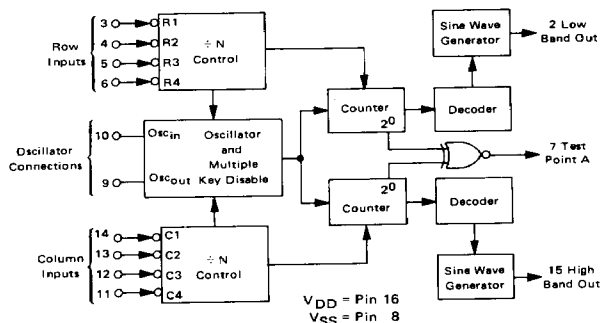


## 2-OF-8 TONE ENCODER

The MC14410 2-of-8 tone encoder is constructed with complementary MOS enhancement mode devices. It is designed to accept digital inputs in a 2-of-8 code format and to digitally synthesize the high and low band sine waves specified by telephone tone dialing systems. The inputs are normally originated from a 4 x 4 matrix keypad, which generates 4 row and 4 column input signals in a 2-of-8 code format (1 row and 1 column are simultaneously connected to V<sub>SS</sub>). The master clocking for the MC14410 is achieved from a crystal controlled oscillator which is included on the chip. Internal clocks, which operate the logic, are enabled only by one or more row and column signals being activated simultaneously. The two sine wave outputs have NPN bipolar structures on the same substrate which allows for low output impedance and large source currents. Applications of this device include telephone tone dialing, radio and mobile telephones, process control, point-of-sale terminals, and credit card verification terminals.

- Diode Protection on All Inputs
- Noise Immunity = 45% of V<sub>DD</sub> Typical
- Supply Voltage Range = 4.4 Vdc to 6.0 Vdc
- On-Chip Oscillator (Crystal or External Clock Source may be applied to Pin 10)
- On-Chip Pull-Up Resistors on Row and Column Inputs
- Designed with Multiple Key Lockout (Eliminates Need for Mechanical Lockout in Keypad)
- Two Sine Wave Generators On-Chip
- Frequency Accuracy  $\pm 0.2\%$
- Low Harmonic Distortion
- Single Tone Capability
- Fast Oscillator Turn-On and Turn-Off Times

## BLOCK DIAGRAM

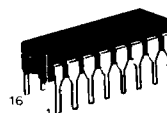


**MC14410**

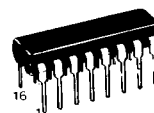
## CMOS LSI

(LOW-POWER COMPLEMENTARY MOS)

## 2-OF-8 TONE ENCODER

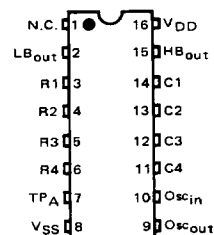


**L SUFFIX**  
 CERAMIC PACKAGE  
 CASE 620



**P SUFFIX**  
 PLASTIC PACKAGE  
 CASE 648

## PIN ASSIGNMENT



This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit. A destructive high-current mode may occur if V<sub>in</sub> and V<sub>out</sub> are not constrained to the range V<sub>SS</sub> (V<sub>in</sub> or V<sub>out</sub>) < V<sub>DD</sub>. Due to the sourcing capability of this circuit, damage can occur to the device if V<sub>DD</sub> is applied, and the outputs are shorted to V<sub>SS</sub> and are at a peak sinewave voltage.

MAXIMUM RATINGS (Voltages referenced to  $V_{SS}$ , Pin 8.)

| Rating                      | Symbol    | Value                                  | Unit             |
|-----------------------------|-----------|----------------------------------------|------------------|
| DC Supply Voltage           | $V_{DD}$  | -0.5 to +6.0                           | Vdc              |
| Input Voltage, All Inputs   | $V_{in}$  | $V_{SS} - 0.5$<br>to<br>$V_{DD} + 0.5$ | Vdc              |
| DC Current Drain per Pin    | I         | 10                                     | mA <sub>dc</sub> |
| Operating Temperature Range | $T_A$     | -40 to +85                             | °C               |
| Storage Temperature Range   | $T_{stg}$ | -65 to +150                            | °C               |

## ELECTRICAL CHARACTERISTICS

| Characteristic                                                                                                         | Symbol           | $V_{DD}$<br>Vdc  | -40°C |      | 25°C  |      |      | +85°C |      | Unit             |
|------------------------------------------------------------------------------------------------------------------------|------------------|------------------|-------|------|-------|------|------|-------|------|------------------|
|                                                                                                                        |                  |                  | Min   | Max  | Min   | Typ  | Max  | Min   | Max  |                  |
| Supply Voltage                                                                                                         | $V_{DD}$         | —                | 4.4   | 6.0  | 4.4   | 5.0  | 6.0  | 4.4   | 6.0  | Vdc              |
| Output Voltage<br>"0" Level<br>Pins 7 and 9<br>"1" Level                                                               | $V_{out}$        | 5.0              | —     | 0.05 | —     | 0    | 0.05 | —     | 0.05 | Vdc              |
|                                                                                                                        |                  | 5.0              | 4.95  | —    | 4.95  | 5.0  | —    | 4.95  | —    | Vdc              |
| Input Voltage<br>( $V_O = 4.5$ or 0.5 Vdc) "0" Level<br>( $V_O = 0.5$ or 4.5 Vdc) "1" Level                            | $V_{IL}$         | 5.0              | —     | 1.5  | —     | 2.25 | 1.5  | —     | 1.5  | Vdc              |
|                                                                                                                        | $V_{IH}$         | 5.0              | 3.5   | —    | 3.5   | 2.75 | —    | 3.5   | —    | Vdc              |
| Output Drive Current<br>( $V_{OH} = 2.5$ Vdc) Source<br>Pin 7<br>Pin 9<br>( $V_{OL} = 0.4$ Vdc) Sink<br>Pin 7<br>Pin 9 | $I_{OH}$         | 5.0              | -0.05 | —    | -0.05 | -0.4 | —    | -0.04 | —    | mA <sub>dc</sub> |
|                                                                                                                        |                  | 5.0              | -0.23 | —    | -0.20 | -1.7 | —    | -0.16 | —    | mA <sub>dc</sub> |
|                                                                                                                        | $I_{OL}$         | 5.0              | 0.05  | —    | 0.05  | 0.20 | —    | 0.04  | —    | mA <sub>dc</sub> |
|                                                                                                                        |                  | 5.0              | 0.23  | —    | 0.20  | 0.78 | —    | 0.16  | —    | mA <sub>dc</sub> |
| Input Pull-Up Resistor Source Current<br>( $V_{in} = 0$ Vdc) Pins 3-6, 11-14                                           | $I_{IL}$         | 6.0              | —     | 140  | —     | 30   | 100  | —     | 80   | μA <sub>dc</sub> |
| Input Capacitance<br>( $V_{in} = 0$ Vdc)                                                                               | $C_{in}$         | —                | —     | —    | —     | 5.0  | —    | —     | —    | pF               |
| Quiescent Current                                                                                                      | $I_Q$            | 4.4              | —     | 0.48 | —     | 0.2  | 0.4  | —     | 0.33 | mA <sub>dc</sub> |
|                                                                                                                        |                  | 6.0              | —     | 1.3  | —     | 0.55 | 1.1  | —     | 0.9  | mA <sub>dc</sub> |
| Total Supply Current<br>(Dynamic plus Quiescent)<br>( $R_L = 15$ kΩ, $f = 1$ MHz)                                      | $I_T$            | 4.4              | —     | 1.7  | —     | 0.7  | 1.4  | —     | 1.15 | mA <sub>dc</sub> |
|                                                                                                                        |                  | 6.0              | —     | 3.5  | —     | 1.45 | 2.9  | —     | 2.4  | mA <sub>dc</sub> |
| Low Band Output<br>Voltage Swing<br>( $R_L = 100$ k) Pin 2 Only                                                        | $V_{Lpp}$        | 4.4              | 400   | 600  | 500   | 600  | 700  | 550   | 750  | mV <sub>pp</sub> |
|                                                                                                                        |                  | 6.0              | 800   | 1000 | 900   | 1000 | 1100 | 950   | 1150 | mV <sub>pp</sub> |
| High Band Output<br>Voltage Swing<br>( $R_L = 100$ k) Pin 15 Only                                                      | $V_{Hpp}$        | 4.4              | 600   | 900  | 700   | 850  | 1000 | 800   | 1100 | mV <sub>pp</sub> |
|                                                                                                                        |                  | 6.0              | 1000  | 1400 | 1100  | 1350 | 1500 | 1200  | 1600 | mV <sub>pp</sub> |
| Low Band—High Band<br>Voltage Differential                                                                             | $\Delta V$       | 5.0              | —     | —    | —     | 2.5  | —    | —     | —    | dB               |
| Low Band—High Band<br>Output Impedance AC only Pin 2, 15                                                               | $z_o$            | —                | —     | —    | —     | 80   | —    | —     | —    | Ω                |
| Low Band—High Band<br>2nd thru 14th Harmonics<br>( $R_L = 15$ kΩ) Pin 2, 15                                            | $V_{2H-V_{14H}}$ | 4.4<br>to<br>6.0 | —     | -20  | —     | -30  | -25  | —     | -25  | dB               |
| Maximum Clock Pulse Frequency                                                                                          | $f_{cl}$         | 4.4              | —     | —    | —     | 1.0  | —    | 1.1   | —    | MHz              |
| Turn-on Time<br>(Power on to oscillation)                                                                              | $t_{on}$         | 5.0              | —     | —    | —     | 8.0  | —    | —     | —    | ms               |

TABLE 1 – FUNCTIONAL TRUTH TABLE

| ACTIVE LOW INPUTS   |                        | OUTPUTS        |                  |
|---------------------|------------------------|----------------|------------------|
| Activated Row Lines | Activated Column Lines | Low Band Pin 2 | High Band Pin 15 |
| None                | X**                    | dc level       | dc level         |
| X**                 | None                   | dc level       | dc level         |
| One                 | One                    | $f_L^*$        | $f_H^*$          |
| Two or more         | One                    | dc level       | $f_H^*$          |
| One                 | Two or more            | $f_L^*$        | dc level         |
| Two or more         | Two or more            | dc level       | dc level         |

\*See Table 2  
\*\*X = Don't care

TABLE 2 – OUTPUT FREQUENCY TABLE

| Input Line Activated (low) | Frequency Generated** |            |
|----------------------------|-----------------------|------------|
|                            | $f_L$ (Hz)            | $f_H$ (Hz) |
| R1                         | 697                   | —          |
| R2                         | 770                   | —          |
| R3                         | 852                   | —          |
| R4                         | 941                   | —          |
| C1                         | —                     | 1209       |
| C2                         | —                     | 1336       |
| C3                         | —                     | 1477       |
| C4                         | —                     | 1633       |

\*\*All frequencies are accurate to  $\pm 0.2\%$  (crystal tolerance not included).

FIGURE 1 – TYPICAL SINE WAVE OUTPUT  
(Pins 2 or 15, No External Filtering)

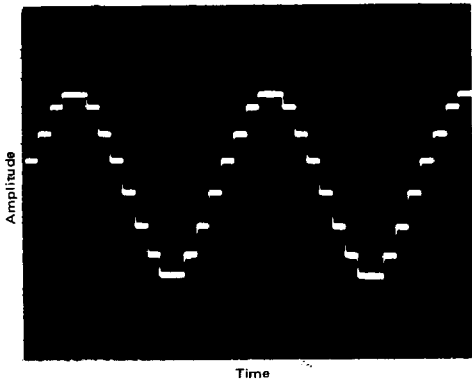


FIGURE 2 – TYPICAL FREQUENCY SPECTRUM  
(Pins 2 or 15, No External Filtering)

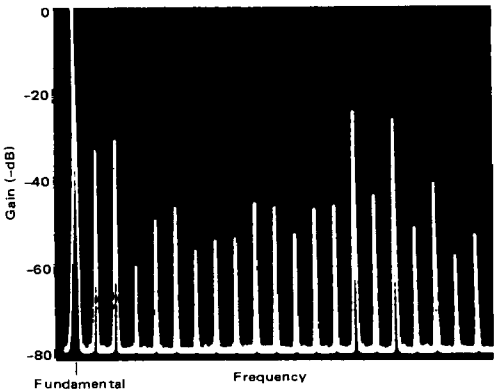


FIGURE 3 – TYPICAL CRYSTAL CIRCUIT

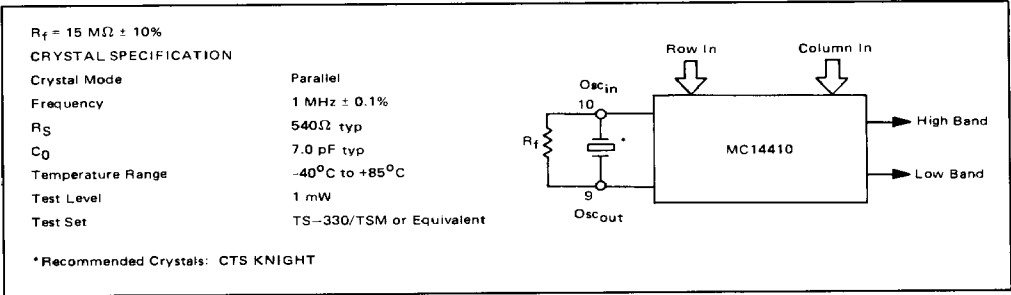


FIGURE 4 – TYPICAL TELEPHONE INTERFACE APPLICATION

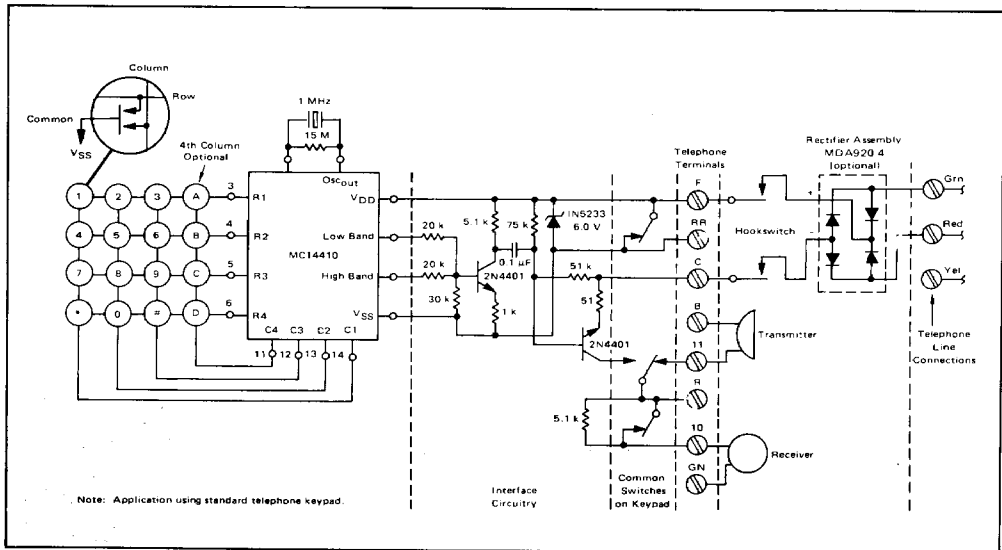


FIGURE 5 – LOW LEVEL OUTPUT TONE GENERATOR APPLICATION

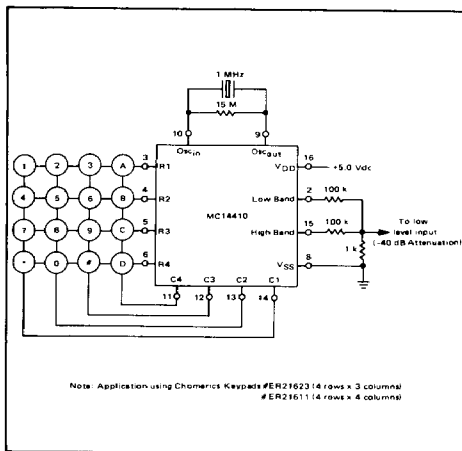
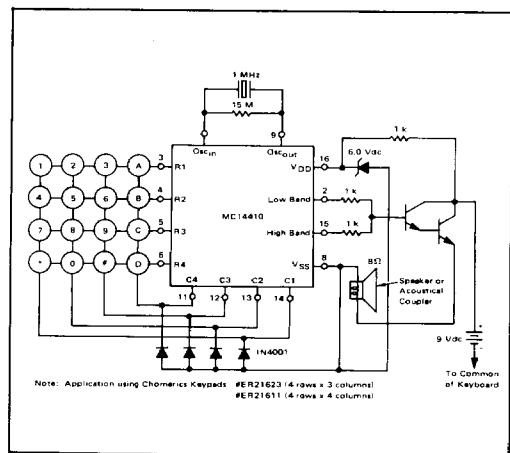


FIGURE 6 – BATTERY POWERED OPERATION (Driving Audio Speaker)



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