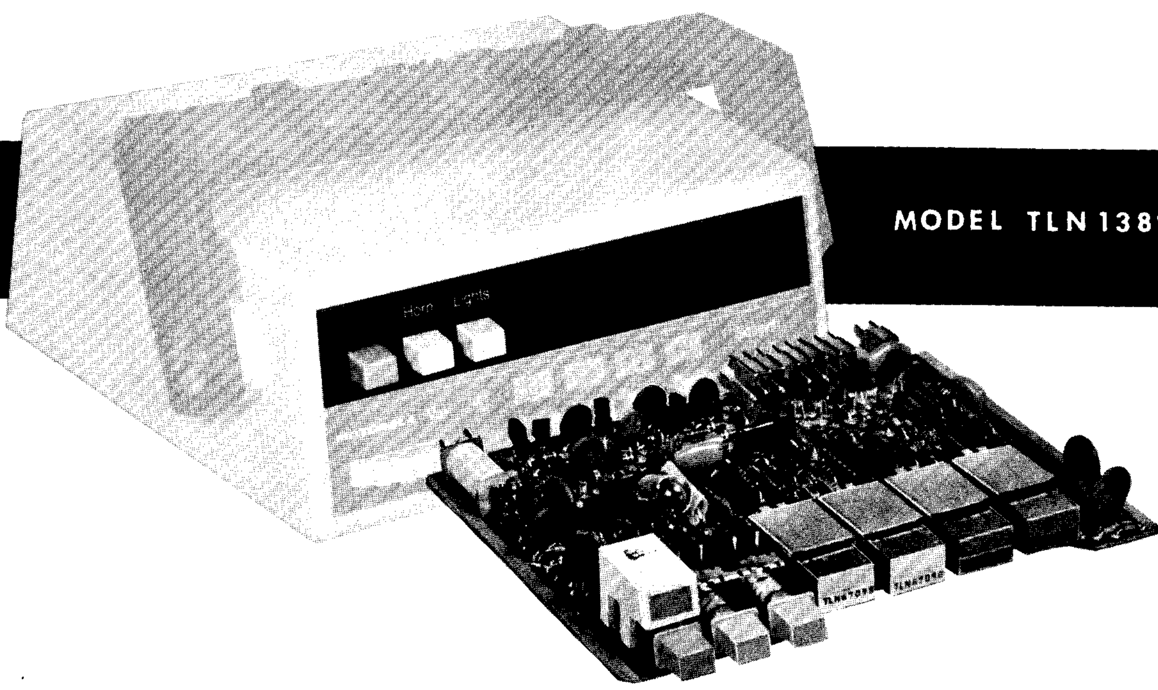
MICOR® | Systems 90

"QUIK-CALL"
MOBILE SELECTIVE SIGNALLING DECODER

MODEL TLN 1389A



MOTOROLA INC. **Communications Division**

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Issue - C

1. TECHNICAL CHARACTERISTICS

TONE FREQUENCIES	346.7 to 1122.1 Hz
TONE STABILITY	±0.2% from -30°C to +85°C ambient (+25°C reference)
SENSITIVITY	Less than 6 dB quieting
MUTING	Greater than 50 dB below 10 watts of audio
TONE CODING	INDIVIDUAL CALL - Two pulses of two tones each (automatic encoder timing) GROUP CALL - One pulse of two tones (manual timing)
PULSE LENGTHS	1st pulse: 1.25 ±0.25 seconds 2nd pulse: 1.0 ±.2 second Interval between pulses: approx. 0.2 second
INPUT IMPEDANCE	Greater than 25 kilohms
NOMINAL INPUT VOLTAGE	±13.6 volts dc
CURRENT DRAIN	Standby: 190 mA Decoding: Call Light & alert tone 300 mA; Horn Relay add 150 mA; Lights Relay add 150 mA
HORN AND LIGHT RELAY CONTACT RATINGS	30 amperes @13.6 V

2. DESCRIPTION

The "Quik-Call" Mobile Selective Signalling Decoder equips Motorola "Micor" FM Two-Way mobile radio for use in a mobile selective signalling system. The decoder is fully solid-state and uses three integrated circuits in addition to transistorized circuits. Circuits are built on a circuit board card which slides into a Motorola "Systems 90" accessory housing. Switches and indicators of the operator's panel are an integral part of the board, as is the connector at the rear of the unit. All necessary related items are included such as the microphone hang-up switch box, interconnecting cable with connector, and the horn and light relays. The housing is ordered separately, since numerous combinations of housings and accessories are possible.

3. MOBILE PAGING SYSTEM

a. Typical System

A mobile selective signalling system allows a dispatcher to call any mobile unit of an FM two-way radio network without disturbing the other mobile units. The mobile radio units do not respond unless they are called by the dispatcher.

The equipment comprising such a system includes:

-- A base station, through which the dispatcher transmits calls and messages to mobile radio units.

-- A selective signalling encoder which is used by the dispatcher to generate the coding tones.

-- A mobile radio set for each vehicle of the system.

-- A mobile selective signalling decoder in each mobile unit.

Each mobile decoder is assigned a specific code and will not allow the mobile radio set to respond unless the correct code is received. The encoder which is used by the dispatcher is able to send any of the codes used in the system. The dispatcher selects the code for the desired mobile radio unit and transmits the coded tones. The selected mobile radio unit alerts the operator by the lighting of a CALL lamp and the sounding of an alert tone from the radio's speaker.

The decoder may be connected for automatic channel monitoring for a five-second period immediately after the alert tone (tone only operation) or for automatic channel monitoring after the alert tone until the decoder is reset (tone and voice operation). The CALL light remains lit until reset by the operator. Thereby, the mobile operator is notified of any call that was received while he was away from the vehicle.

When the vehicle is unattended, the decoder output can be used to turn on the vehicle lights or sound the horn as a method of announcing an incoming call. Switches on the decoder allow the horn and lights alerting methods to be deactivated when the operator is present.

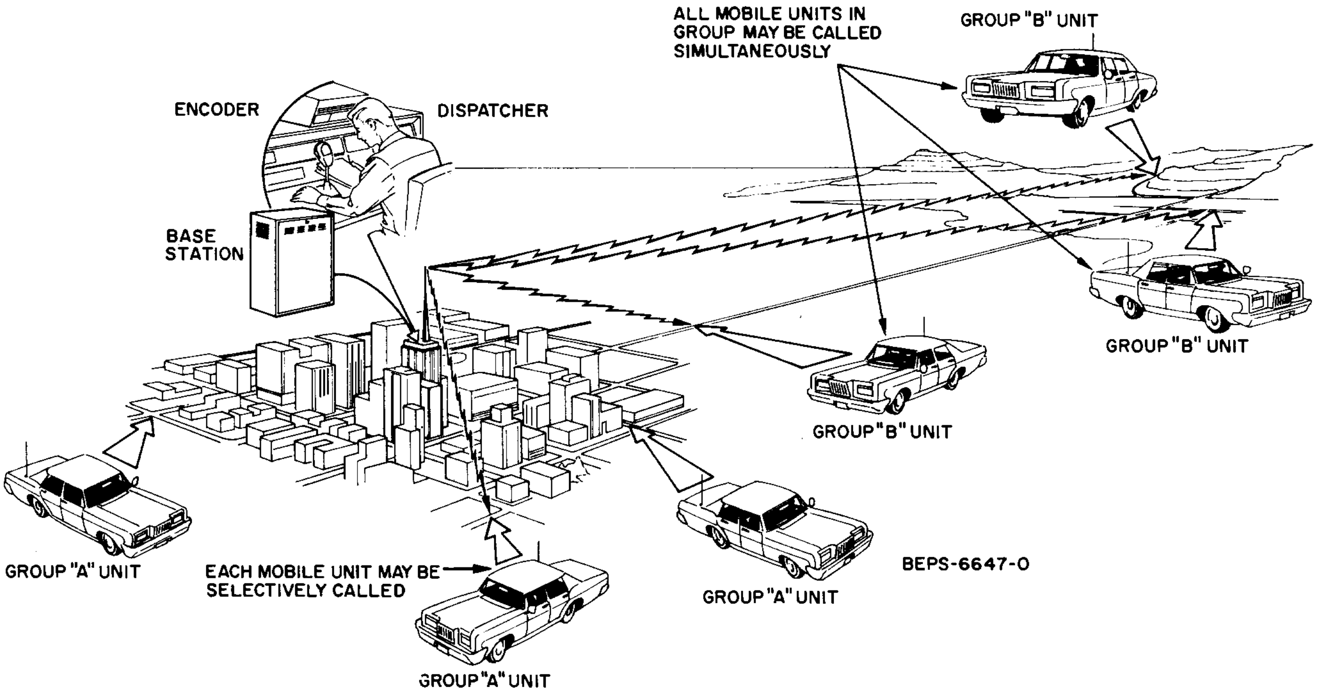

Figure 1.
Typical Mobile Selective Signalling System

The group call feature permits a group of mobile units to be called simultaneously. The group call coding can be set up to call all the mobile units in the system, or several groups may be established.

b. Coding Technique

The coding scheme used in a mobile selective signalling system is the Motorola "Quik-Call" type as shown in Figure 2. The decoder will respond only if the first two tones are the correct frequencies, the second two tones are the correct frequencies and only if they occur in the proper sequence. The scheme allows selective signalling systems of up to 4314 mobile units in a system. The scheme is secure from false operation since all coding conditions must be met to activate the decoder.

Group call coding consists of two simultaneous tones that are present for at least three seconds. Two out of the four reeds in the decoder respond to the group call frequencies. These two reeds are identical in each mobile unit of the group. To activate the decoder with group call coding, the correct frequencies must be present continuously for at least three seconds. This arrangement gives high security against false operation.

Audio frequencies in the 346.7 to 1161.4 Hz range are used. The frequencies are very precise and the decoding devices are equally precise so that they do not operate except at the assigned code. Motorola "Vibrasponder" resonant reeds are used as the frequency sensitive elements in the decoder. These electromechanical devices will vibrate and produce an output only when the input signal is at the frequency for which the reed is designed. Reeds are available in 36 different "Quik-Call" codes as listed in Table 1. Code frequencies are assigned by Motorola systems analysists at the factory and any add-on order should refer to the initial order for correct assignment.

The code frequencies of the decoder can be determined by correlating the reed code (which consists of two letters such as CZ) with the frequencies as listed in Table 1. Reed placement is very important, interchanging reeds will change the individual call code, and possibly the group call code. The frequencies of the reeds used in sockets 1A and 1B must correspond with the two coding tone frequencies of the first pulse and the reeds used in sockets 2A and 2B must correspond to the coding tones of the second pulse. Furthermore, the reeds used in sockets 1B and 2A are the group call frequencies.

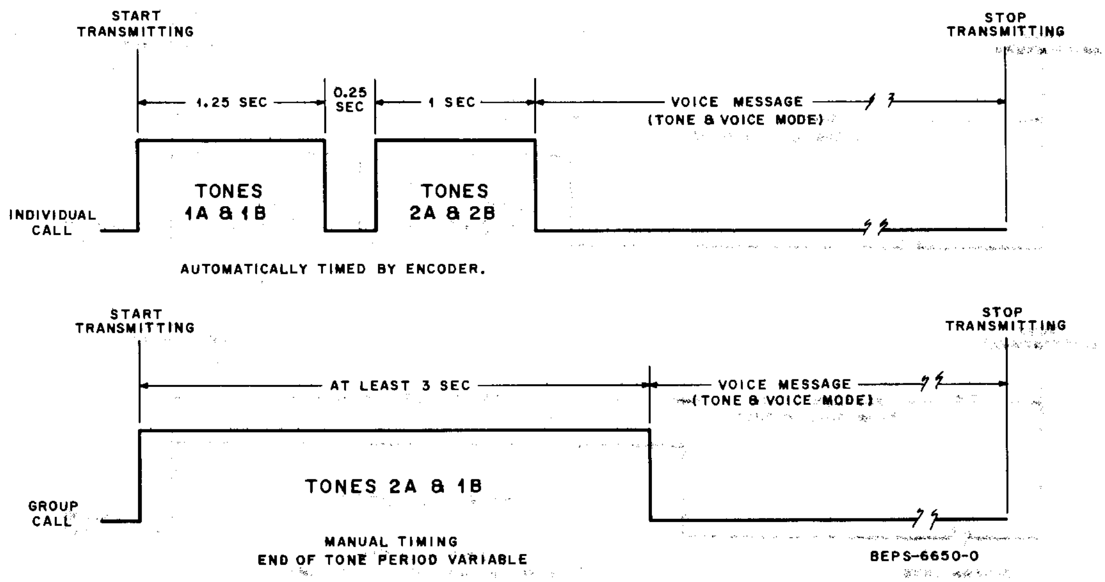

Figure 2.
Coding Scheme

Table 1.
"Quik-Call" Codes

Z Series		B Series		A Series	
Code	Freq. (Hz)	Code	Freq. (Hz)	Code	Freq. (Hz)
CZ	346.7	CB	371.5	CA	358.9
DZ	384.6	DB	412.1	DA	398.1
EZ	426.6	EB	457.1	EA	441.6
FZ	473.2	FB	507.0	FA	489.8
GZ	524.8	GB	562.3	GA	543.3
HZ	582.1	HB	623.7	HA	602.6
JZ	645.7	JB	691.8	JA	668.3
KZ	716.1	KB	767.4	KA	741.3
LZ	794.3	LB	851.1	LA	822.2
MZ	881.0	MB	944.1	MA	912.0
NZ	977.2	NB	1047.1	NA	1011.6
PZ	1084.0	PB	1161.4	PA	1122.1

4. INSTALLATION

The decoder comes either as a factory equipped option, completely prewired, or as a field installed add-on to an existing "Micor" radio set. The decoder circuit card is installed in the accessory housing, either alone or in combination with other radio accessories. The installation instructions provided here are for the decoder used as the only accessory. For instructions pertaining to multiple installations, refer to the installation instructions supplied with the housing assembly.

a. Field Installed Option
(Refer to Figure 3)

(1) Remove the escutcheon backing and apply carefully to the housing assembly front panel. Use care to align the holes in the escutcheon with the holes in the panel.

(2) Place the card into the two rails as shown in Figure 3C and slide the circuit card completely into the housing assembly.

(3) Determine which of the knockout panels in the rear housing cover must be removed to allow access to the 22-pin assembly on the board. (Refer to Figure 3E.) Remove the panel by pushing it out toward the rear of the cover.

(4) Refer to Figure 3C. Install the rear housing cover by inserting the tabs on the top of the cover into the holes in the top of the housing assembly and swinging the cover down against the bottom and securing it with the two captive screws.

(5) Disconnect the black connector (P1101) from the control head.

(6) Use the contact removal tool to remove the following wires, with pins attached, from P1101.

- Yellow wire from position 1.
- Black-violet wire from position 9.
- Black-brown wire from position 16.
- Black-Green wire from position 20.
- Shield from position 21.

NOTE

Steps (7) and (8) are not necessary when the wires extend at least five inches beyond the sleeving on the multiconductor cable.

(7) Remove the "S" clamp from the end of the multiconductor cable and more the strain relief back about five inches from the ends of the wires.

(8) Cut and remove the cable sleeving so that approximately five inches of the wires are exposed. Be careful not to cut the insulation of the wires. Hook the strain relief "S" hook to the bracket on the option housing.

(9) Insert the pins and wires which were removed from P1101 into the green connector (P1) as follows:

- Yellow wire into position 18.
- Black-violet wire into position 13.
- Black-brown wire into position 15.
- Black-green wire into position 21.
- Shield into position 20.

(10) Insert the pins and wires connected from P1 into P1101 as follows:

- Yellow wire into position 1.
- Black-violet wire into position 9.
- Black-brown wire into position 16.
- Black-green wire into position 20.
- Violet-black wire into position 21.

(11) Reconnect P1101 to the control head and connect P1 to the 22-pin receptacle (J1) on the rear of the circuit card.

(12) If a microphone hang-up box was installed with the radio, ("Private-Line" equipped radios) move the green wire from the black connector pin 15 to pin 19 of the green connector, and move the black-blue wire from the black connector, pin 4 to pin 7 of the green connector.

NOTE

If the previously installed radio is a carrier squelch model, do not remove the black-blue wire from pin 4 of the connector.

If no microphone hang-up box was installed with the radio, (carrier squelch radios) the hang-up box supplied with the decoder circuit board must be installed and wired as follows:

(a) Install the hang-up box within easy reach of the operator.

(b) Insert the black wire into pin 19 of the black connector (P1101) and the green wire into pin 19 of the green connector.

(13) Attach the horn and light relays in a secure position in the engine compartment, (such as the firewall, etc) and connect them as illustrated in Figure 3D.

b. Factory Wired Option

When the decoder option is purchased as part of a radio system, the wiring changes will have been completed. The individual system components are shipped with all interconnecting cables attached, to permit a thorough system check out before unpacking. To install the radio system proceed as follows:

(1) Install the radio and cabling as directed in the radio installation instructions.

(2) Install the trunnion bracket and housing assembly as instructed.

(3) Connect the black (and blue, if used) connector(s) to the control head.

(4) Connect the green connector (P1) to decoder jack (J1).

c. Jumper Options

As shipped from the factory, the jumper between pins 22 and 4 of the green connector provide "Tone and Voice" operation. "Tone Only"

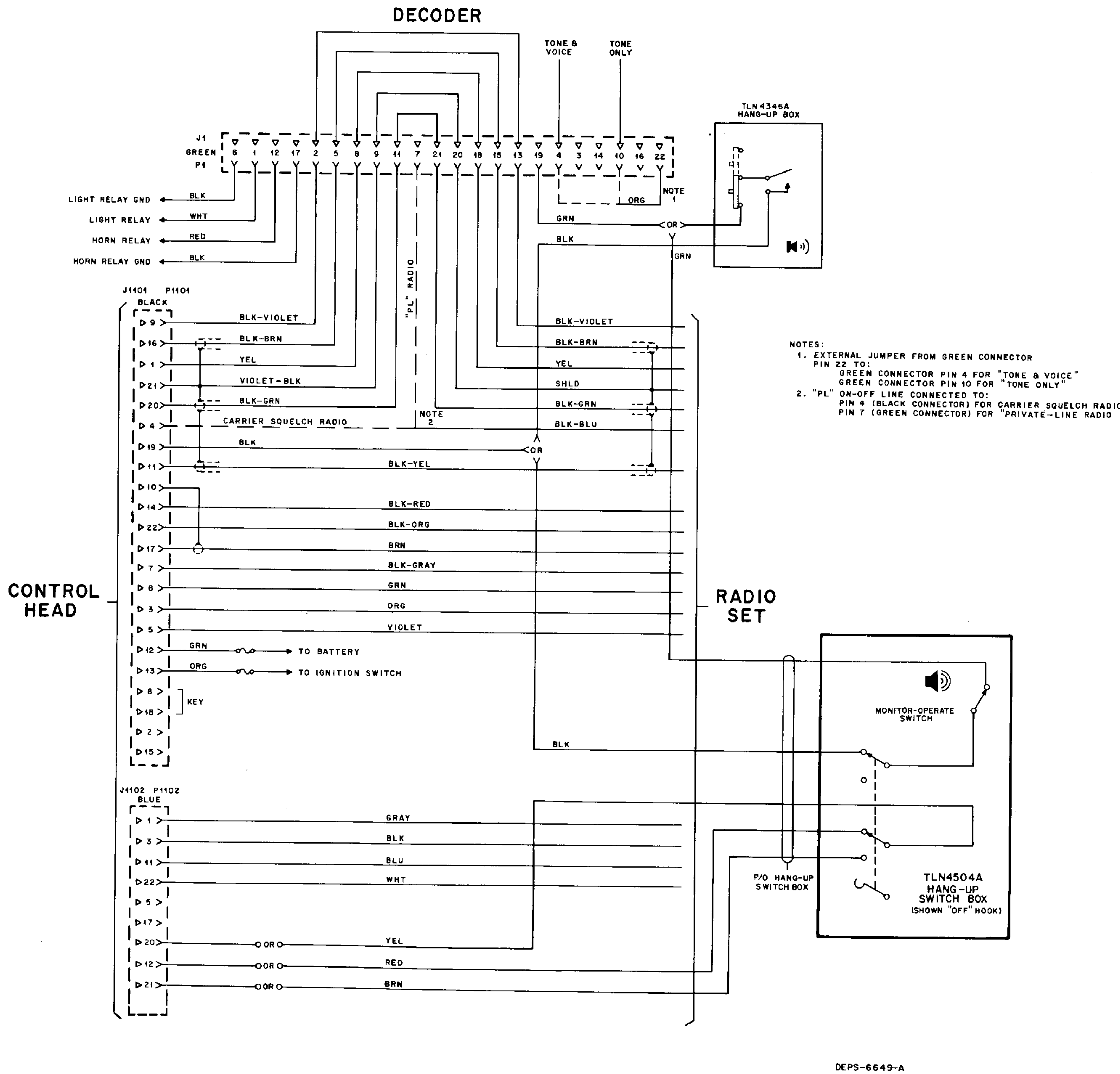

Figure 3A. Connection Diagram

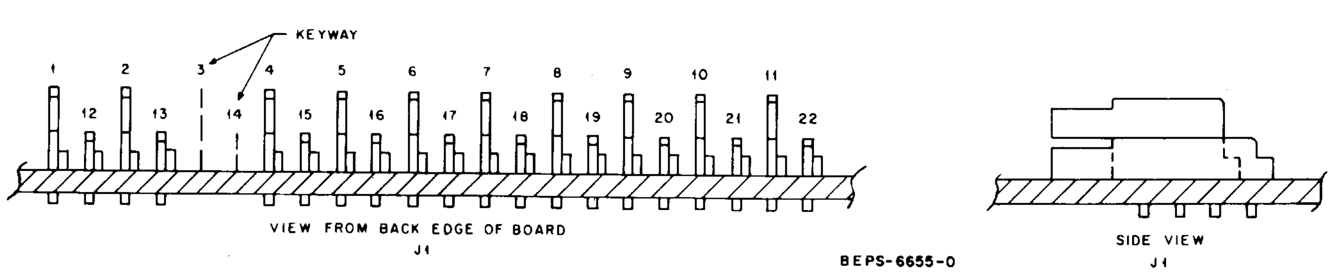

Figure 3B. Pin Location Detail

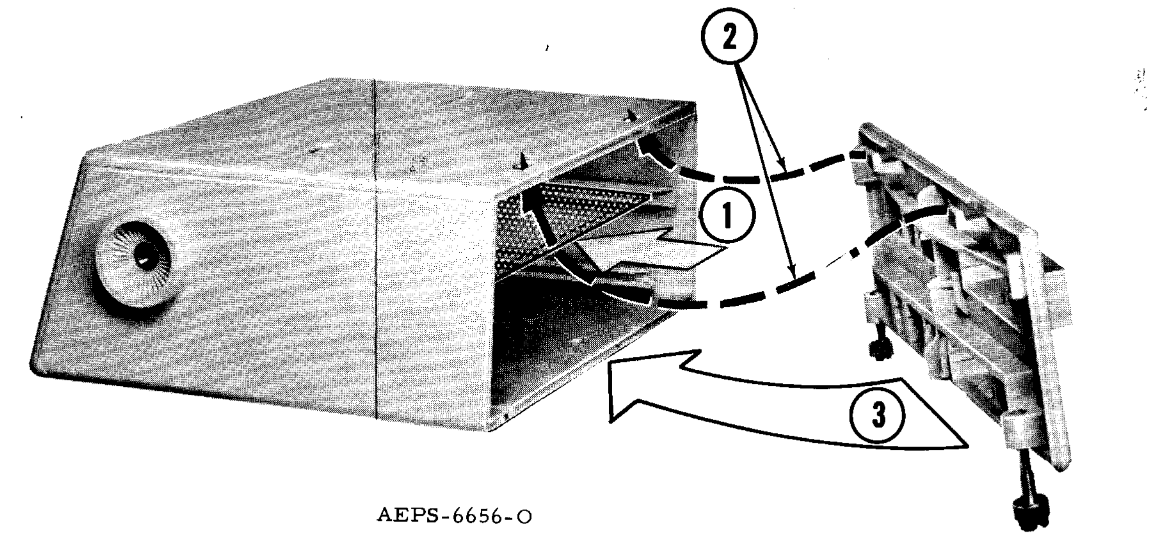

Figure 3C.
Rear Cover Installation Detail

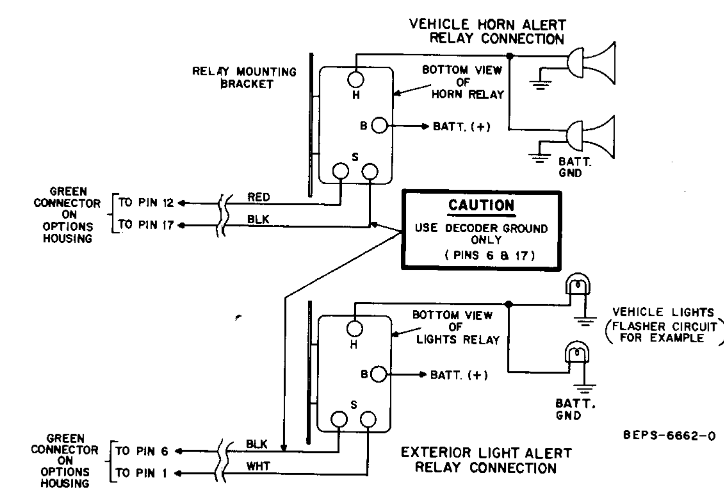

Figure 3D.
Lights and Horn Relay Installation Diagram

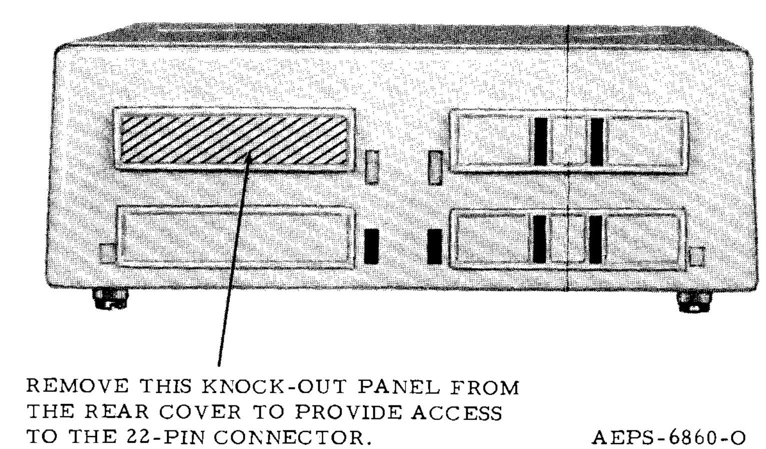

Figure 3E.
Rear Panel Removal

Figure 3.
Installation Detail
Motorola No. PEPS-6861-A
12/12/73-NPC

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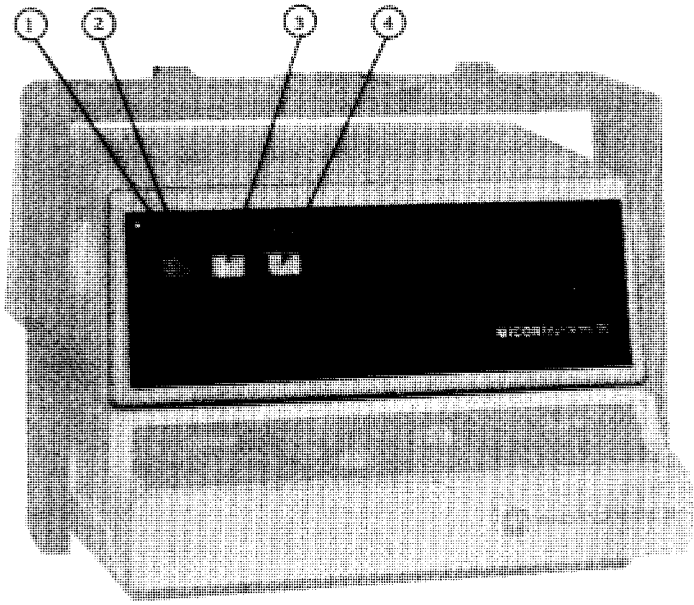

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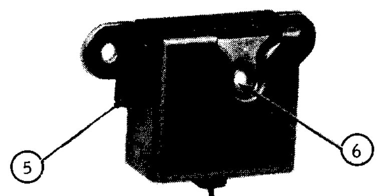

Figure 4.
Controls and Indicators

operation can be obtained by removing the wire from pin 4 and reconnecting it so that pin 22 is connected to pin 10 of the green connector.

d. Installation Options

NOTE

When mobile decoders are used in "Private-Line" system there are various muting options available.

(1) If the decoder is left wired as shipped from the factory, "Private-Line" muting will be in "parallel" with decoder muting. Both the proper "PL" code and the correct selective tones must be received to unmute the receiver. When the microphone is removed from the hang-up box, or the "monitor-operate" switch is placed in the monitor position, all muting is disabled.

(2) If the decoder is to be used only for horn and/or lights activation and all vehicles are to hear all transmissions with the proper "PL" code, continuous unmuting of the decoders without affecting horn and lights or "PL" operation can be achieved by removing the ORG jumper from P1 (the green decoder connector housing). The decoder alert tone will only be heard if the base station transmits the signalling tones and "PL" tone simultaneously.

(3) If individual calling is desired from base-to-mobile without disturbing the other mobiles in the system while retaining "Private-Line" operation for general mobile-to-mobile and mobile-to-base communications, the decoder muting may be wired as an "OR" function, i.e., it will respond to either signalling tones or the proper "PL" tone. Proceed as follows:

(a) Remove and discard the BLK-GRN jumper from P1 (green) pin 11, to P1101 (black) pin 20.

(b) Move the BLK-GRN wire from the "Micor" radio cable from P1 (green) pin 21, to P1101 (black) pin 20.

(c) Move the BLK-BLU "PL Select" wire from the "Micor" radio cable from P1 (green) pin 7 to P1 (green) pin 21 or 11.

(d) Remove resistor R62 (47k ohms). In this configuration, individual base-to-mobile signalling without disturbing other mobiles is accomplished by the base station disabling its transmit "PL" tone while signalling and communicating with the paged vehicle. The decoder pulsating alert tone will not be operational in this configuration, however, a portion of the second paging tone (about one second) will be heard when the receiver unmutes.

(4) Two separate hang-up boxes, one controlling "Private-Line" on/off and the other controlling mobile decoder muting and horn and lights operation, can be installed as follows:

(a) Move hang-up box BLK wire from black connector P1101-19 to blue connector P1102-19.

(b) Move "Private-Line" on/off (BLK-BLU wire) from the green connector (P1-7) to black connector P1101-4.

(c) Install the hang-up box for controlling the "Private-Line" on/off function in the normal manner, GRN to P1101-15 and BLK to P1101-19.

(5) To allow one hang-up box to unmute both "Private-Line" and mobile decoder when off-hook, but have a separate "Private-Line" on/off control when on-hook, connect as shown for carrier squelch. Then modify the second unused hang-up box as follows:

(a) Cut out the short BLK jumper from the slide switch to the spring clip.

(b) Move BLK wire of the 2-conductor cable from ground (chassis) to this now empty terminal on the slide switch.

(c) Connect GRN wire of the 2-conductor cable on the green decoder connector (P1-7) and the BLK wire to black connector P1101-5.

(6) To allow one hang-up box to unmute both "Private-Line" and a mobile decoder when off-hook, but have separate decoder disable when on hook, connect as follows:

(a) Connect a standard hang-up box, GRN wire to P1101-15 and BLK wire to P1101-19.

(b) Modify the second hang-up box as in paragraph (3) and connect GRN to green decoder connector P1-19 and BLK to P1101-4.

(c) Connect "Private-Line" on/off wire (BLK-BLU) to blue connector P1102-7.

The control head must also be slightly modified as follows:

(a) Remove the cover by loosening two Phillips captive screws from bottom.

(b) Locate the plating on the front of the board which runs from P1101-4 and -15 to P1102-7. Cut this plating in a convenient location and solder in a diode (part no. 48C83654H01) with cathode (band) towards P1101-4 and -15.

(c) Replace top cover.

e. Hang-Up Swtich Box (Model TLN4504A)

(1) When the handset hang-up switch box Model TLN4504A is used with a mobile decoder, instead of a microphone hang-up switch box Model TLN4346A, it should be connected as follows: (See Handset Hang-Up Switch Box Manual for Connection to Alternate Control Module.)

(a) BLK wire to pin 19 of BLK connector (P1101).

(b) GRN wire to pin 19 of GRN connector (P1).

(c) RED wire to pin 12 of BLUE connector (P1102).

(d) YEL wire to pin 20 of BLUE connector (P1102).

(e) BRN wire to pin 21 of BLUE connector (P1102).

(f) Remove JU1 and JU2 of the control head to provide audio switching.

(2) The monitor-operate switch function is identical to that of the switch on the microphone hang-up switch box. Automatic monitoring of the channel and automatic decoder reset are provided when the handset is lifted "off-hook".

Also, when lifted "off-hook" received audio is switched from the speaker to the handset earpiece. When the handset is placed back "on-hook" after receipt of a call, audio is switched back to the speaker and the receiver is muted.

5. OPERATING PROCEDURE

a. Controls and Indicators
(Refer to Figure 4)

(1) CALL light - Lights when correctly tone-coded message is received. An alert tone is also heard at this time. The lamp remains on until

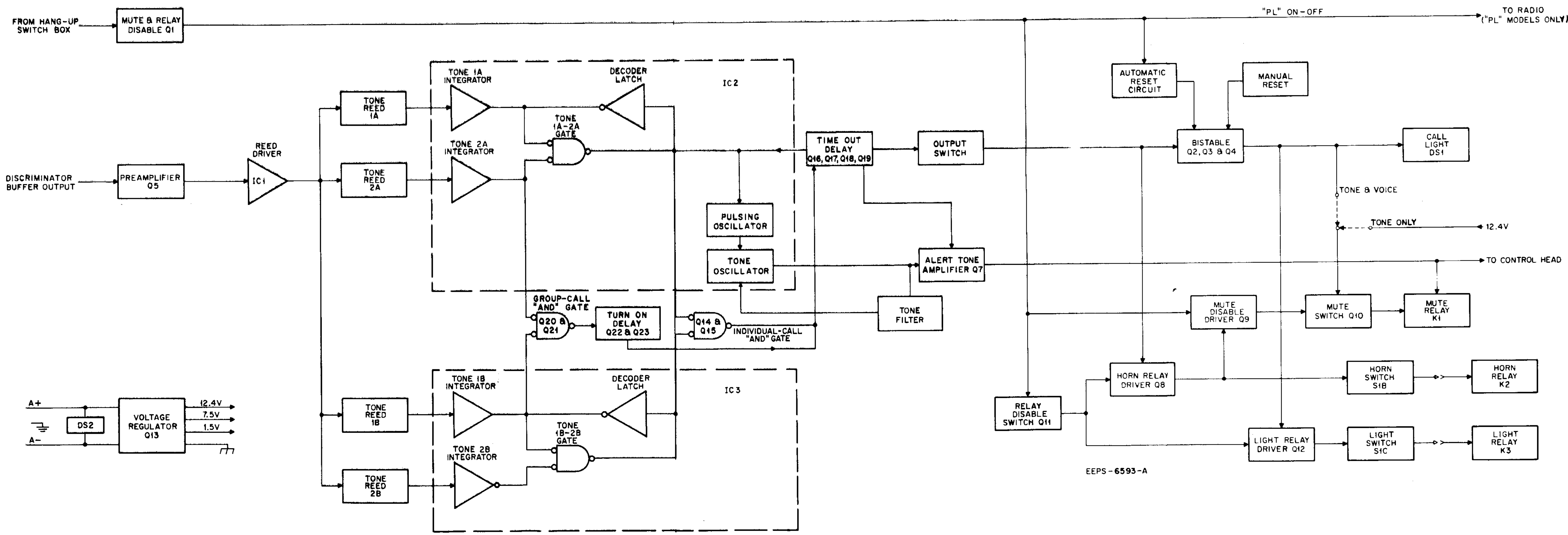

Figure 5.
Functional Block Diagram

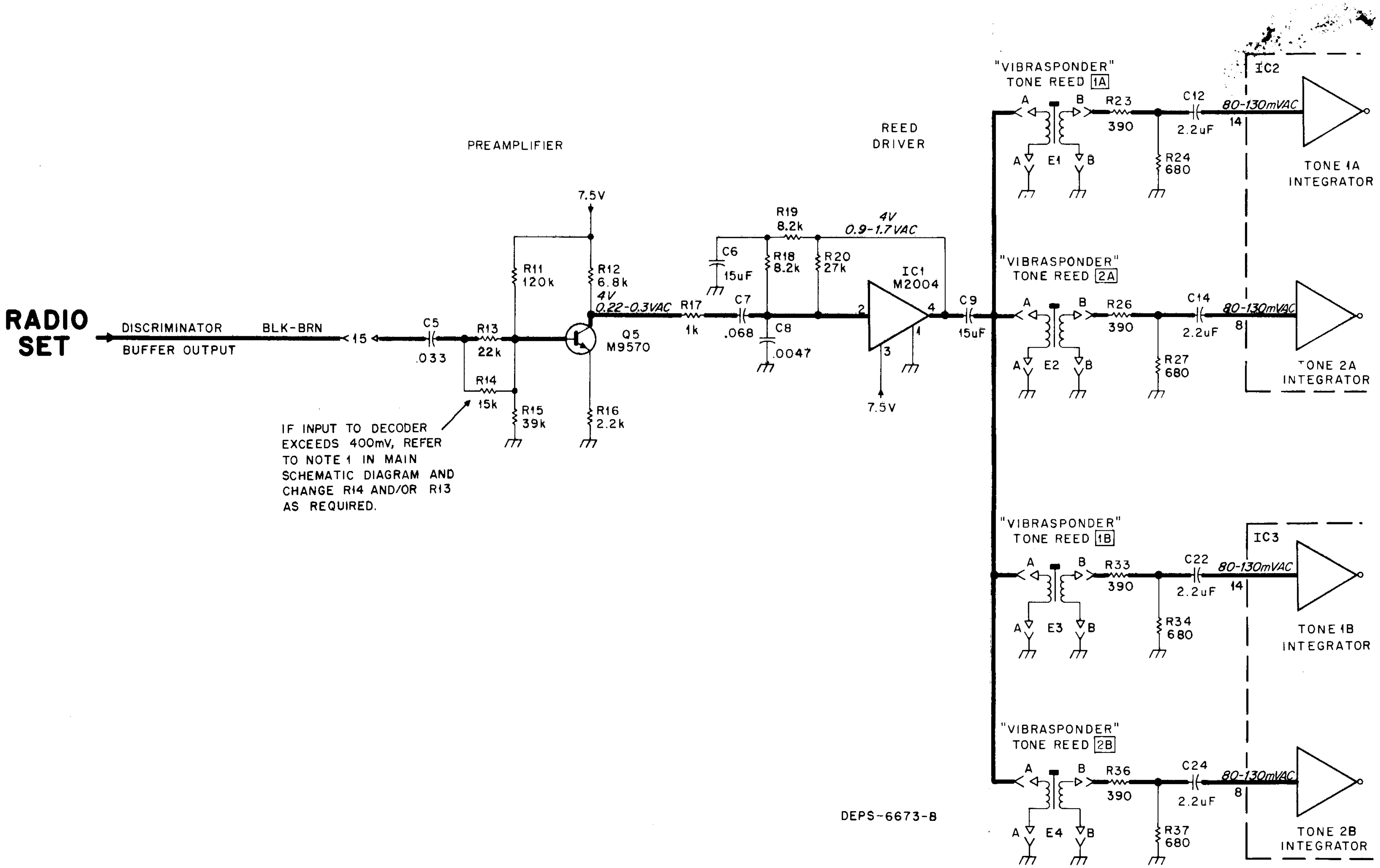

Figure 6.
Audio Input Circuit

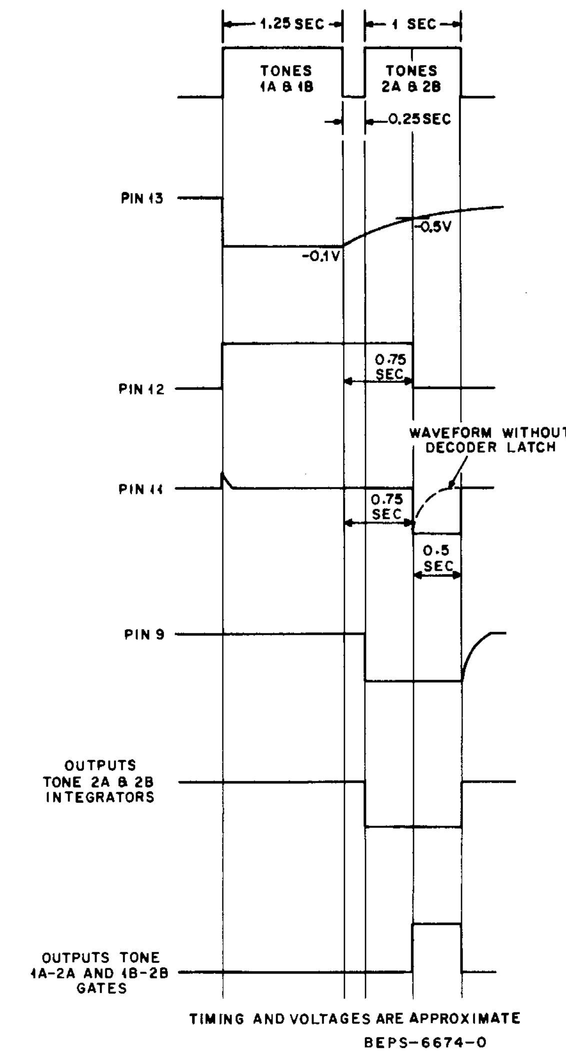

Figure 7.
IC2 and IC3 Timing Waveforms
for an Individual Call

reset. "The Call light will always respond to a correctly coded transmission regardless of the setting of other controls".

(2) Call reset switch - Momentary action pushbutton switch, resets the CALL light and re-mutes the receiver when operated.

(3) HORN switch - Alternate action pushbutton switch. The switch enables or disables the vehicle horn as an external alerting feature of a received call.

(4) LIGHTS switch - Alternate action pushbutton switch. This switch enables or disables the vehicle lights as an external alerting feature of a received call.

(5) Monitor-Operate switch - Slide switch on the side of the microphone hang-up box. When this switch is in the monitor position (nearest the) the receiver is unmuted and all on frequency calls (regardless of tone coding) are heard. Permits monitoring while the microphone is "on-hook".

(6) Hang-Up Box - Automatic monitoring of the channel and automatic reset when the microphone is lifted "off-hook". Also restores receiver muting when the microphone is placed "on-hook" after the alert tone is heard. "Placing of the hang-up box "monitor-operate" switch in the monitor position, or having the microphone off-hook, also disables the horn and lights relays".

b. Receiving a Call

Depending upon the placement of the optional jumper, the decoder functions in one of the following two ways:

(1) Tone Only

Upon reception of a properly coded call, the CALL lamp lights and a series of tone pulses is heard at the speaker. After about five seconds the vehicle operator should then remove the microphone from the hang-up box and call into the station originating the tone call. When the microphone is removed from the hang-up box, the CALL light is turned off. If the operator is absent from the vehicle at the time of the original call, the CALL light remains on to indicate a received call. If either the LIGHTS or HORN functions have been enabled and a call is received, the vehicle lights (flashers for instance) will remain on until reset, while the horn will only sound for 5 seconds. Either function is automatically reset with the CALL light or may be reset by again pressing the LIGHTS or HORN pushbutton which disables the function.

(2) Tone and Voice

The reception of a call is the same as described for "Tone Only" except that the receiver will remain unmuted and an audio message may be heard until the decoder is reset.

c. Transmitting

Lift the microphone off-hook or place the monitor-operate switch in the monitor position ( ) and monitor to make sure it is clear before transmitting. Otherwise, use normal transmitting procedures.

6. FUNCTIONAL OPERATION

a. Audio Input Circuit

The decoder is activated by the signalling code coupled from the discriminator buffer output in the radio set. Figure 2 shows the signalling code for both individual or group calls. These tones are coupled through C5 and a resistive network to the base of Q5. The output of Q5 is coupled to IC 1 which is a 1/4-watt audio amplifier stage. Distortion at the output of the reed driver is reduced by the feedback network consisting of R18, R19, R20, and C6. The output of the reed driver is capacitively coupled to "Vibrasponder" tone reeds 1A, 2A, 1B, and 2B.

These reeds are highly frequency selective so that only tones of the proper frequency are allowed to pass. The 680-ohm and 390-ohm resistors at the reeds output form a voltage divider network so that an acceptable signal level of approximately two-thirds of the signal output from the reeds is coupled to tone integrators 1A, 2A, 1B, and 2B.

b. Decoder Logic
(Refer to Figures 7 and 8)

Tones 1A and 1B cause pins 13 of the IC's to go low (see Figure 7). At the end of the tones, the voltages at pins 13 start to rise toward the supply voltage of 1.5 V. The rate of rise is determined by the charging rate of C10 through R21 and C20 through R31. Tones 2A and 2B cause pins 9 of the IC's to go low. At this same time the outputs of both the tone 2A and 2B integrators will go low and keep one input to the tone 1A-2A gate and tone 1B-2B gate low for approximately one-second.

After about one-half second into the tones 2A and 2B, C10 and C20 will have changed sufficiently to turn on their next respective stages. At this time, pins 12 goes low and the RC networks of C11-R22 and C21-R32 each produce a sharp negative pulse. Tones 2A and 2B and the sharp negative pulses turn on both of the AND gates, and each provides a positive output. These outputs are fed back and inverted through the decoder latch to hold pins 11 low. This arrangement of circuitry therefore provides two simultaneous low inputs to each of the AND gates until tones 2A and 2B disappear. The positive output from the 1A-2A AND gate is coupled to an astable pulsing oscillator. The charge-discharge function of external capacitor C15 turns the tone oscillator on and off. The tone oscillator and twin tee filter determine the frequency of the alert tone. Pin 3 is the tone oscillator feedback and pin 2 is the output which is coupled to the alert tone amplifier Q7. This pulsating alert tone is a series of pulses at a rate determined by C15. The positive outputs from both AND gates are coupled respectively to the bases of Q14 and Q15 which operate as an AND gate. Both Q14 and Q15 turn on and cause the collector of Q14 to go low.

In a group call situation, tones 2A and 1B (see Figure 2) activate tone integrators 2A and 1B. The tone 2A integrator provides a low at pin 9 which is coupled to the base of Q20 while the tone 1B integrator provides a low at pin 13 which is coupled to the base of Q21. The low base voltages on Q20 and Q21 cuts off these two transistors and the voltage on the two collectors (which are tied together) tries to rise to 7.5 V. As the voltage rises, a point is reached where the base voltage of Q22 causes this transistor to conduct. The series conduction of Q22 provides a voltage divider network consisting of R78 and R77. The divider action places a potential of 1.5 volt at the emitter of Q22. C38 now begins to charge through R79 and attempts to reach the 1.5-volt level. As it charges, the voltage at the base of Q23 rises exponentially. The RC time constant of C38 and R79 is high enough so that it takes more than three seconds before the charge on C38 reaches a level which turns on Q23. With Q23 on, its collector voltage becomes very low and this low is coupled to the collector of Q14.

From the previous explanations, it is apparent that either an individual call or a group call that was present for the proper length of time will bring the collector of Q14 low.

The low output of Q14 is coupled to the base of Q16 and turns this stage on for a very short time duration. When Q16 conducts, its collector voltage will rise to 7.5 volts and C35 can rapidly charge to 7.4 volts through the small resistance of R67. This logic high is coupled back through R68 and CR24 to pin 10 of IC2. Pin 10 going high turns on the pulsing and tone oscillators and they operate as previously described. This feedback path through CR24 is necessary during a group call because the tone 1A-2A gate is never activated.

As soon as Q16 started to conduct, its high collector voltage turned on Q17. Since Q16 conducts for only a very short time, the conduction time of Q17 would also be very short. This undesirable short conduction time of Q17 is prevented by the charge that was built up on C35 during the conduction of Q16. As soon as Q16 cuts off, C35 will begin to discharge. However, the RC time constant on discharge is relatively long because of the high resistance of R66. This long discharge time will maintain a sufficiently high voltage on C35 to keep Q17 conducting for approximately five seconds. While Q17 is conducting its collector voltage is low and turns on both Q18 and Q19. When Q18 conducts, its collector voltage rises to 7.5 volts and this voltage turns on the alert tone amplifier Q7 for approximately five seconds. The pulsating alert tone output is taken from the collector of Q7 and, after attenuation by R80, is coupled to the audio amplifier in the radio set. With this circuit arrangement, the alert tone amplifier will only go on when the proper tone codes are detected.

Q19, which was also turned on by Q17, couples a voltage through CR25 which turns on the output switch stage Q6 for approximately five seconds.

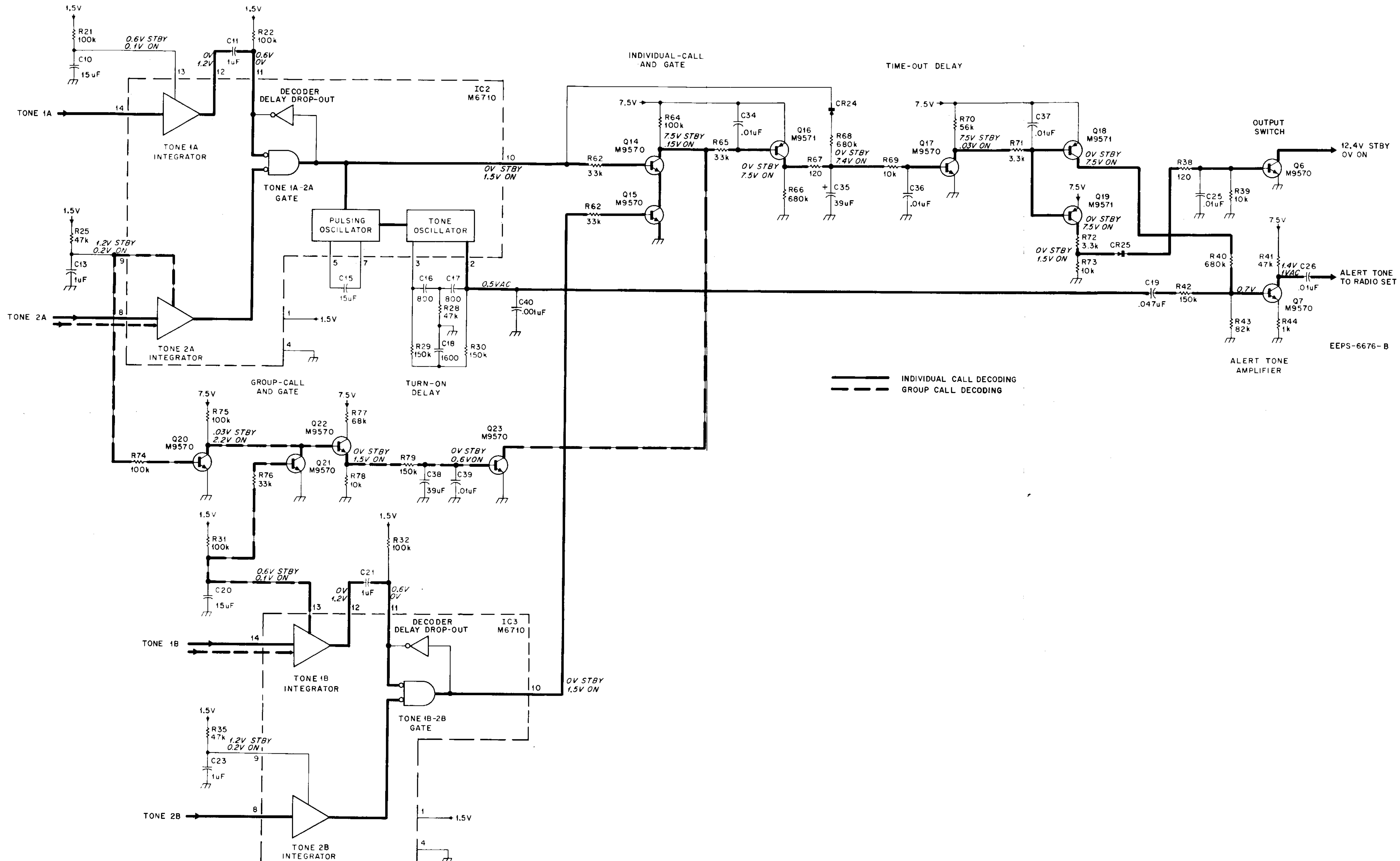

Figure 8.
Decoder Logic Circuits

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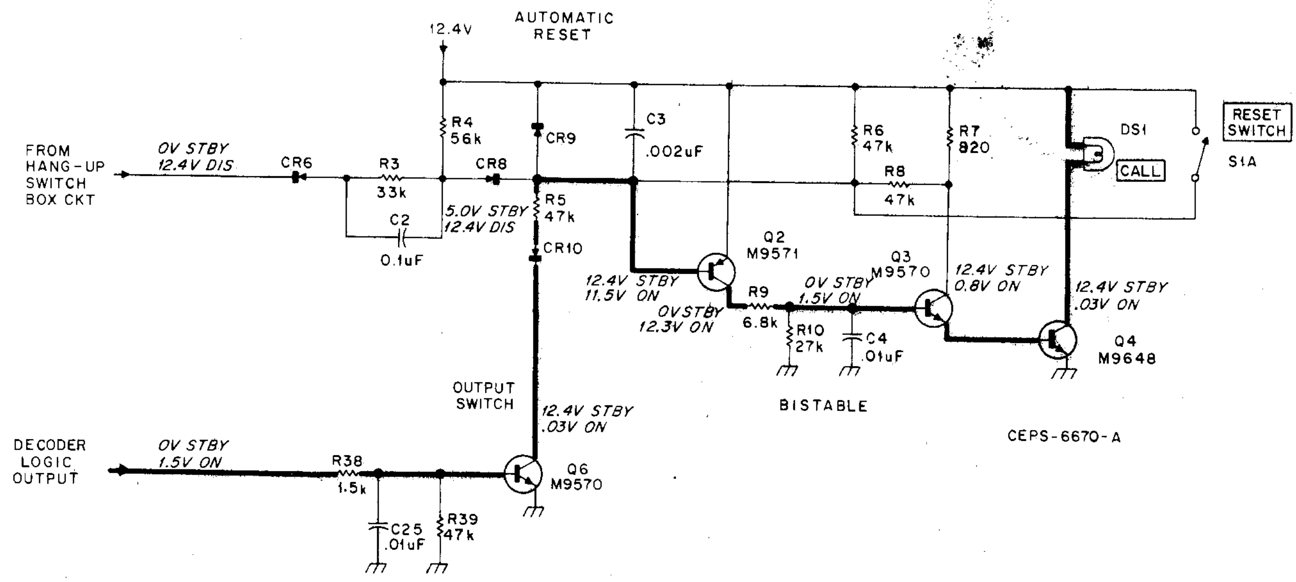


Figure 9.
CALL Light Switching Circuit

c. <u>CALL Light Switching</u>
(Refer to Figure 9)

The high output from the AND gate is coupled to the base of output switch Q6 and causes it to conduct. When it conducts, it effectively places a ground at its collector. This effective grounding of R5 through CR10 causes the base voltage of Q2 to drop and Q2 turns on. The conduction of Q2 biases Q3 and Q4 into conduction. The conduction of Q3 effectively grounds R8 which latches Q2 on. The conduction of Q4 effectively grounds one side of CALL lamp DS1 and places 12.4 volts across the lamp. The lamp will go on and remain on until reset. One method used to extinguish the lamp is to depress reset switch S1A. This action places 0 volts across the base-emitter junction of Q2 and stops its conduction. With Q2 cut off, Q3 and Q4 will be biased into cut-off. This removes the effective ground from DS1 and the lamp will go out.

d. <u>Receiver Unmuting</u>
(Refer to Figure 10)

The incoming call also unmutes the receiver so the alert tone may be heard (tone only operation). For tone and voice operation, the receiver remains unmuted until the decoder is reset.

When a call is received, Q8 remains on as long as the second tone is present and the collector of Q6 is low. The high collector voltage of Q8 is coupled through R51 to the base of Q9 and causes this stage to conduct. The collector of Q9 drops to near zero volts and cuts off Q10. With tone only operation (pin 22 connected to pin 10) reed

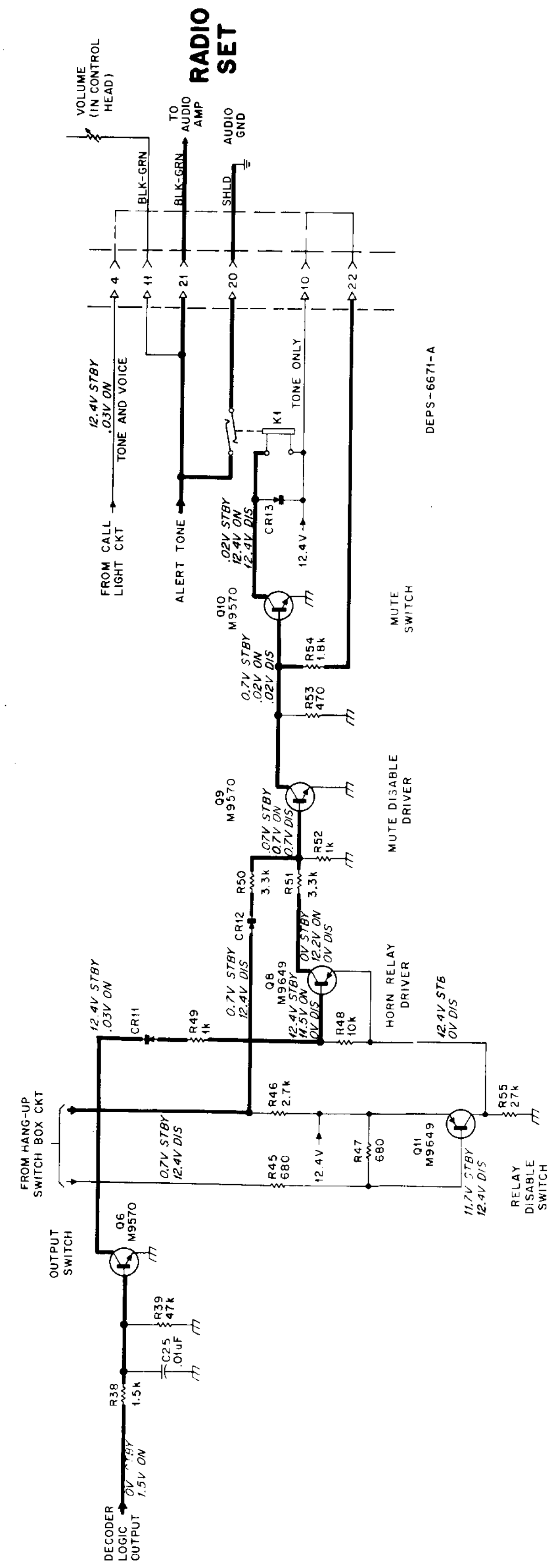


Figure 10.
Receiver Unmuting

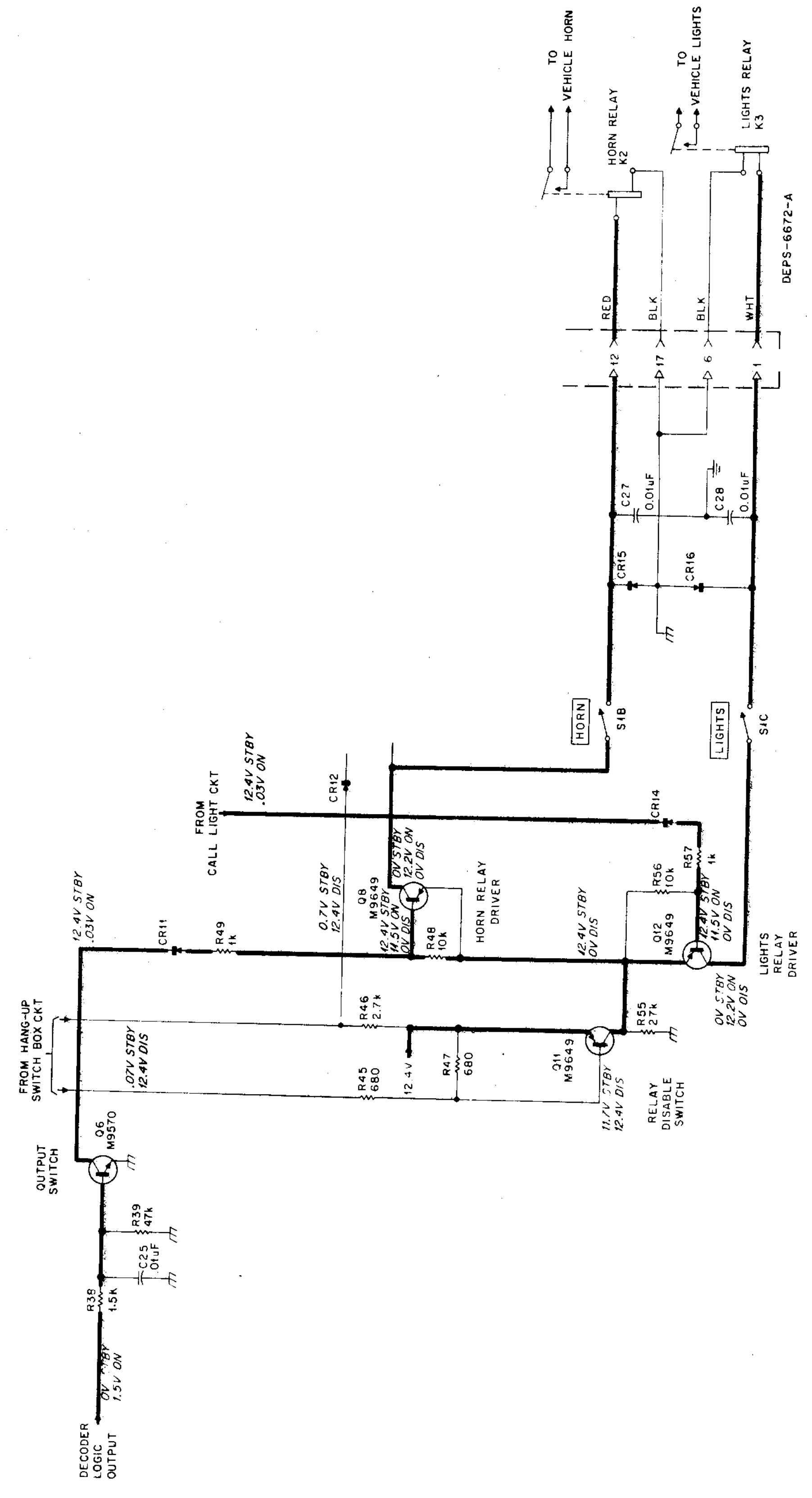


Figure 11.
Lights and Horn Relay Circuits

switch K1 remains de-energized as long as Q10 is cut off. Consequently, the radio set will remain unmuted only until the collector of Q6 goes high (Q8 cuts off).

For tone and voice operation, pin 22 is connected to the CALL light circuit (collector of Q4). With a tone coming through, the collector of Q4 remains low until reset. This low is connected through pins 4 and 22 to the base of Q10 and holds this stage cut off. Therefore, K1 remains de-energized and the radio set stays unmuted until the decoder is reset. The conduction time of Q8 has no effect on the cut-off time of Q10 in the tone and voice mode of operation.

e. Lights and Horn Relay Circuits
(Refer to Figure 11)

The incoming call will activate the horn relay for approximately 5 seconds if the HORN switch is on. It will activate the lights relay until the decoder is reset if the LIGHTS switch is on.

When the proper code is detected and output switch Q6 is switched on, its collector is effectively grounded. This causes conduction from ground to 12.4 volts through voltage divider CR11, R49, R48 and Q11 (which is switched on during standby and "on" modes). A bias is developed for horn relay driver Q8 to turn on that stage. With Q8 switched on, 12.2 volts is applied to the coil of horn relay K2 (if the HORN switch is closed). When output switch Q6 turns off, Q8 also switches off and horn relay K2 de-energizes.

When the incoming code activates the CALL light, a switched ground from that circuit is applied through a voltage divider (CR14, R57, R56, Q11) to the base of lights relay driver Q12 which turns it on. Q12 provides a switched 12.2 volts to the coil of lights relay K3 (if the LIGHTS switch is closed). Since the CALL light circuit remains activated until reset, the lights relay circuit also remains activated for that period.

If the microphone is lifted off hook before the end of the alert tone, the horn and lights relay operation is stopped immediately. During standby (on-hook) operation, relay disable switch Q11 is on which allows the 12.4 volts to be available to Q8 and Q12. The disable (off-hook) condition removes the bias from Q11 and it switches off. The source of operating potential for Q8 and Q12, and thus relays K2 and K3 is removed. Therefore, the horn and lights alerting devices are deactivated.

f. Channel Monitoring and Automatic Reset
(Refer to Figure 12)

When the microphone is lifted off-hook or the monitor-operate switch is placed in the monitor ( ) position, the receiver is unmuted to allow monitoring of the channel (disable mode). If a call has been previously received, the decoder will also reset; that is, the CALL light goes off and the lights relay is de-energized. When the microphone is returned on-hook and the monitor-operate switch is returned to the operate position (both conditions must be met), the receiver is again muted and the decoder is ready to receive the next call. This is the standby mode. The following circuits provide this operation.

Vehicle ground is connected to the microphone hang-up switch box. If the microphone is on-hook and the monitor-operate switch is in the operate position, the decoder is in the standby mode. Ground is routed to the diode bridge in this mode. The ground completes a circuit path from battery hot to battery ground through the diode bridge and bias network resistors R1 and R2, turning on mute & relay disable switch Q1. The diode bridge allows the same circuit operation from either a negative ground or positive ground electrical system. With Q1 on, its collector voltage is at decoder ground. This voltage enables the voltage divider composed of CR6, R3 and R4, which reverse biases diode CR8 and allows capacitor C2 to be charged to 5 volts. The low collector voltage of Q1 also forward biases diode CR7, which holds the anode voltage of CR12 low (reverse bias).

When the microphone is lifted off-hook or the monitor-operate switch is placed in the monitor position, the ground path to the diode bridge is interrupted and the entire circuit floats at battery hot potential. Since no current flows through the bias voltage network R1 and R2, the forward bias for Q1 is lost and Q1 turns off. Its collector voltage rises to 12.4 volts which disables the voltage dividers of which CR6 and CR7 were included. Capacitor C2 discharges its 5-volt charge in addition to the rise to 12.4 volts at the collector of Q1. This voltage forward biases CR8, which reverses the state of bistable Q2/Q3 and turns off the CALL light. This action, of course, also turns off the lights relay if it was previously on. This eliminates the need to push the CALL button to reset the decoder if a reply is to be made.

When the conduction of diode CR7 is cut off by the lifting of the microphone from the hang-up

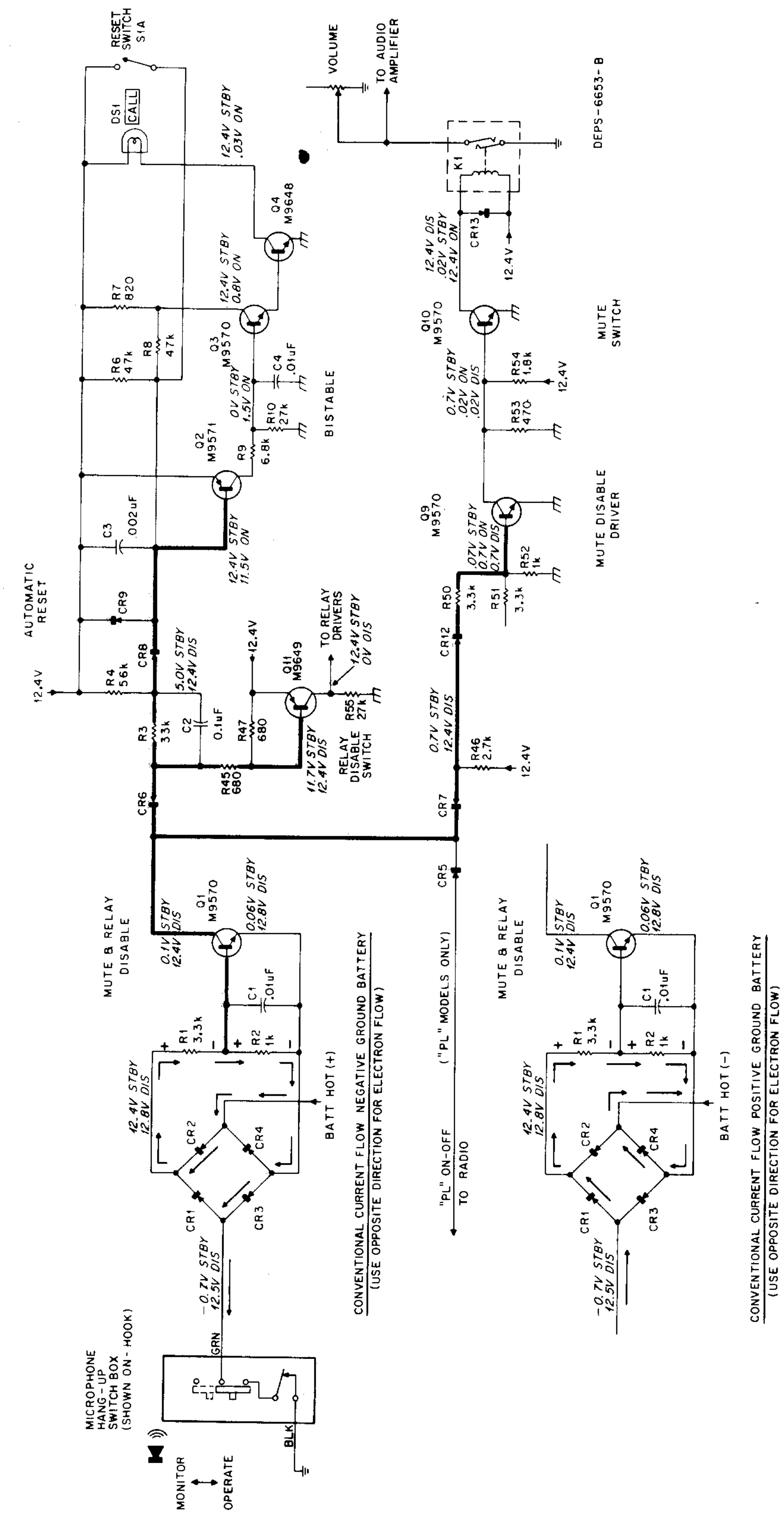
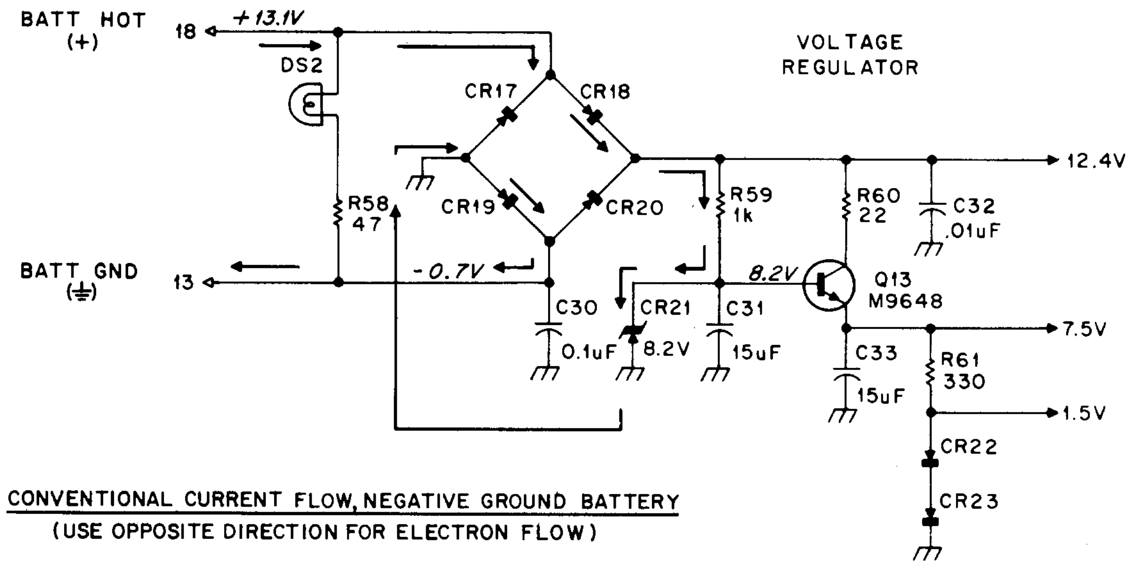


Figure 12.
Channel Monitoring and Automatic Reset



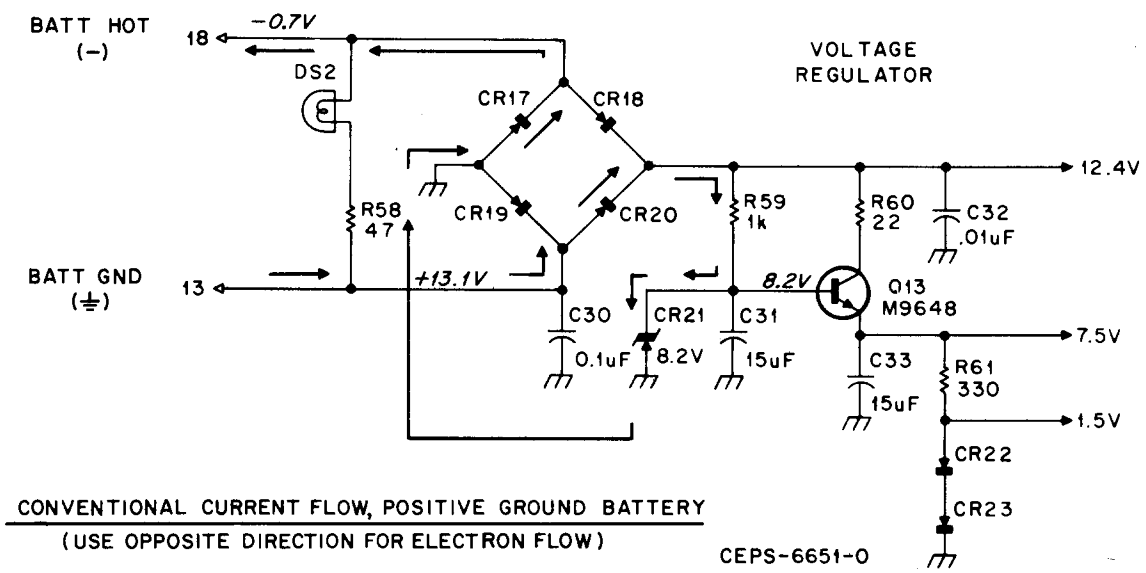


Figure 13.
Power Input and Voltage Regulator Circuit

switch box, diode CR12 becomes forward biased. This, in turn, activates mute disable driver Q9 which allows the mute reed switch K1 to be energized. Its contacts open to unmute the receiver. When the microphone is returned on-hook, the receiver is again muted.

The switched ground output from Q1 is also routed to the radio set on "Private-Line" models so that channel monitoring not only disables the mobile paging decoder, but also disables the "Private-Line" decoder in the radio set as well.

g. Power Input and Voltage Regulator Circuit (Refer to Figure 13)

The decoder will operate from a negative ground or positive ground electrical system with no change of connections. Decoder ground is isolated from vehicle ground (and radio set ground) and no attempt should be made to make both grounds common. Vehicle ground is approximately -0.7 volt with respect to decoder ground in a negative ground system and +13.1 volts in a positive ground system.

Vehicle battery voltage is applied across a diode bridge circuit which permits operation from either negative or positive ground electrical systems. The lamp across the input power terminals gives low level illumination for the HORN and LIGHTS switches identification. This gives a low glare-free illumination that is visible only in dim or dark lighting conditions. The input power to the decoder is turned on and off whenever the radio is turned on and off.

The diode bridge provides a +12.4-volt output in respect to decoder ground. The 12.4-volt unregulated output is used for the stages requiring higher power such as the relay drivers and switching transistors. Zener diode CR21 establishes a regulated reference voltage at the base of voltage regulator transistor Q13. Transistor Q13 provides regulated 7.5-volt output which is used by the audio amplifier stages, including the reed driver integrated circuit IC1, and the individual call and group call logic circuits. A voltage divider network (R61, CR22, and CR23) develop a regulated 1.5-volt output, using the regulated 7.5-volt output as a source of power. The 1.5-volt output is used by the decoding integrated circuits IC2 and IC3.

7. SERVICING

Maintenance of the Mobile Selective Signalling Decoder falls into two areas: testing and troubleshooting. Testing is performed either in-system or on the service bench.

a. In-System Testing

Performing a checkout of the circuit card while it is still connected into the radio system necessitates removing the circuit card from the "Systems 90" housing. This is accomplished as follows:

(1) Disconnect the green connector from the circuit card.

(2) Loosen the two captive screws securing the rear housing cover and remove the cover.

(3) Slide the circuit card out of the housing assembly and place it atop the housing with the solder side up.

(4) Reconnect the green connector to the circuit card.

CAUTION

Do not allow the circuit card to come into contact with any metallic object which may cause damage from an accidental short circuit.

(5) Apply power to the system and proceed to take the voltage measurements necessary to isolate the source of the problem.

b. Bench Testing

Bench testing allows the radio system to stay "in-service" by substituting an operational circuit card for a defective one, while the malfunction is corrected on the service bench. The following equipment is required for a thorough circuit checkout.

- DC power supply
- Motorola TEK-34C Tone Generator with the required "Vibrasender" resonant reeds.
- Service bench VTVM

- General purpose oscilloscope.
- Two short jumper wires terminated in alligator clips.

To perform the bench check proceed as follows:

(1) Remove the green connector from the rear of the circuit card.

(2) Loosen the captive screws securing the rear housing cover and remove the cover.

(3) Remove the circuit card from the housing.

(4) Set up the circuit card as shown in Figure 14, connecting jumper JU1 between pins 19 and 13 and JU2 between pins 22 and 4.

NOTE

JU1 is used to simulate the condition caused by placing the microphone "on-hook". JU2 is used to determine tone only or tone and voice modes and is connected for tone and voice.

(5) Set the tone generator output level for 0.35 V ac.

(6) Depress the CALL button to reset the decoder.

(7) Connect the ohmmeter between pins 20 and 21.

(8) Depress the TONE 1 and TONE 3 switches on the generator, release and quickly depress the TONE 2 and TONE 4 switches.

NOTE

No more than 1/2 second should elapse between the release and actuation of the next switches.

(9) Observe the following indications.

- The ohmmeter indicates open.
- Pulsating 1500 Hz ±100 Hz sine wave displayed on the oscilloscope for approximately 5 seconds.
- CALL light is illuminated.

(10) Depress the CALL button and observe the following:

- CALL light goes "off".
- Ohmmeter indication returns to zero.

(11) Again operate the tone generator to send the proper code and observe the same indications as in step 9.

(12) Remove JU1 (simulating microphone "off-hook") and verify the CALL light goes "off".

(13) Reconnect JU1 between pins 19 and 13 and note that the ohmmeter indicates zero.

(14) Connect the dc voltmeter between pins 12 (+) and 17 (-).

(15) Depress the HORN and LIGHTS switches, and note the voltmeter indicates 0 volts.

(16) Operate the tone generator to send the proper code and verify voltmeter indicates 12.2 volts for approximately 5 seconds.

(17) Move the voltmeter to measure between pin 1 (+) and 6 (-). This point should also give a 12.2-volt indication.

(18) Depress the CALL switch and note voltmeter indication drops to zero.

(19) Reverse the power supply connections and repeat steps (5) through (10) to test positive ground operation.

c. Troubleshooting

A troubleshooting chart is provided as an aid in isolating the cause of any malfunction attributed to the decoder circuits. This chart presents a logical sequence of steps which result in isolating a faulty component or circuit. Refer to this chart when attacking any problem caused by this unit.

d. Repair

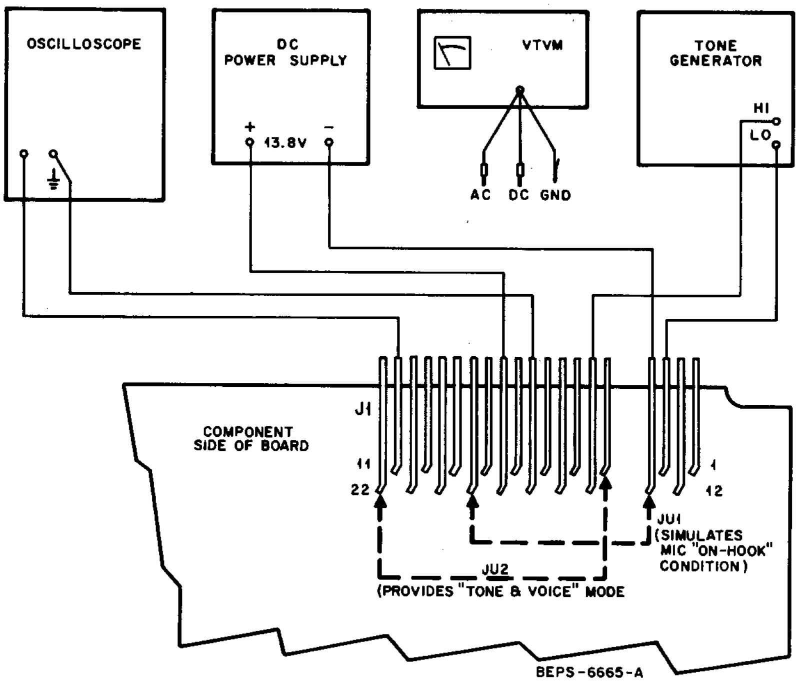
Any component on the circuit card can be replaced by following accepted repair procedures. Refer to the "Micor" radio instruction manual for information pertaining to ordering replacement parts. Upon completion of repairs, the circuit card is reinstalled as follows:

(1) Disconnect the green connector from the circuit card.

(2) Slide the card completely into the housing.

(3) Install the rear housing cover and secure with two captive screws.

(4) Reconnect the green connector to the circuit card.



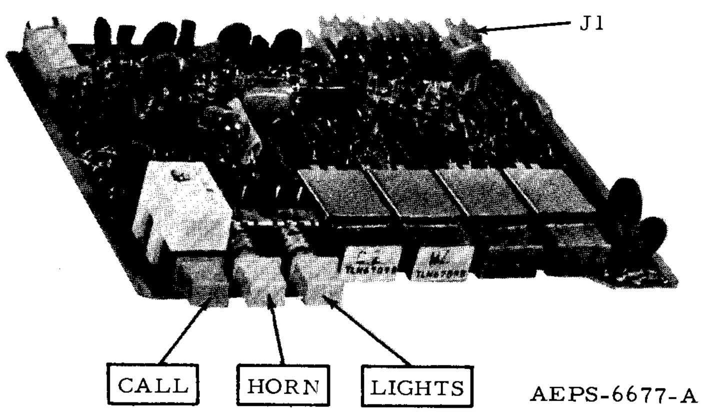


Figure 14.
Bench Testing

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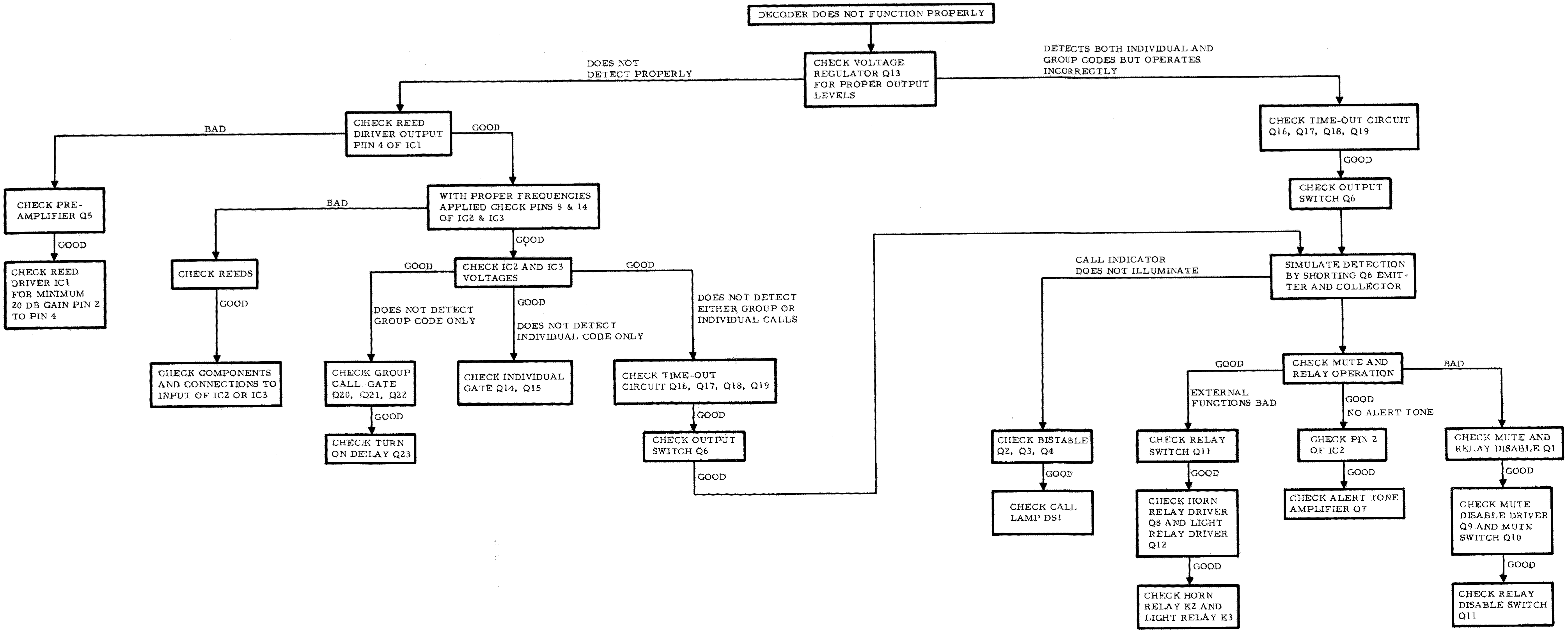
SELECTIVE SIGNALLING DECODER TROUBLESHOOTING CHART



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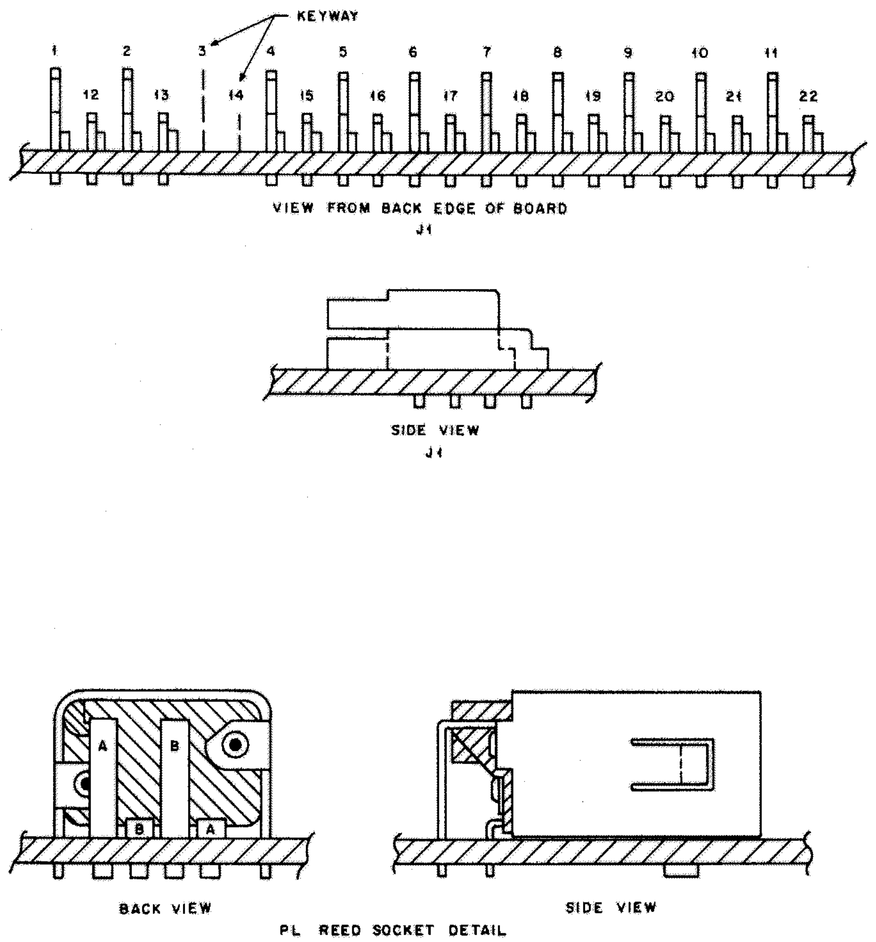

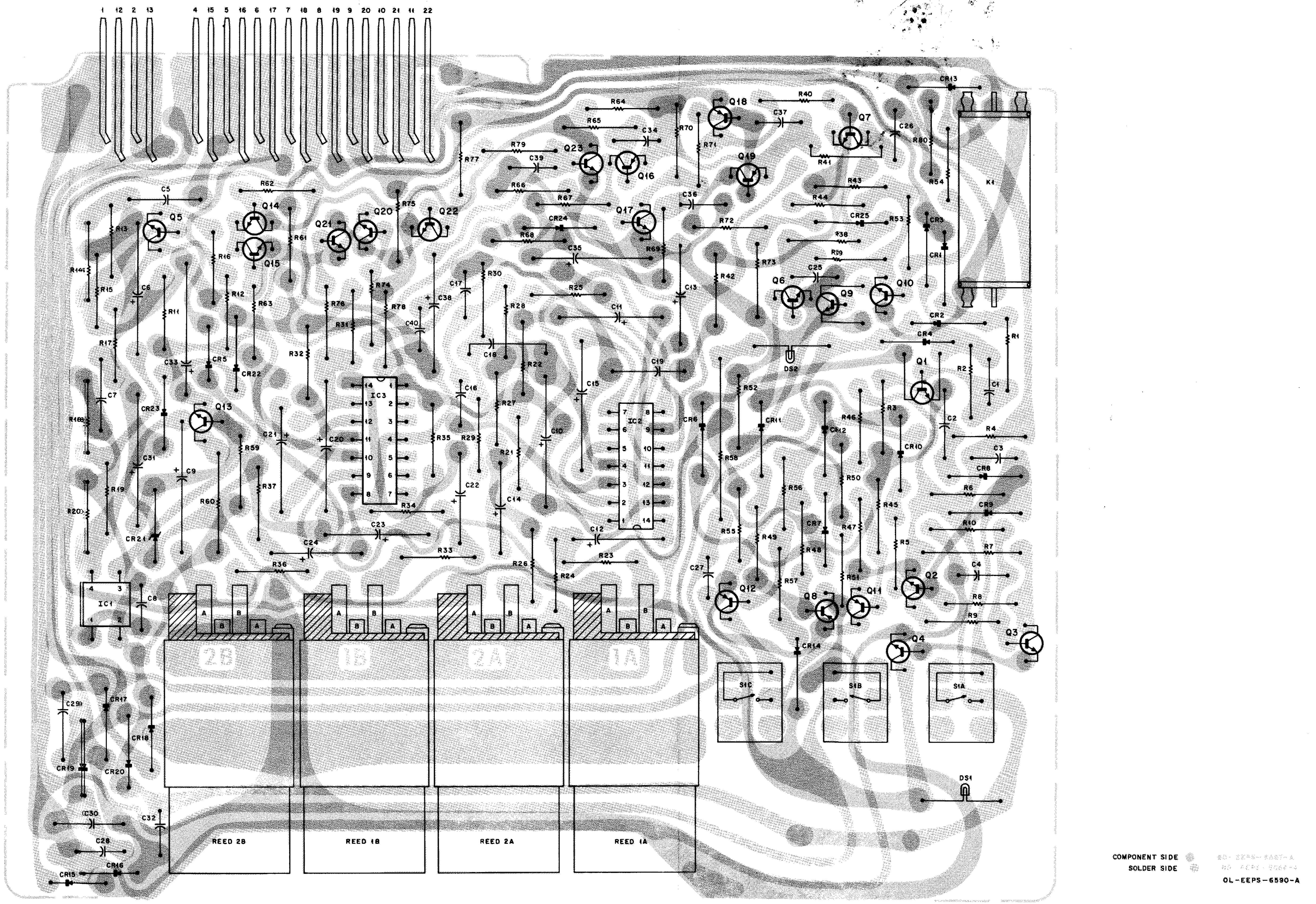

Circuit Board Detail
Motorola No. PEPS-6591-A
5/7/71-NPC

NOTES:

1. REFER TO TABLE 1 CONCERNING DECODER SENSITIVITY ADJUSTMENT.

TABLE 1

APPLY AN "ON-FREQUENCY" TONE-MODULATED CARRIER WITH 60% SYSTEM DEVIATION (3.0 kHz) TO THE ASSOCIATED RADIO SET RECEIVER ANTENNA INPUT	IF THE RESULTING RMS DISCRIMINATOR OUTPUT VOLTAGE IS:	MODIFY THE DECODER INPUT CIRCUIT AS INDICATED BELOW:
	LESS THAN 400 mv	NO MODIFICATION REQUIRED
	400 mv TO 600 mv	REMOVE RESISTOR R14
	OVER 600 mv	REMOVE RESISTOR R14 AND CHANGE RESISTOR R13 TO 68k

2. WHERE MORE THAN ONE DC VOLTAGE READING APPEARS:
   STBY = STANDBY, MICROPHONE ON-HOOK AND MONITOR-OPERATE SWITCH IN OPERATE POSITION, DECODER HAS BEEN RESET.
   ON = PROPER TONE CODE RECEIVED
   DIS = DISABLED, MICROPHONE OFF-HOOK OR MONITOR-OPERATE SWITCH IN MONITOR POSITION.
3. DC VOLTAGE READINGS TAKEN WITH HIGH IMPEDANCE (11 MEGOHM) DC VOLTMETER. ALL MEASUREMENTS WITH RESPECT TO DECODER GROUND.
4. AC VOLTAGE READINGS TAKEN WITH HIGH IMPEDANCE (10 MEGOHM) AC VOLTMETER. ALL RMS MEASUREMENTS MADE WITH RESPECT TO DECODER GROUND.
5. = BATTERY GROUND
   = DECODER GROUND

EPS-6584-B

MODEL AND SUFFIX TABLE

MODEL	SUFFIX	ITEM	SUFFIX	DESCRIPTION
TLN1389A		TLN4521A	1	SELECTIVE SIGNALLING DECODER BOARD
		TKN6503A		CABLE ASSEMBLY
		TLN4533A		FIREWALL RELAYS (HORN AND LIGHTS RELAYS)
		TLN4346A		MICROPHONE HANG-UP SWITCH BOX
		TLN6709B		"VIBRASPONDER" RESONANT REED
		TLN4510A		HARDWARE & ESCUTCHEON

EPS-6654-A

PREVIOUS REVISIONS AND PARTS LIST SHOWN ON BACK OF THIS DIAGRAM

Mobile Selective Signalling Decoder
Schematic Diagram
Motorola No. 63P81102E26-B
12/12/73-NPC

REVISIONS

63P81102E26-B

CHASSIS AND SUFFIX NO.	REF. SYMBOL	CHANGE	LOCATION	REFER TO CIRCUIT BOARD
TLN4521A-1	DS1	FROM 65K861828 TO 65C84047E01	PARTS LIST	NONE
	R13	FROM 6S129299, 68k TO 6S129667, 22k	PREAMPLIFIER Q5 BASE	
	R14	FROM 6S129668, 10k TO 6S129236, 15k		

PARTS LIST

TLN1389A Mobile Selective-Signalling Decoder PL-1224-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: uF: ±10%: 15 V: unl. stated
C1	21D82428B59	.01 +80-20%: 200 V
C2	21C82372C01	0.1 +80-20%: 25 V
C3	21D82428B25	.002 ±20%: 500 V
C4	21D82428B59	.01 +80-20%: 200 V
C5	8D82905G08	.033: 50 V
C6	23D83214C27	15 ±20%: 25 V
C7	8D82905G04	.068: 50 V
C8	21D82428B09	.0047: 100 V
C9	23D83214C27	15 ±20%: 25 V
C10	23D83214C27	15 ±20%: 25 V
C11	23D83214C28	1 ±20%
C12	23D84762H04	2.2
C13	23D83214C28	1 ±20%
C14	23D84762H04	2.2
C15	23D83214C27	15 ±20%: 25 V
C16	21C82633E15	800 pF ±5%: 100 V
C17	21C82633E15	800 pF ±5%: 100 V
C18	21E82537B37	1600 pF ±5%: 100 V
C19	8D82905G03	.047: 50 V
C20	23D83214C27	15 ±20%: 25 V
C21	23D83214C28	1 ±20%
C22	23D84762H04	2.2
C23	23D83214C28	1 ±20%
C24	23D84762H04	2.2
C25	21D82428B59	.01 +80-20%: 200 V
C26	21D82428B59	.01 +80-20%: 200 V
C27	21D82428B59	.01 +80-20%: 200 V
C28	21D82428B59	.01 +80-20%: 200 V
C29	21C82372C01	0.1 +80-20%: 25 V
C30	21C82372C01	0.1 +80-20%: 25 V
C31	23D83214C27	15 ±20%: 25 V
C32	21D82428B59	.01 +80-20%: 200 V
C33	23D83214C27	15 ±20%: 25 V
C34	21D82428B59	.01 +80-20%: 200 V
C35	23D83214C29	39 ±10%: 10 V
C36	21D82428B59	.01 +80-20%: 200 V
C37	21D82428B59	.01 +80-20%: 200 V
C38	23D83214C29	39 ±10%: 10 V
C39	21D82428B59	.01 +80-20%: 200 V
C40	21D82187B20	.001
		SEMICONDUCTOR DEVICE, diode: (SEE NOTE)
CR1 thru 4	48C83654H01	silicon
CR5	48C83654H01	silicon
CR6 thru 16	48C83654H01	silicon
CR17 thru 20	48D82466H13	silicon
CR21	48D82256C16	silicon; Zener type; 8.2 V
CR22 thru 25	48C83654H01	silicon
		LAMP,
DS1	65C84047E01	Lamp Assy. (encapsulated)
DS2	65B83554G01	incandescent: min. wedge base; 12 V; 0.19 A; type no. 161
		"VIBRASPONDER" RESONANT REED: (SEE NOTE)
E1 thru 4	TLN6709B	"plug-in" unit
		INTEGRATED CIRCUIT:
IC1	51R84320A04	type M2004
IC2	51R84267A10	type M6710
IC3	51R84267A10	type M6710
		CONNECTOR, receptacle:
J1		c/o contact terminals mounted on edge of circuit board as follows: 28C84269C01 TERMINAL, contact: narrow mounting tab (lower row) 28C84269C02 TERMINAL, contact: wide mounting tab (upper row)
		RELAY, magnetic reed:
K1	80D84082A01	8.0 to 16.5 V; 1 form "A"; coil res 820 ohms ±10%
		RELAY, armature:
K2, 3	59K813674	12 V; 1 form "A"; coil res 85 ohms ±10%
		CONNECTOR, plug:
P1		incl. 14C84556B03 BODY, 9C84151B01 TERMINAL, cont.
		TRANSISTOR: (SEE NOTE)
Q1	48R869570	N-P-N: type M9570
Q2	48R869571	P-N-P: type M9571
Q3	48R869570	N-P-N: type M9570
Q4	48R869648	N-P-N: type M9648
Q5	48R869570	N-P-N: type M9570
Q6	48R869570	N-P-N: type M9570
Q7	48R869570	N-P-N: type M9570
Q8	48R869649	P-N-P: type M9649
Q9	48R869570	N-P-N: type M9570
Q10	48R869570	N-P-N: type M9570
Q11	48R869649	P-N-P: type M9649
Q12	48R869649	P-N-P: type M9649
Q13	48R869648	N-P-N: type M9648
Q14	48R869570	N-P-N: type M9570
Q15	48R869570	N-P-N: type M9570
Q16	48R869571	P-N-P: type M9571
Q17	48R869570	N-P-N: type M9570
Q18	48R869571	P-N-P: type M9571
Q19	48R869571	P-N-P: type M9571
Q20 thru 23	48R869570	N-P-N: type M9570
		RESISTOR, fixed: ±5%: 1/4 W: unl. stated
R1	6S129981	3.3k
R2	6S129805	1k
R3	6S129526	33k
R4	6S128684	56k
R5	6S131527	47k
R6	6S131527	47k
R7	6S129818	820: 1/2 W
R8	6S131527	47k
R9	6S129237	6.8k
R10	6S129886	27k
R11	6S131446	120k
R12	6S129237	6.8k
R13	6S129667	22k
R14	6S129236	15k
R15	6S129777	39k
R16	6S129804	2.2k
R17	6S129805	1k
R18	6S129983	8.2k
R19	6S129983	8.2k
R20	6S129886	27k
R21	6S124A97	100k
R22	6S124A97	100k
R23	6S124A39	390
R24	6S129984	680
R25	6S131527	47k
R26	6S124A39	390
R27	6S129984	680
R28	6S131527	47k
R29	6S128683	150k
R30	6S128683	150k
R31	6S124A97	100k
R32	6S124A97	100k
R33	6S124A39	390
R34	6S129984	680
R35	6S131527	47k
R36	6S124A39	390
R37	6S129984	680
R38	6S124A27	120
R39	6S129668	10k
R40	6S131857	680k
R41	6S131527	47k
R42	6S128683	150k
R43	6S124A95	82k
R44	6S129805	1k
R45	6S129984	680
R46	6S129707	2.7k
R47	6S129984	680
R48	6S129668	10k
R49	6S129805	1k
R50	6S129981	3.3k
R51	6S129981	3.3k
R52	6S129805	1k
R53	6S129709	470
R54	6S129820	1.8k
R55	6S129886	27k
R56	6S129668	10k
R57	6S129805	1k
R58	17C82350A02	47 ±10%: 1.5 W
R59	6S129805	1k
R60	6S124A09	22; 1/2 W
R61	6S129806	330
R62	6S129526	33k
R63	6S129526	33k
R64	6S124A97	100k
R65	6S129526	33k
R66	6S131857	680k
R67	6S124A27	120
R68	6S128683	150k
R69	6S129668	10k
R70	6S128684	56k
R71	6S129981	3.3k
R72	6S129981	3.3k
R73	6S129668	10k
R74	6S124A97	100k
R75	6S124A97	100k
R76	6S129526	33k
R77	6S129299	68k
R78	6S129668	10k
R79	6S128683	150k
R80	6S131527	47k
		SWITCH ASSEMBLY, push:
S1	40D84324C04	3 independent sections; incl.
S1A		spdt; momentary action
S1B		spdt; alternate action
S1C		spdt; alternate action (pushbuttons are listed under NON-REFERENCED ITEMS)
		SOCKET,
XDS2	9C84285C01	Bulb Socket
XE1 thru 4	42B84116B02	"Vibrasponder" Resonant Reed: 4-contact
		NON-REFERENCED ITEMS
	14C84360C01	INSULATOR, Switch (3 req'd)
	14C84006D01	SPACER, (DS1/S1A)
	13D84319C01	ESCUTCHEON
	38C84321C01	PUSHBUTTON (shadow-pearl)
	38C84321C02	PUSHBUTTON (orange)

NOTE:

Replacement diodes and transistors must be ordered by Motorola part number only for optimum performance.

When ordering replacement "Vibrasponder" Resonant Reeds, specify the code and frequency. Do not add reed frequencies to your system without consulting your Motorola Area Systems Engineer for assignment of tones that will provide the most satisfactory operation.

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