

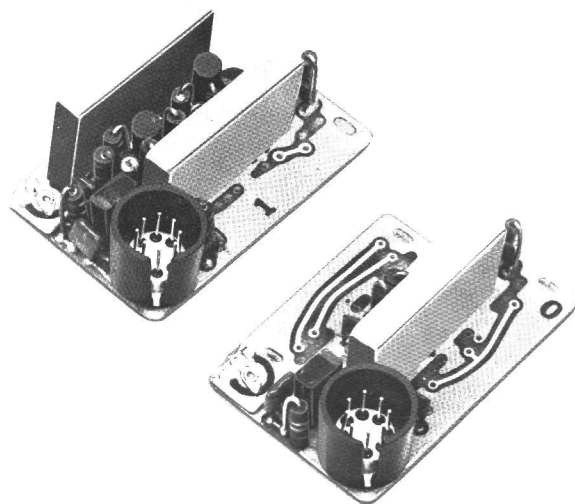
 **MOBILE RADIO**

# MASTR<sup>®</sup> Personal Series

## PROGRESS LINE

### PE MODELS

(TYPE 90 ENCODER/DECODER MODEL 4EK18A10 & 11  
AND TYPE 90 ENCODER MODEL 4EH20A10 & 11)



### SPECIFICATIONS \*

Tone Frequencies	1050 Hz to 3000 Hz
Frequency Stability	$\pm 0.3\%$
Transmit Drain	3.6 Milliamperes
Temperature Range	-30°C to +60°C (-22°F to +140°F)
Nominal Input Voltage Requirements	+7.5 VDC

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

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— WARNING —

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

## DESCRIPTION

## TYPE 90 ENCODER/DECODER

Type 90 Encoder/Decoder Models 4EK18A10 & 11 are pulsed tone encoder/decoder assemblies for operating on standard Type 90 tone frequencies of 1000 to 3000 Hz. The assemblies each use three Integrated Circuit modules consisting of Input Amplifier A601, Limiter-Switch A602, and Selective Amplifier A603. Encoder/Decoder 4EK18A11 also contains Tone Control board 19B219507G1. A typical diagram of the Limiter Switch is shown in Figure 1 and a typical diagram of the Input Amplifier is shown in Figure 2.

The Type 90 circuit is controlled by Monitor-Normal-Reset switch S2 with Encoder/Decoder model 4EK18A10 and with S2 and multi-frequency switch S1 with Encoder/Decoder model 4EK18A11.

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.

## 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.

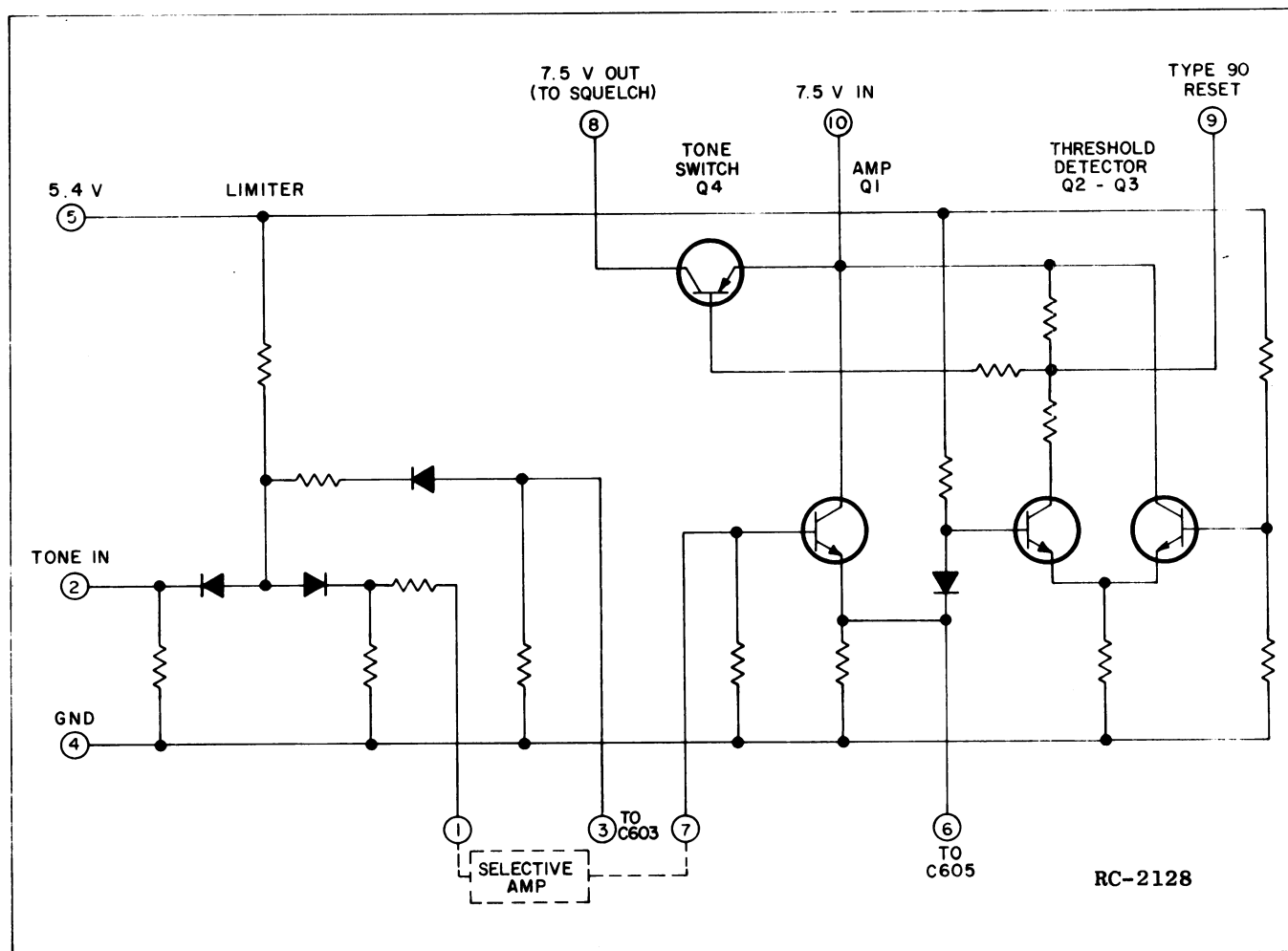


Figure 1 - Typical Limiter Switch Circuit

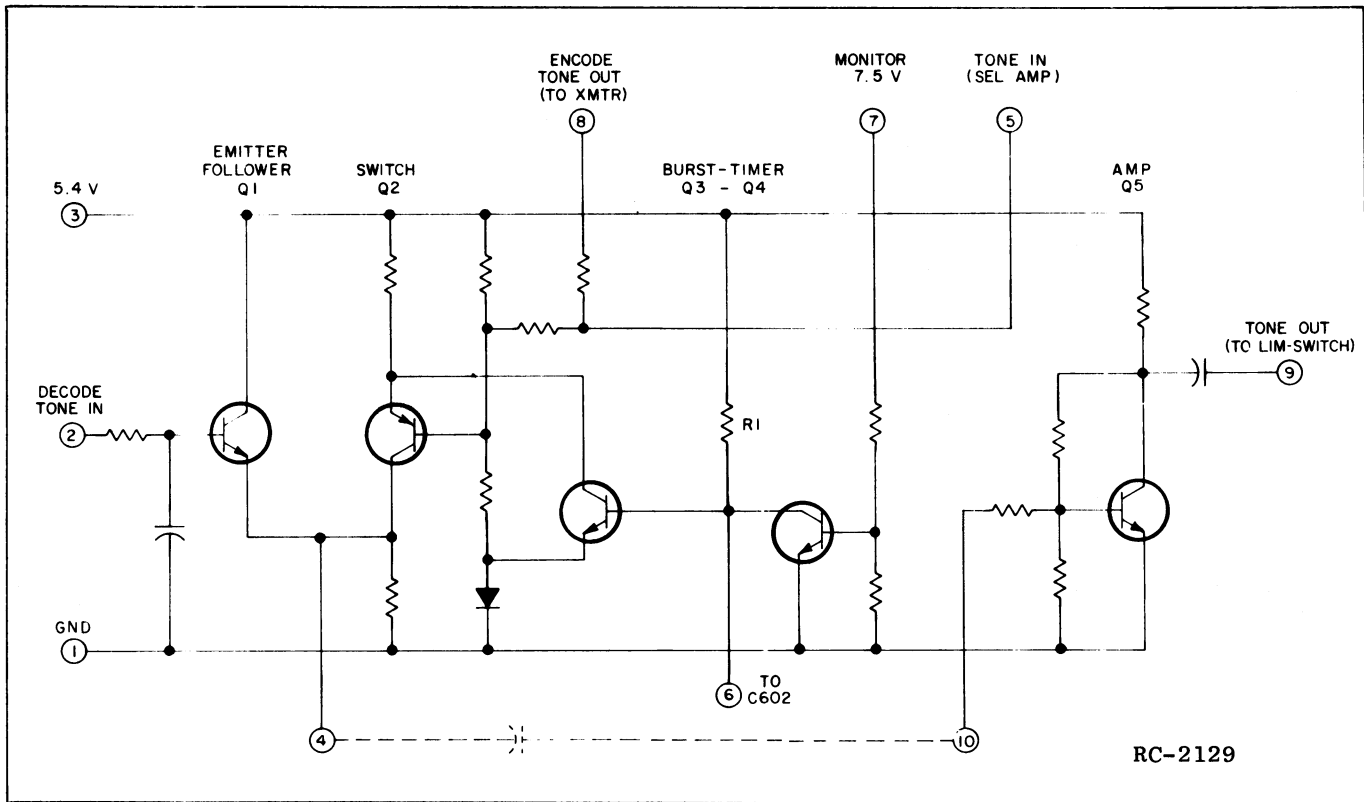


Figure 2 - Typical Input Amplifier Circuit

## CIRCUIT ANALYSIS

### TYPE 90 ENCODER/DECODER

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.

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.

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  $\pm 3$  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.

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.

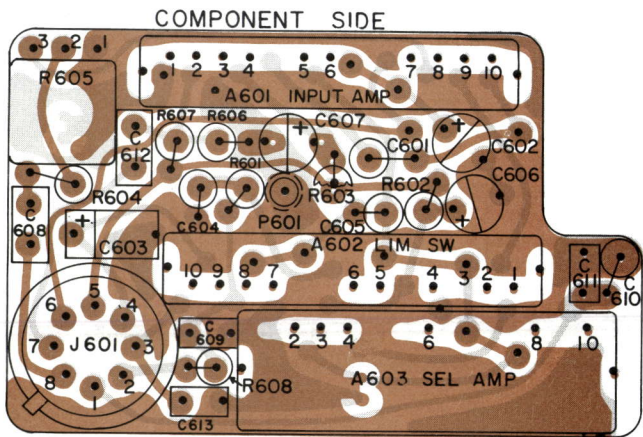
#### TYPE 90 ENCODER

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.

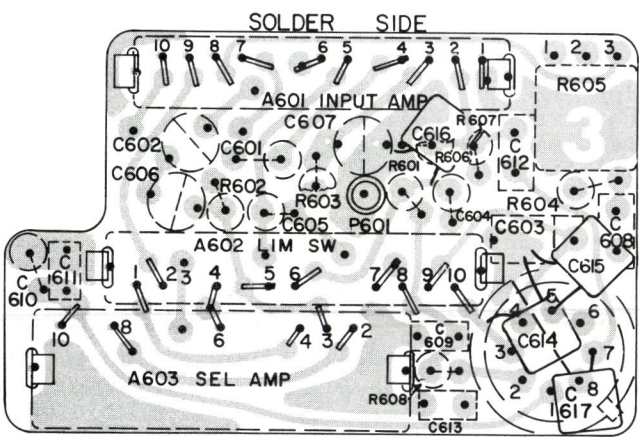
Applying power to the modules causes the Selective Amplifier to start oscillating at the desired tone frequency, and also start the tone burst timer circuit. The burst timer provides a tone output for approximately one second. The encode tone is coupled through Encode Tone Adjust R603 to the transmitter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

#### TYPE 90 TONE FREQUENCIES

1050 Hz  
1125  
1200  
1275  
1350  
1425  
1500  
1575  
1650  
1725  
1800  
1875  
1950  
2025  
2100  
2175  
2250  
2325  
2400  
2475  
2550  
2625  
2700  
2775  
2850  
2925  
3000



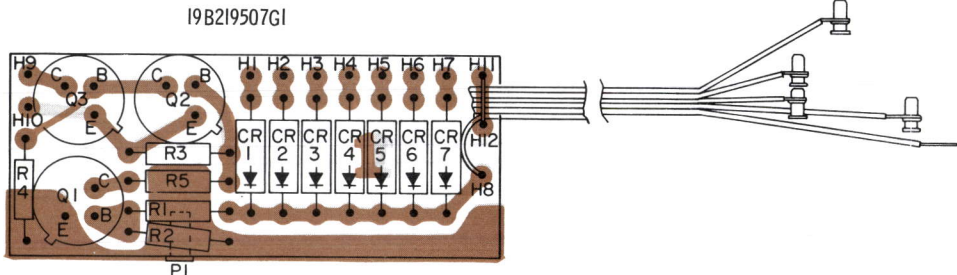
(19C317940, Rev. 2)  
(19B219040, Sh. 1, Rev. 3)  
(19B219040, Sh. 2, Rev. 3)



(19C317940, Rev. 2)  
(19B219040, Sh. 2, Rev. 3)

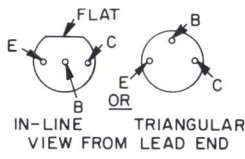
TONE CONTROL BOARD

19B219507G1

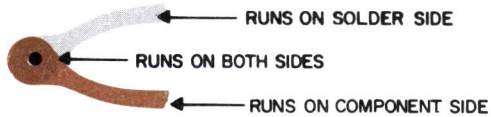


(19B219807, Rev. 0)  
(19B219490, Sh. 1, Rev. 1)  
(19B219490, Sh. 2, Rev. 1)

LEAD IDENTIFICATION  
FOR Q1-Q3

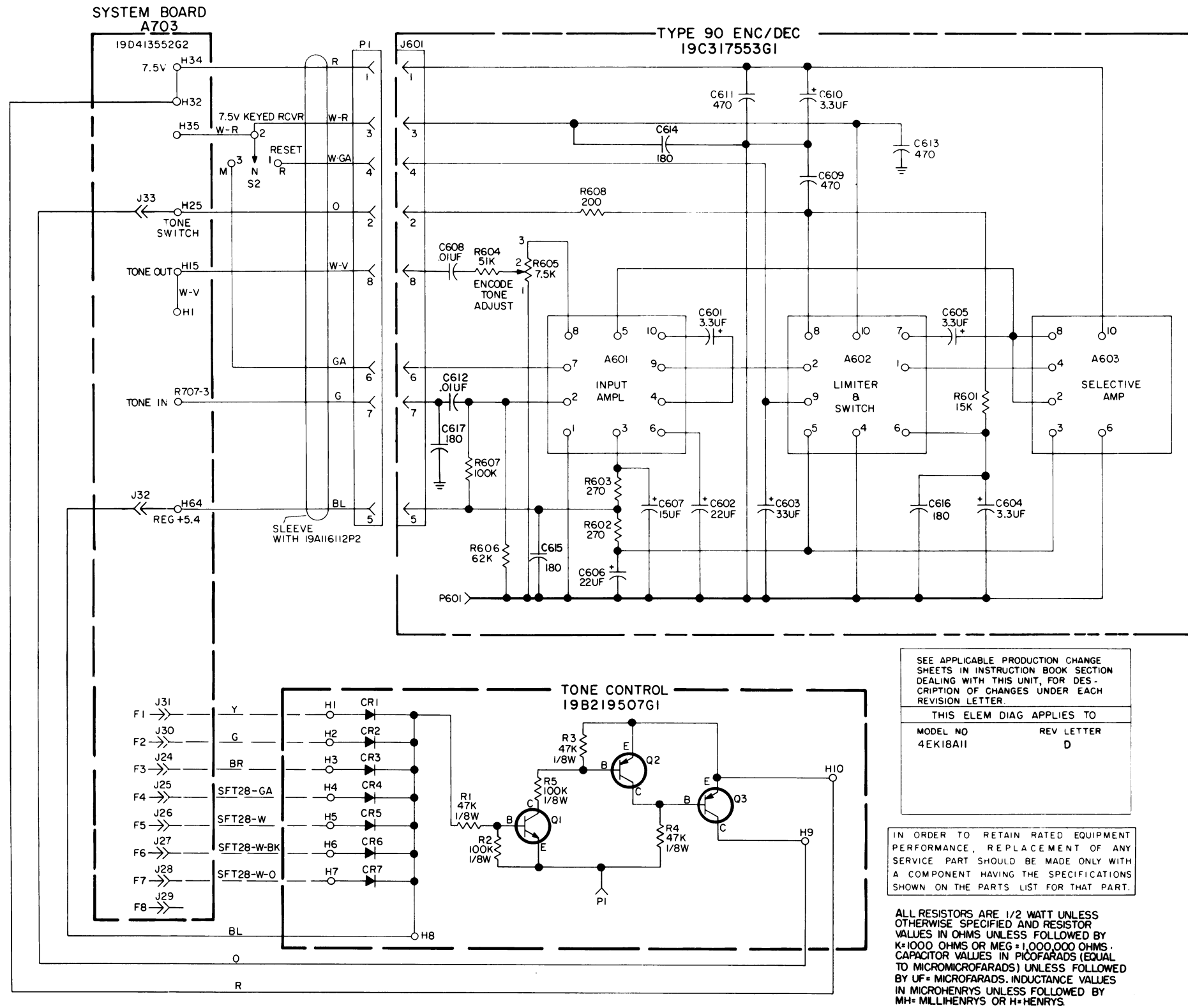


NOTE: LEAD ARRANGEMENT, AND NOT  
CASE SHAPE, IS DETERMINING  
FACTOR FOR LEAD IDENTIFICATION.

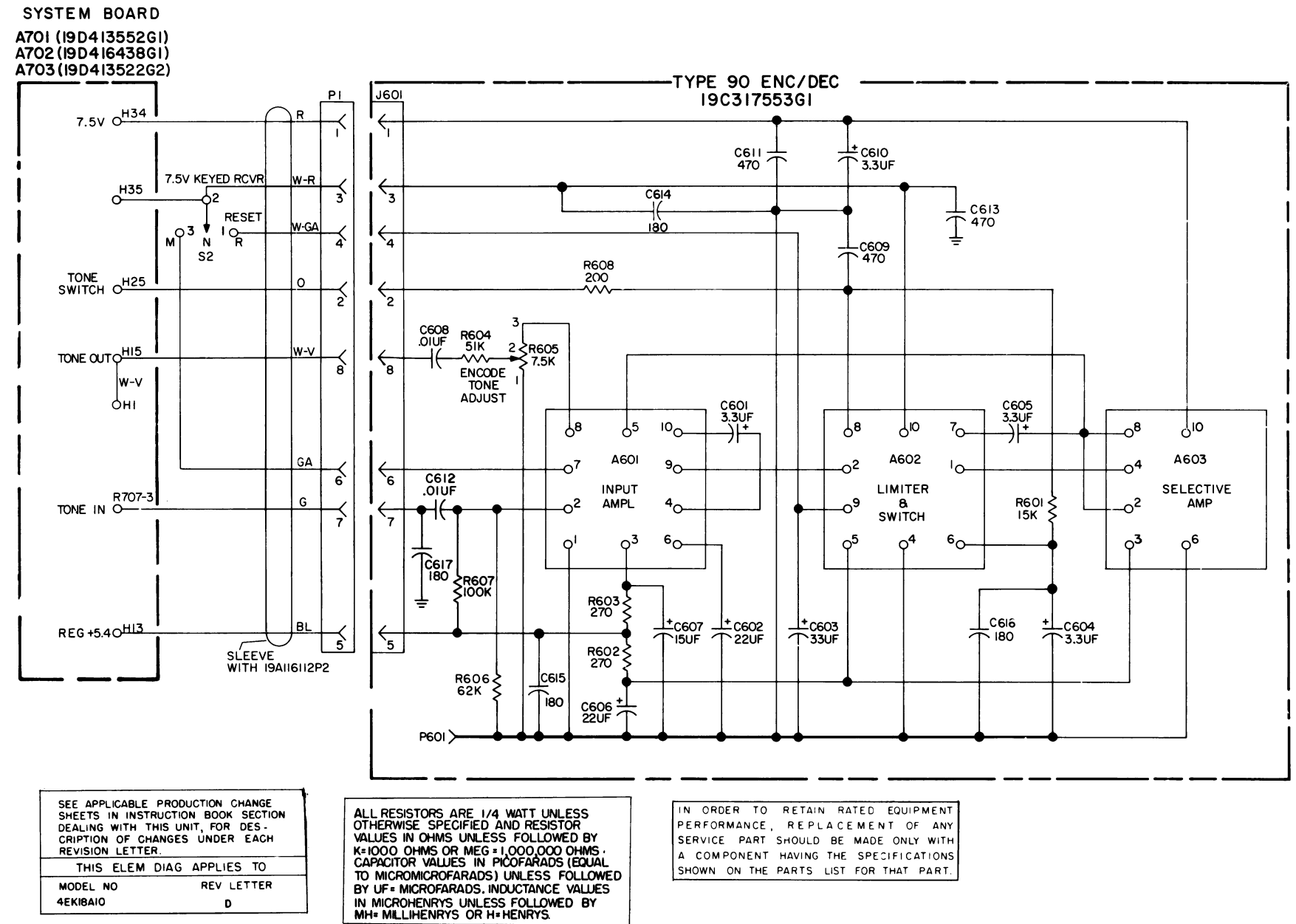


OUTLINE DIAGRAM

TYPE 90 ENCODER/DECODER  
MODEL 4EK18A10 & 11



(19D416548, Rev. 5)



(19C317552, Rev. 7)

## SCHEMATIC DIAGRAMS

TYPE 90 ENCODER/DECODER  
MODEL 4EK18A10 & 11

PARTS LIST

LBI-4372D

TYPE 90 ENCODER/DECODER  
MODEL 4EK18A10  
MODEL 4EK18A11 TONE CONTROL

SYMBOL	GE PART NO.	DESCRIPTION
P1	19B219052G1	----- PLUGS -----
		Socket, crystal: 8 contacts.
S2	19B219053G3	----- SWITCHES -----
		Toggle: SPDT; sim to C and K Components 7107SDG.
		TYPE 90 ENCODER/DECODER BOARD 19C317553G1
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 $\mu$ f $\pm$ 20%, 10 VDCW; sim to Sprague Type 162D.
C602	19C307102P15	Tantalum: 22 $\mu$ f $\pm$ 20%, 6 VDCW; sim to Component Inc G226R.
C603	19C307102P4	Tantalum: 33 $\mu$ f $\pm$ 20%, 10 VDCW; sim to Component Inc S336R.
C604 and C605	5491674P36	Tantalum: 3.3 $\mu$ f $\pm$ 20%, 10 VDCW; sim to Sprague Type 162D.
C606	19C307102P15	Tantalum: 22 $\mu$ f $\pm$ 20%, 6 VDCW; sim to Component Inc G226R.
C607	19C307102P14	Tantalum: 15 $\mu$ f $\pm$ 20%, 10 VDCW; sim to Component Inc G156R.
C608	19A116192P1	Ceramic: 0.01 $\mu$ f $\pm$ 20%, 50 VDCW; sim to Erie 8121 SPECIAL.
C609	19A116192P2	Ceramic: 470 pf $\pm$ 20%, 50 VDCW; sim to Erie 8111-050-W5R.
C610	5491674P36	Tantalum: 3.3 $\mu$ f $\pm$ 20%, 10 VDCW; sim to Sprague Type 162D.
C611	19A116192P2	Ceramic: 470 pf $\pm$ 20%, 50 VDCW; sim to Erie 8111-050-W5R.
C612	19A116192P1	Ceramic: 0.01 $\mu$ f $\pm$ 20%, 50 VDCW; sim to Erie 8121 SPECIAL.
C613	19A116192P2	Ceramic: 470 pf $\pm$ 20%, 50 VDCW; sim to Erie 8111-050-W5R.
C614* thru C616*	19A116114P10073	Ceramic: 180 pf $\pm$ 10%, 100 VDCW; temp coef -3300 PPM. Added by REV A.
C617*	19A116114P10073	Ceramic: 180 pf $\pm$ 10%, 100 VDCW; temp coef -3300 PPM. Added by REV D.
		----- 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 $\pm$ 10%, 1/4 w.
R602 and R603	3R152P271K	Composition: 270 ohms $\pm$ 10%, 1/4 w.

SYMBOL	GE PART NO.	DESCRIPTION
R604	3R152P513J	Composition: 51,000 ohms $\pm$ 5%, 1/4 w.
R605	19A116093P1	Variable, carbon film: 7500 ohms $\pm$ 20%, 0.20 w; sim to Centralab Series 3 Type 620-1.
R606	3R152P623J	Composition: 62,000 ohms $\pm$ 5%, 1/4 w.
R607	3R152P104K	Composition: 0.10 megohm $\pm$ 10%, 1/4 w.
R608	3R152P201J	Composition: 200 ohms $\pm$ 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 $\pm$ 10%, 1/8 w.
R2	3R151P104K	Composition: 0.10 megohm $\pm$ 10%, 1/8 w.
R3 and R4	3R151P473K	Composition: 47,000 ohms $\pm$ 10%, 1/8 w.
R5	3R151P104K	Composition: 0.10 megohm $\pm$ 10%, 1/8 w.
		----- MISCELLANEOUS -----
	19C320721P1	Boot, moisture seal. (Used with S2).
	19B216926P3	Decorative cap. (Used with S2).
	19B216316P1	Insulator. (Used with J601).
	4035306P11	Insulator. (Used with Q1-Q3 on Tone Control Board).
	4035306P2	Washer. (Used with S2).

PRODUCTION CHANGES

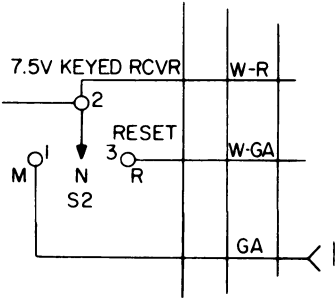
Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A - To improve RF Filtering. Added C614, C615 and C616.

REV. B - To improve switch. Changed S2 and added washer.

REV. C - To improve switch position. Moved W-Ga wire from terminal 3 to terminal 1. Moved Ga wire from terminal 1 to terminal 3.

Schematic Diagram was:



REV. D - To improve RF filtering. Added C617.



PARTS LIST

LBI-4250B  
TYPE 90 ENCODER  
MODEL 4EH20A10 1 TONE  
MODEL 4EH20A11 2 TONE

PRODUCTION CHANGES

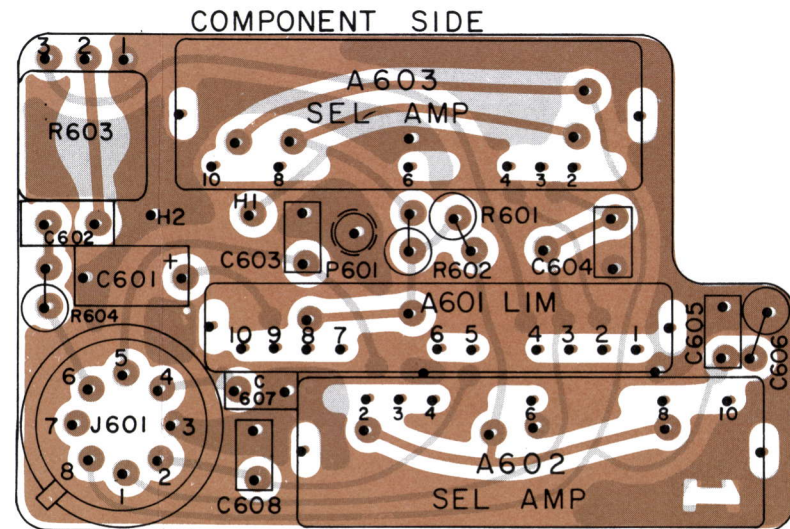
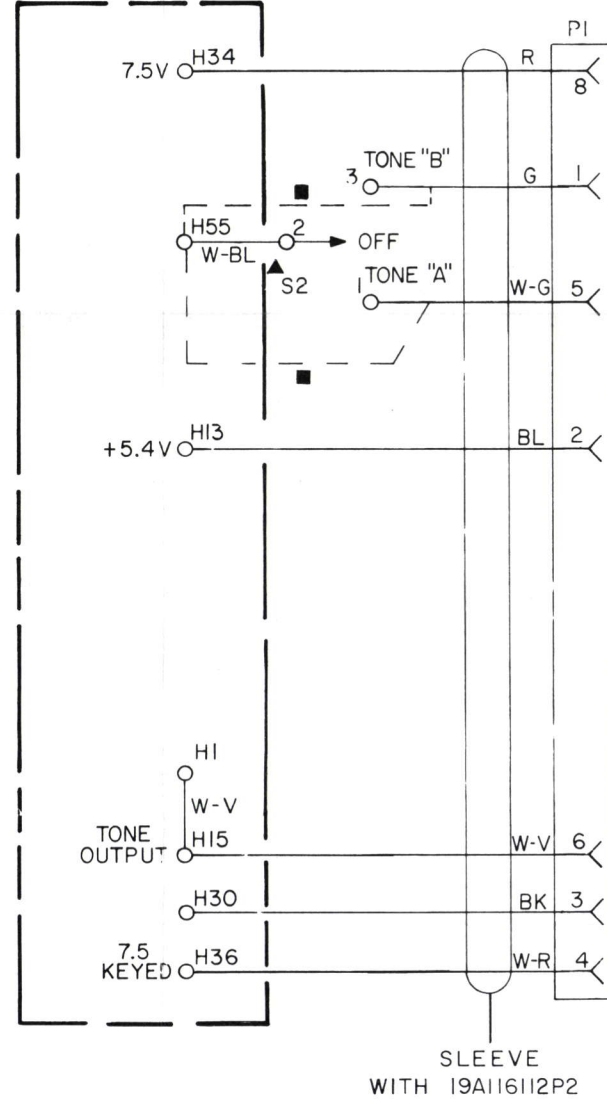
Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A - Model 4EH20A10&11  
To improve switch. Changes S2 and added washer.  
REV. B - Model 4EH20A11  
To improve switch position. Rotate S2 180°.

SYMBOL	GE PART NO.	DESCRIPTION
----- PLUGS -----		
P1	19B219051G1	Socket, crystal: 8 contacts.
----- SWITCHES -----		
S2	19B219053G2	Toggle: SPDT; sim to C and K Components 7103SDG.
A601	19C317037G2	Limiter.
A602 and A603	19D413245G4	Selective Amplifier. 1050-3000 Hz.
----- CAPACITORS -----		
C601	19C307102P4	Tantalum: 33 $\mu$ f $\pm$ 20%, 10 VDCW.
C602	19A116192P1	Ceramic: 0.01 $\mu$ f $\pm$ 20%, 50 VDCW; sim to Erie 8121-050-W5R.
C603 thru C605	19A116192P2	Ceramic: 470 pf $\pm$ 20%, 50 VDCW; sim to Erie 8111-050-W5R.
C606	5491674P36	Tantalum: 3.3 $\mu$ f $\pm$ 20%, 10 VDCW; sim to Sprague Type 162D.
C607 and C608	19A116192P2	Ceramic: 470 pf $\pm$ 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 $\pm$ 10%, 1/4 w.
R603	19A116093P1	Variable, carbon film: 7500 ohms $\pm$ 20%, 0.20 w; sim to Centralab Series 3 Type 620-1.
R604	3R152P513J	Composition: 51,000 ohms $\pm$ 5%, 1/4 w.
----- MISCELLANEOUS -----		
	19C320721P1	Boot, moisture seal. (Used with S2).
	19B216926P4	Decorative cap. (Used with S2).
	19B216316P1	Insulator. (Used with J601).
	4035306P2	Flat washer. (Used with S2).

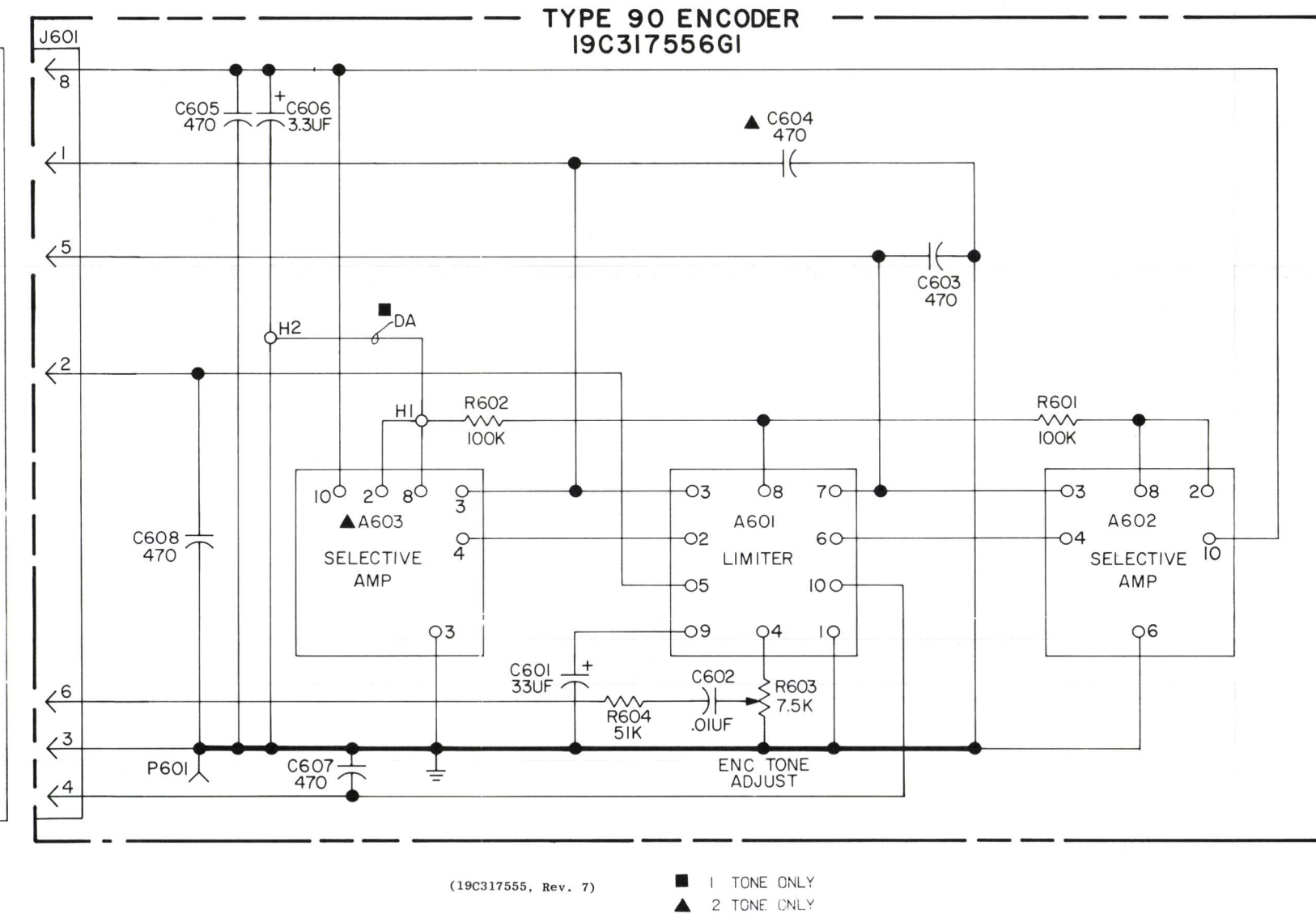
\*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

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



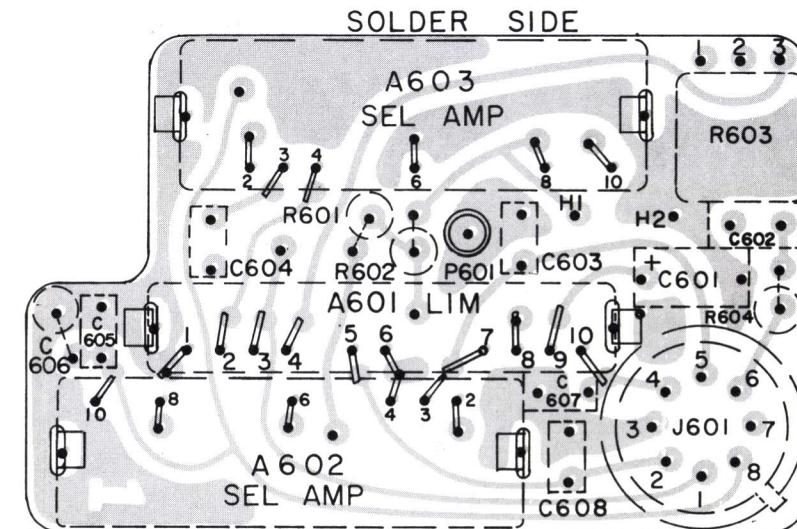
(19C317933, Rev. 0)  
(19B219043, Sh. 1, Rev. 1)  
(19B219043, Sh. 2, Rev. 1)

SCHEMATIC DIAGRAM



(19C317555, Rev. 7)  
■ 1 TONE ONLY  
▲ 2 TONE ONLY

OUTLINE DIAGRAM



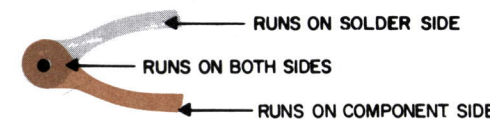
(19C317933, Rev. 0)  
(19B219043, Sh. 2, Rev. 1)

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 PICO FARADS (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
4EH20A10	A
4EH20A11	B

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.

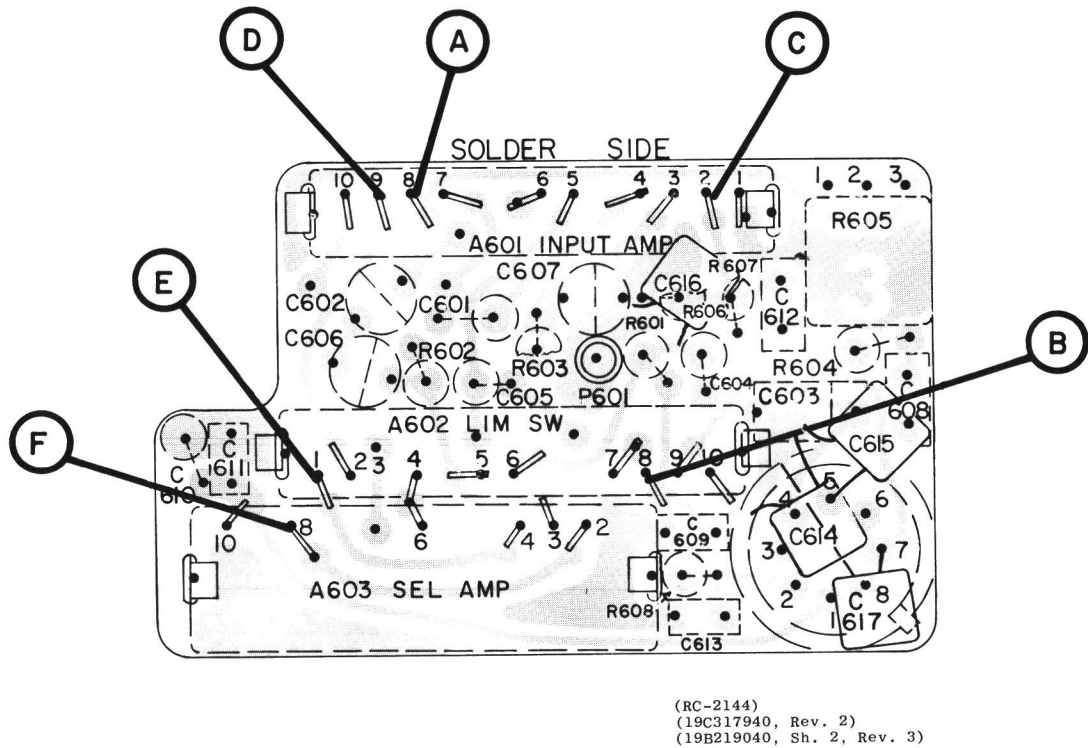


SCHEMATIC & OUTLINE DIAGRAMS

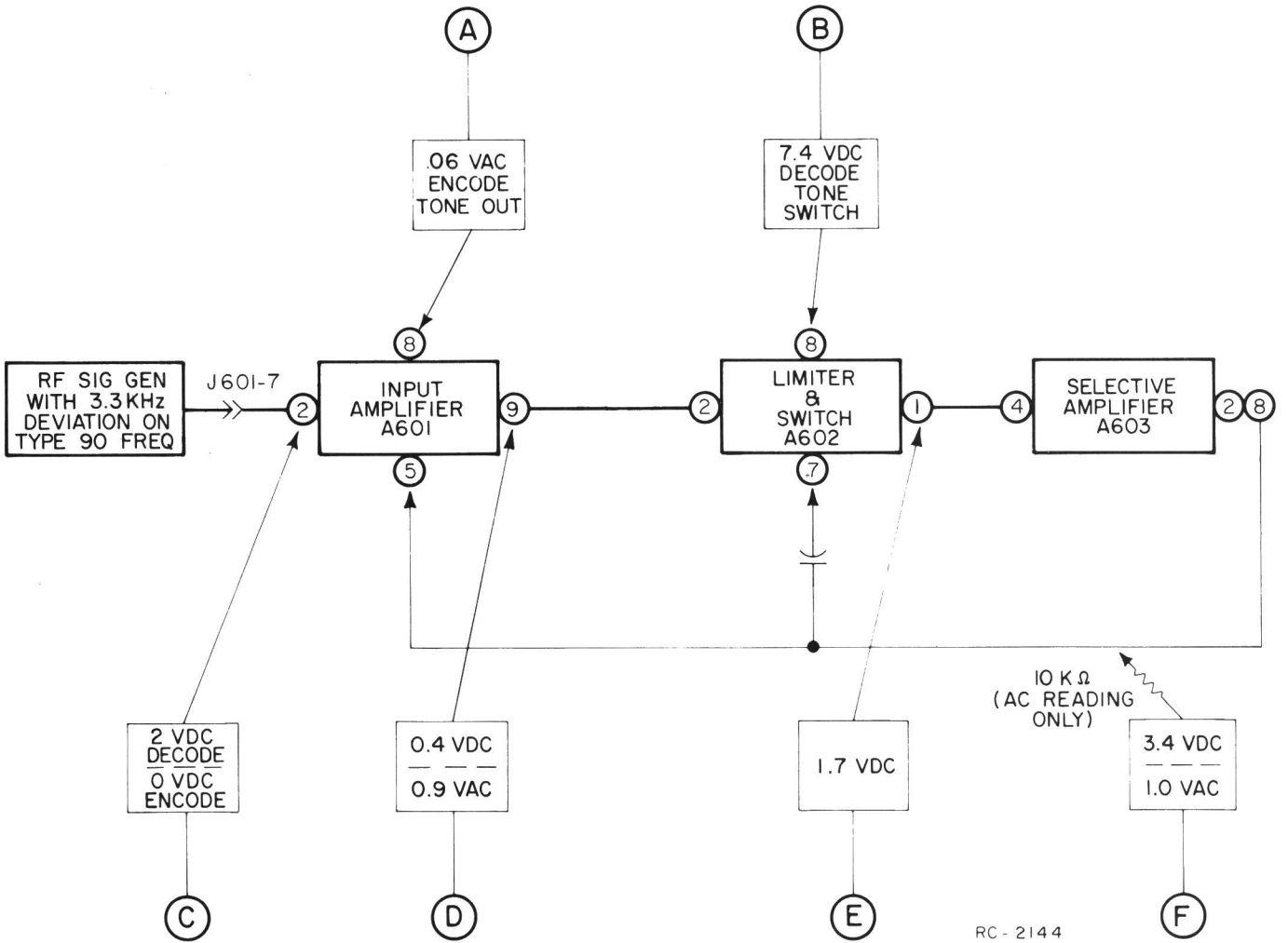
TYPE 90 ENCODER MODELS 4EH20A10 & 11

TROUBLESHOOTING

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



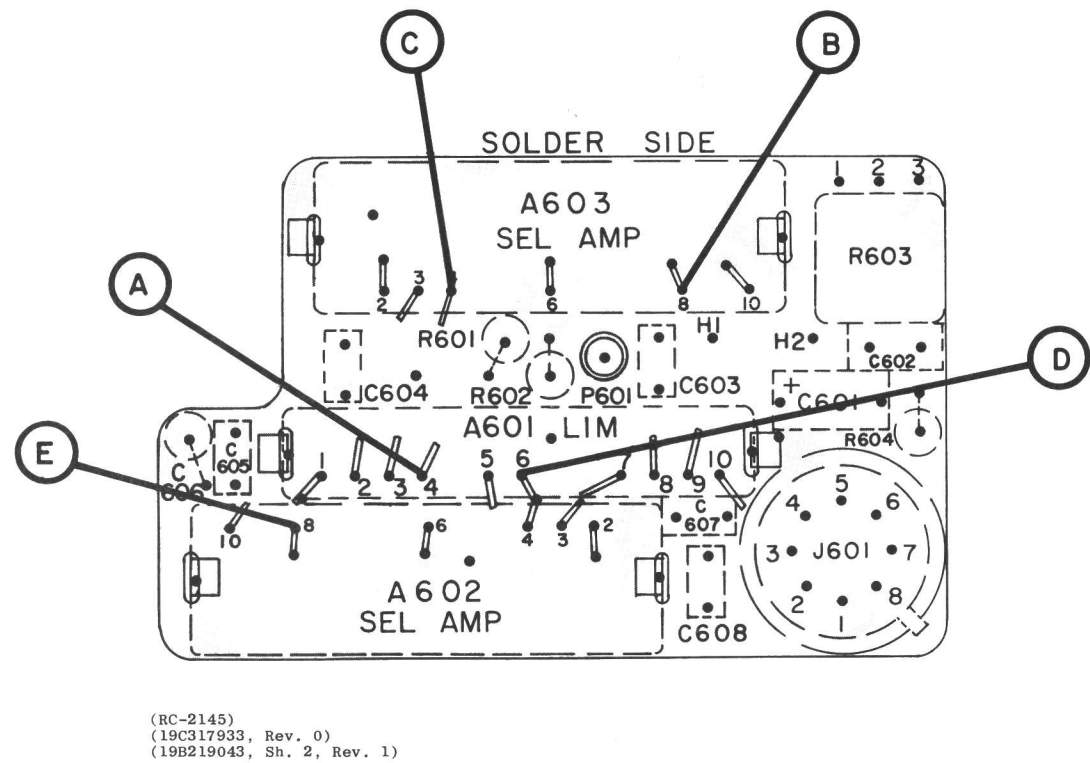
SYMPTOM	PROCEDURE
Unit won't encode	<ol style="list-style-type: none"><li>Place Type 90 switch (S2) in the Monitor (encode) position, and check for .06 volts RMS at position (A). Next, key the transmitter and check for the reading at (A) to drop to zero in approximately one second (pulsed tone).</li><li>If these readings are correct, check the transmitter audio circuit and modulation setting.</li><li>If the readings are not correct, isolate the defective module by checking readings (C) through (F).</li></ol>
<p>- CAUTION -</p> <p>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.</p>	
Unit won't decode	<ol style="list-style-type: none"><li>Place Type 90 switch S2 in the Reset and then in the Monitor position and check for proper operation of the receiver.</li><li>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).</li><li>If the readings are not correct, isolate the defective module by checking readings (C) through (F).</li></ol>



TROUBLESHOOTING PROCEDURE

TYPE 90 ENCODER/DECODER MODEL 4EK18A10 & 11





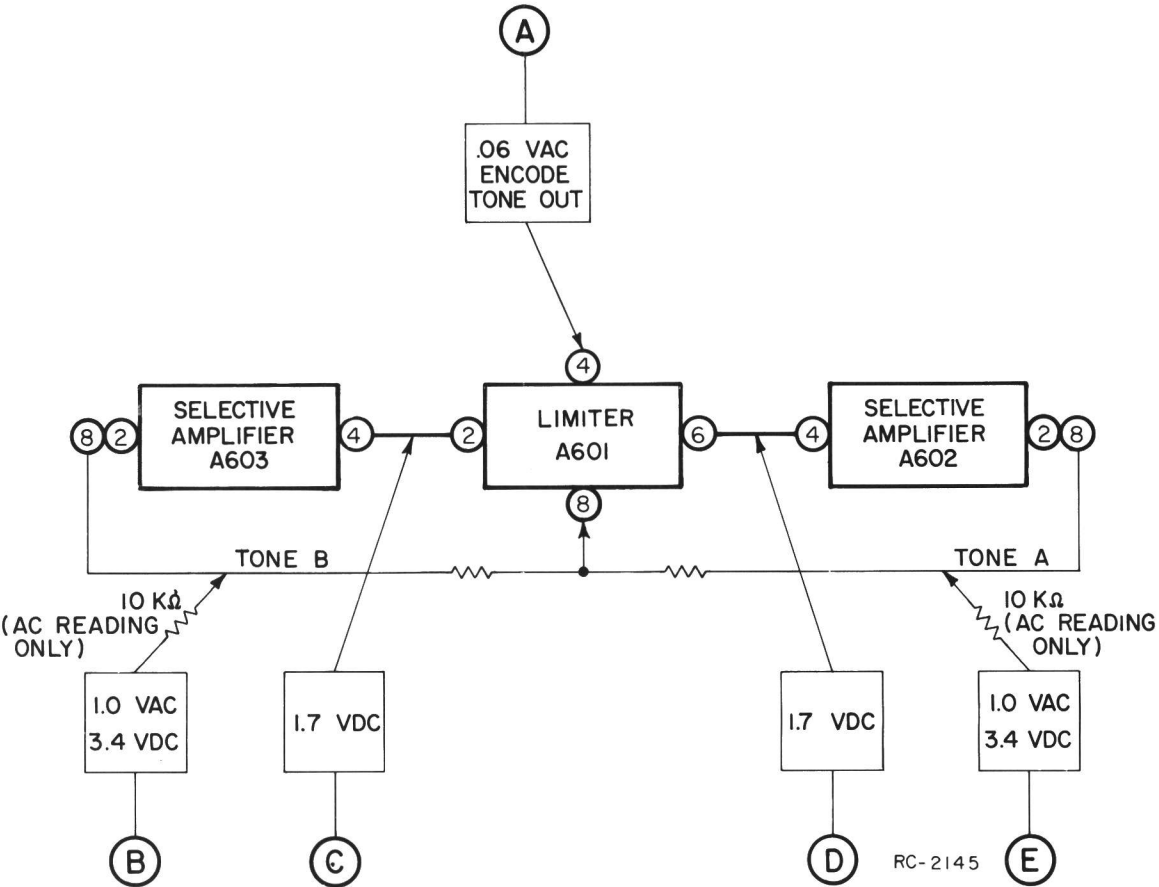
TROUBLESHOOTING

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

## ORDERING SERVICE PARTS

Each component appearing on the schematic diagram is identified by a symbol number to simplify locating it in the parts list. Each component is listed by symbol number, followed by its description and GE Part Number.

Service parts may be obtained from Authorized GE Communication Equipment Service Stations or through any GE Radio Communication Equipment Sales Office. When ordering a part, be sure to give:

1. GE Part Number for component
2. Description of part
3. Model number of equipment
4. Revision letter stamped on unit

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These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired, or should particular problems arise which are not covered sufficiently for the purchaser's purposes, contact the nearest Radio Communication Equipment Sales Office of the General Electric Company.

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MOBILE RADIO DEPARTMENT  
GENERAL ELECTRIC COMPANY • LYNCHBURG, VIRGINIA 24502

