

# NLAS4053

## Analog Multiplexer/ Demultiplexer

### Triple 2:1 Analog Switch–Multiplexer Improved Process, Sub–Micron Silicon Gate CMOS

The NLAS4053 is an improved version of the MC14053 and MC74HC4053 fabricated in sub–micron Silicon Gate CMOS technology for lower  $R_{DS(on)}$  resistance and improved linearity with low current. This device may be operated either with a single supply or dual supply up to  $\pm 3$  V to pass a 6  $V_{PP}$  signal without coupling capacitors.

When operating in single supply mode, it is only necessary to tie  $V_{EE}$ , pin 7 to ground. For dual supply operation,  $V_{EE}$  is tied to a negative voltage, not to exceed maximum ratings. Pin for pin compatible with all industry standard versions of '4053.'

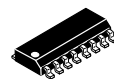
- Improved  $R_{DS(on)}$  Specifications
- Pin for Pin Replacement for MAX4053 and MAX4053A
  - One Half the Resistance Operating at 5.0 Volts
- Single or Dual Supply Operation
  - Single 3–5 Volt Operation, or Dual  $\pm 3$  Volt Operation
  - With  $V_{CC}$  of 3.0 to 3.3 V, Device Can Interface with 1.8 V Logic, No Translators Needed
  - Address and Inhibit Pins are Over–Voltage Tolerant and May Be Driven Up +6 V Regardless of  $V_{CC}$
- Address and Control Pins are Standard TTL Compatible
  - Greatly Improved Noise Margin Over MAX4053 and MAX4053A
- Improved Linearity Over Standard HC4053 Devices
- Popular SOIC, and Space Saving TSSOP, and QSOP 16 Pin Packages



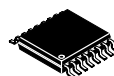
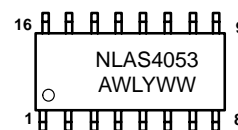
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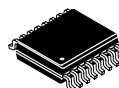
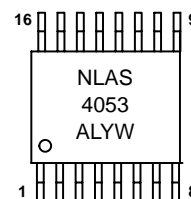
#### MARKING DIAGRAMS



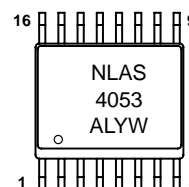
SO–16  
D SUFFIX  
CASE 751B



TSSOP–16  
DT SUFFIX  
CASE 948F



QSOP–16  
QS SUFFIX  
CASE 492



A = Assembly Location  
L, WL = Wafer Lot  
Y, YY = Year  
W, WW = Work Week

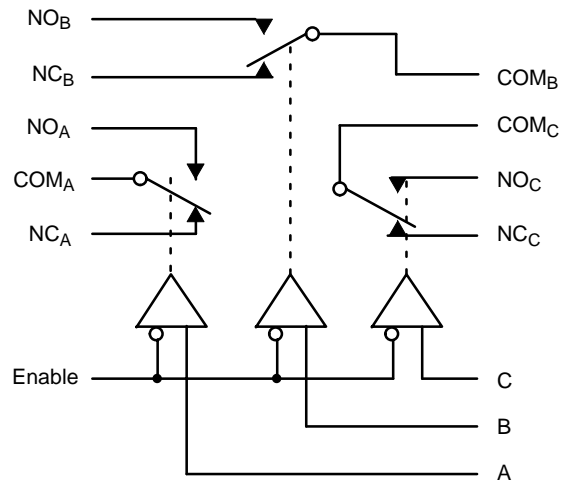
#### ORDERING INFORMATION

Device	Package	Shipping
NLAS4053D	SO–16	48 Units/Rail
NLAS4053DR2	SO–16	2500 Units/Reel
NLAS4053DT	TSSOP–16	96 Units/Rail
NLAS4053DTR2	TSSOP–16	2500 Units/Reel
NLAS4053QS	QSOP–16	48 Units/Rail
NLAS4053QSR	QSOP–16	2000 Units/Reel

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**Figure 1. Pin Connection**  
(Top View)



**Figure 2. Logic Diagram**

## TRUTH TABLE

Inhibit	Address			ON SWITCHES*
	C	B	A	
1	X don't care	X don't care	X don't care	All switches open
0	0	0	0	COM <sub>A</sub> -NC <sub>A</sub> , COM <sub>B</sub> -NC <sub>B</sub> , COM <sub>C</sub> -NC <sub>C</sub>
0	0	0	1	COM <sub>A</sub> -NO <sub>A</sub> , COM <sub>B</sub> -NC <sub>B</sub> , COM <sub>C</sub> -NC <sub>C</sub>
0	0	1	0	COM <sub>A</sub> -NC <sub>A</sub> , COM <sub>B</sub> -NO <sub>B</sub> , COM <sub>C</sub> -NC <sub>C</sub>
0	0	1	1	COM <sub>A</sub> -NO <sub>A</sub> , COM <sub>B</sub> -NO <sub>B</sub> , COM <sub>C</sub> -NC <sub>C</sub>
0	1	0	0	COM <sub>A</sub> -NC <sub>A</sub> , COM <sub>B</sub> -NC <sub>B</sub> , COM <sub>C</sub> -NO <sub>C</sub>
0	1	0	1	COM <sub>A</sub> -NO <sub>A</sub> , COM <sub>B</sub> -NC <sub>B</sub> , COM <sub>C</sub> -NO <sub>C</sub>
0	1	1	0	COM <sub>A</sub> -NC <sub>A</sub> , COM <sub>B</sub> -NO <sub>B</sub> , COM <sub>C</sub> -NO <sub>C</sub>
0	1	1	1	COM <sub>A</sub> -NO <sub>A</sub> , COM <sub>B</sub> -NO <sub>B</sub> , COM <sub>C</sub> -NO <sub>C</sub>

\*NO, NC, and COM pins are identical and interchangeable. Either may be considered an input or output; signals pass equally well in either direction.

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## MAXIMUM RATINGS (Note 1)

Symbol	Parameter	Value	Unit
V <sub>EE</sub>	Negative DC Supply Voltage (Referenced to GND)	-7.0 to +0.5	V
V <sub>CC</sub>	Positive DC Supply Voltage (Note 2) (Referenced to GND) (Referenced to V <sub>EE</sub> )	-0.5 to +7.0 -0.5 to +7.0	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 7.0	V
I	DC Current, Into or Out of Any Pin	± 50	mA
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
T <sub>J</sub>	Junction Temperature under Bias	+150	°C
θ <sub>JA</sub>	Thermal Resistance SOIC TSSOP QSOP	143 164 164	°C/W
P <sub>D</sub>	Power Dissipation in Still Air, SOIC TSSOP QSOP	500 450 450	mW
MSL	Moisture Sensitivity	Level 1	
F <sub>R</sub>	Flammability Rating Oxygen Index: 30% – 35%	UL 94 V-0 @ 0.125 in	
V <sub>ESD</sub>	ESD Withstand Voltage Human Body Model (Note 3) Machine Model (Note 4) Charged Device Model (Note 5)	> 2000 > 200 > 1000	V
I <sub>LATCH-UP</sub>	Latch-Up Performance Above V <sub>CC</sub> and Below GND at 125°C (Note 6)	± 300	mA

1. Absolute maximum continuous ratings are those values beyond which damage to the device may occur. Extended exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute maximum-rated conditions is not implied.
2. The absolute value of V<sub>CC</sub> ± |V<sub>EE</sub>| ≤ 7.0.
3. Tested to EIA/JESD22-A114-A.
4. Tested to EIA/JESD22-A115-A.
5. Tested to JESD22-C101-A.
6. Tested to EIA/JESD78.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V <sub>EE</sub>	Negative DC Supply Voltage (Referenced to GND)	-5.5	GND	V
V <sub>CC</sub>	Positive DC Supply Voltage (Referenced to GND) (Referenced to V <sub>EE</sub> )	2.5 2.5	5.5 6.6	V
V <sub>IS</sub>	Analog Input Voltage	V <sub>EE</sub>	V <sub>CC</sub>	V
V <sub>IN</sub>	Digital Input Voltage (Note 7) (Referenced to GND)	0	5.5	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) V <sub>CC</sub> = 3.0 V ± 0.3 V V <sub>CC</sub> = 5.0 V ± 0.5 V	0 0	100 20	ns/V

7. Unused digital inputs may not be left open. All digital inputs must be tied to a high-logic voltage level or a low-logic input voltage level.

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## DC CHARACTERISTICS – Digital Section (Voltages Referenced to GND)

Symbol	Parameter	Condition	V <sub>CC</sub> V	Guaranteed Limit			Unit
				-55 to 25°C	≤ 85°C	≤ 125°C	
V <sub>IH</sub>	Minimum High-Level Input Voltage, Address and Inhibit Inputs		2.0	1.5	1.5	1.5	V
			3.0	2.1	2.1	2.1	
			4.5	3.15	3.15	3.15	
			5.5	3.85	3.85	3.85	
V <sub>IL</sub>	Maximum Low-Level Input Voltage, Address and Inhibit Inputs		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	
			5.5	1.65	1.65	1.65	
I <sub>IN</sub>	Maximum Input Leakage Current, Address or Inhibit Inputs	V <sub>IN</sub> = 6.0 or GND	0 V to 6.0 V	± 0.1	± 1.0	± 1.0	μA
I <sub>CC</sub>	Maximum Quiescent Supply Current (per Package)	Channel Select, Enable and V <sub>IS</sub> = V <sub>CC</sub> or GND	6.0	4.0	40	80	μA

## DC ELECTRICAL CHARACTERISTICS – Analog Section

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	V <sub>EE</sub> V	Guaranteed Limit			Unit
					-55 to 25°C	≤ 85°C	≤ 125°C	
R <sub>ON</sub>	Maximum "ON" Resistance	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>IS</sub> = V <sub>EE</sub> to V <sub>CC</sub>  I <sub>S</sub>   = 10 mA (Figures 4 thru 9)	3.0	0	86	108	120	Ω
			4.5	0	37	46	55	
			3.0	-3.0	26	33	37	
ΔR <sub>ON</sub>	Maximum Difference in "ON" Resistance Between Any Two Channels in the Same Package	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> ,  I <sub>S</sub>   = 10 mA, V <sub>IS</sub> = 2.0 V V <sub>IS</sub> = 3.5 V V <sub>IS</sub> = 2.0 V	3.0	0	15	20	20	Ω
			4.5	0	13	18	18	
			3.0	-3.0	10	15	15	
R <sub>flat(ON)</sub>	COM-NO On-Resistance Flatness	V <sub>com</sub> 1, 2, 3.5 V V <sub>com</sub> -2, 0, 2 V  I <sub>S</sub>   = 10 mA	4.5 3.0	0 -3.0	4 2	4 2	5 3	Ω
I <sub>NC(OFF)</sub> I <sub>NO(OFF)</sub>	Maximum Off-Channel Leakage Current	Switch Off V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>IO</sub> = V <sub>CC</sub> -1.0 V or V <sub>EE</sub> +1.0 V (Figure 17)	6.0 3.0	0 -3.0	0.1 0.1	5.0 5.0	100 100	nA
I <sub>COM(ON)</sub>	Maximum On-Channel Leakage Current, Channel- to-Channel	Switch On V <sub>IO</sub> = V <sub>CC</sub> -1.0 V or V <sub>EE</sub> +1.0 V (Figure 17)	6.0 3.0	0 -3.0	0.1 0.1	5.0 5.0	100 100	nA

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## AC CHARACTERISTICS (Input $t_r = t_f = 3$ ns)

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	V <sub>EE</sub> V	Guaranteed Limit				Unit
					-55 to 25°C		≤ 85°C	≤ 125°C	
					Min	Typ*			
t <sub>BBM</sub>	Minimum Break-Before-Make Time	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>IS</sub> = V <sub>CC</sub> R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF (Figure 19)	3.0	0.0	1.0	6.5	–	–	ns
			4.5	0.0	1.0	5.0	–	–	
			3.0	-3.0	1.0	3.5	–	–	

\*Typical Characteristics are at 25°C.

## AC CHARACTERISTICS (C<sub>L</sub> = 50 pF, Input $t_r = t_f = 3$ ns)

Symbol	Parameter	V <sub>CC</sub> V	V <sub>EE</sub> V	Guaranteed Limit						Unit	
				-55 to 25°C			≤ 85°C		≤ 125°C		
				Min	Typ	Max	Min	Max	Min		Max
t <sub>TRANS</sub>	Transition Time (Address Selection Time) (Figure 18)	2.5	0			40		45		50	ns
		3.0	0			28		30		35	
		4.5	0			23		25		30	
		3.0	-3.0			23		25		28	
t <sub>ON</sub>	Turn-on Time (Figures 14, 15, 20, and 21) Enable to N <sub>O</sub> or N <sub>C</sub>	2.5	0			40		45		50	ns
		3.0	0			28		30		35	
		4.5	0			23		25		30	
		3.0	-3.0			23		25		28	
t <sub>OFF</sub>	Turn-off Time (Figures 14, 15, 20, and 21) Enable to N <sub>O</sub> or N <sub>C</sub>	2.5	0			40		45		50	ns
		3.0	0			28		30		35	
		4.5	0			23		25		30	
		3.0	-3.0			23		25		28	

		Typical @ 25°C, V <sub>CC</sub> = 5.0 V	
C <sub>IN</sub>	Maximum Input Capacitance, Select Inputs	8	
C <sub>NO</sub> or C <sub>NC</sub>	Analog I/O	10	
C <sub>COM</sub>	Common I/O	10	
C <sub>(ON)</sub>	Feedthrough	1.0	

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## ADDITIONAL APPLICATION CHARACTERISTICS (GND = 0 V)

Symbol	Parameter	Condition	V <sub>CC</sub> V	V <sub>EE</sub> V	Typ	Unit
					25°C	
BW	Maximum On-Channel Bandwidth or Minimum Frequency Response	V <sub>IS</sub> = ½ (V <sub>CC</sub> - V <sub>EE</sub> ) Source Amplitude = 0 dBm (Figures 10 and 22)	3.0	0.0	145	MHz
			4.5	0.0	165	
			6.0	0.0	180	
			3.0	-3.0	180	
V <sub>ISO</sub>	Off-Channel Feedthrough Isolation	f = 100 kHz; V <sub>IS</sub> = ½ (V <sub>CC</sub> - V <sub>EE</sub> ) Source = 0 dBm (Figures 12 and 22)	3.0	0.0	-93	dB
			4.5	0.0	-93	
			6.0	0.0	-93	
			3.0	-3.0	-93	
V <sub>ONL</sub>	Maximum Feedthrough On Loss	V <sub>IS</sub> = ½ (V <sub>CC</sub> - V <sub>EE</sub> ) Source = 0 dBm (Figures 10 and 22)	3.0	0.0	-2	dB
			4.5	0.0	-2	
			6.0	0.0	-2	
			3.0	-3.0	-2	
Q	Charge Injection	V <sub>IN</sub> = V <sub>CC</sub> to V <sub>EE</sub> , f <sub>IS</sub> = 1 kHz, t <sub>r</sub> = t <sub>f</sub> = 3 ns R <sub>IS</sub> = 0 Ω, C <sub>L</sub> = 1000 pF, Q = C <sub>L</sub> * ΔV <sub>OUT</sub> (Figures 16 and 23)	5.0	0.0	9.0	pC
			3.0	-3.0	12	
THD	Total Harmonic Distortion THD + Noise	f <sub>IS</sub> = 1 MHz, R <sub>L</sub> = 10 KΩ, C <sub>L</sub> = 50 pF, V <sub>IS</sub> = 5.0 V <sub>PP</sub> sine wave V <sub>IS</sub> = 6.0 V <sub>PP</sub> sine wave (Figure 13)	6.0	0.0	0.10	%
			3.0	-3.0	0.05	

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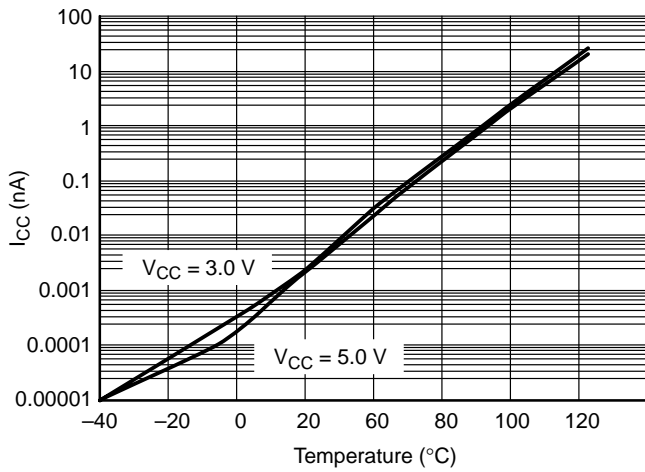


Figure 3.  $I_{CC}$  versus Temp,  $V_{CC} = 3\text{ V}$  and  $5\text{ V}$

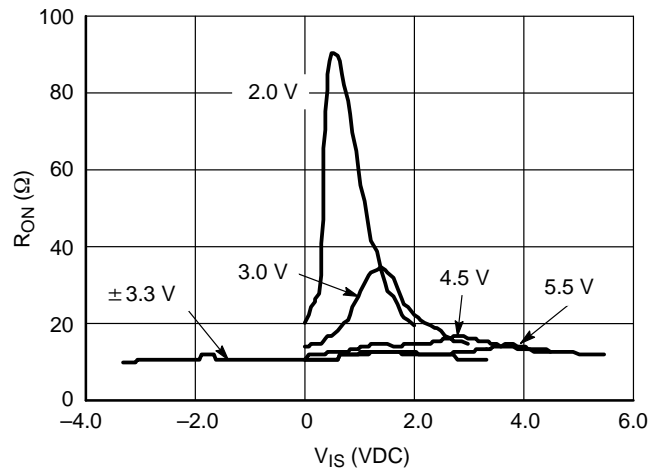


Figure 4.  $R_{ON}$  versus  $V_{CC}$ , Temp =  $25^\circ\text{C}$

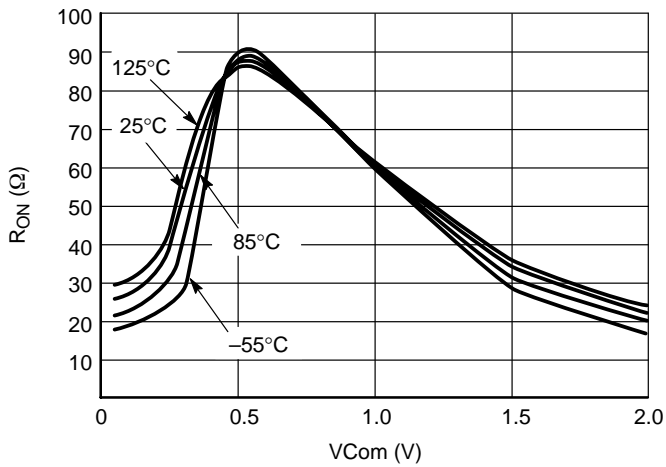


Figure 5. Typical On Resistance  
 $V_{CC} = 2.0\text{ V}$ ,  $V_{EE} = 0\text{ V}$

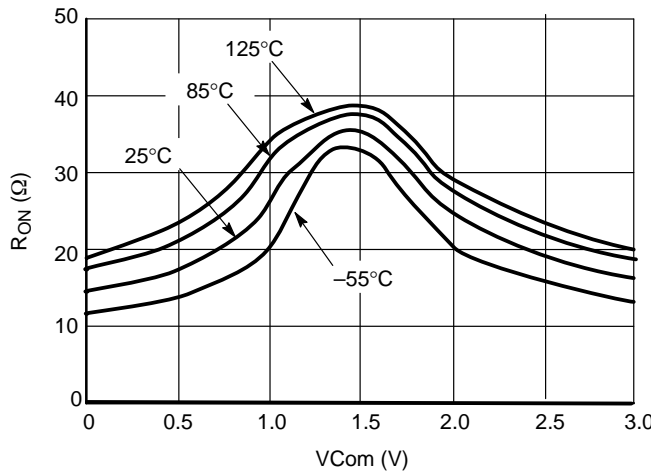


Figure 6. Typical On Resistance  
 $V_{CC} = 3.0\text{ V}$ ,  $V_{EE} = 0\text{ V}$

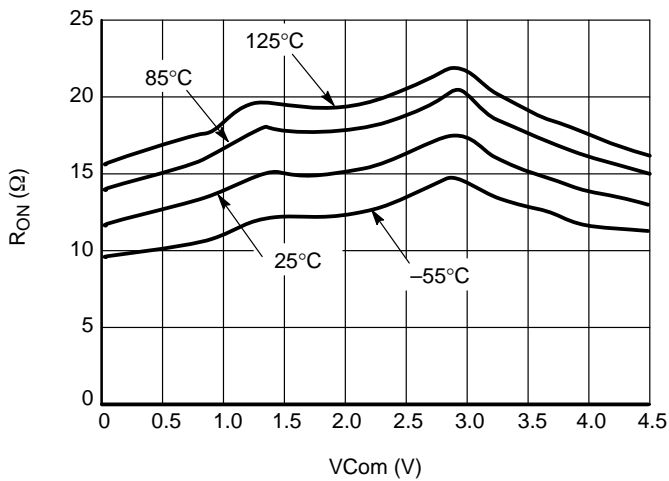


Figure 7. Typical On Resistance  
 $V_{CC} = 4.5\text{ V}$ ,  $V_{EE} = 0\text{ V}$

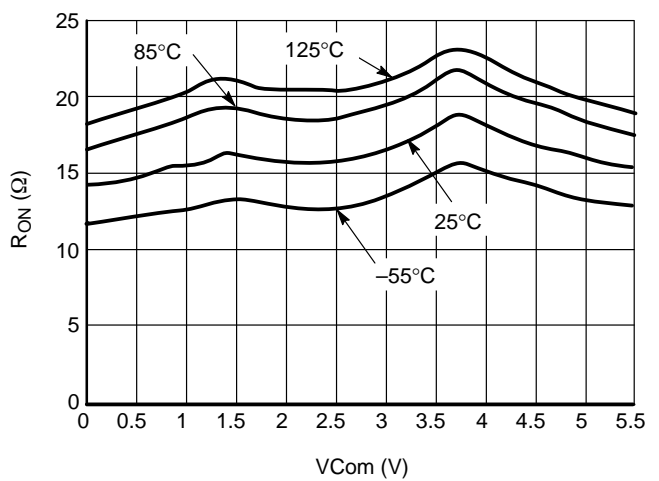
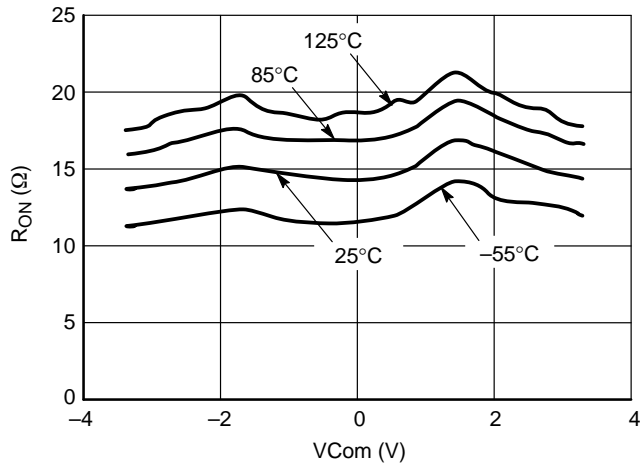
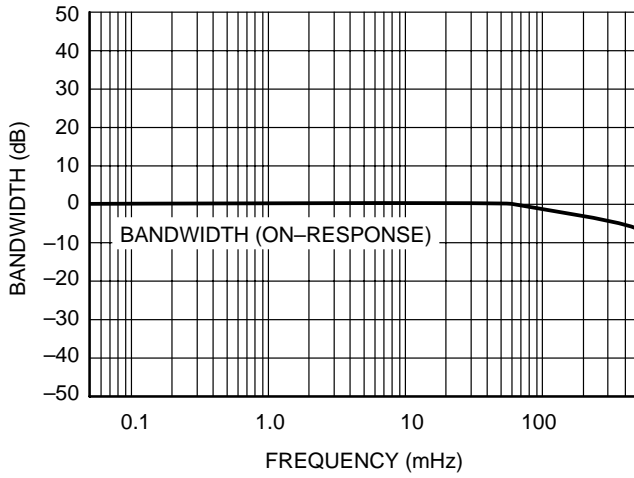


Figure 8. Typical On Resistance  
 $V_{CC} = 5.5\text{ V}$ ,  $V_{EE} = 0\text{ V}$

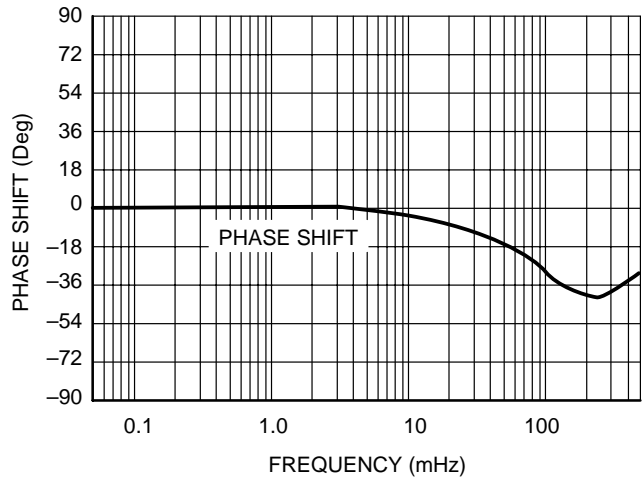
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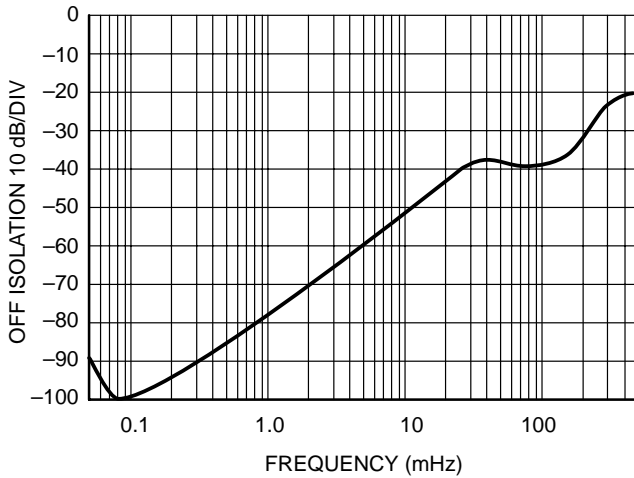
**Figure 9. Typical On Resistance**  
 $V_{CC} = 3.3\text{ V}, V_{EE} = -3.3\text{ V}$



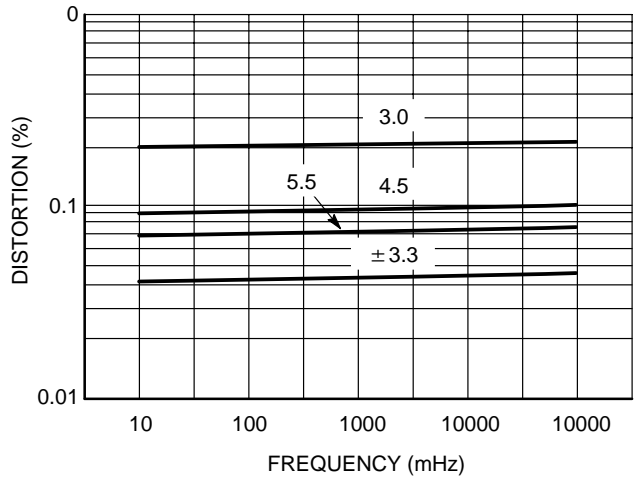
**Figure 10. Bandwidth**



**Figure 11. Phase Shift**



**Figure 12. Off Isolation**



**Figure 13. Total Harmonic Distortion**



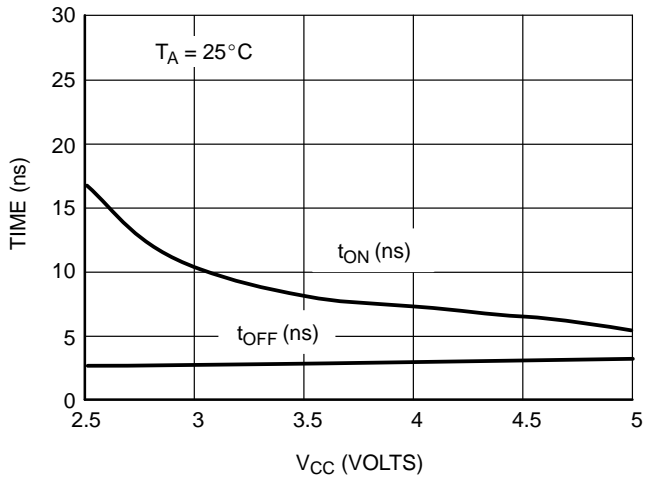


Figure 14.  $t_{ON}$  and  $t_{OFF}$  versus  $V_{CC}$

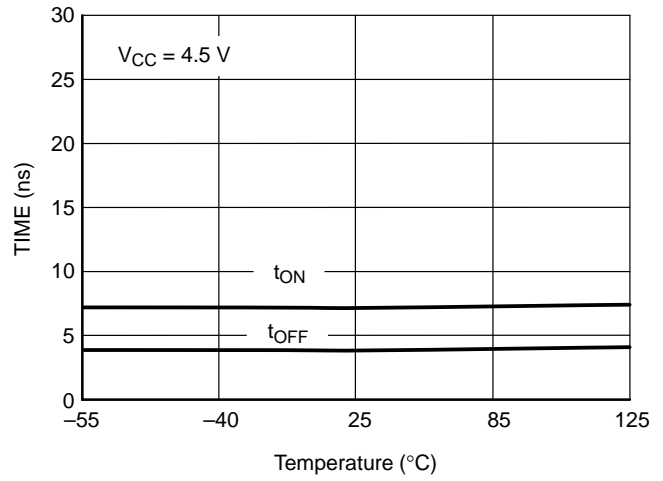


Figure 15.  $t_{ON}$  and  $t_{OFF}$  versus Temp

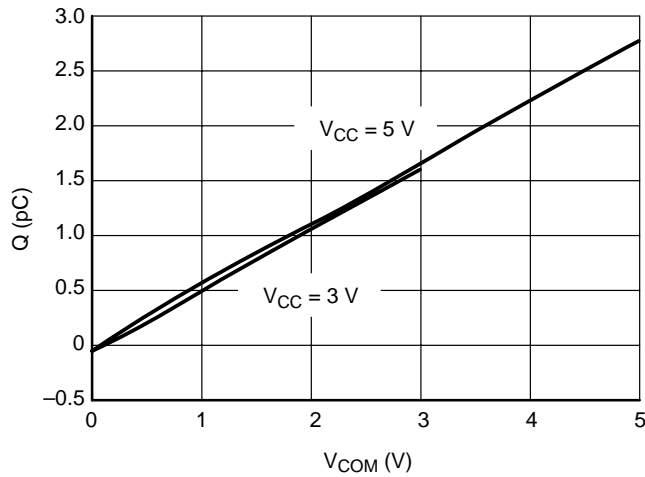


Figure 16. Charge Injection versus COM Voltage

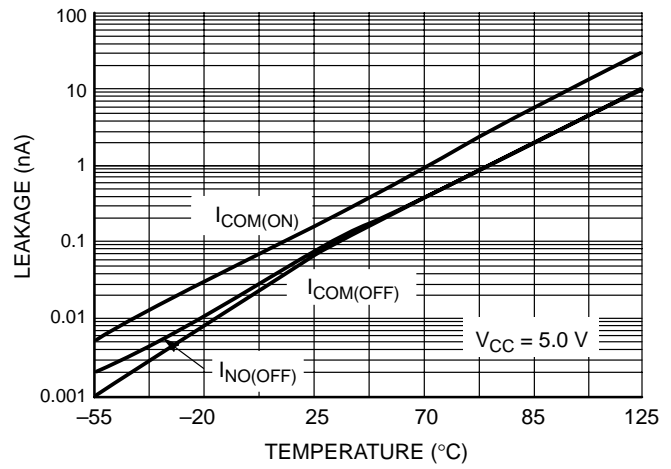


Figure 17. Switch Leakage versus Temperature

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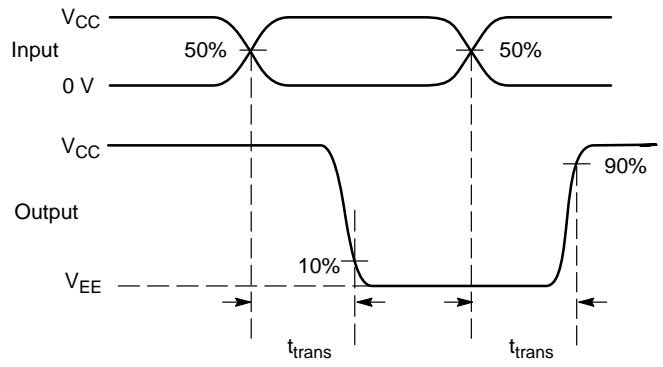
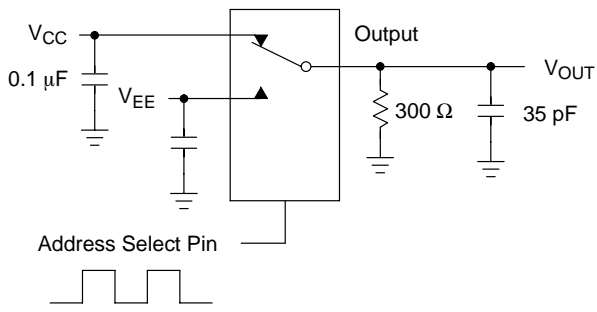


Figure 18. Channel Selection Propagation Delay

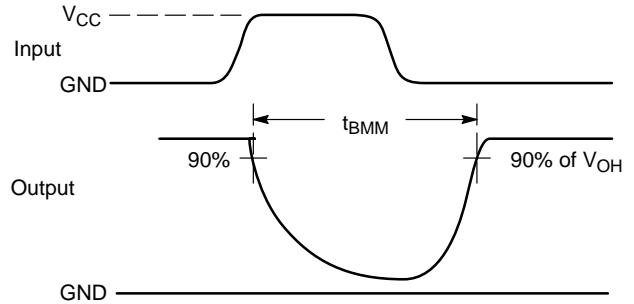
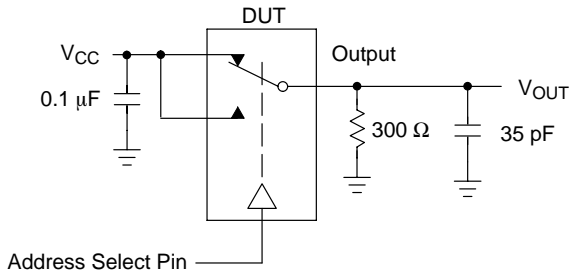


Figure 19.  $t_{BMM}$  (Time Break–Before–Make)

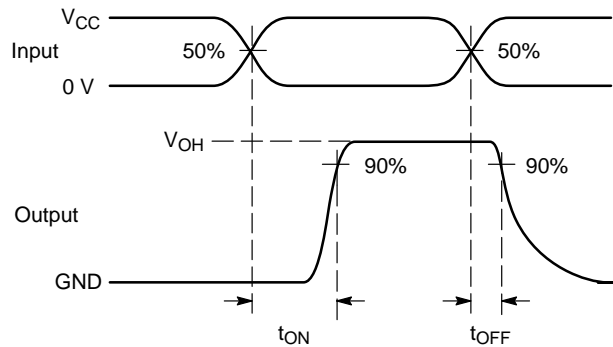
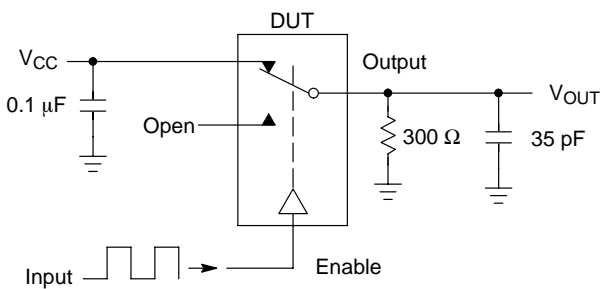


Figure 20.  $t_{ON}/t_{OFF}$

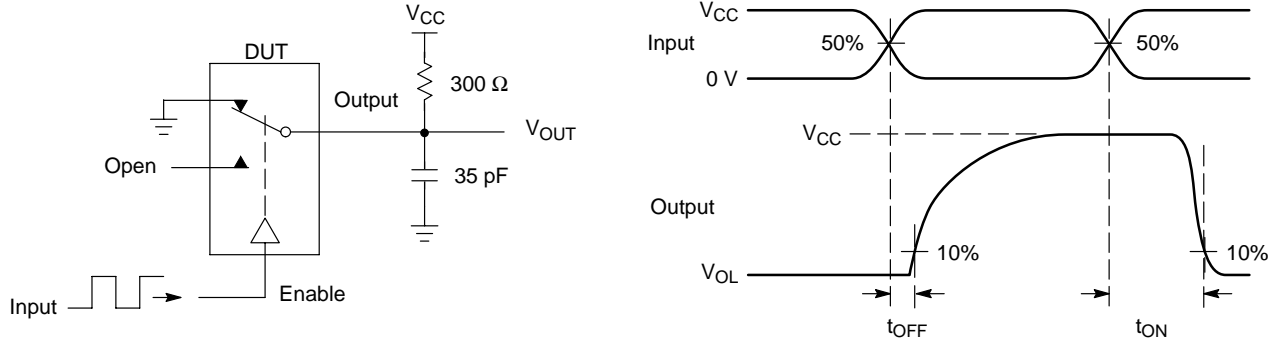
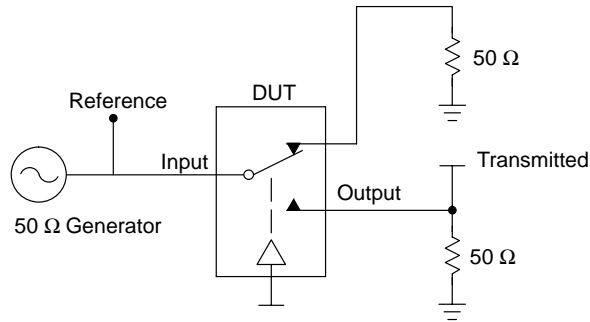


Figure 21.  $t_{ON}/t_{OFF}$



Channel switch control/s test socket is normalized. Off isolation is measured across an off channel. On loss is the bandwidth of an On switch.  $V_{ISO}$ , Bandwidth and  $V_{ONL}$  are independent of the input signal direction.

$$V_{ISO} = \text{Off Channel Isolation} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

$$V_{ONL} = \text{On Channel Loss} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz to } 50 \text{ MHz}$$

Bandwidth (BW) = the frequency 3 dB below  $V_{ONL}$

Figure 22. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/ $V_{ONL}$

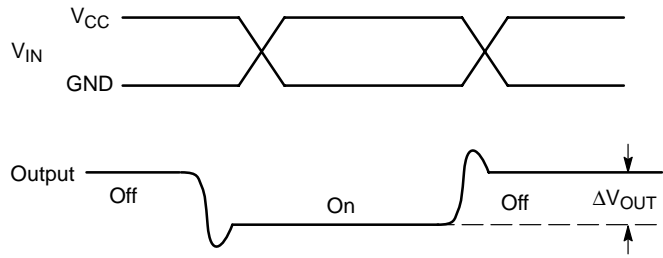
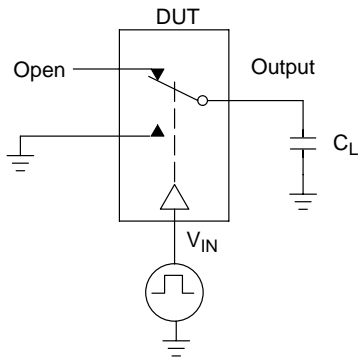


Figure 23. Charge Injection: (Q)

TYPICAL OPERATION

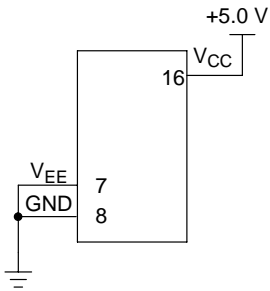


Figure 24. 5.0 Volts Single Supply  
 $V_{CC} = 5.0 \text{ V}$ ,  $V_{EE} = 0$

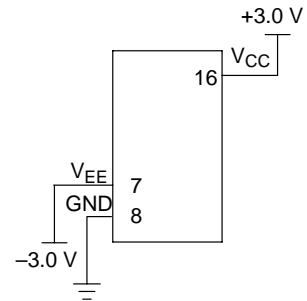
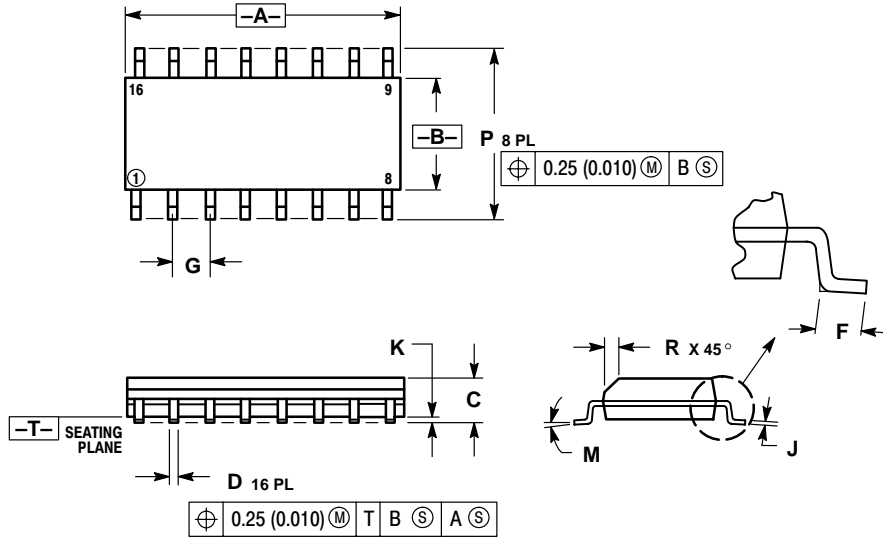


Figure 25. Dual Supply  
 $V_{CC} = 3.0 \text{ V}$ ,  $V_{EE} = -3.0 \text{ V}$

# NLAS4053

## PACKAGE DIMENSIONS

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



### NOTES:

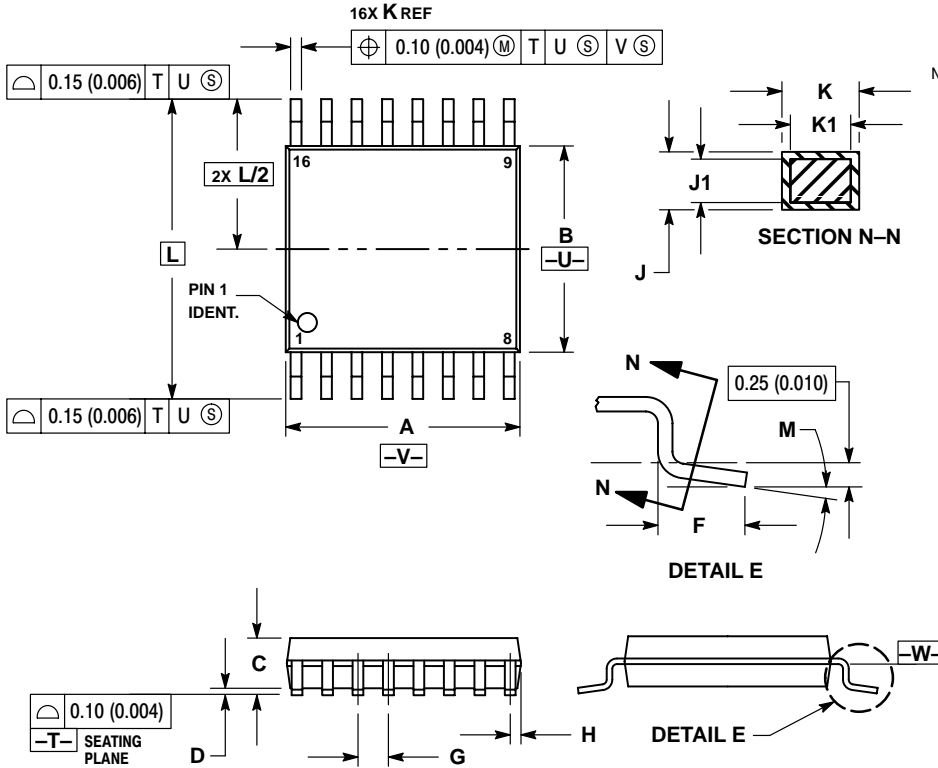
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL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

# NLAS4053

## PACKAGE DIMENSIONS

TSSOP-16  
DT SUFFIX  
CASE 948F-01  
ISSUE O



### NOTES:

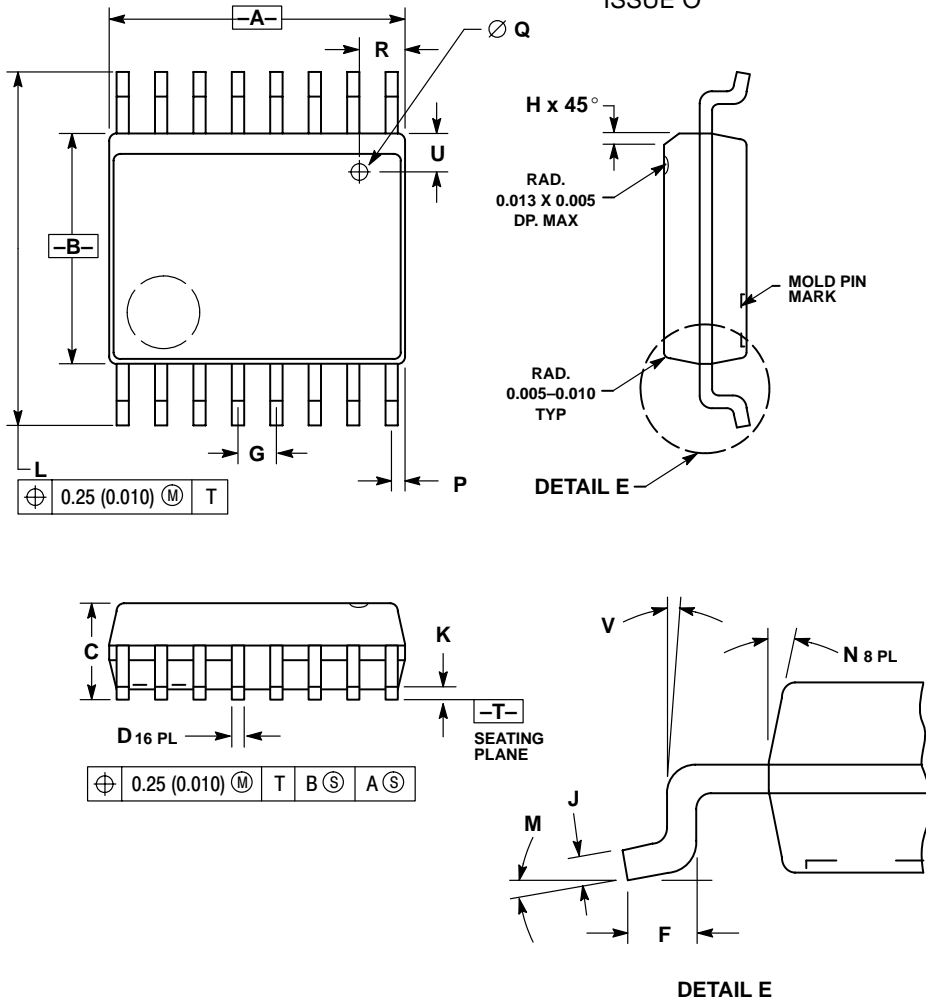
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. 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.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. 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°

# NLAS4053

## PACKAGE DIMENSIONS

QSOP-16  
M SUFFIX  
CASE 492-01  
ISSUE O



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. THE BOTTOM PACKAGE SHALL BE BIGGER THAN THE TOP PACKAGE BY 4 MILS (NOTE: LEAD SIDE ONLY). BOTTOM PACKAGE DIMENSION SHALL FOLLOW THE DIMENSION STATED IN THIS DRAWING.
  4. PLASTIC DIMENSIONS DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 6 MILS PER SIDE.
  5. BOTTOM EJECTOR PIN WILL INCLUDE THE COUNTRY OF ORIGIN (COO) AND MOLD CAVITY I.D.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.189	0.196	4.80	4.98
B	0.150	0.157	3.81	3.99
C	0.061	0.068	1.55	1.73
D	0.008	0.012	0.20	0.31
F	0.016	0.035	0.41	0.89
G	0.025 BSC		0.64 BSC	
H	0.008	0.018	0.20	0.46
J	0.0098	0.0075	0.249	0.191
K	0.004	0.010	0.10	0.25
L	0.230	0.244	5.84	6.20
M	0°	8°	0°	8°
N	0°	7°	0°	7°
P	0.007	0.011	0.18	0.28
Q	0.020 DIA		0.51 DIA	
R	0.025	0.035	0.64	0.89
U	0.025	0.035	0.64	0.89
V	0°	8°	0°	8°

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