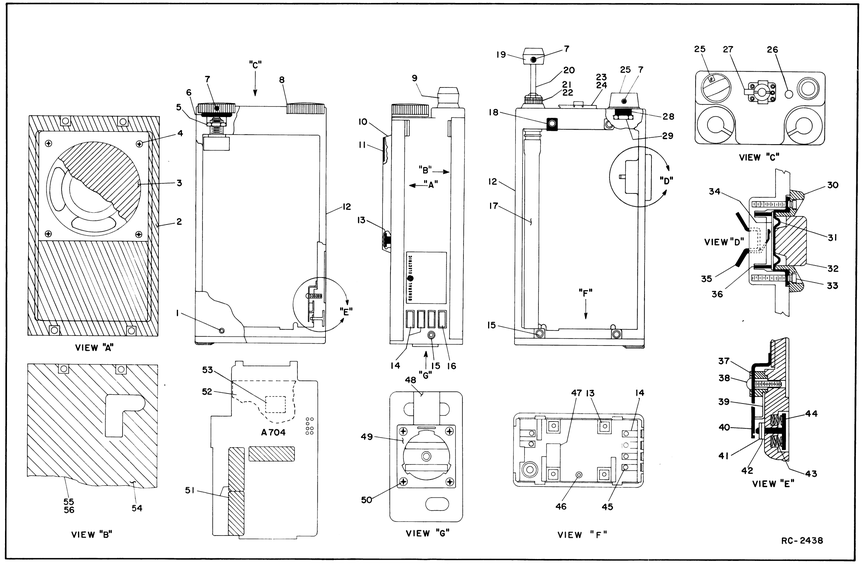
SYSTEM BOARD/CASE ASSEMBLY
19D413548G4
AND
ASSOCIATED ASSEMBLIES

SYMBOL	GE PART NO.	DESCRIPTION
A704		SYSTEM BOARD 19D416438G2
A1	19C320062G1	Transmitter Audio Module.
A2	19C311905G2	Regulator Module.
A3	19C320060G1	Oscillator Compensator Module.
A4	19C320084G1	Modulator Module.
		NOTE: When reordering A5-A12 give GE Part Number and exact crystal frequency. Crystal Freq = Operating Freq 24
A5 thru A12	4EG27A11	Transmitter Oscillator.
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1	5491674P30	Tantalum: 39 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C2	5491674P42	Tantalum: 47 µf ±20%, 6 VDCW; sim to Sprague Type 162D.
C3 and C4	5491674P1	Tantalum: 1.0 µf +40-20%, 10 VDCW; sim to Sprague Type 162D.
C5	19A116264P2	Ceramic: 0.022 µf ±20%, 50 VDCW.
C6	19C307102P19	Tantalum: 68 µf ±20%, 4 VDCW.
C7	5491674P42	Tantalum: 47 µf ±20%, 6 VDCW; sim to Sprague Type 162D.
C8	19A116114P7053	Ceramic: 47 pf ±5%, 100 VDCW; temp coef -750 PPM.
C9	19A116114P7065	Ceramic: 100 pf ±5%, 100 VDCW; temp coef -750 PPM.
C10	19A116114P2007	Ceramic: 2.2 pf ±10%, 100 VDCW; temp coef -80 PPM.
C11	19A116114P10073	Ceramic: 180 pf ±10%, 100 VDCW; temp coef -1300 PPM.
C12	19A116114P2049	Ceramic: 39 pf ±10%, 100 VDCW; temp coef -80 PPM.
C13	5491601P130	Phenolic: 1.0 pf ±5%, 500 VDCW.
C14	19A116114P10073	Ceramic: 180 pf ±10%, 100 VDCW; temp coef -1300 PPM.
C15	19A116193P1	Ceramic: 0.01 pf ±20%, 50 VDCW; sim to Erie 811-050-Y5S.
C18	19A116114P8065	Ceramic: 100 pf ±5%, 100 VDCW; temp coef -1300 PPM.
C21	19A116114P2044	Ceramic: 27 pf ±5%, 100 VDCW; temp coef -80 PPM.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1	19A115250P1	Silicon.
CR2 thru CR5	549492ZP1	Silicon; sim to Hughes 1N456.
CR6	19A115250P1	Silicon.
CV1	5495769P9	Silicon, capacitive.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - JACKS AND RECEPTACLES - - - - - -
J1 thru J5	19A116366P1	Contact, electrical: sim to Cambion 3232-1.
J6 thru J8	19A116366P2	Contact, electrical: sim to Cambion 3233-1.
J9 thru J31	19A116366P1	Contact, electrical: sim to Cambion 3232-1.
J32 thru J34	19A116366P2	Contact, electrical: sim to Cambion 3233-1.
J35	19A116366P1	Contact, electrical: sim to Cambion 3232-1.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L1	19B209430P114	Coil, RF: 1.20 uh ±10%, 0.18 ohms DC res max; sim to Jeffers 4434-1.
L2	19A127798G2	Coil: 3.5-4.3 µh. Includes:
	19B209436P1	Tuning slug.
L3	19B219527G1	Coil.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	3R151P391J	Composition: 390 ohms ±5%, 1/8 w.
R2	3R151P913J	Composition: 91,000 ohms ±5%, 1/8 w.
R3	3R151P103J	Composition: 10,000 ohms ±5%, 1/8 w.
R4	3R151P101K	Composition: 100 ohms ±10%, 1/8 w.
R5	3R151P103J	Composition: 10,000 ohms ±5%, 1/8 w.
R6	3R151P223J	Composition: 2200 ohms ±5%, 1/8 w.
R7	3R151P103J	Composition: 10,000 ohms ±5%, 1/8 w.
R8	19A116412P4	Variable, cermet: 200,000 ohms ±10%, 1/2 w; sim to Bellpot Model 62 PF.
R9	3R151P101K	Composition: 100 ohms ±10%, 1/8 w.
		- - - - - - - - - - SOCKETS - - - - - - - - - -
XK1	19A115834P5	Contact, electrical: sim to AMP 4-331272-3. (Quantity 7).
		- - - - - - - - - - FUSES - - - - - - - - - -
F701	19A127884G1	Fuse Kit.
		- - - - - - - JACKS AND RECEPTACLES - - - - - -
J701	19B216594G2	Connector, female: 6 contacts.
J702		(See Mechanical Parts RC-2438, items 14 and 16).
J703		(See Mechanical Parts RC-2438, item 14).
J704		(See Mechanical Parts RC-2438, items 48-50).
		- - - - - - - - - - RELAYS - - - - - - - - - -
K1	19A127836G1	Relay, sensitive: 90 ohms ±10%, 2 form C contacts, 3.5 to 9.0 VDC (over the temp range indicated); sim to C.P. Clare HF1401G01.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P701	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.
P704 and P705	19A127569P1	Plug: 8 contacts.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R707	19A116227P1	Resistor/Switch: variable, carbon film, 25,000 ohms ±20%, 1/8 w, (includes S703), SPST, 3 amp at 125 VAC.
R708	19A116227P2	Variable, carbon film: 25,000 ±20%, 1/8 w.
		- - - - - - - - - - SWITCHES - - - - - - - - - -
S701		(See Mechanical Parts RC-2438, items 30-36).
S702		(See Mechanical Parts RC-2438, items 37-44).
S703		(Part of R707).

SYMBOL	GE PART NO.	DESCRIPTION
		ASSOCIATED ASSEMBLIES
		FRONT COVER ASSEMBLY 19C317416G2
		- - - - - - - - - - LOUDSPEAKERS - - - - - - - - - -
LS1	19A116090P1	Permanent magnet: 2.00 inch, 8 ohms ±10% voice coil imp, 400 Hz ±12 Hz resonant; freq range 400 to 3000 Hz.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P1 and P2	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.
		HI/LOW SPLIT MODIFICATION KIT 19A127838G3 HI SPLIT 19A127839G4 LOW SPLIT
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C16	19A116114P2038	Ceramic: 18 pf ±5%, 100 VDCW; temp coef -80 PPM.
C17	19A116114P2044	Ceramic: 27 pf ±5%, 100 VDCW; temp coef -80 PPM.
		MULTI-FREQUENCY MODIFICATION KIT 19A129268G1
		- - - - - - - - - - SWITCHES - - - - - - - - - -
S1	19B219515G1	Switch, rotary: 1 section, 1 pole, 10 positions (adjustable stop), non-shorting contacts; sim to Grayhill Co. 50M-36-01-1-HH.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
	5494922P1	Diode, silicon; sim to Hughes 1N456. (Used for repeated frequencies only).
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
	19B216897G3	Rear Cover Assembly. (See RC-2438, items 2, 54, and 55).
	19B216897G4	Rear Cover Assembly. Clip type. (See RC-2438, items 2, 54, 56).
	19B219953G4	Antenna Assembly. (See RC-2438, item 7, 19-23).
	19D413522G1	Battery, rechargeable. Nickel Cadmium.
	4038831P4	Alignment tool. Fork tip.
	19B219079G1	Alignment tool. Allen tip.
		MECHANICAL PARTS (SEE RC-2438)
1	19A116543P1	Cap screw, socket head: No. 2-56 x 1/4.
2	19C317394P4	Gasket.
3	19B206527P2	Diaphragm: No. 2 inches dia.
4	9618P5003C13	Screw, phillips head: No. 2-56 x 1/8.
5	19A127319P1	Nut: No. 1/4-32.
6	19A115983P5	Seal, "O" ring: sim to Parker Seal 2-13.
7	8707P03C13	Set screw: No. 2-56 x 3/16.
8	19C317065P1	Knob, (SQUELCH, ON-OFF-VOLUME).
9	19B219953G4	Antenna assembly. (Includes item 7, 19-23).
10	19D413531P2	Grille.
11	RP370290P2	Nameplate. (GE monogram).
12	19D413542G2	Case assembly. (Includes items 14, 15, 16, 26, 30-36, 45, and 46).
13	19B216858P1	Insert.
14	19A127753P1	Contact. (Part of J702 and J703).
15	19A116719P1	Insert, screw thread: 2-56.
16	19B216863P2	Contact.
17	19A127779G8	Antenna tube.

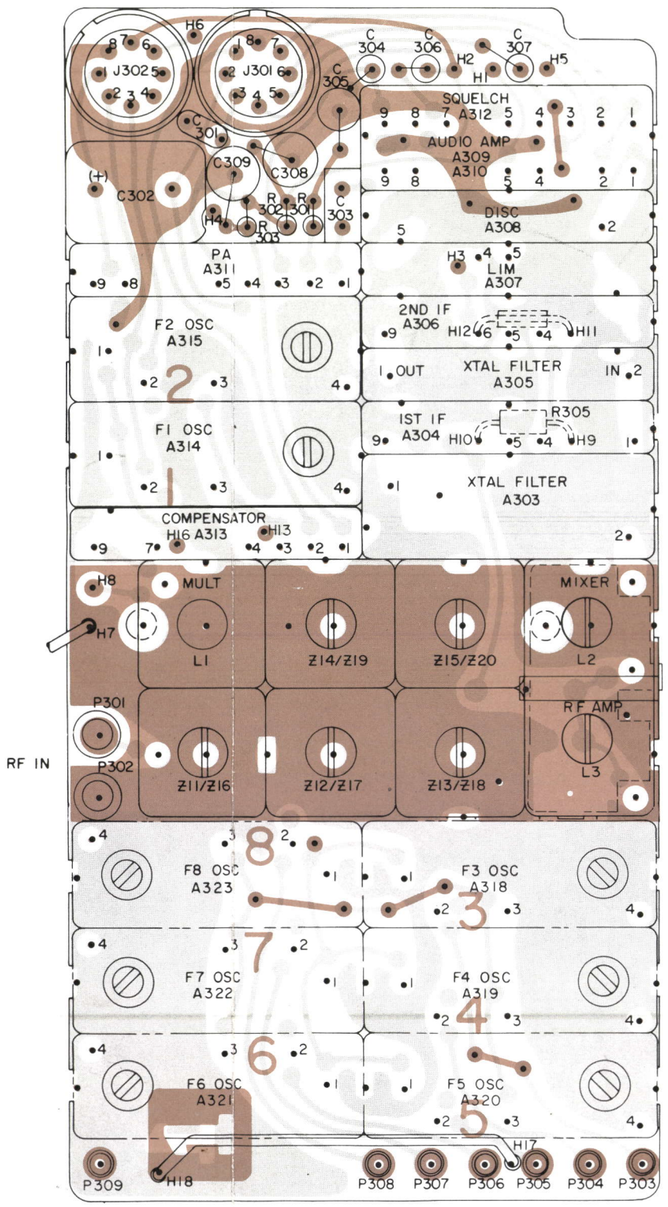
SYMBOL	GE PART NO.	DESCRIPTION
18	19B216875P1	Support.
19	19129649P1	Antenna Cap. (Part of item 9).
20	19B219650P1	Antenna rod. (Part of item 9).
21	19C320352P1	Bushing. (Part of item 9).
22	19A129652P1	Nut, knurled: 7/16 thds. (Part of item 9).
23	19C317050P1	Protective Cover.
24	19A129390P1	Disc. (Located in item 23).
25	19C311888P2	Knob.
26	19A129723P1	Rivet.
27	19B219540P1	Catch.
28	19B216530P4	Washer, nylon: 1/4 inch.
29	19A127319P2	Nut: No. 1/4-28.
30	19C320559P1	Collar. (Part of S701).
31	19C320558P1	Diaphragm. (Part of S701).
32	19C320560P1	Button. (Part of S701).
33	9409106Y	Screw, slotted, brass: No. 0-80 x 3/8. (Part of S701).
34	19A129733P1	Contact plate. (Part of S701).
35	19B219961G1	Terminal. (Part of S701).
36	19A129734P1	Spring. (Part of S701).
37	19B216865P1	Insulator. (Part of S703).
38	9647P5004C	Cap screw: 2-56 x 1/4. (Part of S702).
39	19B216864P1	Contact. (Part of S702).
40	19B216863P1	Spring contact. (Part of S702).
41	8910P6C13	Retaining ring. (Part of S702).
42	19A127754P1	Gasket. (Part of S702).
43	19A127755P1	Spring. (Part of S702).
44	19B216862P1	Contact. (Part of S702).
45	9330P6027Z3	Eyelet, brass: 1/16 x 5/32.
46	9330P6027Z2	Eyelet, brass: 1/16 x 1/16.
47	19A127762P1	Strap.
48	19B216891G1	Spring assembly. (Part of J704).
49	19D413467P1	Fastener (Part of J704).
50	9839P6008E	Flat head screw: brass, 2-56 x 5/16. (Part of J704).
51	19C311491P3	Can. (Used with Regulator, Oscillator Compensator, and Compressor Circuits).
52	19B219510P1	Insulator. (Located between System and Receiver Boards).
53	19A116370P1	Tape, pressure sensitive. (Specify length).
54	19C317394P6	Gasket.
55	19B216897G3	Rear Cover Assembly. (Without clip).
56	19B216897G4	Rear Cover Assembly. (With clip).



*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

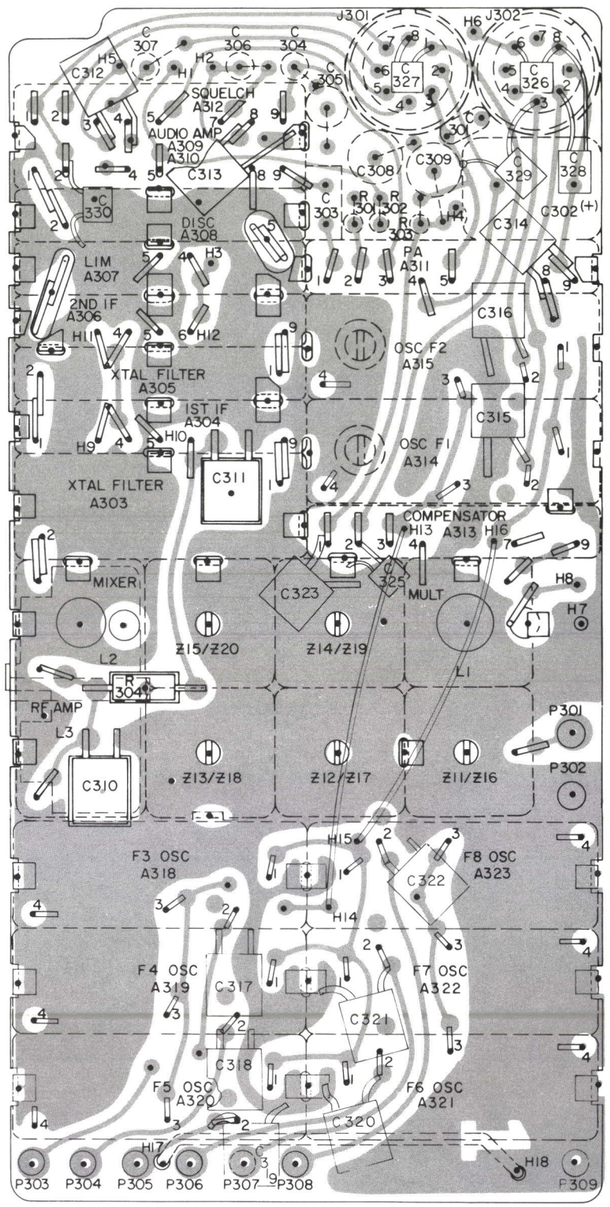
	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8
J301	5.4 V	AUDIO OUT	SWITCHED 7.5V	SQ ARM	VOL ARM	SQ HI	VOL HI	GND
J302		FREQ 1	FREQ 2			7.5V	TONE SWITCH	GND

COMPONENT SIDE



(19D417292, Rev. 0)
(19C320014, Sh. 1, Rev. 1)
(19C320014, Sh. 2, Rev. 1)

SOLDER SIDE

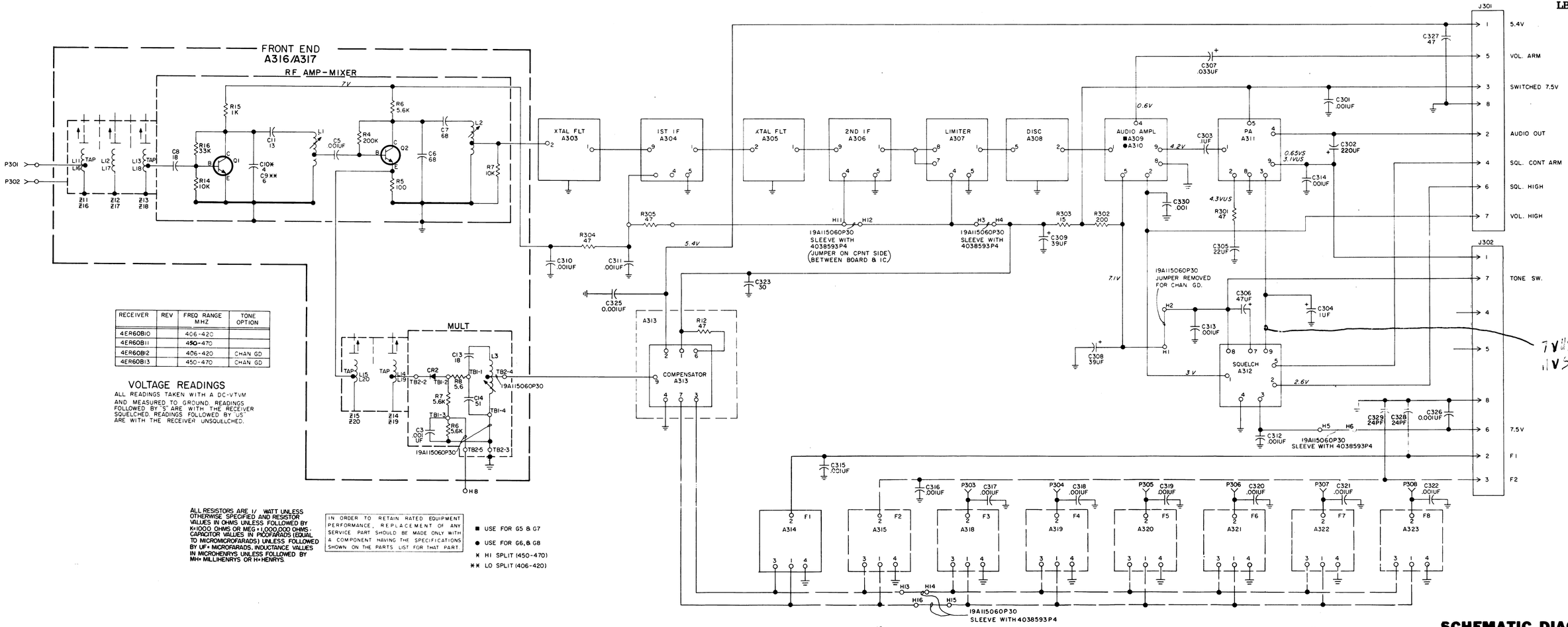


(19D417292, Rev. 0)
(19C320014, Sh. 2, Rev. 1)

RUNS ON SOLDER SIDE
RUNS ON BOTH SIDES
RUNS ON COMPONENT SIDE

OUTLINE DIAGRAM

406—470 MHz RECEIVER
MODELS 4ER60B10-13



RECEIVER	REV	FREQ RANGE MHZ	TONE OPTION
4ER60B10		406-420	
4ER60B11		450-470	
4ER60B12		406-420	CHAN GD
4ER60B13		450-470	CHAN GD

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/ 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.

■ USE FOR G5 & G7
● USE FOR G6, & G8
* HI SPLIT (450-470)
** LO SPLIT (406-420)

(19R621835, Rev. 4)

SCHEMATIC DIAGRAM

406—470 MHz RECEIVER
MODELS 4ER60B10-13

PARTS LIST

LBI-4447

406-470 MHz RECEIVER
MODELS 4ER60B10-13

SYMBOL	GE PART NO.	DESCRIPTION
A303	19C304516G3	Crystal Filter.
A304	19C311879G3	1st IF Amplifier.
A305	19C304824G1	Crystal Filter.
A306	19C311879G4	2nd IF Amplifier.
A307	19C311876G2	Limiter.
A308	19C304504G3	Discriminator.
A309	19C311878G2	Audio Amplifier.
A310	19C311995G2	Audio Amplifier. (Includes Tone Filter).
A311	19C311877G2	PA.
A312	19C311880G2	Squelch.
A313	19C320061G1	Compensator.
		- - - - - - - - - - OSCILLATORS - - - - - - - - -
A314, A315,		NOTE: When reordering, give GE Part Number and specify exact frequency needed.
A318 thru A323	4EG28A12	Oscillator Module. 406-420 MHz. Fx = Fo ÷ 20 / 21
	4EG28A13	Oscillator Module. 450-470 MHz. Fx = Fo ÷ 20 / 21
A316 and A317		FRONT END 19C317295G3 406-420 MHz 19C317295G4 450-470 MHz
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.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - 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	3R151P333J	Composition: 33,000 ohms ±5%, 1/8 w.
R16	3R151P102J	Composition: 1000 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 and R7	3R151P562J	Composition: 5600 ohms ±5%, 1/8 w.
R8	3R151P5R6J	Composition: 5.6 ohms ±5%, 1/8 w.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - -
	19B200495P5	Tuning slug.
		- - - - - - - - - - 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.

SYMBOL	GE PART NO.	DESCRIPTION
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.
A318 thru A323		See A314, A315.
		- - - - - - - - - - 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.
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.
C310 thru C322	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C323	19A116114P2045	Ceramic: 30 pf ±5%, 100 VDCW; temp coef -80 PPM.
C325 and C326	5495323P12	Ceramic: .001 µf +100% -20%, 75 VDCW.
C327	19A116114P8053	Ceramic: 47 pf ±5%, 100 VDCW; temp coef -1500 PPM.
		- - - - - - - - JACKS AND RECEPTACLES - - - - - -
J301 and J302	19A116122P1	Feed-thru: sim to Warren Co 1-B-2994-4.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P301 thru P309	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.
		- - - - - - - - - - RESISTORS - - - - - - - - -
R301	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).
	19B216306P1	Insulator. (Used with J301 and J302).
	19A127110P1	Screw: No. 1-64 x 5/32. (Secures A316, A317, filter, tank).
	19A127737P1	Ground spring. (Used in A316, A317).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

PARTS LIST

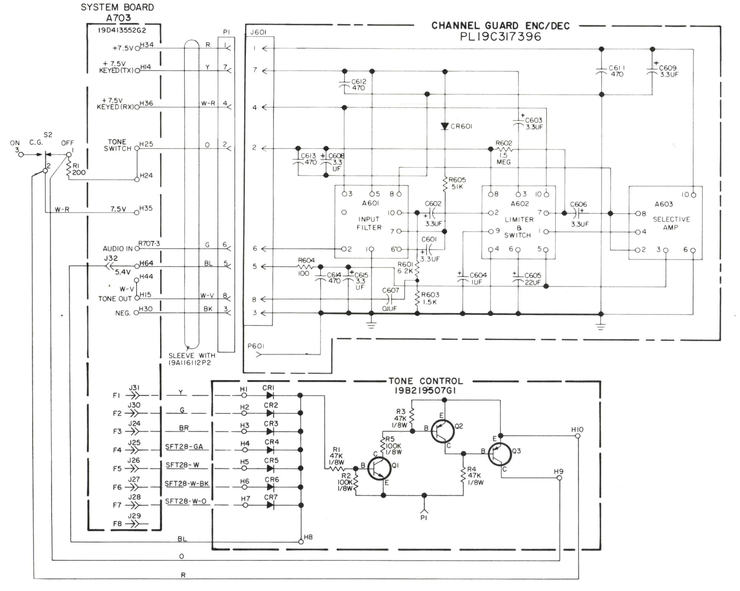
LBI-4371A

CHANNEL GUARD ENCODER/DECODER
MODEL 4EK17A11

SYMBOL	GE PART NO.	DESCRIPTION
		CHANNEL GUARD ENCODER/DECODER BOARD 19C317396G1
		- - - - - - - - - - PLUGS - - - - - - - - - -
P1	19B216958G1	Socket, crystal: 8 contacts.
		- - - - - - - - - - SWITCHES - - - - - - - - - -
		SWITCH ASSEMBLY 19A127835G1
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	3R151P201J	Composition: 200 ohms ±5%, 1/8 w.
		- - - - - - - - - - SWITCHES - - - - - - - - - -
S2	4036949P1	Toggle: SPDT, 100 µa at 5 VDC, mounting hardware; sim to Arrow-Hart and Hegeman TS-3.
A601	19C317009G2	Input Filter.
A602	19C317014G2	Limiter and Switch.
		NOTE: When reordering give GE Part Number and specify exact frequency needed.
A603	19D413245G3	Selective Amplifier. 71.9-203.5 Hz freq range.
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C601 thru C603	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C604	5491674P28	Tantalum: 1.0 µf ±20%, 25 VDCW; sim to Sprague Type 162D.
C605	5491674P35	Tantalum: 22 µf ±20%, 4 VDCW; sim to Sprague Type 162D.
C606	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C607	19A116207P3	Ceramic: 0.1 µf ±20%, 25 VDCW, temp range -55 to 85°C; sim to Aerovox ELA752C104K.
C608 and C609	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C611 thru C614	19A116192P2	Ceramic: 470 pf ±20%, 50 VDCW; sim to Erie 811-050-W5R.
C615	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR601	19A115250P1	Silicon.
		- - - - - - - JACKS AND RECEPTACLES - - - - - - -
J601	19A116122P1	Terminal, feed-thru: sim to Warren Co 1-B-2994-4.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P601	19A115834P4	Contact, electrical: sim to Amp 2-332070-9.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R601	3R152P622J	Composition: 6200 ohms ±5%, 1/2 w.
R602	3R152P155K	Composition: 1.5 megohm ±10%, 1/4 w.
R603	3R152P152J	Composition: 1500 ohms ±5%, 1/4 w.
R604	3R152P101K	Composition: 100 ohms ±10%, 1/4 w.
R605	3R152P513J	Composition: 51,000 ohms ±5%, 1/4 w.
		TONE CONTROL BOARD 19B219507G1
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1 thru CR7	5494922P1	Silicon; sim to Hughes 1N456.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P1	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1	19A129184P1	Silicon, NPN.
Q2 and Q3	19A129187P1	Silicon, PNP.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	3R151P473K	Composition: 47,000 ohms ±10%, 1/8 w.
R2	3R151P104K	Composition: 0.10 megohm ±10%, 1/8 w.
R3 and R4	3R151P473K	Composition: 47,000 ohms ±10%, 1/8 w.
R5	3R151P104K	Composition: 0.10 megohm ±10%, 1/8 w.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
	5490135P3	Boot, moisture seal. (Used with S2).
	19B216926P1	Decorative cap. (Used with S2).
	19B216316P1	Insulator. (Used with J601).
	4035306P11	Insulator. (Used with Q1-Q3).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES.

SCHEMATIC DIAGRAM



(19D416547, Rev. 1)

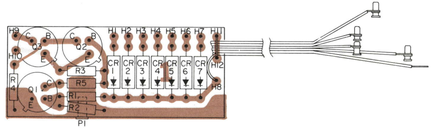
SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.

THIS ELEM DIAG APPLIES TO

MODEL NO	REV LETTER
4EK17A11	

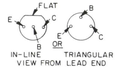
IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN MICROFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH=MILLIHENRYS OR H=HENRYS.



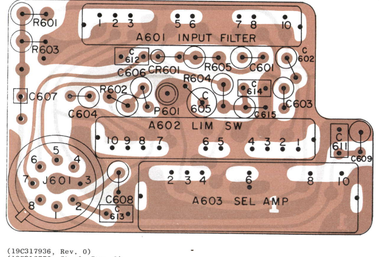
(19B219807, Rev. 0)
(19B219490, Sh. 1, Rev. 1)
(19B219490, Sh. 2, Rev. 1)

LEAD IDENTIFICATION FOR Q1-Q3

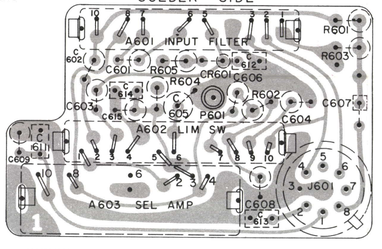


NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

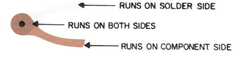
OUTLINE DIAGRAM



(19C317936, Rev. 0)
(19B216776, Sh. 1, Rev. 1)
(19B216776, Sh. 2, Rev. 1)



(19C317936, Rev. 0)
(19B216776, Sh. 2, Rev. 1)



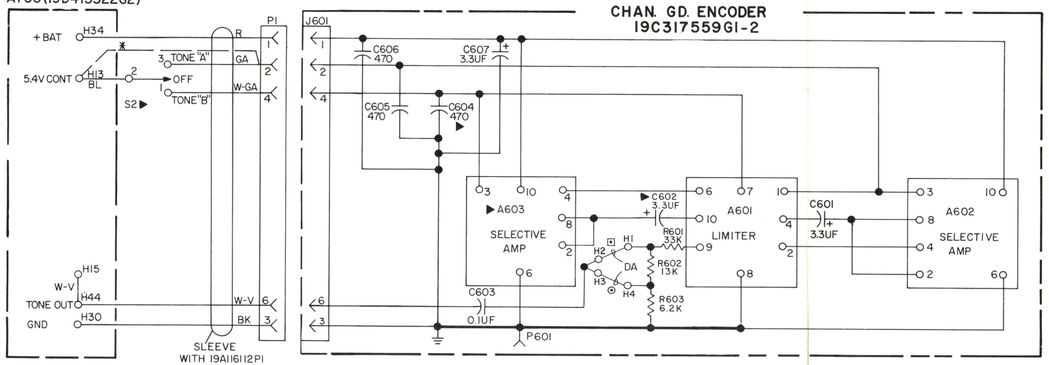
SCHEMATIC & OUTLINE DIAGRAM

CHANNEL GUARD ENCODER/DECODER
MODEL 4EK17A11

Issue 1

SYSTEM BOARD
A701 (19D413552G1)
A702 (19D416438G1)
A703 (19D413522G2)

SCHEMATIC DIAGRAM



(19C317558, Rev. 2)

✱ 19C317559G1 ONLY (1 TONE)
▶ 19C317559G2 ONLY (2 TONE)
⊙ (406-470 MHZ)
⊡ (132-174 MHZ)

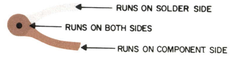
ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR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

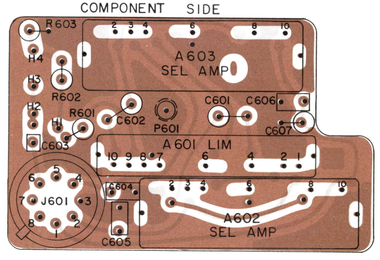
SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.

THIS ELEM DIAG APPLIES TO	
MODEL NO	REV LETTER

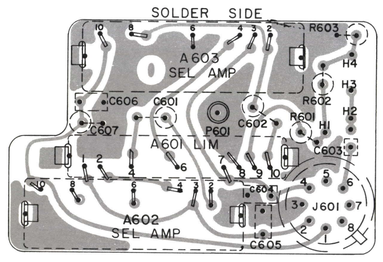
IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

OUTLINE DIAGRAM





(19C317931, Rev. 0)
(19B219044, Sh. 1, Rev. 0)
(19B219044, Sh. 2, Rev. 0)



(19C317931, Rev. 0)
(19B219044, Sh. 2, Rev. 0)

PARTS LIST

LBI-4248

CHANNEL GUARD ENCODER
MODEL 4EH21A10 1 TONE
MODEL 4EH21A11 2 TONE

SYMBOL	GE PART NO.	DESCRIPTION
A601	19C317033G2	Limiter.
		NOTE: When reordering give GE Part Number and specify exact frequency needed.
A602 and A603	19D413245G3	Selective Amplifier. 71.9-203.5 Hz freq range.
		- - - - - - - - - CAPACITORS - - - - - - - - -
C601 and C602	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C603	19A116207P3	Ceramic: 0.1 µf ±20%, 25 VDCW, temp range -55 to 85°C; sim to Aerovox ELA752C104K.
C604 thru C606	19A116192P2	Ceramic: 470 pf ±20%, 50 VDCW; sim to Erie 811-050-W5R.
C607	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
		- - - - - - - - JACKS AND RECEPTACLES - - - - - -
J601	19A116122P1	Terminal, feed-thru: sim to Warren Co 1-B-2994-4.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P601	19A115834P4	Contact, electrical: sim to Amp 2-332070-9.
		- - - - - - - - - - RESISTORS - - - - - - - - -
R601	3R152P333J	Composition: 33,000 ohms ±5%, 1/4 w.
R602	3R152P133J	Composition: 13,000 ohms ±5%, 1/4 w.
R603	3R152P622J	Composition: 6200 ohms ±5%, 1/4 w.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P1	19B219050G1	Socket, crystal: 8 contacts.
		- - - - - - - - - - SWITCHES - - - - - - - - -
S2	19B219053G1	Toggle: SPDT; sim to Arrow-Hart and Hegeman TC-3.
		- - - - - - - - MISCELLANEOUS - - - - - - - -
	19B216926P2	Decorative cap. (Used with S2).
	19B216316P1	Insulator. (Used with J601).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

SCHEMATIC & OUTLINE DIAGRAM

CHANNEL GUARD ENCODER
MODELS 4EH21A10, 11

PARTS LIST

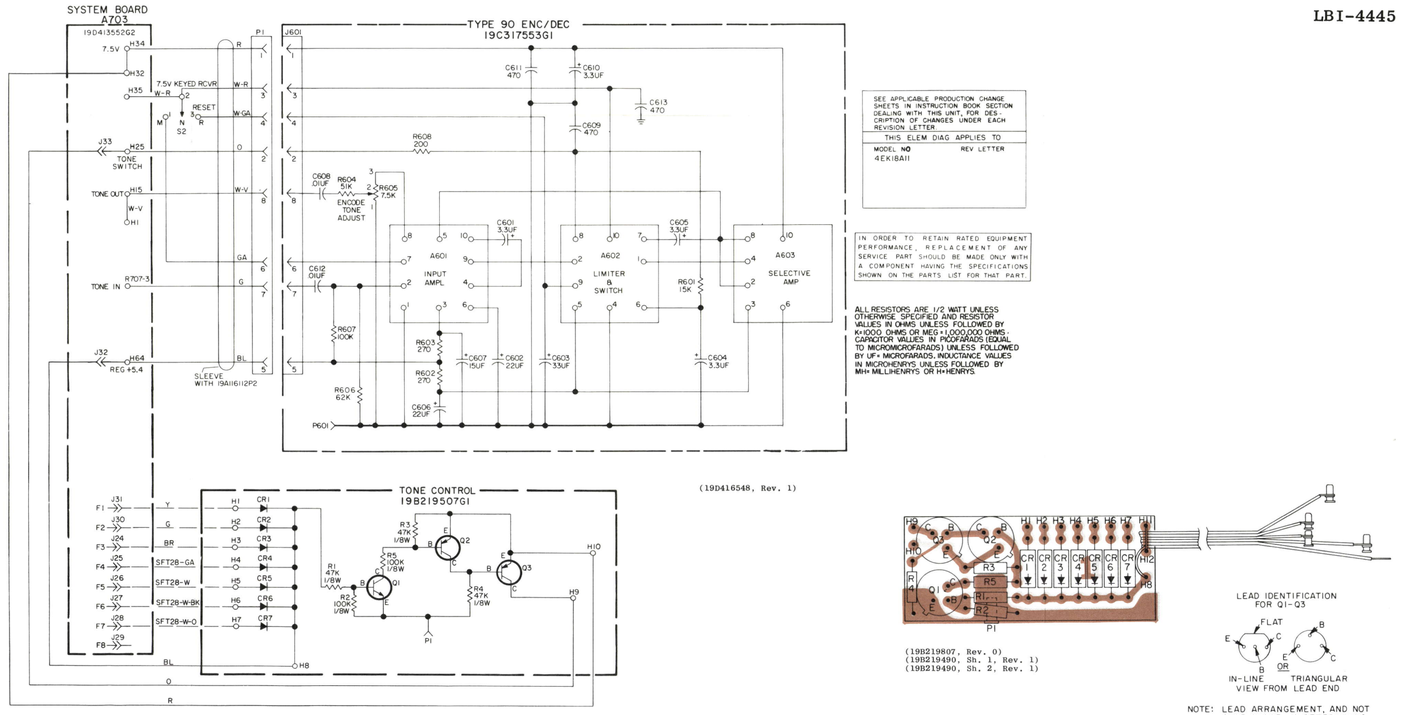
LBI-4372

TYPE 90 ENCODER/DECODER
MODEL 4EK18A11

SYMBOL	GE PART NO.	DESCRIPTION
		TYPE 90 ENCODER/DECODER BOARD 19C317553G1
		- - - - - - - - - - PLUGS - - - - - - - - - -
P1	19B219052G1	Socket, crystal: 8 contacts.
		- - - - - - - - - - SWITCHES - - - - - - - - - -
S2	19B219053G3	Toggle: SPDT; sim to Arrow-Hart and Hegeman TE-3.
A601	19C317061G2	Input Amplifier.
A602	19C317014G2	Limiter and Switch. NOTE: When reordering give GE Part Number and specify exact frequency needed.
A603	19D413245G4	Selective Amplifier. 1050-3000 Hz.
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C601	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C602	19C307102P15	Tantalum: 22 µf ±20%, 6 VDCW; sim to Component Inc G226R.
C603	19C307102P4	Tantalum: 33 µf ±20%, 10 VDCW; sim to Component Inc S336R.
C604 and C605	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C606	19C307102P15	Tantalum: 22 µf ±20%, 6 VDCW; sim to Component Inc G226R.
C607	19C307102P14	Tantalum: 15 µf ±20%, 10 VDCW; sim to Component Inc G156R.
C608	19A116192P1	Ceramic: 0.01 µf ±20%, 50 VDCW; sim to Erie 8121-050-W5R.
C609	19A116192P2	Ceramic: 470 pf ±20%, 50 VDCW; sim to Erie 8111-050-W5R.
C610	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C611	19A116192P2	Ceramic: 470 pf ±20%, 50 VDCW; sim to Erie 8111-050-W5R.
C612	19A116192P1	Ceramic: 0.01 µf ±20%, 50 VDCW; sim to Erie 8121-050-W5R.
C613	19A116192P2	Ceramic: 470 pf ±20%, 50 VDCW; sim to Erie 8111-050-W5R.
		- - - - - - - JACKS AND RECEPTACLES - - - - - -
J601	19A116122P1	Terminal, feed-thru: sim to Warren Co 1-B-2994-4.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P601	19A115834P4	Contact, electrical: sim to Amp 2-332070-9.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R601	3R152P153K	Composition: 15,000 ohms ±10%, 1/4 w.
R602 and R603	3R152P271K	Composition: 270 ohms ±10%, 1/4 w.
R604	3R152P513J	Composition: 51,000 ohms ±5%, 1/4 w.
R605	19A116093P1	Variable, carbon film: 7500 ohms ±20%, 0.20 w; sim to Centralab Series 3 Type 620-1.
R606	3R152P623J	Composition: 62,000 ohms ±5%, 1/4 w.
R607	3R152P104K	Composition: 0.10 megohm ±10%, 1/4 w.
R608	3R152P201J	Composition: 200 ohms ±5%, 1/4 w.
		TONE CONTROL BOARD 19B219507G1
		- - - - - - - - - DIODES AND RECTIFIERS - - - - -
CR1 thru CR7	5494922P1	Silicon; sim to Hughes 1N456.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P1	19A115834P4	Contact, electrical: sim to AMP 2-332070-9.
		- - - - - - - - - TRANSISTORS - - - - - - - - -
Q1	19A129184P1	Silicon, NPN.
Q2 and Q3	19A129187P1	Silicon, PNP.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1	3R151P473K	Composition: 47,000 ohms ±10%, 1/8 w.
R2	3R151P104K	Composition: 0.10 megohm ±10%, 1/8 w.
R3 and R4	3R151P473K	Composition: 47,000 ohms ±10%, 1/8 w.
R5	3R151P104K	Composition: 0.10 megohm ±10%, 1/8 w.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
	5490135P3	Boot, moisture seal. (Used with S2).
	19B216926P3	Decorative cap. (Used with S2).
	19B216316P1	Insulator. (Used with J601).
	4033306P11	Insulator. (Used with Q1-Q3).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

SCHEMATIC DIAGRAM



(19D416548, Rev. 1)

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
4EK18A11	

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.

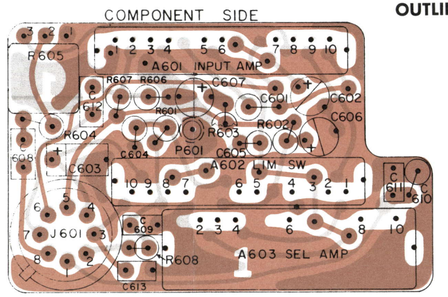
ALL RESISTORS ARE 1/2 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR H=HENRYS.

(19B219807, Rev. 0)
(19B219490, Sh. 1, Rev. 1)
(19B219490, Sh. 2, Rev. 1)

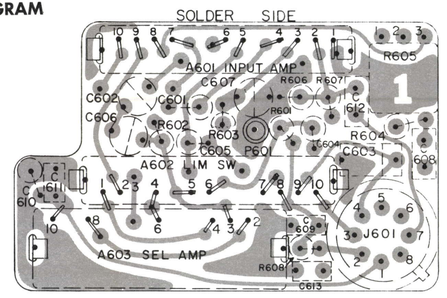
LEAD IDENTIFICATION FOR Q1-Q3

NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

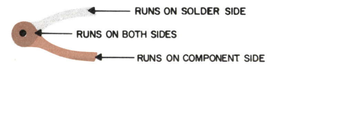
OUTLINE DIAGRAM



(19C317940, Rev. 0)
(19B219040, Sh. 1, Rev. 1)
(19B219040, Sh. 2, Rev. 1)



(19C317940, Rev. 0)
(19B219040, Sh. 2, Rev. 1)



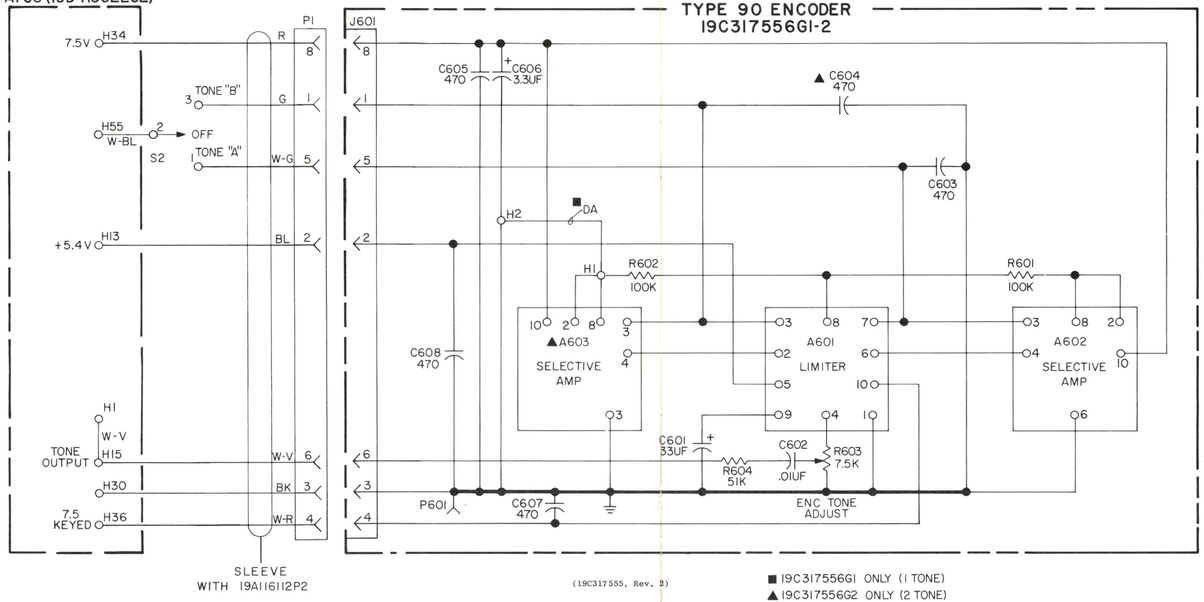
SCHEMATIC & OUTLINE DIAGRAMS

TYPE 90 ENCODER/DECODER
MODEL 4EK18A11

LBI-4445

SYSTEM BOARD
A701 (19D413552G1)
A702 (19D416438G1)
A703 (19D413522G2)

SCHEMATIC DIAGRAM



(19C317555, Rev. 2)

■ 19C317556G1 ONLY (1 TONE)
▲ 19C317556G2 ONLY (2 TONE)

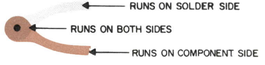
ALL RESISTORS ARE 1/ WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG = 1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR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

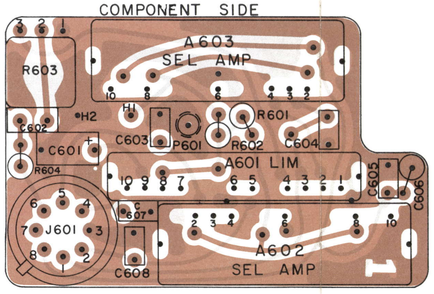
SEE APPLICABLE PRODUCTION CHANGE SHEETS IN INSTRUCTION BOOK SECTION DEALING WITH THIS UNIT, FOR DESCRIPTION OF CHANGES UNDER EACH REVISION LETTER.

THIS ELEM DIAG APPLIES TO	
MODEL NO	REV LETTER

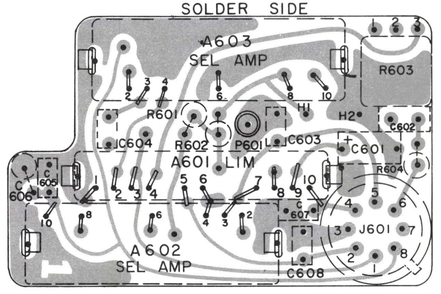
IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

OUTLINE DIAGRAM





(19C317933, Rev. 0)
(19B219043, Sh. 1, Rev. 1)
(19B219043, Sh. 2, Rev. 1)



(19C317933, Rev. 0)
(19B219043, Sh. 2, Rev. 1)

SCHEMATIC & OUTLINE DIAGRAMS

TYPE 90 ENCODER
MODELS 4EH20A10, 11

PARTS LIST

LBI-4250

TYPE 90 ENCODER
MODEL 4EH20A10 1 TONE
MODEL 4EH20A11 2 TONE

SYMBOL	GE PART NO.	DESCRIPTION
A601	19C317037G2	Limiter. NOTE: When reordering give GE Part Number and specify exact frequency needed.
A602 and A603	19D413245G4	Selective Amplifier. 1050-3000 Hz.
		- - - - - - - - - CAPACITORS - - - - - - - - -
C601	19C307102P4	Tantalum: 33 µf ±20%, 10 VDCW; sim to Component Inc 3336R.
C602	19A116192P1	Ceramic: 0.01 µf ±20%, 50 VDCW; sim to Erie 8121-050-W5R.
C603 thru C605	19A116192P2	Ceramic: 470 pf ±20%, 50 VDCW; sim to Erie 8111-050-W5R.
C606	5491674P36	Tantalum: 3.3 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C607 and C608	19A116192P2	Ceramic: 470 pf ±20%, 50 VDCW; sim to Erie 8111-050-W5R.
		- - - - - - - - JACKS AND RECEPTACLES - - - - - -
J601	19A116122P1	Terminal, feed-thru: sim to Warren Co 1-B-2994-4.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P601	19A115834P4	Contact, electrical: sim to Amp 2-332070-9.
		- - - - - - - - - - RESISTORS - - - - - - - -
R601 and R602	3R152P104K	Composition: 0.10 megohm ±10%, 1/4 w.
R603	19A116093P1	Variable, carbon film: 7500 ohms ±20%, 0.20 w; sim to Centralab Series 3 Type 630-1.
R604	3R152P513J	Composition: 51,000 ohms ±5%, 1/4 w.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P1	19B219051G1	Socket, crystal: 8 contacts.
		- - - - - - - - - - SWITCHES - - - - - - - - -
S2	19B219053G2	Toggle: SPDT; sim to Arrow-Hart and Hegeman TC-3.
		- - - - - - - - MISCELLANEOUS - - - - - - - -
	5490135P3	Boot, moisture seal. (Used with S2).
	19B216926P4	Decorative cap. (Used with S2).
	19B216316P1	Insulator. (Used with J601).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

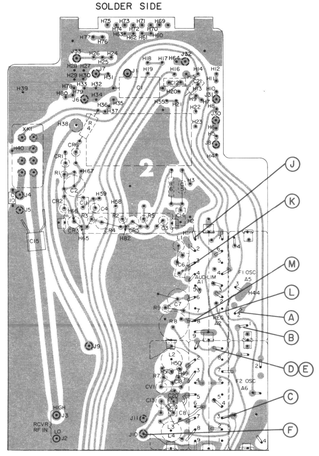
STEP I - QUICK CHECKS

SYMPTOM	QUICKCHECK
No power output	1. Check the current drain. 2. If the current is more than 500 milliamps, check the stripline switch, antenna relay, low-pass filter and for a shorted C10. 3. If the current drain is less than 500 milliamperes, detune the transmitter tuning controls from 10 to 1 in that order to determine which tuning control doesn't cause a decrease in current. Then check the associated stage following that control.
Low Power output	1. Low battery voltage (refer to Battery Checks in operation section of the manual). 2. Check the transmitter alignment.
Distorted or no audio with normal RF output.	1. Check voltage readings at (J), (K), (L) and (M). 2. Improper setting of Mod Adjust R8. 3. Check Mod coil L2. 4. Shorted C3 or C6 on Audio Board. 5. Bad microphone.
No reading at TP1	Check voltage readings at (A), (B), (D), (E) and (F).

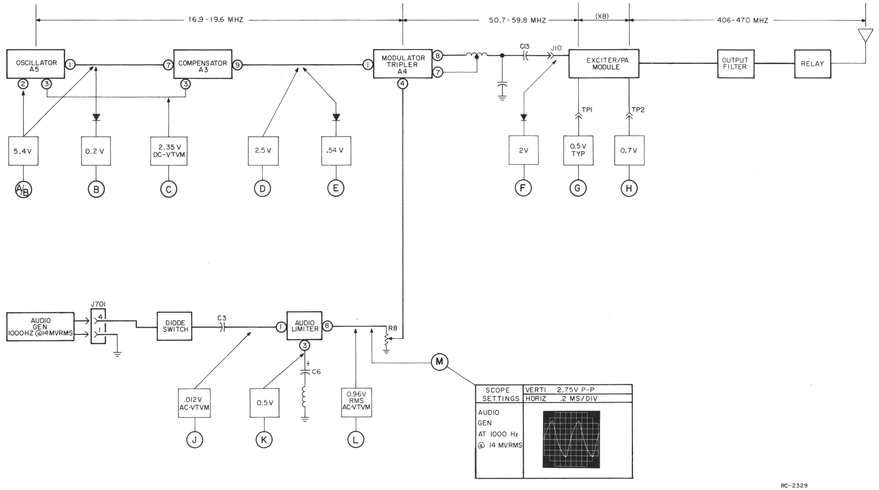
STEP 2 - TYPICAL VOLTAGE READINGS

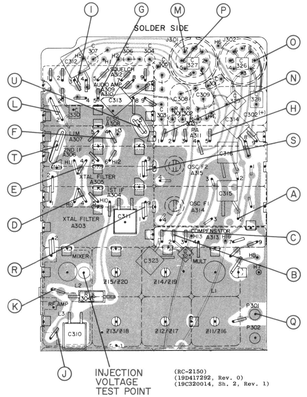
DC READINGS MADE WITH GE TEST SET MODEL 4EX3A0 OR EQUIVALENT. READINGS SHOWN IN SERIES WITH A DIODE ARE RF READINGS TAKEN WITH RF PROBE (SC31370-G) AND TEST SET MODEL 4EX3A0J ON 3 VOLT SCALE.

EXCEPTION: READINGS FOLLOWED BY VTVM WERE MEASURED WITH A VTVM WITH 11 MEG OHM OR GREATER METER INPUT.



(RC-2331)
(190417209, Rev. 0)
(190416614, Sh. 2, Rev. 0)

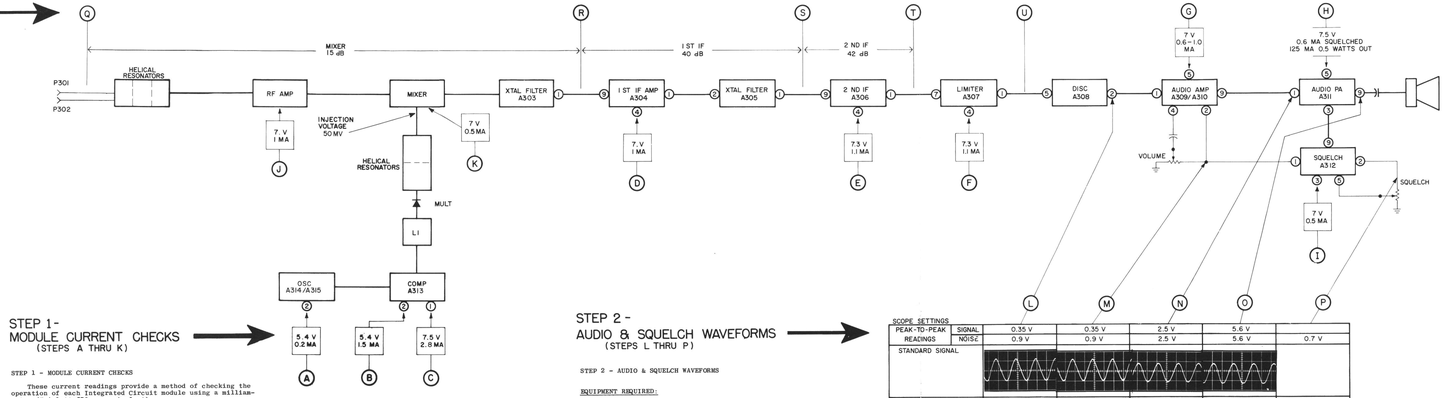




QUICK CHECKS

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:

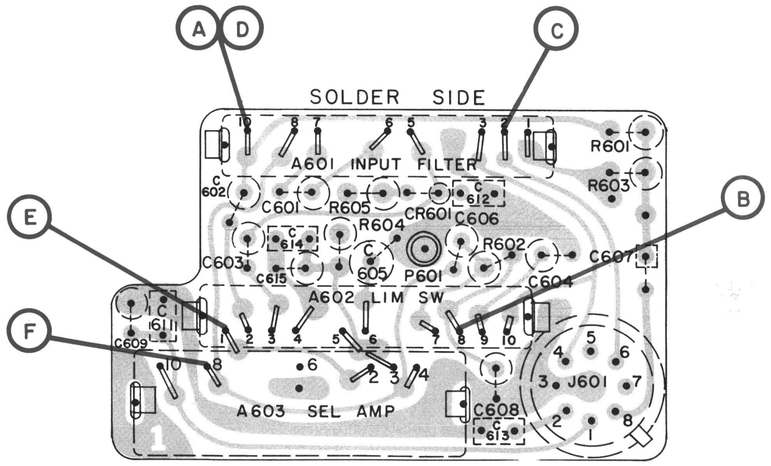
- Oscilloscope connected between the points shown and ground.
- Signal Generator (Measurements M-800 or equivalent).

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.

TROUBLESHOOTING PROCEDURE

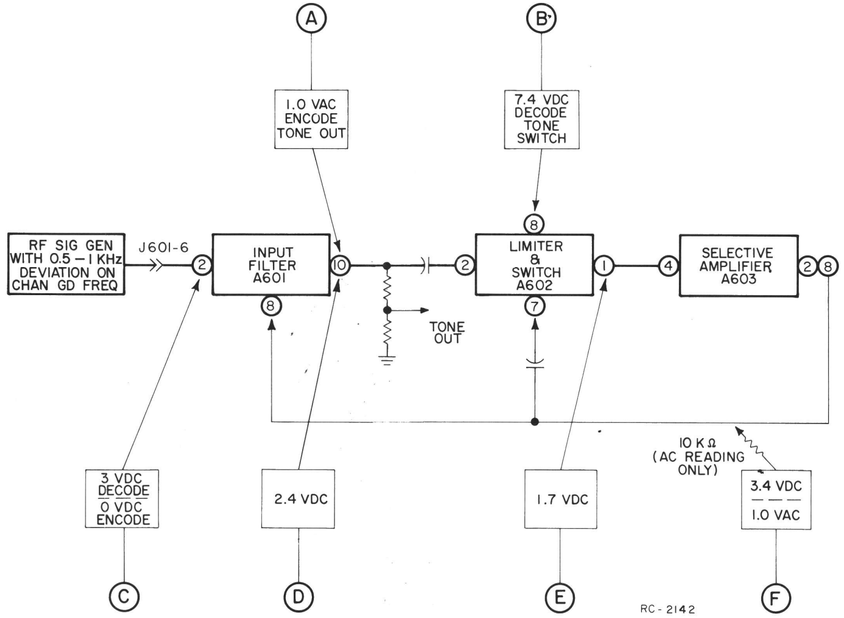
406—470 MHz RECEIVER
MODELS 4ER60B10-13



(RC-2142
(19C317936, Rev. 0)
(19B216776, Sh. 2, Rev. 1)

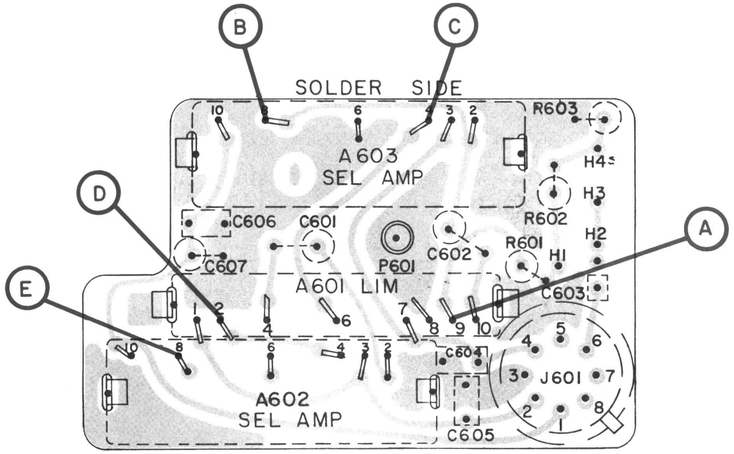
TROUBLESHOOTING

SYMPTOM	PROCEDURE
Unit won't decode	1. Place Channel Guard switch S2 in the OFF position and check for proper operation of the receiver. 2. If the receiver operates properly, apply the proper Channel Guard tone to the radio and check for 7.4-volts DC at Position (B) . Next, remove the tone and check for zero volts at (B) . 3. If readings are not correct, isolate the defective module by checking readings (C) through (F) . CAUTION Do not ground Pins 2 or 8 on Selective Amplifier A603, or Pin 8 on Input Filter A601. To do so will destroy the Selective Amplifier module.
Unit won't encode	1. Key the transmitter and check for 1-volt RMS at Position (A) . 2. If the reading is correct, check the transmitter oscillator module. 3. If the reading is not correct, isolate the defective module by checking readings (C) thru (F) .



TROUBLESHOOTING PROCEDURE

CHANNEL GUARD ENCODER/DECODER
MODEL 4EK17A11



(RC-2143)
(19C317931, Rev. 0)
(19B219044, Sh. 2, Rev. 0)

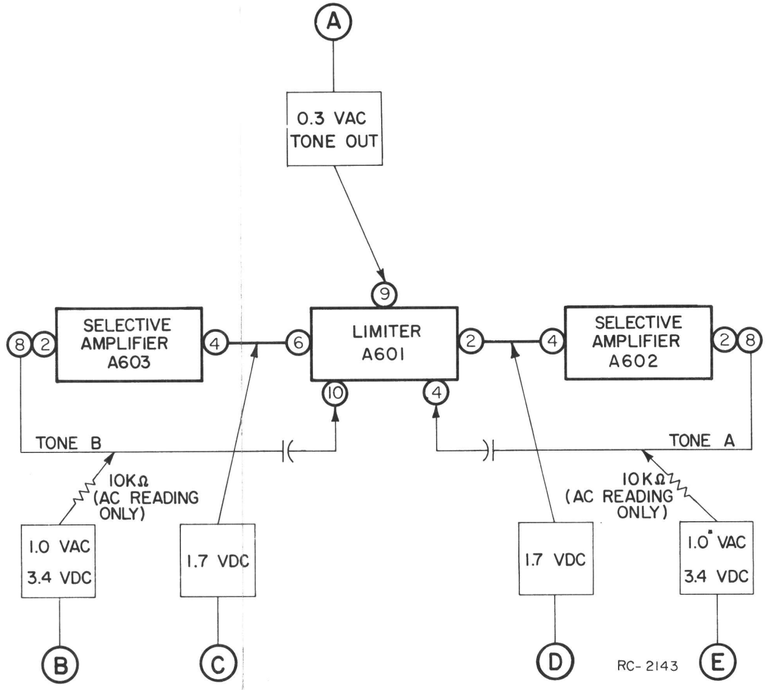
TROUBLESHOOTING

ALWAYS CONNECT THE BOARD TO GROUND WHEN REMOVED FROM THE RADIO FOR TROUBLESHOOTING.

1. Place Channel Guard switch S2 in the tone "A" or "B" position and check for 0.3 volts AC at position (A) .
2. If reading is correct, check the transmitter oscillator module.
3. If reading is not correct, check readings at (B) through (E) .

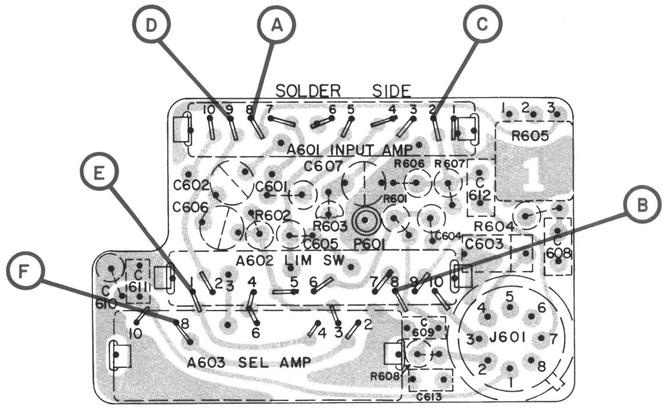
CAUTION

Do not ground Pins 2 or 8 on the selective amplifier modules. To do so will destroy the selective amplifier.



TROUBLESHOOTING PROCEDURE

CHANNEL GUARD ENCODER
MODELS 4EH21A10, 11

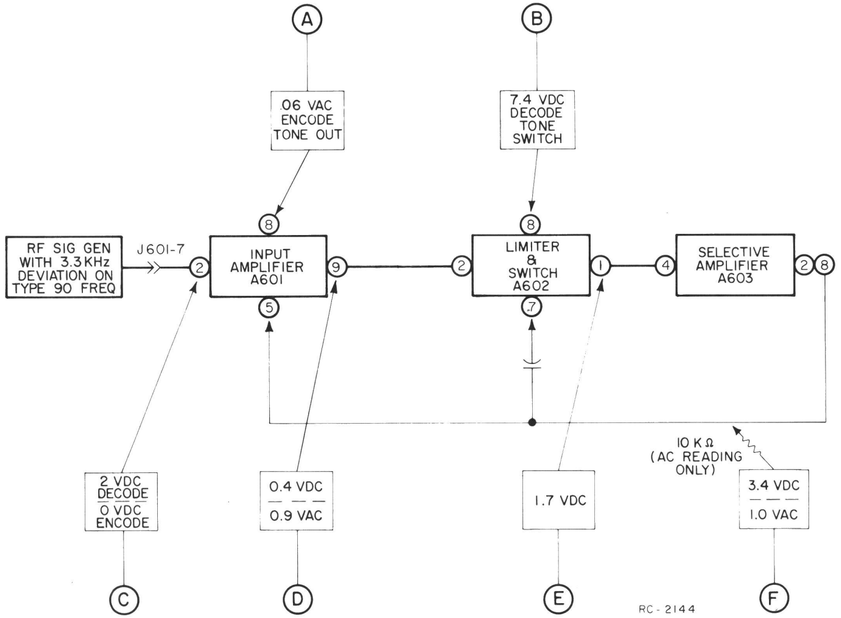


(RC-2144)
(19C317940, Rev. 0)
(19B219040, Sh. 2, Rev. 1)

TROUBLESHOOTING

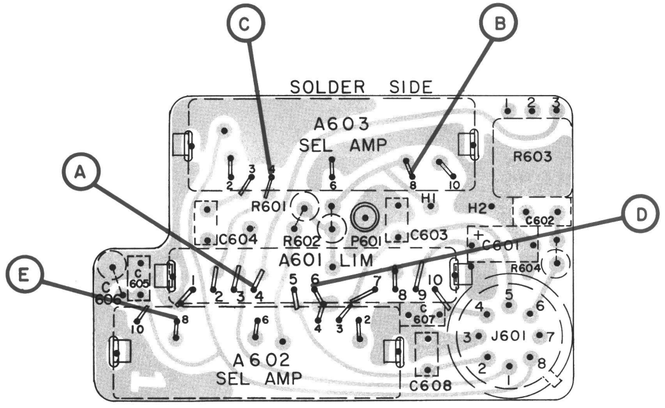
Always connect the board to ground (G11) when removed from the radio for troubleshooting.

SYMPTOM	PROCEDURE
Unit won't encode	1. Place Type 90 switch (S2) in the Monitor (encode) position, and check for .06 volts RMS at position (A). Next, key the transmitter and check for the reading at (A) to drop to zero in approximately one second (pulsed tone). 2. If these readings are correct, check the transmitter audio circuit and modulation setting. 3. If the readings are not correct, isolate the defective module by checking readings (C) through (F).
- CAUTION - Do not ground Pins 2 or 8 on Selective Amplifier A603, or Pin 5 on input amplifier A601. To do so will destroy the Selective Amplifier module.	
Unit won't decode	1. Place Type 90 switch S2 in the Reset and then in the Monitor position and check for proper operation of the receiver. 2. If the receiver operates properly, place the switch in the Reset and then the Normal position. Next, apply the proper Type 90 tone to the radio and check for 7.4 volts DC at position (B). Next, place the switch in the Reset and then the Normal position and check for zero volts at (B). 3. If the readings are not correct, isolate the defective module by checking readings (C) through (F).



TROUBLESHOOTING PROCEDURE

TYPE 90 ENCODER/DECODER
MODEL 4EK18A11



(RC-2145)
(19C317933, Rev. 0)
(19B219043, Sh. 2, Rev. 1)

TROUBLESHOOTING

Always connect the board to ground when removed from the radio for troubleshooting.

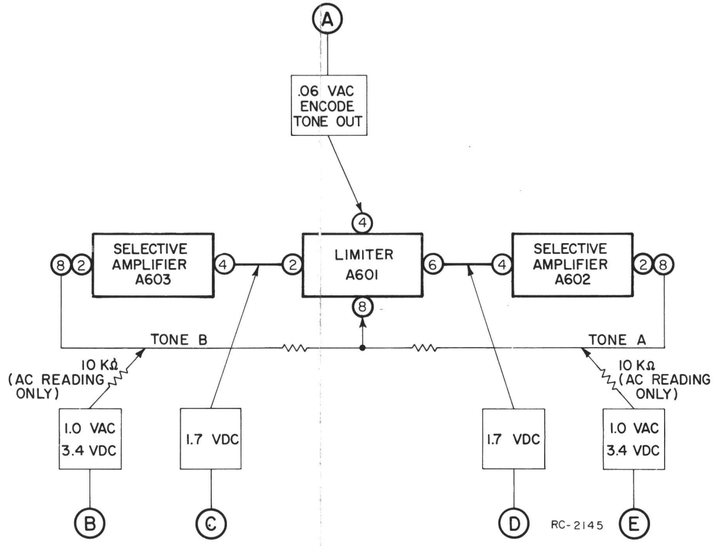
1. Place Type 90 switch S2 in the Tone "A" or "B" position and check for .06 volts RMS at position (A) . Next, key the transmitter and check for the reading at (A) to drop to zero in approximately one second (pulsed tone).

2. If these readings are correct, then check the transmitter audio circuit and modulation setting.

3. If the readings are not correct, isolate the defective module by checking readings (B) through (E) .

- CAUTION -

Do not ground Pins 2 or 8 of Selective Amplifiers A602 and A603, or Pin 8 of limiter A601. To do so will destroy the Selective Amplifier.



TROUBLESHOOTING PROCEDURE

TYPE 90 ENCODER
MODELS 4EH20A10, 11