1. TECHNICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>DESCRIPTION</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLN1390A</td>
<td>4-REED MOBILE PAGING DECODER</td>
<td>INDIVIDUAL AND GROUP CALL</td>
</tr>
<tr>
<td>TLN1391A</td>
<td>2-REED MOBILE PAGING DECODER</td>
<td>INDIVIDUAL CALL</td>
</tr>
</tbody>
</table>

| TONE FREQUENCIES | 288.5 to 1433.4 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      | Two pulses of one tone each (automatic encoder timing) |
| PULSE LENGTHS    | 1st pulse: 1.25 ±0.25 seconds |
|                  | 2nd pulse: 3.0 ±0.5 seconds |
|                  | Interval between pulses: 0.24 to 0.33 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 II" Mobile Paging Decoder equips Motorola "Micor" FM Two-Way Mobile Radio for use in a mobile paging system. The decoder is fully solid-state and uses two integrated circuits (three in 4-reed models) 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 lights relays. The housing is ordered separately, since numerous combinations of housings and accessories are possible.

3. MOBILE PAGING SYSTEM

a. Typical System

A mobile paging 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 paging encoder which is used by the dispatcher to generate the coding tones.
- A mobile radio set for each vehicle of the system.
- A mobile paging decoder in each mobile unit.

Each mobile paging 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 mobile operator then disables the decoder and monitors the channel for messages from the dispatcher (tone only operation). The decoder can be connected for automatic channel monitoring after the alert tone ends 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.

Two types of decoders are available; 2-reed and 4-reed models. Both types allow selective calling of an individual mobile radio unit as just described. However, the 4-reed model additionally permits a group of mobile units to be called simultaneously. The 4-reed decoders respond to either of two codes. One code is the individual call code which is different for each vehicle, and the second code is the group call code which is identical in a group of vehicles. 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 paging system is a two tone sequential type as shown in Figure 2. The decoder will respond only if the tones are the correct frequencies and only if they occur in the proper sequence. The scheme allows paging systems of from 2 to 3540 units. The scheme is secure from false operation since two conditions must be met to activate the decoder.

Audio frequencies in the 288- to 1450-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 "Vibraponder" 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 60 different paging tones and 36 different "Quik-Call" tones as listed in Tables 1 and 2. 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.
Figure 2.
Coding Scheme

Table 1. Radio Paging Codes

<table>
<thead>
<tr>
<th>TONE NUMBER (2nd &amp; 3rd digits)</th>
<th>Reed Group 1 REED CODE</th>
<th>Reed Group 1 FREQ. (Hz)</th>
<th>Reed Group 2 REED CODE</th>
<th>Reed Group 2 FREQ. (Hz)</th>
<th>Reed Group 3 REED CODE</th>
<th>Reed Group 3 FREQ. (Hz)</th>
<th>Reed Group 4 REED CODE</th>
<th>Reed Group 4 FREQ. (Hz)</th>
<th>Reed Group 5 REED CODE</th>
<th>Reed Group 5 FREQ. (Hz)</th>
<th>Reed Group 6 REED CODE</th>
<th>Reed Group 6 FREQ. (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>111</td>
<td>349.0</td>
<td>121</td>
<td>600.9</td>
<td>131</td>
<td>584.8</td>
<td>138</td>
<td>288.5</td>
<td>191</td>
<td>1153.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>112</td>
<td>385.8</td>
<td>122</td>
<td>634.5</td>
<td>132</td>
<td>617.4</td>
<td>138</td>
<td>296.5</td>
<td>192</td>
<td>1185.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>113</td>
<td>389.0</td>
<td>123</td>
<td>669.9</td>
<td>143</td>
<td>651.9</td>
<td>139</td>
<td>304.7</td>
<td>193</td>
<td>1217.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>114</td>
<td>410.8</td>
<td>124</td>
<td>707.3</td>
<td>154</td>
<td>688.3</td>
<td>140</td>
<td>313.0</td>
<td>194</td>
<td>1251.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>115</td>
<td>433.7</td>
<td>125</td>
<td>746.8</td>
<td>155</td>
<td>726.8</td>
<td>146</td>
<td>422.1</td>
<td>195</td>
<td>1285.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>116</td>
<td>457.9</td>
<td>126</td>
<td>788.5</td>
<td>166</td>
<td>767.4</td>
<td>130</td>
<td>979.9</td>
<td>196</td>
<td>1321.2</td>
<td></td>
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<tr>
<td>7</td>
<td>117</td>
<td>483.5</td>
<td>127</td>
<td>832.5</td>
<td>157</td>
<td>810.2</td>
<td>161</td>
<td>1006.9</td>
<td>197</td>
<td>1357.6</td>
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<tr>
<td>8</td>
<td>118</td>
<td>510.5</td>
<td>128</td>
<td>879.0</td>
<td>158</td>
<td>855.5</td>
<td>131</td>
<td>1034.7</td>
<td>198</td>
<td>1395.0</td>
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<td></td>
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<tr>
<td>9</td>
<td>119</td>
<td>539.0</td>
<td>129</td>
<td>928.1</td>
<td>159</td>
<td>903.2</td>
<td>162</td>
<td>1063.2</td>
<td>199</td>
<td>1433.4</td>
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<tr>
<td>0</td>
<td>120</td>
<td>569.1</td>
<td>140</td>
<td>321.7</td>
<td>150</td>
<td>553.9</td>
<td>189</td>
<td>1092.4</td>
<td>190</td>
<td>1122.5</td>
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</table>

Table 2. "Quick-Call" Codes

<table>
<thead>
<tr>
<th>A Series</th>
<th>B Series</th>
<th>Z Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Freq. (Hz)</td>
<td>Code</td>
</tr>
<tr>
<td>CZ</td>
<td>346.7</td>
<td>CB</td>
</tr>
<tr>
<td>DZ</td>
<td>384.6</td>
<td>DB</td>
</tr>
<tr>
<td>EZ</td>
<td>426.6</td>
<td>EB</td>
</tr>
<tr>
<td>FZ</td>
<td>473.2</td>
<td>FB</td>
</tr>
<tr>
<td>GZ</td>
<td>524.8</td>
<td>GB</td>
</tr>
<tr>
<td>HZ</td>
<td>582.1</td>
<td>HB</td>
</tr>
<tr>
<td>JZ</td>
<td>645.7</td>
<td>JB</td>
</tr>
<tr>
<td>KZ</td>
<td>716.1</td>
<td>KB</td>
</tr>
<tr>
<td>LZ</td>
<td>794.3</td>
<td>LB</td>
</tr>
<tr>
<td>MZ</td>
<td>881.0</td>
<td>MB</td>
</tr>
<tr>
<td>NZ</td>
<td>977.2</td>
<td>NB</td>
</tr>
<tr>
<td>PZ</td>
<td>1084.0</td>
<td>PB</td>
</tr>
</tbody>
</table>
On decoders using the paging codes, a three-digit number is stamped on each reed to identify the code frequency for that unit. Each number identifies the reed group and reed frequency (Table 1).

On decoders that may use the "Quik-Call" frequencies, the number stamped on the reed consists of two letters (example LZ). The letters correspond to the reed codes as identified in Table 2. For the example given, the reed (LZ) operates at 794.3 Hz.

Reed placement is very important; reversing the order of the reeds reverses the coding sequence of the decoder. For individual call codes, the frequency of the reed in socket 1A must correspond to the first tone and the frequency of the reed in socket 2A must correspond to the second tone. For group call operation (4-reed models), the frequency of the reed in socket 1B must correspond to the frequency of the first group call tone, and 2B must correspond to the second group call tone. The reed sockets are labeled for easy identification.

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 3D 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 3D. 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 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:
O Yellow wire into position 1.
O Black-violet wire into position 5.
O Black-brown wire into position 16.
O Black-green wire into position 20.
O Violet-black wire into position 21.

(11) Reconnect P101 to the control head and connect P1 to the 32-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 radio) 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 black connector.
If a microphone hang-up box was installed with the radio, (carrier squelch radio) the hang-up box 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 (P101) and the green wire into pin 19 of the green connector.
(c) Attach the horn and light relay in a secure position in the engine compartment, evacuate the firewall, etc., and connect them as illustrated in Figure 12.

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 trimout bracket and housing assembly as instructed.
(3) Connect the black (and blue, if used) connectors to the control head.
(4) Connect the green connector (P1) to decoder jack (J1).

c. Jumper Options

(1) 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.
(2) If the system includes both mobile paging and selective signaling coding, a wired decoder can be wired to permit two simultaneous tone-decoding for group call operation by adding a jumper as shown in Figure 13. This form of tone-coding is not as reliable as the normal sequential coding and is not recommended.

d. Installation Options

(1) When mobile decoders are used in "Private Line" systems there are various metering options available.

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

(c) 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:

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

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

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

4. 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.

(2) 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.

(3) 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 on the slide switch.

(c) Connect GRN wire of the 2-conductor cable to the green decoder connector (P1-7) and the BLK wire to black connector P1101-15.

(4) 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.
Figure 4.
Controls and Indicators

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

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 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 remutes the receiver when operated.

3. HORN switch - Alternate action pushbutton switch. This 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
Figure 5,
Functional Block Diagram
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".

Hang-Up Box - Automatic monitoring of the channel and automatic reset when the microphone is lifted "off-hook". Also restores receiver muting when 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 & 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 brief series of tone pulses are heard at the speaker. 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 a few 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 (Refer to Figure 6)

The decoder is activated by the paging code coupled from the discriminator buffer output in the radio set. The paging code consists of a tone approximately one second in duration followed by a 1/4-second delay and then a second tone whose duration is approximately three seconds. These tones are coupled through C5 to the parallel network consisting of R13 and R14. If the amplitude of the tones exceeds 400 mV at 60% system deviation, the resistance of the decoder input circuit (R13 and R14) should be adjusted in accordance with NGT 1 in the main schematic diagram to provide the proper drive to the base of Q5. The output of Q5 is coupled to reed driver 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 and 2A (also 1B and 2B in a four-reed model).

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

b. Decoder Logic

Tone 1A causes pin 13 of IC2 to go low (see Figures 7 and 8). At the end of the tone, the voltage at pin 13 again starts to rise toward its supply voltage of 5.5 volts. The rate of rise is determined by the charging rate of C10 through R21. Tone 2A causes pin 9 of IC2 to go low. At this same time the output of the tone 2A integrator will go low and keep one input to the tone 1A-2A gate (AND gate) low for approximately three seconds.

After about 3/4 second into the tone 2A pulse, C10 will have charged sufficiently high to turn the next stage on. At this time pin 12 goes low and the RC network of C11 and R22 produce a sharp negative pulse. Tone 2A and the sharp negative pulse will turn on the AND gate to provide a positive output. This output is fed back and inverted through the decoder latch to hold pin 11 low. This arrangement of circuitry will therefore provide for two simultaneous low inputs to the AND gate until tone 2A disappears.

The positive output from the 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 output is taken from the collector of Q7 and, after attenuation by R62, is coupled to the audio amplifier in the radio set.

IC3, which is used on four-reed models only, is identical to IC2 but the pulsing or tone oscillators are not used. However, its pin 10 output
Figure 8.
Decoder Logic Circuit

Figure 9.
CALL Light Switching Circuit
coupled to pin 10 on IC2 and, in this manner, the pulsating alert tone will be generated.

Failing protection against tone reversal is inherent in the IC circuit, if tone 2A should come in first, the output of the tone 2A integrator will remain low for only approximately three seconds. When tone 1A comes in, the inherent delay designed into the circuit (previously described) will not produce a low at pin 11 until after the low from tone 2A has disappeared. Therefore, the AND gate will not operate. If tones 1A and 2A happen to come in simultaneously, failing protection is provided by the fact that although the outputs of tone 2A integrator and pin 13 are low; pin 11 is high. Therefore the inputs to the AND gate are dissimilar and it will not operate.

c. 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 lamps. The lamps 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 volt 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. 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 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 switch K1 remains de-energized as long as Q10 is cut off. Consequently, the radio set will remain unmuted only until the second tone has disappeared and 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, which only continued until the disappearance of the tone signal, 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 the duration of the alert tone 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 the paging tones end and 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 is removed and relays K2 and K3 are de-energized. Therefore, the horn and lights alerting devices are deactivated.
Figure 12.
Channel Monitoring and Automatic Reset
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 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 switch box, diode CR12 becomes forward biased. This, in turn, activates mute disable driver Q9 which allows the mute reed switch K1 to be de-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.

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 a regulated 7.5-volt output which is used by the audio amplifier stages, including the reed driver integrated circuit IC1. A voltage divider network (R361, CR22, and CR23) develops 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 decoder integrated circuits IC2 and IC3.

7. MAINTENANCE

Maintenance of the mobile paging 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.
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
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 check-out.

- 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 switch on the generator, release and quickly depress the TONE 2 switch.

**NOTE**

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

(9) Observe the following indications.

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

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

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

(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 volt.
Figure 14.
Bench Test Set-Up
16. Operate the tone generator to send the proper code and verify voltmeter indicates 12.2 volts for approximately 2.5 seconds.

17. Move the voltmeter to measure between pins 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. To check four-reed models, perform steps (5) through (7) and then depress the TONE 3 switch, release and depress the TONE 4 switch. Observe the indications listed in step (9).

20. 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.