

# NLAST4053

## Analog Multiplexer/ Demultiplexer

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

The NLAST4053 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<sub>PP</sub> 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. Translation is provided in the device, the Address and Inhibit pins are standard TTL level compatible. For CMOS compatibility see NLAS4053. 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 Inhibit Pins are Standard TTL Compatible
  - Greatly Improved Noise Margin Over MAX4053 and MAX4053A
  - True TTL Compatibility  $V_{IL} = 0.8$  V,  $V_{IH} = 2.0$  V
- Improved Linearity Over Standard HC4053 Devices
- Popular SOIC, and Space Saving TSSOP, and QSOP 16 Pin Packages
- This is a Pb-Free Device



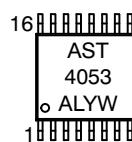
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#### MARKING DIAGRAM



TSSOP-16  
DT SUFFIX  
CASE 948F



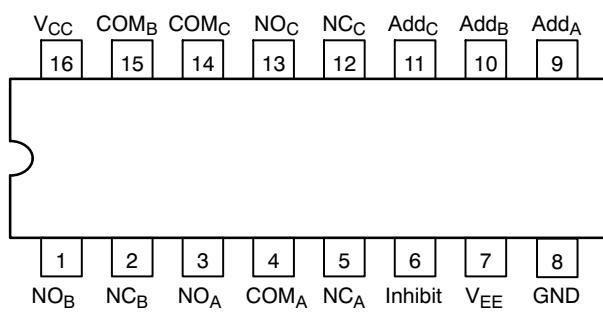
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week

#### ORDERING INFORMATION

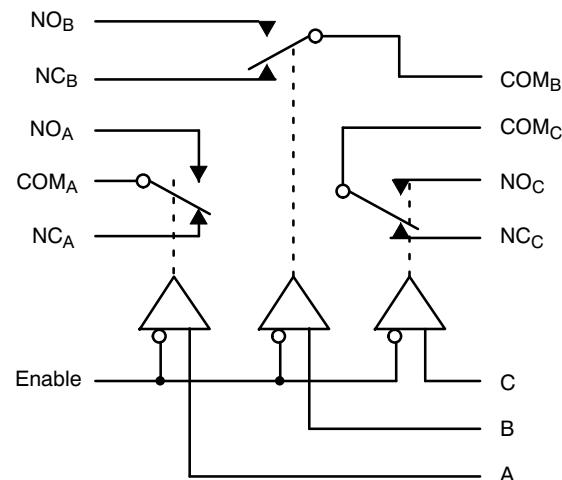
Device	Package	Shipping <sup>†</sup>
NLAST4053DTR2G	TSSOP-16 (Pb-Free)	2500 / Tape & Reel

<sup>†</sup>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.

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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.

## MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{EE}$	Negative DC Supply Voltage (Referenced to GND)	-7.0 to +0.5	V
$V_{CC}$	Positive DC Supply Voltage (Note 1) (Referenced to GND) (Referenced to $V_{EE}$ )	-0.5 to +7.0 -0.5 to +7.0	V
$V_{IS}$	Analog Input Voltage	$V_{EE}$ -0.5 to $V_{CC}$ +0.5	V
$V_{IN}$	Digital Input Voltage (Referenced to GND)	-0.5 to 7.0	V
$I$	DC Current, Into or Out of Any Pin	$\pm 50$	mA
$T_{STG}$	Storage Temperature Range	-65 to +150	°C
$T_L$	Lead Temperature, 1 mm from Case for 10 Seconds	260	°C
$T_J$	Junction Temperature under Bias	+150	°C
$\theta_{JA}$	Thermal Resistance SOIC TSSOP QSOP	143 164 164	°C/W
$P_D$	Power Dissipation in Still Air, SOIC TSSOP QSOP	500 450 450	mW
MSL	Moisture Sensitivity	Level 1	
$F_R$	Flammability Rating Oxygen Index: 30% - 35%	UL 94 V-0 @ 0.125 in	
$V_{ESD}$	ESD Withstand Voltage Human Body Model (Note 2) Machine Model (Note 3) Charged Device Model (Note 4)	>2000 > 200 >1000	V
$I_{LATCH-UP}$	Latch-Up Performance Above $V_{CC}$ and Below GND at 125°C (Note 5)	$\pm 300$	mA

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. The absolute value of  $V_{CC} \pm |V_{EE}| \leq 7.0$ .
2. Tested to EIA/JESD22-A114-A.
3. Tested to EIA/JESD22-A115-A.
4. Tested to JESD22-C101-A.
5. Tested to EIA/JESD78.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit	
$V_{EE}$	Negative DC Supply Voltage (Referenced to GND)	-5.5	GND	V	
$V_{CC}$	Positive DC Supply Voltage (Referenced to GND) (Referenced to $V_{EE}$ )	2.5 2.5	5.5 6.6	V	
$V_{IS}$	Analog Input Voltage	$V_{EE}$	$V_{CC}$	V	
$V_{IN}$	Digital Input Voltage (Note 6) (Referenced to GND)	0	5.5	V	
$T_A$	Operating Temperature Range, All Package Types	-55	125	°C	
$t_r, t_f$	Input Rise/Fall Time (Channel Select or Enable Inputs)	$V_{CC} = 3.0 \text{ V} \pm 0.3 \text{ V}$ $V_{CC} = 5.0 \text{ V} \pm 0.5 \text{ V}$	0 0	100 20	ns/V

6. 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.

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

<b>Symbol</b>	<b>Parameter</b>	<b>Condition</b>	<b>V<sub>CC</sub> V</b>	<b>Guaranteed Limit</b>			<b>Unit</b>
				<b>-55 to 25°C</b>	<b>≤ 85°C</b>	<b>≤ 125°C</b>	
V <sub>IH</sub>	Minimum High-Level Input Voltage, Address and Inhibit Inputs		3.0 4.5 5.5	1.6 2.0 2.0	1.6 2.0 2.0	1.6 2.0 2.0	V
V <sub>IL</sub>	Maximum Low-Level Input Voltage, Address and Inhibit Inputs		3.0 4.5 5.5	0.5 0.8 0.8	0.5 0.8 0.8	0.5 0.8 0.8	V
I <sub>IN</sub>	Maximum Input Leakage Current, Address and 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)	Address and Inhibit, and V <sub>IS</sub> = V <sub>CC</sub> or GND	6.0	4.0	40	80	µA

**DC ELECTRICAL CHARACTERISTICS – Analog Section**

<b>Symbol</b>	<b>Parameter</b>	<b>Test Conditions</b>	<b>V<sub>CC</sub> V</b>	<b>V<sub>EE</sub> V</b>	<b>Guaranteed Limit</b>			<b>Unit</b>
					<b>-55 to 25°C</b>	<b>≤ 85°C</b>	<b>≤ 125°C</b>	
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 4.5 3.0	0 0 -3.0	86 37 26	108 46 33	120 55 37	Ω
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> , V <sub>IS</sub> = 2.0 V V <sub>IS</sub> = 3.0 V V <sub>IS</sub> = 2.0 V  I <sub>S</sub>   = 10 mA,	3.0 4.5 3.0	0 0 -3.0	15 2.0 10	20 2.0 15	20 2.0 15	Ω
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	4.5 3.0	0 -3.0	24 2.0	24 2.0	35 3.0	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	$V_{CC}$ V	$V_{EE}$ V	Guaranteed Limit				Unit	
					-55 to 25°C		$\leq 85^\circ\text{C}$	$\leq 125^\circ\text{C}$		
					Min	Typ*				
$t_{BBM}$	Minimum Break-Before-Make Time	$V_{IN} = V_{IL}$ or $V_{IH}$ $V_{IS} = V_{CC}$ $R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$ (Figure 19)	3.0 4.5 3.0	0.0 0.0 -3.0	1.0 1.0 1.0	6.5 5.0 3.5	- - -	- - -	ns	

\*Typical Characteristics are at 25°C.

## AC CHARACTERISTICS ( $C_L = 50\ \text{pF}$ , Input $t_r = t_f = 3$ ns)

Symbol	Parameter	$V_{CC}$ V	$V_{EE}$ V	Guaranteed Limit					Unit		
				-55 to 25°C			$\leq 85^\circ\text{C}$				
				Min	Typ	Max	Min	Max			
$t_{TRANS}$	Transition Time (Address Selection Time) (Figure 18)	2.5 3.0 4.5 3.0	0 0 0 -3.0			40 28 23 23		45 30 25 25		50 35 30 28	ns
$t_{ON}$	Turn-on Time (Figures 14, 15, 20, and 21) Enable to $N_O$ or $N_C$	2.5 3.0 4.5 3.0	0 0 0 -3.0			40 28 23 23		45 30 25 25		50 35 30 28	ns
$t_{OFF}$	Turn-off Time (Figures 14, 15, 20, and 21) Enable to $N_O$ or $N_C$	2.5 3.0 4.5 3.0	0 0 0 -3.0			40 28 23 23		45 30 25 25		50 35 30 28	ns

		Typical @ 25°C, $V_{CC} = 5.0\ \text{V}$					
$C_{IN}$	Maximum Input Capacitance, Select Inputs	8				pF	
$C_{NO}$ or $C_{NC}$	Analog I/O	10					
$C_{COM}$	Common I/O	10					
$C_{(ON)}$	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 4.5 6.0 3.0	0.0 0.0 0.0 -3.0	145 165 180 180		MHz
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 4.5 6.0 3.0	0.0 0.0 0.0 -3.0	-93 -93 -93 -93		dB
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 4.5 6.0 3.0	0.0 0.0 0.0 -3.0	-2 -2 -2 -2		dB
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 3.0	0.0 -3.0	9.0 12		pC
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 3.0	0.0 -3.0	0.10 0.05		%

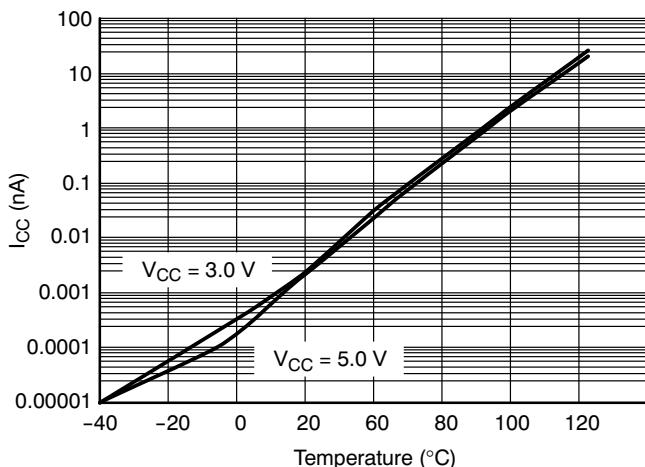


Figure 3.  $I_{CC}$  versus Temp,  $V_{CC} = 3\text{ V}$  and  $5\text{ V}$

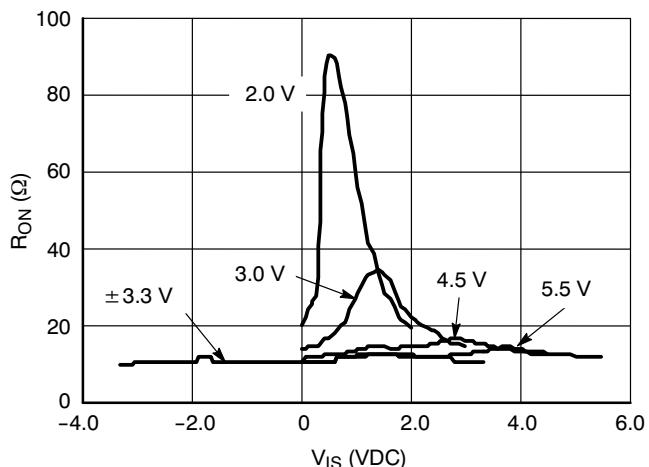


Figure 4.  $R_{ON}$  versus  $V_{CC}$ , Temp =  $25^\circ\text{C}$

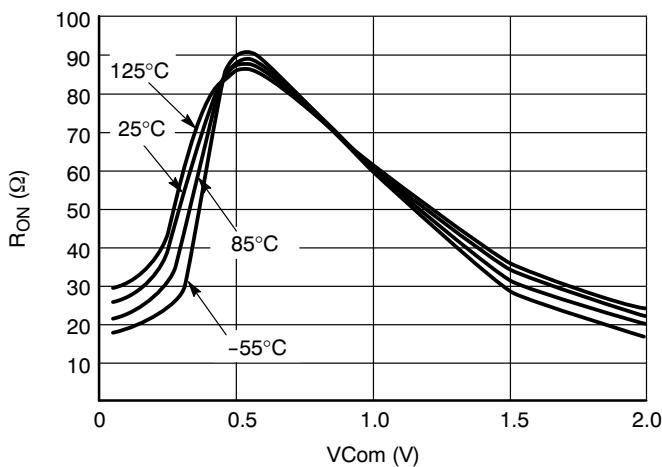


Figure 5. Typical On Resistance  
 $V_{CC} = 2.0\text{ V}$ ,  $V_{EE} = 0\text{ V}$

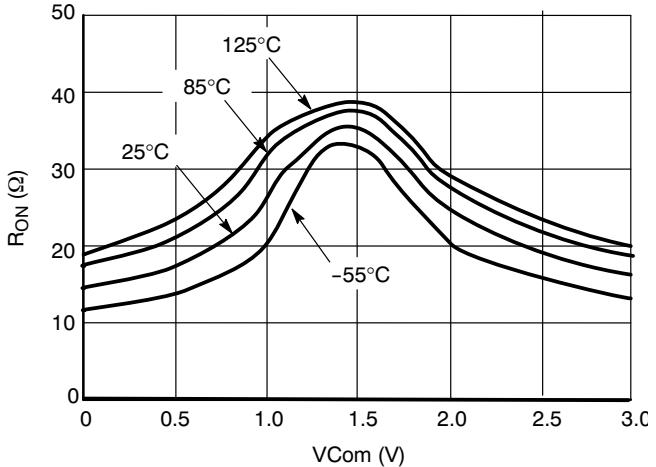


Figure 6. Typical On Resistance  
 $V_{CC} = 3.0\text{ V}$ ,  $V_{EE} = 0\text{ V}$

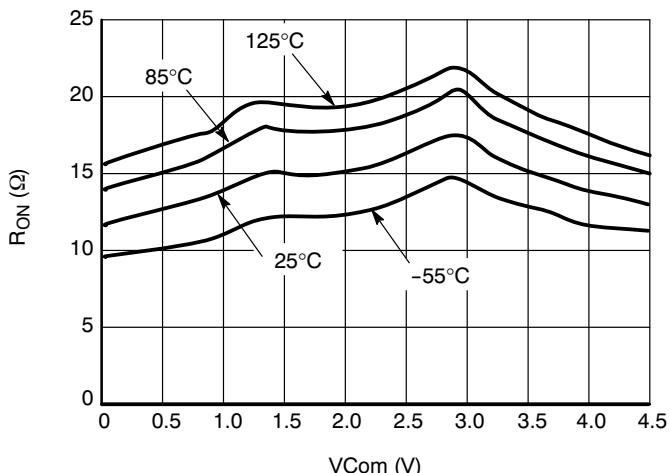


Figure 7. Typical On Resistance  
 $V_{CC} = 4.5\text{ V}$ ,  $V_{EE} = 0\text{ V}$

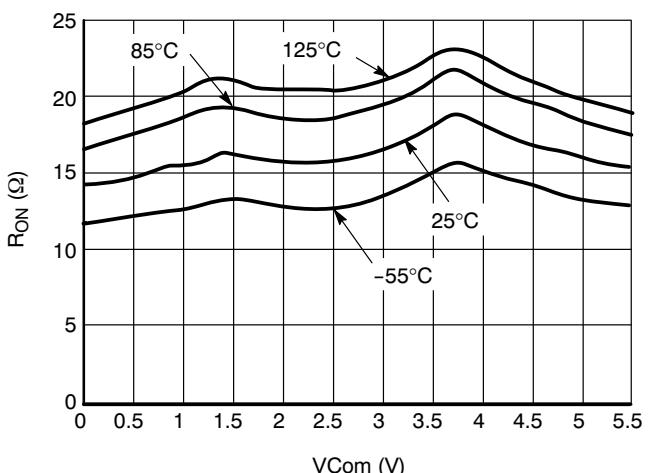
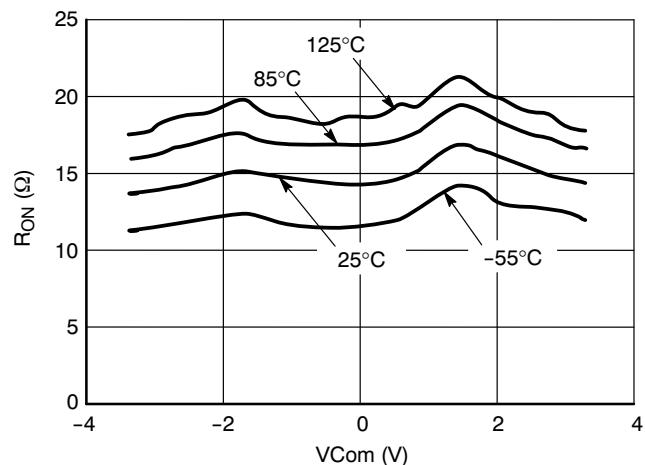
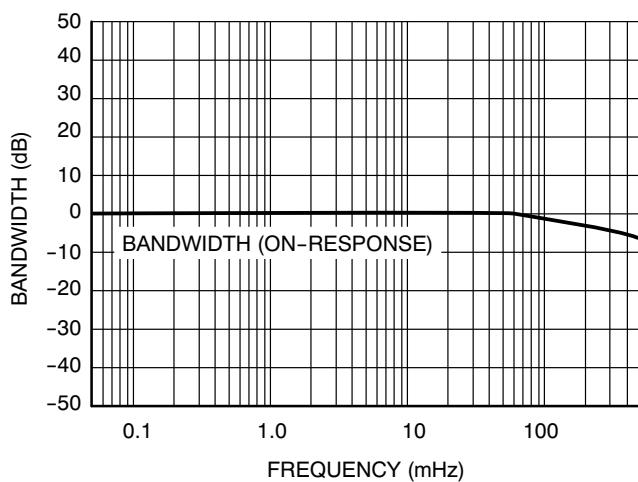


Figure 8. Typical On Resistance  
 $V_{CC} = 5.5\text{ V}$ ,  $V_{EE} = 0\text{ V}$

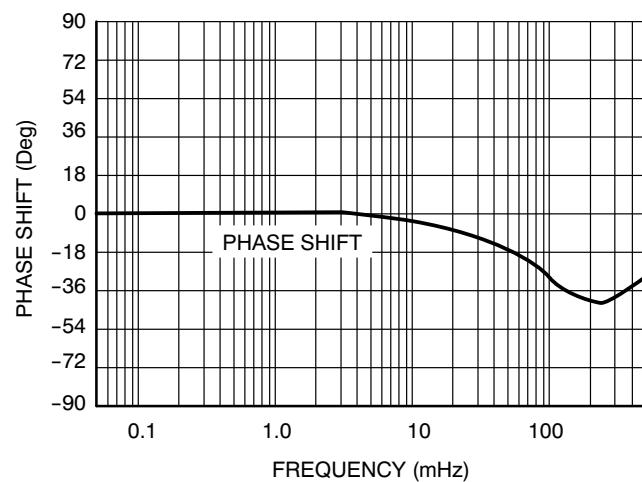
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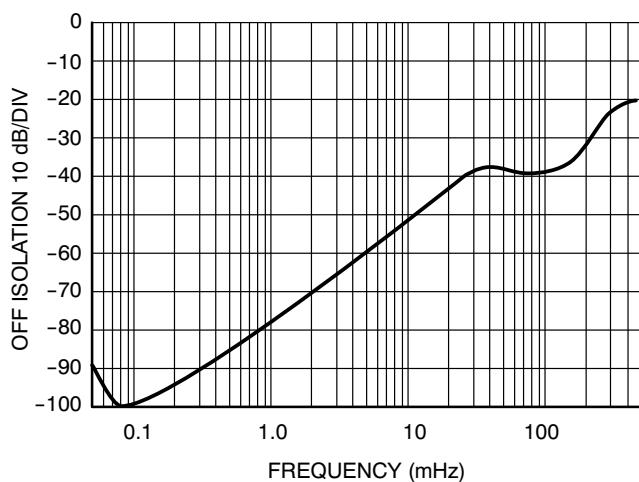
**Figure 9. Typical On Resistance**  
 $V_{CC} = 3.0$  V,  $V_{EE} = -3.0$  V



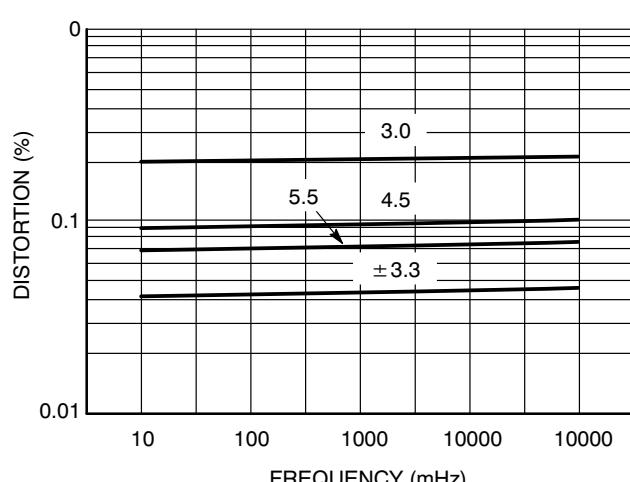
**Figure 10. Bandwidth**



**Figure 11. Phase Shift**



**Figure 12. Off Isolation**



**Figure 13. Total Harmonic Distortion**

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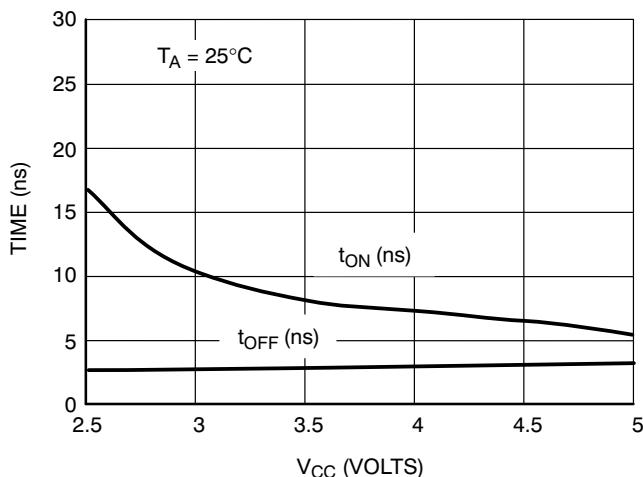


Figure 14.  $t_{ON}$  and  $t_{OFF}$  versus  $V_{CC}$

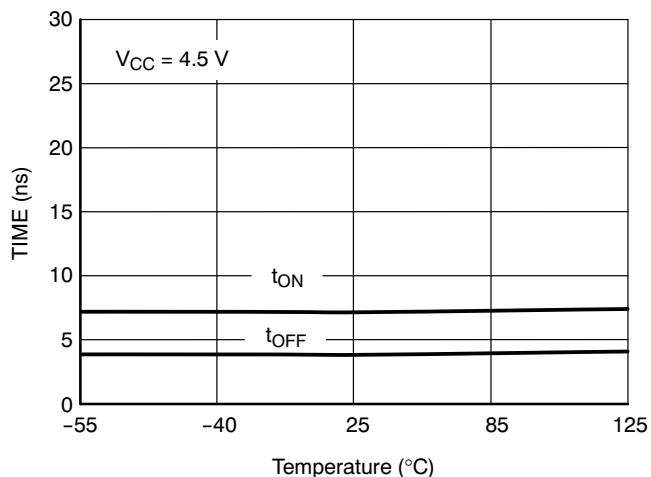


Figure 15.  $t_{ON}$  and  $t_{OFF}$  versus Temp

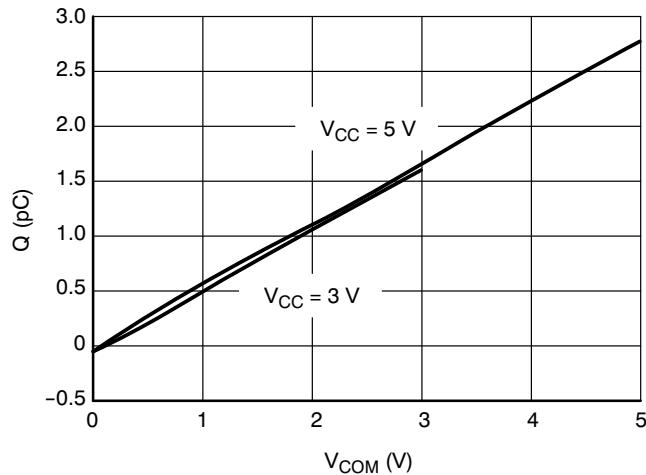


Figure 16. Charge Injection versus COM Voltage

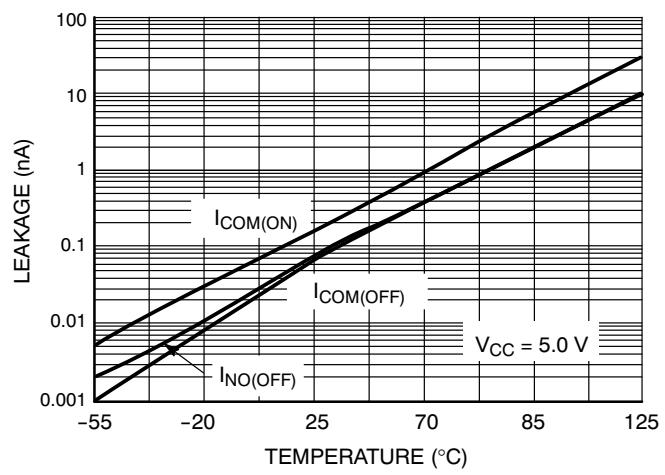


Figure 17. Switch Leakage versus Temperature

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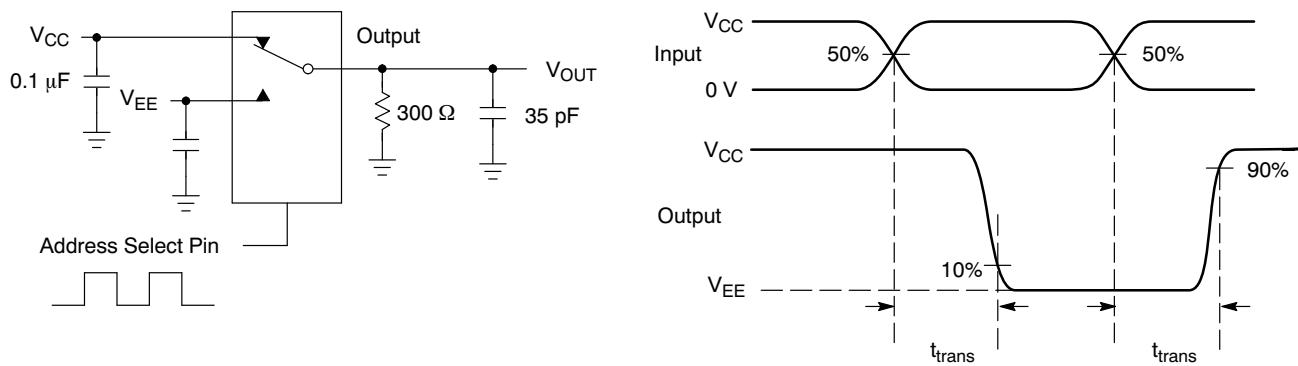


Figure 18. Channel Selection Propagation Delay

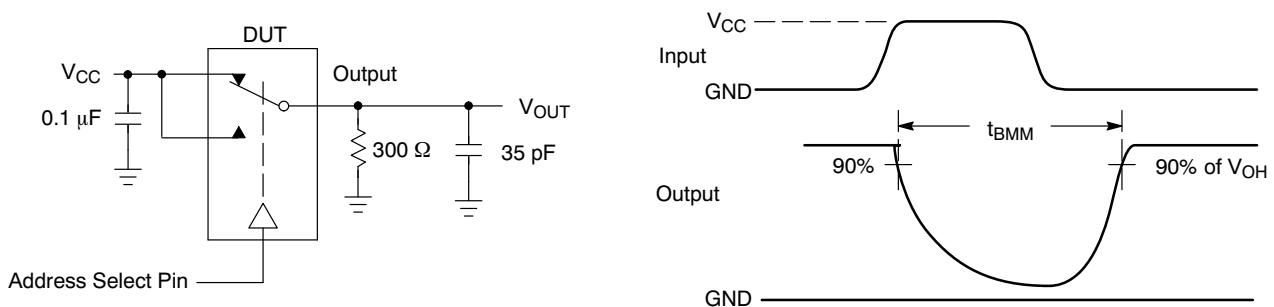


Figure 19.  $t_{BMM}$  (Time Break-Before-Make)

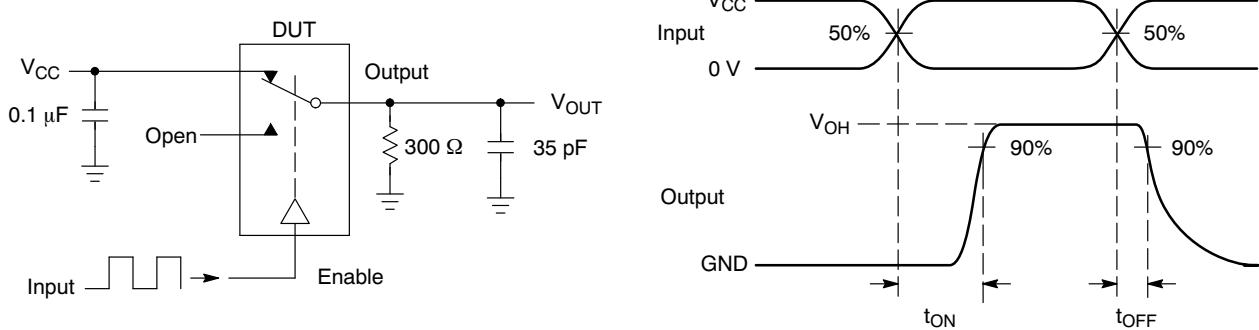


Figure 20.  $t_{ON}/t_{OFF}$

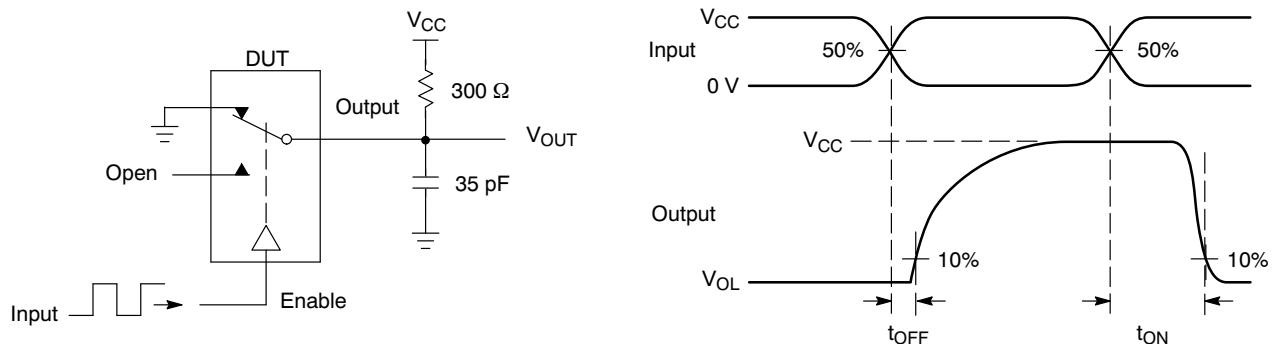
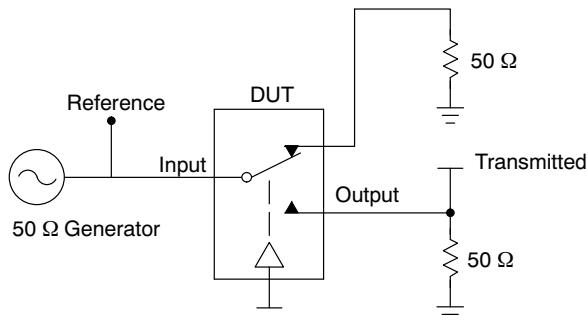


Figure 21.  $t_{ON}/t_{OFF}$



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.

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

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

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

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

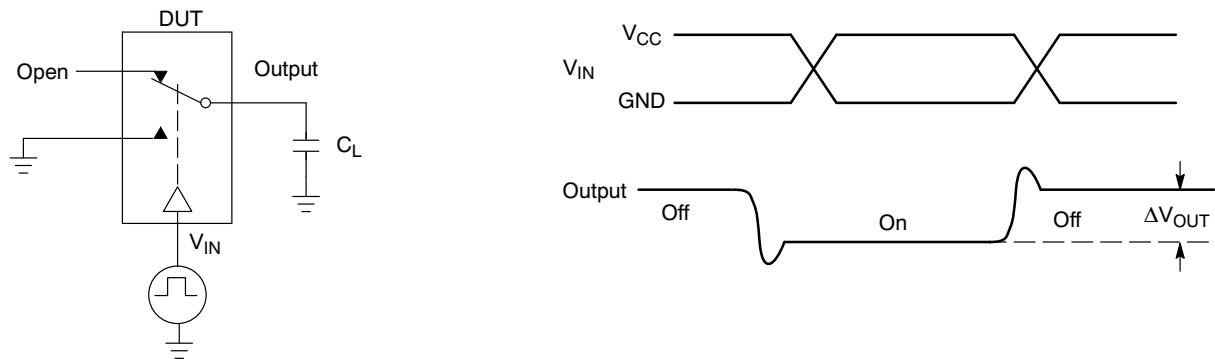


Figure 23. Charge Injection: (Q)

#### TYPICAL OPERATION

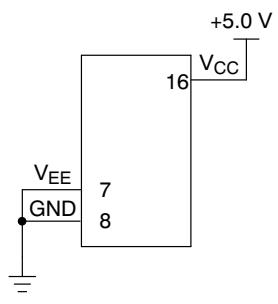


Figure 24. 5.0 Volts Single Supply  
 $V_{CC} = 5.0 \text{ V}$ ,  $V_{EE} = 0$

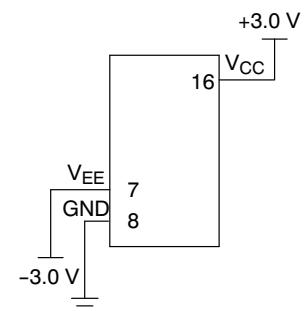


Figure 25. Dual Supply  
 $V_{CC} = 3.0 \text{ V}$ ,  $V_{EE} = -3.0 \text{ V}$

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

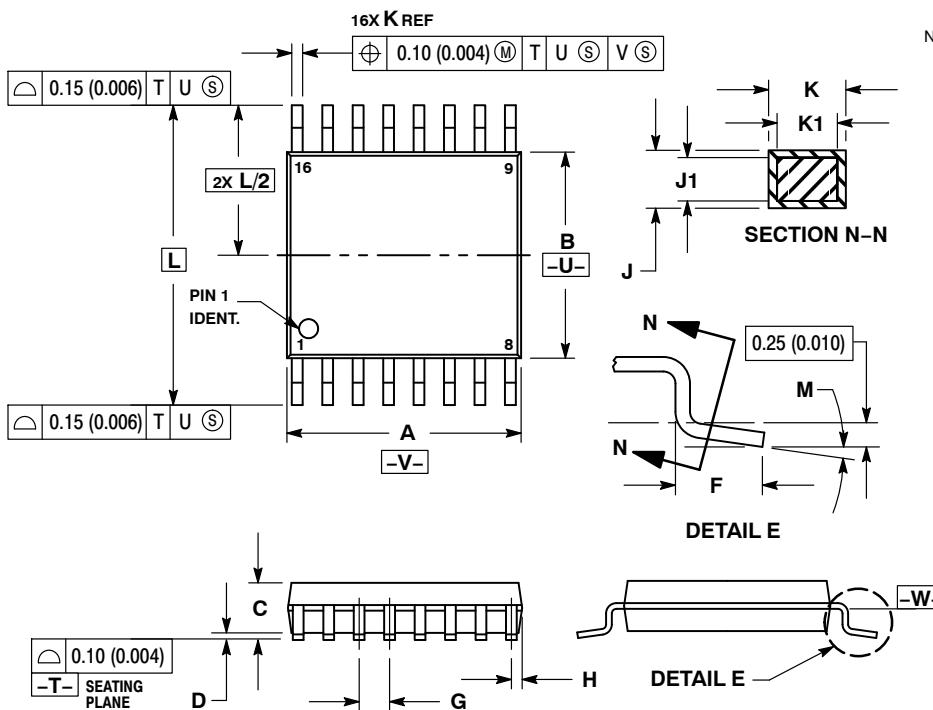
ON Semiconductor®



1  
SCALE 2:1

TSSOP-16  
CASE 948F-01  
ISSUE B

DATE 19 OCT 2006

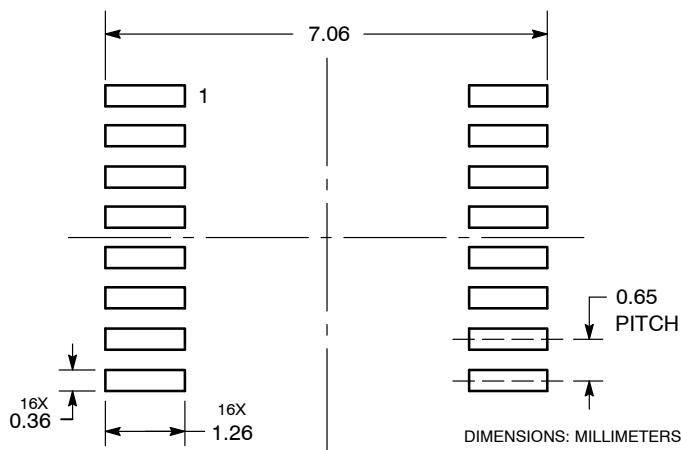


NOTES:

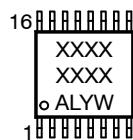
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH. PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD 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 °

### 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.

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