MOBILE RADIO

MAINTENANCE MANUAL

SOLID STATE TYPE 99 TONE DECODERS

Maintenance Manual LBI4867H
DATAFILE FOLDER - DF5046
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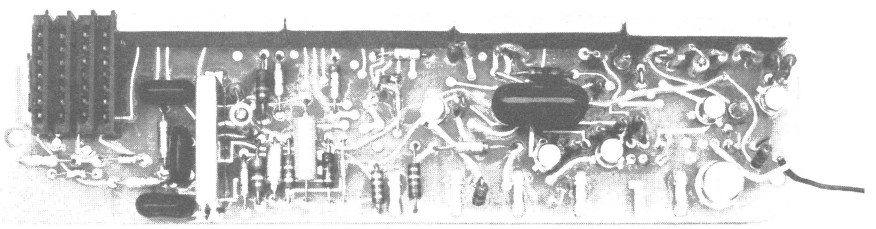

SPECIFICATIONS *

Tone Frequencies	288.5 Hz to 1433.4 Hz
Frequency Stability	±0.4%
Alert Tone	1150 ±200 Hz Interrupted Tone
Current Drain	≥500 Millivolts to Volume/Squelch Hi
Standby	50 Milliamperes Maximum
Decoded	50 Milliamperes Maximum
During Alert	75 Milliamperes Maximum
Temperature Range	-40°C to 70°C (-40°F to 158°F)
Voltage Requirements	13.8 ±20% VDC

TYPE 99 TONE DECODERS
19A129567G9, 11, 28

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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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

General Electric Type 99 Decoders are Solid State sequential tone decoders mounted on a single printed wiring board that plugs into the option board slot in the control unit. The decoder has a four call capability with Versatone networks responding to a maximum of four different tone codes. The decoders will operate with 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 Decoders operate on Type 99 tone frequencies from 288.5 to 1433.4 Hz. The chart below identifies the part number and functions provided by each option kit.

Type 99 Decoders may be provided as original equipment, factory installed or as an option kit to be installed in the field.

The component board, in addition to the Versatone networks, is comprised of discrete components and five integrated circuits (IC's). The number of tone networks used is dictated by the option employed i.e., two-tone or four-tone. The IC's consist of the following:

U1401 - Threshold Detector

U1402 - Frequency Switchable Selective Amplifier (FSSA)

U1403 - Control

U1404 - Four-Tone Search

U1405 - Interface Control

FL1401 thru FL1404 - Versatone Networks

The option kits contain the following components. See Figure 1.

Control Unit Kit 19A129567G9

Type 99 Decoder Component Board 19C320645G1

Option Indicator (LED) 19B219800G2

Indicator Retainer Clip 19A116807P1

Cable 19A129932G3

External Relay Mod Kit 19A129567G11

Control Unit Nameplate NP270753P8

Option Switch with mounting hardware 19A129831G1

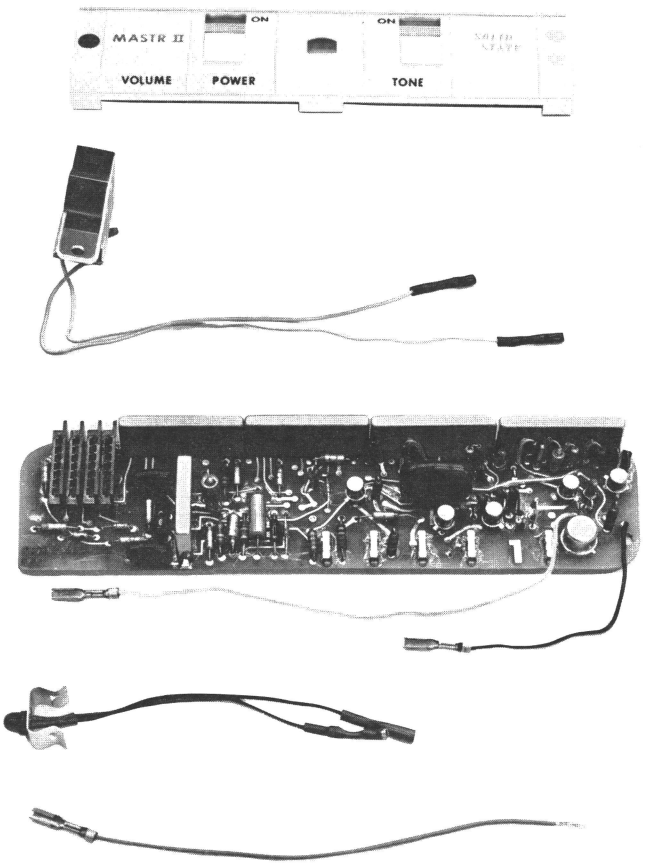

Figure 1 - Option Kit 19A129567G9/G11/28

Part No.	Functions	External Alarm
19A129567G9	Individual Call; two tones	No
19A129567G9	Group/supergroup call, four tones	No
19A129567G9*, 11*	Individual call; two tone	Yes
19A129567G9*, 11*	Group/supergroup call, four tone	Yes
*Includes External Relay Kit 19B226025G1		

OPERATION

MONITOR/RESET

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 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.

EXTERNAL RELAY (optional)

The external relay option activates a horn or light circuit to indicate receipt of a properly tone coded call. Operation is controlled by the OPTION switch on the control unit. When the OPTION switch is in the ON position, the external horn or light will operate when a properly tone coded call is received. When in the "off" position, the external circuit is inactive.

CIRCUIT ANALYSIS

FOUR-TONE OPERATION

In 4-Tone Decoders the Control IC controls the resistor OR gates in the 4-Tone Search IC that select the Versatone networks. 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: 1, 2 & 3, 4 to complete the search of all four possible tone combinations. Tone combinations decoded are: A1-B1, A1-B2, A2-B2 & A2-B1. With 4-tone operation, the jumper wire between H35 & H36 is omitted.

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

The 2nd tone switch in the Control IC provides +5.0 V to "B" tone resistor OR gates 2 and 4 in the 4-Tone Search IC via pin 14. Since a +5 V on either input of the resistor OR gates 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 "A" tone resistor OR gates 1 and 3 in the 4-Tone Search IC via pin 10. Thus, when the free running FF alternately applies A- to OR gate pairs 1,2 and 3,4 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 tone frequency.

The input tone (taken from the Volume/Squelch Hi) is applied to the Threshold Detector IC. The tone 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 4.7 V to pin 5 of the 4-Tone Search IC. This turns on the FF lock and stops the free running FF. This voltage is also applied to the 2nd tone search timer, the 1st tone clamp and the "B" input of the decode gate in the Control IC. The 4.7 V sets the 2nd tone search timer; however, the 1st tone clamp prevents it from starting its 1.5 second run until the "A" tone ends.

The decode gate requires A- on the "A" input and a positive voltage on the "B" input before it will provide a timed output. When the decode gate receives a positive input voltage on the "B" input from the first tone, it is still disabled by 5.0 V on the "A" input from the 2nd 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 the "A" input of the decode gate in the Control IC. The input 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 FF lock unlatches and starts the free running FF again but now the free running FF alternately supplies A- to resistor OR gates 2 and 4 which enable tone networks B1 and B2. Circuit operation is the same as that described above for "A" tone selection.

When a proper second 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 and stops the free running FF.

This voltage is also applied to the "B" input of the decode gate in the Control IC. If the "B" tone occurs within 1.5 seconds of the "A" tone, the "A" input of the decode gate remains at A- due to the 2nd tone switch. A- applied to the "A" input and the positive voltage at "B" 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 decode gate turns on the decode latched gate and the alert tone mute gate to provide 5.2 V at pin 11 and 2.8 V at pin 12 of the Control IC. Either of these outputs may be used (via holes H19, H20, and H21) to operate the external option relay K1701. The output of the decode latched gate also is applied to the Interface IC via pin 12 and turns on the control unit indicator and turns off the receiver mute switches. A- is supplied by indicator driver switch Q5 in the Interface IC to the option light, turning it on. The receiver mute switch removes A- from pin 14 of the Interface IC to allow the receiver to return to noise squelch operation.

The timed output of the Control IC turns on the alert tone oscillator which in turn provides an 1150 Hz tone to the tone amplifier in the Interface IC via pins 15 and 2 respectively. A free running FF within 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 buffered and applied to the audio circuits via Volume/Squelch Hi out at P1412

TWO-TONE OPERATION

Two-tone operation uses two Versatone networks and limits the number of tone paths to one, A1-B1.

Except for a different jumper arrangement that alters the operation of the 4-Tone Search IC, operation of the 2-Tone Decoder is identical to the 4-Tone Decoder described above. In 2-tone operation a DA jumper wire is present between H35 and H36 and locks the free running FF. With the free running FF locked, OR gates 1 and 2 are continuously enabled; thus, the 1st tone switch in the Control IC selects only the A1 Versatone via OR gate 1 and the 2nd tone switch selects only the B1 Versatone via OR gate 2. 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 2 thru 7. 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 2, 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.

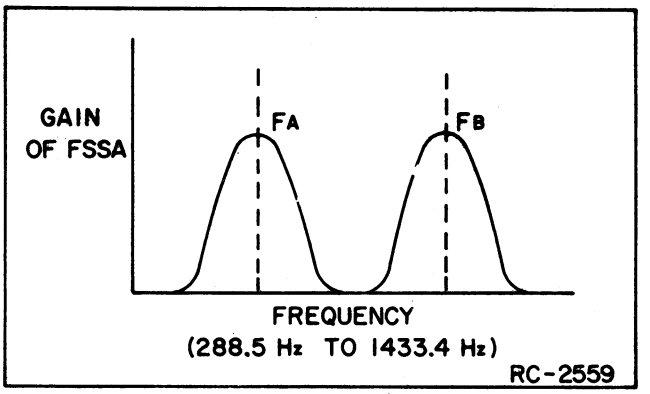

Figure 2 - Gain vs Frequency

TONE NETWORKS

Versatone networks FL1401 through FL1404 are parallel connected, precision resistors. A typical Versatone network is shown in Figure 3. 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.

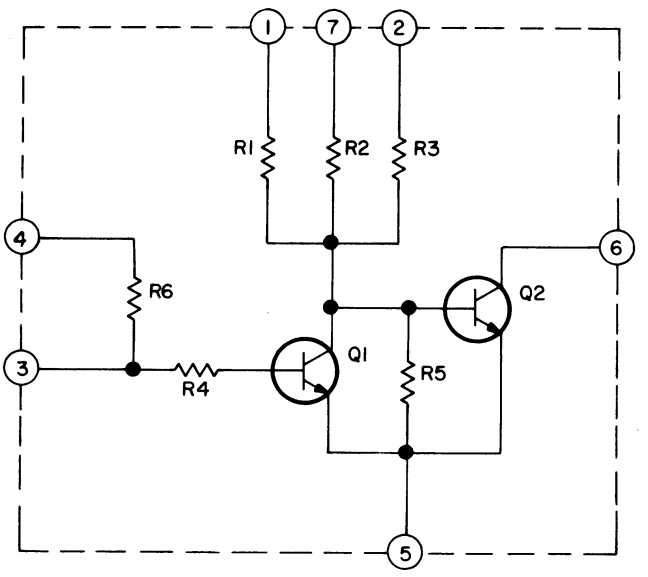

Figure 3 - Typical Versatone Network

THRESHOLD DETECTOR

Initially, the 4-Tone Search IC is searching 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 4.

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.

FOUR-TONE SEARCH IC

The 4-Tone Search IC alternately switches Versatone Networks, FL1401 and FL1402 or FL1402 and FL1404, into the FSSA circuit. A typical 4-Tone Search IC is shown in Figure 5. 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 selects the individual tone network.

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 and 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 the Control IC time to react.

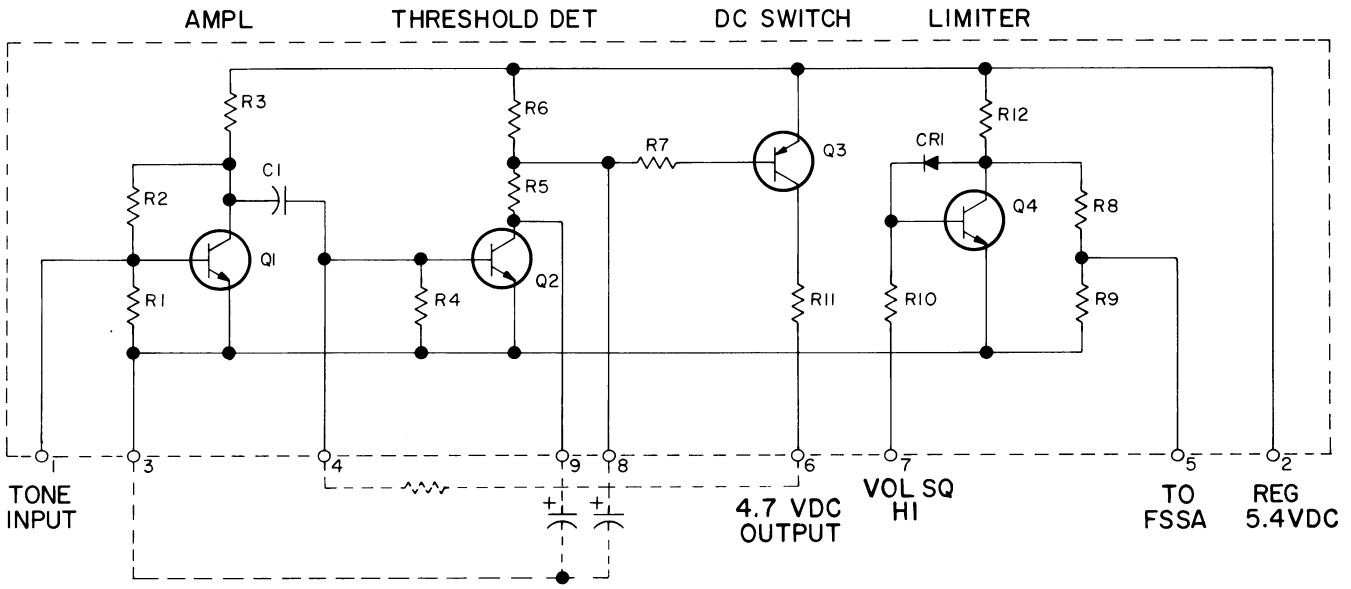

Figure 4 - Typical Threshold Detector Circuit

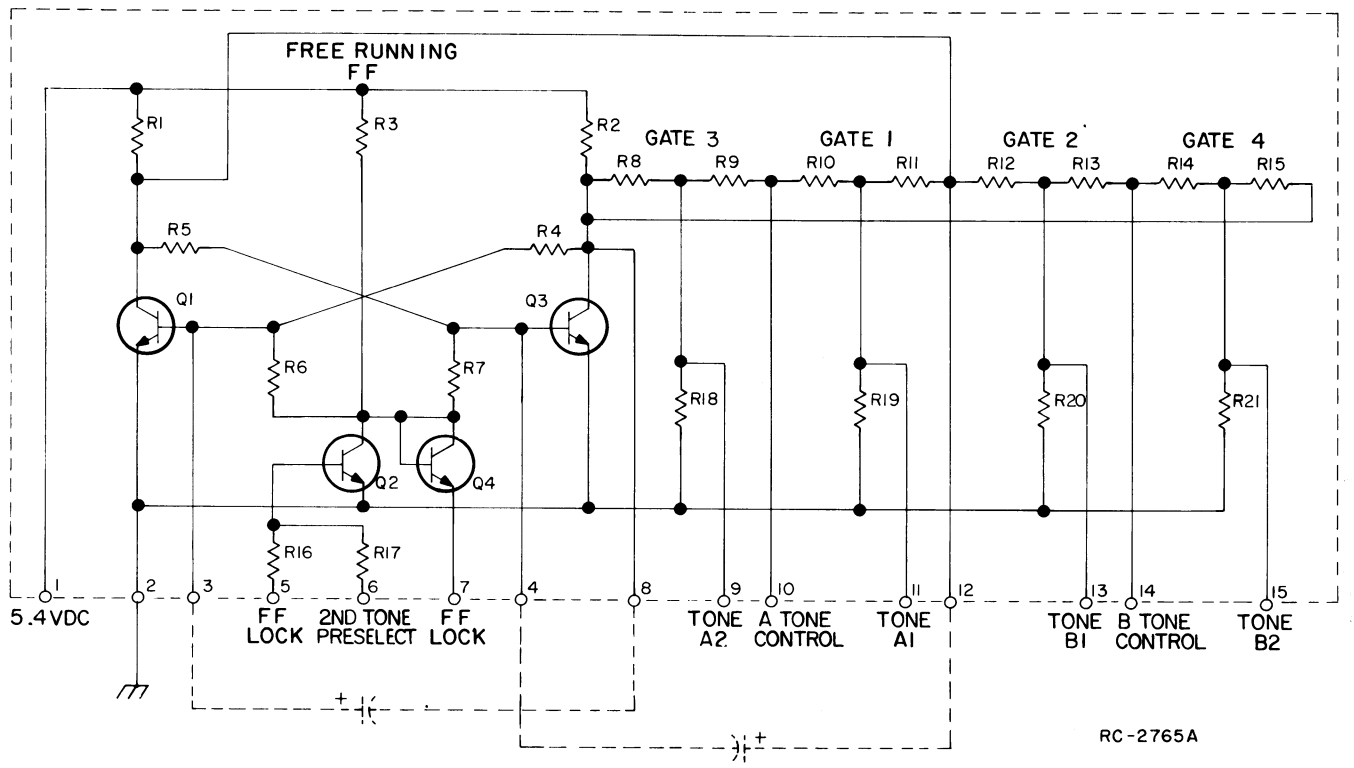

Figure 5 - Typical 4-Tone Search IC

CONTROL IC

The 4.7 V from the Threshold Detector (applied to pin 2 when a lst tone is received) causes lst 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 6. When the 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 lst tone switch transistor Q4 off causing the 4-Tone Search IC to stop searching for an "A" tone. Q4 also turns 2nd tone clamp transistor Q1 on. Turning Q1 on holds lst 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, 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 during receipt of a "B" tone.

Q5 also causes decode latch transistors Q6 and Q7 to conduct, and provide a latched decode output to the external relay option circuit and to the Interface IC.

When the second tone ends, the alert tone will stop, the clock in the 4-Tone Search IC will start and the timing circuit in the Control IC will reset the decoder to receive a first tone.

The receiver will remain on noise squelch operation until decode latch transistors Q6 and Q7 are reset.

INTERFACE IC

The Interface IC (Figure 7) keeps the receiver muted by grounding the receiver mute lead through P1434 until the proper sequential tones are received, provides a ground return for the LED and chops the alert tone received from the Control IC.

When the proper sequential tones are received pin 12 goes high causing receiver mute switch Q6 to turn on and Q7 to turn off. This removes ground from the receiver mute lead and allows the receiver to respond to incoming calls. Q5 also conducts at this time to complete the ground return for the LED indicator.

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

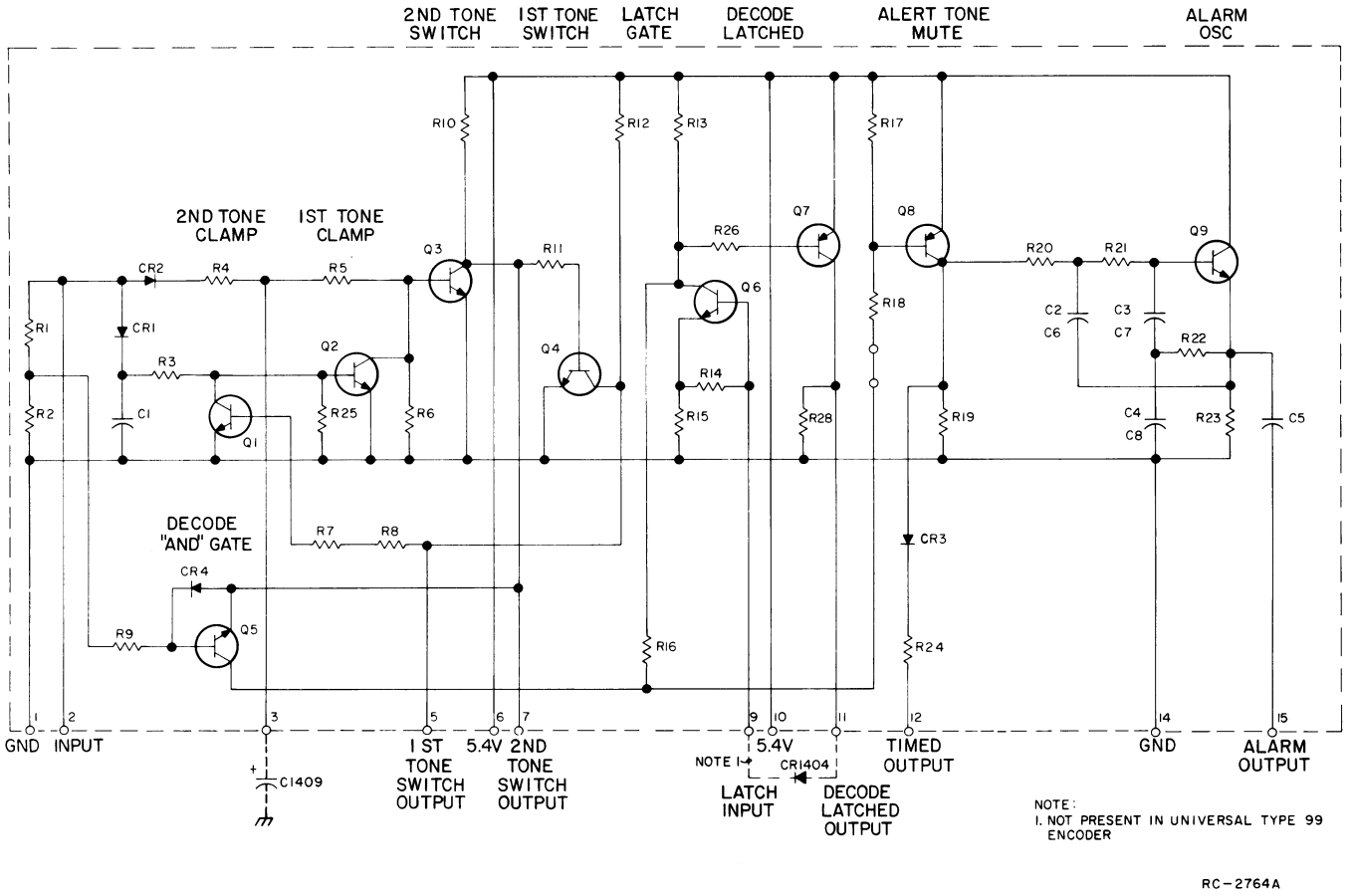

Figure 6 - Typical Control Circuit

the receiver. Normally, Q8 is conducting 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 tone switch Q1403. When the proper sequential tones have been decoded 2.8 V from the alert tone mute turns on the alert tone oscillator and Q1405. Q1405 turns mute switch Q1404 off which then removes the clamp from the base of buffer Q1403, allowing the alert tone to appear at the Volume/Squelch Hi out pin P1412. During this time, switching diode CR1403 is reversed biased (via A+ through Q1403) blocking the discriminator/FM 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 buffer Q1403 off allowing normal audio to pass through switching diode CR1403 to the audio circuits. 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 on and the alert tone (1150 Hz tone bursts) sounds. Should a valid Type 99 tone be received simultaneously with an incorrect channel guard tone the option light will turn on 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.

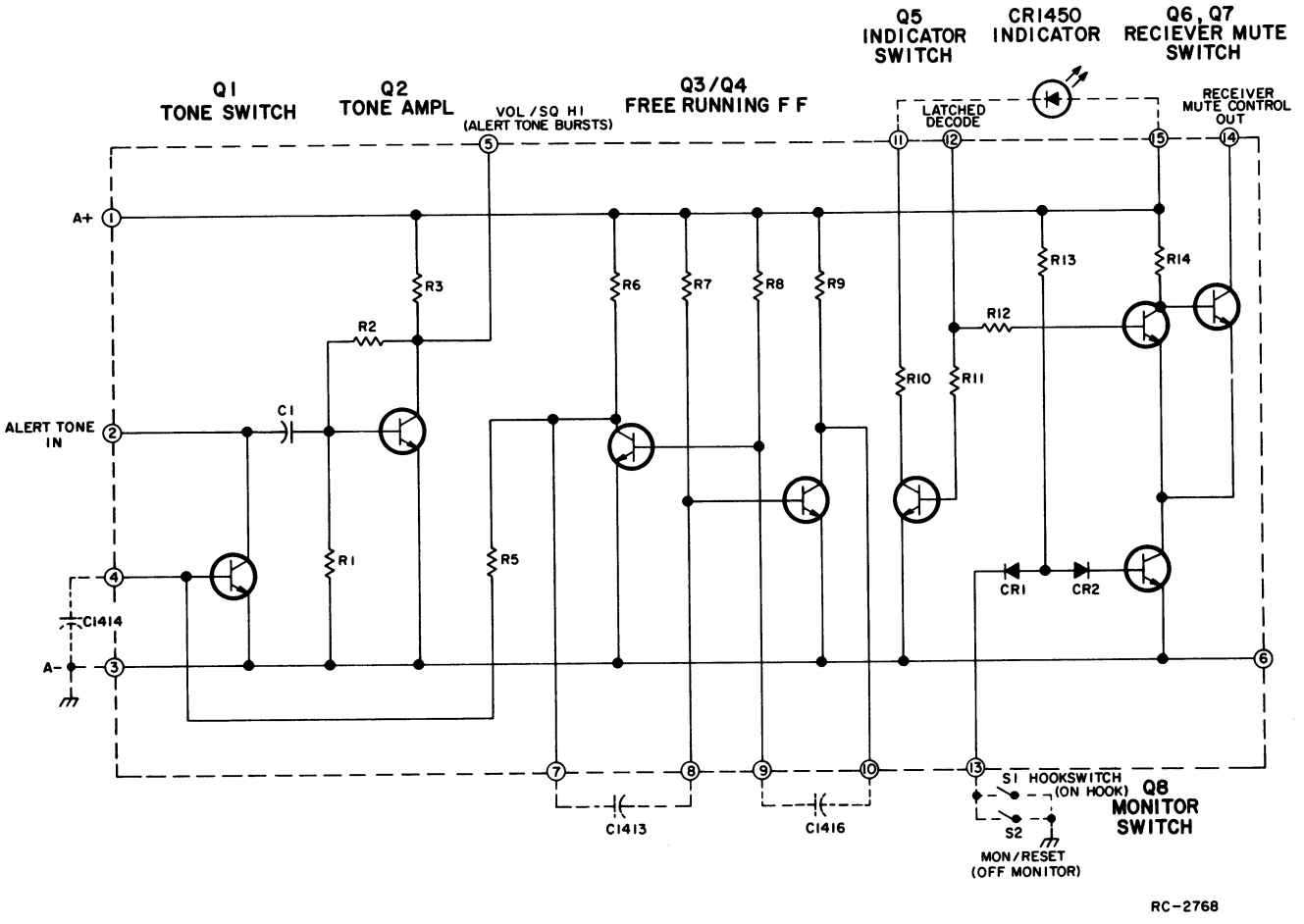

Figure 7 - Interface IC, Typical

In the OR configuration, receipt of either a valid channel guard tone or Type 99 sequential tones 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 a diode and appropriate strapping. Refer to the Installation section for proper connection data.

Type 99 Decode AND Channel Guard

When operating with Type 99 Decoders AND Channel Guard, the receiver mute switch at pin 14 of the Interface IC is connected directly to the receiver mute line via a strap from H29-H31 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 T99 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 operating with Type 99 Decoders OR Channel Guard an inverter is inserted in the circuit between the receiver mute output at pin 14 of the Interface IC and the Channel Guard disable input at J702-12 on the control unit.

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 J702-12 to disable Channel Guard and allow 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 H12 and H13, and adding a jumper between H11 and H12. 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.

EXTERNAL RELAY (OPTIONS 1014 AND 1015)

The external relay option permits timed or latched operation of an externally connected horn or light. Maximum allowable current through the relay contacts is 15 amperes.

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.

Selection of timed or latched operation is determined by strapping on the decoder component board.

FIELD INSTALLATION

The following instructions can be used to install the Type 99 board in a multi-frequency control unit that is not equipped with any other option boards.

Control Unit Models:
19A129576G1 (Common Kit)
19A129578G1 (1-thru 8-Freq. Kit)
19A129578G2 (1-thru 12-Freq. Kit)

Installation of the Type 99 Option Kit in this model requires that the control unit printed wiring board (PWB) be removed from the control unit. This is necessary in order to cut the applicable points on the control unit PWB. Proceed as follows:

PROCEDURE

1. Remove the PWB from the control unit and cut the printed wire run on solder side at point G. Refer to the Control Unit Maintenance Manual to locate run "G".

2. Reinstall the board assembly in the control unit, but do not replace the top cover at this time.

3. Install the blue wire interconnecting the Monitor/Reset line by soldering one end to H4 on the control unit PWB and connecting the other end to J1403 on the Type 99 Decode board.

4. Position the Type 99 Decoder board in the guide slots (shown on Service Outline) of the control unit. Gently insert the board assembly into the control unit, making sure that the connectors on the board assembly mate correctly with the square pins of the control unit PWB.

5. (Options 1014 and 1015 only) Mount the option switch (S1701) in the space provided in the control unit. Orient the switch as shown on the Outline Diagram. Secure the switch to the control mounting bracket with the 4-40 x 1/4 inch Phillips head POZIDRIV® tap screw provided. Secure the other end of the switch to the control unit housing with the 4-40 1/4 inch Phillips head tap screw provided.

6. Position the LED (CR1450) in the rear indicator slot of the control unit housing and secure in place with the spring clip provided.

7. (Options 1014 and 1015 only) Make LED and switch connections as indicated on the Outline Diagram.

8. Verify correct option number to be installed and make appropriate connections indicated in connection chart on Service Outline.

9. (Options 1014 and 1015 only) Remove the existing nameplate from the control unit top cover and install new nameplate (NP270753P8) as follows:

   a. Viewing the control unit from the front, note that there are only three of the plastic nameplate tabs which lock in place. These are the top left hand tab, the top right hand tab and the bottom center tab. The remaining tabs function only as guide tabs.

b. Release the locking action of the tabs, starting with the top right hand tab, then the top left hand tab. Apply pressure with fingers or use a small flat blade screwdriver to release tabs. Push released tabs up through slots to prevent relocking of tabs.

c. Release the locking action of the bottom center tab and pry the nameplate loose from the top cover. The old nameplate is not used.

d. Install the new nameplate.

10. Replace the control unit top cover and secure in position with the two screws previously removed.

Control Unit Models:
19D423590G3, 4 & 5

Installation of the Type 99 Option Kit in this control unit model requires the following:

1. Remove the two screws on the bottom of the front edge of the control unit and lift off the top cover.

2. On the control unit printed wire board cut DA jumper H68 and H69 and jumper "G" (H53 to H54). Refer to the control unit Maintenance Manual for the location of jumper.

3. Install the blue wire interconnecting the Monitor/Reset line by soldering one end to H80 on the control unit PWB and connecting the other end to J1403 on the Type 99 Decode board.

4. Position the Type 99 Decoder board in the guide slots (shown on Service Outline) of the control unit. Gently insert the board assembly into the control unit, making sure that the connectors on the board assembly mate correctly with the square pins of the control unit PWB.

5. (Options 1014 and 1015 only) Mount the option switch (S1701) in the space provided in the control unit. Orient the switch as shown on the Outline Diagram. Secure the switch to the control mounting bracket with the 4-40 x 1/4 inch Phillips head POZIDRIV® tap screw provided. Secure the other end of the switch to the control unit housing with the 4-40 1/4 inch Phillips head tap screw provided.

6. Position the LED (CR1450) in the rear indicator slot of the control unit housing and secure in place with the spring clip provided.

7. (Options 1014 and 1015 only) Make LED and switch connections as indicated on the Outline Diagram.

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   b. Release the locking action of the tabs, starting with the top right hand tab, then the top left hand tab. Apply pressure with fingers or use a small flat blade screwdriver to release tabs. Push released tabs up through slots to prevent relocking of tabs.

   c. Release the locking action of the bottom center tab and pry the nameplate loose from the top cover. The old nameplate is not used.

   d. Install the new nameplate.

10. Replace the control unit top cover and secure in position with the two screws previously removed.

NOTE

In radios equipped with Channel Guard move wire on handset or microphone hookswitch from J701-10 to J701-8. This is required to electrically insert MON/RESET switch in circuit.

External Relay Kit 19B226025G1

Refer to Outline Diagram and Systems Board manual to locate and identify connecting points.

1. Install relay in desired locations using self tapping screws.

2. Connect yellow lead from lug 4 of relay to vehicle systems plug P701-19 located on rear of control unit. Insert the contact on lead, flat side down, in hole 19 until it locks.

3. Cut red fused lead so that fuse assembly is close to voltage source. Attach the solderless terminal to the end of red fused lead to be connected to relay. Using 8-32 x 5/16 hardware connect the terminal to lug 3 of the relay.

4. Connect the other end of fused lead to voltage source.

5. Connect external alarm (horn, light, etc.) to lugs 1 and 2 of relay.

MAINTENANCE

A Troubleshooting Diagram (Figure 7) and associated procedures contain typical voltage data taken at selected points on the Decoder board to expedite maintenance.

An Extender board (19C320588G1) is available for use with the Decoder and can be inserted directly into the control unit to facilitate troubleshooting.

REMOVING INTEGRATED CIRCUITS

Removing IC's (and all other soldered in components) can be easily accomplished by using a de-soldering tool such as the SOLDA-PULLT® or equivalent. To remove an IC, heat each lead separately on the solder side with the de-soldering tool.

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

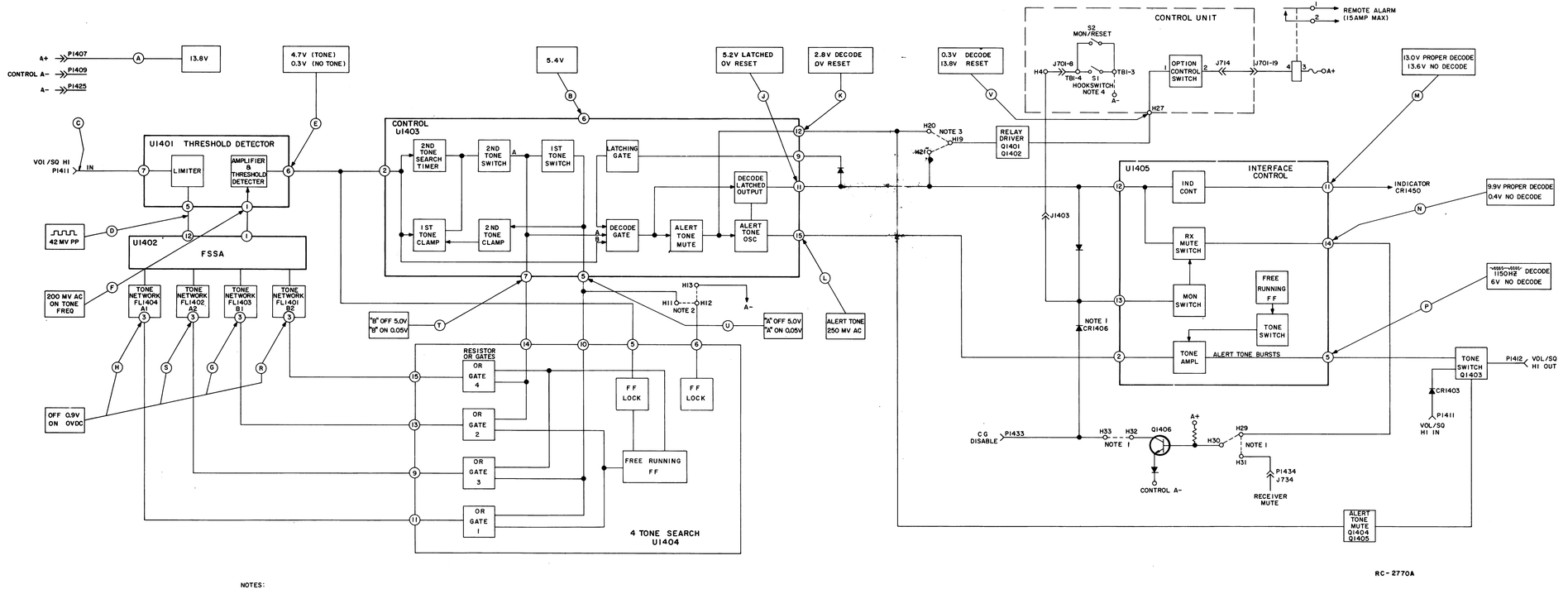
	Flip	Flop	Tone	A	Tone	Tone	B	Tone
	Q1 C	Q2 C	A2	Control	A1	B1	Control	B2
No Tone In	0	1	1	0	0	1	+5.0 V	1
(Searching)	1	0	0	0	1	1	+5.0 V	1
	0	1	1	0	0	1	+5.0 V	1
	1	0	0	0	1	1	+5.0 V	1
Stopped (Tone A1 Present)	0	1	1	0	0	1	+5.0 V	1
Searching	0	1	1	+5.0 V	1	0	0	1
(No B Tone)	1	0	1	+5.0 V	1	1	0	0
	0	1	1	+5.0 V	1	0	0	1
Stopped (Tone B1 Present)	0	1	1	+5.0 V	1	0	0	1

Figure 8 - Four Tone Search IC Troubleshooting Chart

GENERAL ELECTRIC COMPANY • MOBILE COMMUNICATIONS DIVISION
WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

GENERAL ELECTRIC* U.S.A.

SYMPTOM	STEP	TEST POINT	ACTION
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. Tone networks may be checked by substitution.
	2	(A)	Check for +13.8 V (battery) between P1407 (A) and P1409.
	3	(B)	Check for +5.4 V (B) .
	4	(D)	Apply correct Type 99 tone to P1411 (C) at a level sufficient to cause limiting at (D) . Approximately 100 mV.
	5	(E)	Check for 4.7 V.
	6	(F)	If (E) is incorrect check for 200 mV AC.
	7	(G)(H)	If FSSA appears to be defective, before replacing check: 1) XFL1401 for proper contact. 2) Versatone switching voltages at (G) and (H) . 3) Replace FL1401 (may be interchanged with FL1402).
	8	(E)	If the switching voltages at (F) and (G) are incorrect, connect pin 3 of FL1401 to ground. Remove FL1402. Repeat step 5.
	9	(H)(S)	Remove ground connection from U1404-4. With no tone applied, monitor switching voltages at (H) and (S) . If FF is not switching check: 1) Timing capacitors C1410 and C1411. 2) Replace U1404.
	10	(G)(H)	If 4.7 V is present at (E) , monitor the switching voltages at (G) and (H) with no tone and then a continuous "A" tone. Remove tone and verify that voltages at (G) and (H) reverse for approximately 1.5 seconds. If this sequence is correct proceed to step 11. If the switching voltages are incorrect, check: 1) XFL1402 and replace FL1402. 2) 4.7 V across C1409 during the "A" tone. If no voltage replace C1409. If still no voltage replace U1403. 3) Check for shorts on U1403. 4) Replace U1403.
	11	(F)	If the response at (E) is correct, a decode indication (0.05 V) 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 light, replace CR1450. Verify proper strapping at H29, H30 and H31.
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	(K)(J)(V)	Check line fuse between battery and external relay. Verify proper strapping at H19, H20 and H21. Recheck indications at (J) and (K) . Verify indications at (V) . If battery voltage is present, replace relay drivers Q1401 and Q1402 as required. If A- (0.5 or less) is present check option control switch and relay K1.

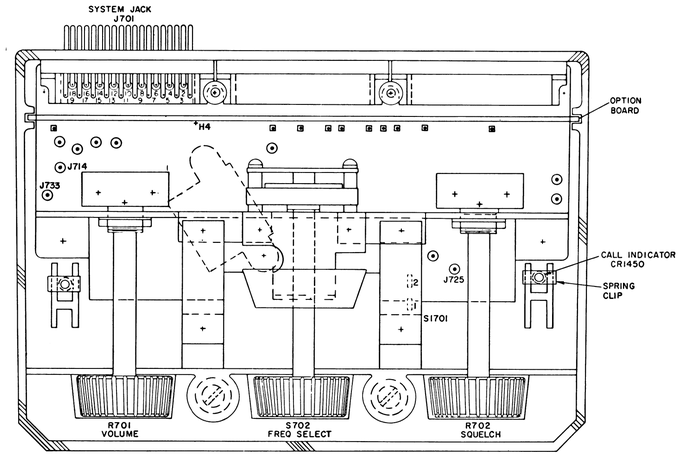


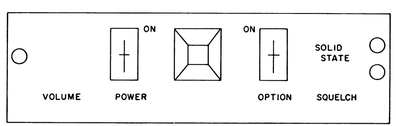
NOTES:
1. FOR TYPE 99 OR CHANNEL GUARD OPERATION, CR1406 IS REMOVED AND A JUMPER WIRE IS PRESENT BETWEEN H29-H30 AND H32-H33. FOR TYPE 99 AND CHANNEL GUARD OPERATION OR T99 ONLY, A JUMPER WIRE IS PRESENT BETWEEN H29-H31.
2. FOR PRESELECTION OF THE 2ND TONE, A JUMPER WIRE IS CONNECTED BETWEEN H12-H11.
3. FOR TIMED RELAY DRIVER OPERATION, A JUMPER WIRE IS CONNECTED BETWEEN H19-H20. FOR LATCHED RELAY DRIVER OPERATION, A JUMPER WIRE IS CONNECTED BETWEEN H19-H21.
4. S1 SHOWN ON HOOK, S2 ON RESET.

TROUBLESHOOTING PROCEDURE

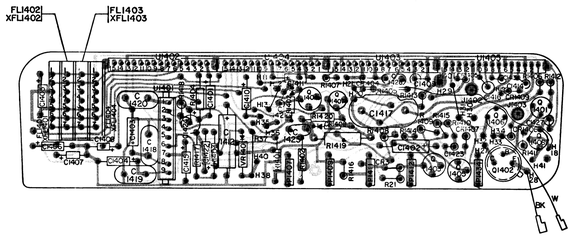
TYPE 99 TONE DECODER

CONTROL UNIT TOP VIEW





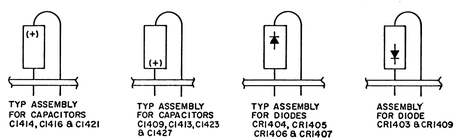
TYPE 99 TONE OPTION BOARD



LEAD IDENTIFICATION FOR Q1401-Q1406

VIEW FROM CASE END

NOTE LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION. TAB INDICATES EMITTER LEAD.

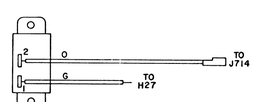


TYP ASSEMBLY FOR CAPACITORS C1414, C1416 & C1421

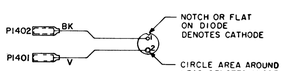
TYP ASSEMBLY FOR CAPACITORS C1409, C1413, C1423 & C1427

TYP ASSEMBLY FOR DIODES CR1404, CR1405 CR1406 & CR1407

ASSEMBLY FOR DIODE CR1403 & CR1409

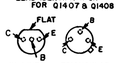


S1701 TERMINAL VIEW
(USED WITH OPTIONS 1014 & 1015)



LED CONNECTIONS FOR CALL INDICATOR CR1450

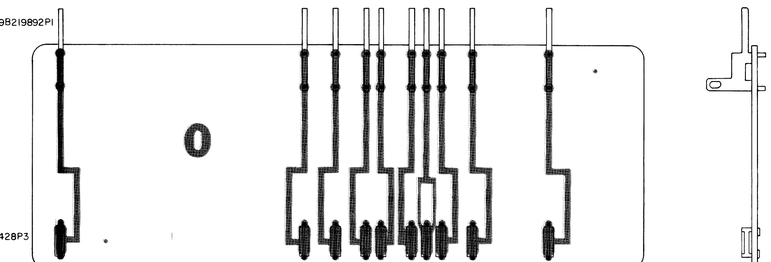
LEAD IDENTIFICATION FOR Q1407 & Q1408



TOP VIEW

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

MASTR II CONTROL UNIT EXTENDER BOARD 19C320588G1



NOTES:
1. REFER TO CONTROL UNIT MANUAL AND CUT PRINTED WIRE RUN "G" ON CONTROL UNIT PWB.

(19C321356, Rev. 0)
(19C320590, Sh. 2, Rev. 0)
(19C320590, Sh. 3, Rev. 0)

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

NAMEPLATE
(USED WITH OPTIONS 1014 & 1015)

OPTION-1012

CONNECTIONS FOR INDIVIDUAL CALL (2 TONE) WITHOUT EXTERNAL DECODER ALARM		
FROM	TO	WIRE
CR1450-1	J1402	BK
CR1450-2	J1401	V
PL19C320645G1 DECODER BD H28	J725	SF22-BK
PL19C320645G1 DECODER BD H34	J733	SF22-W
CONTROL UNIT BD 19D416737G3 H4 thru H80 19D423588G3-5	PL19C320645G1 DECODER BD J1403	WIRE ASM PL19A129932G3
PL19C320645G1 DECODER BD H35	PL19C320645G1 DECODER BD H36	DA

OPTION-1013

CONNECTIONS FOR GROUP CALL (4 TONE) WITHOUT EXTERNAL DECODER ALARM		
FROM	TO	WIRE
CR1450-1	J1402	BK
CR1450-2	J1401	V
PL19C320645G1 DECODER BD H28	J725	SF22-BK
PL19C320645G1 DECODER BD H34	J733	SF22-W
CONTROL UNIT BD 19D416737G3 H4 thru H80 19D423588G3-5	PL19C320645G1 DECODER BD J1403	WIRE ASM PL19A129932G3

OPTION-1014

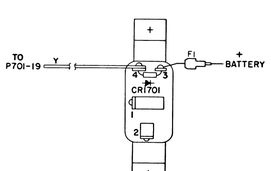
CONNECTIONS FOR INDIVIDUAL CALL (2 TONE) WITH EXTERNAL DECODER ALARM		
FROM	TO	WIRE
CR1450-1	J1402	BK
CR1450-2	J1401	V
S1701-1	PL19C320645G1 DECODER BD H27	G
S1701-2	J714	O
PL19C320645G1 DECODER BD H28	J725	SF22-BK
PL19C320645G1 DECODER BD H34	J733	SF22-W
CONTROL UNIT BD 19D416737G3 H4 thru H80 19D423588G3-5	PL19C320645G1 DECODER BD J1403	WIRE ASM PL19A129932G3
PL19C320645G1 DECODER BD H35	PL19C320645G1 DECODER BD H36	DA

OPTION-1015

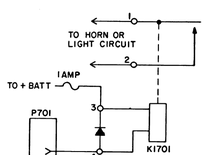
CONNECTIONS FOR GROUP CALL (4 TONE) WITH EXTERNAL DECODER ALARM		
FROM	TO	WIRE
CR1450-1	J1402	BK
CR1450-2	J1401	V
S1701-1	PL19C320645G1 DECODER BD H27	G
S1701-2	J714	O
PL19C320645G1 DECODER BD H28	J725	SF22-BK
PL19C320645G1 DECODER BD H34	J733	SF22-W
CONTROL UNIT BD 19D416737G3 H4 thru H80 19D423588G3-5	PL19C320645G1 DECODER BD J1403	WIRE ASM PL19A129932G3

(19B622207, Rev. 5)
(19C320641, Sh. 3, Rev. 6)
(19C320641, Sh. 3, Rev. 6)

EXTERNAL RELAY KIT



TERMINAL VIEW K1701



OUTLINE DIAGRAMS

TYPE 99 TONE DECODER AND CONTROL UNIT EXTENDER BOARD

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
PL19C320645G1	E

NOTES.

1. FOR TIMED RELAY DRIVER OPERATION A DA WIRE JUMPER IS PRESENT BETWEEN H18 AND H20.
2. FOR LATCHED RELAY DRIVER OPERATION A DA WIRE JUMPER IS PRESENT BETWEEN H19 AND H21, AND JUMPER BETWEEN H18 AND H20 IS REMOVED.
3. WHEN 2ND TONE IS PRESELECTED A DA JUMPER IS CONNECTED BETWEEN H11 AND H12.
4. WHEN 2ND TONE IS NOT PRESELECTED A DA JUMPER IS CONNECTED BETWEEN H12 AND H13.
5. FOR T99 AND CG OPERATION OR T99 OPERATION ONLY A DA JUMPER IS PRESENT BETWEEN H29 AND H31.
6. FOR T99 OR CG OPERATION, CR1406 IS REMOVED AND DA JUMPERS ARE PRESENT BETWEEN H32 AND H33 AND BETWEEN H29 AND H30.
7. FOR TWO FREQUENCY OPERATION, A DA WIRE JUMPER IS PRESENT BETWEEN H35 AND H36.
8. ■ DENOTES SQUARE POST
9. THIS WIRE GOES TO H80 IN 19D423590 CONTROL UNIT.

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.

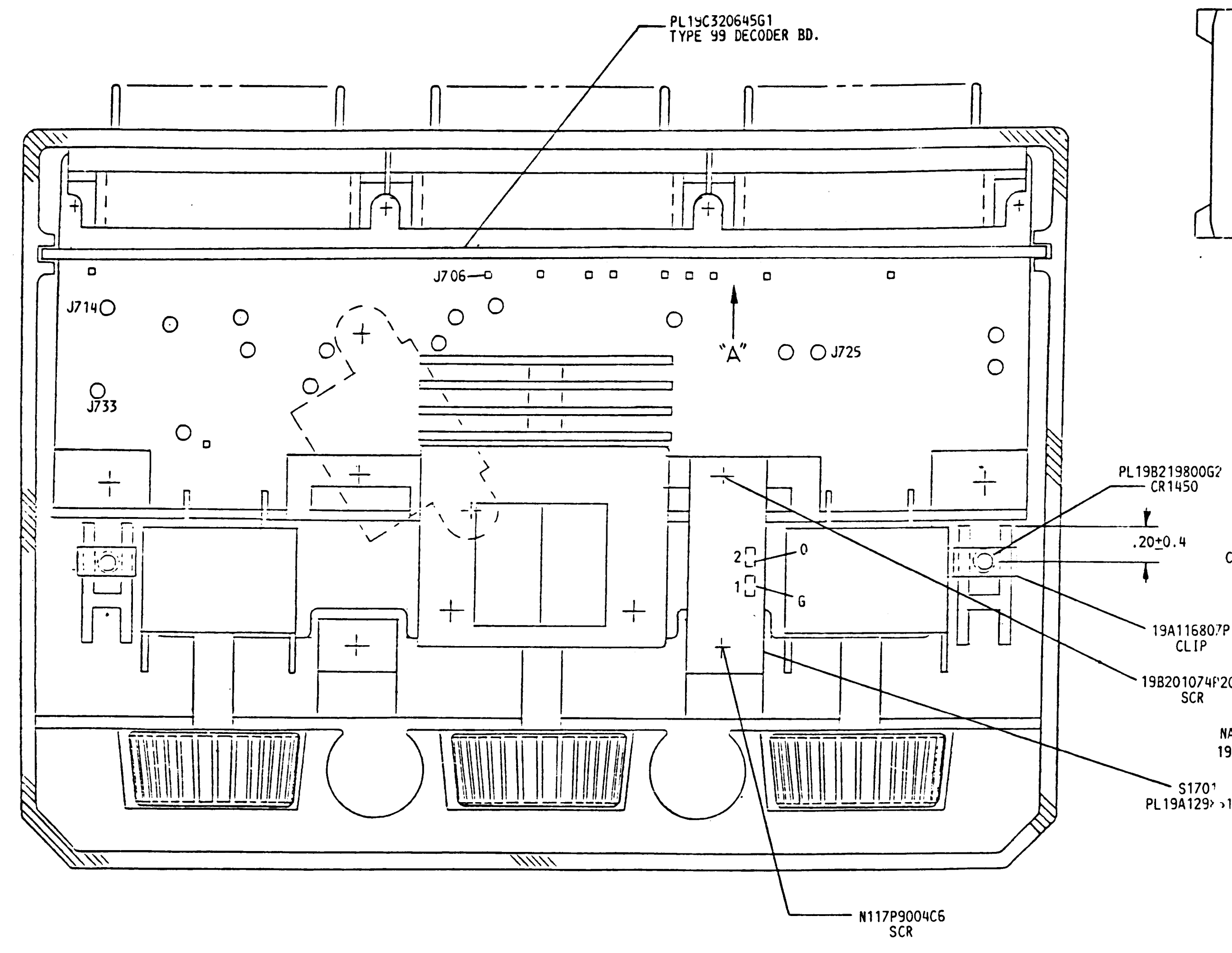
ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH=MILLIHENRYS OR H=HENRYS.

SCHEMATIC DIAGRAM

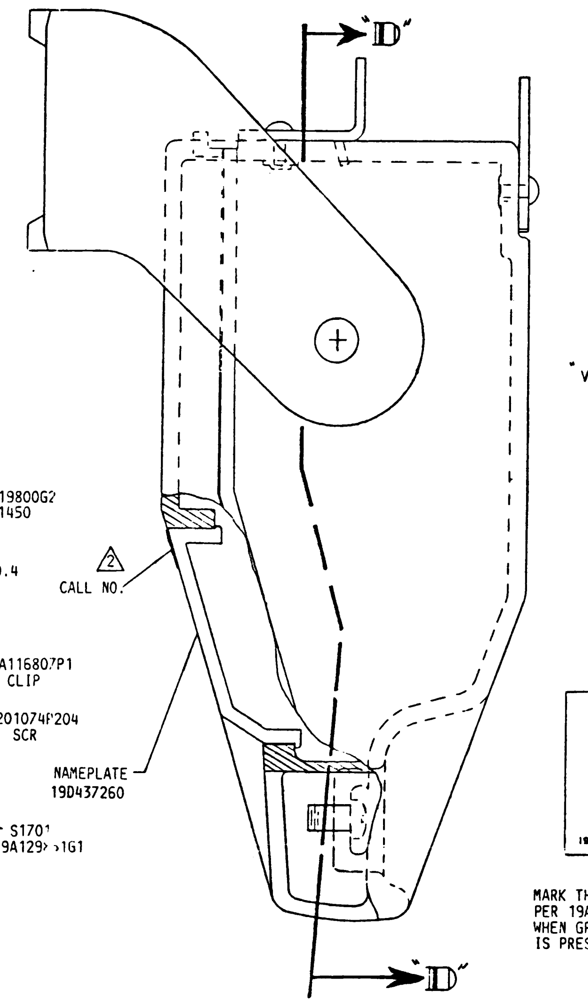
TYPE 99 TONE DECODER

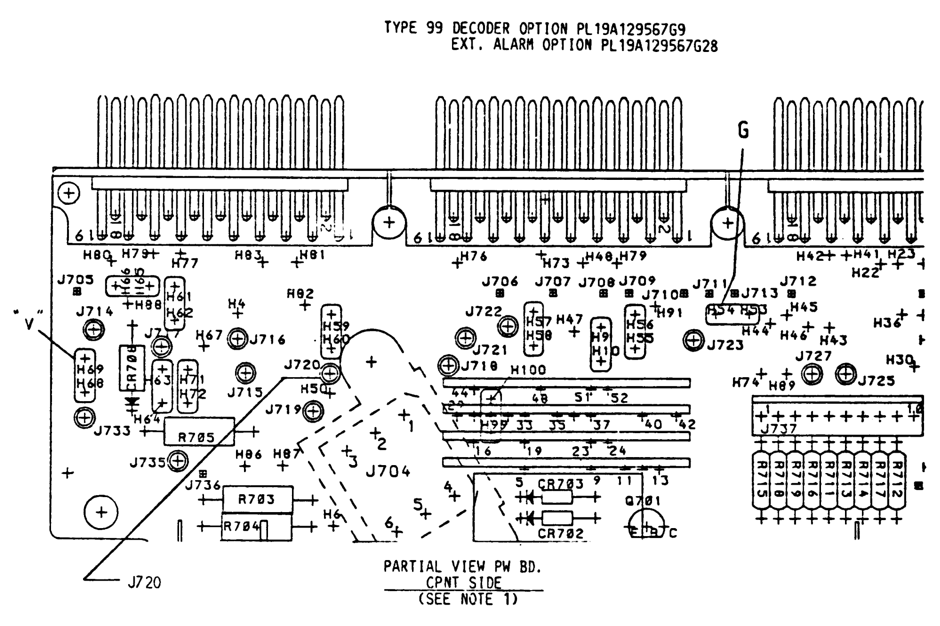
(19R622017, Rev. 9)

Issue 6



SECTION D - D



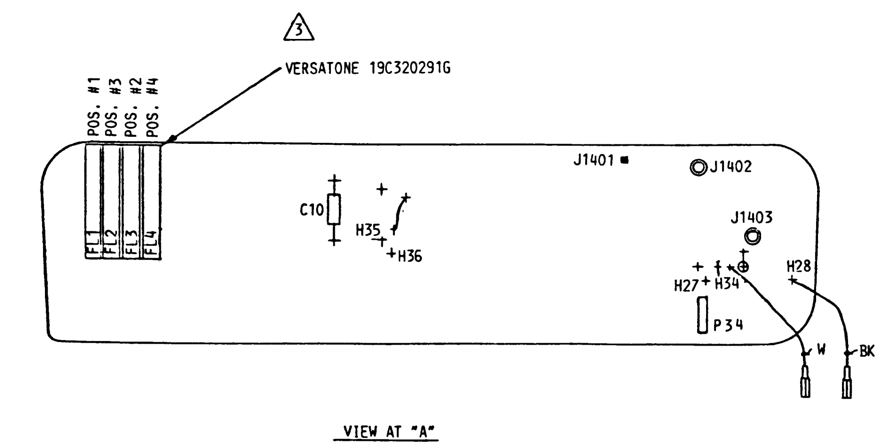


THIS UNIT CONTAINS THE FOLLOWING OPTION KITS:

MARK THIS SQUARE AS SHOWN PER 19A115740P1 WHEN GP. 9 OR GP. 28 IS PRESENT

NOTES:

1. ON PRINTED BOARD CUT JUMPER "G" - H53 & H54 AND JUMPER "V" -H68 & H69.
2. APPLY CALL NUMBER AS SHOWN BELOW USING NP243580.
3. PUT THE VERSATONE FREQUENCY ELEMENTS IN THE POSITIONS INDICATED ON THE "SELECTIVE CALLING SYSTEM REQUISITION WORK SHEET".
4. WHEN INSTALLING TYPE 99 DECODER OPTION. REMOVE THE NINTH AND THIRD SQUARE PIN J706 FROM RIGHT SIDE OF 19D433795 CPNT. BD. ALSO REMOVE J720



VIEW AT "A"

(12)

CONNECTIONS FOR INDIVIDUAL CALL (2 TONE) WITHOUT EXTERNAL DECODER ALARM		
FROM	TO	WIRE
CR1450-1	J1402	BK
CR1450-2	J1401	V
PL19C320645G1 DECODER BD H28	J725	SF22-BK
PL19C320645G1 DECODER BD H34	J733	SF22-W
CONTROL UNIT BD H69	J1403	WIRE ASM PL19A129932G3
PL19C320645G1 DECODER BD H35	PL19C320645G1 DECODER BD H36	DA

(13)

CONNECTIONS FOR GROUP CALL (4 TONE) WITHOUT EXTERNAL DECODER ALARM		
FROM	TO	WIRE
CR1450-1	J1402	BK
CR1450-2	J1401	V
PL19C320645G1 DECODER BD H28	J725	SF22-BK
PL19C320645G1 DECODER BD H34	J733	SF22-W
CONTROL UNIT BD H69	J1403	WIRE ASM PL19A129932G3

(14)

CONNECTIONS FOR INDIVIDUAL CALL (2 TONE) WITH EXTERNAL DECODER ALARM		
FROM	TO	WIRE
CR1450-1	J1402	BK
CR1450-2	J1401	Y
S1701-1	PL19C320645G1 DECODER BD H27	G
S1701-2	J714	O
PL19C320645G1 DECODER BD H28	J725	SF22-BK
PL19C320645G1 DECODER BD H34	J733	SF22-W
CONTROL UNIT BD H69	J1403	WIRE ASM PL19A129932G3
PL19C320645G1 DECODER BD H35	PL19C320645G1 DECODER BD H36	DA

(15)

CONNECTIONS FOR GROUP CALL (4 TONE) WITH EXTERNAL DECODER ALARM		
FROM	TO	WIRE
CR1450-1	J1402	BK
CR1450-2	J1401	V
S1701-1	PL19C320645G1 DECODER BD H27	G
S1701-2	J714	O
PL19C320645G1 DECODER BD H28	J725	SF22-BK
PL19C320645G1 DECODER BD H34	J733	SE22-W
CONTROL, UNIT BD H69	J1403	WIRE ASM PL19A129932G3

INSTALLATION DIAGRAM

TYPE 99 DECODER- DELTA-S

(19D437285, Sh. 8, Rev. 1)

PARTS LIST

LBI4868F

TYPE 99 DECODER
19A129567G9 TYPE 99 DECODER
19A129567G11 EXTERNAL RELAY MOD KIT

SYMBOL	GE PART NO.	DESCRIPTION
		COMPONENT BOARD 19C320645G1
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1401	5491674P43	Tantalum: 0.1 uf ±20%, 35 VDCW; sim. to Sprague Type 162D.
C1402	5496267P224	Tantalum: 0.1 uf ±10%, 35 VDCW, sim. to Sprague Type 150D.
C1403	5491674P37	Tantalum: 10 uF ±20%, 10 VDCW; sim to Sprague Type 162D.
C1404	5491674P27	Tantalum: 0.47 uF ±20%, 35 VDCW; sim to Sprague Type 162D.
C1405 and C1406	5491674P44	Tantalum: 2.2 uF ±20%, 15 VDCW; sim to Sprague Type 162D.
C1407 and C1408	5491674P1	Tantalum: 1 uF +40-20%, 10 VDCW; sim to Sprague Type 162D.
C1409	5491674P37	Tantalum: 10 uF ±20%, 10 VDCW; sim to Sprague Type 162D.
C1410 and C1411	5491674P45	Tantalum: 4.7 uF ±10%, 6 VDCW; sim to Sprague Type 162D.
C1412	5496267P10	Tantalum: 22 uF ±20%, 15 VDCW; sim to Sprague Type 150D.
C1413 and C1414	5491674P44	Tantalum: 2.2 uF ±20%, 15 VDCW; sim to Sprague Type 162D.
C1415	5491674P43	Tantalum: 0.1 uf ±20%, 35 VDCW; sim. to Sprague Type 162D.
C1416	5496267P213	Tantalum: 2.2 uF ±20%, 15 VDCW; sim to Sprague Type 150D.
C1417	19A116080P111	Polyester: 0.47 uF ±10%, 50 VDCW.
C1418 thru C1420	7489162P43	Silver mica: 470 pF ±5%, 500 VDCW; sim to Sprague Type 118.
C1421*	19B200240P15	Tantalum: 1.8 uF ±5%, 20 VDCW.
		Earlier than REV A:
	5491674P44	Tantalum: 2.2 uF ±20%, 15 VDCW; sim to Sprague Type 162D.
C1422	5496267P227	Tantalum: 0.33 uF ±10%, 35 VDCW; sim to Sprague Type 150D.
C1423	5491674P1	Tantalum: 1 uF +40-20%, 10 VDCW; sim to Sprague Type 162D.
C1424	5496267P10	Tantalum: 22 uF ±20%, 15 VDCW; sim to Sprague Type 150D.
C1425* and C1426*	19A116192P14	Ceramic: 0.1 uF ±20%, 50 VDCW; sim to Erie USCC CW20C104-M2. Added by REV B.
C1427*	5491674P39	Tantalum: 6.8 uF ±20%, 15 VDCW; sim to Sprague Type 162D. Added by REV C.
		- - - - - - - - DIODES AND RECTIFIERS - - - - - - - -
CR1402 thru CR1407	19A115250P1	Silicon, fast recovery, 225 mA, 50 PIV.
CR1408*	19A115250P1	Silicon, fast recovery, 225 mA, 50 PIV. Added by REV B.
CR1409*	19A115250P1	Silicon, fast recovery, 225 mA, 50 PIV. Added by REV C.
		- - - - - - - - JACKS AND RECEPTACLES - - - - - - - -
J1401	19A701785P1	Contact, electrical; sim to Molex 08-50-0404.
J1402 and J1403	4033513P4	Contact, electrical: sim to Bead Chain L93-3.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P1407	19A701883P3	Contact, electrical; sim to AMP 85487-3. (Strip Form).
P1409	19A701883P3	Contact, electrical; sim to AMP 85487-3. (Strip Form).
P1411 and P1412	19A701883P3	Contact, electrical; sim to AMP 85487-3. (Strip Form).
P1434	19A701883P3	Contact, electrical; sim to AMP 85487-3. (Strip Form).
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1401	19A116755P1	Silicon, NPN; sim to Type 2N3947.
Q1402	19A115300P2	Silicon, NPN; sim to Type 2N3053.
Q1403 thru Q1406	19A116755P1	Silicon, NPN; sim to Type 2N3947.
Q1407*	19A115910P1	Silicon, NPN; sim to Type 2N3904. Added by REV B.
Q1408*	19A702084P1	Silicon, NPN; sim to MPS 2369. Added by REV C.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R1401	19A700106P55	Composition: 470 ohms ±5%, 1/4 w.
R1402	19A700106P105	Composition: 56K ohms ±5%, 1/4 w.
R1403	3R152P185J	Composition: 1.8 megohms ±5%, 1/4 w.
R1404	3R152P203J	Composition: 20K ohms ±5%, 1/4 w.
R1405	19A700106P15	Composition: 10 ohms ±5%, 1/4 w.
R1406	19A700106P87	Composition: 10K ohms ±5%, 1/4 w.
R1407*	19A700106P79	Composition: 4.7K ohms ±5%, 1/4 w.
		In REV C & earlier:
	3R152P103J	Composition: 10K ohms ±5%, 1/4 w.
R1408	19A700106P87	Composition: 10K ohms ±5%, 1/4 w.
R1409	19A700106P111	Composition: 100K ohms ±5%, 1/4 w.
R1410	3R152P203J	Composition: 20K ohms ±5%, 1/4 w.
R1411	3R152P513J	Composition: 51K ohms ±5%, 1/4 w.
R1412	19A700106P63	Composition: 1K ohms ±5%, 1/4 w.
R1413	3R152P202J	Composition: 2K ohms ±5%, 1/4 w.
R1414	19A700106P39	Composition: 100 ohms ±5%, 1/4 w.
R1415	19A700106P91	Composition: 15K ohms ±5%, 1/4 w.
R1416	19A700106P87	Composition: 10K ohms ±5%, 1/4 w.
R1417	19A700106P111	Composition: 100K ohms ±5%, 1/4 w.
R1418	19A700106P32	Composition: 51 ohms ±5%, 1/4 w.
R1419*	3R77P106J	Composition: 10 megohms ±5%, 1/2 w. Added by REV B.
R1420*	19A700106P87	Composition: 10K ohms ±5%, 1/4 w. Added by REV B.
R1421*	19A700106P87	Composition: 10K ohms ±5%, 1/4 w. Added by REV E.
		- - - - - - - - INTEGRATED CIRCUITS - - - - - - - -
U1401	19C320539G1	Limiter Threshold Detector.
U1402	19D417092G1	Selective Amplifier.
U1403	19D417098G2	Control.
U1404	19D417132G1	4 Tone Search.
U1405	19D417373G2	Interface Control Hybrid.
		- - - - - - - - - VOLTAGE REGULATORS - - - - - - - -
VR1401	4036887P5	Zener: 500 mW, 5.4 v. nominal.
		- - - - - - - - - - SOCKETS - - - - - - - - - -
XF1401 thru XF1404	19C320299G1	Socket. Includes:
	19D416714P1	Socket.
	19B219681P1	Contact, electrical.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
CR1450	19B219800G2	Diode, light emitting: red.
	19A129831G1	Option switch: Push, SPDT, 3 amp at VAC or o.5 amp VDC at 125 v; sim to Switchcraft 11K1089. (Includes 4029840P2 contact).
	19A129932G1	Cable. SF22-BK. 3-1/2 inches long. (Includes 4029840P2 contact).
	19A129932G2	Cable. SF22-W. 6-1/4 inches long. (Includes 4029840P2 contact).
	19A129932G3	Cable. SF22-BL. 5 inches long. (Includes 4029840P2 contact).
	19A116807P1	Clip, spring tension.
	NP270753P8	Nameplate, plastic.
	4036555P1	Insulator, washer: Nylon. (Used with Q2).
	19A130013P1	Insulator. (Used with U1).
	19B201074P204	Tap screw, phillips POZIDRIV®: No. 4-40 x 1/4.
	N117P9004C6	Tap screw, phillips: No. 4-40 x 1/4.
		ASSOCIATED PARTS
		- - - - - - - - - - TONE NETWORKS - - - - - - - - - -
		NOTE: When reordering give GE Part Number and specify exact frequency needed.
FL1401 thru FL1404	19C320291G2	Hybrid. 517.5 to 997.5 Hz.
FL1401 thru FL1404	19C320291G3	Hybrid. 288.5 to 1433.4 MHz.
		EXTERNAL RELAY KIT 19B226025G1
		- - - - - - - - DIODES AND RECTIFIERS - - - - - - - -
CR1701	19A704142P2	General Purpose Silicon; sim to 1N4005.
		- - - - - - - - - - - RELAYS - - - - - - - - - - -
K1701	7486515P2	Armature, enclosed: 12 VDC nominal, 85 to 90 ohms coil res, 1 form A contact rated at 15 amps.
	19B226454G1	Fused lead.
	19A129833P1	Support.
	N402P37C6	Flatwasher: No. 6.
	N130P1608C6	Tap screw: No. 10-16 x 1/2.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

PRODUCTION CHANGES

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

REV. A - To improve operation. Changed C1421.

REV. B - To improve performance in noisy vehicles. Added C1425, C1426, CR1408, Q1407, R1419 and R1420.

REV. C - To improve performance of timed output. Added C1427 and Q1408.

REV. D - To increase volume squelch Hi output. Changed R1407.

REV. E - To improve quieting when used with MASTR II radios. Added R1421.