

## CD4093BC

### Quad 2-Input NAND Schmitt Trigger

#### General Description

The CD4093B consists of four Schmitt-trigger circuits. Each circuit functions as a 2-input NAND gate with Schmitt-trigger action on both inputs. The gate switches at different points for positive and negative-going signals. The difference between the positive ( $V_T^+$ ) and the negative voltage ( $V_T^-$ ) is defined as hysteresis voltage ( $V_H$ ).

All outputs have equal source and sink currents and conform to standard B-series output drive (see Static Electrical Characteristics).

#### Features

- Wide supply voltage range: 3.0V to 15V
- Schmitt-trigger on each input with no external components
- Noise immunity greater than 50%
- Equal source and sink currents
- No limit on input rise and fall time
- Standard B-series output drive
- Hysteresis voltage (any input)  $T_A = 25^\circ\text{C}$

|            |                        |                     |
|------------|------------------------|---------------------|
| Typical    | $V_{DD} = 5.0\text{V}$ | $V_H = 1.5\text{V}$ |
|            | $V_{DD} = 10\text{V}$  | $V_H = 2.2\text{V}$ |
|            | $V_{DD} = 15\text{V}$  | $V_H = 2.7\text{V}$ |
| Guaranteed | $V_H = 0.1 V_{DD}$     |                     |

#### Applications

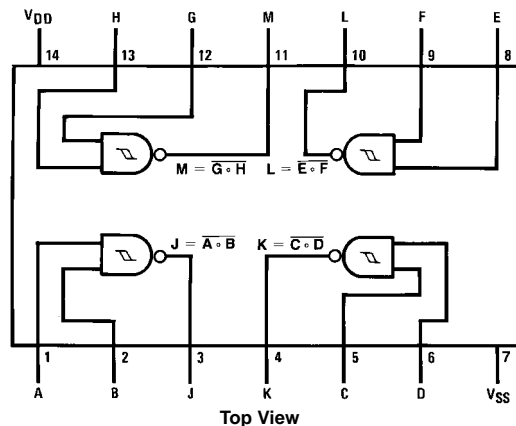
- Wave and pulse shapers
- High-noise-environment systems
- Monostable multivibrators
- Astable multivibrators
- NAND logic

#### Ordering Code:

| Order Number | Package Number | Package Description  |
|--------------|----------------|--|
| CD4093BCM    | M14A           | 14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| CD4093BCN    | N14A           | 14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide       |

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

#### Connection Diagram



**Absolute Maximum Ratings**(Note 1)

(Note 2)

|                                     |                                |
|-------------------------------------|--------------------------------|
| DC Supply Voltage ( $V_{DD}$ )      | –0.5 to +18 $V_{DC}$           |
| Input Voltage ( $V_{IN}$ )          | –0.5 to $V_{DD}$ +0.5 $V_{DC}$ |
| Storage Temperature Range ( $T_S$ ) | –65°C to +150°C                |
| Power Dissipation ( $P_D$ )         |                                |
| Dual-In-Line                        | 700 mW                         |
| Small Outline                       | 500 mW                         |
| Lead Temperature ( $T_L$ )          |                                |
| (Soldering, 10 seconds)             | 260°C                          |

**Recommended Operating Conditions** (Note 2)

|                                       |                        |
|---------------------------------------|------------------------|
| DC Supply Voltage ( $V_{DD}$ )        | 3 to 15 $V_{DC}$       |
| Input Voltage ( $V_{IN}$ )            | 0 to $V_{DD}$ $V_{DC}$ |
| Operating Temperature Range ( $T_A$ ) | –55°C to +125°C        |

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed; they are not meant to imply that the devices should be operated at these limits. The table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for actual device operation.

**Note 2:**  $V_{SS} = 0V$  unless otherwise specified.

**DC Electrical Characteristics** (Note 2)

| Symbol   | Parameter                                    | Conditions  | –55°C                 |                      | +25°C                 |                         |                      | +125°C                |                      | Units   |
|----------|--|---|-----------------------|----------------------|-----------------------|-------------------------|----------------------|-----------------------|----------------------|---------|
|          |  |   | Min                   | Max                  | Min                   | Typ                     | Max                  | Min                   | Max                  |         |
| $I_{DD}$ | Quiescent Device Current                     | $V_{DD} = 5V$<br>$V_{DD} = 10V$<br>$V_{DD} = 15V$   |                       | 0.25<br>0.5<br>1.0   |                       |                         | 0.25<br>0.5<br>1.0   |                       | 7.5<br>15.0<br>30.0  | $\mu A$ |
| $V_{OL}$ | LOW Level Output Voltage                     | $V_{IN} = V_{DD}$ , $ I_{OL}  < 1 \mu A$<br>$V_{DD} = 5V$<br>$V_{DD} = 10V$<br>$V_{DD} = 15V$                         |                       | 0.05<br>0.05<br>0.05 |                       | 0<br>0<br>0             | 0.05<br>0.05<br>0.05 |                       | 0.05<br>0.05<br>0.05 | V       |
| $V_{OH}$ | HIGH Level Output Voltage                    | $V_{IN} = V_{SS}$ , $ I_{OH}  < 1 \mu A$<br>$V_{DD} = 5V$<br>$V_{DD} = 10V$<br>$V_{DD} = 15V$                         | 4.95<br>9.95<br>14.95 |                      | 4.95<br>9.95<br>14.95 | 5<br>10<br>15           |                      | 4.95<br>9.95<br>14.95 |                      | V       |
| $V_{T-}$ | Negative-Going Threshold Voltage (Any Input) | $ I_{OL}  < 1 \mu A$<br>$V_{DD} = 5V$ , $V_O = 4.5V$<br>$V_{DD} = 10V$ , $V_O = 9V$<br>$V_{DD} = 15V$ , $V_O = 13.5V$ | 1.3<br>2.85<br>4.35   | 2.25<br>4.5<br>6.75  | 1.5<br>3.0<br>4.5     | 1.8<br>4.1<br>6.3       | 2.25<br>4.5<br>6.75  | 1.5<br>3.0<br>4.5     | 2.3<br>4.65<br>6.9   | V       |
| $V_{T+}$ | Positive-Going Threshold Voltage (Any Input) | $ I_{OL}  < 1 \mu A$<br>$V_{DD} = 5V$ , $V_O = 0.5V$<br>$V_{DD} = 10V$ , $V_O = 1V$<br>$V_{DD} = 15V$ , $V_O = 1.5V$  | 2.75<br>5.5<br>8.25   | 3.6<br>7.15<br>10.65 | 2.75<br>5.5<br>8.25   | 3.3<br>6.2<br>9.0       | 3.5<br>7.0<br>10.5   | 2.65<br>5.35<br>8.1   | 3.5<br>7.0<br>10.5   | V       |
| $V_H$    | Hysteresis ( $V_{T+} - V_{T-}$ ) (Any Input) | $V_{DD} = 5V$<br>$V_{DD} = 10V$<br>$V_{DD} = 15V$   | 0.5<br>1.0<br>1.5     | 2.35<br>4.3<br>6.3   | 0.5<br>1.0<br>1.5     | 1.5<br>2.2<br>2.7       | 2.0<br>4.0<br>6.0    | 0.35<br>0.70<br>1.20  | 2.0<br>4.0<br>6.0    | V       |
| $I_{OL}$ | LOW Level Output Current (Note 3)            | $V_{IN} = V_{DD}$<br>$V_{DD} = 5V$ , $V_O = 0.4V$<br>$V_{DD} = 10V$ , $V_O = 0.5V$<br>$V_{DD} = 15V$ , $V_O = 1.5V$   | 0.64<br>1.6<br>4.2    |                      | 0.51<br>1.3<br>3.4    | 0.88<br>2.25<br>8.8     |                      | 0.36<br>0.9<br>2.4    |                      | mA      |
| $I_{OH}$ | HIGH Level Output Current (Note 3)           | $V_{IN} = V_{SS}$<br>$V_{DD} = 5V$ , $V_O = 4.6V$<br>$V_{DD} = 10V$ , $V_O = 9.5V$<br>$V_{DD} = 15V$ , $V_O = 13.5V$  | –0.64<br>–1.6<br>–4.2 |                      | 0.51<br>–1.3<br>–3.4  | –0.88<br>–2.25<br>–8.8  |                      | –0.36<br>–0.9<br>–2.4 |                      | mA      |
| $I_{IN}$ | Input Current                                | $V_{DD} = 15V$ , $V_{IN} = 0V$<br>$V_{DD} = 15V$ , $V_{IN} = 15V$   |                       | –0.1<br>0.1          |                       | $-10^{-5}$<br>$10^{-5}$ | –0.1<br>0.1          |                       | –1.0<br>1.0          | $\mu A$ |

**Note 3:**  $I_{OH}$  and  $I_{OL}$  are tested one output at a time.

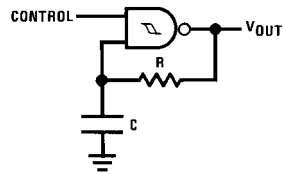
**AC Electrical Characteristics** (Note 4) $T_A = 25^\circ\text{C}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ k}\Omega$ , Input  $t_r$ ,  $t_f = 20\text{ ns}$ , unless otherwise specified

| Symbol                | Parameter                     | Conditions   | Min | Typ              | Max               | Units |
|-----------------------|-------------------------------|--|-----|------------------|-------------------|-------|
| $t_{PHL}$ , $t_{PLH}$ | Propagation Delay Time        | $V_{DD} = 5\text{V}$<br>$V_{DD} = 10\text{V}$<br>$V_{DD} = 15\text{V}$ |     | 300<br>120<br>80 | 450<br>210<br>160 | ns    |
| $t_{THL}$ , $t_{TLH}$ | Transition Time               | $V_{DD} = 5\text{V}$<br>$V_{DD} = 10\text{V}$<br>$V_{DD} = 15\text{V}$ |     | 90<br>50<br>40   | 145<br>75<br>60   | ns    |
| $C_{IN}$              | Input Capacitance             | (Any Input)  |     | 5.0              | 7.5               | pF    |
| $C_{PD}$              | Power Dissipation Capacitance | (Per Gate)   |     | 24               |                   | pF    |

**Note 4:** AC Parameters are guaranteed by DC correlated testing.

## Typical Applications

### Gated Oscillator



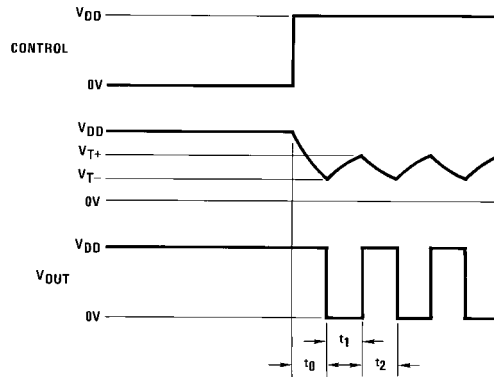
Assume  $t_1 + t_2 \gg t_{PHL} + t_{PLH}$  then:

$$t_0 = RC \ln [V_{DD}/V_{T-}]$$

$$t_1 = RC \ln [(V_{DD} - V_{T-})/(V_{DD} - V_{T+})]$$

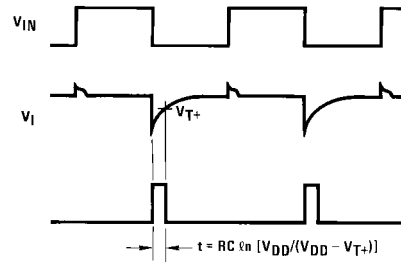
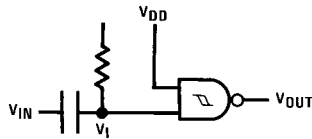
$$t_2 = RC \ln [V_{T+}/V_{T-}]$$

$$f = \frac{1}{t_1 + t_2} = \frac{1}{RC \ln \frac{(V_{T+})(V_{DD} - V_{T-})}{(V_{T-})(V_{DD} - V_{T+})}}$$

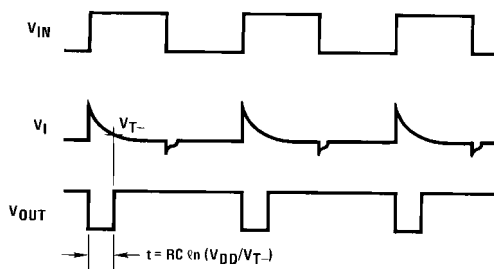
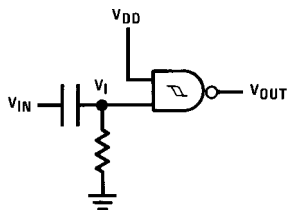


### Gated One-Shot

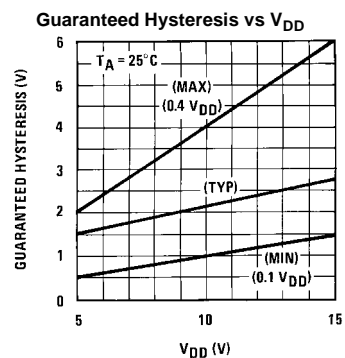
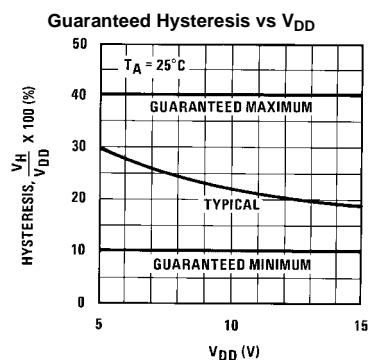
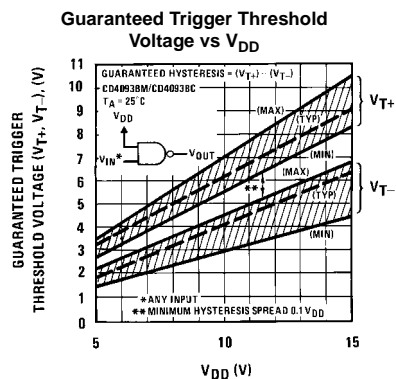
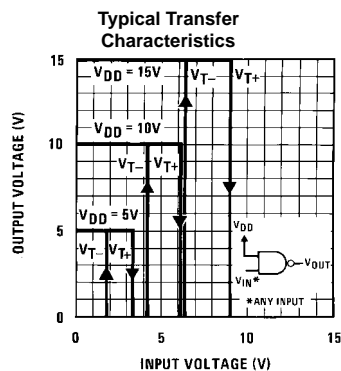
#### (a) Negative-Edge Triggered



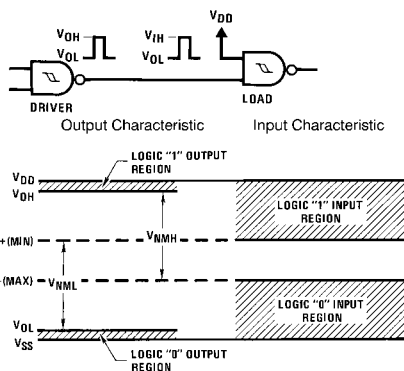
#### (b) Positive-Edge Triggered



## Typical Performance Characteristics



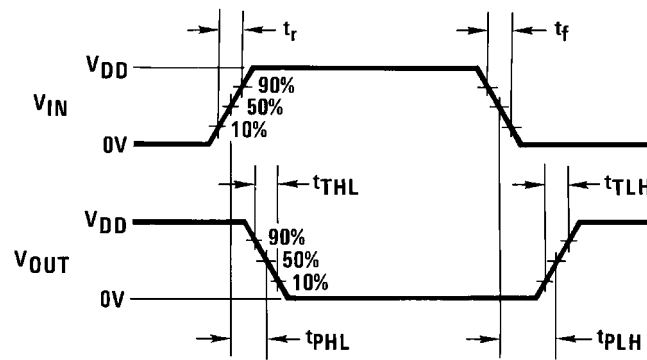
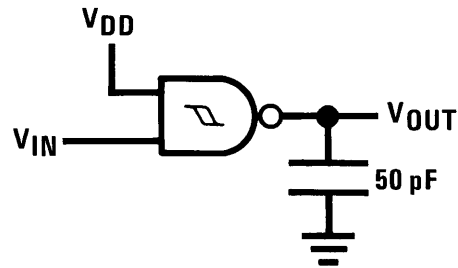
## Input and Output Characteristics

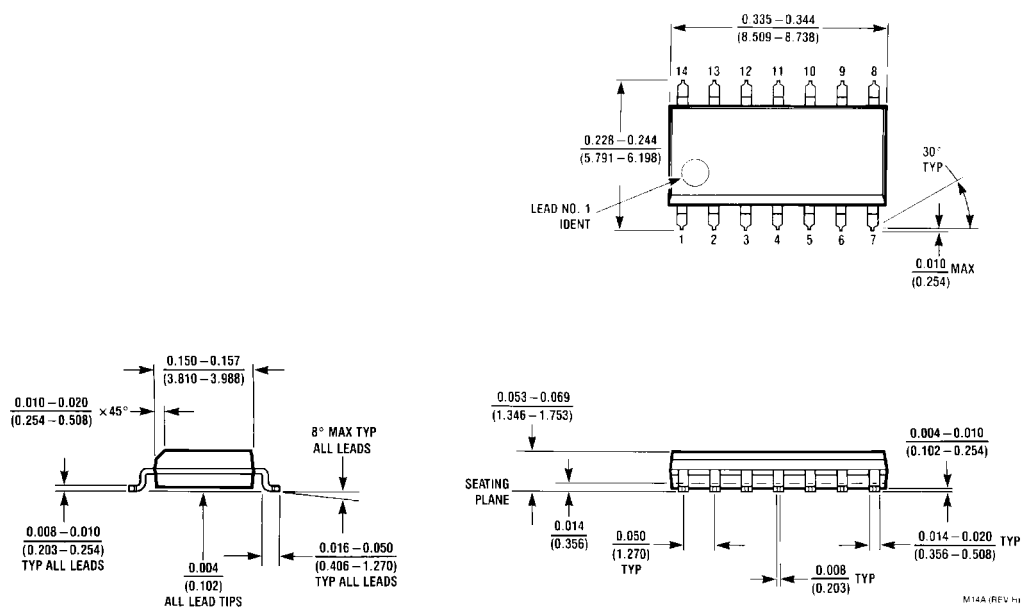


$$V_{NML} = V_{IH(MIN)} - V_{OL} \cong V_{IH(MIN)} = V_{T+ (MIN)}$$

$$V_{NMH} = V_{OH} - V_{IL (MAX)} \cong V_{DD} - V_{IL (MAX)} = V_{DD} - V_{T- (MAX)}$$

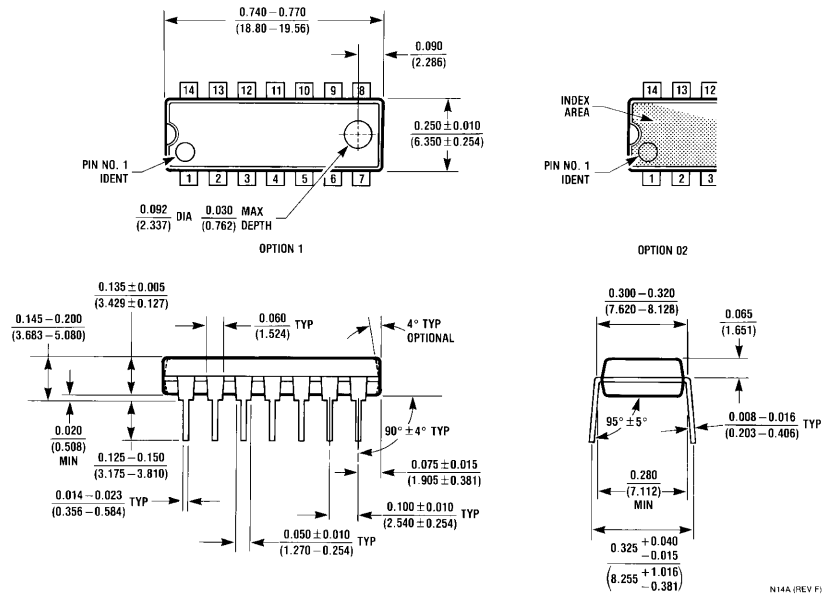
## AC Test Circuits and Switching Time Waveforms



**Physical Dimensions** inches (millimeters) unless otherwise noted


**14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow  
Package Number M14A**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide  
Package Number N14A

Fairchild does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and Fairchild reserves the right at any time without notice to change said circuitry and specifications.

### LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

[www.fairchildsemi.com](http://www.fairchildsemi.com)



ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada

**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910

**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)

**Order Literature:** <http://www.onsemi.com/orderlit>

For additional information, please contact your local  
Sales Representative