

## MM74HC4066 Quad Analog Switch

### General Description

The MM74HC4066 devices are digitally controlled analog switches utilizing advanced silicon-gate CMOS technology. These switches have low "ON" resistance and low "OFF" leakages. They are bidirectional switches, thus any analog input may be used as an output and visa-versa. Also the MM74HC4066 switches contain linearization circuitry which lowers the "ON" resistance and increases switch linearity. The MM74HC4066 devices allow control of up to 12V (peak) analog signals with digital control signals of the same range. Each switch has its own control input which disables each switch when LOW. All analog inputs and outputs and digital inputs are protected from electrostatic damage by diodes to  $V_{CC}$  and ground.

### Features

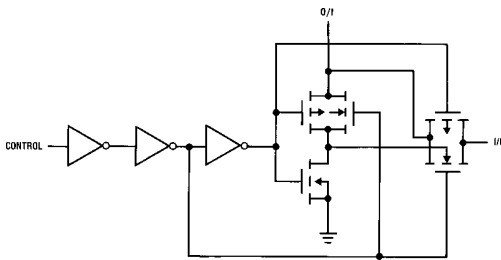
- Typical switch enable time: 15 ns
- Wide analog input voltage range: 0–12V
- Low "ON" resistance: 30 typ. (MM74HC4066)
- Low quiescent current: 80  $\mu$ A maximum (74HC)
- Matched switch characteristics
- Individual switch controls

### Ordering Code:

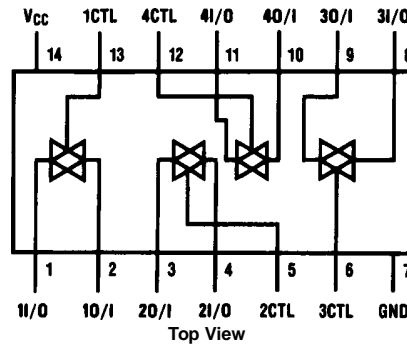
Order Number	Package Number	Package Description
MM74HC4066M	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow
MM74HC4066SJ	M14D	14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
MM74HC4066MTC	MTC14	14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
MM74HC4066N	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

### Schematic Diagram



### Connection Diagram



### Truth Table

Input	Switch
CTL	I/O–O/I
L	"OFF"
H	"ON"

Absolute Maximum Ratings (Note 1)			Recommended Operating Conditions		
Supply Voltage ( $V_{CC}$ )	-0.5 to +15V		Min	Max	Units
DC Control Input Voltage ( $V_{IN}$ )	-1.5 to $V_{CC}$ +1.5V	Supply Voltage ( $V_{CC}$ )	2	12	V
DC Switch I/O Voltage ( $V_{IO}$ )	$V_{EE}$ -0.5 to $V_{CC}$ +0.5V	DC Input or Output Voltage			
Clamp Diode Current ( $I_{IK}, I_{OK}$ )	$\pm 20$ mA	( $V_{IN}, V_{OUT}$ )	0	$V_{CC}$	V
DC Output Current, per pin ( $I_{OUT}$ )	$\pm 25$ mA	Operating Temperature Range ( $T_A$ )	-40	+85	$^{\circ}$ C
DC $V_{CC}$ or GND Current, per pin ( $I_{CC}$ )	$\pm 50$ mA	Input Rise or Fall Times			
Storage Temperature Range ( $T_{STG}$ )	-65 $^{\circ}$ C to +150 $^{\circ}$ C	( $t_r, t_f$ ) $V_{CC} = 2.0V$		1000	ns
Power Dissipation ( $P_D$ )		$V_{CC} = 4.5V$		500	ns
(Note 3)	600 mW	$V_{CC} = 9.0V$		400	ns
S.O. Package only	500 mW				
Lead Temperature ( $T_L$ )					
(Soldering 10 seconds)	260 $^{\circ}$ C				

**Note 1:** Absolute Maximum Ratings are those values beyond which damage to the device may occur.

**Note 2:** Unless otherwise specified all voltages are referenced to ground.

**Note 3:** Power Dissipation temperature derating — plastic "N" package: -12 mW/ $^{\circ}$ C from 65 $^{\circ}$ C to 85 $^{\circ}$ C.

### DC Electrical Characteristics (Note 4)

Symbol	Parameter	Conditions	$V_{CC}$	$T_A = 25^{\circ}\text{C}$			Units	
				Typ	Guaranteed Limits			
$V_{IH}$	Minimum HIGH Level Input Voltage		2.0V		1.5	1.5	V	
			4.5V		3.15	3.15	V	
			9.0V		6.3	5.3	V	
			12.0V		8.4	8.4	V	
$V_{IL}$	Maximum LOW Level Input Voltage		2.0V		0.5	0.5	V	
			4.5V		1.35	1.35	V	
			9.0V		2.7	2.7	V	
			12.0V		3.6	3.6	V	
$R_{ON}$	Maximum "ON" Resistance (Note 5)	$V_{CTL} = V_{IH}, I_S = 2.0$ mA $V_{IS} = V_{CC}$ or GND (Figure 1)	4.5V	100	170	200	$\Omega$	
			9.0V	50	85	105	$\Omega$	
			12.0V	30	70	85	$\Omega$	
		$V_{CTL} = V_{IH}, I_S = 2.0$ mA $V_{IS} = V_{CC}$ or GND (Figure 1)	2.0V	120	180	215	$\Omega$	
			4.5V	50	80	100	$\Omega$	
			9.0V	35	60	75	$\Omega$	
$R_{ON}$	Maximum "ON" Resistance Matching	$V_{CTL} = V_{IH}$ $V_{IS} = V_{CC}$ or GND	4.5V	10	15	20	$\Omega$	
			9.0V	5	10	15	$\Omega$	
			12.0V	5	10	15	$\Omega$	
$I_{IN}$	Maximum Control Input Current	$V_{IN} = V_{CC}$ or GND $V_{CC} = 2-6V$			$\pm 0.1$	$\pm 1.0$	$\pm 1.0$	$\mu\text{A}$
$I_{IZ}$	Maximum Switch "OFF" Leakage Current	$V_{OS} = V_{CC}$ or GND $V_{IS} = \text{GND}$ or $V_{CC}$ $V_{CTL} = V_{IL}$ (Figure 3)	6.0V	10	$\pm 60$	$\pm 600$	$\pm 600$	nA
			9.0V	15	$\pm 80$	$\pm 800$	$\pm 800$	nA
			12.0V	20	$\pm 100$	$\pm 1000$	$\pm 1000$	nA
$I_{IZ}$	Maximum Switch "ON" Leakage Current	$V_{IS} = V_{CC}$ or GND $V_{CTL} = V_{IH}$ $V_{OS} = \text{OPEN}$ (Figure 2)	6.0V	10	$\pm 40$	$\pm 150$	$\pm 150$	nA
			9.0V	15	$\pm 50$	$\pm 200$	$\pm 200$	nA
			12.0V	20	$\pm 60$	$\pm 300$	$\pm 300$	nA
$I_{CC}$	Maximum Quiescent Supply Current	$V_{IN} = V_{CC}$ or GND $I_{OUT} = 0$ $\mu\text{A}$	6.0V		2.0	20	40	$\mu\text{A}$
			9.0V		4.0	40	80	$\mu\text{A}$
			12.0V		8.0	80	160	$\mu\text{A}$

**Note 4:** For a power supply of 5V  $\pm 10\%$  the worst case on resistance ( $R_{ON}$ ) occurs for HC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case  $V_{IH}$  and  $V_{IL}$  occur at  $V_{CC} = 5.5V$  and 4.5V respectively. (The  $V_{IH}$  value at 5.5V is 3.85V.) The worst case leakage current occurs for CMOS at the higher voltage and so the 5.5V values should be used.

**Note 5:** At supply voltages ( $V_{CC}$ -GND) approaching 2V the analog switch on resistance becomes extremely non-linear. Therefore it is recommended that these devices be used to transmit digital only when using these supply voltages.

AC Electrical Characteristics								
V <sub>CC</sub> = 2.0V–6.0V V <sub>EE</sub> = 0V–12V, C <sub>L</sub> = 50 pF (unless otherwise specified)								
Symbol	Parameter	Conditions	V <sub>CC</sub>	T <sub>A</sub> = 25°C		T <sub>A</sub> = –40 to 85°C	T <sub>A</sub> = –55 to 125°C	Units
				Typ	Guaranteed Limits			
t <sub>PHL</sub> , t <sub>PLH</sub>	Maximum Propagation Delay Switch In to Out		2.0V	25	50	30	75	ns
			4.5V	5	10	13	15	ns
			9.0V	4	8	10	12	ns
			12.0V	3	7	11	13	ns
t <sub>PZL</sub> , t <sub>PZH</sub>	Maximum Switch Turn "ON" Delay	R <sub>L</sub> = 1 kΩ	2.0V	30	100	125	150	ns
			4.5V	12	20	25	30	ns
			9.0V	6	12	15	18	ns
			12.0V	5	10	13	15	ns
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Maximum Switch Turn "OFF" Delay	R <sub>L</sub> = 1 kΩ	2.0V	60	168	210	252	ns
			4.5V	25	36	45	54	ns
			9.0V	20	32	40	48	ns
			12.0V	15	30	38	45	ns
f <sub>MAX</sub>	Minimum Frequency Response (Figure 7) 20 log (V <sub>O</sub> /V <sub>I</sub> ) = –3 dB	R <sub>L</sub> = 600Ω V <sub>IS</sub> = 2 V <sub>PP</sub> at (V <sub>CC</sub> /2) (Note 6) (Note 7)	4.5V	40				MHz
			9.0V	100				MHz
	Crosstalk Between any Two Switches (Figure 8)	R <sub>L</sub> = 600Ω, F = 1 MHz (Note 7) (Note 8)	4.5V	–52				dB
			9.0V	–50				dB
	Peak Control to Switch Feedthrough Noise (Figure 9)	R <sub>L</sub> = 600Ω, F = 1 MHz C <sub>L</sub> = 50 pF	4.5V	100				mV
			9.0V	250				mV
	Switch OFF Signal Feedthrough Isolation (Figure 10)	R <sub>L</sub> = 600Ω, F = 1 MHz V <sub>(CT)</sub> V <sub>IL</sub> (Note 7) (Note 8)	4.5V	–42				dB
			9.0V	–44				dB
THD	Total Harmonic Distortion (Figure 11)	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 50 pF, F = 1 kHz V <sub>IS</sub> = 4 V <sub>PP</sub> V <sub>IS</sub> = 8 V <sub>PP</sub>	4.5V	.013				%
			9.0V	.008				%
C <sub>IN</sub>	Maximum Control Input Capacitance			5	10	10	10	pF
C <sub>IN</sub>	Maximum Switch Input Capacitance			20				pF
C <sub>IN</sub>	Maximum Feedthrough Capacitance	V <sub>CTL</sub> = GND		0.5				pF
C <sub>PD</sub>	Power Dissipation Capacitance			15				pF
<p><b>Note 6:</b> Adjust 0 dBm for F = 1 kHz (Null R<sub>L</sub>/R<sub>ON</sub> Attenuation).</p> <p><b>Note 7:</b> V<sub>IS</sub> is centered at V<sub>CC</sub>/2.</p> <p><b>Note 8:</b> Adjust input for 0 dBm.</p>								

AC Test Circuits and Switching Time Waveforms

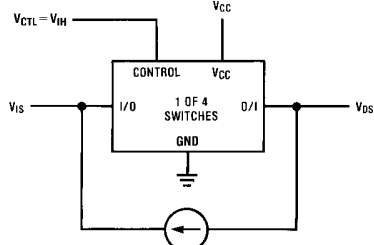


FIGURE 1. "ON" Resistance

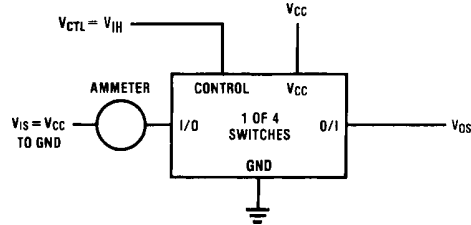


FIGURE 2. "ON" Channel Leakage Current

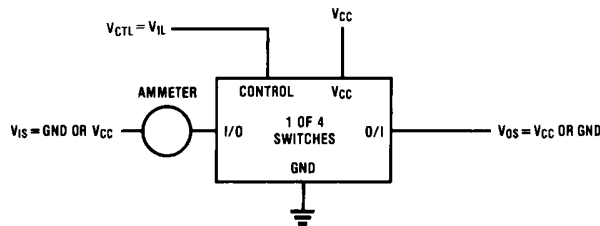


FIGURE 3. "OFF" Channel Leakage Current

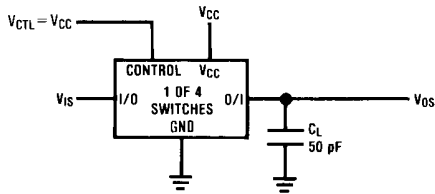


FIGURE 4.  $t_{PHL}$ ,  $t_{PLH}$  Propagation Delay Time Signal Input to Signal Output

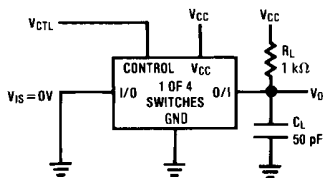
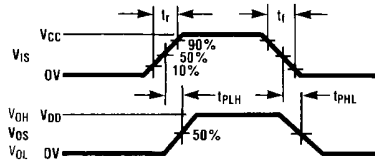


FIGURE 5.  $t_{PZL}$ ,  $t_{PLZ}$  Propagation Delay Time Control to Signal Output

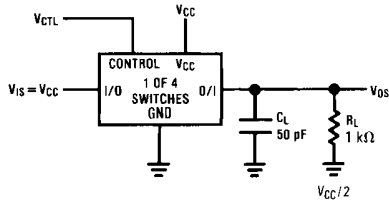
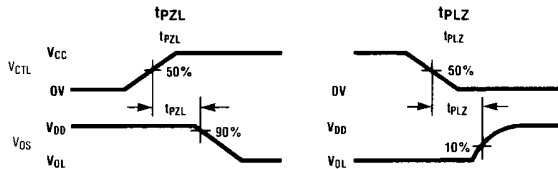
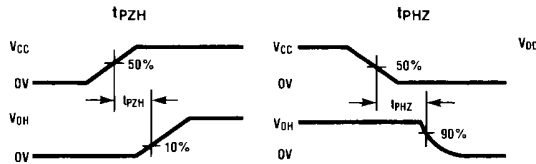


FIGURE 6.  $t_{PZH}$ ,  $t_{PHZ}$  Propagation Delay Time Control to Signal Output



AC Test Circuits and Switching Time Waveforms (Continued)

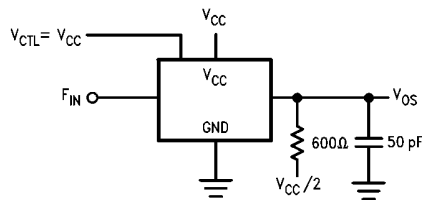


FIGURE 7. Frequency Response

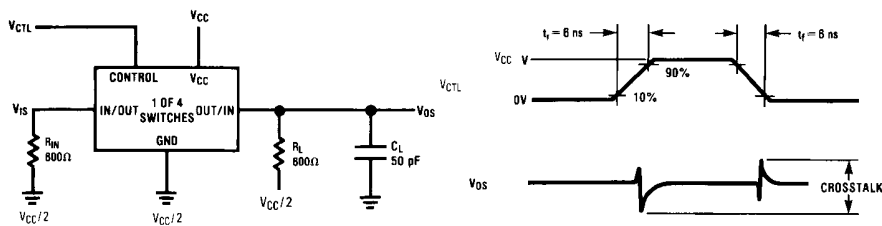


FIGURE 8. Crosstalk: Control Input to Signal Output

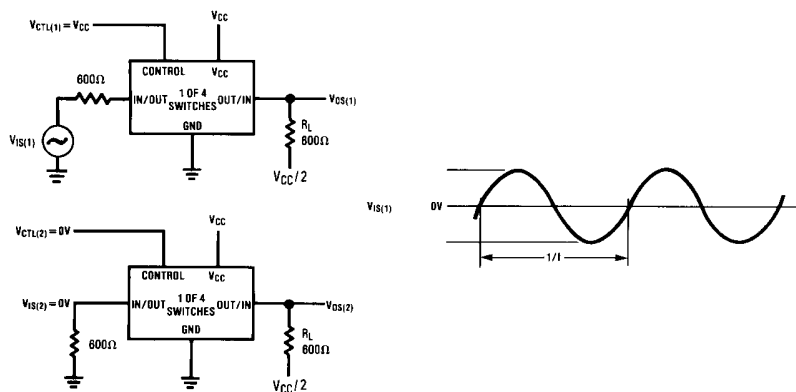


FIGURE 9. Crosstalk Between Any Two Switches

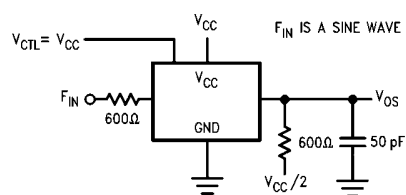


FIGURE 10. Switch OFF Signal Feedthrough Isolation

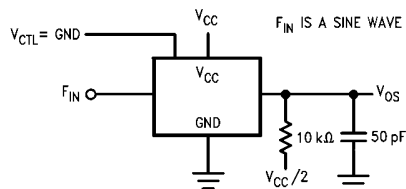
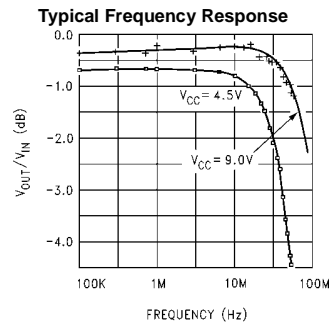
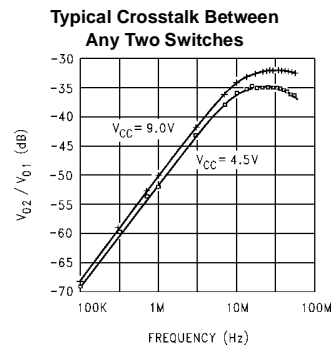
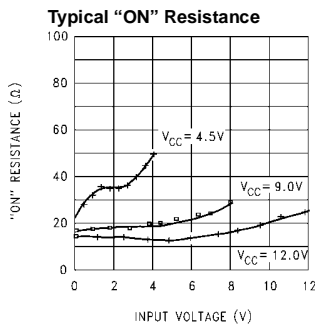


FIGURE 11. Sinewave Distortion

## Typical Performance Characteristics

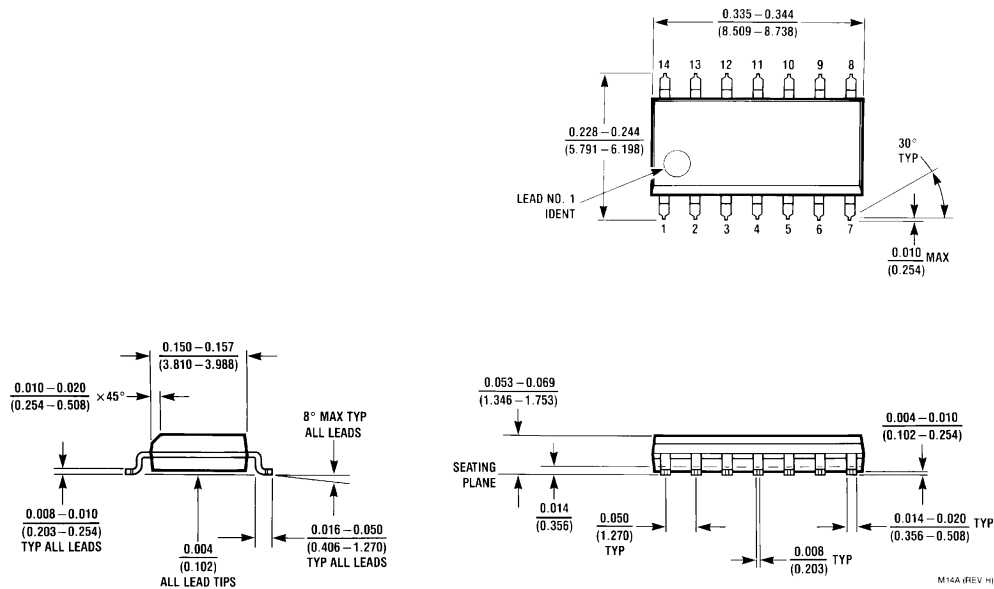


## Special Considerations

In certain applications the external load-resistor current may include both  $V_{CC}$  and signal line components. To avoid drawing  $V_{CC}$  current when switch current flows into

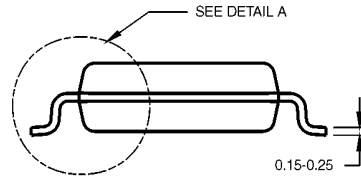
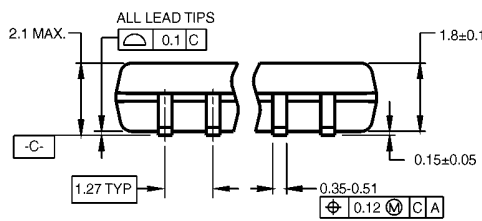
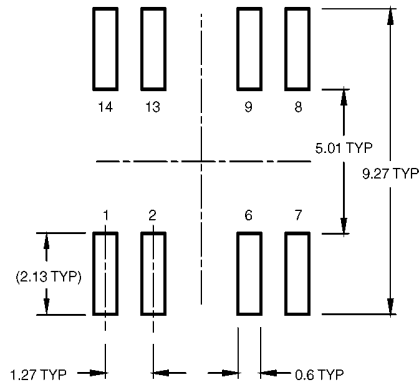
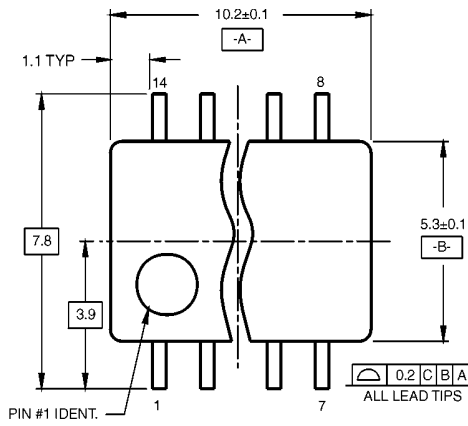
the analog switch input pins, the voltage drop across the switch must not exceed 0.6V (calculated from the ON resistance).

**Physical Dimensions** inches (millimeters) unless otherwise noted



**14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-120, 0.150" Narrow  
Package Number M14A**

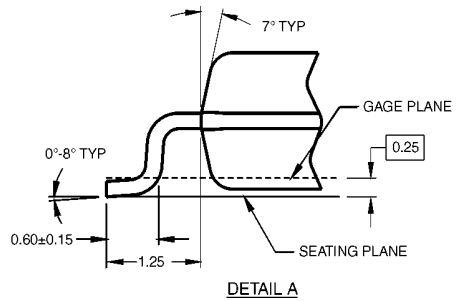
**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



DIMENSIONS ARE IN MILLIMETERS

- NOTES:
- A. CONFORMS TO EIAJ EDR-7320 REGISTRATION, ESTABLISHED IN DECEMBER, 1998.
  - B. DIMENSIONS ARE IN MILLIMETERS.
  - C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

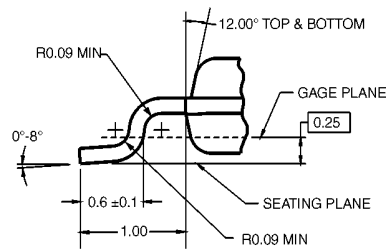
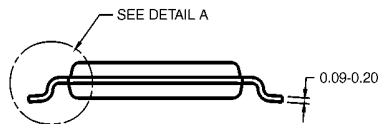
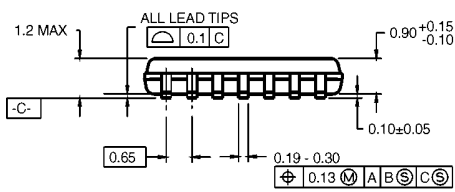
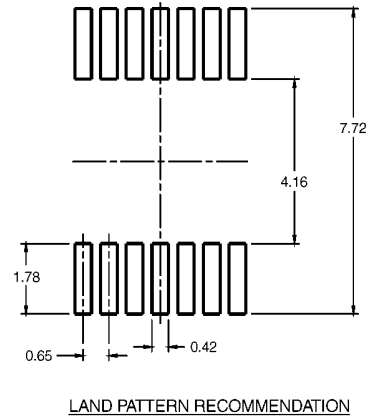
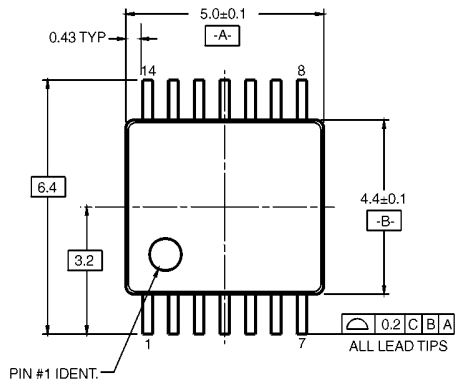
M14DRevB1



**14-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide  
Package Number M14D**



**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)

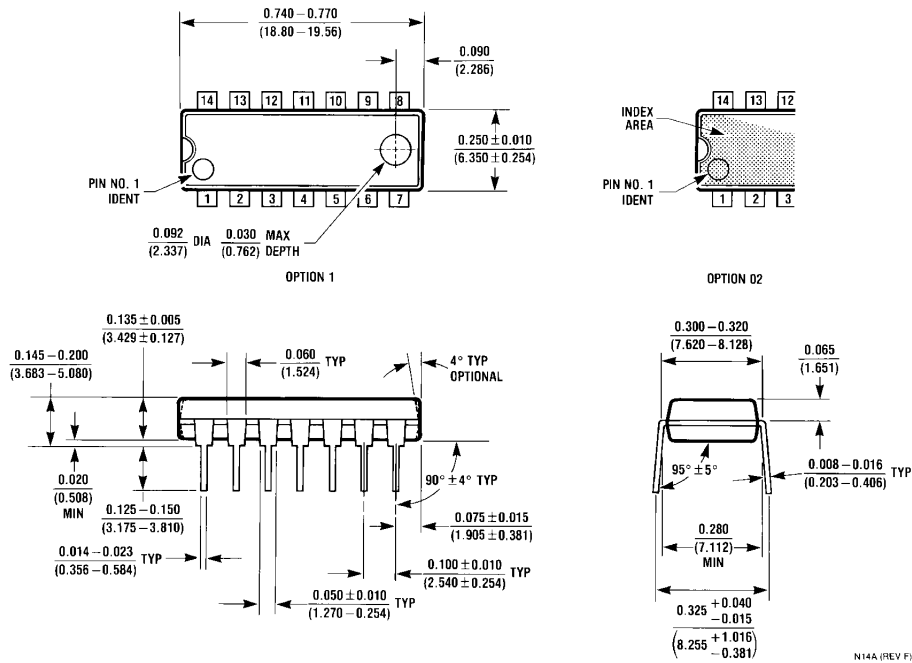


- NOTES:  
 A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AB, REF NOTE 6, DATE 7/93.  
 B. DIMENSIONS ARE IN MILLIMETERS.  
 C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.  
 D. DIMENSIONS AND TOLERANCES PER ANSI Y14.5M, 1982.

MTC14RevC3

**14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide  
 Package Number MTC14**

**Physical Dimensions** inches (millimeters) unless otherwise noted (Continued)



**14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide Package Number N14A**

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2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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