MICOR® Systems 90

"QUIK-CALL"
MOBILE SELECTIVE SIGNALLING DECODER

MODEL TLN 1389A

MOTOROLA INC.
Communications Division

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THIS MANUAL HAS BEEN DISCONTINUED
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1. TECHNICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>TONE FREQUENCIES</th>
<th>346.7 to 1122.1 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>TONE STABILITY</td>
<td>±0.2% from -30°C to +85°C ambient (±25°C reference)</td>
</tr>
<tr>
<td>SENSITIVITY</td>
<td>Less than 6 dB quieting</td>
</tr>
<tr>
<td>MUTING</td>
<td>Greater than 50 dB below 10 watts of audio</td>
</tr>
<tr>
<td>TONE CODING</td>
<td>INDIVIDUAL CALL - Two pulses of two tones each (automatic encoder timing)</td>
</tr>
<tr>
<td></td>
<td>GROUP CALL - One pulse of two tones (manual timing)</td>
</tr>
<tr>
<td>PULSE LENGTHS</td>
<td>1st pulse: 1.25 ±0.25 seconds</td>
</tr>
<tr>
<td></td>
<td>2nd pulse: 1.0 ±0.2 second</td>
</tr>
<tr>
<td></td>
<td>Interval between pulses: approx. 0.2 second</td>
</tr>
<tr>
<td>INPUT IMPEDANCE</td>
<td>Greater than 25 kilohms</td>
</tr>
<tr>
<td>NOMINAL INPUT VOLTAGE</td>
<td>±13.6 volts dc</td>
</tr>
<tr>
<td>CURRENT DRAIN</td>
<td>Standby: 190 mA</td>
</tr>
<tr>
<td></td>
<td>Decoding: Call Light &amp; alert tone 300 mA; Horn Relay add 150 mA; Lights Relay add 150 mA</td>
</tr>
<tr>
<td>HORN AND LIGHT RELAY</td>
<td>30 amperes @13.6 V</td>
</tr>
<tr>
<td>CONTACT RATINGS</td>
<td>-A selective signalling encoder which is used by the dispatcher to generate the coding tones.</td>
</tr>
<tr>
<td></td>
<td>-A mobile radio set for each vehicle of the system.</td>
</tr>
<tr>
<td></td>
<td>-A mobile selective signalling decoder in each mobile unit.</td>
</tr>
</tbody>
</table>

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.

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 analysts 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 C2) 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.
Table 1. "Quik-Call" Codes

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

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 3C.) 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 multicorder cable.

(7) Remove the "S" clamp from the end of the multicorder cable and move 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.

(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"
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 unmut 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 Switch 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
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 push- 
button 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 
 Bluetooth symbol) the receiver is unmuted and all on frequency 
calls (regardless of tone coding) are heard. Per- 
mits 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".

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 IC1 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 in 
tegrators 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 cause 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 if 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 charge 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.
CALL Light Switching
(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.

Receiver Unmuting
(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 un muted 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
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 "off" 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
CONVENTIONAL CURRENT FLOW, NEGATIVE GROUND BATTERY
(USE OPPOSITE DIRECTION FOR ELECTRON FLOW)

CONVENTIONAL CURRENT FLOW, POSITIVE GROUND BATTERY
(USE OPPOSITE DIRECTION FOR ELECTRON FLOW)

Figure 13.
Power Input and Voltage Regulator Circuit
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 one defective, 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 "Vibra sender" 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
SELECTIVE SIGNALLING DECODER TROUBLESHOOTING CHART

DECODER DOES NOT FUNCTION PROPERLY

DARK

BAD

CHECK PRE-AMPLIFIER Q7

GOOD

CHECK REED SWITCH OUTPUT PIN 4 OF IC1

GOOD

WITH PROPER FREQUENCIES APPLIED CHECK PIN 6 & 14 OF IC2 & IC3

BAD

DOES NOT DETECT GROUP CODE ONLY

GOOD

CHECK 4IC AND 1IC VOLTAGE

GOOD

DOES NOT DETECT INDIVIDUAL CODE ONLY

GOOD

CHECK INDIVIDUAL GATE QH1, QH2

GOOD

CHECK TIME-OUT CIRCUIT QH1, QH2, QH3

GOOD

CHECK TIME-OUT CIRCUIT QH1, QH2, QH3

GOOD

CALL INDICATOR DOES NOT ILLUMINATE

BAD

EXTERNAL FUNCTIONS BAD

GOOD

CHECK INPUT QL1, QL2, QL3

GOOD

CHECK RELAY DRIVER QN AND LIGHT RELAY DRIVER QN

GOOD

CHECK RELAY DRIVER QH1

GOOD

CHECK MUTE AND RELAY DRIVER QH1

GOOD

CHECK MUTE AND RELAY Driver QH1

GOOD

CHECK MUTE AND RELAY DRIVER QH1

GOOD

CHECK ALERT TONE AMPLIFIER Q7

GOOD

CHECK MUTE AND RELAY DRIVER QH1

GOOD

CHECK MUTE AND RELAY DRIVER QH1

GOOD

CHECK MUTE AND RELAY DRIVER QH1

GOOD

CHECK MUTE AND RELAY DRIVER QH1

GOOD

CHECK MUTE AND RELAY DRIVER QH1

GOOD
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