

# MC74VHC1G09

## 2-Input AND Gate with Open Drain Output

The MC74VHC1G09 is an advanced high speed CMOS 2-input AND gate with open drain output 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 an open drain output which provides the capability to set output switching level. This allows the MC74VHC1G09 to be used to interface 5 V circuits to circuits of any voltage between  $V_{CC}$  and 7 V using an external resistor and power supply.

The MC74VHC1G09 input structure provides protection when voltages up to 7 V are applied, regardless of the supply voltage.

### Features

- High Speed:  $t_{PD} = 4.3$  ns (Typ) at  $V_{CC} = 5$  V
- Low Internal Power Dissipation:  $I_{CC} = 1$   $\mu$ A (Max) at  $T_A = 25^\circ\text{C}$
- Power Down Protection Provided on Inputs
- Pin and Function Compatible with Other Standard Logic Families
- Chip Complexity: FETs = 62; Equivalent Gates = 16
- Pb-Free Packages are Available

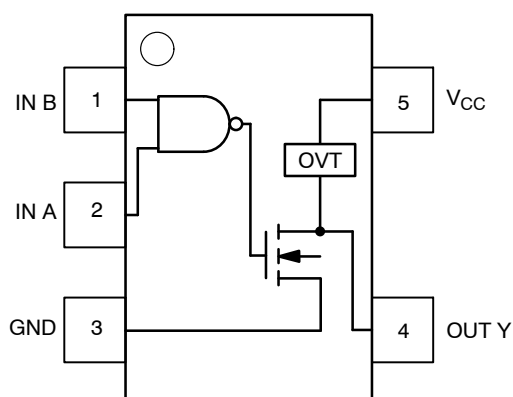


Figure 1. Pinout (Top View)

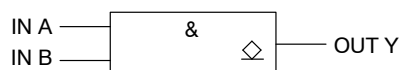


Figure 2. Logic Symbol

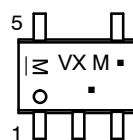


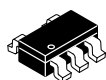
**ON Semiconductor®**

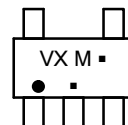
<http://onsemi.com>

### MARKING DIAGRAMS

  
**SC-88A / SOT-353 / SC-70**  
**DF SUFFIX**  
**CASE 419A**



  
**TSOP-5 / SOT-23 / SC-59**  
**DT SUFFIX**  
**CASE 483**



VX = Device Code  
M = Date Code\*  
▪ = Pb-Free Package

(Note: Microdot may be in either location)  
\*Date Code orientation and/or position may vary depending upon manufacturing location.

### PIN ASSIGNMENT

| 1 | IN B     |
|---|----------|
| 2 | IN A     |
| 3 | GND      |
| 4 | OUT Y    |
| 5 | $V_{CC}$ |

### FUNCTION TABLE

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

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

# MC74VHC1G09

## MAXIMUM RATINGS

| Symbol               | Characteristics                            | 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 7.0                                                                          | 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 | +50                                                                                  | mA   |
| P <sub>D</sub>       | Power dissipation in still air             | SC-88A, TSOP-5                                                                       | mW   |
| θ <sub>JA</sub>      | Thermal resistance                         | SC-88A, TSOP-5                                                                       | °C/W |
| T <sub>L</sub>       | Lead temperature, 1 mm from case for 10 s  | 260                                                                                  | °C   |
| T <sub>J</sub>       | Junction temperature under bias            | +150                                                                                 | °C   |
| T <sub>stg</sub>     | Storage temperature                        | −65 to +150                                                                          | °C   |
| MSL                  | Moisture Sensitivity                       | Level 1                                                                              |      |
| F <sub>R</sub>       | Flammability Rating                        | Oxygen Index: 28 to 34<br>UL 94 V-0 @ 0.125 in                                       |      |
| V <sub>ESD</sub>     | ESD Withstand Voltage                      | Human Body Model (Note 1)<br>Machine Model (Note 2)<br>Charged Device Model (Note 3) | V    |
| I <sub>Latchup</sub> | Latchup Performance                        | Above V <sub>CC</sub> and Below GND at 125°C (Note 4)                                | ±500 |

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. Tested to EIA/JESD22-A114-A
2. Tested to EIA/JESD22-A115-A
3. Tested to JESD22-C101-A
4. Tested to EIA/JESD78

## RECOMMENDED OPERATING CONDITIONS

| Symbol                          | Characteristics                                                                                | Min    | Max       | Unit |
|---------------------------------|------------------------------------------------------------------------------------------------|--------|-----------|------|
| V <sub>CC</sub>                 | DC Supply Voltage                                                                              | 2.0    | 5.5       | V    |
| V <sub>IN</sub>                 | DC Input Voltage                                                                               | 0.0    | 5.5       | V    |
| V <sub>OUT</sub>                | DC Output Voltage                                                                              | 0.0    | 7.0       | V    |
| T <sub>A</sub>                  | Operating Temperature Range                                                                    | −55    | +125      | °C   |
| t <sub>r</sub> , t <sub>f</sub> | Input Rise and Fall Time<br>V <sub>CC</sub> = 3.3 V ± 0.3 V<br>V <sub>CC</sub> = 5.0 V ± 0.5 V | 0<br>0 | 100<br>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         |

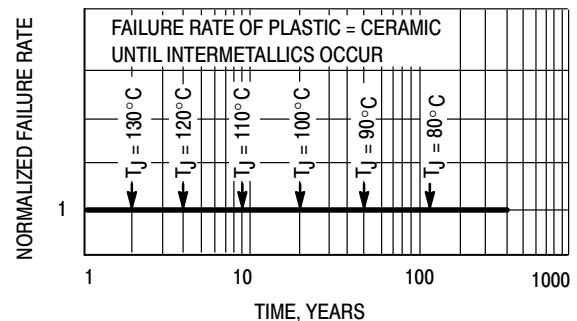


Figure 3. Failure Rate vs. Time Junction Temperature

# MC74VHC1G09

## 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      |                            | -55 ≤ T <sub>A</sub> ≤ 125°C |                            | Unit |
|------------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------|----------------------------|-------------------|----------------------------|----------------------------|----------------------------|------------------------------|----------------------------|------|
|                  |                                                                                          |                                                                                                          |                          | Min                        | Typ               | Max                        | Min                        | Max                        | Min                          | Max                        |      |
| V <sub>IH</sub>  | Minimum High-Level Input Voltage                                                         |                                                                                                          | 2.0<br>3.0<br>4.5<br>5.5 | 1.5<br>2.1<br>3.15<br>3.85 |                   |                            | 1.5<br>2.1<br>3.15<br>3.85 |                            | 1.5<br>2.1<br>3.15<br>3.85   |                            | V    |
| V <sub>IL</sub>  | Maximum Low-Level Input Voltage                                                          |                                                                                                          | 2.0<br>3.0<br>4.5<br>5.5 |                            |                   | 0.5<br>0.9<br>1.35<br>1.65 |                            | 0.5<br>0.9<br>1.35<br>1.65 |                              | 0.5<br>0.9<br>1.35<br>1.65 | 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> = 50 μA                          | 2.0<br>3.0<br>4.5        |                            | 0.0<br>0.0<br>0.0 | 0.1<br>0.1<br>0.1          |                            | 0.1<br>0.1<br>0.1          |                              | 0.1<br>0.1<br>0.1          | V    |
|                  |                                                                                          | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>I <sub>OL</sub> = 4 mA<br>I <sub>OL</sub> = 8 mA | 3.0<br>4.5               |                            |                   | 0.36<br>0.36               |                            | 0.44<br>0.44               |                              | 0.52<br>0.52               | V    |
| 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                      |                            |                   | 1.0                        |                            | 20                         |                              | 40                         | μA   |
| I <sub>OFF</sub> | Power Off-Output Leakage Current                                                         | V <sub>OUT</sub> = 5.5 V<br>V <sub>IN</sub> = 5.5 V                                                      | 0                        |                            |                   | 0.25                       |                            | 2.5                        |                              | 5                          | μA   |

## AC ELECTRICAL CHARACTERISTICS C<sub>load</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 3.0 ns

| Symbol           | Parameter                                     | Test Conditions                                                                                                        | T <sub>A</sub> = 25°C |            |             | T <sub>A</sub> ≤ 85°C |              | -55 ≤ T <sub>A</sub> ≤ 125°C |              | Unit |
|------------------|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------|------------|-------------|-----------------------|--------------|------------------------------|--------------|------|
|                  |                                               |                                                                                                                        | Min                   | Typ        | Max         | Min                   | Max          | Min                          | Max          |      |
| t <sub>pZL</sub> | Maximum Output Enable Time, Input A or B to Y | V <sub>CC</sub> = 3.3 ± 0.3 V C <sub>L</sub> = 15 pF<br>R <sub>L</sub> = R <sub>I</sub> = 500 Ω C <sub>L</sub> = 50 pF |                       | 6.2<br>8.7 | 8.8<br>12.3 |                       | 10.5<br>14.0 |                              | 12.5<br>16.5 | ns   |
|                  |                                               | V <sub>CC</sub> = 5.0 ± 0.5 V C <sub>L</sub> = 15 pF<br>R <sub>L</sub> = R <sub>I</sub> = 500 Ω C <sub>L</sub> = 50 pF |                       | 4.3<br>5.8 | 5.9<br>7.9  |                       | 7.0<br>9.0   |                              | 9.0<br>11.0  |      |
| t <sub>pLZ</sub> | Maximum Output Disable Time                   | V <sub>CC</sub> = 3.3 ± 0.3 V C <sub>L</sub> = 50 pF<br>R <sub>L</sub> = R <sub>I</sub> = 500 Ω                        |                       | 8.7        | 12.3        |                       | 14.0         |                              | 16.5         | ns   |
|                  |                                               | V <sub>CC</sub> = 5.0 ± 0.5 V C <sub>L</sub> = 50 pF<br>R <sub>L</sub> = R <sub>I</sub> = 500 Ω                        |                       | 5.8        | 7.9         |                       | 9.0          |                              | 11.0         |      |
| C <sub>IN</sub>  | Maximum Input Capacitance                     |                                                                                                                        |                       | 6.0        | 10          |                       | 10           |                              | 10           | pF   |

|                 |                                        |                                         |    |
|-----------------|----------------------------------------|-----------------------------------------|----|
| C <sub>PD</sub> | Power Dissipation Capacitance (Note 5) | Typical @ 25°C, V <sub>CC</sub> = 5.0 V | pF |
|                 |                                        | 18                                      |    |

5. 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>. 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>.

# MC74VHC1G09

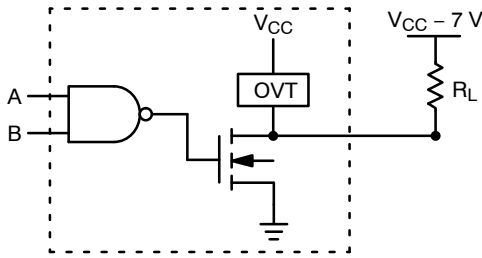


Figure 4. Output Voltage Mismatch Application

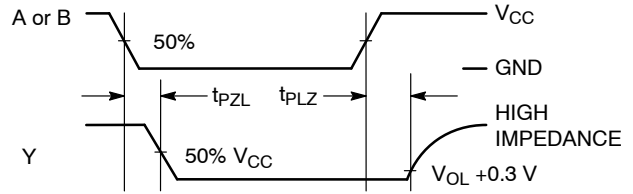
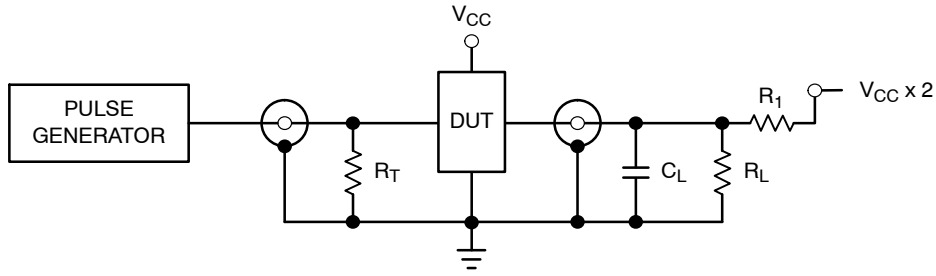


Figure 5. Switching Waveforms



$C_L = 50 \text{ pF}$  equivalent (Includes jig and probe capacitance)  
 $R_L = R_1 = 500 \Omega$  or equivalent  
 $R_T = Z_{OUT}$  of pulse generator (typically  $50 \Omega$ )

Figure 6. Test Circuit

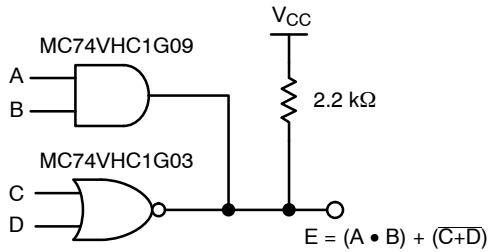


Figure 7. Complex Boolean Functions

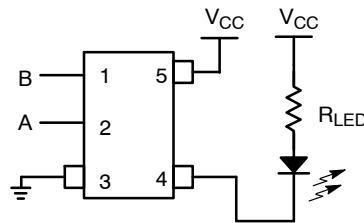


Figure 8. LED Driver

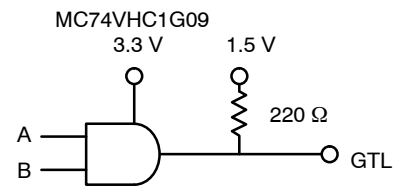


Figure 9. GTL Driver

## ORDERING INFORMATION

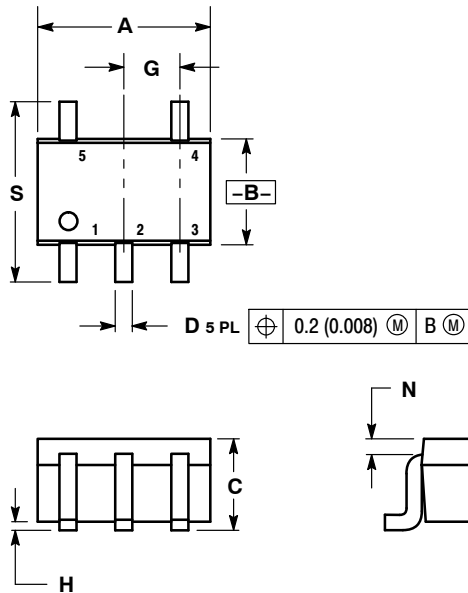
| Device           | Package                                | Shipping <sup>†</sup> |
|------------------|----------------------------------------|-----------------------|
| MC74VHC1G09DFT1  | SC70-5 / SC-88A / SOT-353              | 3000/Tape & Reel      |
| MC74VHC1G09DFT1G | SC70-5 / SC-88A / SOT-353<br>(Pb-Free) |                       |
| MC74VHC1G09DFT2  | SC70-5 / SC-88A / SOT-353              |                       |
| MC74VHC1G09DFT2G | SC70-5 / SC-88A / SOT-353<br>(Pb-Free) |                       |
| MC74VHC1G09DTT1  | SOT23-5 / TSOP-5 / SC59-5              |                       |
| MC74VHC1G09DTT1G | SOT23-5 / TSOP-5 / SC59-5<br>(Pb-Free) |                       |

<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.

# MC74VHC1G09

## PACKAGE DIMENSIONS

SC-88A, SOT-353, SC-70  
CASE 419A-02  
ISSUE J

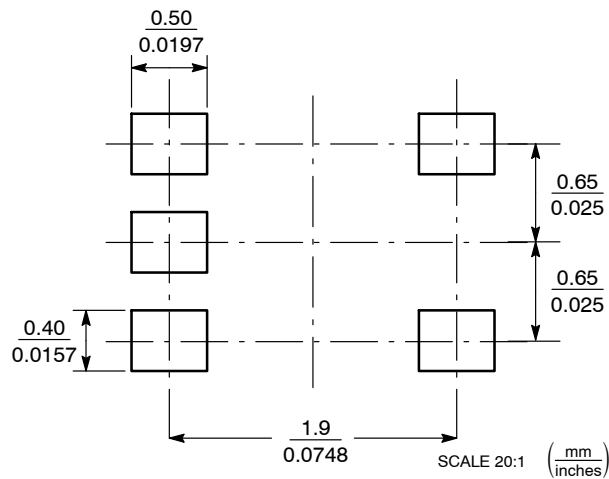


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A-01 OBSOLETE. NEW STANDARD 419A-02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| DIM | INCHES    |       | MILLIMETERS |      |
|-----|-----------|-------|-------------|------|
|     | MIN       | MAX   | MIN         | MAX  |
| A   | 0.071     | 0.087 | 1.80        | 2.20 |
| B   | 0.045     | 0.053 | 1.15        | 1.35 |
| C   | 0.031     | 0.043 | 0.80        | 1.10 |
| D   | 0.004     | 0.012 | 0.10        | 0.30 |
| G   | 0.026 BSC |       | 0.65 BSC    |      |
| H   | ---       | 0.004 | ---         | 0.10 |
| J   | 0.004     | 0.010 | 0.10        | 0.25 |
| K   | 0.004     | 0.012 | 0.10        | 0.30 |
| N   | 0.008 REF |       | 0.20 REF    |      |
| S   | 0.079     | 0.087 | 2.00        | 2.20 |

## SOLDERING FOOTPRINT\*

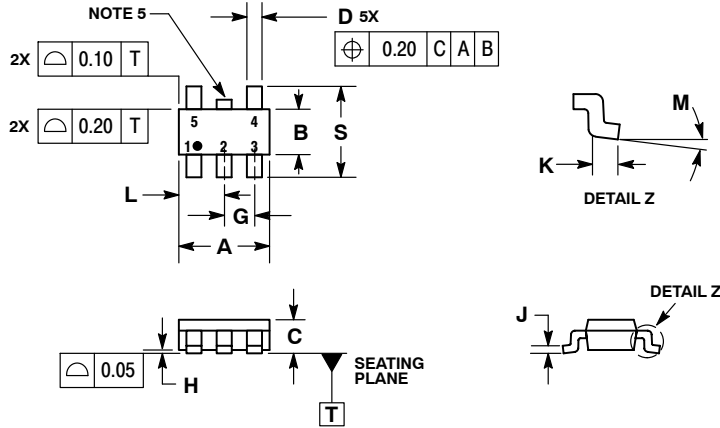


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# MC74VHC1G09

## PACKAGE DIMENSIONS

### TSOP-5 CASE 483-02 ISSUE F

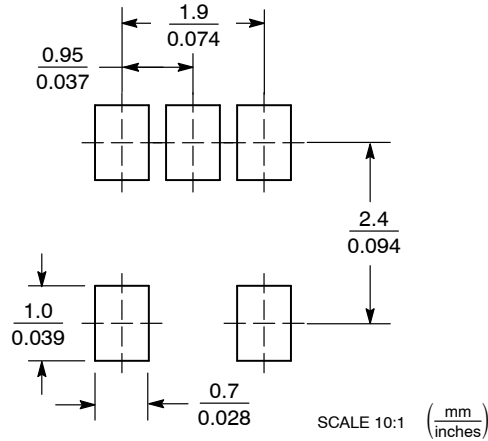


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 3.00 BSC    |      |
| B   | 1.50 BSC    |      |
| C   | 0.90        | 1.10 |
| D   | 0.25        | 0.50 |
| G   | 0.95 BSC    |      |
| H   | 0.01        | 0.10 |
| J   | 0.10        | 0.26 |
| K   | 0.20        | 0.60 |
| L   | 1.25        | 1.55 |
| M   | 0°          | 10°  |
| S   | 2.50        | 3.00 |

### 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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- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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- Подбор аналогов;
- Консультации по применению компонента;
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- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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**Факс:** 8 (812) 320-02-42

**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

**Адрес:** 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.