

# MC74VHCT86A

## Quad 2-Input XOR Gate / CMOS Logic Level Shifter with LSTTL-Compatible Inputs

The MC74VHCT86A is an advanced high speed CMOS 2-input Exclusive-OR gate fabricated with silicon gate CMOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining CMOS low power dissipation.

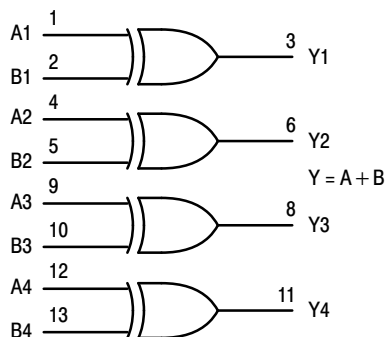
The internal circuit is composed of three stages, including a buffer output which provides high noise immunity and stable output.

The device input 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 MC74VHCT86A input structure provides protection when voltages up to 7 V are applied, regardless of the supply voltage. This allows it 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.

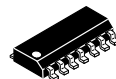
- High Speed:  $t_{PD} = 4.8$  ns (Typ) at  $V_{CC} = 5$  V
- Low Power Dissipation:  $I_{CC} = 2$   $\mu$ A (Max) at  $T_A = 25^\circ$ C
- TTL-Compatible Inputs:  $V_{IL} = 0.8$  V;  $V_{IH} = 2.0$  V
- Power Down Protection Provided on Inputs and Outputs
- Balanced Propagation Delays
- Designed for 2 V to 5.5 V Operating Range
- Low Noise:  $V_{OLP} = 0.8$  V (Max)
- Pin and Function Compatible with Other Standard Logic Families
- Latchup Performance Exceeds 300 mA
- ESD Performance: HBM > 2000 V; Machine Model > 200 V
- These Devices are Pb-Free and are RoHS Compliant

### LOGIC DIAGRAM

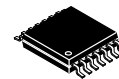


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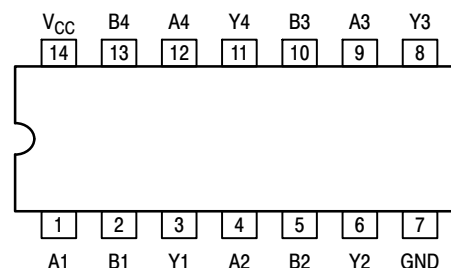


**14-LEAD SOIC  
D SUFFIX  
CASE 751A**



**14-LEAD TSSOP  
DT SUFFIX  
CASE 948G**

### PIN CONNECTION AND MARKING DIAGRAM (Top View)



For detailed package marking information, see the Marking Diagram section on page 4 of this data sheet.

### FUNCTION TABLE

| Inputs |   | Output |
|--------|---|--------|
| A      | B | Y      |
| L      | L | L      |
| L      | H | H      |
| H      | L | H      |
| H      | H | L      |

### ORDERING INFORMATION

| Device           | Package               | Shipping              |
|------------------|-----------------------|-----------------------|
| MC74VHCT86ADR2G  | SOIC-14<br>(Pb-Free)  | 2500 / Tape &<br>Reel |
| MC74VHCT86ADTR2G | TSSOP-14<br>(Pb-Free) | 2500 / Tape &<br>Reel |

# MC74VHCT86A

## MAXIMUM RATINGS

| Symbol    | Parameter                                                          | Value                                     | Unit |
|-----------|--------------------------------------------------------------------|-------------------------------------------|------|
| $V_{CC}$  | DC Supply Voltage                                                  | – 0.5 to + 7.0                            | V    |
| $V_{in}$  | DC Input Voltage                                                   | – 0.5 to + 7.0                            | V    |
| $V_{out}$ | DC Output Voltage<br>$V_{CC} = 0$<br>High or Low State             | – 0.5 to + 7.0<br>– 0.5 to $V_{CC} + 0.5$ | V    |
| $I_{IK}$  | Input Diode Current                                                | – 20                                      | mA   |
| $I_{OK}$  | Output Diode Current ( $V_{OUT} < GND$ ; $V_{OUT} > V_{CC}$ )      | ± 20                                      | mA   |
| $I_{out}$ | DC Output Current, per Pin                                         | ± 25                                      | mA   |
| $I_{CC}$  | DC Supply Current, $V_{CC}$ and GND Pins                           | ± 50                                      | mA   |
| $P_D$     | Power Dissipation in Still Air,<br>SOIC Package†<br>TSSOP Package† | 500<br>450                                | mW   |
| $T_{stg}$ | 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,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $GND \leq (V_{in} \text{ or } V_{out}) \leq V_{CC}$ . Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or  $V_{CC}$ ). Unused outputs must be left open.

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.

†Derating — SOIC Package: – 7 mW/°C from 65° to 125°C  
TSSOP Package: – 6.1 mW/°C from 65° to 125°C

## RECOMMENDED OPERATING CONDITIONS

| Characteristics                                                                  | Symbol     | Min        | Max             | Unit |
|----------------------------------------------------------------------------------|------------|------------|-----------------|------|
| DC Supply Voltage                                                                | $V_{CC}$   | 2.0        | 5.5             | V    |
| DC Input Voltage                                                                 | $V_{IN}$   | 0.0        | 5.5             | V    |
| DC Output Voltage<br>$V_{CC} = 0$<br>High or Low State                           | $V_{OUT}$  | 0.0<br>0.0 | 5.5<br>$V_{CC}$ | V    |
| Operating Temperature Range                                                      | $T_A$      | –55        | +85             | °C   |
| Input Rise and Fall Time<br>$V_{CC} = 3.3V \pm 0.3V$<br>$V_{CC} = 5.0V \pm 0.5V$ | $t_r, t_f$ | 0<br>0     | 100<br>20       | ns/V |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

## NOISE CHARACTERISTICS (Input $t_r = t_f = 3.0ns$ , $C_L = 50pF$ , $V_{CC} = 5.0V$ , Measured in SOIC Package)

| Symbol    | Characteristic                           | $T_A = 25^\circ C$ |       | Unit |
|-----------|------------------------------------------|--------------------|-------|------|
|           |                                          | Typ                | Max   |      |
| $V_{OLP}$ | Quiet Output Maximum Dynamic $V_{OL}$    | 0.3                | 0.8   | V    |
| $V_{OLV}$ | Quiet Output Minimum Dynamic $V_{OL}$    | – 0.3              | – 0.8 | V    |
| $V_{IHD}$ | Minimum High Level Dynamic Input Voltage |                    | 3.5   | V    |
| $V_{ILD}$ | Maximum Low Level Dynamic Input Voltage  |                    | 1.5   | V    |

# MC74VHCT86A

## DC ELECTRICAL CHARACTERISTICS

| Symbol            | Parameter                                                                                 | Test Conditions                                                                 | V <sub>CC</sub><br>(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<br>4.5<br>5.5      | 1.2<br>2.0<br>2.0     |            |                    | 1.2<br>2.0<br>2.0     |                    | 1.2<br>2.0<br>2.0      |                    | V    |
| V <sub>IL</sub>   | Maximum Low-Level Input Voltage                                                           |                                                                                 | 3.0<br>4.5<br>5.5      |                       |            | 0.53<br>0.8<br>0.8 |                       | 0.53<br>0.8<br>0.8 |                        | 0.53<br>0.8<br>0.8 | V    |
| V <sub>OH</sub>   | Minimum High-Level Output Voltage<br>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><br>I <sub>OH</sub> = -50μA | 3.0<br>4.5             | 2.9<br>4.4            | 3.0<br>4.5 |                    | 2.9<br>4.4            |                    | 2.9<br>4.4             |                    | V    |
|                   |                                                                                           | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OH</sub> = -4mA  | 3.0<br>4.5             | 2.58<br>3.94          |            |                    | 2.48<br>3.80          |                    | 2.34<br>3.66           |                    | V    |
|                   |                                                                                           | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OH</sub> = -8mA  | 3.0<br>4.5             |                       |            |                    |                       |                    |                        |                    | V    |
| V <sub>OL</sub>   | Maximum Low-Level Output Voltage<br>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><br>I <sub>OL</sub> = 50μA  | 3.0<br>4.5             |                       | 0.0<br>0.0 | 0.1<br>0.1         |                       | 0.1<br>0.1         |                        | 0.1<br>0.1         | V    |
|                   |                                                                                           | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OL</sub> = 4mA   | 3.0<br>4.5             |                       |            | 0.36<br>0.36       |                       | 0.44<br>0.44       |                        | 0.52<br>0.52       | V    |
|                   |                                                                                           | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OL</sub> = 8mA   | 3.0<br>4.5             |                       |            |                    |                       |                    |                        |                    | V    |
| I <sub>IN</sub>   | Maximum Input Leakage Current                                                             | V <sub>IN</sub> = 5.5V 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   |

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.

## 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> = - 40 to 85°C |      | Unit |
|----------------------------------------|-----------------------------------|----------------------------------------------------|-----------------------|-----|------|-------------------------------|------|------|
|                                        |                                   |                                                    | Min                   | Typ | Max  | Min                           | Max  |      |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Propagation Delay,<br>A or B to Y | V <sub>CC</sub> = 3.3 ± 0.3V C <sub>L</sub> = 15pF |                       | 7.0 | 11.0 | 1.0                           | 13.0 | ns   |
|                                        |                                   | C <sub>L</sub> = 50pF                              |                       | 9.5 | 14.5 | 1.0                           | 16.5 |      |
|                                        |                                   | V <sub>CC</sub> = 5.0 ± 0.5V C <sub>L</sub> = 15pF |                       | 4.8 | 6.8  | 1.0                           | 8.0  |      |
| C <sub>in</sub>                        | Input Capacitance                 | C <sub>L</sub> = 50pF                              |                       | 6.3 | 8.8  | 1.0                           | 10.0 | pF   |
|                                        |                                   |                                                    |                       | 4   | 10   |                               | 10   |      |

|                 |                                        |                                        |    |
|-----------------|----------------------------------------|----------------------------------------|----|
| C <sub>PD</sub> | Power Dissipation Capacitance (Note 1) | Typical @ 25°C, V <sub>CC</sub> = 5.0V | pF |
|                 |                                        | 18                                     |    |

1. 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>/4 (per gate). 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>.

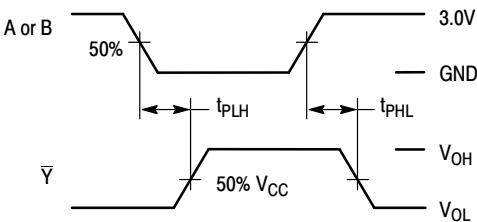
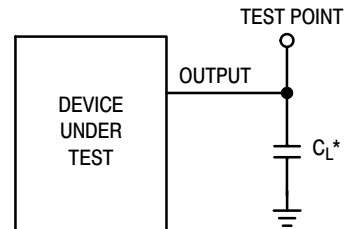


Figure 1. Switching Waveforms

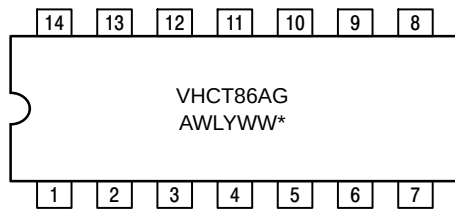


\*Includes all probe and jig capacitance

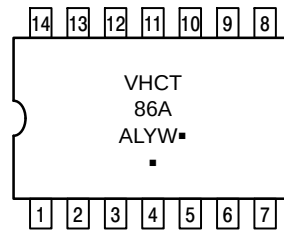
Figure 2. Test Circuit

# MC74VHCT86A

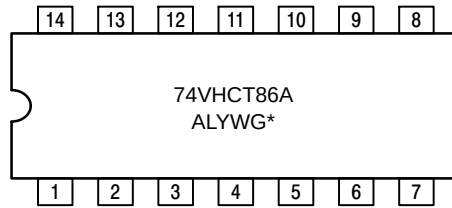
## MARKING DIAGRAMS (Top View)



**14-LEAD SOIC**  
**D SUFFIX**  
**CASE 751A**



**14-LEAD TSSOP**  
**DT SUFFIX**  
**CASE 948G**



**14-LEAD SOEIAJ**  
**M SUFFIX**  
**CASE 965**

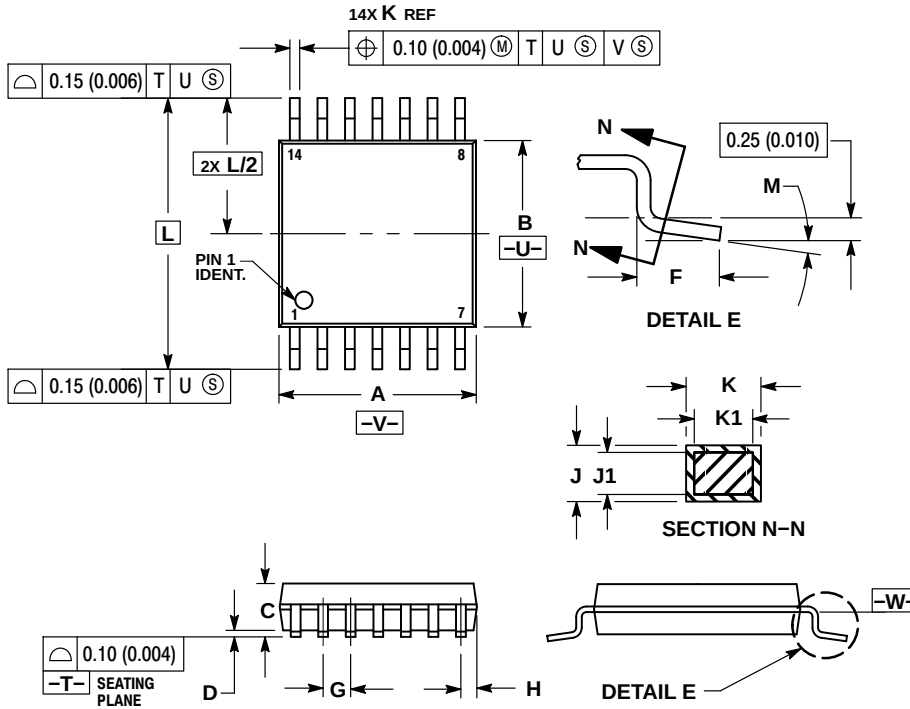
A = Assembly Location  
WL, L = Wafer Lot  
Y = Year  
WW, W = Work Week  
G or ■ = Pb-Free Package

\*See Applications Note #AND8004/D for date code and traceability information.

# MC74VHCT86A

## PACKAGE DIMENSIONS

TSSOP-14  
CASE 948G  
ISSUE B

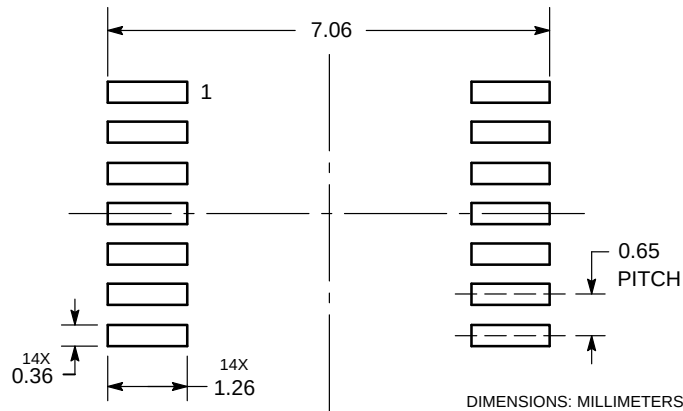


### NOTES:

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   | 0.50        | 0.60 | 0.020  | 0.024 |
| 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°    |

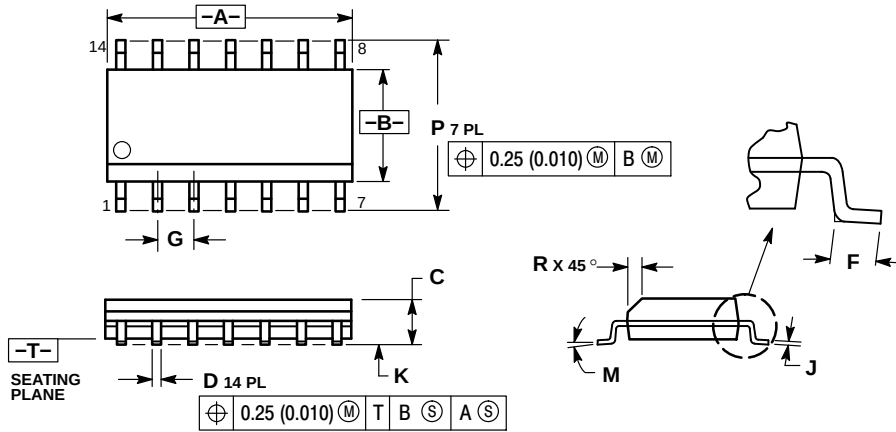
### SOLDERING FOOTPRINT



# MC74VHCT86A

## PACKAGE DIMENSIONS

SOIC-14  
D SUFFIX  
CASE 751A-03  
ISSUE J

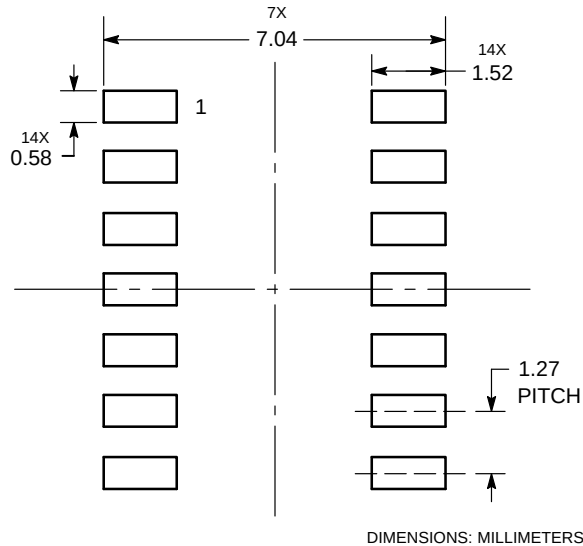


### NOTES:

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.

|     | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
| DIM | MIN         | MAX  | MIN       | MAX   |
| A   | 8.55        | 8.75 | 0.337     | 0.344 |
| 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 | 0.228     | 0.244 |
| R   | 0.25        | 0.50 | 0.010     | 0.019 |

## SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

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