

**MOTOROLA**  
**SEMICONDUCTOR**  
**TECHNICAL DATA**

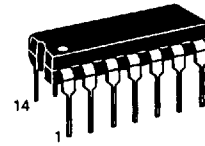
**MC145436**

**Dual Tone Multiple Frequency Receiver**

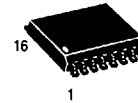
The MC145436 is a silicon gate CMOS LSI device containing the filter and decoder for detection of a pair of tones conforming to the DTMF standard with outputs in hexadecimal. Switched capacitor filter technology is used together with digital circuitry for the timing control and output circuits. The MC145436 provides excellent power line noise and dial tone rejection and is suitable for applications in central office equipment, PABX, and keyphone systems, remote control equipment and consumer telephony products.

The MC145436 offers the following performance features:

- Single +5 V Power Supply
- Detects All 16 Standard Digits
- Uses Inexpensive 3.58-MHz Crystal
- Provides Guard Time Controls to Improve Speech Immunity
- Output in 4-Bit Hexadecimal Code
- Built-in 60 Hz and Dial Tone Rejection
- MC145436P Pin Compatible with SSI-204



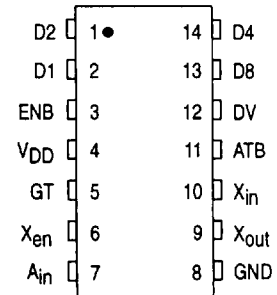
**P SUFFIX**  
PLASTIC  
CASE 646



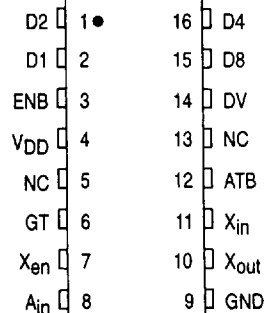
**DW SUFFIX**  
SOG  
CASE 751G

**PIN ASSIGNMENTS**

**PLASTIC**

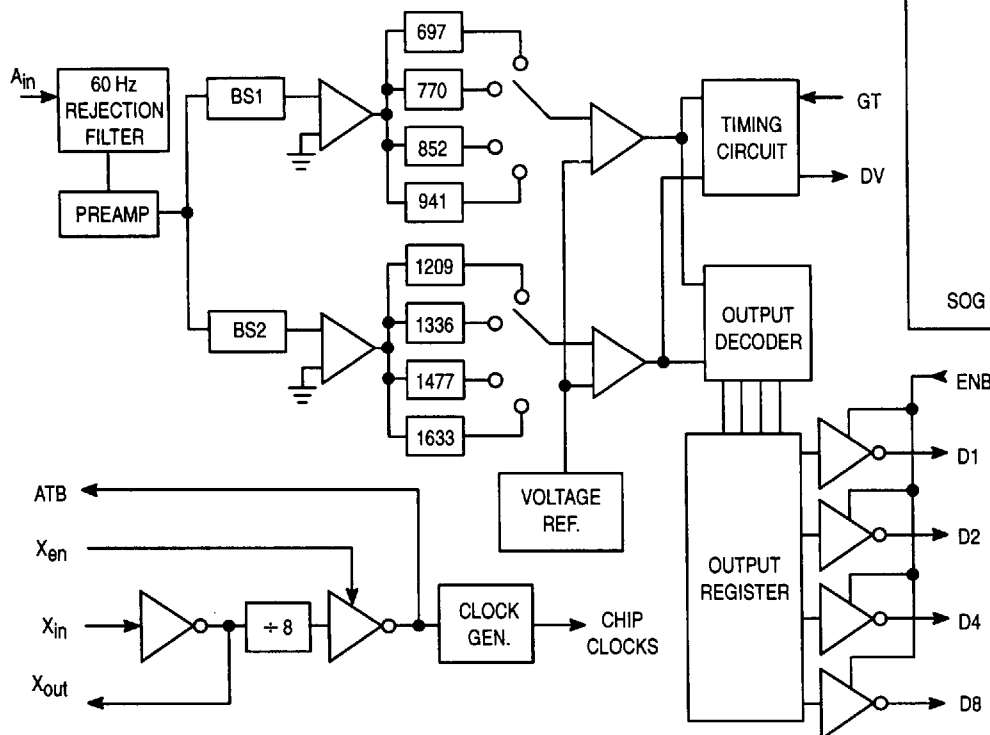


**SOG**



NC = NO CONNECTION  
SOG IS NOT PIN COMPATIBLE WITH SSI-204

**BLOCK DIAGRAM**



**MAXIMUM RATINGS** (Voltages Referenced to GND Unless Otherwise Noted)

Rating	Symbol	Value	Unit
DC Supply Voltage	V <sub>DD</sub>	-0.5 to +6.0	V
Input Voltage, Any Pin Except A <sub>in</sub>	V <sub>in</sub>	-0.5 to V <sub>DD</sub> + 0.5	V
Input Voltage, A <sub>in</sub>	V <sub>in</sub>	V <sub>DD</sub> - 10 to V <sub>DD</sub> + 0.5	V
DC Current Drain per Pin	I	± 10	mAdc
Power Dissipation	P <sub>D</sub>	30	mW
Operating Temperature Range	T <sub>A</sub>	-40 to +85	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C

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 applications of any voltage higher than the maximum rated voltages to this high impedance circuit.

For proper operation it is recommended that V<sub>in</sub> and V<sub>out</sub> be constrained to the range V<sub>SS</sub> ≤ (V<sub>in</sub> or V<sub>out</sub>) ≤ V<sub>DD</sub>. Reliability of operation is enhanced if unused inputs are tied to an appropriate logic voltage level (e.g., either V<sub>SS</sub> or V<sub>DD</sub>).

**ELECTRICAL CHARACTERISTICS**

(All Polarities Referenced to V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 5.0 V ±10%, T<sub>A</sub> = -40 to +85°C, Unless Otherwise Noted)

Parameter	Symbol	Min	Typ	Max	Unit
DC Supply Voltage	V <sub>DD</sub>	4.5	5	5.5	V
Supply Current (f <sub>CLK</sub> = 3.58 MHz)	I <sub>DD</sub>	—	7	15	mA
Input Current ENB, X <sub>in</sub> , X <sub>en</sub>	I <sub>in</sub>	—	—	200 ±1	μA
Input Voltage Low	ENB, GT, X <sub>en</sub>	V <sub>IL</sub>	—	1.5	V
Input Voltage High	ENB, GT, X <sub>en</sub>	V <sub>IH</sub>	3.5	—	V
I <sub>out</sub> Data and DV Pins: V <sub>out</sub> = 4.5 V (Source)	I <sub>OH</sub>	800	—	—	μA
I <sub>out</sub> Data and DV Pins: V <sub>out</sub> = 0.4 V (Sink)	I <sub>OL</sub>	1.0	—	—	mA
Input Impedance	A <sub>in</sub>	R <sub>in</sub>	90	100	kΩ
Fanout	ATB	F <sub>out</sub>	—	10	
Input Capacitance	X <sub>en</sub> , ENB	C <sub>in</sub>	—	6	pF

**ANALOG CHARACTERISTICS** (V<sub>DD</sub> = 5.0 V ±10%, T<sub>A</sub> = -40 to +85°C, Unless Otherwise Noted)

Parameter	Min	Typ	Max	Unit
Signal Level for Detection (A <sub>in</sub> )	-35	—	-2	dBm
Twist = High Tone/Low Tone	-10	—	10	dB
Frequency Detect Bandwidth	±(1.5 + 2 Hz)	±2.5	±3.5	% f <sub>O</sub>
60-Hz Tolerance	—	—	0.8	V <sub>rms</sub>
Dial Tone Tolerance (Note 1) (Dial Tone 330 + 440)	—	—	0	dB
Noise Tolerance (Notes 1 and 2)	—	—	-12	dB
Power Supply Noise (Wide Band)	—	—	10	mVp-p
Talk Off (Mitel Tape #CM7290)	—	2	—	Hits

NOTES:

1. Referenced to lower amplitude tone.
2. Bandwidth limited (0 to 3.4 kHz) Gaussian Noise.

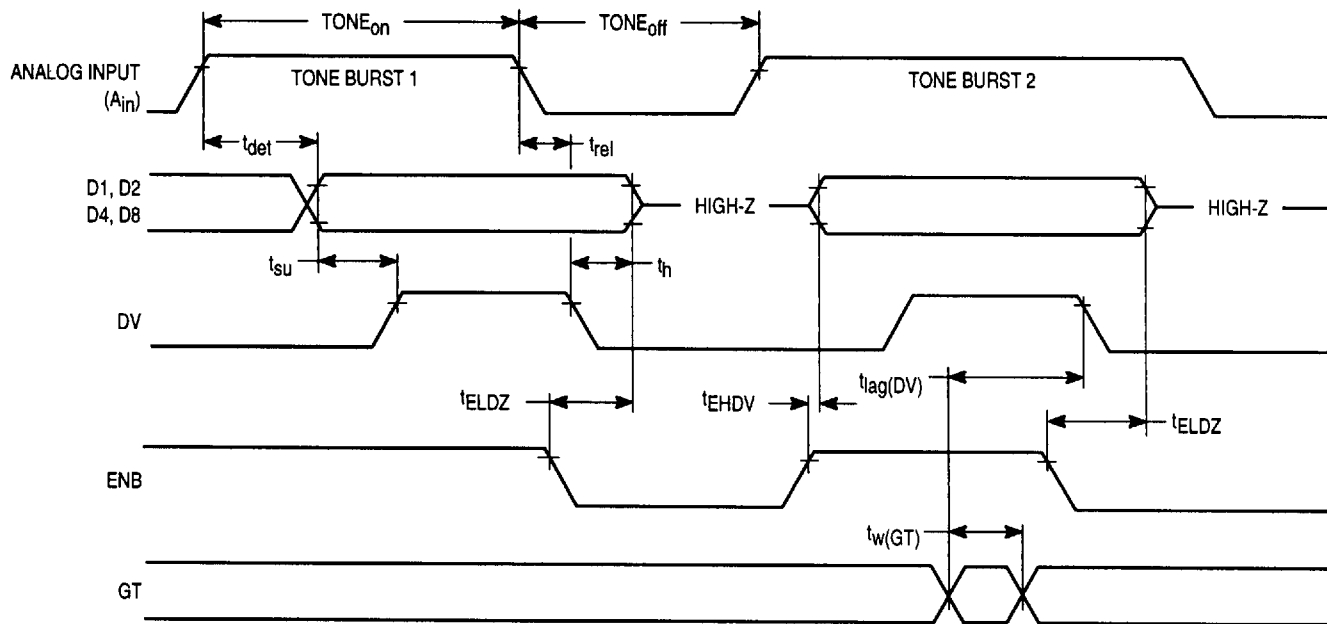
**AC CHARACTERISTICS** ( $V_{DD} = 5.0\text{ V} \pm 10\%$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

Characteristic		Symbol	Min	Typ	Max	Unit
Tone On Time For Rejection	For Detection	$TONE_{on}$	40 —	— —	— 20	ms
Pause Time For Rejection	For Detection	$TONE_{off}$	40 —	— —	— 20	ms
Detect Time GT = 1	GT = 0	$t_{det}$	22 32	— —	40 50	ms
Release Time GT = 1	GT = 0	$t_{rel}$	28 18	— —	40 30	ms
Data Setup Time		$t_{su}$	7	—	—	$\mu\text{s}$
Data Hold Time		$t_h$	4.2	4.6	5	ms
Pulse Width	GT	$t_w(GT)$	18	—	—	$\mu\text{s}$
DV Reset Lag Time		$t_{lag}(DV)$	—	—	5	ms
ENB High to Output DV (Note 1)		$t_{EHDV}$	—	120	500	ns
ENB Low to Output High-Z (Note 1)		$t_{ELDZ}$	—	110	300	ns

**NOTE:**

1. Data out:  $C_L = 35\text{ pF} \parallel R_L = 500\ \Omega$ .

**TIMING DIAGRAM**



**PIN DESCRIPTIONS**

**VDD**  
**Positive Power Supply**

The digital supply pin, which is connected to the positive side of the power supply.

**VSS**  
**Ground**

Ground return pin is typically connected to the system ground.

**D1, D2, D4, D8**  
**Data Output**

These digital outputs provide the hexadecimal codes corresponding to the detected digit. The digital outputs become valid after a tone pair has been detected and are cleared when a valid pause is timed. See Table 1 for hexadecimal codes. These output pins are high impedance when the enable pin is at logic 0.

**EN**  
**Enable**

Outputs D1, D2, D4, D8 are enabled when ENB is at a logic 1, and high impedance (disabled) when ENB is at a logic 0.

**GT**  
**Guard Time**

The Guard Time control input provides two sets of detected time and release time, both within the allowed ranges of tone on and tone off (see Figure 1). A longer tone detect time rejects signals too short to be considered valid. With GT = 1, talk off performance is improved, since it reduces the probability that tones simulated by speech will maintain signal conditions long enough to be accepted. In addition, a shorter release time reduces the probability that a pause simulated by an interrupt in speech will be detected as a valid pause. On the other hand, a shorter tone detect time with a long release time would be

**Table 1. Hexadecimal Codes**

Digit	Output Code			
	D8	D4	D2	D1
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0
A	1	1	0	1
B	1	1	1	0
C	1	1	1	1
D	0	0	0	0

appropriate for an extremely noisy environment where fast acquisition time and immunity to dropouts would be required. In general, the tone signal time generated by a telephone is 100 ms, nominal, followed by a pause of about 100 ms. A high-to-low or low-to-high transition on the GT pin resets the internal logic and the MC145436 is immediately ready to accept a new tone input. If left open, this pin is internally pulled to ground.

**Xen**  
**Oscillator Enable**

A logic 1 on X<sub>EN</sub> enables the on-chip crystal oscillator. When using alternate time base from the ATB pin, X<sub>EN</sub> should be tied to V<sub>SS</sub>.

**Ain**  
**Analog Input**

This pin accepts the analog input and is internally biased so that the input signal may be ac coupled. The input may be dc coupled so long as it does not exceed the positive supply (see Figure 2).

**Xin/Xout**  
**Oscillator In and Oscillator Out**

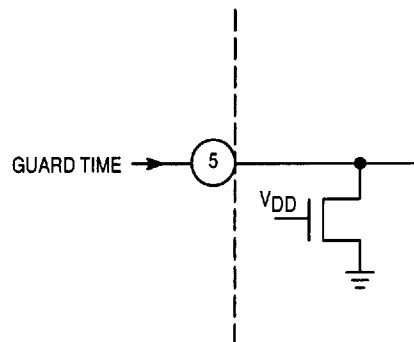
These pins connect to an internal crystal oscillator. In operation, a parallel resonant crystal is connected from X<sub>IN</sub> to X<sub>OUT</sub>, as well as a 1-MΩ resistor in parallel with the crystal. When using the alternate clock source from ATB, X<sub>IN</sub> should be tied to V<sub>DD</sub>.

**ATB**  
**Alternate Time Base**

This pin serves as a frequency reference when more than one MC145436 is used, so that only one crystal is required for multiple MC145436s. When doing so, all ATB pins should be tied together as shown in Figure 3. When only one MC145436 is used, this pin should be left unconnected. The output frequency of ATB is 447.4 kHz.

**DV**  
**Data Valid**

DV signals a detection by going high after a valid tone pair is sensed and decoded at output pins D1, D2, D4, D8. DV remains high until a loss of the current DTMF signal occurs or until a transition in GT occurs.



**Figure 1. Guard Time**

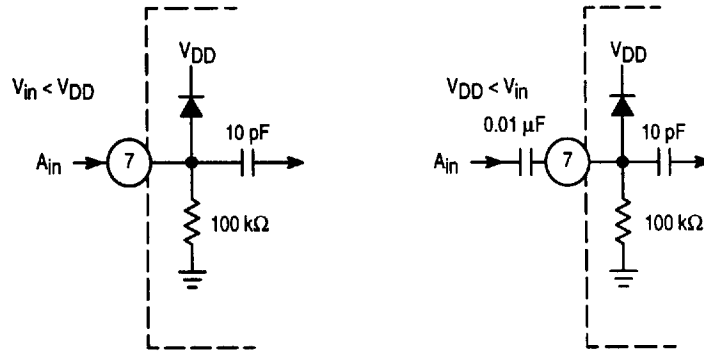


Figure 2. Analog Input (Operational Information based on PDIP package)

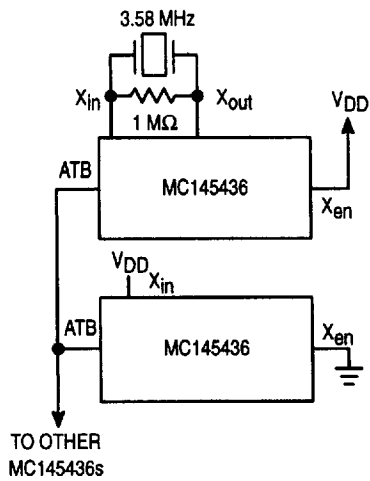


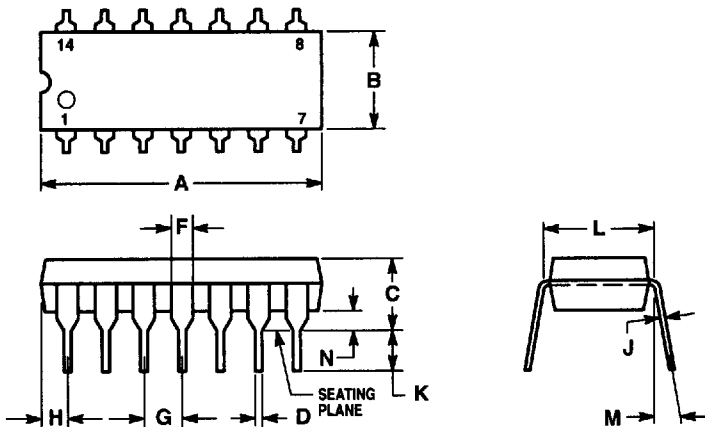
Figure 3. Multiple MC145436s

	COL 1	COL 2	COL 3	COL 4	
	1	2	3	A	ROW 1
697	4	5	6	B	ROW 2
770	7	8	9	C	ROW 3
852	*	0	#	D	ROW 4
941	1209	1336	1477	1633	
	STD DTMF (Hz)				

Figure 4. 4 × 4 Keyboard Matrix

PACKAGE DIMENSIONS

P SUFFIX  
PLASTIC  
CASE 646-06

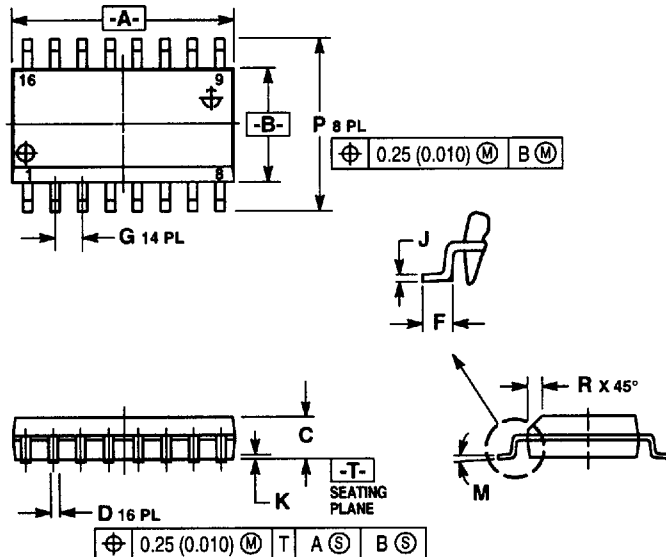


NOTES:

- LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
- DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
- DIMENSION B DOES NOT INCLUDE MOLD FLASH.
- ROUNDED CORNERS OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	19.56
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.300 BSC		7.62 BSC	
M	0°	10°	0°	10°
N	0.015	0.039	0.39	1.01

DW SUFFIX  
SOG  
CASE 751G-02



NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
- DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
- MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
- DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 (0.005) TOTAL IN EXCESS OF D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.15	10.45	0.400	0.411
B	7.40	7.60	0.292	0.299
C	2.35	2.65	0.093	0.104
D	0.35	0.49	0.014	0.019
F	0.50	0.90	0.020	0.035
G	1.27 BSC		0.050 BSC	
J	0.25	0.32	0.010	0.012
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	10.05	10.55	0.395	0.415
R	0.25	0.75	0.010	0.029

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