

# Analog Multiplexers / Demultiplexers

## High-Performance Silicon-Gate CMOS

### MC74VHC4051, MC74VHC4052, MC74VHC4053

The MC74VHC4051, MC74VHC4052 and MC74VHC4053 utilize silicon-gate CMOS technology to achieve fast propagation delays, low ON resistances, and low OFF leakage currents. These analog multiplexers/demultiplexers control analog voltages that may vary across the complete power supply range (from  $V_{CC}$  to  $V_{EE}$ ).

The VHC4051, VHC4052 and VHC4053 are identical in pinout to the high-speed HC4051A, HC4052A and HC4053A, and the metal-gate MC14051B, MC14052B and MC14053B. The Channel-Select inputs determine which one of the Analog Inputs/Outputs is to be connected, by means of an analog switch, to the Common Output/Input. When the Enable pin is HIGH, all analog switches are turned off.

The Channel-Select and Enable inputs are compatible with standard CMOS outputs; with pullup resistors they are compatible with LSTTL outputs.

These devices have been designed so that the ON resistance ( $R_{on}$ ) is more linear over input voltage than  $R_{on}$  of metal-gate CMOS analog switches.

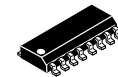
- Fast Switching and Propagation Speeds
- Low Crosstalk Between Switches
- Diode Protection on All Inputs/Outputs
- Analog Power Supply Range ( $V_{CC} - V_{EE}$ ) = 2.0 to 12.0 V
- Digital (Control) Power Supply Range ( $V_{CC} - GND$ ) = 2.0 to 6.0 V
- Improved Linearity and Lower ON Resistance Than Metal-Gate Counterparts
- Low Noise
- Chip Complexity: VHC4051 — 184 FETs or 46 Equivalent Gates  
VHC4052 — 168 FETs or 42 Equivalent Gates  
VHC4053 — 156 FETs or 39 Equivalent Gates
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



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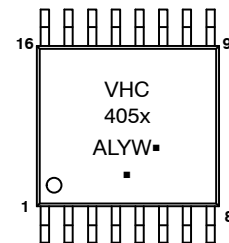
#### MARKING DIAGRAMS



SOIC-16  
D SUFFIX  
CASE 751B



TSSOP-16  
DT SUFFIX  
CASE 948F



VHC405x = Specific Device Code  
(x = 1, 2 or 3)

A = Assembly Location

L, WL = Wafer Lot

Y, YY = Year

W, WW = Work Week

G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

#### ORDERING INFORMATION

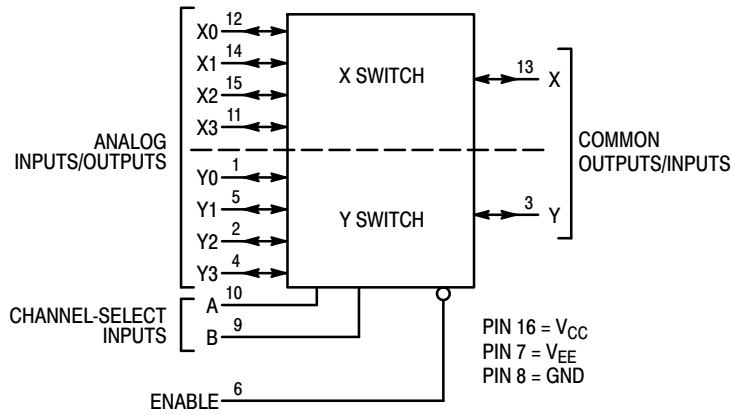
See detailed ordering and shipping information in the package dimensions section on page 16 of this data sheet.

**MC74VHC4051, MC74VHC4052, MC74VHC4053**



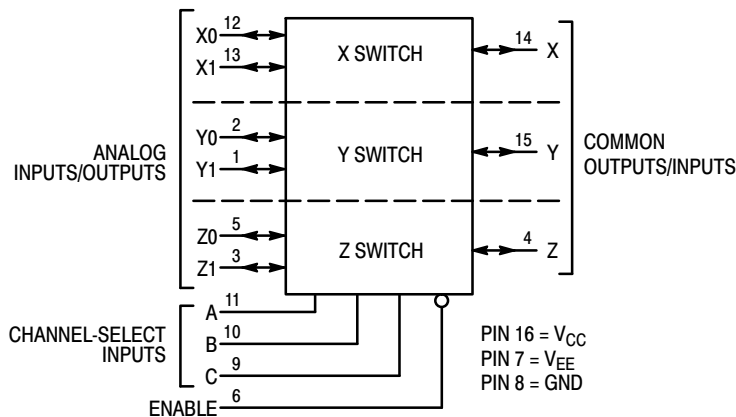
**MC74VHC4051**

**Single-Pole, 8-Position Plus Common Off**



**MC74VHC4052**

**Double-Pole, 4-Position Plus Common Off**



NOTE: This device allows independent control of each switch. Channel-Select Input A controls the X-Switch, Input B controls the Y-Switch and Input C controls the Z-Switch

**MC74VHC4053**

**Triple Single-Pole, Double-Position Plus Common Off**

**Figure 1. Logic Diagrams**

# MC74VHC4051, MC74VHC4052, MC74VHC4053

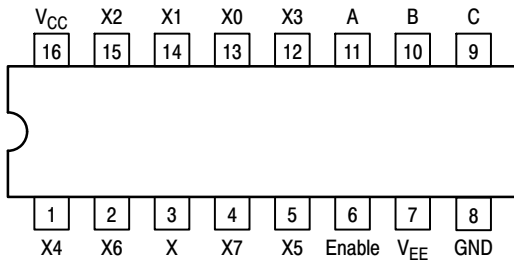


Figure 2. Pinout: MC74VHC4051 (Top View)

FUNCTION TABLE – MC74VHC4051

Control Inputs				ON Channels
Enable	Select			
	C	B	A	
L	L	L	L	X0
L	L	L	H	X1
L	L	H	L	X2
L	L	H	H	X3
L	H	L	L	X4
L	H	L	H	X5
L	H	H	L	X6
L	H	H	H	X7
H	X	X	X	NONE

X = Don't Care

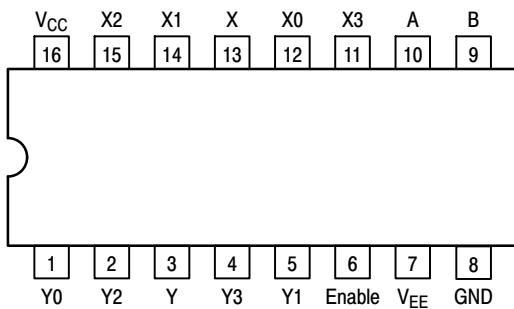


Figure 3. Pinout: MC74VHC4052 (Top View)

FUNCTION TABLE – MC74VHC4052

Control Inputs			ON Channels	
Enable	Select			
	B	A		
L	L	L	Y0	X0
L	L	H	Y1	X1
L	H	L	Y2	X2
L	H	H	Y3	X3
H	X	X	NONE	

X = Don't Care

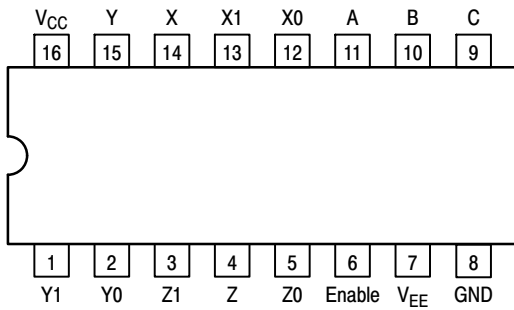


Figure 4. Pinout: MC74VHC4053 (Top View)

FUNCTION TABLE – MC74VHC4053

Control Inputs				ON Channels		
Enable	Select					
	C	B	A			
L	L	L	L	Z0	Y0	X0
L	L	L	H	Z0	Y0	X1
L	L	H	L	Z0	Y1	X0
L	L	H	H	Z0	Y1	X1
L	H	L	L	Z1	Y0	X0
L	H	L	H	Z1	Y0	X1
L	H	H	L	Z1	Y1	X0
L	H	H	H	Z1	Y1	X1
H	X	X	X	NONE		

X = Don't Care

# MC74VHC4051, MC74VHC4052, MC74VHC4053

## MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Positive DC Supply Voltage (Referenced to GND) (Referenced to V <sub>EE</sub> )	- 0.5 to + 7.0 - 0.5 to + 14.0	V
V <sub>EE</sub>	Negative DC Supply Voltage (Referenced to GND)	- 7.0 to + 5.0	V
V <sub>IS</sub>	Analog Input Voltage	V <sub>EE</sub> - 0.5 to V <sub>CC</sub> + 0.5	V
V <sub>in</sub>	Digital Input Voltage (Referenced to GND)	- 0.5 to V <sub>CC</sub> + 0.5	V
I	DC Current, Into or Out of Any Pin	± 25	mA
P <sub>D</sub>	Power Dissipation in Still Air SOIC Package† TSSOP Package†	500 450	mW
T <sub>stg</sub>	Storage Temperature Range	- 65 to + 150	°C
T <sub>L</sub>	Lead Temperature, 1 mm from Case for 10 Seconds	260	°C

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V<sub>in</sub> and V<sub>out</sub> should be constrained to the range GND ≤ (V<sub>in</sub> or V<sub>out</sub>) ≤ V<sub>CC</sub>. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V<sub>CC</sub>). Unused outputs must be left open.

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

†Derating — SOIC Package: - 7 mW/°C from 65° to 125°C  
TSSOP Package: - 6.1 mW/°C from 65° to 125°C

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V <sub>CC</sub>	Positive DC Supply Voltage (Referenced to GND) (Referenced to V <sub>EE</sub> )	2.0 2.0	6.0 12.0	V
V <sub>EE</sub>	Negative DC Supply Voltage, Output (Referenced to GND)	- 6.0	GND	V
V <sub>IS</sub>	Analog Input Voltage	V <sub>EE</sub>	V <sub>CC</sub>	V
V <sub>in</sub>	Digital Input Voltage (Referenced to GND)	GND	V <sub>CC</sub>	V
V <sub>IO*</sub>	Static or Dynamic Voltage Across Switch		1.2	V
T <sub>A</sub>	Operating Temperature Range, All Package Types	- 55	+ 125	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise/Fall Time (Channel Select or Enable Inputs)	0	1000	ns
	V <sub>CC</sub> = 2.0 V	0	800	
	V <sub>CC</sub> = 3.0 V	0	500	
	V <sub>CC</sub> = 4.5 V	0	400	
	V <sub>CC</sub> = 6.0 V	0	400	

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

\*For voltage drops across switch greater than 1.2V (switch on), excessive V<sub>CC</sub> current may be drawn; i.e., the current out of the switch may contain both V<sub>CC</sub> and switch input components. The reliability of the device will be unaffected unless the Maximum Ratings are exceeded.

# MC74VHC4051, MC74VHC4052, MC74VHC4053

## DC CHARACTERISTICS — Digital Section (Voltages Referenced to GND) $V_{EE} = \text{GND}$ , Except Where Noted

Symbol	Parameter	Condition	$V_{CC}$ V	Guaranteed Limit			Unit
				-55 to 25°C	≤85°C	≤125°C	
$V_{IH}$	Minimum High-Level Input Voltage, Channel-Select or Enable Inputs	$R_{on} = \text{Per Spec}$	2.0	1.50	1.50	1.50	V
			3.0	2.10	2.10	2.10	
			4.5	3.15	3.15	3.15	
			6.0	4.20	4.20	4.20	
$V_{IL}$	Maximum Low-Level Input Voltage, Channel-Select or Enable Inputs	$R_{on} = \text{Per Spec}$	2.0	0.5	0.5	0.5	V
			3.0	0.9	0.9	0.9	
			4.5	1.35	1.35	1.35	
			6.0	1.8	1.8	1.8	
$I_{in}$	Maximum Input Leakage Current, Channel-Select or Enable Inputs	$V_{in} = V_{CC}$ or GND, $V_{EE} = -6.0 \text{ V}$	6.0	± 0.1	± 1.0	± 1.0	μA
$I_{CC}$	Maximum Quiescent Supply Current (per Package)	Channel Select, Enable and $V_{IS} = V_{CC}$ or GND; $V_{EE} = \text{GND}$ $V_{IO} = 0 \text{ V}$ $V_{EE} = -6.0$	6.0	1	10	40	μA
			6.0	4	40	80	

## DC ELECTRICAL CHARACTERISTICS Analog Section

Symbol	Parameter	Test Conditions	$V_{CC}$ V	$V_{EE}$ V	Guaranteed Limit			Unit
					- 55 to 25°C	≤ 85°C	≤ 125°C	
$R_{on}$	Maximum "ON" Resistance	$V_{in} = V_{IL}$ or $V_{IH}$ $V_{IS} = V_{CC}$ to $V_{EE}$ $I_S \leq 2.0 \text{ mA}$ (Figures 5 through 11)	3.0	0.0	200	240	320	Ω
			4.5	0.0	160	200	280	
		4.5	- 4.5	120	150	170		
		6.0	- 6.0	100	125	140		
		$V_{in} = V_{IL}$ or $V_{IH}$ $V_{IS} = V_{CC}$ or $V_{EE}$ (Endpoints) $I_S \leq 2.0 \text{ mA}$ (Figures 5 through 11)	3.0	0.0	150	180	230	
			4.5	0.0	110	140	190	
$\Delta R_{on}$	Maximum Difference in "ON" Resistance Between Any Two Channels in the Same Package	$V_{in} = V_{IL}$ or $V_{IH}$ $V_{IS} = 1/2 (V_{CC} - V_{EE})$ $I_S \leq 2.0 \text{ mA}$	3.0	0.0	40	50	80	Ω
			4.5	0.0	20	25	40	
			4.5	- 4.5	10	15	18	
			6.0	- 6.0	10	12	14	
$I_{off}$	Maximum Off-Channel Leakage Current, Any One Channel	$V_{in} = V_{IL}$ or $V_{IH}$ ; $V_{IO} = V_{CC} - V_{EE}$ ; Switch Off (Figure 12)	6.0	- 6.0	0.1	0.5	1.0	μA
			Maximum Off-Channel Leakage Current, Common Channel	$V_{in} = V_{IL}$ or $V_{IH}$ ; $V_{IO} = V_{CC} - V_{EE}$ ; Switch Off (Figure 13)	6.0	- 6.0	0.2	
	6.0	- 6.0			0.1	1.0	2.0	
$I_{on}$	Maximum On-Channel Leakage Current, Channel-to-Channel	$V_{in} = V_{IL}$ or $V_{IH}$ ; Switch-to-Switch = $V_{CC} - V_{EE}$ ; (Figure 14)	6.0	- 6.0	0.2	2.0	4.0	μA
			6.0	- 6.0	0.1	1.0	2.0	
			6.0	- 6.0	0.1	1.0	2.0	

# MC74VHC4051, MC74VHC4052, MC74VHC4053

## AC CHARACTERISTICS (C<sub>L</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 6 ns)

Symbol	Parameter	V <sub>CC</sub> V	Guaranteed Limit			Unit
			-55 to 25°C	≤85°C	≤125°C	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Channel-Select to Analog Output (Figures 18, 19)	2.0	270	320	350	ns
		3.0	90	110	125	
		4.5	59	79	85	
		6.0	45	65	75	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Analog Input to Analog Output (Figures 20, 21)	2.0	40	60	70	ns
		3.0	25	30	32	
		4.5	12	15	18	
		6.0	10	13	15	
t <sub>PLZ</sub> , t <sub>PHZ</sub>	Maximum Propagation Delay, Enable to Analog Output (Figures 22, 23)	2.0	160	200	220	ns
		3.0	70	95	110	
		4.5	48	63	76	
		6.0	39	55	63	
t <sub>PZL</sub> , t <sub>PZH</sub>	Maximum Propagation Delay, Enable to Analog Output (Figures 22, 23)	2.0	245	315	345	ns
		3.0	115	145	155	
		4.5	49	69	83	
		6.0	39	58	67	
C <sub>in</sub>	Maximum Input Capacitance, Channel-Select or Enable Inputs		10	10	10	pF
C <sub>I/O</sub>	Maximum Capacitance (All Switches Off)	Analog I/O	35	35	35	pF
		Common O/I: VHC4051	130	130	130	
		VHC4052	80	80	80	
		VHC4053	50	50	50	
	Feedthrough		1.0	1.0	1.0	
C <sub>PD</sub>	Power Dissipation Capacitance (Figure 25)*	Typical @ 25°C, V <sub>CC</sub> = 5.0 V, V <sub>EE</sub> = 0 V			pF	
		VHC4051	45			
		VHC4052	80			
		VHC4053	45			

\* Used to determine the no-load dynamic power consumption: P<sub>D</sub> = C<sub>PD</sub> V<sub>CC</sub><sup>2</sup>f + I<sub>CC</sub> V<sub>CC</sub>.

# MC74VHC4051, MC74VHC4052, MC74VHC4053

## ADDITIONAL APPLICATION CHARACTERISTICS (GND = 0 V)

Symbol	Parameter	Condition	V <sub>CC</sub> V	V <sub>EE</sub> V	Limit*			Unit
					25°C			
BW	Maximum On-Channel Bandwidth or Minimum Frequency Response (Figure 15)	f <sub>in</sub> = 1MHz Sine Wave; Adjust f <sub>in</sub> Voltage to Obtain 0dBm at V <sub>OS</sub> ; Increase f <sub>in</sub> Frequency Until dB Meter Reads -3dB; R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF	2.25	-2.25	'51	'52	'53	MHz
			4.50	-4.50	80	95	120	
			6.00	-6.00	80	95	120	
—	Off-Channel Feedthrough Isolation (Figure 16)	f <sub>in</sub> = Sine Wave; Adjust f <sub>in</sub> Voltage to Obtain 0dBm at V <sub>IS</sub> f <sub>in</sub> = 10kHz, R <sub>L</sub> = 600Ω, C <sub>L</sub> = 50pF	2.25	-2.25	-50			dB
			4.50	-4.50	-50			
		6.00	-6.00	-50				
		f <sub>in</sub> = 1.0MHz, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF		2.25	-2.25	-40		
—	Feedthrough Noise. Channel-Select Input to Common I/O (Figure 17)	V <sub>in</sub> ≤ 1MHz Square Wave (t <sub>r</sub> = t <sub>f</sub> = 6ns); Adjust R <sub>L</sub> at Setup so that I <sub>S</sub> = 0A; Enable = GND R <sub>L</sub> = 600Ω, C <sub>L</sub> = 50pF	2.25	-2.25	25			mV <sub>PP</sub>
			4.50	-4.50	105			
		6.00	-6.00	135				
		R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 10pF		2.25	-2.25	35		
—	Crosstalk Between Any Two Switches (Figure 24) (Test does not apply to VHC4051)	f <sub>in</sub> = Sine Wave; Adjust f <sub>in</sub> Voltage to Obtain 0dBm at V <sub>IS</sub> f <sub>in</sub> = 10kHz, R <sub>L</sub> = 600Ω, C <sub>L</sub> = 50pF	2.25	-2.25	-50			dB
			4.50	-4.50	-50			
		6.00	-6.00	-50				
		f <sub>in</sub> = 1.0MHz, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF		2.25	-2.25	-60		
THD	Total Harmonic Distortion (Figure 26)	f <sub>in</sub> = 1kHz, R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 50pF THD = THD <sub>measured</sub> - THD <sub>source</sub> V <sub>IS</sub> = 4.0V <sub>PP</sub> sine wave V <sub>IS</sub> = 8.0V <sub>PP</sub> sine wave V <sub>IS</sub> = 11.0V <sub>PP</sub> sine wave	2.25	-2.25	0.10			%
			4.50	-4.50	0.08			
			6.00	-6.00	0.05			

\*Limits not tested. Determined by design and verified by qualification.

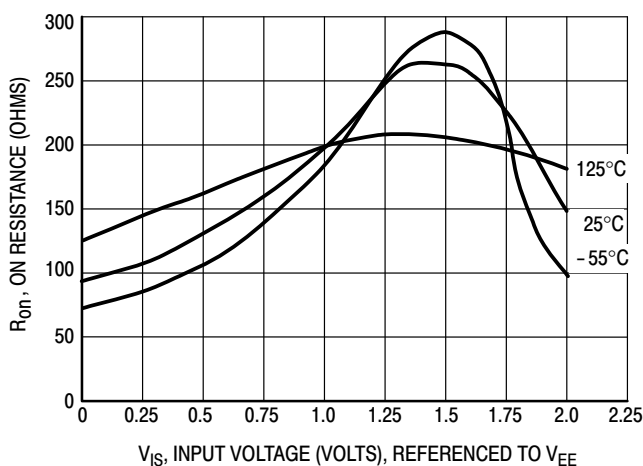


Figure 5. Typical On Resistance, V<sub>CC</sub> - V<sub>EE</sub> = 2.0 V

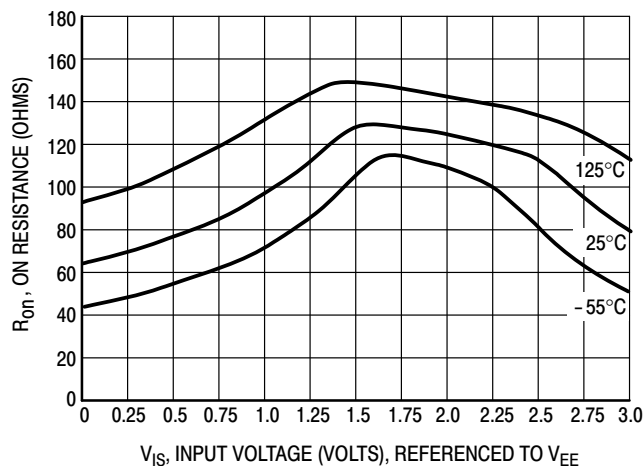


Figure 6. Typical On Resistance, V<sub>CC</sub> - V<sub>EE</sub> = 3.0 V

# MC74VHC4051, MC74VHC4052, MC74VHC4053

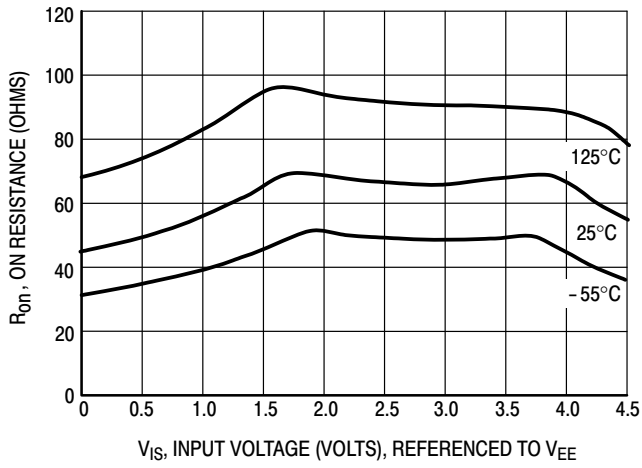


Figure 7. Typical On Resistance,  $V_{CC} - V_{EE} = 4.5$  V

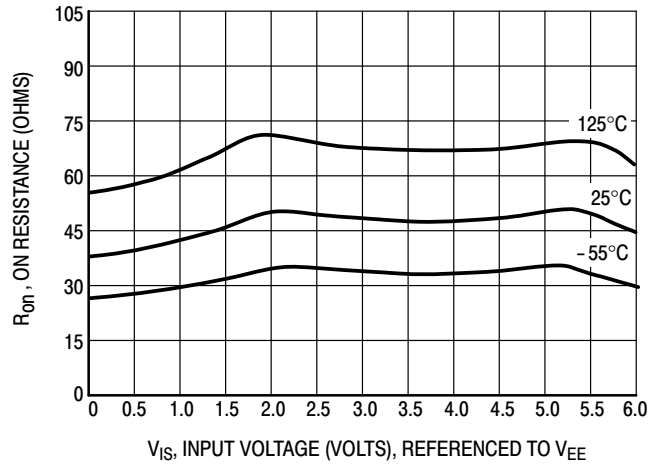


Figure 8. Typical On Resistance,  $V_{CC} - V_{EE} = 6.0$  V

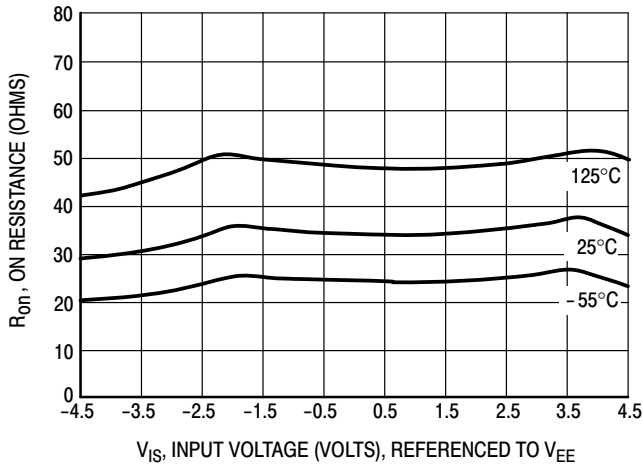


Figure 9. Typical On Resistance,  $V_{CC} - V_{EE} = 9.0$  V

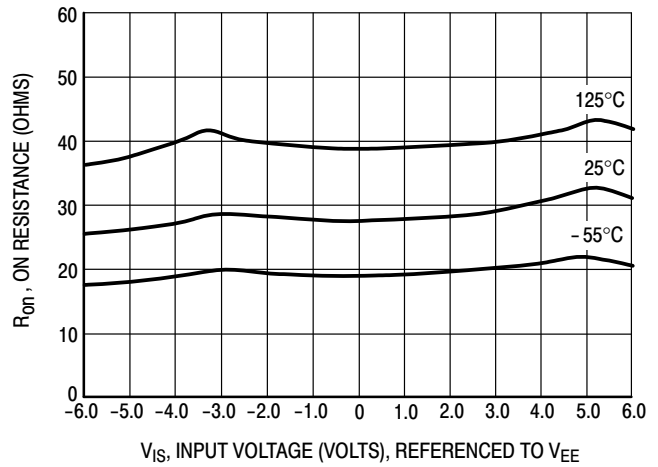


Figure 10. Typical On Resistance,  $V_{CC} - V_{EE} = 12.0$  V

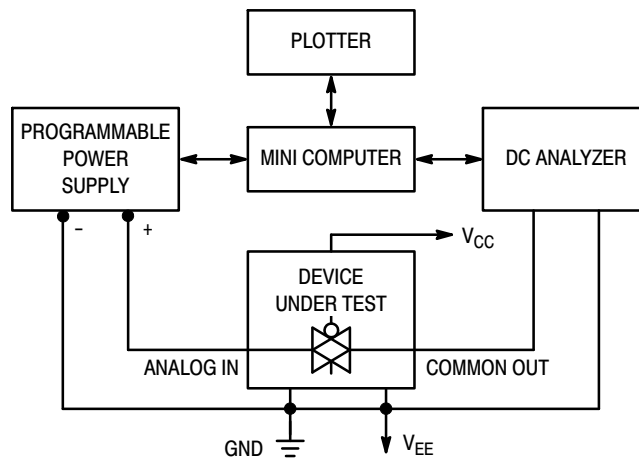


Figure 11. On Resistance Test Set-Up



# MC74VHC4051, MC74VHC4052, MC74VHC4053

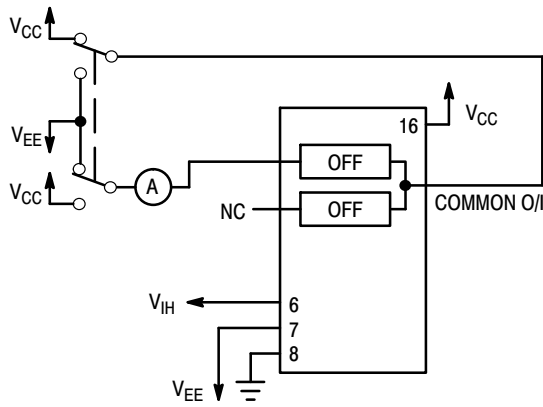


Figure 12. Maximum Off Channel Leakage Current, Any One Channel, Test Set-Up

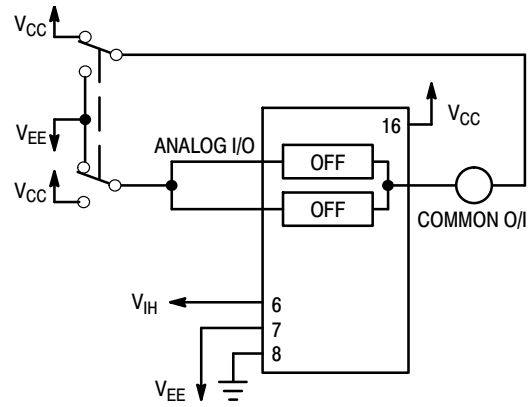


Figure 13. Maximum Off Channel Leakage Current, Common Channel, Test Set-Up

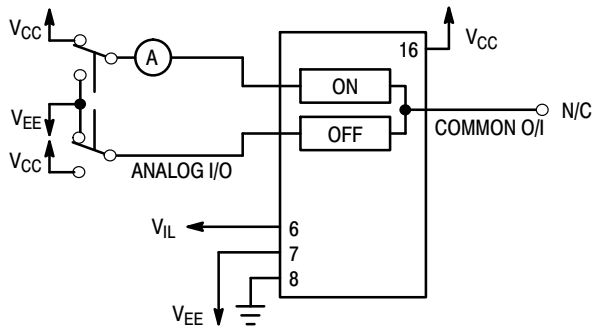
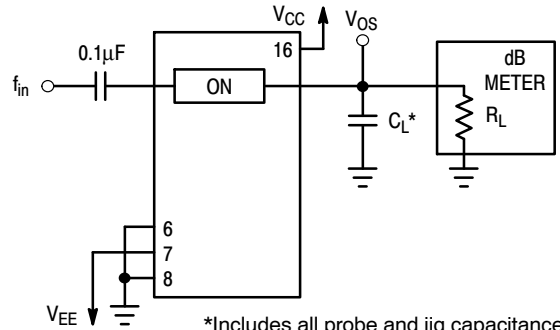
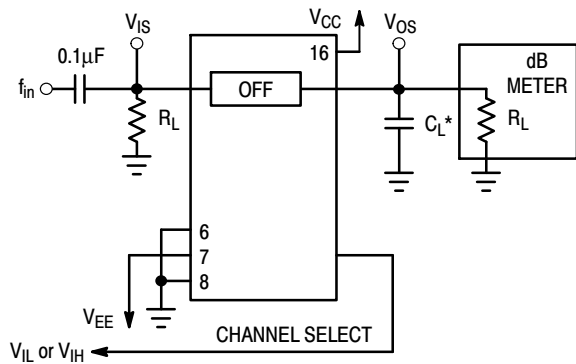


Figure 14. Maximum On Channel Leakage Current, Channel to Channel, Test Set-Up



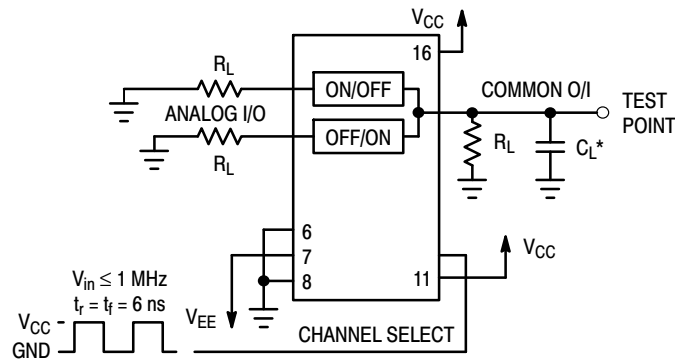
\*Includes all probe and jig capacitance

Figure 15. Maximum On Channel Bandwidth, Test Set-Up



\*Includes all probe and jig capacitance

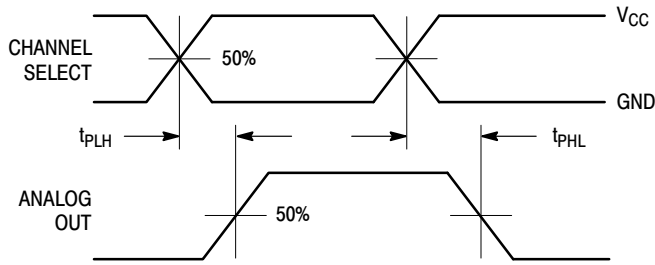
Figure 16. Off Channel Feedthrough Isolation, Test Set-Up



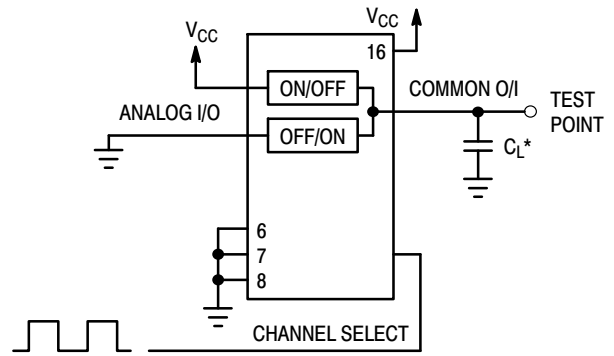
\*Includes all probe and jig capacitance

Figure 17. Feedthrough Noise, Channel Select to Common Out, Test Set-Up

# MC74VHC4051, MC74VHC4052, MC74VHC4053

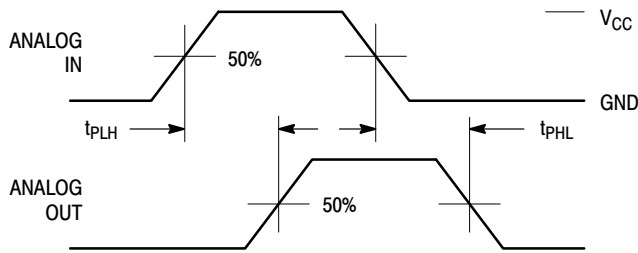


**Figure 18. Propagation Delays, Channel Select to Analog Out**

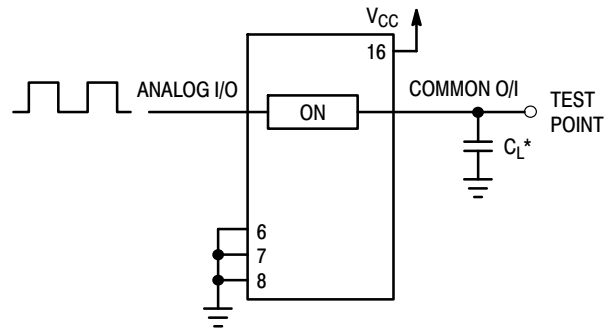


\*Includes all probe and jig capacitance

**Figure 19. Propagation Delay, Test Set-Up Channel Select to Analog Out**

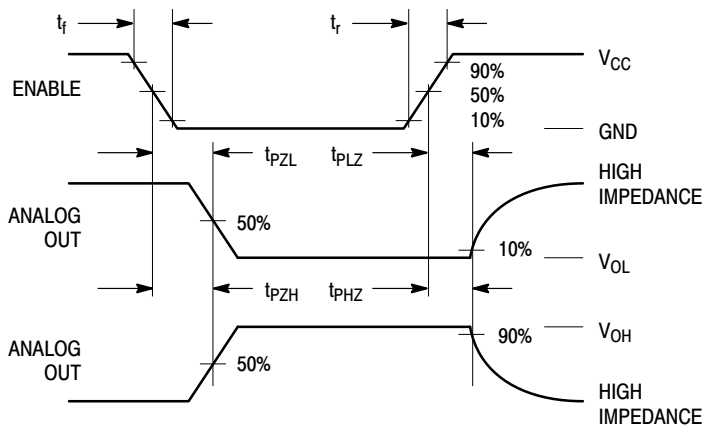


**Figure 20. Propagation Delays, Analog In to Analog Out**

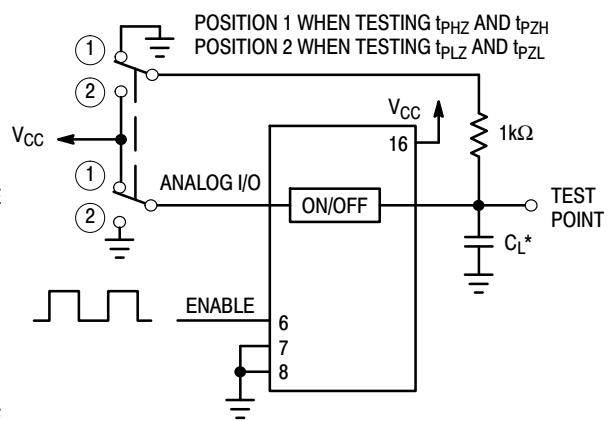


\*Includes all probe and jig capacitance

**Figure 21. Propagation Delay, Test Set-Up Analog In to Analog Out**

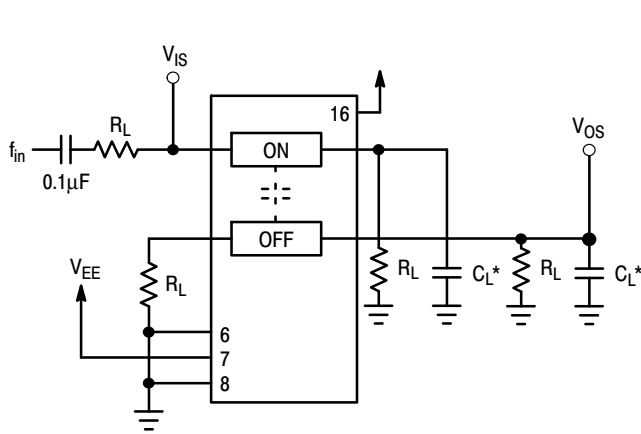


**Figure 22. Propagation Delays, Enable to Analog Out**



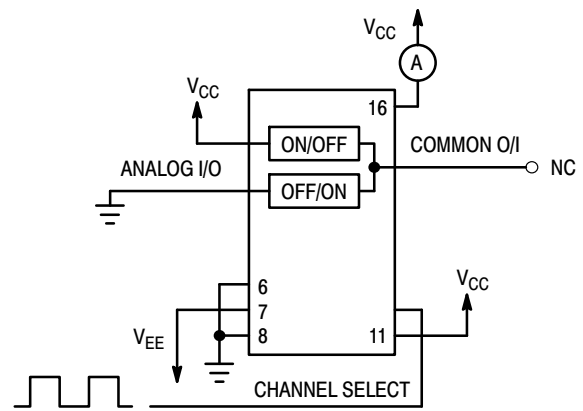
**Figure 23. Propagation Delay, Test Set-Up Enable to Analog Out**

## MC74VHC4051, MC74VHC4052, MC74VHC4053

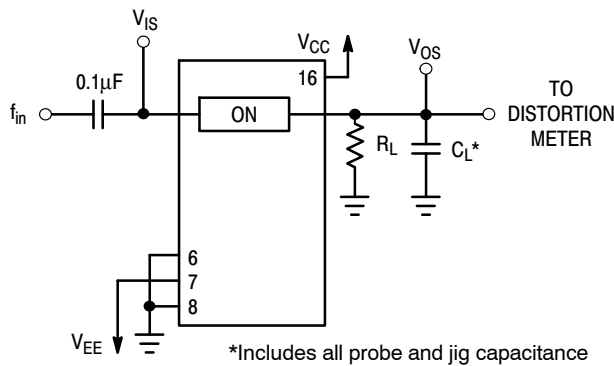


\*Includes all probe and jig capacitance

**Figure 24. Crosstalk Between Any Two Switches, Test Set-Up**

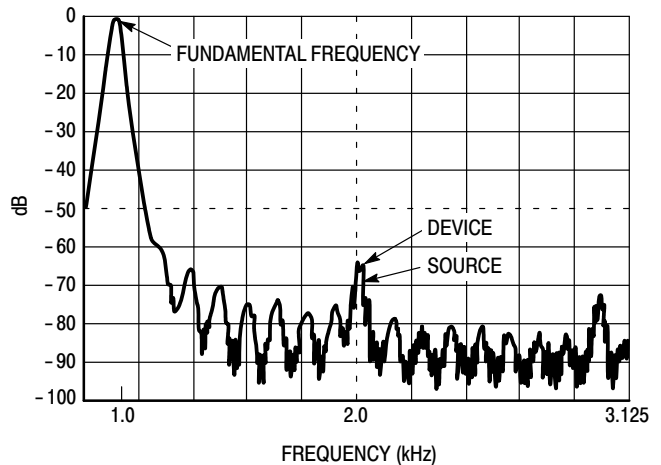


**Figure 25. Power Dissipation Capacitance, Test Set-Up**



\*Includes all probe and jig capacitance

**Figure 26. Total Harmonic Distortion, Test Set-Up**



**Figure 27. Plot, Harmonic Distortion**

## APPLICATIONS INFORMATION

The Channel Select and Enable control pins should be at  $V_{CC}$  or GND logic levels.  $V_{CC}$  being recognized as a logic high and GND being recognized as a logic low. In this example:

$$\begin{aligned} V_{CC} &= +5V = \text{logic high} \\ \text{GND} &= 0V = \text{logic low} \end{aligned}$$

The maximum analog voltage swings are determined by the supply voltages  $V_{CC}$  and  $V_{EE}$ . The positive peak analog voltage should not exceed  $V_{CC}$ . Similarly, the negative peak analog voltage should not go below  $V_{EE}$ . In this example, the difference between  $V_{CC}$  and  $V_{EE}$  is ten volts. Therefore, using the configuration of Figure 28, a maximum analog signal of ten volts peak-to-peak can be controlled. Unused analog inputs/outputs may be left floating (i.e., not connected). However, tying unused analog inputs and

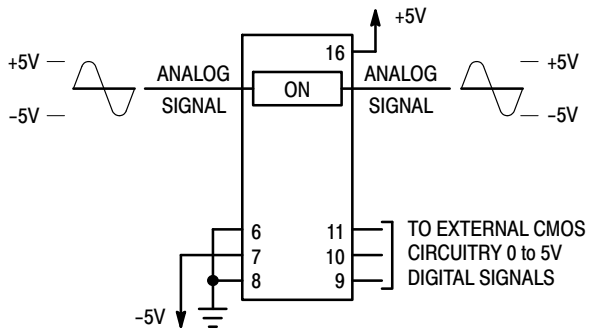
outputs to  $V_{CC}$  or GND through a low value resistor helps minimize crosstalk and feedthrough noise that may be picked up by an unused switch.

Although used here, balanced supplies are not a requirement. The only constraints on the power supplies are that:

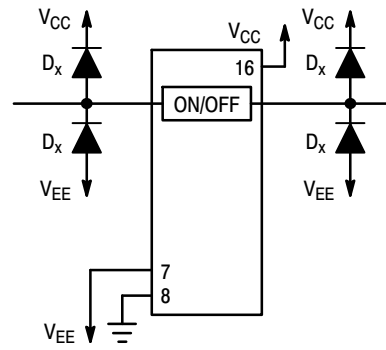
$$\begin{aligned} V_{CC} - \text{GND} &= 2 \text{ to } 6 \text{ volts} \\ V_{EE} - \text{GND} &= 0 \text{ to } -6 \text{ volts} \\ V_{CC} - V_{EE} &= 2 \text{ to } 12 \text{ volts} \\ &\text{and } V_{EE} \leq \text{GND} \end{aligned}$$

When voltage transients above  $V_{CC}$  and/or below  $V_{EE}$  are anticipated on the analog channels, external Germanium or Schottky diodes ( $D_x$ ) are recommended as shown in Figure 29. These diodes should be able to absorb the maximum anticipated current surges during clipping.

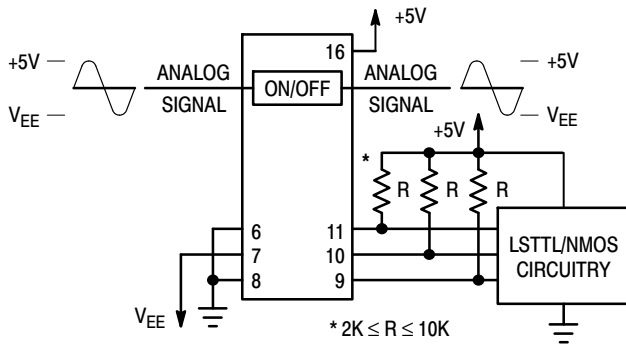
**MC74VHC4051, MC74VHC4052, MC74VHC4053**



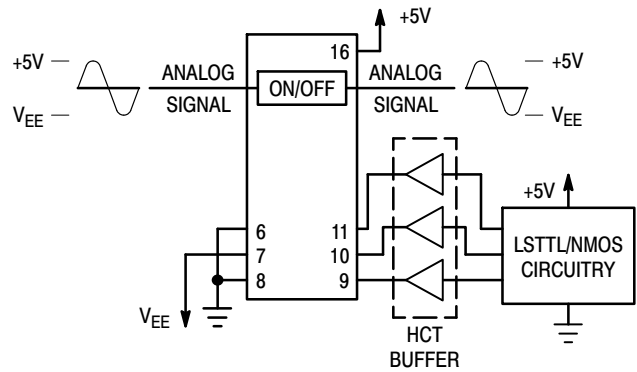
**Figure 28. Application Example**



**Figure 29. External Germanium or Schottky Clipping Diodes**



**a. Using Pull-Up Resistors**



**b. Using HCT Interface**

**Figure 30. Interfacing LSTTL/NMOS to CMOS Inputs**

MC74VHC4051, MC74VHC4052, MC74VHC4053

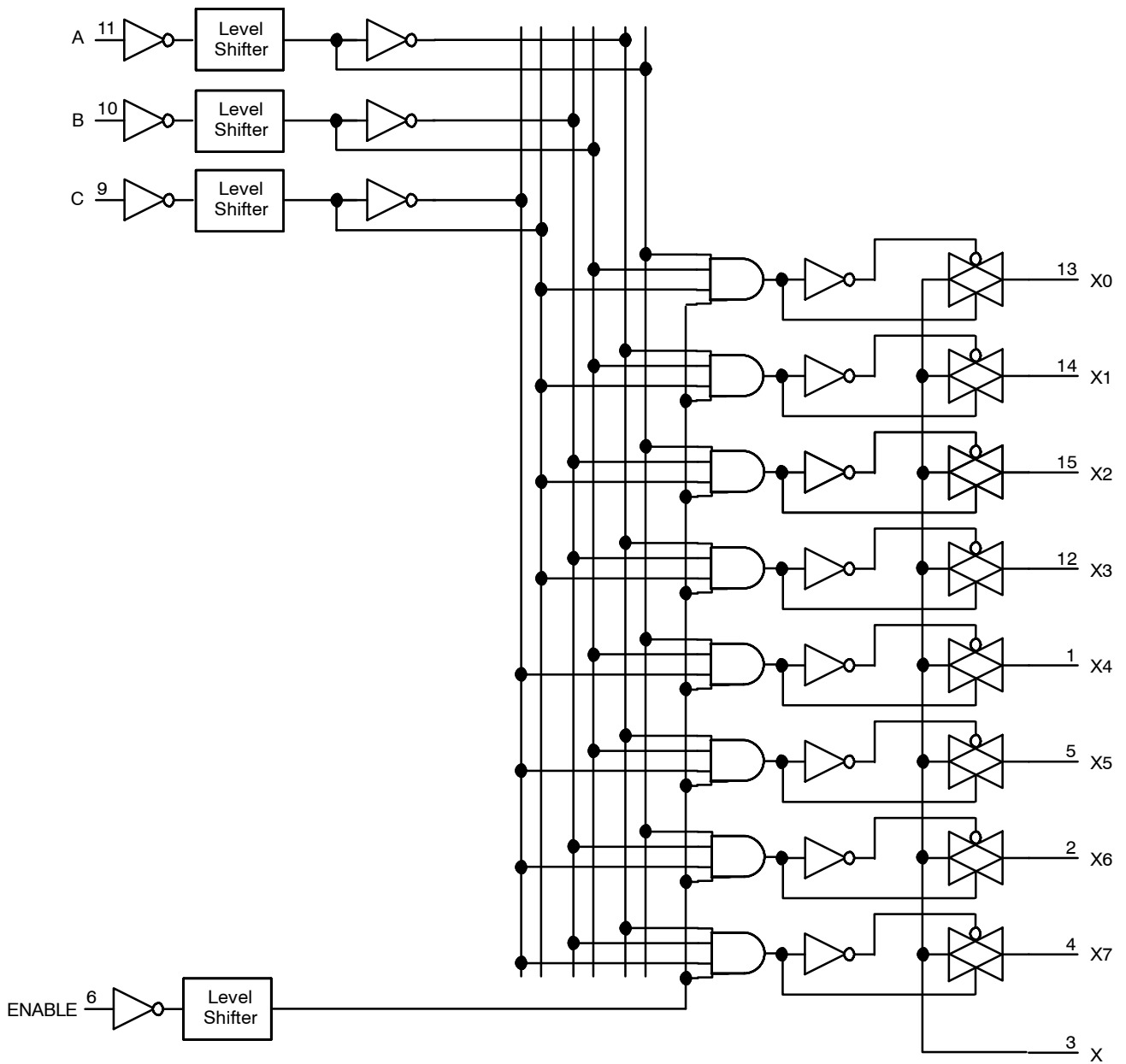


Figure 31. Function Diagram, VHC4051

MC74VHC4051, MC74VHC4052, MC74VHC4053

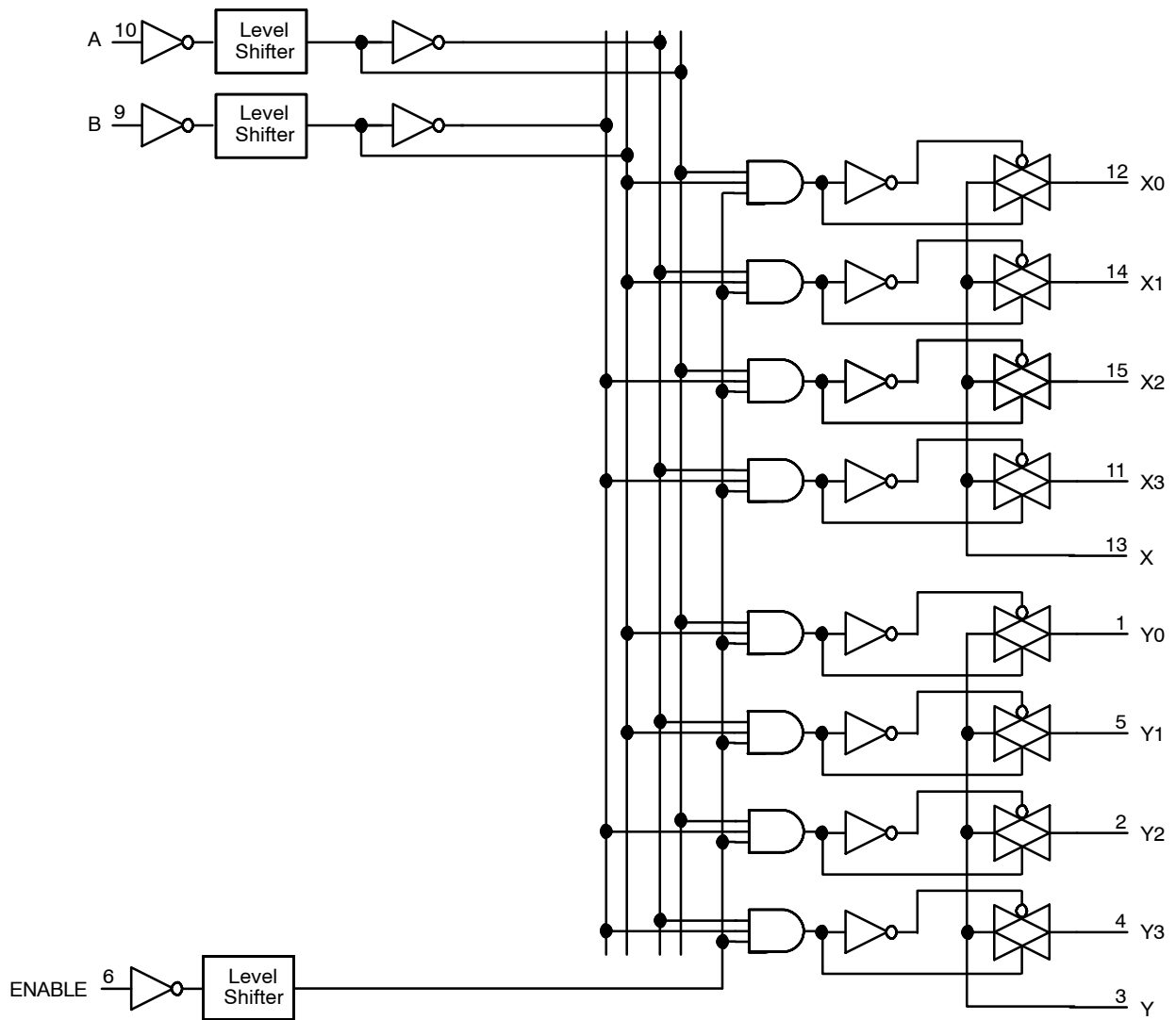


Figure 32. Function Diagram, VHC4052

MC74VHC4051, MC74VHC4052, MC74VHC4053

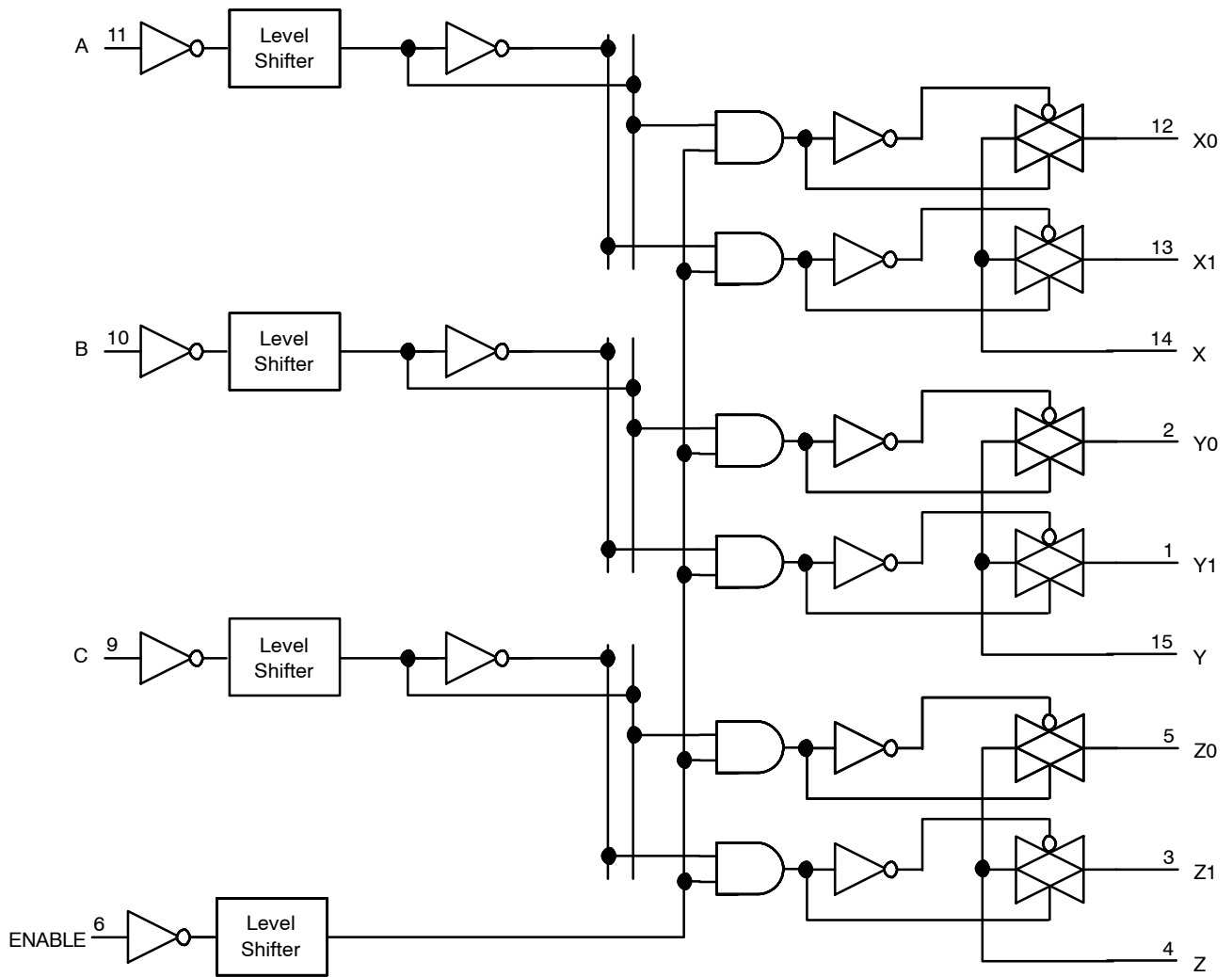


Figure 33. Function Diagram, VHC4053

## MC74VHC4051, MC74VHC4052, MC74VHC4053

### ORDERING & SHIPPING INFORMATION

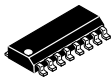
Device	Package	Shipping†
MC74VHC4051DR2G	SOIC-16 (Pb-Free)	2500 / Tape & Reel
MC74VHC4052DR2G		
MC74VHC4053DR2G		
MC74VHC4051DTR2G	TSSOP-16 (Pb-Free)	2500 / Tape & Reel
NLVVHC4051DTR2G*		
MC74VHC4052DTR2G		
NLVVHC4052DTR2G*		
MC74VHC4053DTR2G		
NLVVHC4053DTR2G*		

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.



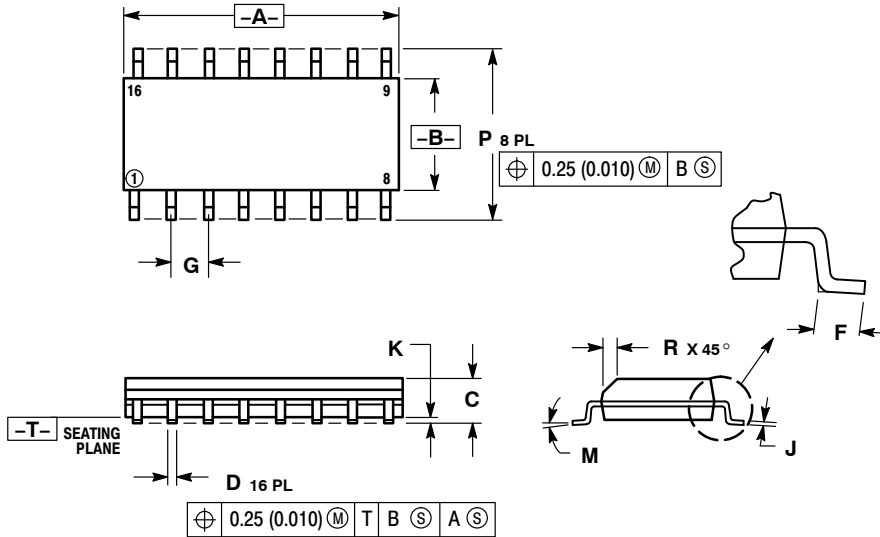
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-16  
CASE 751B-05  
ISSUE K

DATE 29 DEC 2006



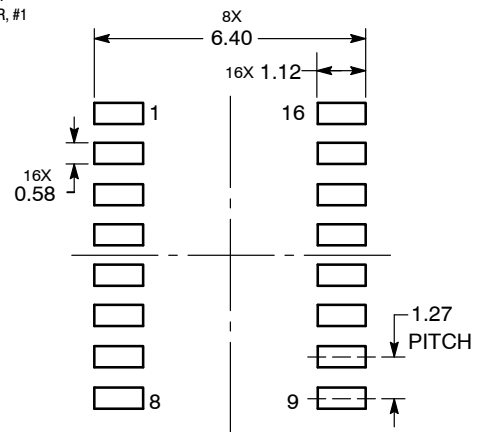
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0° 7°		0° 7°	
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

- |  |  |  |  |
|--|--|--|--|
| <p>STYLE 1:</p> <p>PIN 1. COLLECTOR</p> <p>2. BASE</p> <p>3. EMITTER</p> <p>4. NO CONNECTION</p> <p>5. EMITTER</p> <p>6. BASE</p> <p>7. COLLECTOR</p> <p>8. COLLECTOR</p> <p>9. BASE</p> <p>10. EMITTER</p> <p>11. NO CONNECTION</p> <p>12. EMITTER</p> <p>13. BASE</p> <p>14. COLLECTOR</p> <p>15. EMITTER</p> <p>16. COLLECTOR</p>                           | <p>STYLE 2:</p> <p>PIN 1. CATHODE</p> <p>2. ANODE</p> <p>3. NO CONNECTION</p> <p>4. CATHODE</p> <p>5. CATHODE</p> <p>6. NO CONNECTION</p> <p>7. ANODE</p> <p>8. CATHODE</p> <p>9. CATHODE</p> <p>10. ANODE</p> <p>11. NO CONNECTION</p> <p>12. CATHODE</p> <p>13. CATHODE</p> <p>14. NO CONNECTION</p> <p>15. ANODE</p> <p>16. CATHODE</p> | <p>STYLE 3:</p> <p>PIN 1. COLLECTOR, DYE #1</p> <p>2. BASE, #1</p> <p>3. EMITTER, #1</p> <p>4. COLLECTOR, #1</p> <p>5. COLLECTOR, #2</p> <p>6. BASE, #2</p> <p>7. EMITTER, #2</p> <p>8. COLLECTOR, #2</p> <p>9. COLLECTOR, #3</p> <p>10. BASE, #3</p> <p>11. EMITTER, #3</p> <p>12. COLLECTOR, #3</p> <p>13. COLLECTOR, #4</p> <p>14. BASE, #4</p> <p>15. EMITTER, #4</p> <p>16. COLLECTOR, #4</p>   | <p>STYLE 4:</p> <p>PIN 1. COLLECTOR, DYE #1</p> <p>2. COLLECTOR, #1</p> <p>3. COLLECTOR, #2</p> <p>4. COLLECTOR, #2</p> <p>5. COLLECTOR, #3</p> <p>6. COLLECTOR, #3</p> <p>7. COLLECTOR, #4</p> <p>8. COLLECTOR, #4</p> <p>9. BASE, #4</p> <p>10. EMITTER, #4</p> <p>11. BASE, #3</p> <p>12. EMITTER, #3</p> <p>13. BASE, #2</p> <p>14. EMITTER, #2</p> <p>15. BASE, #1</p> <p>16. EMITTER, #1</p> |
| <p>STYLE 5:</p> <p>PIN 1. DRAIN, DYE #1</p> <p>2. DRAIN, #1</p> <p>3. DRAIN, #2</p> <p>4. DRAIN, #2</p> <p>5. DRAIN, #3</p> <p>6. DRAIN, #3</p> <p>7. DRAIN, #4</p> <p>8. DRAIN, #4</p> <p>9. GATE, #4</p> <p>10. SOURCE, #4</p> <p>11. GATE, #3</p> <p>12. SOURCE, #3</p> <p>13. GATE, #2</p> <p>14. SOURCE, #2</p> <p>15. GATE, #1</p> <p>16. SOURCE, #1</p> | <p>STYLE 6:</p> <p>PIN 1. CATHODE</p> <p>2. CATHODE</p> <p>3. CATHODE</p> <p>4. CATHODE</p> <p>5. CATHODE</p> <p>6. CATHODE</p> <p>7. CATHODE</p> <p>8. CATHODE</p> <p>9. ANODE</p> <p>10. ANODE</p> <p>11. ANODE</p> <p>12. ANODE</p> <p>13. ANODE</p> <p>14. ANODE</p> <p>15. ANODE</p> <p>16. ANODE</p>                                 | <p>STYLE 7:</p> <p>PIN 1. SOURCE N-CH</p> <p>2. COMMON DRAIN (OUTPUT)</p> <p>3. COMMON DRAIN (OUTPUT)</p> <p>4. GATE P-CH</p> <p>5. COMMON DRAIN (OUTPUT)</p> <p>6. COMMON DRAIN (OUTPUT)</p> <p>7. COMMON DRAIN (OUTPUT)</p> <p>8. SOURCE P-CH</p> <p>9. SOURCE P-CH</p> <p>10. COMMON DRAIN (OUTPUT)</p> <p>11. COMMON DRAIN (OUTPUT)</p> <p>12. COMMON DRAIN (OUTPUT)</p> <p>13. GATE N-CH</p> <p>14. COMMON DRAIN (OUTPUT)</p> <p>15. COMMON DRAIN (OUTPUT)</p> <p>16. SOURCE N-CH</p> |  |

RECOMMENDED  
SOLDERING FOOTPRINT\*



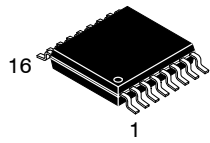
DIMENSIONS: MILLIMETERS

\*For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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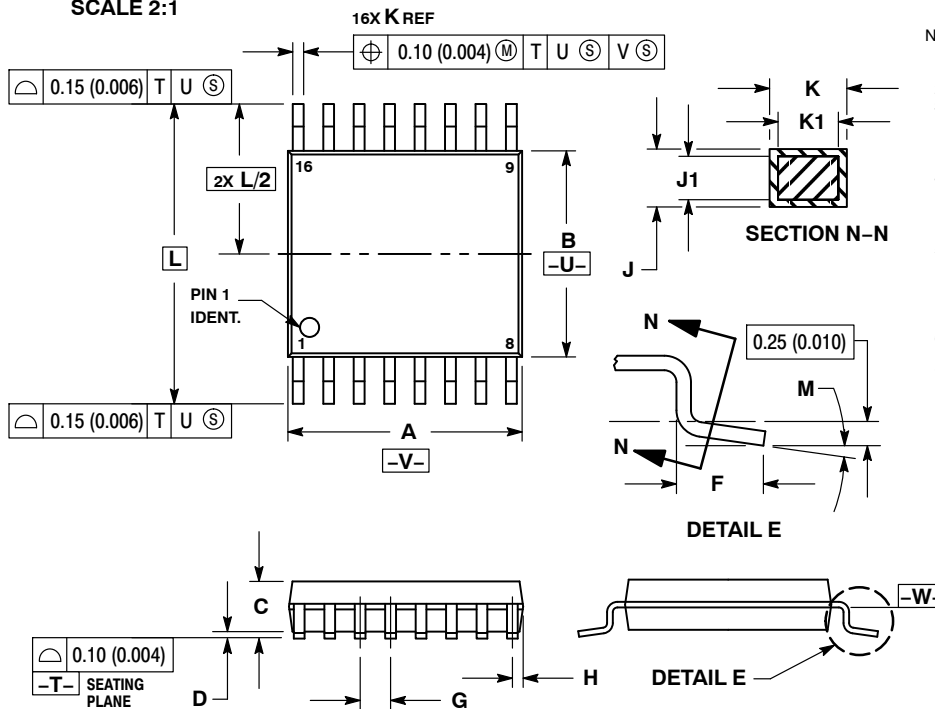
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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



**TSSOP-16 WB**  
CASE 948F  
ISSUE B

DATE 19 OCT 2006

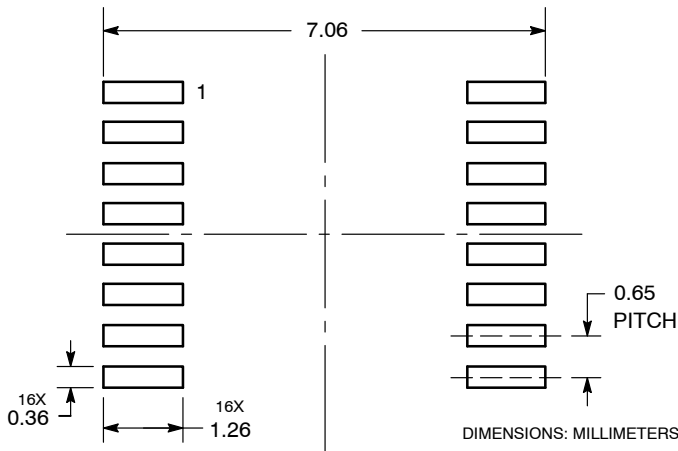


**NOTES:**

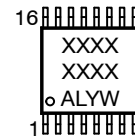
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- CONTROLLING DIMENSION: MILLIMETER.
- DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
- DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
- DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
- TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
- DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.18	0.28	0.007	0.011
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

**RECOMMENDED  
SOLDERING FOOTPRINT\***



**GENERIC  
MARKING DIAGRAM\***



- XXXX = Specific Device Code
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- G or ■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present. Some products may not follow the Generic Marking.

\*For additional information on our Pb-Free strategy and soldering details, please download the **onsemi** Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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