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# 74VHC4051, 8-Channel Analog Multiplexer 74VHC4052, Dual 4-Channel Analog Multiplexer 74VHC4053, Triple 2-Channel Analog Multiplexer

## Features

- Wide analog input voltage range:  $\pm 6V$
- Low "ON" resistance: 50 Typ. ( $V_{CC}-V_{EE} = 4.5V$ )
- 30 Typ. ( $V_{CC}-V_{EE} = 9V$ )
- Logic level translation to enable 5V logic with  $\pm 5V$  analog signals
- Low quiescent current: 80 $\mu A$  maximum
- Matched switch characteristic
- Pin and function compatible with the 74HC4051/ 4052/4053

## General Description

These multiplexers are digitally controlled analog switches implemented in 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 vice-versa. Also these switches contain linearization circuitry which lowers the "ON" resistance and increases switch linearity. These devices allow control of up to  $\pm 6V$  (peak) analog signals with digital control signals of 0 to 6V. Three supply pins are provided for  $V_{CC}$ , ground, and  $V_{EE}$ . This enables the connection of 0–5V logic signals when  $V_{CC} = 5V$  and an analog input range of  $\pm 5V$  when  $V_{EE} = 5V$ . All three devices also have an inhibit control which when high will disable all switches to their off state. All analog inputs and outputs and digital inputs are protected from electrostatic damage by diodes to  $V_{CC}$  and ground.

VHC4051: This device connects together the outputs of 8 switches, thus achieving an 8 channel Multiplexer. The binary code placed on the A, B, and C select lines determines which one of the eight switches is "ON", and connects one of the eight inputs to the common output.

VHC4052: This device connects together the outputs of 4 switches in two sets, thus achieving a pair of 4-channel multiplexers. The binary code placed on the A, and B select lines determine which switch in each 4 channel section is "ON", connecting one of the four inputs in each section to its common output. This enables the implementation of a 4-channel differential multiplexer.

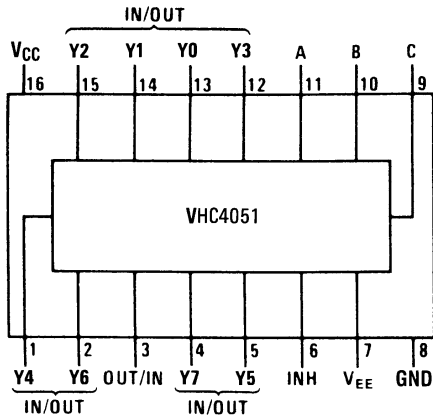
VHC4053: This device contains 6 switches whose outputs are connected together in pairs, thus implementing a triple 2 channel multiplexer, or the equivalent of 3 single-pole-double throw configurations. Each of the A, B, or C select lines independently controls one pair of switches, selecting one of the two switches to be "ON".

## Ordering Information

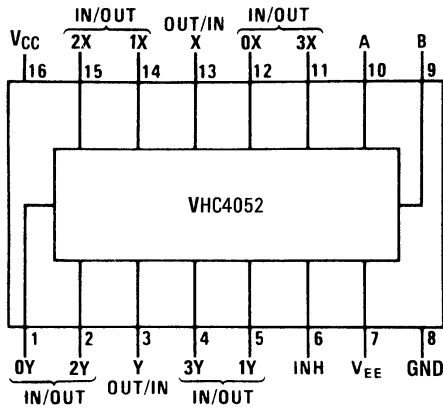
Order Number	Package Number	Package Description
74VHC4051M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
74VHC4051WM	M16B	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
74VHC4051MTC	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
74VHC4051N	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
74VHC4052M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
74VHC4052WM	M16B	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
74VHC4052MTC	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide
74VHC4053M	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
74VHC4053WM	M16B	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
74VHC4053MTC	MTC16	16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide

Surface mount packages are also available on Tape and Reel. Specify by appending the suffix letter "X" to the ordering number.

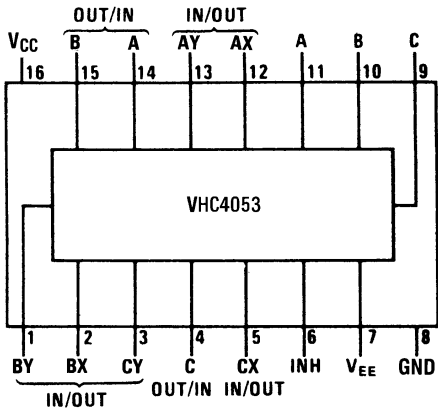
## Connection Diagrams



Top View



Top View



Top View

## Truth Tables

### 74VHC4051

Input				"ON" Channel
INH	C	B	A	
H	X	X	X	None
L	L	L	L	Y0
L	L	L	H	Y1
L	L	H	L	Y2
L	L	H	H	Y3
L	H	L	L	Y4
L	H	L	H	Y5
L	H	H	L	Y6
L	H	H	H	Y7

### 74VHC4052

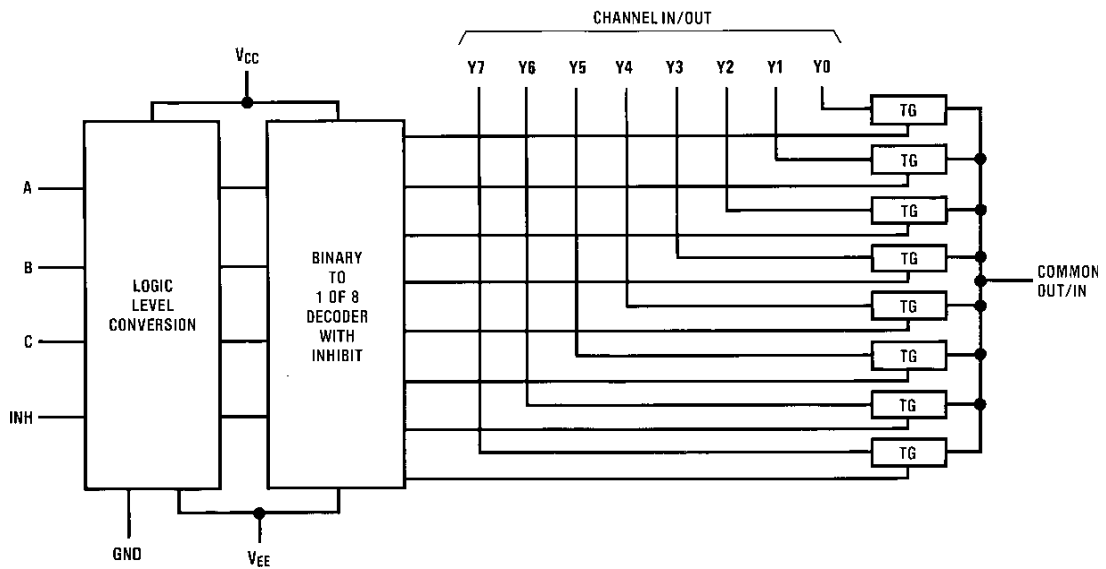
Inputs			"ON" Channels	
INH	B	A	X	Y
H	X	X	None	None
L	L	L	0X	0Y
L	L	H	1X	1Y
L	H	L	2X	2Y
L	H	H	3X	3Y

### 74VHC4053

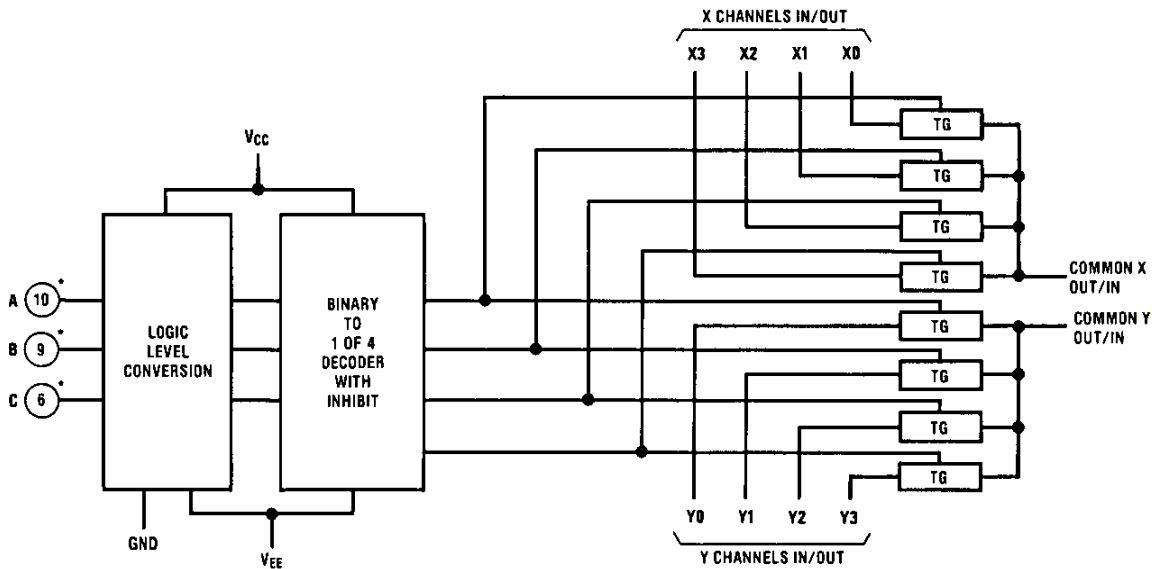
Input				"ON" Channels		
INH	C	B	A	C	B	A
H	X	X	X	None	None	None
L	L	L	L	CX	BX	AX
L	L	L	H	CX	BX	AY
L	L	H	L	CX	BY	AX
L	L	H	H	CX	BY	AY
L	H	L	L	CY	BX	AX
L	H	L	H	CY	BX	AY
L	H	H	L	CY	BY	AX
L	H	H	H	CY	BY	AY

# Logic Diagrams

74VHC4051

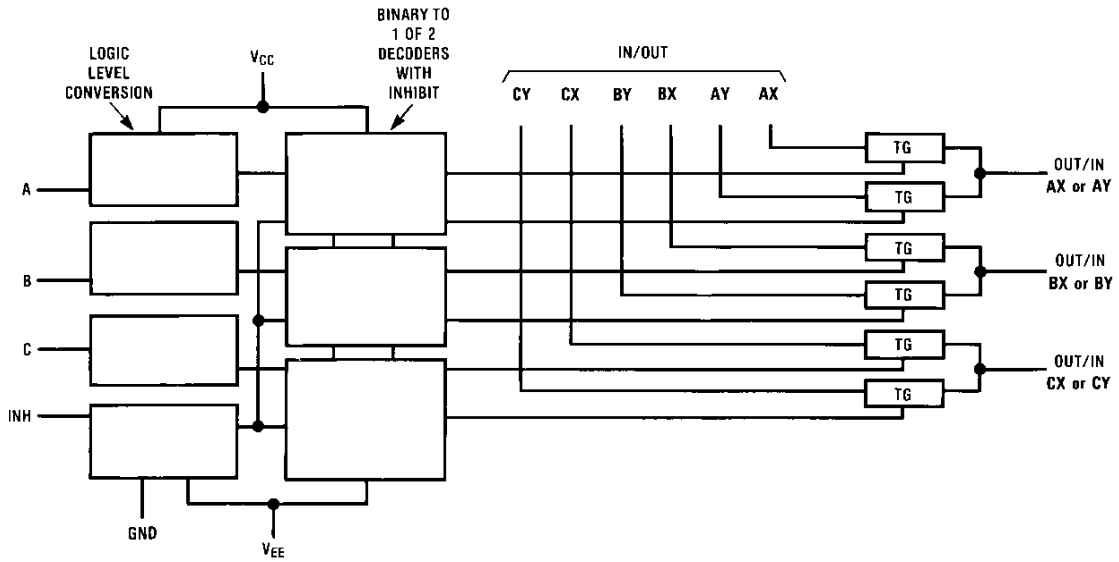


74VHC4052



74VHC4051, 8-Channel Analog Multiplexer 74VHC4052, Dual 4-Channel Analog Multiplexer  
74VHC4053, Triple 2-Channel Analog Multiplexer

74VHC4053



74VHC4051, 8-Channel Analog Multiplexer 74VHC4052, Dual 4-Channel Analog Multiplexer  
 74VHC4053, Triple 2-Channel Analog Multiplexer

## Absolute Maximum Ratings<sup>(1)</sup>

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter	Rating
$V_{CC}$	Supply Voltage	-0.5 to +7.5V
$V_{EE}$	Supply Voltage	+0.5 to -7.5V
$V_{IN}$	Control Input Voltage	-1.5 to $V_{CC}+1.5V$
$V_{IO}$	Switch I/O Voltage	$V_{EE}-0.5$ to $V_{CC}+0.5V$
$I_{IK}, I_{OK}$	Clamp Diode Current	$\pm 20mA$
$I_{OUT}$	Output Current, per pin	$\pm 25mA$
$I_{CC}$	$V_{CC}$ or GND Current, per pin	$\pm 50mA$
$T_{STG}$	Storage Temperature Range	-65°C to +150°C
$P_D$	Power Dissipation <sup>(2)</sup>	600mW
	S.O. Package only	500mW
$T_L$	Lead Temperature (Soldering 10 seconds)	260°C

### Note:

1. Unless otherwise specified all voltages are referenced to ground.
2. Power Dissipation temperature derating; plastic "N" package: -12mW/°C from 65°C to 85°C.

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Min.	Max.	Units
$V_{CC}$	Supply Voltage	2	6	V
$V_{EE}$	Supply Voltage	0	-6	V
$V_{IN}, V_{OUT}$	DC Input or Output Voltage	0	$V_{CC}$	V
$T_A$	Operating Temperature Range	-40	+85	°C
$t_r, t_f$	Input Rise or Fall Times			
	$V_{CC} = 2.0V$		1000	ns
	$V_{CC} = 4.5V$		500	
	$V_{CC} = 6.0V$		400	

### DC Electrical Characteristics<sup>(3)</sup>

Symbol	Parameter	Conditions	V <sub>EE</sub>	V <sub>CC</sub>	Typ.	T <sub>A</sub> = 25°C	T <sub>A</sub> = -40 to 85°C	Units	
						Guaranteed Limits			
V <sub>IH</sub>	Minimum HIGH Level Input Voltage			2.0V		1.5	1.5	V	
				4.5V		3.15	3.15		
				6.0V		4.2	4.2		
V <sub>IL</sub>	Maximum LOW Level Input Voltage			2.0V		0.5	0.5	V	
				4.5V		1.35	1.35		
				6.0V		1.8	1.8		
R <sub>ON</sub>	Maximum "ON" Resistance <sup>(4)</sup>	V <sub>INH</sub> = V <sub>IL</sub> , I <sub>S</sub> = 2.0mA, V <sub>IS</sub> = V <sub>CC</sub> to V <sub>EE</sub> (Fig. 1)	GND	4.5V	40	160	200	Ω	
			-4.5V	4.5V	30	120	150		
			-6.0V	6.0V	20	100	125		
		V <sub>INH</sub> = V <sub>IL</sub> , I <sub>S</sub> = 2.0mA, V <sub>IS</sub> = V <sub>CC</sub> or V <sub>EE</sub> (Fig. 1)	GND	2.0V	100	230	280	Ω	
			GND	4.5V	40	110	140		
			-4.5V	4.5V	20	90	120		
R <sub>ON</sub>	Maximum "ON" Resistance Matching	V <sub>INH</sub> = V <sub>IL</sub> , V <sub>IS</sub> = V <sub>CC</sub> to GND	GND	4.5V	10	20	25	Ω	
			-4.5V	4.5V	5	10	15		
			-6.0V	6.0V	5	10	12		
I <sub>N</sub>	Maximum Control Input Current	V <sub>IN</sub> = V <sub>CC</sub> or GND, V <sub>CC</sub> = 2 - 6V				±0.05	±0.5	μA	
I <sub>CC</sub>	Maximum Quiescent Supply Current	V <sub>IN</sub> = V <sub>CC</sub> or GND, I <sub>OUT</sub> = 0μA	GND	6.0V		4	40	μA	
			-6.0V	6.0V		8	80		
I <sub>IZ</sub>	Maximum Switch "OFF" Leakage Current (Switch Input)	V <sub>OS</sub> = V <sub>CC</sub> or V <sub>EE</sub> , V <sub>IS</sub> = V <sub>EE</sub> or V <sub>CC</sub> , V <sub>INH</sub> = V <sub>IH</sub> (Fig. 2)	GND	6.0V		±60	±300	nA	
			-6.0V	6.0V		±100	±500		
I <sub>IZ</sub>	Maximum Switch "ON" Leakage Current	VHC4051	V <sub>IS</sub> = V <sub>CC</sub> to V <sub>EE</sub> , V <sub>INH</sub> = V <sub>IL</sub> (Fig. 3)	GND	6.0V		±0.1	±1.0	μA
				-6.0V	6.0V		±0.2	±2.0	
		VHC4052	V <sub>IS</sub> = V <sub>CC</sub> to V <sub>EE</sub> , V <sub>INH</sub> = V <sub>IL</sub> (Fig. 3)	GND	6.0V		±0.050	±0.5	μA
				-6.0V	6.0V		±0.1	±1.0	
		VHC4053	V <sub>IS</sub> = V <sub>CC</sub> to V <sub>EE</sub> , V <sub>INH</sub> = V <sub>IL</sub> (Fig. 3)	GND	6.0V		±0.05	±0.5	μA
				-6.0V	6.0V		±0.5	±0.5	
I <sub>IZ</sub>	Maximum Switch "OFF" Leakage Current (Common Pin)	VHC4051	V <sub>OS</sub> = V <sub>CC</sub> or V <sub>EE</sub> , V <sub>IS</sub> = V <sub>EE</sub> or V <sub>CC</sub> , V <sub>INH</sub> = V <sub>IH</sub>	GND	6.0V		±0.1	±1.0	μA
				-6.0V	6.0V		±0.2	±2.0	
		VHC4052	V <sub>OS</sub> = V <sub>CC</sub> or V <sub>EE</sub> , V <sub>IS</sub> = V <sub>EE</sub> or V <sub>CC</sub> , V <sub>INH</sub> = V <sub>IH</sub>	GND	6.0V		±0.05	±0.5	μA
				-6.0V	6.0V		±0.1	±1.0	
		VHC4053	V <sub>OS</sub> = V <sub>CC</sub> or V <sub>EE</sub> , V <sub>IS</sub> = V <sub>EE</sub> or V <sub>CC</sub> , V <sub>INH</sub> = V <sub>IH</sub>	GND	6.0V		±0.05	±0.5	μA
				-6.0V	6.0V		±0.05	±0.5	

**Notes:**

- For a power supply of 5V ±10% the worst case on resistances (R<sub>ON</sub>) occurs for VHC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case V<sub>IH</sub> and V<sub>IL</sub> occur at V<sub>CC</sub> = 5.5V and 4.5V respectively. (The V<sub>IH</sub> value at 5.5V is 3.85V.) The worst case leakage current occur for CMOS at the higher voltage and so the 5.5V values should be used.
- At supply voltages (V<sub>CC</sub>-V<sub>EE</sub>) 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.
- Adjust 0dB for f = 1kHz (Null R1/R<sub>ON</sub> Attenuation).



### AC Electrical Characteristics

$V_{CC} = 2.0V - 6.0V$ ,  $V_{EE} = 0V - 6V$ ,  $C_L = 50pF$  (unless otherwise specified)

Symbol	Parameter	Conditions	$V_{EE}$	$V_{CC}$	$T_A = 25^\circ C$		$T_A = -40 \text{ to } 85^\circ C$		Units
					Typ.	Guaranteed Limits			
$t_{PHL}$ , $t_{PLH}$	Maximum Propagation Delay Switch In to Out		GND	3.3V	25	35	40	ns	
			GND	4.5V	5	12	15		
			-4.5V	4.5V	4	8	12		
			-6.0V	6.0V	3	7	11		
$t_{PZL}$ , $t_{PZH}$	Maximum Switch Turn "ON" Delay	$R_L = 1k\Omega$	GND	3.3V	92	200	250	ns	
			GND	4.5V		69	87		
			-4.5V	4.5V	16	46	58		
			-6.0V	6.0V	15	41	51		
$t_{PHZ}$ , $t_{PLZ}$	Maximum Switch Turn "OFF" Delay		GND	3.3V	65	170	210	ns	
			GND	4.5V	28	58	73		
			-4.5V	4.5V	18	37	46		
			-6.0V	6.0V	16	32	41		
$f_{MAX}$	Minimum Switch Frequency Response $20 \log (V_I/V_O) = 3dB$		GND	4.5V	30			MHz	
			-4.5V	4.5V	35				
	Control to Switch Feedthrough Noise	$R_L = 600\Omega$ , $f = 1MHz$ , $C_L = 50pF$	$V_{IS} = 4 V_{PP}$	0V	4.5V	1080		mV	
			$V_{IS} = 8 V_{PP}$	-4.5V	4.5V	250			
	Crosstalk Between any Two Switches	$R_L = 600\Omega$ , $f = 1 MHz$	$V_{IS} = 4 V_{PP}$	0V	4.5	-52		dB	
			$V_{IS} = 8 V_{PP}$	-4.5V	4.5V	-50			
	Switch OFF Signal Feedthrough Isolation	$R_L = 600\Omega$ , $f = 1 MHz$ , $V_{CTL} = V_{IL}$	$V_{IS} = 4 V_{PP}$	0V	4.5V	-42		dB	
			$V_{IS} = 8 V_{PP}$	-4.5V	4.5V	-44			
THD	Sinewave Harmonic Distortion	$R_L = 10k\Omega$ , $C_L = 50pF$ , $f = 1kHz$	$V_{IS} = 4 V_{PP}$	0V	4.5V	0.013		%	
			$V_{IS} = 8 V_{PP}$	-4.5V	4.5V	0.008			
$C_{IN}$	Maximum Control Input Capacitance				5	10	10	pF	
$C_{IN}$	Maximum Switch Input Capacitance	Input			15			pF	
		4051 Common			90				
		4052 Common			45				
		4053 Common			30				
$C_{IN}$	Maximum Feedthrough Capacitance				5			pF	

## AC Test Circuits and Switching Time Waveforms

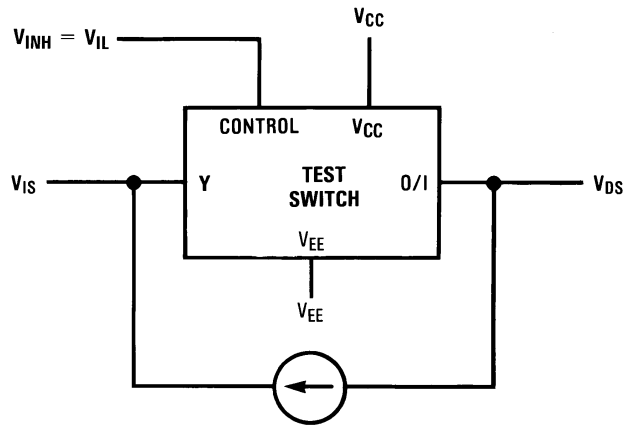


Figure 1. "ON" Resistance

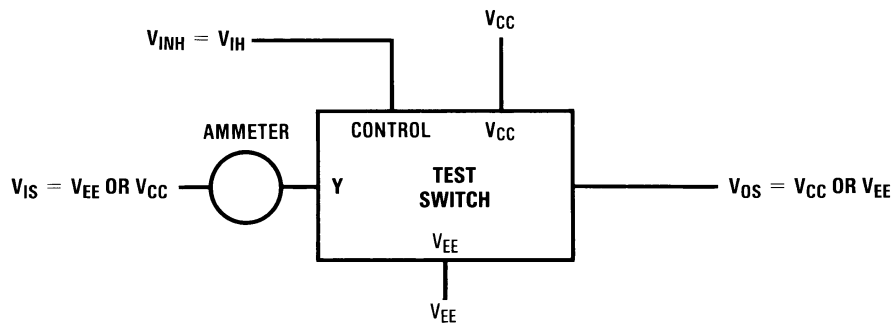


Figure 2. "OFF" Channel Leakage Current

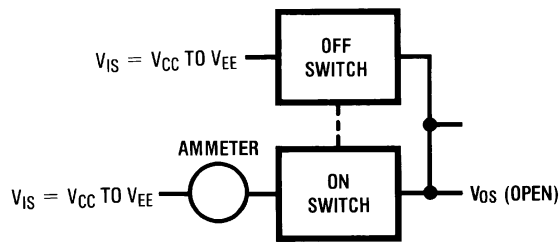


Figure 3. "ON" Channel Leakage Current

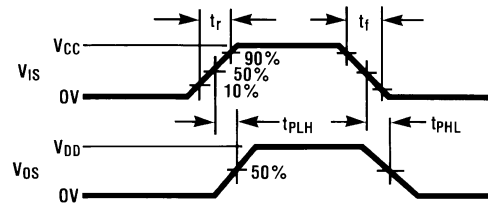
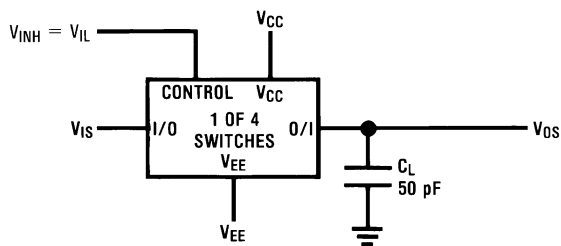


Figure 4.  $t_{PHL}$ ,  $t_{PLH}$  Propagation Delay Time Signal Input to Signal Output

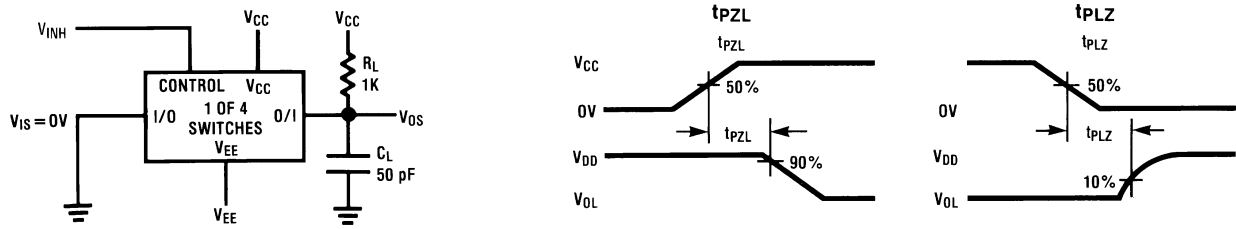


Figure 5.  $t_{PZL}$ ,  $t_{PLZ}$  Propagation Delay Time Control to Signal Output

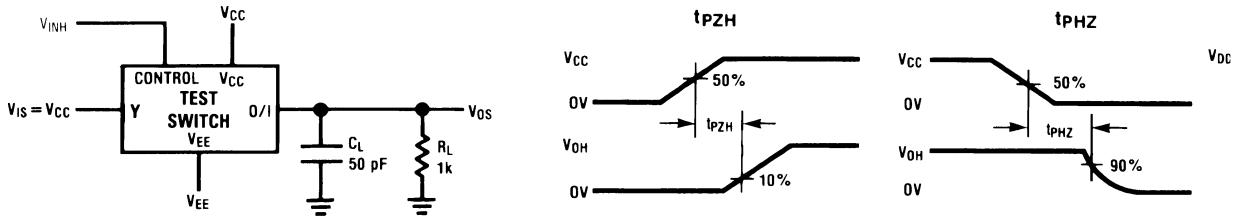


Figure 6.  $t_{PZH}$ ,  $t_{PHZ}$  Propagation Delay Time Control to Signal Output

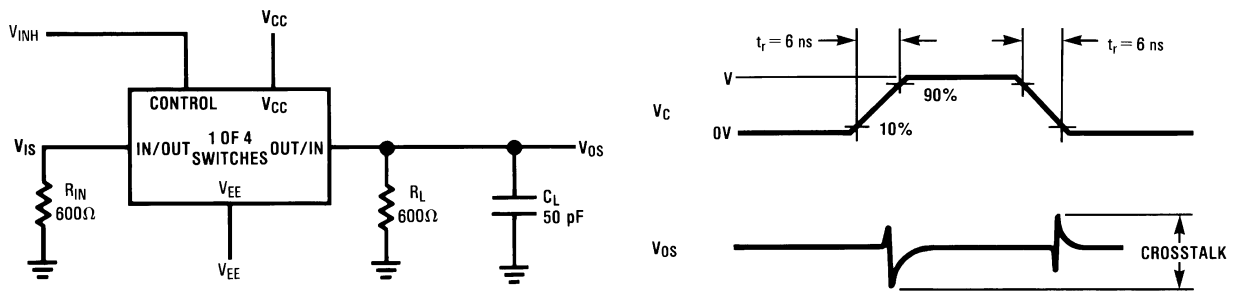


Figure 7. Crosstalk: Control Input to Signal Output

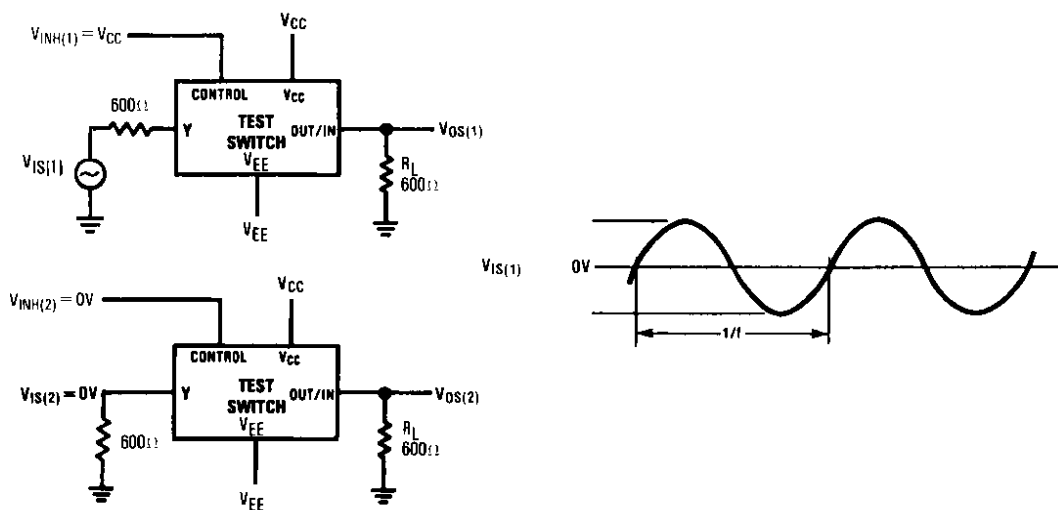
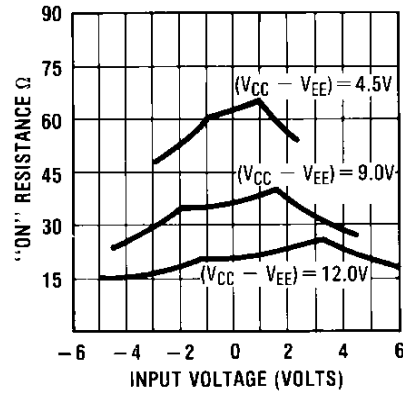


Figure 8. Crosstalk Between Any Two Switches

## Typical Performance Characteristics

Typical "On" Resistance vs Input Voltage



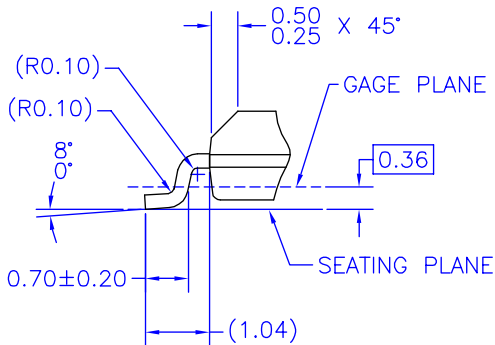
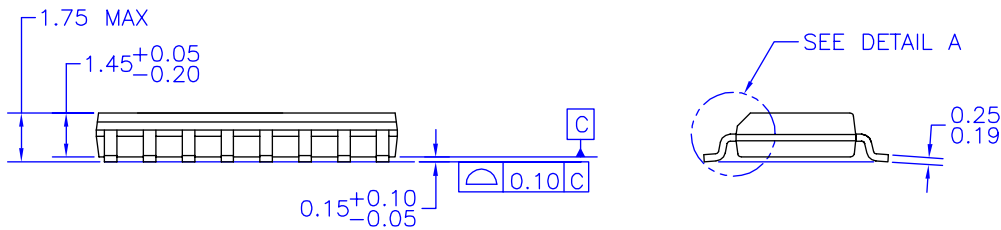
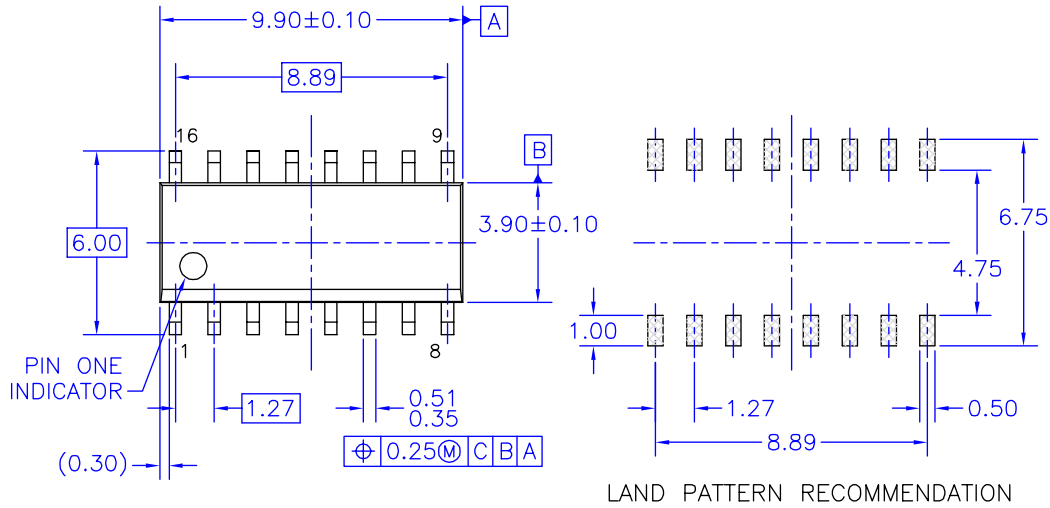
$$V_{CC} = -V_{EE}$$

### 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 pins, the voltage drop across the switch must not exceed 1.2V (calculated from the ON resistance).

### Physical Dimensions

Dimensions are in millimeters unless otherwise noted.



DETAIL A  
 SCALE: 2:1

NOTES: UNLESS OTHERWISE SPECIFIED

- A) THIS PACKAGE CONFORMS TO JEDEC MS-012, VARIATION AC, ISSUE C, DATED MAY 1990.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.
- D) STANDARD LEAD FINISH:  
 200 MICRONS / 5.08 MICRONS MIN. LEAD/TIN (SOLDER) ON COPPER.

M16AREVK

Figure 9. 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow Package Number M16A

### Physical Dimensions (Continued)

Dimensions are in inches (millimeters) unless otherwise noted.

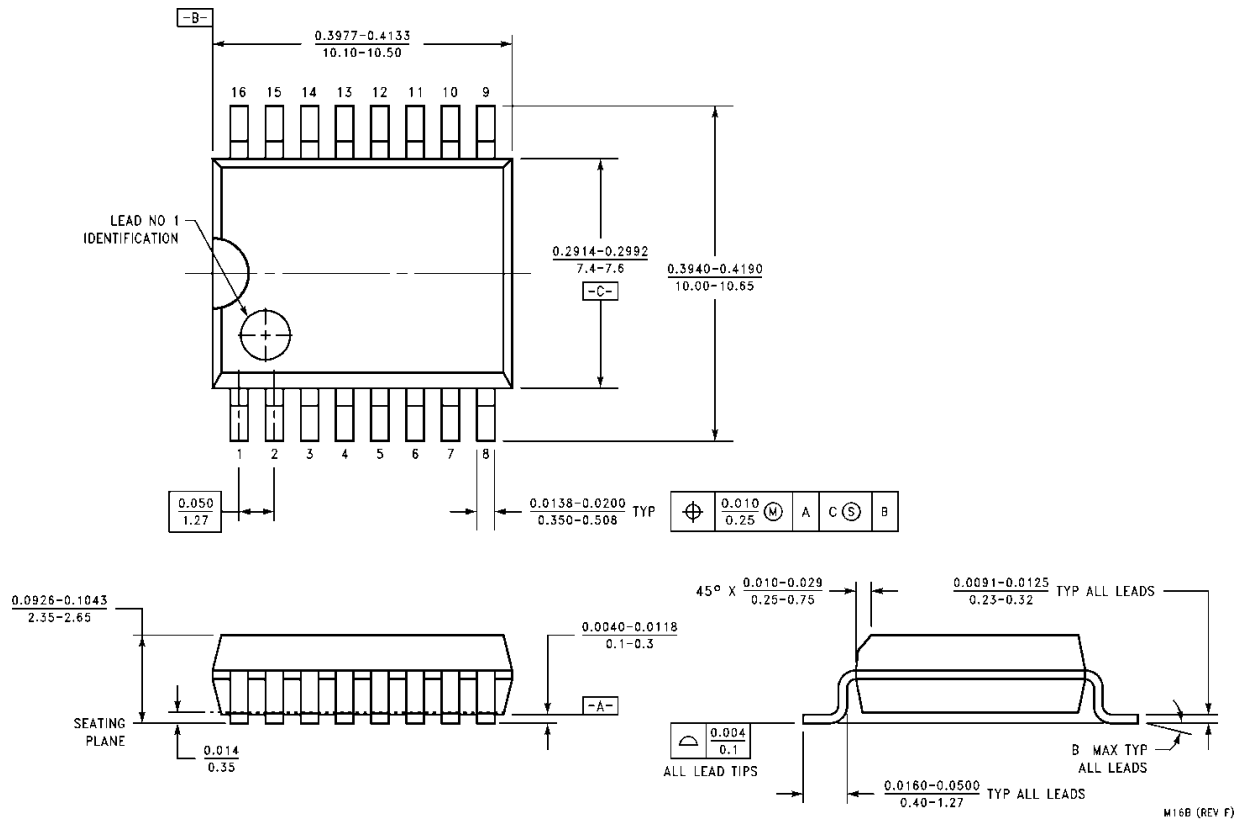
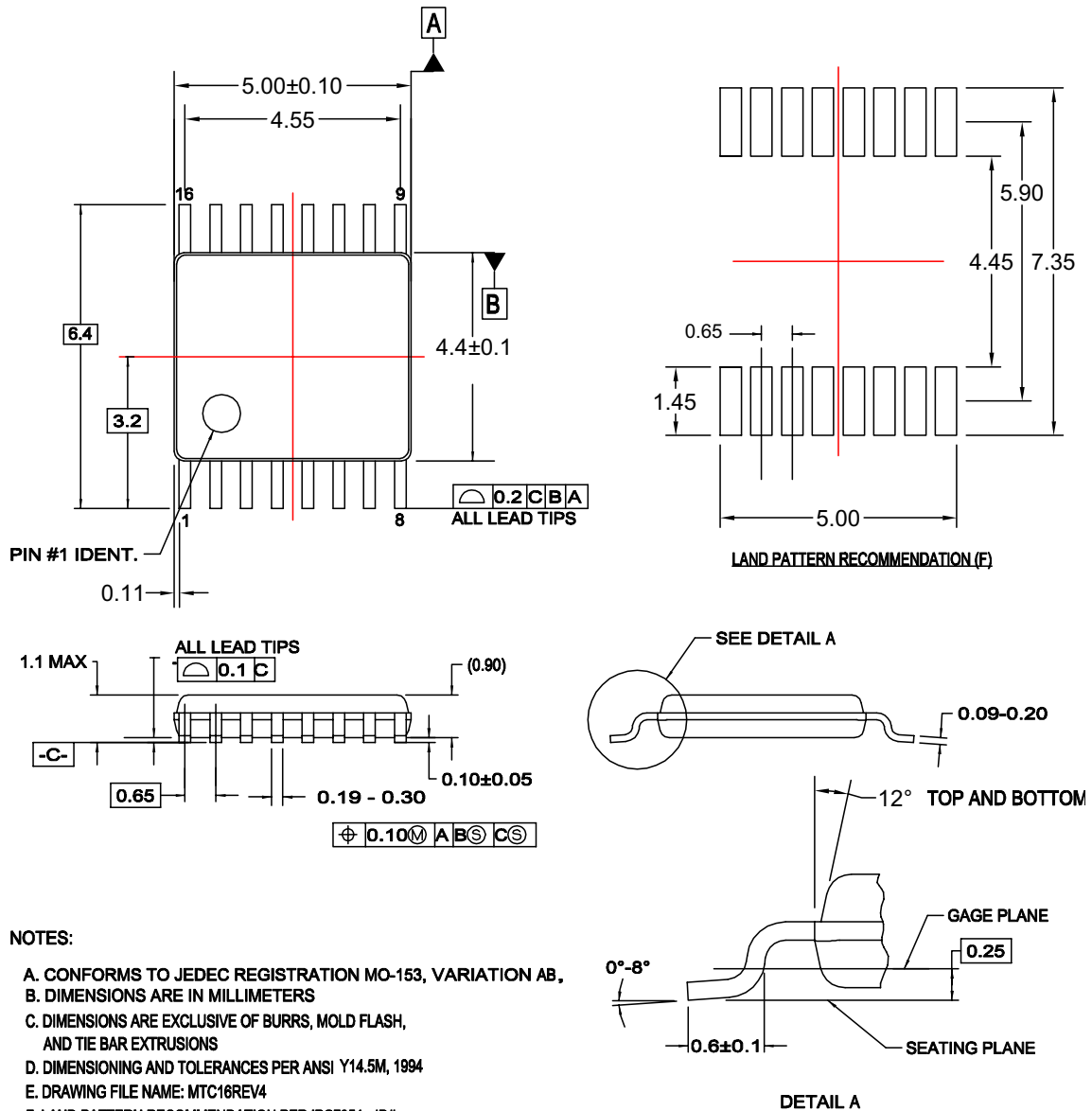


Figure 10. 16-Lead Small Outline Intergrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide  
 Package Number M16B

### Physical Dimensions (Continued)

Dimensions are in millimeters unless otherwise noted.



MTC16rev4

Figure 11. 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide Package Number MTC16

**Physical Dimensions** (Continued)

Dimensions are in inches (millimeters) unless otherwise noted.

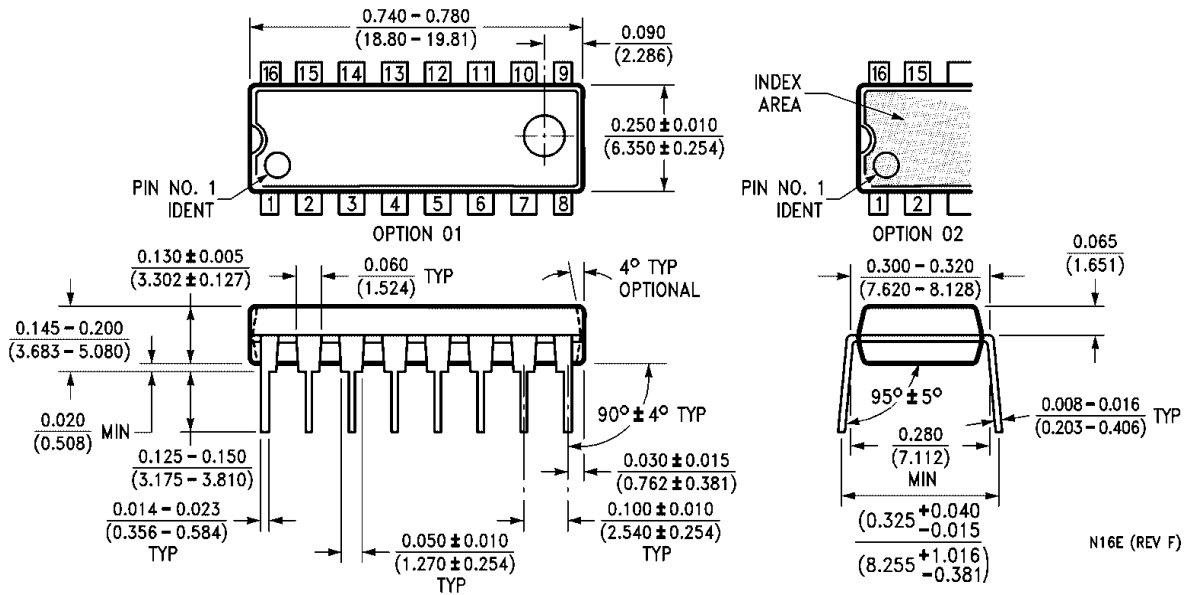



Figure 12. 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide Package Number N16E





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