MICOR® Systems 90

SINGLE-TONE ENCODER

MODEL TLN1393A
TLN1394A

MOTOROLA
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Issue - A
1. DESCRIPTION

The "Micor" Single-Tone Encoder provides a selective tone source for mobile radio units in a single-tone controlled two-way radio system. Designed as a circuit card that slides into a "Systems 90" accessory housing, an oscillator generates a short, fixed duration audio tone when the mobile radio transmitter is keyed. This tone modulates the carrier and is transmitted to the associated receiver stations on the same rf channel. Some of the more common applications for single-tone signalling are:

- Tone-alert the receiving station to a pertinent incoming call.
- The associated receiver station may incorporate a tone decoder unit which, when activated by reception of the single tone, will complete the audio output circuit. Thus, only the receiver for whom the call was intended will receive the message.
- The receiving station may incorporate a tone decoder unit which, when activated, will open and/or close an external control circuit for repeater or external alarm system.

TECHNICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>BASIC UNIT</th>
<th>TLN1393A one-tone output</th>
</tr>
</thead>
<tbody>
<tr>
<td>TONE FREQUENCY RANGE</td>
<td>1050 to 3000 Hz in 150-Hz steps.</td>
</tr>
<tr>
<td>POWER INPUT</td>
<td>12-volt dc operation; positive or negative ground</td>
</tr>
<tr>
<td>TONE DURATION</td>
<td>0.5 or 1.5 seconds. Addition of a jumper will provide a continuous tone.</td>
</tr>
<tr>
<td>OUTPUT</td>
<td>0.2 V maximum for a transmitter having an input impedance of approximately 220 ohms. Will provide 3.3 kHz deviation.</td>
</tr>
<tr>
<td>DIMENSIONS</td>
<td>Approximately 6&quot; long, 4-1/2&quot; deep, and 3/4&quot; high (circuit board only)</td>
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</table>

2. INSTALLATION

a. Field Installed Option

The single-tone encoder circuit card is installed in the accessory housing, either alone or in conjunction with other radio accessories. The installation instructions provided here are for the single-tone encoder used as the only accessory. For instructions pertaining to multiple installations refer to the Installation Instructions supplied with the housing assembly.

To add the single-tone encoder in a negative ground system, refer to the schematic diagram and proceed as follows:

1. Slide the circuit card completely into the housing assembly.
2. Install the rear housing cover and secure with two captive screws.
3. Disconnect the black connector (P1101) from the control head.
4. Use the contact removal tool to remove six wires, with pins attached, from P1101 as follows:
   - Yellow wire from position 1.
   - Black-violet wire from position 9.
   - Black-yellow wire from position 11.
   - Black-orange wire from position 22.
   - Orange wire from position 13.
   - Violet wire from position 5.

**NOTE**

Steps (5) and (6) are not applicable when the wires extend at least five inches beyond the sleeving on the multiconductor cable.

5. Remove the "S" clamp from the end of the multiconductor cable and move the strain relief back about five inches.

6. Cut approximately five inches of sleeving off the cable. Avoid cutting the insulation of any wires.

7. Insert the pins and wires which were removed from P1101 into the white connector (P1) as follows:
   - Yellow wire into position 19.
   - Black-violet wire into position 12.
   - Black-yellow wire into position 20.
Black-orange wire into position 17.
Orange wire into position 15.
Violet wire into position 14.

(8) Insert the pins and wires connected from P1 into P1101 as follows:
- Yellow wire into position 1.
- Black-violet wire into position 9.
- Black-yellow wire into position 11.
- Black-orange wire into position 22.
- Orange wire into position 13.

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

(10) Remove the escutcheon backing and attach escutcheon to the housing assembly front panel.

(11) To install the monitor-tone circuit board, remove the radio set from its housing.

(12) Position the radio set with the bottom side facing up.

(13) Loosen, but do not remove, the two screws securing connector block P901 (see Figure 1).

(14) Slip the monitor-tone circuit board bracket lugs underneath the screws and tighten the screws.

(15) Connect the shorter wire (red) connector to pin 27 on P901. When viewing the connector from the front of the radio set, pin 27 is at the extreme right corner of the top row of pins.

Figure 1.
Monitor-Tone Circuit Board Installation Details
(16) Connect the longer wire (yellow) connector to pin 14 on P903 located on the control board. When viewing this connector, pin 14 is the fifth pin counting from the front of the radio set.

(17) Do not replace the radio set until the overall installation satisfies the performance requirements given in the ADJUSTMENTS section of this manual.

To install the single-tone encoder in a positive ground system, the procedure is the same as for a negative ground system with the following exceptions:

- Reverse pins 12 and 19 in the white connector (P1). (Yellow to pin 12, black-violet to pin 19.)

- Reverse pins 1 and 9 in the white connector (P1). (Yellow to pin 1, black-violet to pin 9.)

- Change the flexible wire jumper on the circuit card as shown on the single-tone encoder circuit board detail diagram.

- Reverse pins 8 and 15 in the white connector (P1). Both leads are orange colored.

b. Factory Wired Option

When the single-tone encoder 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) connectors to the control head.

4. Connect the white connector (P1) to the single-tone encoder board jack (J1).

3. OPERATION

The operator controls on the single-tone encoder panel (see Figure 2) consist of six push button switches labelled OFF, ST1, ST2, . . . , ST5 (OFF and ST1 buttons only on one-tone models). The switches are mechanically interlocked so that only one can be activated at a given time. Operation of the unit is as follows:

a. Select the desired tone frequency by pushing one of the ST buttons.

b. Close the P-T-T switch on the microphone. A tone of 0.5 or 1.5 seconds (depending on the connection of JU1) duration will be heard in the loudspeaker.

c. After the tone has ended, the operator may proceed with his speech transmission.

d. Push the OFF button to turn the unit "off".

Figure 2.
Operator's Controls

4. ADJUSTMENTS

The field installed single-tone encoder circuit board option is shipped from the factory wired for negative ground operation. Jumper JU1 (see schematic and circuit board detail) is wired to provide a 0.5 second tone. The tone level control (R15) has been factory adjusted to provide for ±3 to ±3, 3 kHertz deviation with a nominal radio set. Upon installation, this deviation should be checked as follows:

a. Turn on the radio set and key the transmitter. Check the deviation of the tone (on five-tone encoder units, check the deviation on the ST3 position).

b. If the deviation is not approximately ±3 to ±3, 3 kHertz with ST3 depressed, disconnect connector P1 and remove the rear panel of option housing. Adjust R15, the small blue control on the rear edge of the circuit card (see Figure 4) to obtain the desired deviation of the tone. Reinstall the rear panel and P1.

AEPS-5714-O
c. Check the maximum audio deviation of the radio set from the microphone. It is sometimes necessary to readjust the IDC control in the radio set for ±5 kHz deviation after the addition of a single-tone encoder option.

5. FUNCTIONAL OPERATION

a. Standby

In a standby condition, Q6 in the timing circuit, monostable holds switch Q1 on (see Figure 3). The output of Q1 holds the first integrator E2 off thus disabling the active filter oscillator. Therefore, there is no tone signal applied to the inputs of the output buffer and monitor tone amplifier stages. A dc control voltage from Q6 holds Q7 in saturation to prevent any internally generated noises from leaving the single-tone encoder board. The monitor-tone circuit board prevents noise picked up by the lead connecting the output of Q7 to the input of the radio set from reaching the audio stages.

b. Transmit

When the P-T-T function is activated, the P-T-T bridge activates the timing circuit monostable -- turns Q5 off and Q4 and Q6 on. Q6, in the timing circuit, turns switch Q1 off and also brings monitor tone amplifier Q7 out of saturation. The active filter oscillator is now enabled by Q1 and generates a tone in the 1050 to 3000 Hz range (depending on the value of the tone code resistors). The oscillator output passes through the output buffer amplifier and modulates the transmitter carrier. The oscillator output also passes through the monitor tone amplifier, the monitor-tone circuit, and the tone (0.5 or 1.5 seconds long) is heard in the loudspeaker. The tone ends when the timing circuit monostable "flips-back" to its standby state and causes switch Q1 to disable the oscillator. At this same time, the monitor tone amplifier is driven back into saturation.

6. THEORY OF OPERATION

a. Standby

In a standby condition, Q5 in the monostable timing circuit is conducting while Q4 is cut off (see Figure 3 and the schematic diagram). The conduction of Q5 places the base of inverter Q6 at approximately ground potential and holds it cut off. The resulting high collector voltage of Q6 is coupled to the base of switch Q1 and also through CR6 to the base of the monitor tone amplifier Q7. The high voltage on the base of Q1 keeps this stage conducting heavily and effectively grounds pin 3 of the first integrator E2. This ground disables the active filter oscillator and no tone signal is generated. At the same time, the high voltage coupled through CR6 causes Q7 to operate in its saturation region which effectively grounds the monitor tone output. Excessive noise generated within the encoder is shunted through Q7 and cannot leave the encoder board. Noise picked up by the lead connecting the output of Q7 to the radio set is kept from reaching the audio stages by the monitor-tone circuit. The noise is reduced by the divider-attenuator network consisting of R101 and R102. The residual noise does not have sufficient amplitude to forward bias the limiter network (CR101, CR102). This effective open circuit keeps noise from entering the radio set.

b. Transmit

When the P-T-T switch on the microphone is activated, a ground is placed at the junction of CR6 and CR10. This ground creates a current path through CR10, R48, R49, and CR9 to A+ (in a negative ground system). The voltage developed across R48 biases Q8 into conduction and its low collector voltage is coupled through CR7 to the junction of R33 and C17. This voltage change is coupled by C17 and reverse biases CR5. Q5 is now zero-biased and cuts-off to activate the timing circuit monostable. The high collector voltage of Q5 biases both Q4 and Q6 into conduction. As Q6 conducts, its low collector voltage drives switch Q1 to near cut-off and at the same time causes Q7 to shift its operating point from saturation to an active region on its amplification characteristic curve.

The high impedance of switch Q1 allows the active filter oscillator to generate a tone whose frequency is determined by the tone code resistors (R17 and R18 only in one-tone models). Positive feedback voltage for the oscillator circuitry is provided by a path through C5, R6, R3, C2 and a limiter (CR1, CR2) from the output of E2 to the input of E1. Because of the extremely high Q's of the active filters, a negative stabilization feedback voltage is coupled from the output of E2 (through R2) to pin 3 of E1. The tone-frequency output of the oscillator circuitry will range from 1050 to 3000 Hz (in 150 Hz steps) depending on the values of the tone code resistors.

The tone output from the active filter oscillator is coupled from pin 5 of E2 to the bases of both the output buffer amplifier and the monitor tone
Figure 3. Functional Operation Diagram
amplifier. The output buffer amplifier isolates the high impedance output of the active filter oscillator circuit from the low impedance of the microphone. The amplified tone signal is coupled through R14, R15, and C15 to the microphone and FM modulates the transmitter carrier. R15 controls the tone amplitude output and consequently the amount of carrier deviation. The tone signal applied to the base of Q7 is amplified (since Q7 is no longer in saturation) and applied to the monitor-tone circuit. The tone signal has sufficient amplitude (approximately 10 V p-p), so that even after passing through the divider-attenuator network, it forward biases the limiter network (CR101, CR102). This allows the tone signal to pass through to the audio stages in the radio set and be heard in the loudspeaker. The operator, upon hearing the end of the 0.5 or 1.5 second tone, may then proceed with his voice transmission.

The active filter oscillator continues to generate a tone until the monostable timing circuit returns to its original stable state. Enabling the P-T-T function originally turned Q5 off and Q4 on. Capacitor C16 will start charging through the resistive network of R30 and R29 (if jumper JU1 is out). The RC time constant of this network determines the reverse bias time of CR5. After 1.5 seconds (0.5 seconds with JU1 in) the charge on C16 reaches a potential which is high enough to forward bias CR5. The conduction of CR5 biases Q5 into conduction. The resulting low collector voltage of Q5 biases both Q4 and Q6 to cut-off. The high collector voltage of Q6 turns on switch Q1 which shuts off the active filter oscillator and the tone ends.

For testing or adjustment purposes, a continuous tone can be generated by connecting a jumper from pin 22 to pin 3 or 13 on J1. This connection holds switch Q1 off and the active filter oscillator will generate a continuous tone.

Diode CR12 prevents the encoder unit from receiving a false keying signal when the ignition switch is turned on or off.

7. MAINTENANCE

Single-tone encoder maintenance can be broken down into two categories: testing and troubleshooting. Testing is actually an extension of troubleshooting and is limited to comparing voltage measurements to those indicated on the schematic diagram.

CAUTION
It is recommended that units installed in a positive ground system be serviced in a negative ground bench test set-up. In a positive ground installation, the ground is "floating" and the encoder board ground should never be connected or shorted to the vehicle ground.

a. In-System Testing

Making circuit voltage checks necessitates removing the circuit card from the housing assembly and is accomplished as follows:

1. Disconnect the white connector attached to 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 the card atop the housing with the solder side up.

4. Reconnect the white connector (removed previously) to the proper location on 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 necessary voltage measurements.

b. Bench Testing

A check out of single-tone encoder can also be performed on a test bench. The following equipment is required for a thorough circuit check-out.

DC Power Supply

Oscilloscope

Service bench VTM

Frequency counter

To perform a bench check proceed as follows:

1. Remove white connector from rear of the circuit card.
(2) Loosen two captive screws securing the rear housing cover and remove the rear cover.

(3) Remove the circuit card from the housing.

(4) Set up the single-tone encoder circuit card as shown in Figure 4.

(5) Depress one of the ST buttons.

Continuous-key the single-tone encoder board by grounding pin 3 or 13 on J1. The signal output amplitude (at pin 20 on J1) should read approximately 150 mV on the VTVFM. (R15 should be adjusted to provide ±3 kHz deviation when installed in a radio set.)

Timing can be measured by connecting an oscilloscope to the output (pin 20 on J1) while grounding pin 7 or 17 (P-T-T function) on J1. The tone duration should be 0.5 seconds with JU1 connected or 1.5 seconds with JU1 disconnected. Be sure to remove the ground from pin 3 or 13.

The tone frequency can be measured by connecting the frequency counter to the output (pin 20 on J1). Ground pin 3 or 13 on J1 to obtain a continuous tone output.

c. Troubleshooting

A troubleshooting chart is provided as an aid in isolating the cause of any malfunction attributed to the single-tone encoder 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. Refer to the schematic diagram for typical voltage readings.

d. Repair

Any component on the circuit card can be replaced by following accepted repair procedures.

If any of the precision parts (R1, R4, R7, C7, C9, E1, E2, or E3) in the active filter oscillator require replacement, re-tuning may
become necessary. Careful factory selection of R5 (between 0 and 6k ohms) assures that the active filter oscillator is operating within specifications.

After replacement of any one of the above precision parts, check the tone frequencies generated by the activation of each push button. If the tone frequencies are within 0.5% of the nominal value, the unit is within specifications. If the tone frequencies are more than 0.5% off, it may be desirable to bring them closer to the nominal frequency.

Increasing the value of R5 will lower the tone frequency, while a decrease in the resistance of R5 will raise the tone frequency. The value of R5 affects each of the tone frequencies or the one tone frequency (one-tone models). The nominal value of R5 is approximately 2.5 to 3k ohms. A ±3k ohm change in the value of R5 will shift the frequency range of the active filter oscillator by approximately ±1%. Therefore, if retuning of the active filter oscillator is necessary, change the value of R5 in small increments using precision resistors.

**NOTE**

The solder side of the single-tone encoder board is coated with "Krylon" plastic spray. To make electrical contact with points on the board it is necessary to "scratch-thru" the protective coating by using a sharp probe. When repair work is complete, it is highly recommended that the board be recoated lightly with "Krylon" spray or equivalent.

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 white 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 white connector to the proper locations.
SINGLE-TONE ENCODER TROUBLESHOOTING CHART

1. CHECK P-T-T LEADS.
   (BLK-ORC WIRES)
2. CHECK THAT BOARD IS
   WIRED PROPERLY FOR NEG.
   OR POS GROUND OPERATION.

SINGLE-TONE ENCODER OPTION
CAUSES INCORRECT OPERATION

NO TONE TRANSMITTED
NO TONE HEARD FROM SPEAKER

TIMING
INCORRECT
TONE TRANSMITTED

NO TONE HEARD FROM SPEAKER

CHECK REGULATED SUPPLY
VOLTAGE AT CB3

CHECK Q4, Q5, AND
TIMING CIRCUIT
COMPONENTS.

CHECK FOR CONTINUITY
BETWEEN PIN 14 ON
21 AND PIN 27 ON P1105

CHECK ADJUSTMENT
OF R15

CHECK OUTPUT BUFFER
AMPLIFIER Q2 AND Q3

CHECK MONITOR TONE
AMPLIFIER Q7

CHECK FOR SHORTS
TO GND OR OPEN
CIRCUIT

GROUN PIN 3 OR 13
ON 21

CHECK SWITCH
CIRCUIT Q1

MEASURE VOLTAGES IN
ACTIVE FILTER OSCILLATOR

CHECK P-T-T BRIDGE

NO TONE
TON PRODUCED

BAD