MOBILE RADIO

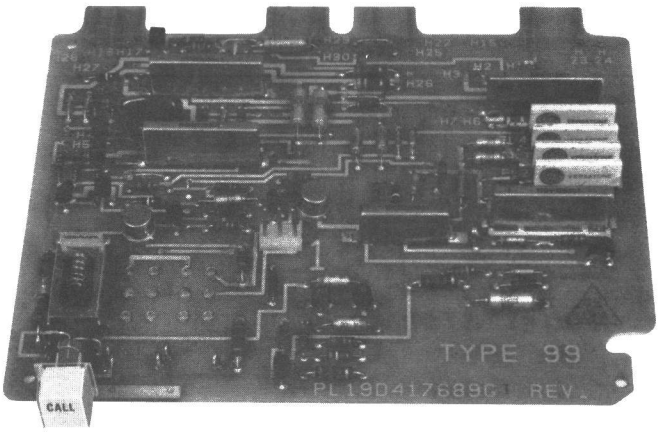
MAINTENANCE MANUAL

SOLID STATE TYPE 99 TONE DECODERS

2-TONE & 4-TONE

Maintenance Manual LBI-30269

DF-6948



TYPE 99 TONE DECODER
19D417689G1

SPECIFICATIONS *

Tone Frequencies	288.5 Hz to 1433.4 Hz
Frequency Stability	±0.4%
Alert Tone	1150 ±200 Hz Interrupted Tone 500 Millivolts to Volume/Squelch Hi
Current Drain	
Standby	50 Milliamperes Maximum
Decoded	50 Milliamperes Maximum
During Alert	100 Milliamperes Maximum
Temperature Range	-40°C to 70°C (-40°F to 158°F)
Voltage Requirements	13.8 ±20% VDC
External/Alarm (Relay Contacts)	15 Amperes (Maximum)
Timed Alarm Duration	0.5 to 3 seconds
Latched	

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

GENERAL ELECTRIC

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ILLUSTRATIONS

WARNING

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

High-level RF energy in the transmitter Power Amplifier assembly can cause RF burns. KEEP AWAY FROM THESE CIRCUITS WHEN THE TRANSMITTER IS ENERGIZED!

DESCRIPTION

The General Electric Type 99 Tone Decoder (19D417689G1) is a solid state, sequential tone decoder used in the C-800 and C-900 Series Control Units to provide individual call, group call and super group call capability. Standard type 99 tones between 288.5 and 1433.4 Hz are used for tone signaling.

Type 99 Decoders will operate with type 99 Encoders that provide two-tone sequential signaling. These include the General Electric Type 99 and Dial Paging Encoders (100, 400 and 900 call). Type 99 Decoder operation is also compatible with Channel Guard and both options may be provided with the same radio.

The decoder circuitry is assembled on a single printed wire board that plugs into the option deck (center or upper deck in the control unit.

The Type 99 Decoder may be provided as original equipment factory installed or as an option kit installed in the field. The option kit (option 9409) consisting of the external alarm switch(es) and external alarm relay(s) may or may not be provided initially but also can be field installed.

When a properly tone coded message is received, the CALL indicator will flash on and off, an alert tone will be heard, and the external alarm(s) (optional) will operate. Calls that are not properly tone coded will not open the receiver and therefore will not be heard. Neither will the CALL light, audible alarm or external alarms operate.

OPERATION

CALL SWITCH

The CALL indicator is normally off and will flash on and off approximately 7 times per second when a call is received. Momentarily pressing the CALL light in resets the light and the decoder in preparation for the next call.

HORN AND LITE SWITCHES (Optional)

The external alarms are selected by the push-push HORN and LITE switches to alert the operator to an incoming call.

When a properly tone coded message is received and the horn alarm is selected, the horn will sound for approximately two seconds. If the LITE alarm is selected, the light alarm will remain on continuously. Both alarms, if present, may be selected simultaneously.

MONITOR/RESET (with Optional Hookswitch)

The MON/RESET switch on the handset holder or hookswitch controls receiver operation. When in the MON position, the receiver reverts to noise squelch operation and responds to all calls transmitted on the operating frequency. When a valid call is received the alert tone will sound; however, the CALL light will remain out since that circuit will be in the reset condition. When in the RESET position the receiver responds only to those calls that are tone coded with the proper Type 99 tones and, if used, the proper channel guard frequency.

The MON/RESET switch and hookswitch are connected in parallel so that when the microphone or handset is removed the receiver reverts to noise squelch operation. Replacing the microphone or handset automatically resets the Type 99 decode circuits and turns off the CALL indicator.

CIRCUIT ANALYSIS

References to symbol numbers mentioned in the following text are found on the Schematic Diagrams, Outline Diagram and Parts List. Type 99 Decoders use either two or four Versatone networks to allow the receiver to respond to 1 set of two sequential tones on to four sets of two sequential tones. A strapping arrangement on the component board determines the mode of operation.

FOUR-TONE OPERATION

Four tone operation utilizes four Versatone networks to provide four call capability i.e., individual call, group call, super group call, and one additional selective calling combination.

In Type 99 Decoders utilizing four Versatone networks, the control IC controls four resistor OR gates within the 4-tone search IC. These OR gates select the appropriate Versatone networks to decode the sequential tone combinations.

The active Versatone network determines the tone frequency that the Frequency Switchable Selective Amplifier (FSSA) responds to. A free running FF in the 4-Tone Search IC alternately enables two pairs of OR gates: A1, B1 and A2, B2 to search all four possible tone combinations. Possible tone combinations are: A1-B1, A1-B2, A2-B1 and A2-B2.

Refer to the Troubleshooting Procedures for a Block Diagram of the Type 99 Decoder.

In the absence of a valid sequential tone combination (no message being received, the second tone switch in the control IC provides +5.0 V to "B" tone resistor OR gates B1 and B2 in the 4-tone search IC via pin 14. Since +5 V on either input of a resistor OR gate prevents selection of the associated Versatone network, the "B" tones are not selected.

At the same time the 1st tone switch in the control IC provides a A- to the "A" tone resistor OR gates A1 and A2 in the 4-tone search IC via pin 10. Thus, when the free running FF alternately applies A- to OR gate pairs A1, B1 and A2, B2 only the "A" tone gates are enabled. As each "A" tone gate is enabled, A- is applied to the associated Versatone network. This allows the FSSA to respond to that "A" tone frequency.

When a tone input is received, it is taken from the Volume/Squelch Hi lead and applied to the threshold detector IC. The tone input is then limited and applied to pin 12 of the FSSA. If the tone corresponds to the Versatone selected, the FSSA applies the tone to the threshold detector IC. After receiving the tone from the FSSA, the threshold detector provides a control voltage of +4.7 V to pin 5 of the 4-tone search IC turning on the FF lock circuit and stopping the free running FF. This voltage is also applied to the 2nd tone search timer, the 1st tone clamp, and one input of the decode gate in the control IC. The +4.7 V arms the 2nd tone search timer; however, the 1st tone clamp prevents the 2nd tone search timer from starting its 1.5 second run until after the "A" tone ends.

The decode gate requires A- from the 2nd tone switch and a positive voltage from the threshold detector before it will provide a timed output. When the decode gate receives a positive input voltage from the threshold detector caused by the "A" tone it is still held off by +5.0 V from the second tone switch.

At the end of the "A" tone, the 2nd tone search timer initiates the 1.5 second run enabling the 2nd tone switch to supply A- to pin 14 of the 4-tone search IC, the 1st tone switch, and one input to the decode gate in the control IC. A- from the 2nd tone switch enables the 1st tone switch to supply +5.0 V to pin 10 of the 4-tone search IC and to the 2nd tone clamp. The 2nd tone clamp then disables the 1st tone clamp in the control IC. The +5 V at the end of the "A" tone and the +4.7 V from the threshold detector are removed from the FF lock circuit allowing the free running FF to alternately select OR gates A1, B1 and A2, B2. The +5 V from the 1st tone switch disables OR gates A1 and A2, while A- from the 2nd tone switch enables OR gates B1 and B2. Therefore as the FF alternately selects OR gates A1, B1 and A2, B2 only the B tone OR gates are enabled.

When a valid "B" tone is received, the FSSA supplies the tone to the threshold detector IC. The threshold detector applies +4.7 V to pin 5 of the 4-tone search IC. This turns on the FF lock circuit and stops the free running FF on the selected "B" tone OR gate.

This voltage is also applied to one input of the decode gate in the control IC. If the "B" tone occurs within 1.5 seconds of the "A" tone, the output of the 2nd tone switch remains at A- (2nd input to the decoder gate). A- applied to the 1st input and the positive voltage from the threshold detector opens the decode gate and provides a timed output to the relay driver and to the alert tone mute switch Q1404 and Q1405. It also starts the alert tone oscillator. The timed output turns on relay drivers Q1407 and Q1408 and applies +2.8 V to the alert tone muting circuit. In addition, the 1150 Hz alert tone is applied to the tone amplifier in the interface IC for the duration of the 2nd tone. A free running FF in the interface IC controls the alert tone switch which turns the tone amplifier on and off at a 10 Hz rate to provide the alert tone burst at pin 5 of the interface IC. The alert tone is then applied to tone switch Q1403. The tone switch is controlled by the alert tone muting circuit. The timed output from pin 12 of the control IC turns Q1405 on and Q1404 off, removing A- from the base of tone switch Q1403. Q1403 turns on and reverse biases audio switch CR1403 to block receiver audio for the duration of the "B" tone. During this time the chopped 1150 Hz is applied to the volume squelch hi lead and heard at the speaker

The decode gate turns on the latched and timed output gates and the alert tone oscillator circuits.

The latched output turns on the LITE alarm relay drivers Q1401 and Q1402 and applies +5.2 V to the indicator and receiver mute switches within the interface IC. The indicator switch turns on the CALL indicator flasher circuit Q1409-Q1410, causing CALL indicator CR1408 to flash on and off. The latched outputs will remain on until reset. The receiver mute switch removes A- from pin 14 of the interface IC, allowing the receiver to revert to noise squelch operation.

The timed output from the control IC disables the alert tone muting circuit and turns on the alert tone switch, allowing the alert tone to be applied to the receiver audio circuits through P1405B-14. At the end of the "B" tone the timed output at pin 12 of the control IC returns to 0 volts turning off the timed external alarms and the alert tone switch Q1403. Audio switch CR1403 becomes forward biased and passes the normal receiver audio.

TWO-TONE OPERATION

Two Versatone networks are used and the number of tone paths is reduced to one, A1-B1.

Except for a different jumper arrangement that alters the operation of the 4-Tone Search IC, operation with two Versatones is identical to the four tone operation described above. In two-tone operation a DA jumper wire is present between H1 and H2 and locks the free running FF. With the free running FF locked, OR gates A1 and B1 are continuously enabled; thus, the 1st tone switch in the control IC selects only the A1 Versatone via OR gate A1 and the 2nd tone switch selects only the B1 Versatone via OR gate B1. With this strapping arrangement only one tone combination, A1-B1, is decoded.

Typical diagrams of the Versatone network, threshold detector, 4-tone search, control and interface IC's are provided in Figures 1 thru 6. References to symbol numbers mentioned in the following text are found on the Schematic Diagram, Outline Diagram, and Parts List.

FREQUENCY SWITCHABLE SELECTIVE AMPLIFIER (FSSA)

The FSSA is a highly stable active bandpass filter operating over a frequency range of 288.5 Hz to 1433.4 Hz. The selectivity of the filter is shifted across the bandpass frequency range by switching Versatone networks in the filter circuit.

In Figure 1, the gain of the FSSA is shown as a function of tone frequency. The tone frequency is determined by the tone network connected in the FSSA circuit. When tone network "A" is in the circuit, the maximum gain occurs at Fa. When tone network "B" is in the circuit, the maximum gain occurs at Fb.

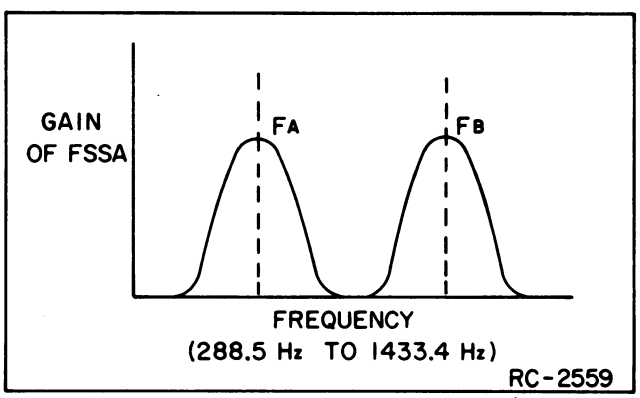


Figure 1 - Gain vs Frequency

TONE NETWORKS

Versatone networks FL1401 through FL1404 are parallel connected precision resistors. A typical Versatone network is shown in Figure 2. Pin 5 of the network is connected to ground. When a positive signal from the 4-tone search IC is applied to pin 3, Q1 will conduct. This disables amplifier Q2 and feedback resistors R1, R2 and R3, effectively removing the network from the FSSA circuit.

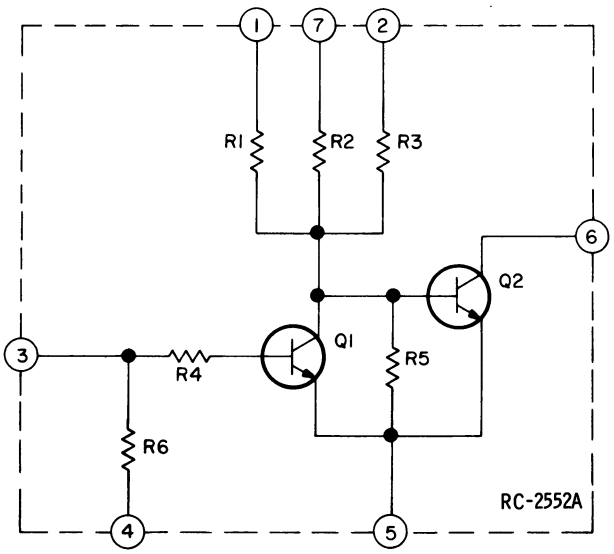


Figure 2 - Typical Versatone Network

THRESHOLD DETECTOR

Initially, the 4-tone search IC searches between tone networks A1 and A2. When either of the correct tones is received and applied to the input of the FSSA, it will appear at the output of the FSSA at a higher signal level than other signals. The FSSA output is coupled through C1401 and R1404 to threshold detector pin 1.

Receiver audio is applied to pin 7 of the threshold detector IC through associated coupling and attenuation networks providing the proper signal level to limiter Q4. Limiter Q4 sets the input level to the FSSA at 42 millivolts peak-to-peak. The output of the limiter is taken from pin 5 and connected to pin 12 on the FSSA. A typical threshold detector circuit is shown in Figure 3.

Amplifier Q1 amplifies the tone and couples it to the base of Q2. If the tone is correct, the signal amplitude will be sufficient for Q2 to conduct. Q2 conducting causes DC switch Q3 to conduct, applying 4.7 V to pin 2 of the control IC and pin 5 of the 4-tone search IC.

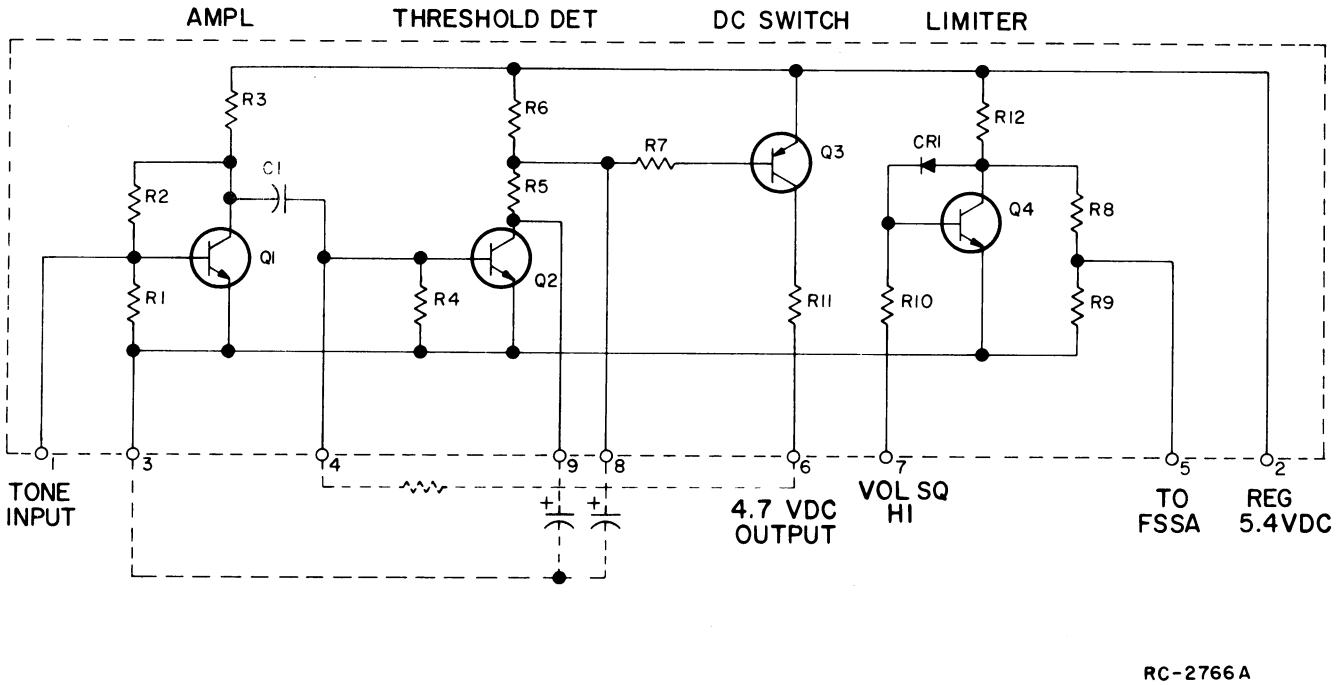


Figure 3 - Typical Threshold Detector Circuit

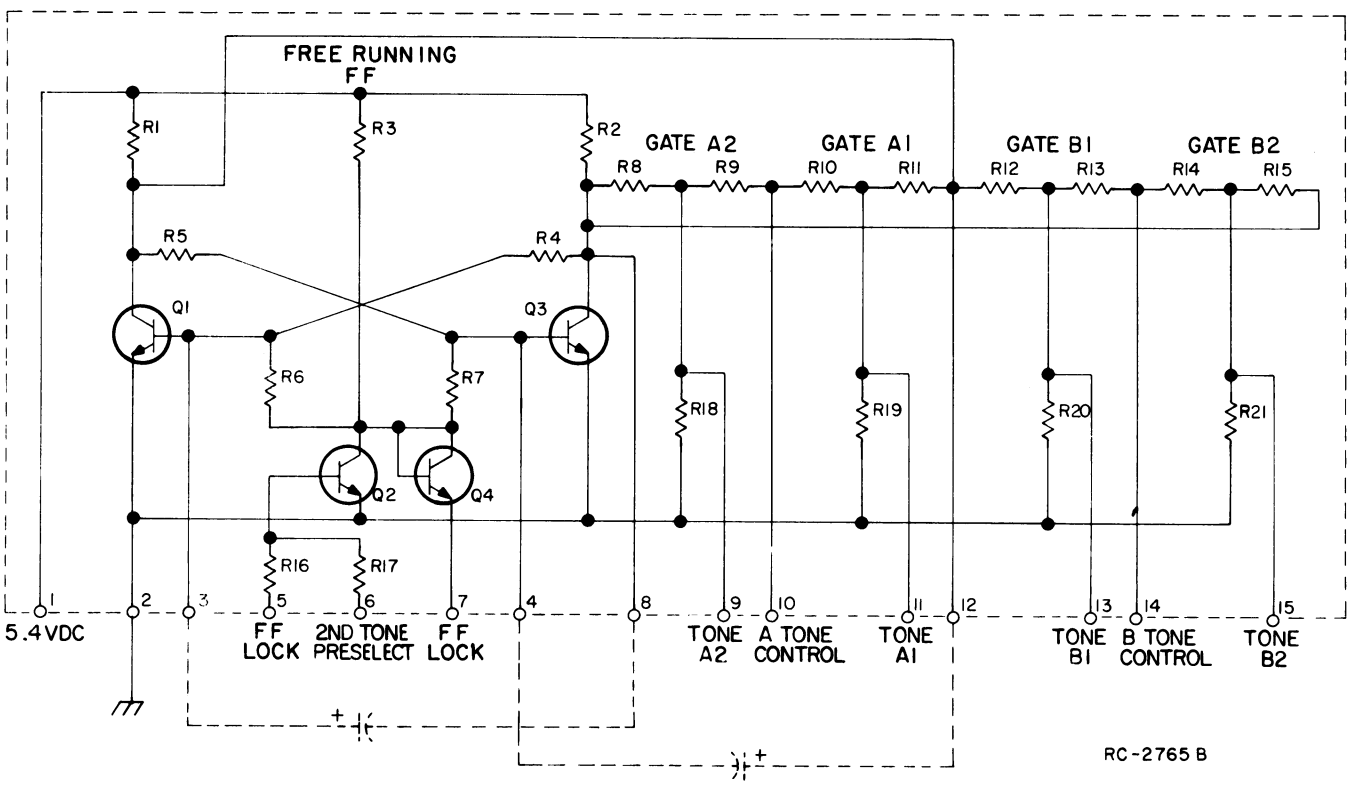


Figure 4 - Typical 4-Tone Search IC

FOUR-TONE SEARCH IC

The 4-tone search IC alternately switches Versatone networks FL1401 and FL1403 or FL1402 and FL1404 into the FSSA circuit. A typical 4-tone search IC is shown in Figure 4. Inputs from the control IC to pins 10 and 14 of the 4-tone search IC determine if the anticipated tone is an "A" or a "B" tone. The free running FF alternately selects OR gate pairs A1, B1 and A2, B2.

The resistor OR gates on the 4-tone search IC inhibit the selection of a tone network as long as a positive voltage is present on either input. Both inputs must be at A- to select the associated tone network.

Before an "A" tone is received, A- is present at pin 10 and +5.0 V at pin 14 of the 4-tone search IC. The FF alternately selects "A" tone networks FL1401 and FL1402.

When a tone is received, +4.7 V is applied to pin 5, causing FF lock transistor Q2 to conduct. Q2 stops the free running FF from switching while the tone is present.

After the first tone ends, the control IC applies 5.0 V to pin 10 and A- to pin 14 of the 4-tone search IC. The FF lock releases the free running FF which then alternately selects "B" tone networks FL1403 and FL1404.

Q4 is a fast FF lock circuit, controlled by the threshold detector IC. When a tone is present, Q4 conducts, instantly stopping the FF. This insures that the control IC has time to react.

CONTROL IC

The 4.7 V from the threshold detector (applied to pin 2 when an A tone is received) causes 1st tone clamp transistor Q2 to clamp 2nd tone switch Q3 off, allowing timing capacitor C1409 to charge. A typical control IC is shown in Figure 5. When the "A" tone ends, +4.7 V is removed from pin 2, turning Q2 off. C1409, in a charged state, causes 2nd tone switch Q3 to conduct. Q3 conducting causes the 4-tone search IC to search for a "B" tone. Q3 also turns 1st tone switch transistor Q4 off causing the 4-tone search IC to stop searching for

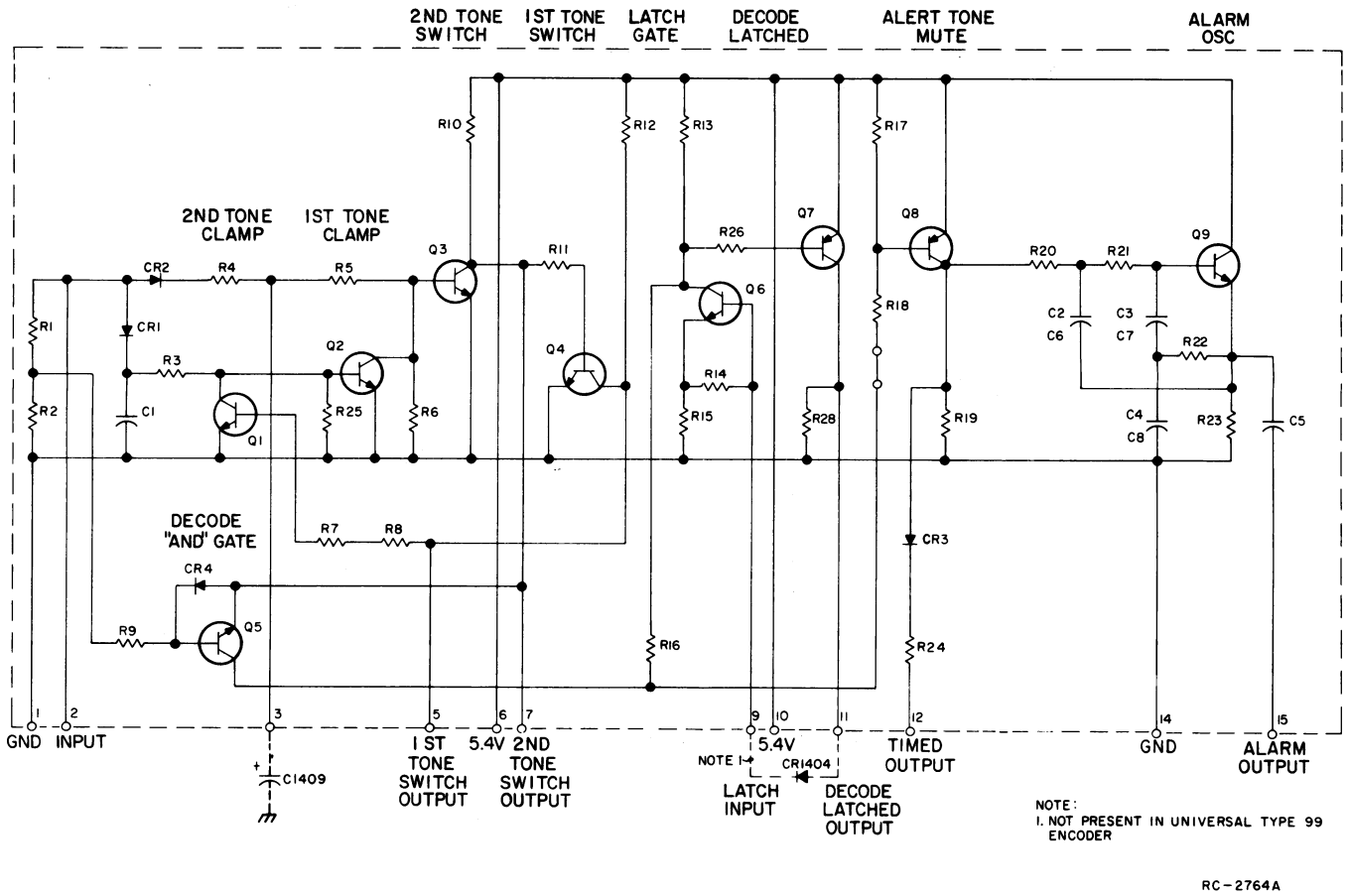


Figure 5 - Typical Control Circuit

an "A" tone. Q4 also turns 2nd tone clamp transistor Q1 on. Turning Q1 on holds 1st tone clamp transistor Q2 off.

If a second tone is not received within 1.5 seconds, timing capacitor C1409 discharges and automatically resets the circuit to receive a new first tone.

If a second tone is received within 1.5 seconds a positive voltage is applied to the base resistor of decode gate Q5. With the emitter of Q5 held low by Q3, the positive voltage on the base resistor causes Q5 to conduct. Q5 turns on alert tone mute transistor Q8. Q8 turns on alert tone oscillator Q9 for the duration of the "B" tone.

Q5 also causes decode latch transistors Q6 and Q7 to conduct, and provide a latched decode output to the light alarm relay drivers and to the interface IC.

When the second tone ends, the alert tone stops, the FF in the 4-tone search IC begins searching and the timing circuit in the control IC resets the decoder to receive a first tone.

The receiver will remain on noise squelch operation until the decoder is reset.

Transistor Q1412 is a delay turn on and delay turn off switch that ensures proper operation of the "B" tone timer. Q1412 is normally on.

INTERFACE IC

The interface IC (Figure 6) keeps the receiver muted by grounding the receiver mute lead through P1405D-13 until the proper sequential tones are received, provides a ground return for the flasher circuit and chops the alert tone received from the control IC.

The alert tone applied to pin 2 is chopped by multivibrator Q3 and Q4 and amplified by Q2 to provide alert tone bursts at pin 5.

Monitor switch Q8 provides the ground return for receiver mute switch Q6 and Q7, thereby controlling the muting function to the receiver. Normally, Q8 is conducting

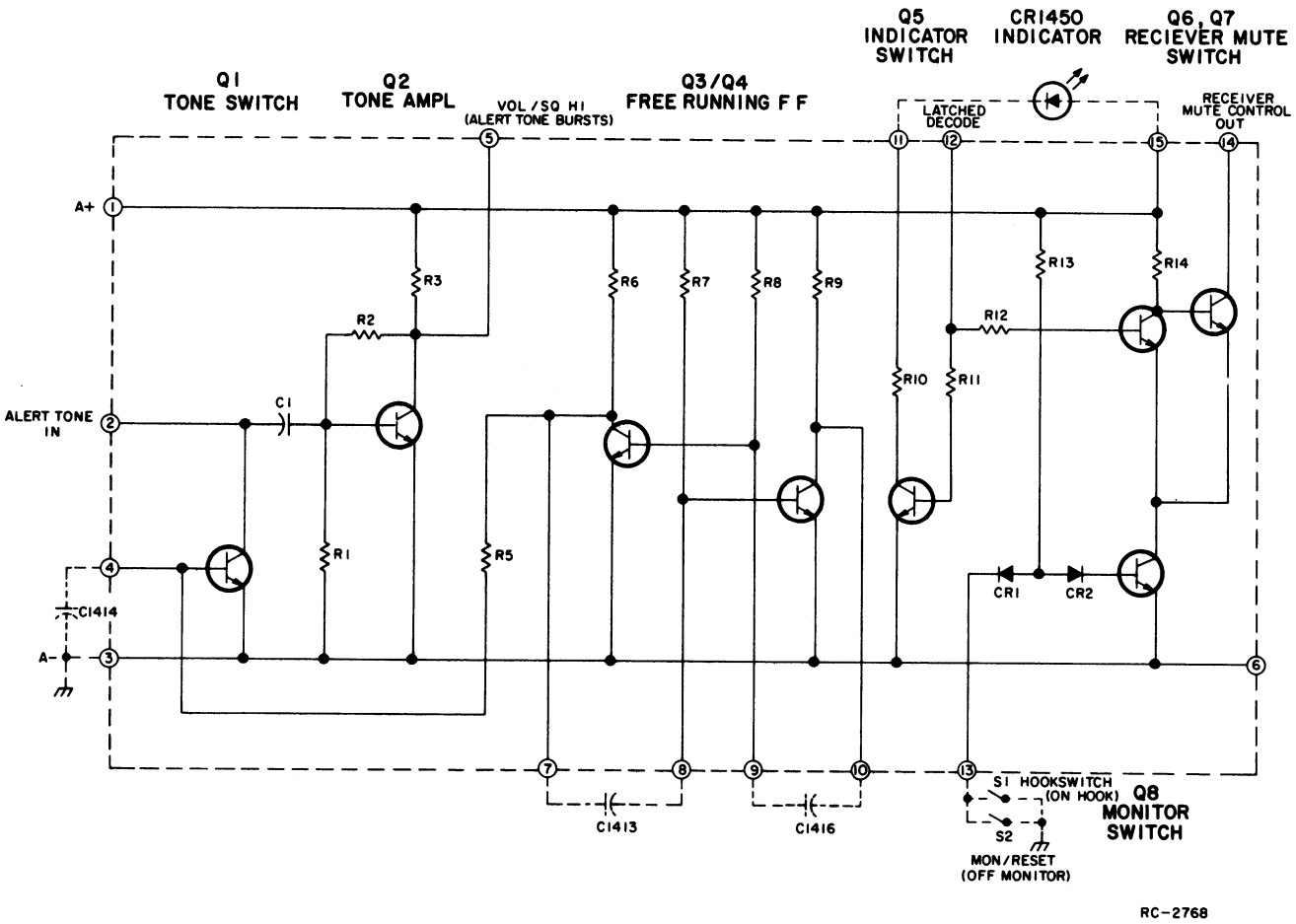


Figure 6 - Interface IC, Typical

and provides this return path. When the MON/RESET switch on the hookswitch is in the MON position or the handset/microphone is removed from the hookswitch, ground is applied to the base of Q8 turning it off. This interrupts the ground return path and allows the receiver to return to noise squelch operation.

ALERT TONE MUTING

Alert tone muting transistors Q1404 and Q1405 function as a muting switch to control output tone switch Q1403. When the proper sequential tones have been decoded, the alert tone is present at pin 15 of the control IC and +2.8 V from pin 12 of the control IC turns on alert tone muting transistor Q1405. Q1405 turns mute switch Q1404 off which then removes the clamp from the base of tone switch Q1403, allowing the alert tone to appear at the Volume/Squelch Hi out lead P1405B-14. During this time, switching diode CR1403 is reverse biased (via A+ through Q1403) blocking the FM discriminator/detector output from entering the audio circuit.

In the absence of the proper sequential tones, Q1405 is turned off and Q1404 is turned on. Q1404 clamps tone switch Q1403 off allowing normal audio to pass through switching diode CR1403 to the audio circuit. However, unless the MON/RESET switch is in the MON position, the receiver mute switch in the interface IC and/or the Channel Guard will mute the receiver.

OPERATION WITH CHANNEL GUARD

When Type 99 and Channel Guard decoders are both present in a system, two types of operation can be provided:

- Type 99 AND Channel Guard
- Type 99 OR Channel Guard

In the AND configuration, when the microphone/handset is on-hook both Channel Guard and Type 99 tones must be present to unmute the receiver and allow it to revert to normal noise squelch operation. A call is indicated when the option light is flashing and the alert tone (1150 Hz tone bursts) sounds. Should a valid Type 99 tone be received at the same time as an incorrect channel guard tone is received, the option light will flash but the alert tone will not sound. In this case, reset the Type 99 Decoder and option light using the MON/RESET switch on the handset holder.

In the OR configuration, receipt of either a valid channel guard tone or a Type 99 sequential tone will unmute the receiver and allow it to revert to noise squelch operation.

Operation in either mode is determined by the presence (or absence) of diode CR1406 and appropriate strapping. Refer to the Installation section for strapping information.

Type 99 Decode AND Channel Guard

When operating with Type 99 Decoders Channel Guard (Type 99 only if Channel Guard is not present), the receiver mute switch at pin 14 of the interface IC is connected directly to the receiver mute line via a strap connected between H8 and H9 on the decoder component board, through the control unit to the Channel Guard output. Since A- on the receiver mute lead will mute the receiver, both the Channel Guard and the Type 99 tones must be present to allow the receiver to revert to noise squelch operation. If either tone is not present the receiver mute lead will be held low and the receiver will remain muted.

Type 99 Decode OR Channel Guard

When calls encode with sequential Type 99 tones are to be monitored, an inverter, (Q1406), is inserted in the circuit between the receiver mute output at pin 14 of the Interface IC and the Channel Guard disable input at P1405B-7.

When the proper Type 99 tones are received, the receiver mute switch in the interface IC removes A- from the base of inverter Q1406. Q1406 conducts and supplies A- to the Channel Guard disable input, allowing the receiver to revert to noise squelch operation. When the proper Type 99 tones have not been received, Q1406 is biased off by the receiver mute switch which effectively removes it from the circuit. Since diode CR1406 is physically removed when the OR function is used, the monitor/reset functions are executed through the monitor and receiver mute switches in the interface IC. When a signal is received with the proper Channel Guard tone, the receiver functions as in normal Channel Guard operation.

PREDETERMINED SIGNALLING PATHS

The 4-Tone Decoder normally has four signalling paths: A1-B1, A1-B2, A2-B1, and A2-B2. The number of signalling paths can be limited to two, A1-B1, and A2-B2 by removing the jumper between H2 and H3, and adding a jumper between H1 and H2. This stops the free running FF after the first tone, preventing the 4-tone search IC from searching the "B" tone. Thus, if A1 is the first tone, B1 must be the second. Likewise, if A2 is the first tone, B2 must be the second.

OPERATION WITH PSLM

The component boards for Type 99 sequential tone signalling contains a strapping arrangement that permits operation with or without Priority Search Lock Monitor (PSLM). The proper jumper connections must be verified prior to initial installation or component board replacement. Refer to the Installation section of this manual or to the Schematic Diagram for details.

EXTERNAL RELAY ALARMS

Two external alarm control circuits, horn and light, are available. Either one or both may be present. A latched relay driver, Q1402 is used to control the light while a timed relay driver, Q1408 is used to sound the horn. Maximum allowable current through the driver transistors is 200 milliamperes. Current through the external relay contacts is limited to 15 Amperes.

Latched relay driver, Q1402 supplies A- through contacts 3 and 5 of S1403 and J1401-1 to the external light relay.

Timed relay driver, Q1408 supplies A- through contacts 3 and 5 of S1402 and J1401-2 to the external horn relay.

The external relay is used when the current rating of the external alarm (horn, lite, etc.) exceeds the current rating of Q1411. A normally open set of contacts, rated at 15 amperes maximum at 12 Volts DC, is provided to operate the external alarm. A diode is connected across the relay coil to suppress voltage spikes produced across the relay when it operates.

Timed relay operation activates the external alarm circuit for approximately 0.5 to 3 seconds during receipt of the second sequential tone. The duration of the alarm is dependent upon whether the decoder is strapped for 2 tone or 4 tone operation and the duration of the second tone.

Latched operation activates the external alarm during receipt of the second sequential tone and holds it on until the decoder is manually reset. The decoder is automatically reset when the microphone or handset is removed from the hookswitch or by momentarily operating the MON/RESET switch on the hookswitch.

FIELD INSTALLATION

The following instructions install the Type 99 Decoder option in the C-800 and C-900 Series Control Units. Refer to the control unit maintenance manual for removal and replacement procedures for the control module and for location of jumpers "K" and "L".

PROCEDURE

Control Module

1. Remove front panel of control unit.
2. Refer to control unit maintenance manual for control module removal procedures. Remove control module (lower deck).
3. Remove or cut jumpers "K" and "L" on control module.
4. Do not reinstall control module at this time.

Type 99 Option Module

The Type 99 Decoder is compatible with all board options; however, when the Type 99 component board is used with PSLM, a different strapping arrangement is required. Refer to the control modules Schematic Diagram and install/remove the appropriate jumpers.

NOTE

When the type 99 option board is installed in a C-900 control unit equipped with a multi-frequency PSLM board, the backplane board also must be modified. Solder a DA jumper wire between H29-H30 on the backplane board and remove the DA jumper wire connected between H9-H10. Refer to control unit manual for jumper location.

Option Switch Installation

1. Unsolder and discard pin from LED contact. (See Outline Diagram). Do not unsolder or damage LED contact. Hole thru LED contact must remain open.
2. Install and solder switch. Shoulder of switch terminal must be tight against board, .010 max gap after solder.
3. Install and solder LED.
4. Insert red wire into auxilliary switch jack J760-1 and black wire into J760-2.
5. Remove second option module, if present and necessary to gain access to install J760.
6. Install J760 by pressing connector into rear cover from inside control unit.
7. Install cable clip around cable and fasten clip to backplane board using an existing 6-32 screw.

8. Install type 99 option board in appropriate option deck and plug short cable into J1401 on option board. Install second option board if removed.

9. Reinstall control module.

10. Replace front cover.

11. Plug external alarm cable plug into J760 on rear of control unit.

EXTERNAL RELAY KIT

Refer to the Outline Diagram to locate and identify connecting points.

1. Fasten relay in desired location using self tapping screws.

2. Crimp terminal 19B209260P12 to red or black wire. Connect terminal to relay lug #4 using 8-32 x 5/16 screw.

3. Cut red fused lead so fuse assembly is close to voltage source. Attach the solderless terminal with the 0.197 inch hole to the end of the lead going to the relay. Using #8-32 x 5/16 LG hardware attach the terminal to lug 3 of the relay. Attach other end of fused lead to voltage source with appropriate hardware.

4. Connect horn or light circuit to lugs 1 and 2 of relay.

MAINTENANCE

Troubleshooting the Type 99 component board in the control unit is facilitated by using option extender board 19D417773. The extender board plugs into the control unit backplane printed wire board.

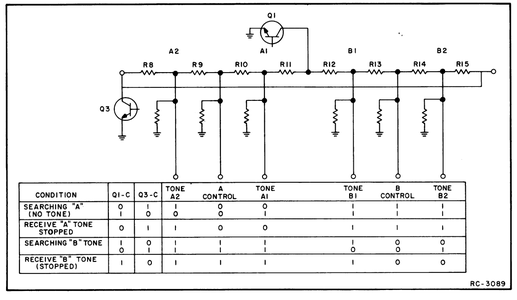
A troubleshooting chart containing fault symptoms and associated troubleshooting procedures is provided to assist in isolating defective components. In addition, a truth table is included for the 4-tone search IC.

REMOVING INTEGRATED CIRCUITS

Removing integrated circuits (IC's) can be easily accomplished by using a de-soldering tool such as a Solda-PULLT® or equivalent. To remove an IC, heat each lead separately on the solder side and remove the old solder with the de-soldering tool.

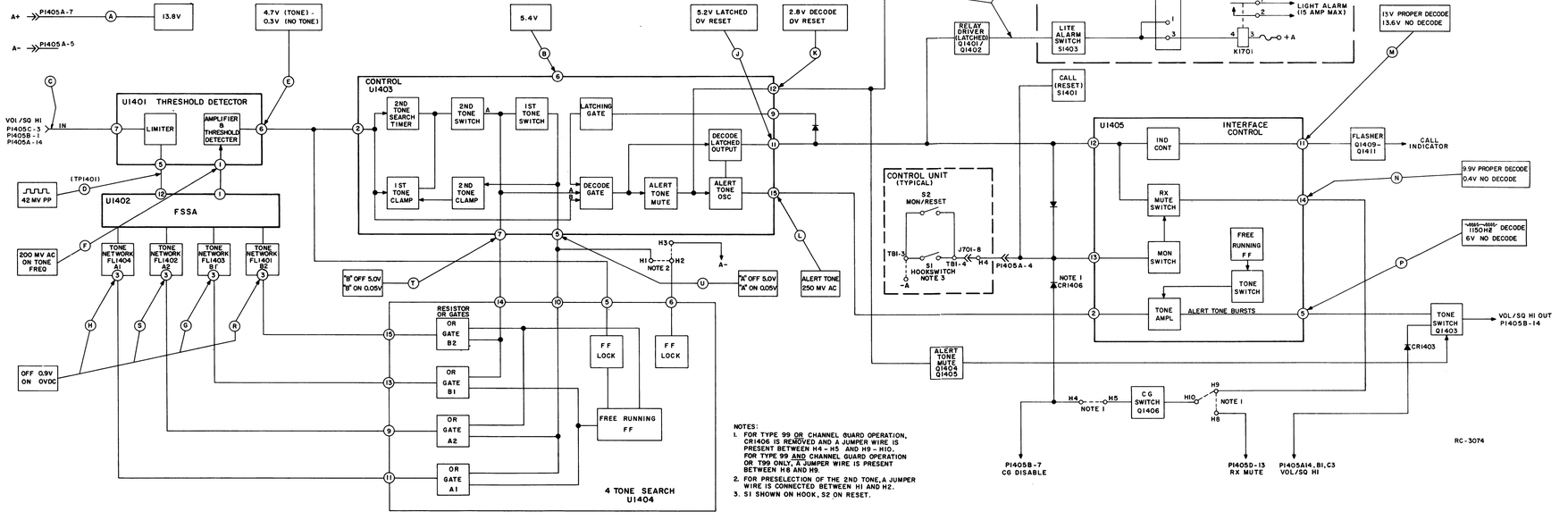
An alternate method is to use a special soldering tip that heats all the pins simultaneously.

SYMPTOM	STEP	TEST POINT	
Unit does not decode.	1		Connect U1404-4 to ground. This stops the free running FF and allows the decoder to be checked as a two tone decoder. Two tone networks may be checked by substitution.
	2	(A)	Check for +13.8 V (battery) between P1405A-7 (A) and P1405A-5.
	3	(B)	Check for +5.4 V (B).
	4	(N) TP-1401	Apply correct Type 99 tone to Volume/Squelch H1 (N) at a level sufficient to cause limiting at (N)(TP1401). Approximately 100 mV.
	5	(E)	Check for 4.7 V.
	6	(F)	If (E) is incorrect check for 200 mV AC.
	7	(O)(H)	If FSSA appears to be defective, before replacing check: 1) XF1401 for proper content. 2) Terminal switching voltages at (L) and (G). 3) Replace FL 1401 (may be interchanged with FL1402).
	8	(G)	If the switching voltages at (F) and (G) are incorrect, connect pin 3 of FL1401 to ground. Recork FL1402.
	9	(H)(I)	Remove ground connection from U1404-4. With no tone applied, monitor switching voltages at (H) and (I). If FF is not switching check: 1) Timing capacitors C1410 and C1411. 2) Replace U1404.
	10	(O)(H)	If (O) V is present at (H), monitor the switching voltages at (H) and (I). Apply an 1800 and then a continuous "A" tone. Search tone and verify that voltages at (H) and (I) reverse for approximately 1.5 seconds. If this sequence is correct proceed to step 11. If the switching voltages are incorrect, check: 1) XF1408 and replace FL1402. 2) 4.7 V across C1409 during the "A" tone. If no voltage, check Q1412. Check Q1412, if still no voltage replace U1404. 3) Check for shorts in U1403. 4) Replace U1402.
	11	(F)	If the response at (E) is correct, a decode indication 0.05V should be present at (F) during the second tone. If decode does not occur replace U1402.
	12	(J)(K)(L)	Check performance at (J)(K)(L). Replace U1402 if any test point fails to respond properly.
Receiver does not mute.	13	(M)(N)	Check performance at (M)(N). Replace U1405 if test point indication is incorrect. If indicator does not operate check Q1408-Q1411. Verify proper strapping at R8, R9, R10, R4, R5. Check Q1406.
Alert tone not heard.	14	(P)	Check performance at (P). If indication is incorrect, replace U1405. Check Q1403 and CR1403.
Alert tone does not reset.	15	(K)	Check for A- (0.6 V or less) at base of Q1403. If indication is incorrect recheck conditions at (K). If (K) is normal check and replace Q1405 and/or Q1404 as necessary.
External relay circuit does not respond.	16	(S)(J)(V)	Check line fuse between battery and external relay.
			Recheck indications at (J) and (S). Verify indications at (V). If battery voltage is present, replace relay drivers Q1401, Q1402, Q1407 and Q1408 as required.
			If A- (0.5 or less) is present check option control switch and external relay K1701.

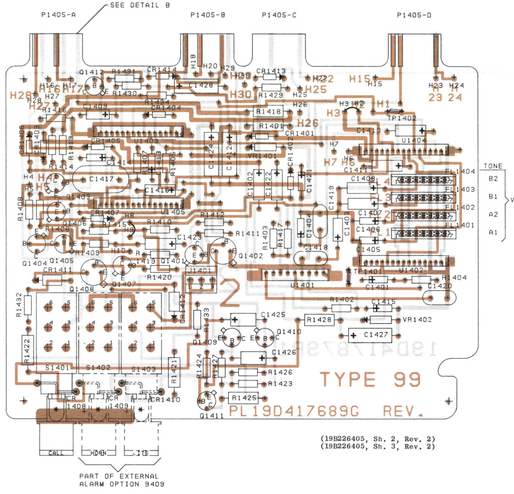


CONDITION	Q1-C	Q3-C	TONE A2	A CONTROL	TONE A1	TONE B1	B CONTROL	TONE B2
SEARCHING "A" (NO TONE)	O I	I O	I O	O O	O I	I I	I I	I I
RECEIVE "A" TONE STOPPED	O	I	I	O	O	I	I	I
SEARCHING "B" TONE	I O	O I	I I	I I	I I	I O	O I	O I
RECEIVE "B" TONE (STOPPED)	I	O	I	I	I	I	O	O

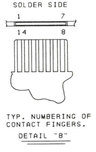
RC-3089

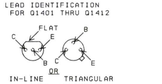


NOTES:
1. FOR TYPE 99 OR CHANNEL GUARD OPERATION, CR1406 IS REMOVED AND A JUMPER WIRE IS PRESENT BETWEEN H4 - H5 AND H9 - H10. FOR TYPE 99 AND CHANNEL GUARD OPERATION OR T99 ONLY, A JUMPER WIRE IS PRESENT BETWEEN H8 AND H9.
2. FOR PRESELECTION OF THE 2ND TONE, A JUMPER WIRE IS CONNECTED BETWEEN H1 AND H2.
3. S1 SHOWN ON HOOK, S2 ON RESET.

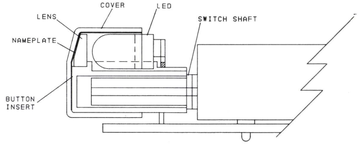


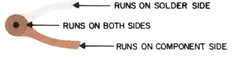
(19B226405, Sh. 2, Rev. 2)
(19B226405, Sh. 3, Rev. 2)



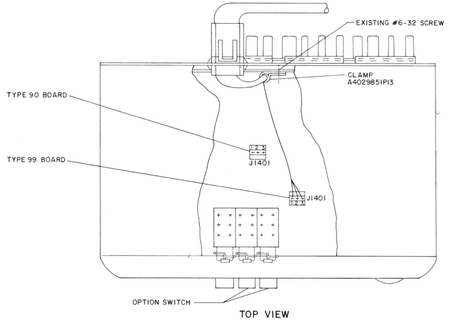


NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

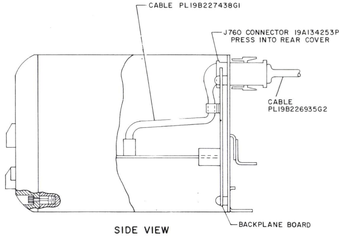




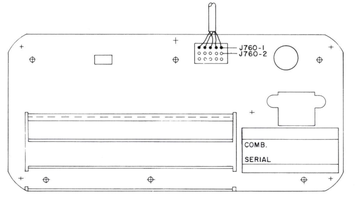
(19D424536, Rev. 0)



TOP VIEW

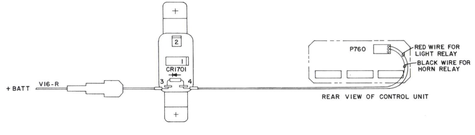


SIDE VIEW



REAR VIEW

RC-3090

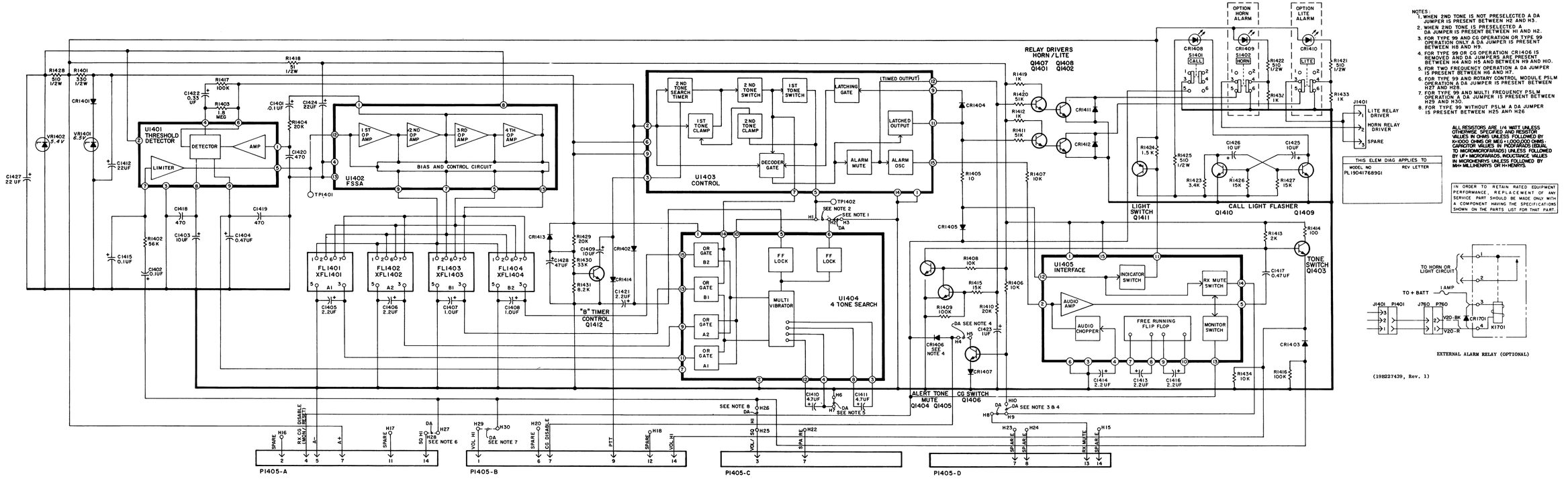


EXTERNAL ALARM RELAY (OPTIONAL)

(19B227439, Rev. 1)

OUTLINE & INSTALLATION DIAGRAM

TYPE 99 TONE DECODER



NOTES:
1. WHEN 2ND TONE IS NOT PRESELECTED A DA JUMPER IS PRESENT BETWEEN H2 AND H3.
2. WHEN 2ND TONE IS PRESELECTED A DA JUMPER IS PRESENT BETWEEN H1 AND H2.
3. FOR TYPE 99 AND CG OPERATION OR TYPE 99 OPERATION ONLY A DA JUMPER IS PRESENT BETWEEN H8 AND H9.
4. FOR TYPE 99 OR CG OPERATION CR1406 IS REMOVED AND DA JUMPERS ARE PRESENT BETWEEN H4 AND H5 AND BETWEEN H9 AND H10.
5. FOR TWO FREQUENCY OPERATION A DA JUMPER IS PRESENT BETWEEN H6 AND H7.
6. FOR TYPE 99 AND ROTARY CONTROL MODULE PSLM OPERATION A DA JUMPER IS PRESENT BETWEEN H27 AND H28.
7. FOR TYPE 99 AND MULTI FREQUENCY PSLM OPERATION A DA JUMPER IS PRESENT BETWEEN H29 AND H30.
8. FOR TYPE 99 WITHOUT PSLM A DA JUMPER IS PRESENT BETWEEN H25 AND H26

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 MICROFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR H=HENRYS.

THIS ELEM DIAG APPLIES TO
MODEL NO PL19041768901
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.

(19B622093, Rev. 4)

(19B227439, Rev. 1)

SCHEMATIC DIAGRAM

TYPE 99 TONE DECODER

Issue 1

PARTS LIST

LBI-30087

TYPE 99 DECODER
19D417689G1

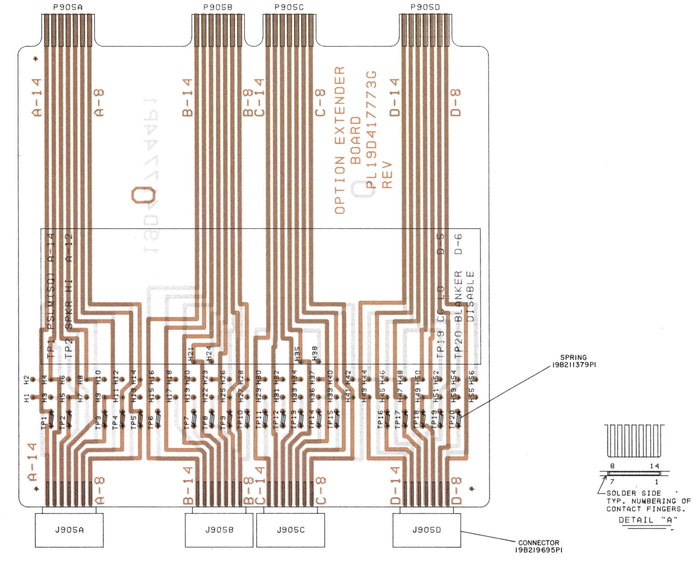
SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1401	5491674P43	Tantalum: 0.1 µf ±20%, 35 VDCW; sim to Sprague Type 162D.
C1402	5496267P224	Tantalum: 0.1 µf ±10%, 35 VDCW; sim to Sprague Type 150D.
C1403	5491674P37	Tantalum: 10 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C1404	5491674P27	Tantalum: .47 µf ±20%, 35 VDCW; sim to Sprague Type 162D.
C1405 and C1406	5491674P44	Tantalum: 2.2 µf ±20%, 15 VDCW; sim to Sprague Type 162D.
C1407 and C1408	5491674P17	Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 162D.
C1409	5491674P37	Tantalum: 10 µf ±20%, 10 VDCW; sim to Sprague Type 162D.
C1410 and C1411	5491674P45	Tantalum: 4.7 µf ±10%, 6 VDCW; sim to Sprague Type 162D.
C1412	5496267P10	Tantalum: 22 µf ±20%, 15 VDCW; sim to Sprague Type 150D.
C1413 and C1414	5491674P44	Tantalum: 2.2 µf ±20%, 15 VDCW; sim to Sprague Type 162D.
C1415	5491674P43	Tantalum: 0.1 µf ±20%, 35 VDCW; sim to Sprague Type 162D.
C1416	5491674P44	Tantalum: 2.2 µf ±20%, 15 VDCW; sim to Sprague Type 162D.
C1417	19A116080P111	Polyester: 0.47 µf ±10%, 50 VDCW.
C1418 thru C1420	5494481P107	Ceramic disc: 470 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C1421	5491674P44	Tantalum: 2.2 µf ±20%, 15 VDCW; sim to Sprague Type 162D.
C1422	5496267P227	Tantalum: 0.33 µf ±20%, 35 VDCW; sim to Sprague Type 150D.
C1423	5496267P17	Tantalum: 1.0 µf ±20%, 35 VDCW; sim to Sprague Type 150D.
C1424	5496267P10	Tantalum: 22 µf ±20%, 15 VDCW; sim to Sprague Type 150D.
C1425 and C1426	5491674P40	Tantalum: 10 µf ±20%, 20 VDCW; sim to Sprague Type 162D.
C1427	5496267P10	Tantalum: 22 µf ±20%, 15 VDCW; sim to Sprague Type 150D.
C1428	5496267P2	Tantalum: 47 µf ±20%, 6 VDCW; sim to Sprague Type 150D.
		- - - - - - - DIODES AND RECTIFIERS - - - - - -
CR1401 thru CR1407	19A115250P1	Silicon.
CR1408	19A134146P4	Diode, optoelectronic: red; sim to Opcoa LSM-6L.
CR1411 and CR1412	4037822P1	Silicon.
CR1413 and CR1414	19A115250P1	Silicon.
		- - - - - - - - - TONE NETWORKS - - - - - - - -
		NOTE: When reordering give GE Part Number and spcfify exact frequency needed.
FL1401 thru FL1404	19C320291G2	Hybrid: 517.5 to 997.5 Hz.
FL1401 thru FL1404	19C320291G3	Hybrid: 288.5 to 1433.4 Hz.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - JACKS AND RECEPTACLES - - - - - -
J1401	19A116659P26	Connector, printed wiring: 3 contacts; sim to Molex 09-64-1031.
		- - - - - - - - - TRANSISTORS - - - - - - - - -
Q1401	19A115910P1	Silicon, NPN; sim to Type 2N3904.
Q1402	19A115300P2	Silicon, NPN; sim to Type 2N3053.
Q1403 thru Q1407	19A115910P1	Silicon, NPN; sim to Type 2N3904.
Q1408	19A115300P2	Silicon, NPN; sim to Type 2N3053.
Q1409 and Q1410	19A115910P1	Silicon, NPN; sim to Type 2N3904.
Q1411	19A115852P1	Silicon, PNP; sim to Type 2N3906.
Q1412	19A115910P1	Silicon, NPN; sim to Type 2N3904.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1401	3R77P331J	Composition: 330 ohms ±5%, 1/2 w.
R1402	3R152P563J	Composition: 56,000 ohms ±5%, 1/4 w.
R1403	3R152P185J	Composition: 1.8 megohms ±5%, 1/4 w.
R1404	3R152P203J	Composition: 20,000 ohms ±5%, 1/4 w.
R1405	3R152P100J	Composition: 10 ohms ±5%, 1/4 w.
R1406 thru R1408	3R152P103J	Composition: 10,000 ohms ±5%, 1/4 w.
R1409	3R152P104J	Composition: 100,000 ohms ±5%, 1/4 w.
R1410	3R152P203J	Composition: 20,000 ohms ±5%, 1/4 w.
R1411	3R152P513J	Composition: 51,000 ohms ±5%, 1/4 w.
R1412	3R152P102J	Composition: 1000 ohms ±5%, 1/4 w.
R1413	3R152P202J	Composition: 2000 ohms ±5%, 1/4 w.
R1414	3R152P101J	Composition: 100 ohms ±5%, 1/4 w.
R1415	3R152P153J	Composition: 15,000 ohms ±5%, 1/4 w.
R1416 and R1417	3R152P104J	Composition: 100,000 ohms ±5%, 1/4 w.
R1418	3R152P510J	Composition: 51 ohms ±5%, 1/4 w.
R1419	3R152P102J	Composition: 1000 ohms ±5%, 1/4 w.
R1420	3R152P513J	Composition: 51,000 ohms ±5%, 1/4 w.
R1421 and R1422	3R77P511J	Composition: 510 ohms ±5%, 1/2 w.
R1423	3R152P392J	Composition: 3900 ohms ±5%, 1/4 w.
R1424	3R152P152J	Composition: 1500 ohms ±5%, 1/4 w.
R1425	3R77P511J	Composition: 510 ohms ±5%, 1/2 w.
R1426 and R1427	3R152P153J	Composition: 15,000 ohms ±5%, 1/4 w.
R1428	3R77P511J	Composition: 510 ohms ±5%, 1/2 w.
R1429	3R152P203J	Composition: 20,000 ohms ±5%, 1/4 w.
R1430	3R152P333J	Composition: 33,000 ohms ±5%, 1/4 w.
R1431	3R152P822J	Composition: 8200 ohms ±5%, 1/4 w.
R1432 and R1433	3R152P102J	Composition: 1000 ohms ±5%, 1/4 w.
R1434	3R152P103J	Composition: 10,000 ohms ±5%, 1/4 w.
		- - - - - - - - - - SWITCHES - - - - - - - - - -
S1401	19B209563P3	Push: DPDT, 1 station, momentary action; sim to Switchcraft Series 70,000.
		- - - - - - - - - TEST POINTS - - - - - - - - -
TP1401 and TP1402	19B211379P1	Spring (Test Point).

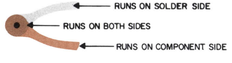
SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - INTEGRATED CIRCUITS - - - - - -
U1401	19C320539G1	Threshold Detector Limiter.
U1402	19D417092G1	Selective Amplifier.
U1403	19D417098G2	Control.
U1404	19D417132G1	4 Tone Search.
U1405	19D417373G1	Interface.
		- - - - - - - - VOLTAGE REGULATORS - - - - - - -
VR1401	4036887P6	Silicon, Zener.
VR1402	4036887P5	Silicon, Zener.
		- - - - - - - - - - SOCKETS - - - - - - - - - -
XF1401 thru XF1404	19C320299G1	Socket. Includes:
	19D416714P1	Socket.
	19B219681P1	Contact.
		&EXTERNAL RELAY ASSEMBLY 19B226025G2
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1701	4037822P2	Silicon.
		- - - - - - - - - - RELAYS - - - - - - - - - -
K1701	7486515P2	Armature, enclosed: 12 VDC nominal, 85 to 90 ohms at 25°C, 1 form A contact, without mounting screws.
		SWITCH ASSEMBLY 19B227037G7
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1412 and CR1413	19A134146P14	Diode, optoelectronic: yellow; sim to Opcoa LSM-23L-101.
		- - - - - - - JACKS AND RECEPTACLES - - - - - - -
J760	19A134253P1	Connector: sim to AMP 1-480921-9.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P760	19B226935G2	Cable: 2 conductor, approx 12 feet long.
P1401	19B227438G1	Cable: approx 11 inches long.
		- - - - - - - - - - SWITCHES - - - - - - - - - -
S1402 and S1403	19B209563P2	Push: 1 station, 2PDT, alternate action; sim to Switchcraft Series 70,000.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
	NP243580L	Call number decal.
	19A115010P3	Contact, electrical. (Used with CR1408-CR1410).
	19A130553P1	Pin. (Used when CR1409, CR1410 are not used).
	NP276459P23	Nameplate, plastic (CALL - used with S1401).
	19B226334P1	Pushbutton. (Used with S1401).
	19B226331P1	Actuator. (Used with S1401).
	19C321004P1	Lens. (Used with S1401).
	4036555P1	Insulator, washer: nylon. (Used with Q1402, Q1408).
	19A130013P1	Insulator. (Used with U1401).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

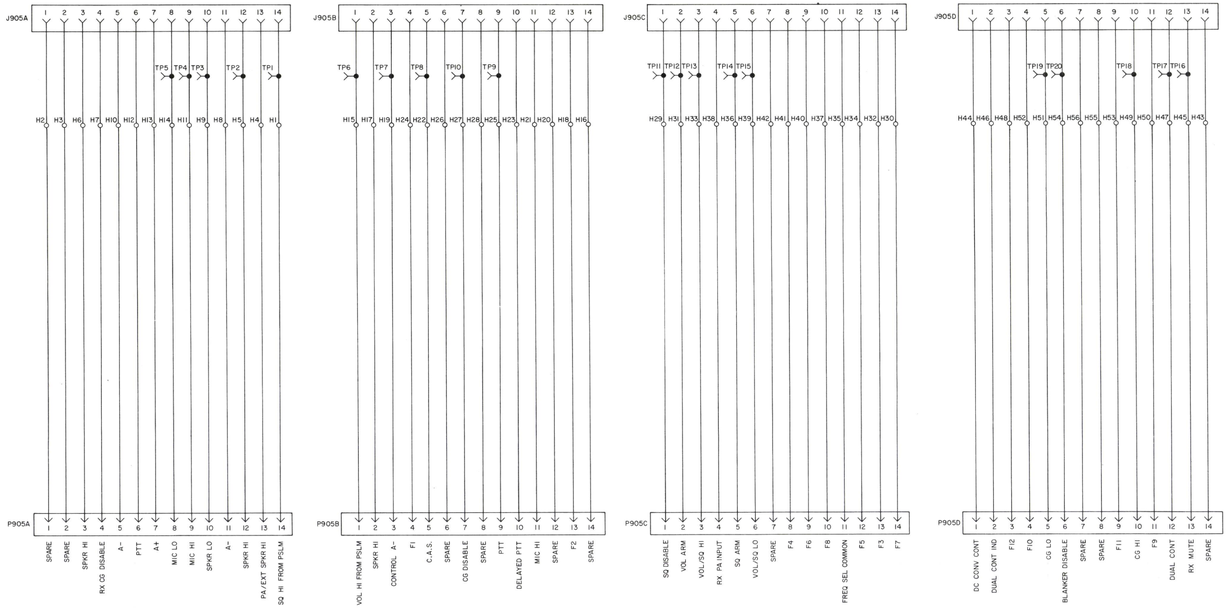
OUTLINE DIAGRAM



(19D424211, Rev. 0)
(19B226451, Sh. 2, Rev. 0)
(19B226451, Sh. 3, Rev. 0)



SCHEMATIC DIAGRAM



(19B622088, Rev. 1)

THIS ELEM DIAG APPLIES TO	
MODEL NO	REV LETTER
PL19D417773	

OUTLINE & SCHEMATIC DIAGRAM

OPTION MODULE EXTENDER BOARD

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

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.

DF-5048

MOBILE RADIO DEPARTMENT
GENERAL ELECTRIC COMPANY • LYNCHBURG, VIRGINIA 24502

GENERAL ELECTRIC

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