

# Octal Bus Buffer Inverting

The MC74VHCT540A is an advanced high speed CMOS inverting octal bus buffer fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

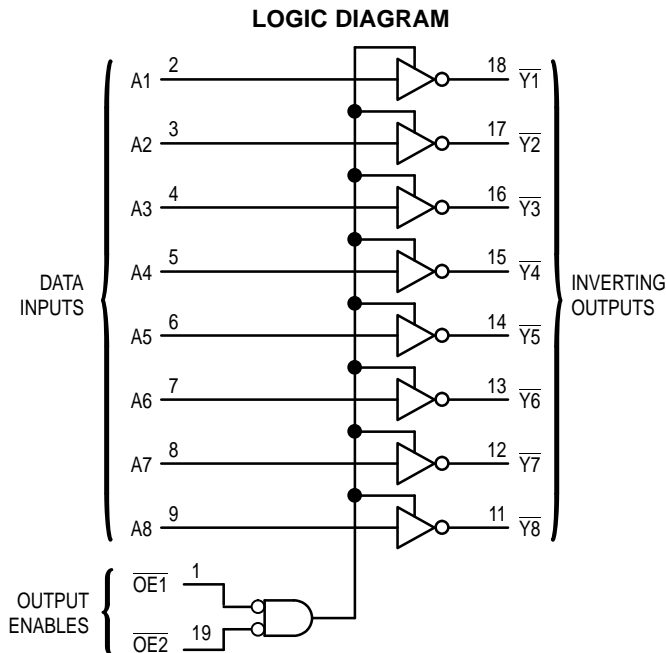
The MC74VHCT540A features inputs and outputs on opposite sides of the package and two AND-ed active-low output enables. When either  $\overline{OE1}$  or  $\overline{OE2}$  are high, the terminal outputs are in the high impedance state.

The VHCT inputs are compatible with TTL levels. This device can be used as a level converter for interfacing 3.3V to 5.0V, because it has full 5V CMOS level output swings.

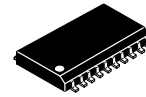
The VHCT540A input and output (when disabled) structures provide protection when voltages between 0V and 5.5V are applied, regardless of the supply voltage. These input and output structures help prevent device destruction caused by supply voltage – input/output voltage mismatch, battery backup, hot insertion, etc.

The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output. The inputs tolerate voltages up to 7V, allowing the interface of 5V systems to 3V systems.

- High Speed:  $t_{pD} = 3.7ns$  (Typ) at  $V_{CC} = 5V$
- Low Power Dissipation:  $I_{CC} = 4\mu A$  (Max) at  $T_A = 25^\circ C$
- TTL-Compatible Inputs:  $V_{IL} = 0.8V$ ;  $V_{IH} = 2.0V$
- Power Down Protection Provided on Inputs
- Balanced Propagation Delays
- Designed for 2V to 5.5V Operating Range
- Low Noise:  $V_{OLP} = 1.2V$  (Max)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 300mA
- ESD Performance: HBM > 2000V; Machine Model > 200V
- Chip Complexity: 124 FETs or 31 Equivalent Gates



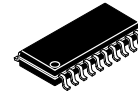
## MC74VHCT540A



**DW SUFFIX**  
20-LEAD SOIC WIDE PACKAGE  
CASE 751D-05



**DT SUFFIX**  
20-LEAD TSSOP PACKAGE  
CASE 948E-02

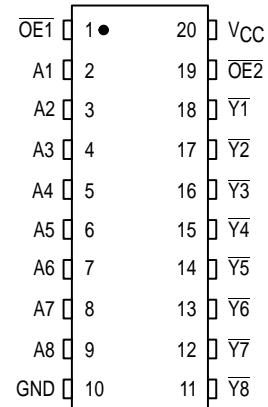


**M SUFFIX**  
20-LEAD SOIC EIAJ PACKAGE  
CASE 967-01

**ORDERING INFORMATION**

MC74VHCTXXXADW	SOIC WIDE
MC74VHCTXXXADT	TSSOP
MC74VHCTXXXAM	SOIC EIAJ

**PIN ASSIGNMENT**



**FUNCTION TABLE**

Inputs			Output $\bar{Y}$
$\overline{OE1}$	$\overline{OE2}$	A	
L	L	L	H
L	L	H	L
H	X	X	Z
X	H	X	Z



**MAXIMUM RATINGS\***

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	DC Supply Voltage	- 0.5 to + 7.0	V
V <sub>in</sub>	DC Input Voltage	- 0.5 to + 7.0	V
V <sub>out</sub>	DC Output Voltage	- 0.5 to V <sub>CC</sub> + 0.5	V
I <sub>IK</sub>	Input Diode Current	- 20	mA
I <sub>OK</sub>	Output Diode Current	± 20	mA
I <sub>out</sub>	DC Output Current, per Pin	± 25	mA
I <sub>CC</sub>	DC Supply Current, V <sub>CC</sub> and GND Pins	± 75	mA
P <sub>D</sub>	Power Dissipation in Still Air, SOIC Packages† TSSOP Package†	500 450	mW
T <sub>stg</sub>	Storage Temperature	- 65 to + 150	°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.

\* Absolute maximum continuous ratings are those values beyond which damage to the device may occur. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute-maximum-rated conditions is not implied.

†Derating — SOIC Packages: - 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>	DC Supply Voltage	4.5	5.5	V
V <sub>in</sub>	DC Input Voltage	0	5.5	V
V <sub>out</sub>	DC Output Voltage Outputs in 3-State High or Low State	0 0	5.5 V <sub>CC</sub>	V
T <sub>A</sub>	Operating Temperature	- 40	+ 85	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise and Fall Time V <sub>CC</sub> = 5.0V ± 0.5V	0	20	ns/V

**DC ELECTRICAL CHARACTERISTICS**

Symbol	Parameter	Test Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C			T <sub>A</sub> ≤ 85°C		T <sub>A</sub> ≤ 125°C		Unit
				Min	Typ	Max	Min	Max	Min	Max	
V <sub>IH</sub>	Minimum High-Level Input Voltage		3.0	1.2			1.2		1.2		V
			4.5	2.0			2.0		2.0		
			5.5	2.0			2.0		2.0		
V <sub>IL</sub>	Maximum Low-Level Input Voltage		3.0			0.53		0.53		0.53	V
			4.5			0.8		0.8		0.8	
			5.5			0.8		0.8		0.8	
V <sub>OH</sub>	Minimum High-Level Output Voltage V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = - 50µA	3.0	2.9	3.0		2.9		2.9		V
		4.5	4.4	4.5		4.4		4.4			
		V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = - 4mA	3.0	2.58			2.48		2.34		
		4.5	3.94			3.80		3.66			
V <sub>OL</sub>	Maximum Low-Level Output Voltage V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OL</sub> = 50µA	3.0		0.0	0.1		0.1		0.1	V
		4.5		0.0	0.1		0.1		0.1		
		V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OL</sub> = 4mA	3.0			0.36		0.44		0.52	
		4.5			0.36		0.44		0.52		
I <sub>IN</sub>	Maximum Input Leakage Current	V <sub>in</sub> = 5.5 V or GND	0 to 5.5			± 0.1		± 1.0		± 1.0	µA
I <sub>CC</sub>	Maximum Quiescent Supply Current	V <sub>in</sub> = V <sub>CC</sub> or GND	5.5			2.0		20		40	µA
I <sub>CC</sub> T	Quiescent Supply Current	Input: V <sub>IN</sub> = 3.4V	5.5			1.35		1.50		1.65	mA
I <sub>OPD</sub>	Output Leakage Current	V <sub>OUT</sub> = 5.5V	0.0			0.5		5.0		10	µA

**AC ELECTRICAL CHARACTERISTICS** (Input  $t_r = t_f = 3.0\text{ns}$ )

Symbol	Parameter	Test Conditions	$T_A = 25^\circ\text{C}$			$T_A = -40 \text{ to } 85^\circ\text{C}$		$T_A \leq 125^\circ\text{C}$		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$t_{PLH}$ , $t_{PHL}$	Maximum Propagation Delay, A to $\bar{Y}$ (Figures 1 and 3)	$V_{CC} = 3.3 \pm 0.3\text{V}$ $C_L = 15\text{pF}$		4.8	7.0	1.0	8.5		10.5	ns
		$C_L = 50\text{pF}$		7.3	10.5	1.0	12.0		14.0	
		$V_{CC} = 5.0 \pm 0.5\text{V}$ $C_L = 15\text{pF}$		3.7	5.0	1.0	6.0		8.0	
		$C_L = 50\text{pF}$		5.2	7.0	1.0	8.0		10.0	
$t_{PZL}$ , $t_{PZH}$	Output Enable Time, $\bar{O}E_n$ to $\bar{Y}$ (Figures 2 and 4)	$V_{CC} = 3.3 \pm 0.3\text{V}$ $C_L = 15\text{pF}$		6.8	10.5	1.0	12.5		15.0	ns
		$R_L = 1\text{k}\Omega$ $C_L = 50\text{pF}$		9.3	14.0	1.0	16.0		19.0	
		$V_{CC} = 5.0 \pm 0.5\text{V}$ $C_L = 15\text{pF}$		4.7	7.2	1.0	8.5		10.5	
		$R_L = 1\text{k}\Omega$ $C_L = 50\text{pF}$		6.2	9.2	1.0	10.5		13.0	
$t_{PLZ}$ , $t_{PHZ}$	Output Disable Time, $\bar{O}E_n$ to $\bar{Y}$ (Figures 2 and 4)	$V_{CC} = 3.3 \pm 0.3\text{V}$ $C_L = 50\text{pF}$		11.2	15.4	1.0	17.5		20.0	ns
		$R_L = 1\text{k}\Omega$								
		$V_{CC} = 5.0 \pm 0.5\text{V}$ $C_L = 50\text{pF}$		6.0	8.8	1.0	10.0		11.5	
		$R_L = 1\text{k}\Omega$								
$t_{OSLH}$ , $t_{OSHL}$	Output to Output Skew	$V_{CC} = 3.3 \pm 0.3\text{V}$ $C_L = 50\text{pF}$			1.5		1.5		2.0	ns
		(Note 1.)								
		$V_{CC} = 5.0 \pm 0.5\text{V}$ $C_L = 50\text{pF}$			1.0		1.0		1.5	ns
		(Note 1.)								
$C_{in}$	Maximum Input Capacitance			4	10		10		10	pF
$C_{out}$	Maximum Three-State Output Capacitance (Output in High Impedance State)			6						pF

$C_{PD}$	Power Dissipation Capacitance (Note 2.)	Typical @ $25^\circ\text{C}$ , $V_{CC} = 5.0\text{V}$		pF
			17	

- Parameter guaranteed by design.  $t_{OSLH} = |t_{PLHm} - t_{PLHn}|$ .  $t_{OSHL} = |t_{PHLm} - t_{PHLn}|$ .
- $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation:  $I_{CC(OPR)} = C_{PD} \cdot V_{CC} \cdot f_{in} + I_{CC}/8$  (per bit).  $C_{PD}$  is used to determine the no-load dynamic power consumption;  $P_D = C_{PD} \cdot V_{CC}^2 \cdot f_{in} + I_{CC} \cdot V_{CC}$ .

**NOISE CHARACTERISTICS** (Input  $t_r = t_f = 3.0\text{ns}$ ,  $C_L = 50\text{pF}$ ,  $V_{CC} = 5.0\text{V}$ )

Symbol	Parameter	$T_A = 25^\circ\text{C}$		Unit
		Typ	Max	
$V_{OLP}$	Quiet Output Maximum Dynamic $V_{OL}$	0.9	1.2	V
$V_{OLV}$	Quiet Output Minimum Dynamic $V_{OL}$	-0.9	-1.2	V
$V_{IHD}$	Minimum High Level Dynamic Input Voltage		3.5	V
$V_{ILD}$	Maximum Low Level Dynamic Input Voltage		1.5	V

SWITCHING WAVEFORMS

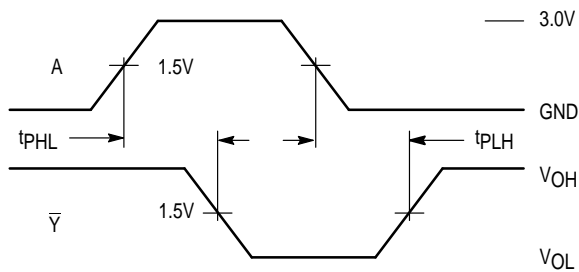


Figure 1.

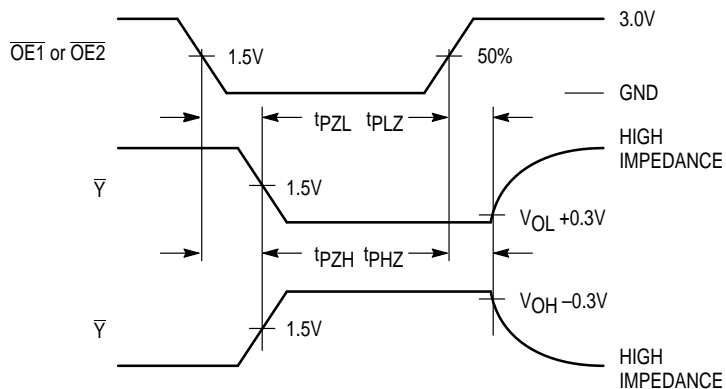
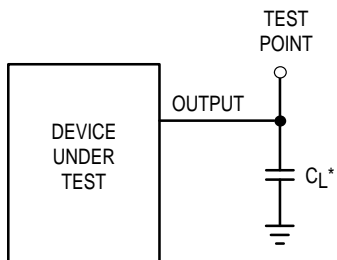


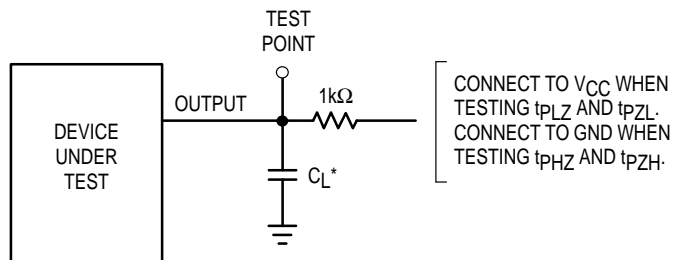
Figure 2.

TEST CIRCUITS



\*Includes all probe and jig capacitance

Figure 3.

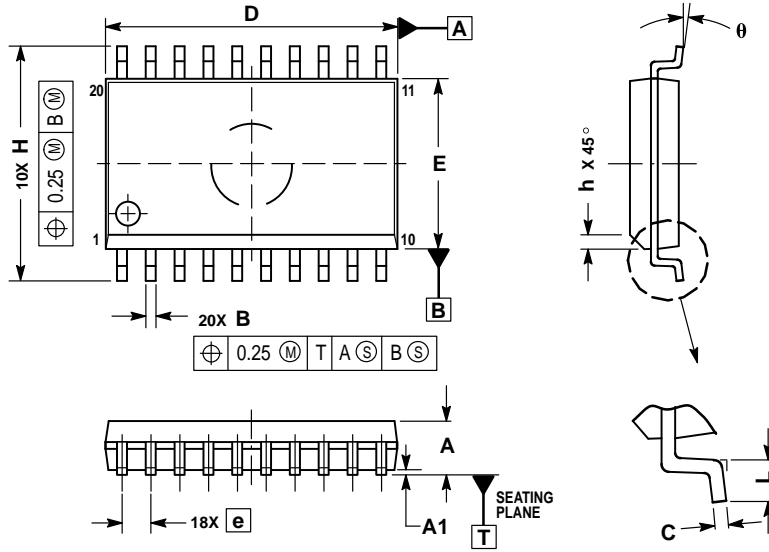


\*Includes all probe and jig capacitance

Figure 4.

OUTLINE DIMENSIONS

DW SUFFIX  
 PLASTIC SOIC WIDE PACKAGE  
 CASE 751D-05  
 ISSUE F

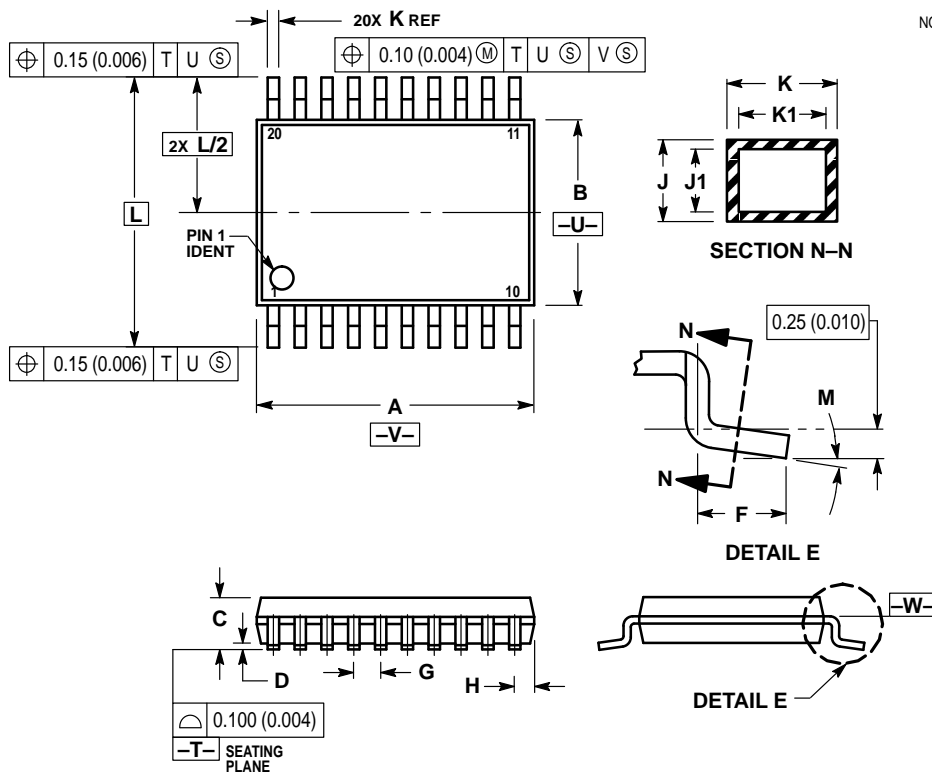


- NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
  3. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
  5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF B DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS	
	MIN	MAX
A	2.35	2.65
A1	0.10	0.25
B	0.35	0.49
C	0.23	0.32
D	12.65	12.95
E	7.40	7.60
e	1.27 BSC	
H	10.05	10.55
h	0.25	0.75
L	0.50	0.90
theta	0°	7°

OUTLINE DIMENSIONS

DT SUFFIX  
 PLASTIC TSSOP PACKAGE  
 CASE 948E-02  
 ISSUE A



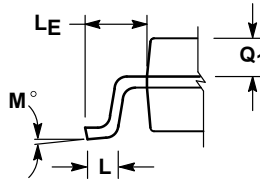
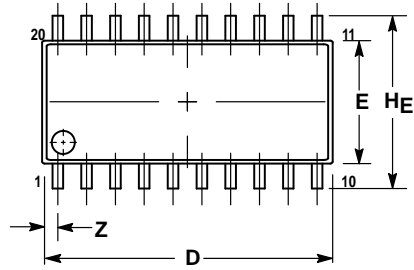
NOTES:

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-.

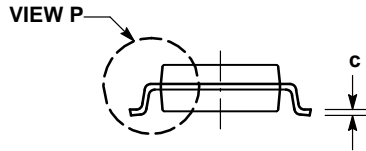
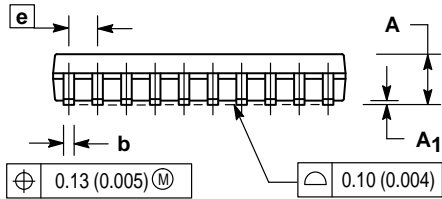
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.40	6.60	0.252	0.260
B	4.30	4.50	0.169	0.177
C	—	1.20	—	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.27	0.37	0.011	0.015
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

OUTLINE DIMENSIONS

M SUFFIX  
 PLASTIC SOIC EIAJ PACKAGE  
 CASE 967-01  
 ISSUE O




DETAIL P



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	—	2.05	—	0.081
A <sub>1</sub>	0.05	0.20	0.002	0.008
b	0.35	0.50	0.014	0.020
c	0.18	0.27	0.007	0.011
D	12.35	12.80	0.486	0.504
E	5.10	5.45	0.201	0.215
e	1.27 BSC		0.050 BSC	
H <sub>E</sub>	7.40	8.20	0.291	0.323
L	0.50	0.85	0.020	0.033
L <sub>E</sub>	1.10	1.50	0.043	0.059
M	0°	10°	0°	10°
Q <sub>1</sub>	0.70	0.90	0.028	0.035
Z	—	0.81	—	0.032

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