

# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

## Single Supply Quad Comparators

These comparators are designed for use in level detection, low-level sensing and memory applications in consumer, automotive, and industrial electronic applications.

### Features

- Single or Split Supply Operation
- Low Input Bias Current: 25 nA (Typ)
- Low Input Offset Current:  $\pm 5.0$  nA (Typ)
- Low Input Offset Voltage
- Input Common Mode Voltage Range to GND
- Low Output Saturation Voltage: 130 mV (Typ) @ 4.0 mA
- TTL and CMOS Compatible
- ESD Clamps on the Inputs Increase Reliability without Affecting Device Operation
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



**ON Semiconductor®**

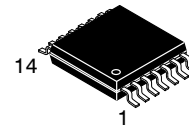
<http://onsemi.com>



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

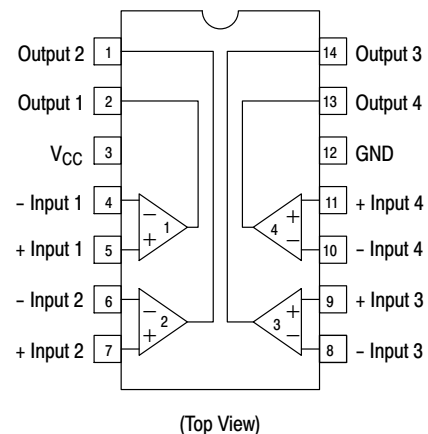


**PDIP-14  
N, P SUFFIX  
CASE 646**



**TSSOP-14  
DTB SUFFIX  
CASE 948G**

### PIN CONNECTIONS



### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 8 of this data sheet.

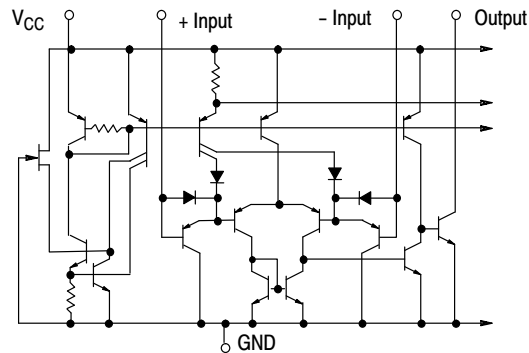
# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

## MAXIMUM RATINGS

| Rating   | Symbol                         | Value  | Unit                      |
|--|--------------------------------|--|---------------------------|
| Power Supply Voltage<br><br>LM239/LM339/LM2901, V<br>MC3302  | $V_{CC}$                       | +36 or $\pm 18$<br>+30 or $\pm 15$                                 | Vdc                       |
| Input Differential Voltage Range<br><br>LM239/LM339/LM2901, V<br>MC3302                            | $V_{IDR}$                      | 36<br>30   | Vdc                       |
| Input Common Mode Voltage Range  | $V_{ICMR}$                     | $-0.3$ to $V_{CC}$   | Vdc                       |
| Output Short Circuit to Ground (Note 1)  | $I_{SC}$                       | Continuous   |                           |
| Power Dissipation @ $T_A = 25^\circ\text{C}$<br>Plastic Package<br>Derate above $25^\circ\text{C}$ | $P_D$<br><br>$1/R_{\theta JA}$ | 1.0<br>8.0   | W<br>mW/ $^\circ\text{C}$ |
| Junction Temperature   | $T_J$                          | 150  | $^\circ\text{C}$          |
| Operating Ambient Temperature Range<br><br>LM239<br>MC3302<br>LM2901<br>LM2901V, NCV2901<br>LM339  | $T_A$                          | -25 to +85<br>-40 to +85<br>-40 to +105<br>-40 to +125<br>0 to +70 | $^\circ\text{C}$          |
| Storage Temperature Range  | $T_{stg}$                      | -65 to +150  | $^\circ\text{C}$          |
| ESD Protection at any Pin (Note 2)<br>Human Body Model<br>Machine Model                            | $V_{ESD}$                      | 1500<br>200  | V                         |

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.

- The maximum output current may be as high as 20 mA, independent of the magnitude of  $V_{CC}$ . Output short circuits to  $V_{CC}$  can cause excessive heating and eventual destruction.
- $V_{ESD}$  rating for NCV/SC devices is: Human Body Model – 2000 V; Machine Model – 200 V.



NOTE: Diagram shown is for 1 comparator.

**Figure 1. Circuit Schematic**

# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = +5.0$ Vdc, $T_A = +25^\circ\text{C}$ , unless otherwise noted)

| Characteristic   | Symbol     | LM239/339 |            |                | LM2901/2901V/<br>NCV2901 |            |                | MC3302 |            |                | Unit          |
|--|------------|-----------|------------|----------------|--------------------------|------------|----------------|--------|------------|----------------|---------------|
|  |            | Min       | Typ        | Max            | Min                      | Typ        | Max            | Min    | Typ        | Max            |               |
| Input Offset Voltage (Note 4)  | $V_{IO}$   | -         | $\pm 2.0$  | $\pm 5.0$      | -                        | $\pm 2.0$  | $\pm 7.0$      | -      | $\pm 3.0$  | $\pm 20$       | mVdc          |
| Input Bias Current (Notes 4, 5)<br>(Output in Analog Range)  | $I_{IB}$   | -         | 25         | 250            | -                        | 25         | 250            | -      | 25         | 500            | nA            |
| Input Offset Current (Note 4)  | $I_{IO}$   | -         | $\pm 5.0$  | $\pm 50$       | -                        | $\pm 5.0$  | $\pm 50$       | -      | $\pm 3.0$  | $\pm 100$      | nA            |
| Input Common Mode Voltage Range  | $V_{ICMR}$ | 0         | -          | $V_{CC} - 1.5$ | 0                        | -          | $V_{CC} - 1.5$ | 0      | -          | $V_{CC} - 1.5$ | V             |
| Supply Current<br>$R_L = \infty$ (For All Comparators)<br>$R_L = \infty$ , $V_{CC} = 30$ Vdc                                 | $I_{CC}$   | -         | 0.8<br>1.0 | 2.0<br>2.5     | -                        | 0.8<br>1.0 | 2.0<br>2.5     | -      | 0.8<br>1.0 | 2.0<br>2.5     | mA            |
| Voltage Gain<br>$R_L \geq 15$ k $\Omega$ , $V_{CC} = 15$ Vdc   | $A_{VOL}$  | 50        | 200        | -              | 25                       | 100        | -              | 25     | 100        | -              | V/mV          |
| Large Signal Response Time<br>$V_I =$ TTL Logic Swing,<br>$V_{ref} = 1.4$ Vdc, $V_{RL} = 5.0$ Vdc,<br>$R_L = 5.1$ k $\Omega$ | -          | -         | 300        | -              | -                        | 300        | -              | -      | 300        | -              | ns            |
| Response Time (Note 6)<br>$V_{RL} = 5.0$ Vdc, $R_L = 5.1$ k $\Omega$   | -          | -         | 1.3        | -              | -                        | 1.3        | -              | -      | 1.3        | -              | $\mu\text{s}$ |
| Output Sink Current<br>$V_I(-) \geq +1.0$ Vdc, $V_I(+)$ = 0,<br>$V_O \leq 1.5$ Vdc   | $I_{Sink}$ | 6.0       | 16         | -              | 6.0                      | 16         | -              | 6.0    | 16         | -              | mA            |
| Saturation Voltage<br>$V_I(-) \geq +1.0$ Vdc, $V_I(+)$ = 0,<br>$I_{sink} \leq 4.0$ mA  | $V_{sat}$  | -         | 130        | 400            | -                        | 130        | 400            | -      | 130        | 500            | mV            |
| Output Leakage Current<br>$V_I(+)$ $\geq +1.0$ Vdc, $V_I(-)$ = 0,<br>$V_O = +5.0$ Vdc  | $I_{OL}$   | -         | 0.1        | -              | -                        | 0.1        | -              | -      | 0.1        | -              | nA            |

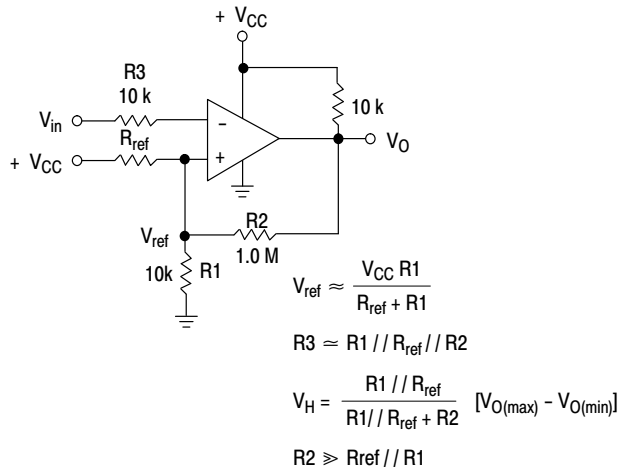
3. (LM239)  $T_{low} = -25^\circ\text{C}$ ,  $T_{high} = +85^\circ$   
 (LM339)  $T_{low} = 0^\circ\text{C}$ ,  $T_{high} = +70^\circ\text{C}$   
 (MC3302)  $T_{low} = -40^\circ\text{C}$ ,  $T_{high} = +85^\circ\text{C}$   
 (LM2901)  $T_{low} = -40^\circ\text{C}$ ,  $T_{high} = +105^\circ$   
 (LM2901V & NCV2901)  $T_{low} = -40^\circ\text{C}$ ,  $T_{high} = +125^\circ\text{C}$   
*NCV2901 is qualified for automotive use.*
4. At the output switch point,  $V_O \approx 1.4$  Vdc,  $R_S \leq 100 \Omega$   $5.0$  Vdc  $\leq V_{CC} \leq 30$  Vdc, with the inputs over the full common mode range (0 Vdc to  $V_{CC} - 1.5$  Vdc).
5. The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
6. The response time specified is for a 100 mV input step with 5.0 mV overdrive. For larger signals, 300 ns is typical.

# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

## PERFORMANCE CHARACTERISTICS $(V_{CC} = +5.0 \text{ Vdc}, T_A = T_{low} \text{ to } T_{high} \text{ [Note 7]})$

| Characteristic  | Symbol     | LM239/339 |     |                | LM2901/2901V/<br>NCV2901 |     |                | MC3302 |     |                | Unit          |
|---|------------|-----------|-----|----------------|--------------------------|-----|----------------|--------|-----|----------------|---------------|
|   |            | Min       | Typ | Max            | Min                      | Typ | Max            | Min    | Typ | Max            |               |
| Input Offset Voltage (Note 8)   | $V_{IO}$   | -         | -   | $\pm 9.0$      | -                        | -   | $\pm 15$       | -      | -   | $\pm 40$       | mVdc          |
| Input Bias Current (Notes 8, 9)<br>(Output in Analog Range)   | $I_{IB}$   | -         | -   | 400            | -                        | -   | 500            | -      | -   | 1000           | nA            |
| Input Offset Current (Note 8)   | $I_{IO}$   | -         | -   | $\pm 150$      | -                        | -   | $\pm 200$      | -      | -   | $\pm 300$      | nA            |
| Input Common Mode Voltage Range   | $V_{ICMR}$ | 0         | -   | $V_{CC} - 2.0$ | 0                        | -   | $V_{CC} - 2.0$ | 0      | -   | $V_{CC} - 2.0$ | V             |
| Saturation Voltage<br>$V_{I(-)} \geq +1.0 \text{ Vdc}, V_{I(+)} = 0,$<br>$I_{sink} \leq 4.0 \text{ mA}$ | $V_{sat}$  | -         | -   | 700            | -                        | -   | 700            | -      | -   | 700            | mV            |
| Output Leakage Current<br>$V_{I(+)} \geq +1.0 \text{ Vdc}, V_{I(-)} = 0,$<br>$V_O = 30 \text{ Vdc}$     | $I_{OL}$   | -         | -   | 1.0            | -                        | -   | 1.0            | -      | -   | 1.0            | $\mu\text{A}$ |
| Differential Input Voltage<br>All $V_I \geq 0 \text{ Vdc}$  | $V_{ID}$   | -         | -   | $V_{CC}$       | -                        | -   | $V_{CC}$       | -      | -   | $V_{CC}$       | Vdc           |

7. (LM239)  $T_{low} = -25^\circ\text{C}, T_{high} = +85^\circ\text{C}$   
 (LM339)  $T_{low} = 0^\circ\text{C}, T_{high} = +70^\circ\text{C}$   
 (MC3302)  $T_{low} = -40^\circ\text{C}, T_{high} = +85^\circ\text{C}$   
 (LM2901)  $T_{low} = -40^\circ\text{C}, T_{high} = +105^\circ\text{C}$   
 (LM2901V & NCV2901)  $T_{low} = -40^\circ\text{C}, T_{high} = +125^\circ\text{C}$   
*NCV2901 is qualified for automotive use.*
8. At the output switch point,  $V_O \approx 1.4 \text{ Vdc}, R_S \leq 100 \Omega, 5.0 \text{ Vdc} \leq V_{CC} \leq 30 \text{ Vdc}$ , with the inputs over the full common mode range (0 Vdc to  $V_{CC} - 1.5 \text{ Vdc}$ ).
9. The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
10. The response time specified is for a 100 mV input step with 5.0 mV overdrive. For larger signals, 300 ns is typical.



**Figure 2. Inverting Comparator with Hysteresis**



**Figure 3. Noninverting Comparator with Hysteresis**

Typical Characteristics

( $V_{CC} = 15\text{ Vdc}$ ,  $T_A = +25^\circ\text{C}$  (each comparator) unless otherwise noted.)



Figure 4. Normalized Input Offset Voltage

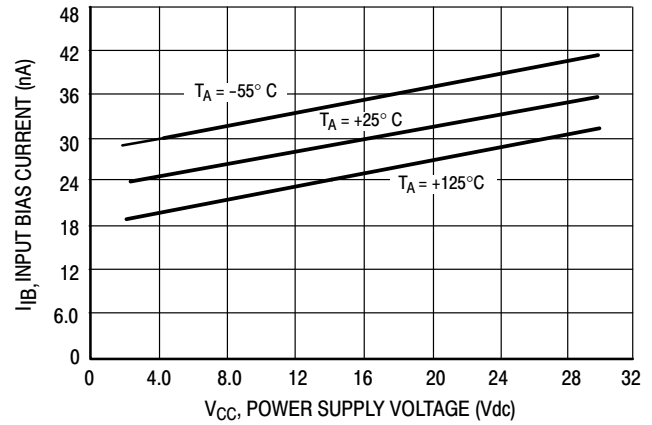


Figure 5. Input Bias Current



Figure 6. Output Sink Current versus Output Saturation Voltage



| Logic | Device      | $V_{CC}$ (V) | $R_L$ $k\Omega$ |
|-------|-------------|--------------|-----------------|
| CMOS  | 1/4 MC14001 | +15          | 100             |
| TTL   | 1/4 MC7400  | +5.0         | 10              |

Figure 7. Driving Logic

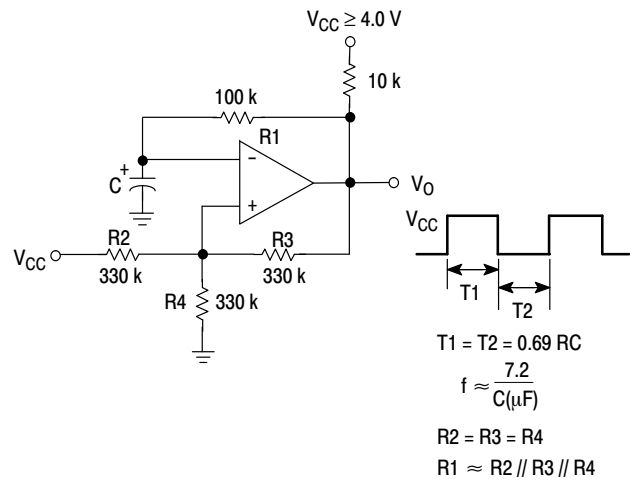


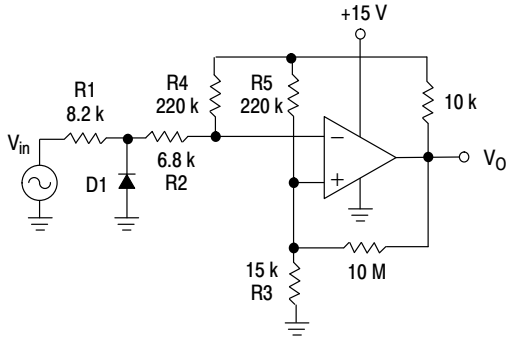
Figure 8. Squarewave Oscillator

APPLICATIONS INFORMATION

These quad comparators feature high gain, wide bandwidth characteristics. This gives the device oscillation tendencies if the outputs are capacitively coupled to the inputs via stray capacitance. This oscillation manifests itself during output transitions ( $V_{OL}$  to  $V_{OH}$ ). To alleviate this situation input resistors  $< 10\text{ k}\Omega$  should be used. The

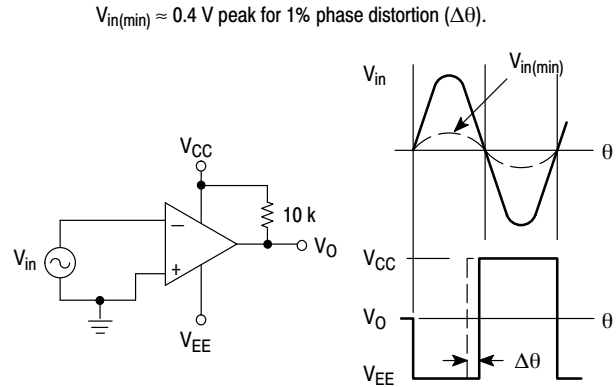
addition of positive feedback ( $< 10\text{ mV}$ ) is also recommended. It is good design practice to ground all unused input pins.

Differential input voltages may be larger than supply voltages without damaging the comparator's inputs. Voltages more negative than  $-300\text{ mV}$  should not be used.



D1 prevents input from going negative by more than  $0.6\text{ V}$ .  
 $R1 + R2 = R3$   
 $R3 \leq \frac{R5}{10}$  for small error in zero crossing

Figure 9. Zero Crossing Detector (Single Supply)



$V_{in(min)} \approx 0.4\text{ V}$  peak for 1% phase distortion ( $\Delta\theta$ ).

Figure 10. Zero Crossing Detector (Split Supplies)

**LM339, LM239, LM2901, LM2901V, NCV2901, MC3302**

**ORDERING INFORMATION**

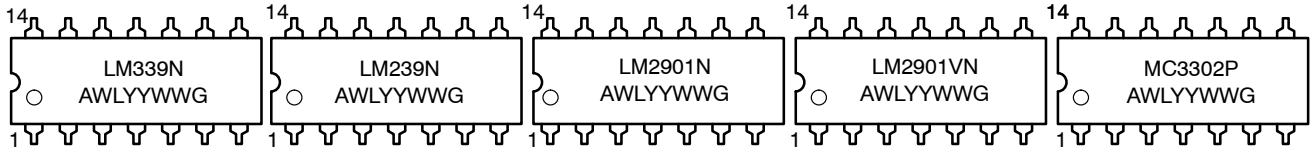
| Device        | Package  | Shipping†          |
|---------------|----------|--------------------|
| LM239DG       | SOIC-14  | 55 Units/Tube      |
| LM239DR2G     | SOIC-14  | 2500 / Tape & Reel |
| LM239DTBR2G   | TSSOP-14 |                    |
| LM239NG       | PDIP-14  | 25 Units/Rail      |
| LM339DG       | SOIC-14  | 55 Units/Tube      |
| LM339DR2G     | SOIC-14  | 2500 / Tape & Reel |
| LM339DTBR2G   | TSSOP-14 |                    |
| LM339NG       | PDIP-14  | 25 Units/Rail      |
| LM2901DG      | SOIC-14  | 55 Units/Rail      |
| LM2901DR2G    | SOIC-14  | 2500 / Tape & Reel |
| LM2901DTBR2G  | TSSOP-14 |                    |
| LM2901NG      | PDIP-14  | 25 Units/Rail      |
| LM2901VDG     | SOIC-14  | 55 Units/Tube      |
| LM2901VDR2G   | SOIC-14  | 2500 / Tape & Reel |
| LM2901VDTBR2G | TSSOP-14 |                    |
| LM2901VNG     | PDIP-14  | 25 Units/Rail      |
| NCV2901DR2G   | SOIC-14  | 2500 / Tape & Reel |
| NCV2901DTBR2G | TSSOP-14 |                    |
| NCV2901CTR    | Bare Die | 6000 / Tape & Reel |
| MC3302DG      | SOIC-14  | 55 Units/Tube      |
| MC3302DR2G    | SOIC-14  | 2500 / Tape & Reel |
| MC3302DTBR2G  | TSSOP-14 |                    |
| MC3302PG      | PDIP-14  | 25 Units/Rail      |

†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.

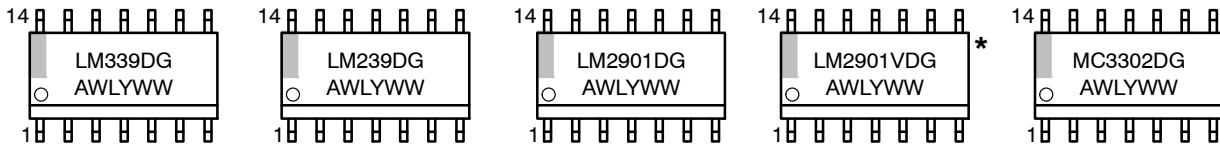
# LM339, LM239, LM2901, LM2901V, NCV2901, MC3302

## MARKING DIAGRAMS

### PDIP-14 N, P SUFFIX CASE 646



### SOIC-14 D SUFFIX CASE 751A



### TSSOP-14 DTB SUFFIX CASE 948G



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

(Note: Microdot may be in either location)

\*This marking diagram also applies to NCV2901.



PACKAGE DIMENSIONS

PDIP-14  
CASE 646-06  
ISSUE P



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.715     | 0.770 | 18.16       | 19.56 |
| B   | 0.240     | 0.260 | 6.10        | 6.60  |
| C   | 0.145     | 0.185 | 3.69        | 4.69  |
| D   | 0.015     | 0.021 | 0.38        | 0.53  |
| F   | 0.040     | 0.070 | 1.02        | 1.78  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.052     | 0.095 | 1.32        | 2.41  |
| J   | 0.008     | 0.015 | 0.20        | 0.38  |
| K   | 0.115     | 0.135 | 2.92        | 3.43  |
| L   | 0.290     | 0.310 | 7.37        | 7.87  |
| M   | ---       | 10°   | ---         | 10°   |
| N   | 0.015     | 0.039 | 0.38        | 1.01  |

PACKAGE DIMENSIONS

SOIC-14  
CASE 751A-03  
ISSUE H

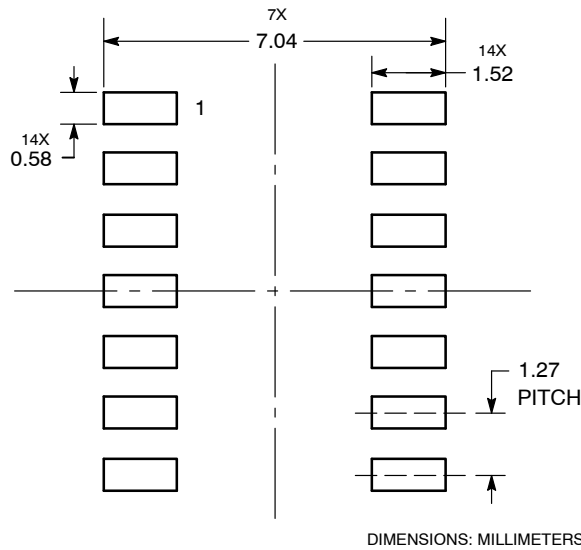


NOTES:

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   | 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 |

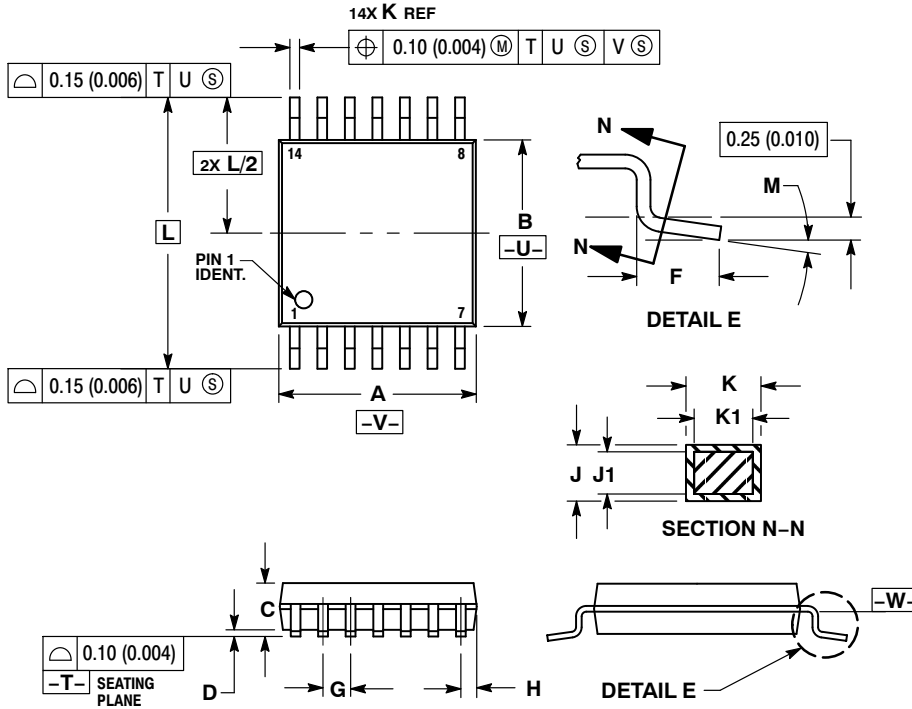
SOLDERING FOOTPRINT\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

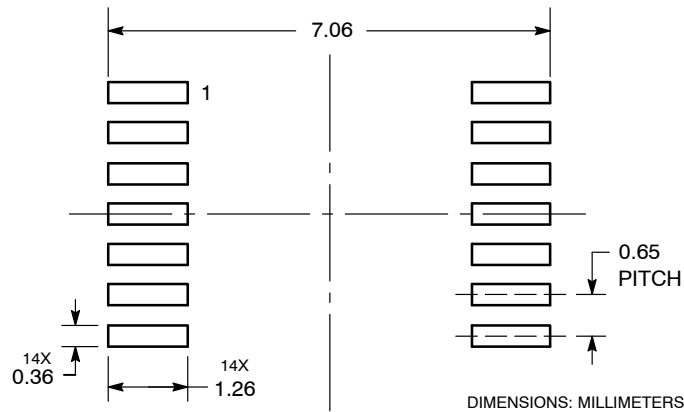
TSSOP-14  
CASE 948G-01  
ISSUE B



- 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 -V-.

| 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\*



\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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