

# MC74VHCT139A

## Product Preview

### Dual 2-to-4 Decoder/ Demultiplexer

The MC74VHCT139A is an advanced high speed CMOS 2-to-4 decoder/demultiplexer fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL devices while maintaining CMOS low power dissipation.

When the device is enabled ( $\bar{E} = \text{low}$ ), it can be used for gating or as a data input for demultiplexing operations. When the enable input is held high, all four outputs are fixed high, independent of other inputs.

The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output.

The device output is compatible with TTL-type input thresholds and the output has a full 5 V CMOS level output swing. The input protection circuitry on this device allows overvoltage tolerance on the input, allowing the device to be used as a logic-level translator from 3.0 V CMOS logic to 5.0 V CMOS logic, or from 1.8 V CMOS logic to 3.0 V CMOS logic while operating at the high-voltage power supply

The MC74VHCT139A input structure provides protection when voltages up to 7 V are applied, regardless of the supply voltage. This allows the MC74VHCT139A to be used to interface 5 V circuits to 3 V circuits. The output structures also provide protection when  $V_{CC} = 0$  V. These input and output structures help prevent device destruction caused by supply voltage—input/output voltage mismatch, battery backup, hot insertion, etc.

- High Speed:  $t_{PD} = 5.0\text{ns}$  (Typ) at  $V_{CC} = 5\text{V}$
- Low Power Dissipation:  $I_{CC} = 4\mu\text{A}$  (Max) at  $T_A = 25^\circ\text{C}$
- TTL-Compatible Inputs:  $V_{IL} = 0.8\text{V}$ ;  $V_{IH} = 2.0\text{V}$
- Power Down Protection Provided on Inputs and Outputs
- Balanced Propagation Delays
- Designed for 2V to 5.5V Operating Range
- Low Noise:  $V_{OLP} = 0.8\text{V}$  (Max)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 300mA
- ESD Performance: HBM > 2000V; Machine Model > 200V
- Chip Complexity: 100 FETs or 25 Equivalent Gates

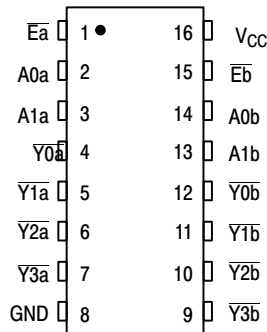
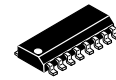


Figure 1. Pin Assignment



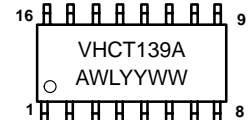
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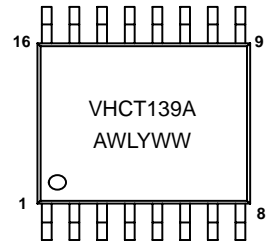


SOIC-16  
D SUFFIX  
CASE 751B

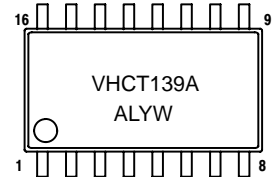
#### MARKING DIAGRAMS



TSSOP-16  
DT SUFFIX  
CASE 948F



SOIC EIAJ-16  
M SUFFIX  
CASE 966



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

#### ORDERING INFORMATION

Device	Package	Shipping
MC74VHCT139AD	SOIC-16	48 Units/Rail
MC74VHCT139ADR2	SOIC-16	2500 Units/Reel
MC74VHCT139ADT	TSSOP-16	96 Units/Rail
MC74VHCT139ADTR2	TSSOP-16	2000 Units/Reel
MC74VHCT139AM	SOIC EIAJ-16	48 Units/Rail
MC74VHCT139AMEL	SOIC EIAJ-16	2000 Units/Reel

# MC74VHCT139A

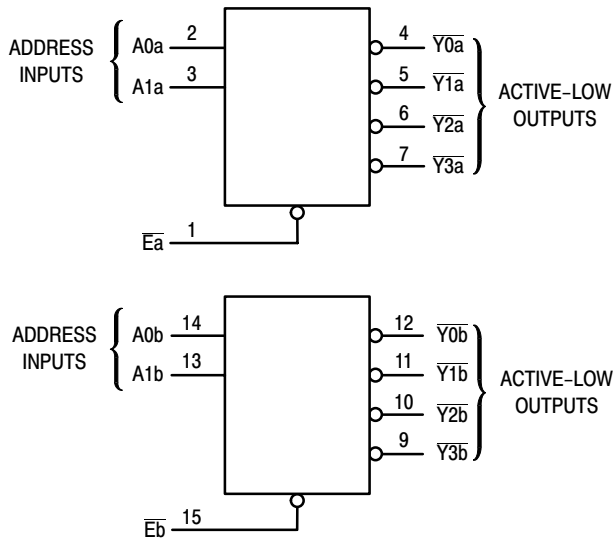


Figure 2. Logic Diagram

FUNCTION TABLE

Inputs			Outputs			
$\bar{E}$	A1	A0	Y0	Y1	Y2	Y3
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	L	H	H	L	H	H
L	H	L	H	H	L	H
L	H	H	H	H	H	L

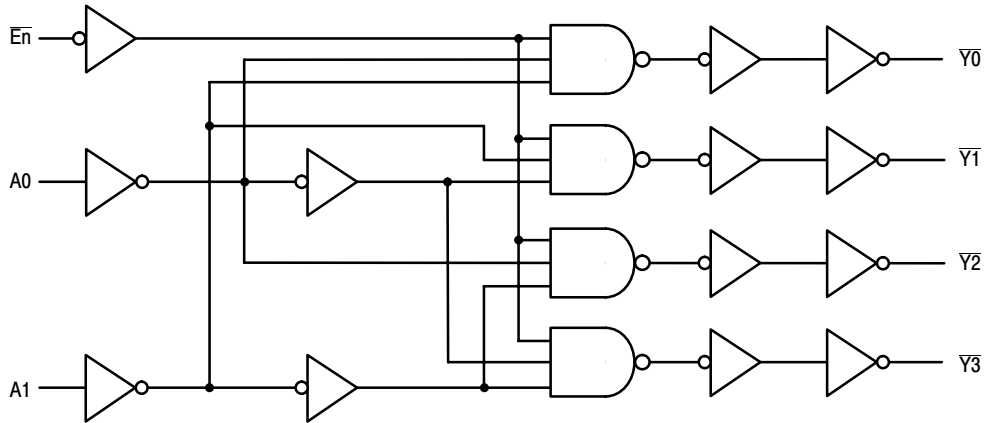


Figure 3. Expanded Logic Diagram  
(1/2 of Device)

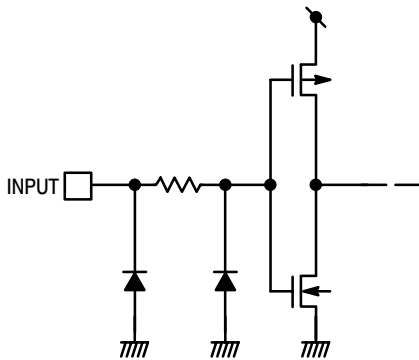


Figure 4. Input Equivalent Circuit

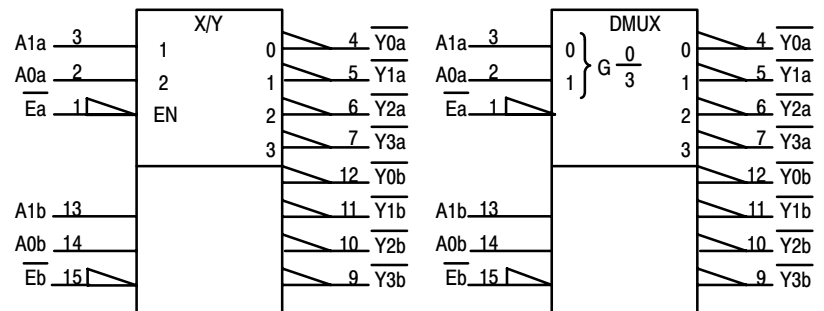


Figure 5. IEC Logic Diagram

# MC74VHCT139A

## MAXIMUM RATINGS (Note 1.)

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Positive DC Supply Voltage	-0.5 to +7.0	V
V <sub>IN</sub>	Digital Input Voltage	-0.5 to +7.0	V
V <sub>OUT</sub>	DC Output Voltage	Output in 3-State High or Low State -0.5 to +7.0 -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 Package TSSOP 200 180	mW
T <sub>STG</sub>	Storage Temperature Range	-65 to +150	°C
V <sub>ESD</sub>	ESD Withstand Voltage	Human Body Model (Note 2.) Machine Model (Note 3.) Charged Device Model (Note 4.) >2000 >200 >2000	V
I <sub>LATCH-UP</sub>	Latch-Up Performance	Above V <sub>CC</sub> and Below GND at 125°C (Note 5.)	± 300 mA
θ <sub>JA</sub>	Thermal Resistance, Junction to Ambient	SOIC Package TSSOP 143 164	°C/W

1. Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.
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	Characteristics	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	Output in 3-State High or Low State 0 0	5.5 V <sub>CC</sub>	V
T <sub>A</sub>	Operating Temperature Range, all Package Types	-55	125	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise or Fall Time	V <sub>CC</sub> = 5.0 V ± 0.5 V	0	20 ns/V

## DEVICE JUNCTION TEMPERATURE VERSUS TIME TO 0.1% BOND FAILURES

Junction Temperature °C	Time, Hours	Time, Years
80	1,032,200	117.8
90	419,300	47.9
100	178,700	20.4
110	79,600	9.4
120	37,000	4.2
130	17,800	2.0
140	8,900	1.0

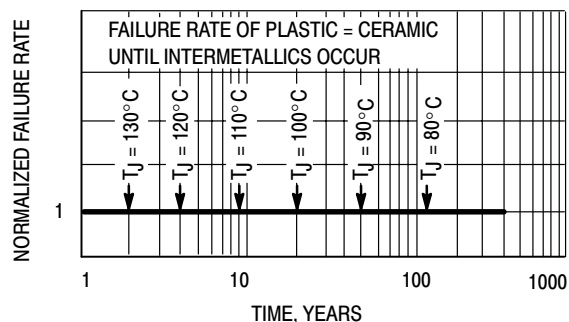


Figure 6. Failure Rate vs. Time Junction Temperature

# MC74VHCT139A

## DC CHARACTERISTICS (Voltages Referenced to GND)

Symbol	Parameter	Condition	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C			T <sub>A</sub> ≤ 85°C		T <sub>A</sub> = -55 to 125°C		Unit
				Min	Typ	Max	Min	Max	Min	Max	
V <sub>IH</sub>	Minimum High-Level Input Voltage		4.5 to 5.5	2			2		2		V
V <sub>IL</sub>	Maximum Low-Level Input Voltage		4.5 to 5.5			0.8		0.8		0.8	V
V <sub>OH</sub>	Maximum High-Level Output Voltage	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = -50 μA	4.5	4.4	4.5		4.4		4.4		V
		V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = -8 mA	4.5	3.94			3.8		3.66		V
V <sub>OL</sub>	Maximum Low-Level Output Voltage	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OL</sub> = 50 μA	4.5		0	0.1		0.1		0.1	V
		V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = 8 mA	4.5			0.36		0.44		0.52	V
I <sub>IN</sub>	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			4.0		40.0		40.0	μA
I <sub>CCT</sub>	Additional Quiescent Supply Current (per Pin)	Any one input: V <sub>IN</sub> = 3.4 V All other inputs: V <sub>IN</sub> = V <sub>CC</sub> or GND	5.5			1.35		1.5		1.5	μA
I <sub>OPD</sub>	Output Leakage Current	V <sub>OUT</sub> = 5.5 V	0			0.5		5		5	μA

## AC ELECTRICAL CHARACTERISTICS (Input t<sub>r</sub> = t<sub>f</sub> = 3.0ns)

Symbol	Parameter	Test Conditions	T <sub>A</sub> = 25°C			T <sub>A</sub> ≤ 85°C		T <sub>A</sub> = -55 to 125°C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, A to Y	V <sub>CC</sub> = 3.3 ± 0.3 V C <sub>L</sub> = 15 pF		7.2	11.0	1.0	13.0	1.0	13.0	ns
		V <sub>CC</sub> = 5.0 ± 0.5 V C <sub>L</sub> = 50 pF		9.7	14.5	1.0	16.5	1.0	16.5	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, E to Y	V <sub>CC</sub> = 3.3 ± 0.3 V C <sub>L</sub> = 15 pF		6.4	9.2	1.0	11.0	1.0	11.0	ns
		V <sub>CC</sub> = 5.0 ± 0.5 V C <sub>L</sub> = 50 pF		8.9	12.7	1.0	14.5	1.0	14.5	
C <sub>IN</sub>	Maximum Input Capacitance	V <sub>CC</sub> = 3.3 ± 0.3 V C <sub>L</sub> = 15 pF		4.4	6.3	1.0	7.5	1.0	7.5	pF
		V <sub>CC</sub> = 5.0 ± 0.5 V C <sub>L</sub> = 50 pF		5.9	8.3	1.0	9.5	1.0	9.5	

C <sub>PD</sub>	Power Dissipation Capacitance (Note 6.)	<b>Typical @ 25°C, V<sub>CC</sub> = 5.0V</b>	pF
		26	

6. C<sub>PD</sub> 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<sub>CC(OPR)</sub> = C<sub>PD</sub> • V<sub>CC</sub> • f<sub>in</sub> + I<sub>CC</sub>/2 (per decoder). C<sub>PD</sub> is 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<sub>in</sub> + I<sub>CC</sub> • V<sub>CC</sub>.

# MC74VHCT139A

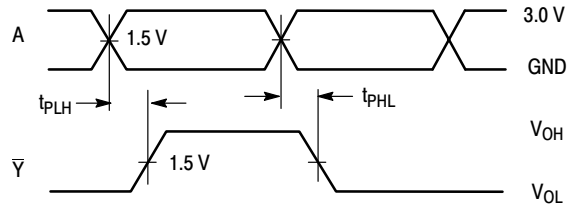


Figure 7. Switching Waveform

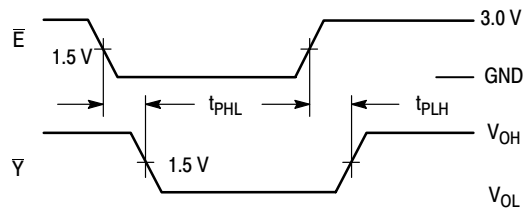
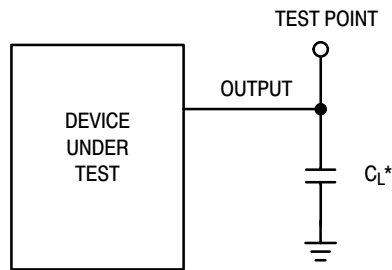


Figure 8. Switching Waveform



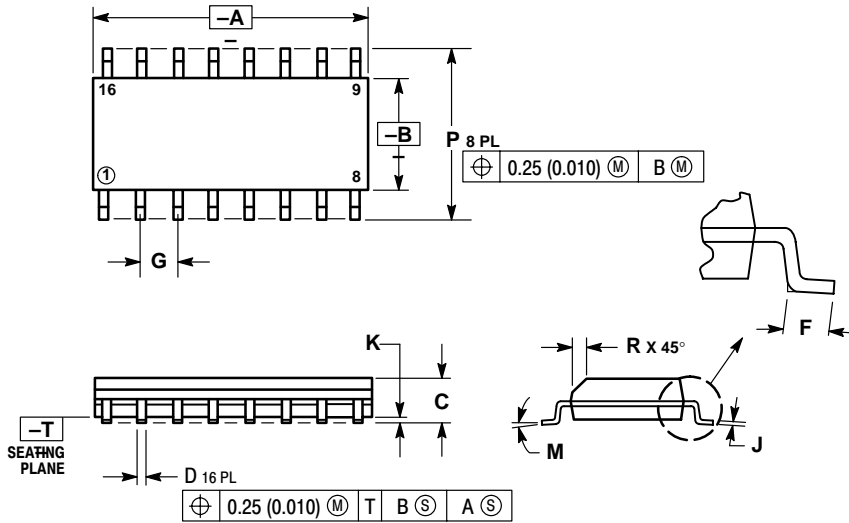
\*Includes all probe and jig capacitance

Figure 9. Test Circuit

# MC74VHCT139A

## PACKAGE DIMENSIONS

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

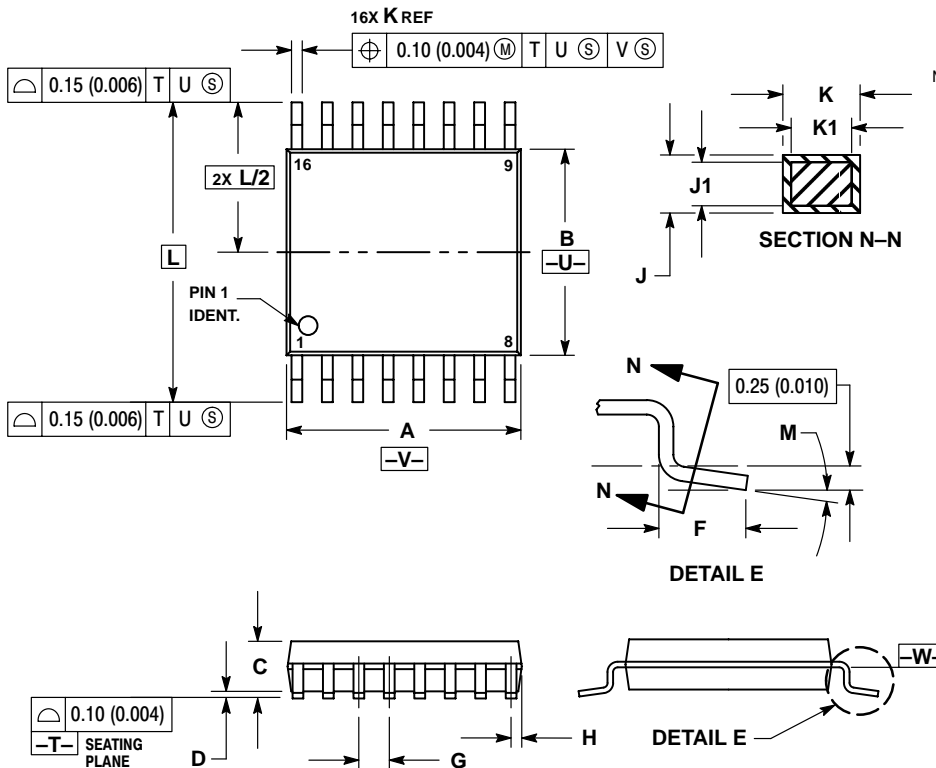


**NOTES:**

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

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



**NOTES:**

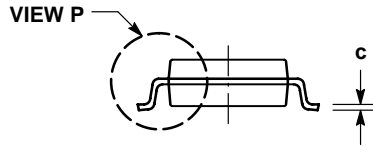
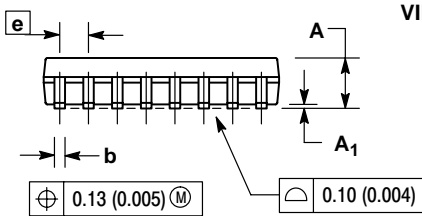
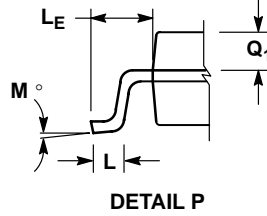
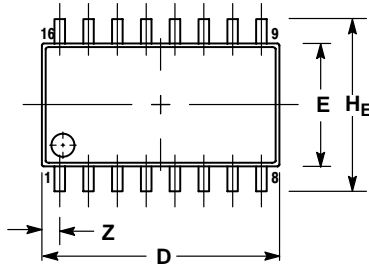
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OF GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD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

# MC74VHCT139A

## PACKAGE DIMENSIONS


SOIC EIAJ-16  
M SUFFIX  
CASE 966-01  
ISSUE O



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	9.90	10.50	0.390	0.413
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>F</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	---	0.78	---	0.031

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