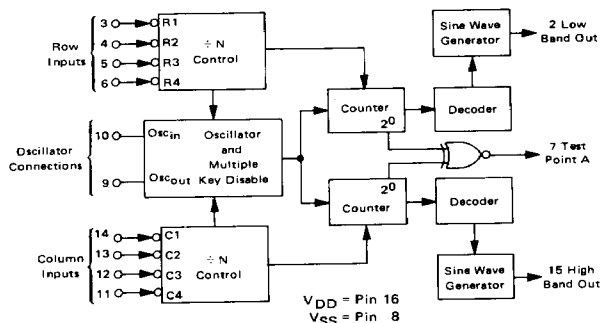


2-OF-8 TONE ENCODER

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_{SS}). 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_{DD} 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

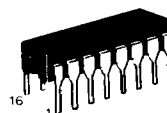


MC14410

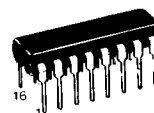
CMOS LSI

(LOW-POWER COMPLEMENTARY MOS)

2-OF-8 TONE ENCODER

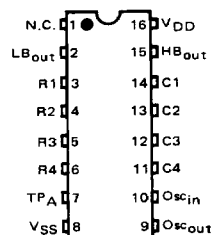


L SUFFIX
 CERAMIC PACKAGE
 CASE 620



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_{in} and V_{out} are not constrained to the range V_{SS} (V_{in} or V_{out}) < V_{DD}. Due to the sourcing capability of this circuit, damage can occur to the device if V_{DD} is applied, and the outputs are shorted to V_{SS} 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}	$V_{SS} - 0.5$ to $V_{DD} + 0.5$	Vdc
DC Current Drain per Pin	I	10	mA _{dc}
Operating Temperature Range	T_A	-40 to +85	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	V_{DD} 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 "0" Level Pins 7 and 9 "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 ($V_O = 4.5$ or 0.5 Vdc) "0" Level ($V_O = 0.5$ 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 ($V_{OH} = 2.5$ Vdc) Source Pin 7 Pin 9 ($V_{OL} = 0.4$ Vdc) Sink Pin 7 Pin 9	I_{OH}	5.0	-0.05	—	-0.05	-0.4	—	-0.04	—	mA _{dc}
		5.0	-0.23	—	-0.20	-1.7	—	-0.16	—	mA _{dc}
	I_{OL}	5.0	0.05	—	0.05	0.20	—	0.04	—	mA _{dc}
		5.0	0.23	—	0.20	0.78	—	0.16	—	mA _{dc}
Input Pull-Up Resistor Source Current ($V_{in} = 0$ Vdc) Pins 3-6, 11-14	I_{IL}	6.0	—	140	—	30	100	—	80	μA _{dc}
Input Capacitance ($V_{in} = 0$ Vdc)	C_{in}	—	—	—	—	5.0	—	—	—	pF
Quiescent Current	I_Q	4.4	—	0.48	—	0.2	0.4	—	0.33	mA _{dc}
		6.0	—	1.3	—	0.55	1.1	—	0.9	mA _{dc}
Total Supply Current (Dynamic plus Quiescent) ($R_L = 15$ kΩ, $f = 1$ MHz)	I_T	4.4	—	1.7	—	0.7	1.4	—	1.15	mA _{dc}
		6.0	—	3.5	—	1.45	2.9	—	2.4	mA _{dc}
Low Band Output Voltage Swing ($R_L = 100$ k) Pin 2 Only	V_{Lpp}	4.4	400	600	500	600	700	550	750	mV _{pp}
		6.0	800	1000	900	1000	1100	950	1150	mV _{pp}
High Band Output Voltage Swing ($R_L = 100$ k) Pin 15 Only	V_{Hpp}	4.4	600	900	700	850	1000	800	1100	mV _{pp}
		6.0	1000	1400	1100	1350	1500	1200	1600	mV _{pp}
Low Band—High Band Voltage Differential	ΔV	5.0	—	—	—	2.5	—	—	—	dB
Low Band—High Band Output Impedance AC only Pin 2, 15	z_o	—	—	—	—	80	—	—	—	Ω
Low Band—High Band 2nd thru 14th Harmonics ($R_L = 15$ kΩ) Pin 2, 15	$V_{2H-V_{14H}}$	4.4 to 6.0	—	-20	—	-30	-25	—	-25	dB
Maximum Clock Pulse Frequency	f_{cl}	4.4	—	—	—	1.0	—	1.1	—	MHz
Turn-on Time (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 ±0.2% (crystal tolerance not included).

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

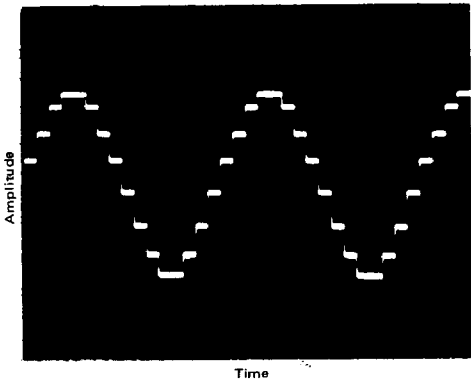


FIGURE 2 – TYPICAL FREQUENCY SPECTRUM
(Pins 2 or 15, No External Filtering)

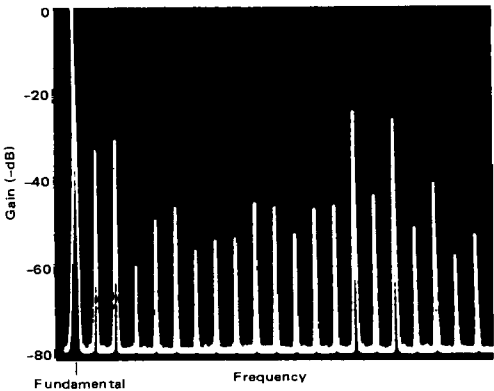


FIGURE 3 – TYPICAL CRYSTAL CIRCUIT

R_f = 15 MΩ ± 10%

CRYSTAL SPECIFICATION

Crystal Mode	Parallel
Frequency	1 MHz ± 0.1%
R _S	540Ω typ
C ₀	7.0 pF typ
Temperature Range	-40°C to +85°C
Test Level	1 mW
Test Set	TS-330/TSM or Equivalent

*Recommended Crystals: CTS KNIGHT

FIGURE 4 – TYPICAL TELEPHONE INTERFACE APPLICATION

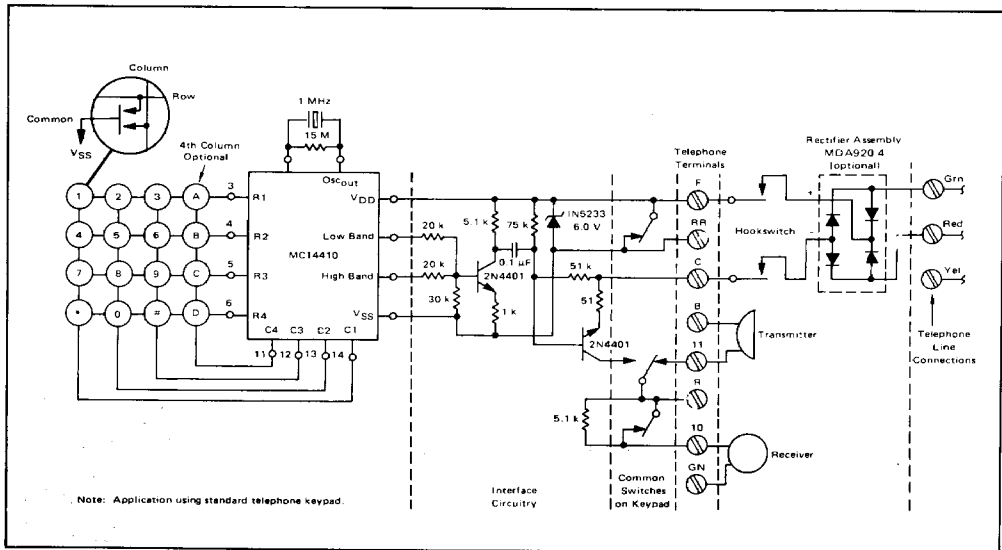


FIGURE 5 – LOW LEVEL OUTPUT TONE GENERATOR APPLICATION

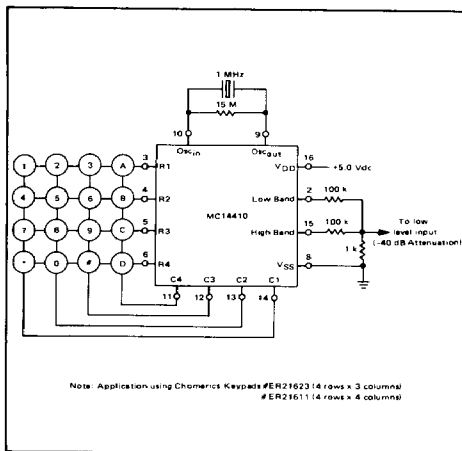


FIGURE 6 – BATTERY POWERED OPERATION (Driving Audio Speaker)

