

# NLHV4051, NLHV4052, NLHV4053

## Analog Multiplexers/Demultiplexers

The NLHV4051, NLHV4052, and NLHV4053 analog multiplexers are digitally-controlled analog switches. The NLHV4051 effectively implements an SP8T solid state switch, the NLHV4052 a DP4T, and the NLHV4053 a Triple SPDT. All three devices feature low ON impedance and very low OFF leakage current. Control of analog signals up to the complete supply voltage range can be achieved.

### Features

- Triple Diode Protection on Control Inputs
- Switch Function is Break Before Make
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Analog Voltage Range ( $V_{DD} - V_{EE}$ ) = 3.0 to 18 V  
Note:  $V_{EE}$  must be  $\leq V_{SS}$
- Linearized Transfer Characteristics
- Low-noise –  $12 \text{ nV}/\sqrt{\text{Cycle}}$ ,  $f \geq 1.0 \text{ kHz}$  Typical
- Pin-for-Pin Replacement for CD4051, CD4052, and CD4053
- For 4PDT Switch, See MC14551B
- For Lower  $R_{ON}$ , Use the HC4051, HC4052, or HC4053 High-Speed CMOS Devices
- These Devices are Pb-Free and are RoHS Compliant

### MAXIMUM RATINGS (Voltages Referenced to $V_{SS}$ )

Symbol	Parameter	Value	Unit
$V_{DD}$	DC Supply Voltage Range (Referenced to $V_{EE}$ , $V_{SS} \geq V_{EE}$ )	-0.5 to +18.0	V
$V_{in}$ , $V_{out}$	Input or Output Voltage Range (DC or Transient) (Referenced to $V_{SS}$ for Control Inputs and $V_{EE}$ for Switch I/O)	-0.5 to $V_{DD} + 0.5$	V
$I_{in}$	Input Current (DC or Transient) per Control Pin	+10	mA
$I_{SW}$	Switch Through Current	$\pm 25$	mA
$P_D$	Power Dissipation per Package (Note 1)	500	mW
$T_A$	Ambient Temperature Range	-55 to +125	$^{\circ}\text{C}$
$T_{stg}$	Storage Temperature Range	-65 to +150	$^{\circ}\text{C}$
$T_L$	Lead Temperature (8-Second Soldering)	260	$^{\circ}\text{C}$

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.

1. Temperature Derating: "D/DW" Packages:  $-7.0 \text{ mW}/^{\circ}\text{C}$  From  $65^{\circ}\text{C}$  To  $125^{\circ}\text{C}$

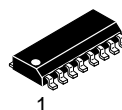
This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either  $V_{SS}$ ,  $V_{EE}$  or  $V_{DD}$ ). Unused outputs must be left open.

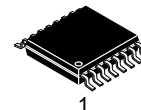


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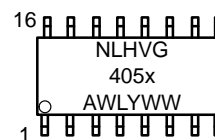


SOIC-16  
D SUFFIX  
CASE 751B

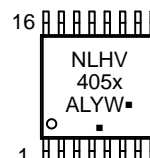


TSSOP-16  
DT SUFFIX  
CASE 948F

### MARKING DIAGRAMS



SOIC-16



TSSOP-16

- x = 1, 2, or 3
- A = Assembly Location
- WL, L = Wafer Lot
- Y = Year
- WW, W = Work Week
- G or  $\blacksquare$  = Pb-Free Package

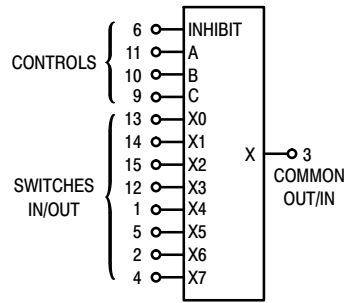
(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

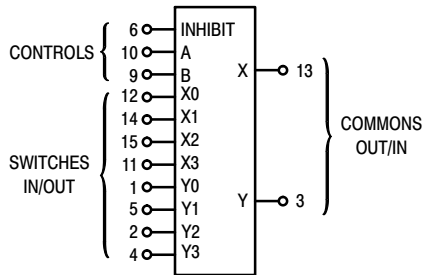
# NLHV4051, NLHV4052, NLHV4053

## NLHV4051 8-Channel Analog Multiplexer/Demultiplexer



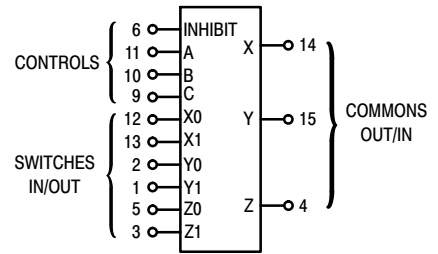
$V_{DD}$  = PIN 16  
 $V_{SS}$  = PIN 8  
 $V_{EE}$  = PIN 7

## NLHV4052 Dual 4-Channel Analog Multiplexer/Demultiplexer



$V_{DD}$  = PIN 16  
 $V_{SS}$  = PIN 8  
 $V_{EE}$  = PIN 7

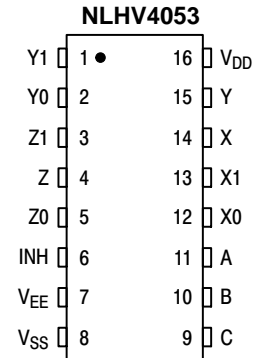
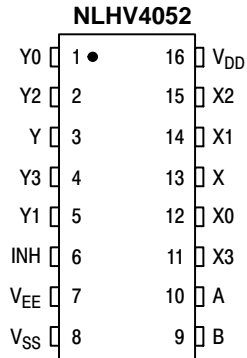
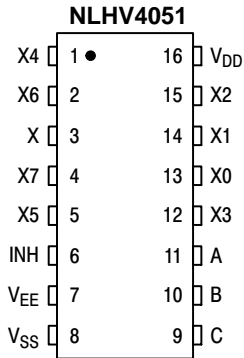
## NLHV4053 Triple 2-Channel Analog Multiplexer/Demultiplexer



$V_{DD}$  = PIN 16  
 $V_{SS}$  = PIN 8  
 $V_{EE}$  = PIN 7

Note: Control Inputs referenced to  $V_{SS}$ . Analog Inputs and Outputs reference to  $V_{EE}$ .  $V_{EE}$  must be  $\leq V_{SS}$ .

### PIN ASSIGNMENT



# NLHV4051, NLHV4052, NLHV4053

## ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	V <sub>DD</sub>	Test Conditions	-55°C		25°C			125°C		Unit
				Min	Max	Min	Typ (Note 2)	Max	Min	Max	

### SUPPLY REQUIREMENTS (Voltages Referenced to V<sub>EE</sub>)

Power Supply Voltage Range	V <sub>DD</sub>	-	V <sub>DD</sub> - 3.0 ≥ V <sub>SS</sub> ≥ V <sub>EE</sub>	3.0	18	3.0	-	18	3.0	18	V	
Quiescent Current Per Package	I <sub>DD</sub>	5.0 10 15	Control Inputs: V <sub>in</sub> = V <sub>SS</sub> or V <sub>DD</sub> . Switch I/O: V <sub>EE</sub> ≤ V <sub>I/O</sub> ≤ V <sub>DD</sub> , and ΔV <sub>switch</sub> ≤ 500 mV (Note 3)	- - -	5.0 10 20	- - -	0.005 0.010 0.015	5.0 10 20	- - -	150 300 600	μA	
Total Supply Current (Dynamic Plus Quiescent, Per Package)	I <sub>D(AV)</sub>	5.0 10 15	T <sub>A</sub> = 25°C only (The channel component, (V <sub>in</sub> - V <sub>out</sub> )/R <sub>on</sub> , is not included.)	Typical					(0.07 μA/kHz) f + I <sub>DD</sub> (0.20 μA/kHz) f + I <sub>DD</sub> (0.36 μA/kHz) f + I <sub>DD</sub>			μA

### CONTROL INPUTS — INHIBIT, A, B, C (Voltages Referenced to V<sub>SS</sub>)

Low-Level Input Voltage	V <sub>IL</sub>	5.0 10 15	R <sub>on</sub> = per spec, I <sub>off</sub> = per spec	- - -	1.5 3.0 4.0	- - -	2.25 4.50 6.75	1.5 3.0 4.0	- - -	1.5 3.0 4.0	V
High-Level Input Voltage	V <sub>IH</sub>	5.0 10 15	R <sub>on</sub> = per spec, I <sub>off</sub> = per spec	3.5 7.0 11	- - -	3.5 7.0 11	2.75 5.50 8.25	- - -	3.5 7.0 11	- - -	V
Input Leakage Current	I <sub>in</sub>	15	V <sub>in</sub> = 0 or V <sub>DD</sub>	-	±0.1	-	±0.00001	±0.1	-	1.0	μA
Input Capacitance	C <sub>in</sub>	-		-	-	-	5.0	7.5	-	-	pF

### SWITCHES IN/OUT AND COMMONS OUT/IN — X, Y, Z (Voltages Referenced to V<sub>EE</sub>)

Recommended Peak-to-Peak Voltage Into or Out of the Switch	V <sub>I/O</sub>	-	Channel On or Off	0	V <sub>DD</sub>	0	-	V <sub>DD</sub>	0	V <sub>DD</sub>	V <sub>PP</sub>
Recommended Static or Dynamic Voltage Across the Switch (Note 3) (Figure 5)	ΔV <sub>switch</sub>	-	Channel On	0	600	0	-	600	0	300	mV
Output Offset Voltage	V <sub>OO</sub>	-	V <sub>in</sub> = 0 V, No Load	-	-	-	10	-	-	-	μV
ON Resistance	R <sub>on</sub>	5.0 10 15	ΔV <sub>switch</sub> ≤ 500 mV (Note 3) V <sub>in</sub> = V <sub>IL</sub> or V <sub>IH</sub> (Control), and V <sub>in</sub> = 0 to V <sub>DD</sub> (Switch)	- - -	800 400 220	- - -	250 120 80	1050 500 280	- - -	1200 520 300	Ω
ΔON Resistance Between Any Two Channels in the Same Package	ΔR <sub>on</sub>	5.0 10 15		- - -	70 50 45	- - -	25 10 10	70 50 45	- - -	135 95 65	Ω
Off-Channel Leakage Current (Figure 10)	I <sub>off</sub>	15	V <sub>in</sub> = V <sub>IL</sub> or V <sub>IH</sub> (Control) Channel to Channel or Any One Channel	-	±100	-	±0.05	±100	-	±1000	nA
Capacitance, Switch I/O	C <sub>I/O</sub>	-	Inhibit = V <sub>DD</sub>	-	-	-	10	-	-	-	pF
Capacitance, Common O/I	C <sub>O/I</sub>	-	Inhibit = V <sub>DD</sub> (NLHV4051) (NLHV4052) (NLHV4053)	- - -	- - -	- - -	60 32 17	- - -	- - -	- - -	pF
Capacitance, Feedthrough (Channel Off)	C <sub>I/O</sub>	- -	Pins Not Adjacent Pins Adjacent	- -	- -	- -	0.15 0.47	- -	- -	- -	pF

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

2. Data labeled "Typ" is not to be used for design purposes, but is intended as an indication of the IC's potential performance.

3. For voltage drops across the switch (ΔV<sub>switch</sub>) > 600 mV (> 300 mV at high temperature), excessive V<sub>DD</sub> current may be drawn, i.e. the current out of the switch may contain both V<sub>DD</sub> and switch input components. The reliability of the device will be unaffected unless the Maximum Ratings are exceeded. (See first page of this data sheet.)

# NLHV4051, NLHV4052, NLHV4053

## ELECTRICAL CHARACTERISTICS (Note 4) ( $C_L = 50 \text{ pF}$ , $T_A = 25^\circ\text{C}$ ) ( $V_{EE} \leq V_{SS}$ unless otherwise indicated)

Characteristic	Symbol	$V_{DD} - V_{EE}$ Vdc	Typ (Note 5) All Types	Max	Unit
Propagation Delay Times (Figure 6) Switch Input to Switch Output ( $R_L = 1 \text{ k}\Omega$ ) NLHV4051 $t_{PLH}, t_{PHL} = (0.17 \text{ ns/pF}) C_L + 26.5 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.08 \text{ ns/pF}) C_L + 11 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.06 \text{ ns/pF}) C_L + 9.0 \text{ ns}$ NLHV4052 $t_{PLH}, t_{PHL} = (0.17 \text{ ns/pF}) C_L + 21.5 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.08 \text{ ns/pF}) C_L + 8.0 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.06 \text{ ns/pF}) C_L + 7.0 \text{ ns}$ NLHV4053 $t_{PLH}, t_{PHL} = (0.17 \text{ ns/pF}) C_L + 16.5 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.08 \text{ ns/pF}) C_L + 4.0 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.06 \text{ ns/pF}) C_L + 3.0 \text{ ns}$	$t_{PLH}, t_{PHL}$	5.0	35	90	ns
		10	15	40	
		15	12	30	
		5.0	30	75	ns
		10	12	30	
		15	10	25	
		5.0	25	65	ns
		10	8.0	20	
		15	6.0	15	
Inhibit to Output ( $R_L = 10 \text{ k}\Omega$ , $V_{EE} = V_{SS}$ ) Output "1" or "0" to High Impedance, or High Impedance to "1" or "0" Level NLHV4051  NLHV4052  NLHV4053	$t_{PHZ}, t_{PLZ},$ $t_{PZH}, t_{PZL}$	5.0	350	700	ns
		10	170	340	
		15	140	280	
		5.0	300	600	ns
		10	155	310	
		15	125	250	
		5.0	275	550	ns
		10	140	280	
		15	110	220	
Control Input to Output ( $R_L = 1 \text{ k}\Omega$ , $V_{EE} = V_{SS}$ ) NLHV4051  NLHV4052  NLHV4053	$t_{PLH}, t_{PHL}$	5.0	360	720	ns
		10	160	320	
		15	120	240	
		5.0	325	650	ns
		10	130	260	
		15	90	180	
		5.0	300	600	ns
		10	120	240	
		15	80	160	
Second Harmonic Distortion ( $R_L = 10 \text{ k}\Omega$ , $f = 1 \text{ kHz}$ ) $V_{in} = 5 V_{PP}$	–	10	0.07	–	%
Bandwidth (Figure 7) ( $R_L = 50 \Omega$ , $V_{in} = 1/2 (V_{DD} - V_{EE})$ p-p, $C_L = 50 \text{ pF}$ $20 \text{ Log } (V_{out}/V_{in}) = -3 \text{ dB}$ )	BW	10	17	–	MHz
Off Channel Feedthrough Attenuation (Figure 7) $R_L = 1 \text{ k}\Omega$ , $V_{in} = 1/2 (V_{DD} - V_{EE})$ p-p $f_{in} = 4.5 \text{ MHz}$ — NLHV4051 $f_{in} = 30 \text{ MHz}$ — NLHV4052 $f_{in} = 55 \text{ MHz}$ — NLHV4053	–	10	–50	–	dB
Channel Separation (Figure 8) ( $R_L = 1 \text{ k}\Omega$ , $V_{in} = 1/2 (V_{DD} - V_{EE})$ p-p, $f_{in} = 3.0 \text{ MHz}$ )	–	10	–50	–	dB
Crosstalk, Control Input to Common O/I (Figure 9) ( $R_1 = 1 \text{ k}\Omega$ , $R_L = 10 \text{ k}\Omega$ Control $t_{TLH} = t_{THL} = 20 \text{ ns}$ , Inhibit = $V_{SS}$ )	–	10	75	–	mV

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. The formulas given are for the typical characteristics only at  $25^\circ\text{C}$ .

5. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

# NLHV4051, NLHV4052, NLHV4053

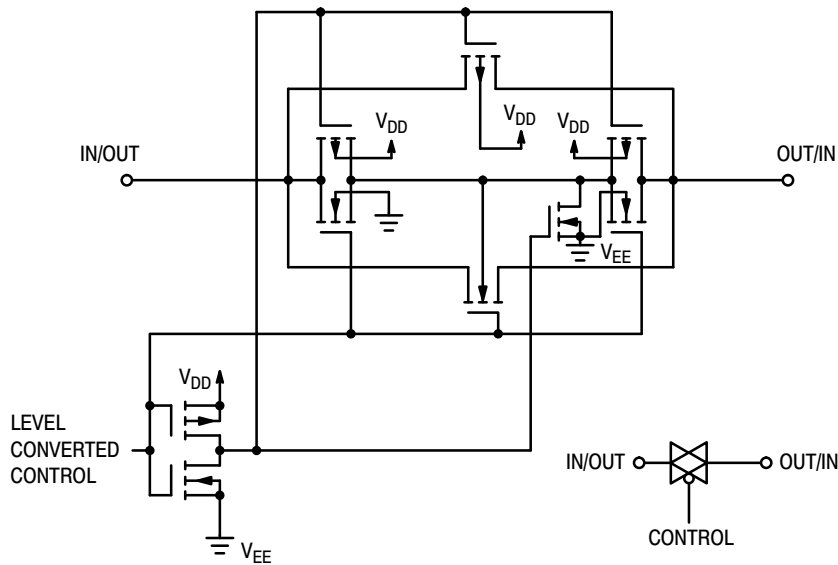


Figure 1. Switch Circuit Schematic

## TRUTH TABLE

Control Inputs			ON Switches		
Inhibit	Select		NLHV4051	NLHV4052	NLHV4053
	C*	B A			
0	0 0 0	X0	Y0 X0	Z0 Y0 X0	
0	0 0 1	X1	Y1 X1	Z0 Y0 X1	
0	0 1 0	X2	Y2 X2	Z0 Y1 X0	
0	0 1 1	X3	Y3 X3	Z0 Y1 X1	
0	1 0 0	X4		Z1 Y0 X0	
0	1 0 1	X5		Z1 Y0 X1	
0	1 1 0	X6		Z1 Y1 X0	
0	1 1 1	X7		Z1 Y1 X1	
1	x x x	None	None	None	

\*Not applicable for MC14052  
x = Don't Care

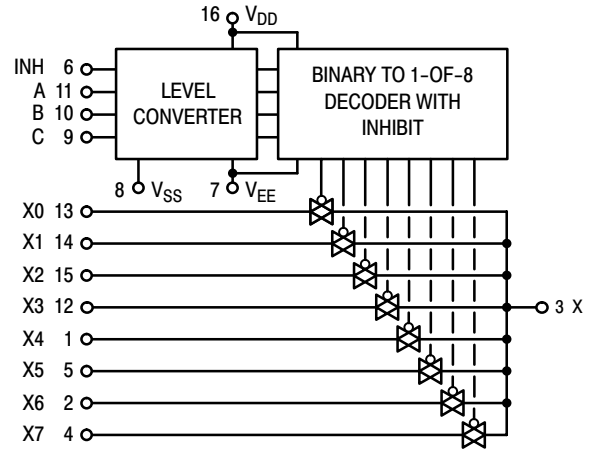


Figure 2. NLHV4051 Functional Diagram

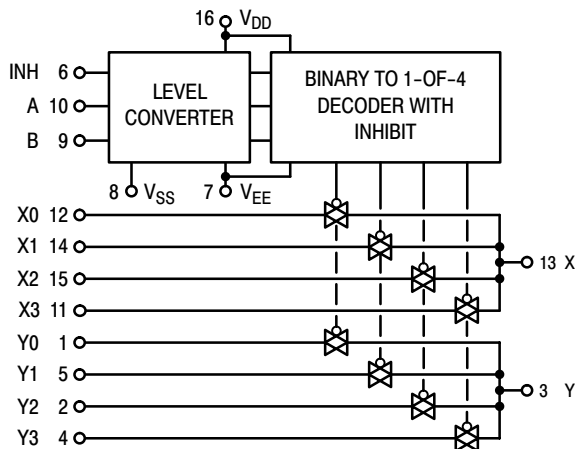


Figure 3. NLHV4052 Functional Diagram

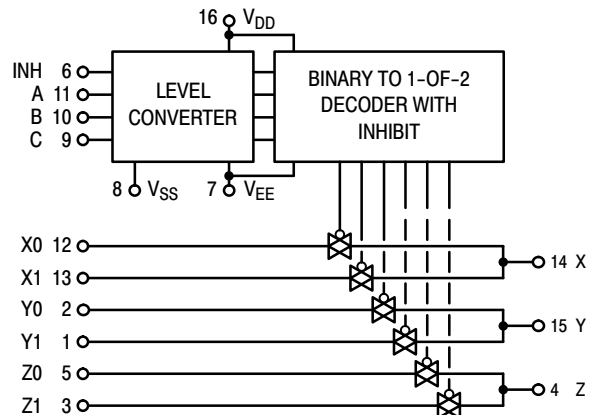


Figure 4. NLHV4053 Functional Diagram

TEST CIRCUITS

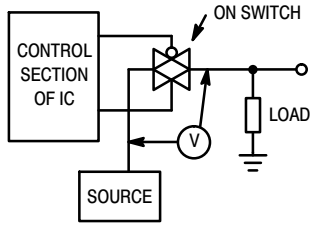


Figure 5.  $\Delta V$  Across Switch

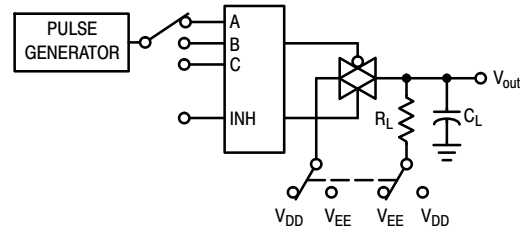


Figure 6. Propagation Delay Times, Control and Inhibit to Output

A, B, and C inputs used to turn ON or OFF the switch under test.

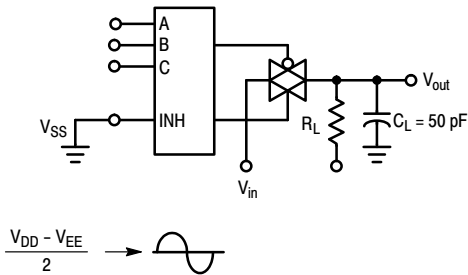


Figure 7. Bandwidth and Off-Channel Feedthrough Attenuation

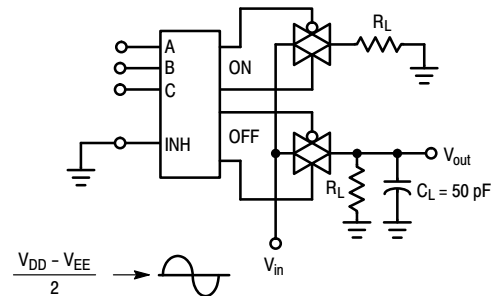


Figure 8. Channel Separation (Adjacent Channels Used For Setup)

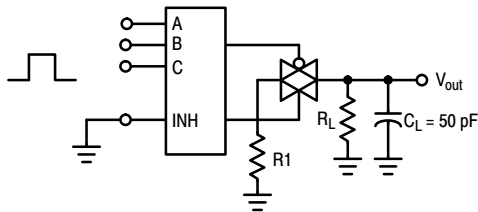


Figure 9. Crosstalk, Control Input to Common O/I

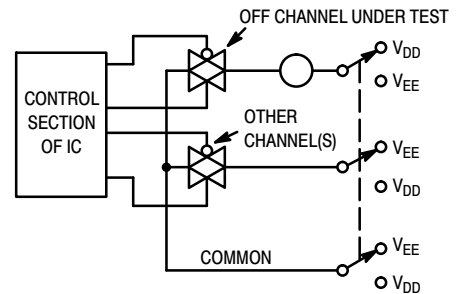


Figure 10. Off Channel Leakage

NOTE: See also Figures 7 and 8 in the MC14016B data sheet.

# NLHV4051, NLHV4052, NLHV4053

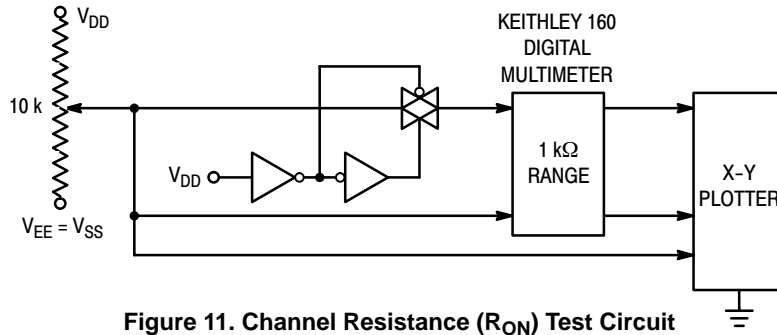


Figure 11. Channel Resistance ( $R_{ON}$ ) Test Circuit

## TYPICAL RESISTANCE CHARACTERISTICS

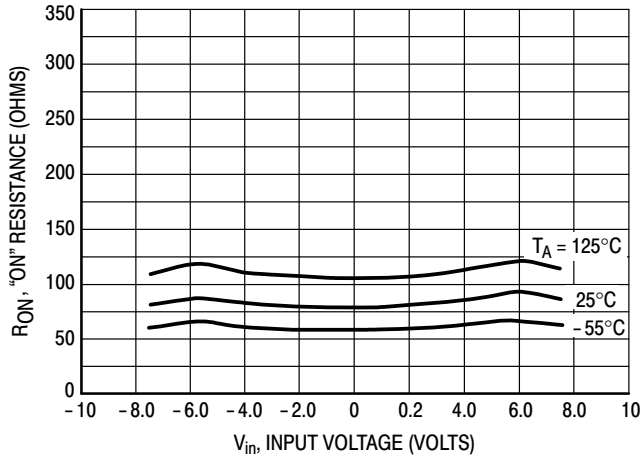


Figure 12.  $V_{DD} = 7.5\text{ V}$ ,  $V_{EE} = -7.5\text{ V}$

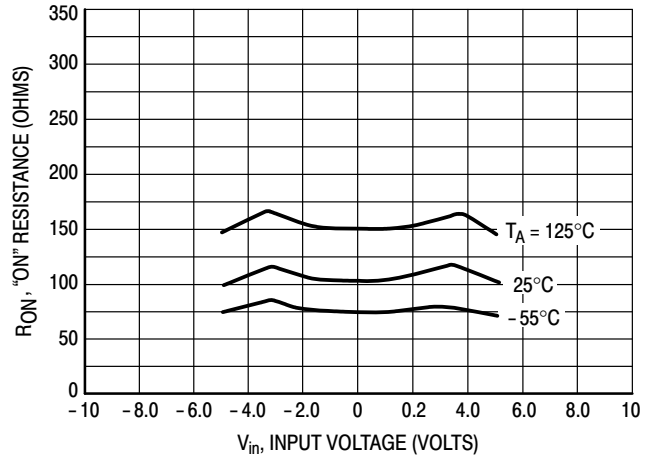


Figure 13.  $V_{DD} = 5.0\text{ V}$ ,  $V_{EE} = -5.0\text{ V}$

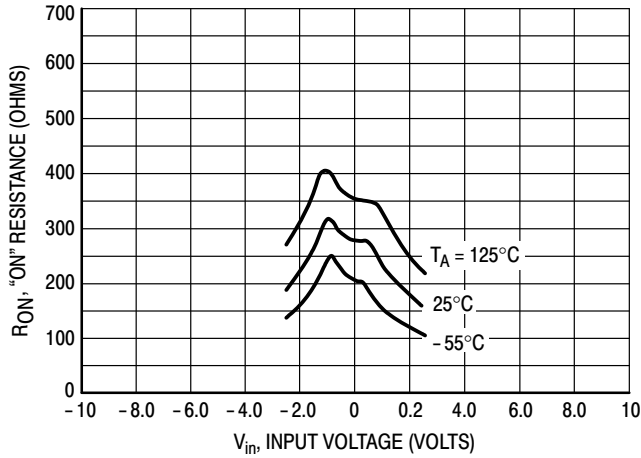


Figure 14.  $V_{DD} = 2.5\text{ V}$ ,  $V_{EE} = -2.5\text{ V}$

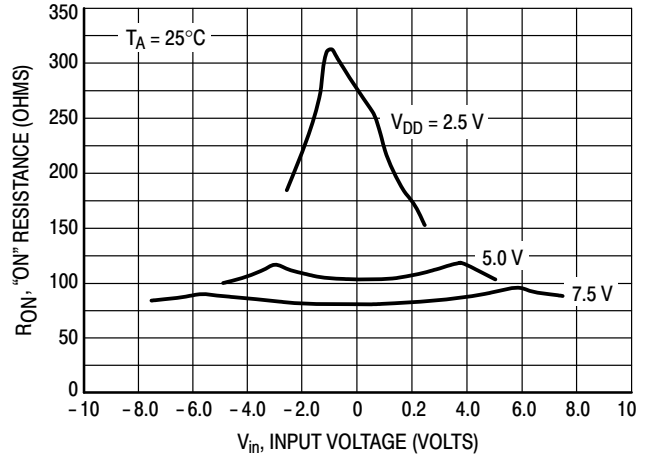


Figure 15. Comparison at  $25^\circ\text{C}$ ,  $V_{DD} = -V_{EE}$

# NLHV4051, NLHV4052, NLHV4053

## APPLICATIONS INFORMATION

Figure A illustrates use of the on-chip level converter detailed in Figures 2, 3, and 4. The 0-to-5 V Digital Control signal is used to directly control a 9 V<sub>p-p</sub> analog signal.

The digital control logic levels are determined by V<sub>DD</sub> and V<sub>SS</sub>. The V<sub>DD</sub> voltage is the logic high voltage; the V<sub>SS</sub> voltage is logic low. For the example, V<sub>DD</sub> = +5 V = logic high at the control inputs; V<sub>SS</sub> = GND = 0 V = logic low.

The maximum analog signal level is determined by V<sub>DD</sub> and V<sub>EE</sub>. The V<sub>DD</sub> voltage determines the maximum recommended peak above V<sub>SS</sub>. The V<sub>EE</sub> voltage determines the maximum swing below V<sub>SS</sub>. For the example, V<sub>DD</sub> - V<sub>SS</sub> = 5 V maximum swing above V<sub>SS</sub>; V<sub>SS</sub> - V<sub>EE</sub> = 5 V maximum swing below V<sub>SS</sub>. The example shows a ±4.5 V signal which allows a 1/2 volt margin at each

peak. If voltage transients above V<sub>DD</sub> and/or below V<sub>EE</sub> are anticipated on the analog channels, external diodes (D<sub>x</sub>) are recommended as shown in Figure B. These diodes should be small signal types able to absorb the maximum anticipated current surges during clipping.

The *absolute* maximum potential difference between V<sub>DD</sub> and V<sub>EE</sub> is 18.0 V. Most parameters are specified up to 15 V which is the *recommended* maximum difference between V<sub>DD</sub> and V<sub>EE</sub>.

Balanced supplies are not required. However, V<sub>SS</sub> must be greater than or equal to V<sub>EE</sub>. For example, V<sub>DD</sub> = +10 V, V<sub>SS</sub> = +5 V, and V<sub>EE</sub> = -3 V is acceptable. See the Table below.

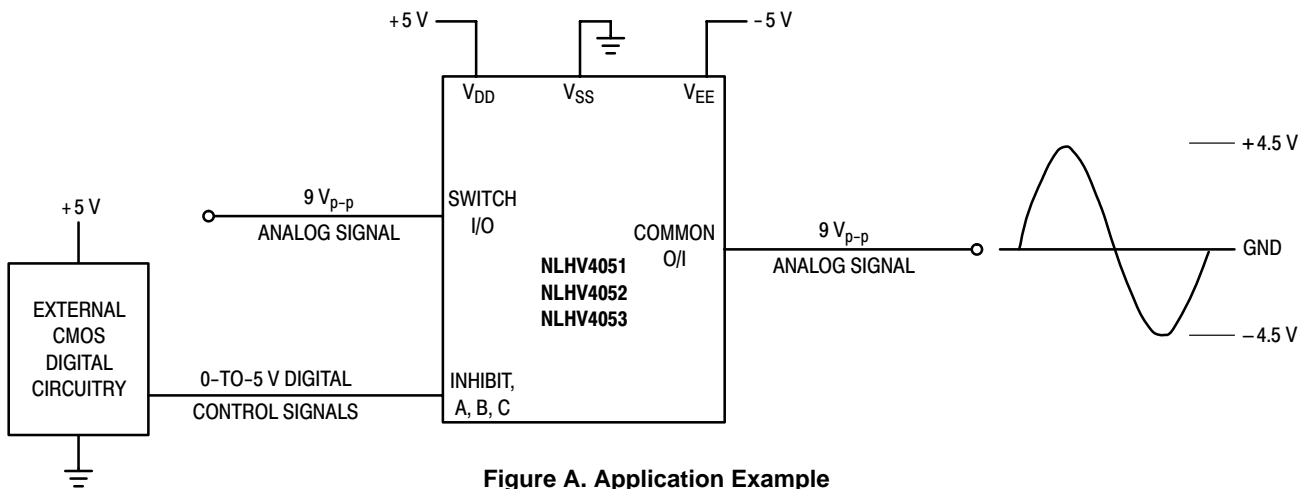


Figure A. Application Example

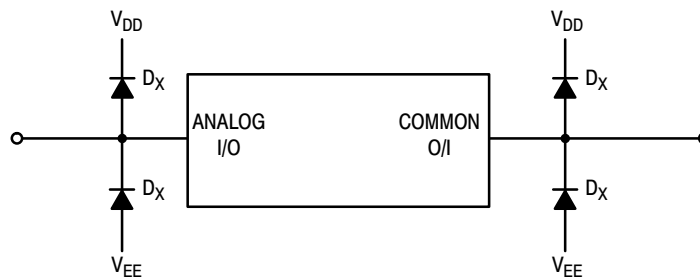


Figure B. External Germanium or Schottky Clipping Diodes

### POSSIBLE SUPPLY CONNECTIONS

V <sub>DD</sub> In Volts	V <sub>SS</sub> In Volts	V <sub>EE</sub> In Volts	Control Inputs Logic High/Logic Low In Volts	Maximum Analog Signal Range In Volts
+8	0	-8	+8/0	+8 to -8 = 16 V <sub>p-p</sub>
+5	0	-12	+5/0	+5 to -12 = 17 V <sub>p-p</sub>
+5	0	0	+5/0	+5 to 0 = 5 V <sub>p-p</sub>
+5	0	-5	+5/0	+5 to -5 = 10 V <sub>p-p</sub>
+10	+5	-5	+10/+5	+10 to -5 = 15 V <sub>p-p</sub>



## NLHV4051, NLHV4052, NLHV4053

### ORDERING INFORMATION

Device	Package	Shipping†
NLHV4051DR2G	SOIC-16 (Pb-Free)	2500 / Tape & Reel
NLHV4051DTR2G	TSSOP-16 (Pb-Free)	2500 / Tape & Reel
NLHV4052DR2G	SOIC-16 (Pb-Free)	2500 / Tape & Reel
NLHV4052DTR2G	TSSOP-16 (Pb-Free)	2500 / Tape & Reel
NLHV4053DR2G (In Development)	SOIC-16 (Pb-Free)	2500 / Tape & Reel
NLHV4053DTR2G (In Development)	TSSOP-16 (Pb-Free)	2500 / Tape & Reel

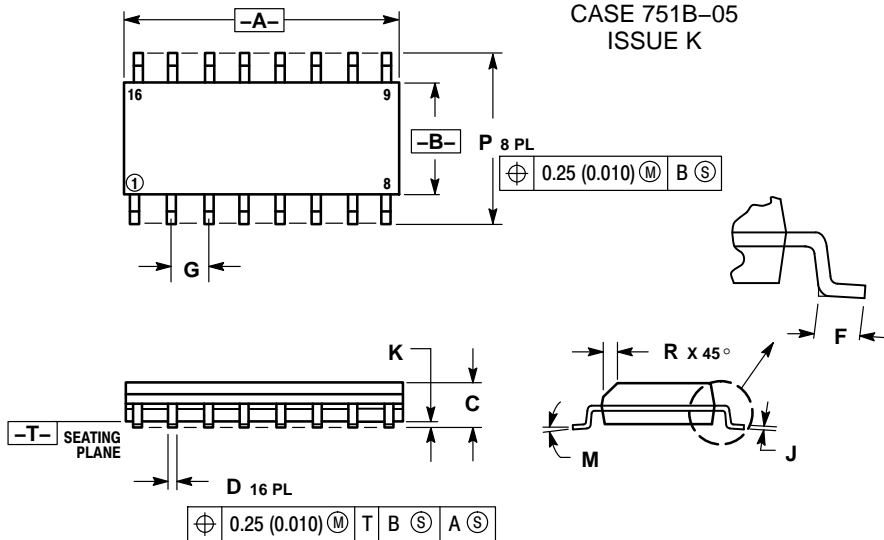
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



# NLHV4051, NLHV4052, NLHV4053

## PACKAGE DIMENSIONS

SOIC-16  
D SUFFIX  
CASE 751B-05  
ISSUE K

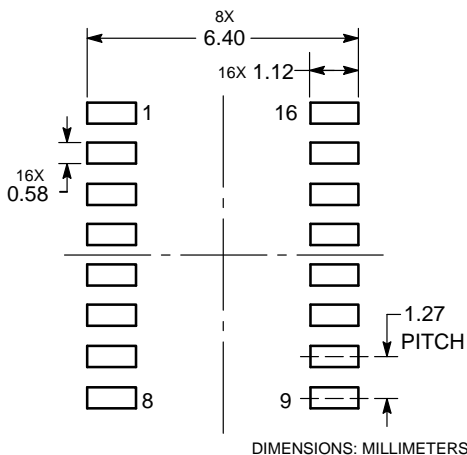


NOTES:

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

### SOLDERING FOOTPRINT\*



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

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