

## CD4541BC Programmable Timer

### General Description

The CD4541BC Programmable Timer is designed with a 16-stage binary counter, an integrated oscillator for use with an external capacitor and two resistors, output control logic, and a special power-on reset circuit. The special features of the power-on reset circuit are first, no additional static power consumption and second, the part functions across the full voltage range (3V–15V) whether power-on reset is enabled or disabled.

Timing and the counter are initialized by turning on power, if the power-on reset is enabled. When the power is already on, an external reset pulse will also initialize the timing and counter. After either reset is accomplished, the oscillator frequency is determined by the external RC network. The 16-stage counter divides the oscillator frequency by any of 4 digitally controlled division ratios.

### Features

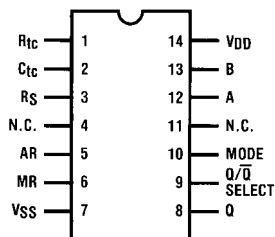
- Available division ratios  $2^8$ ,  $2^{10}$ ,  $2^{13}$ , or  $2^{16}$
- Increments on positive edge clock transitions
- Built-in low power RC oscillator ( $\pm 2\%$  accuracy over temperature range and  $\pm 10\%$  supply and  $\pm 3\%$  over processing @  $< 10$  kHz)
- Oscillator frequency range = DC to 100 kHz
- Oscillator may be bypassed if external clock is available (apply external clock to pin 3)
- Automatic reset initializes all counters when power turns on
- External master reset totally independent of automatic reset operation
- Operates at  $2^n$  frequency divider or single transition timer
- $Q/\bar{Q}$  select provides output logic level flexibility
- Reset (auto or master) disables oscillator during resetting to provide no active power dissipation
- Clock conditioning circuit permits operation with very slow clock rise and fall times
- Wide supply voltage range—3.0V to 15V
- High noise immunity— $0.45 V_{DD}$  (typ.)
- 5V–10V–15V parameter ratings
- Symmetrical output characteristics
- Maximum input leakage  $1 \mu A$  at 15V over full temperature range
- High output drive (pin 8) min. one TTL load

### Ordering Code:

Order Number	Package Number	Package Description
CD4541BCM	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
CD4541BCN	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



N.C.—Not connected

Top View

## Truth Table

Pin	State	
	0	1
5	Auto Reset Operating	Auto Reset Disabled
6	Timer Operational	Master Reset On
9	Output Initially Low after Reset	Output Initially High after Reset
10	Single Cycle Mode	Recycle Mode

## Operating Characteristics

With Auto Reset pin set to a "0" the counter circuit is initialized by turning on power. Or with power already on, the counter circuit is reset when the Master Reset pin is set to a "1". Both types of reset will result in synchronously resetting all counter stages independent of counter state.

The RC oscillator frequency is determined by the external RC network, i.e.:

$$f = \frac{1}{2.3 R_{TC} C_{TC}} \text{ if } (1 \text{ kHz} \leq f \leq 100 \text{ kHz})$$

and  $R_S \approx 2 R_{TC}$  where  $R_S \geq 10 \text{ k}\Omega$

The time select inputs (A and B) provide a two-bit address to output any one of four counter stages ( $2^8$ ,  $2^{10}$ ,  $2^{13}$ , and  $2^{16}$ ). The  $2^n$  counts as shown in the Division Ratio Table represent the Q output of the Nth stage of the counter. When A is "1",  $2^{16}$  is selected for both states of B.

## Division Ratio Table

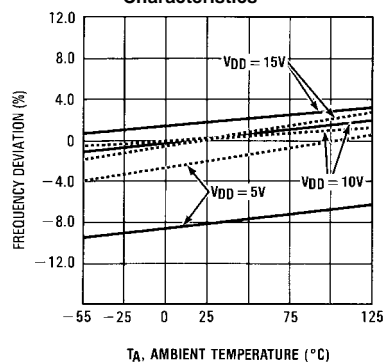
A	B	Number of Counter Stages n	Count $2^n$
		n	
0	0	13	8192
0	1	10	1024
1	0	8	256
1	1	16	65536

However, when B is "0", normal counting is interrupted and the 9th counter stage receives its clock directly from the oscillator (i.e., effectively outputting  $2^8$ ).

The  $Q/\bar{Q}$  select output control pin provides for a choice of output level. When the counter is in a reset condition and  $Q/\bar{Q}$  select pin is set to a "0" the Q output is a "0". Correspondingly, when  $Q/\bar{Q}$  select pin is set to a "1" the Q output is a "1".

When the mode control pin is set to a "1", the selected count is continually transmitted to the output. But, with mode pin "0" and after a reset condition the RS flip-flop resets (see Logic Diagram), counting commences and after  $2^{n-1}$  counts the RS flip-flop sets which causes the output to change state. Hence, after another  $2^{n-1}$  counts the output will not change. Thus, a Master Reset pulse must be applied or a change in the mode pin level is required to reset the single cycle operation.

Typical RC Oscillator Characteristics



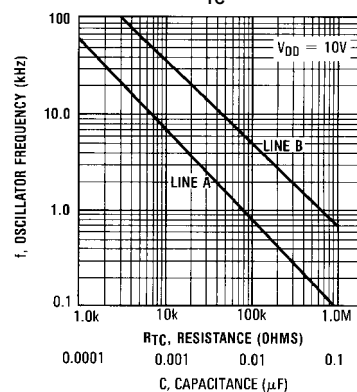
Solid Line =  $R_{TC} = 56 \text{ k}\Omega$ ,  $R_S = 1 \text{ k}\Omega$  and  $C = 1000 \text{ pF}$

$f = 10.2 \text{ kHz}$  @  $V_{DD} = 10\text{V}$  and  $T_A = 25^\circ$

Dashed Line =  $R_{TC} = 56 \text{ k}\Omega$ ,  $R_S = 120 \text{ k}\Omega$  and  $C = 1000 \text{ pF}$

$f = 7.75 \text{ kHz}$  @  $V_{DD} = 10\text{V}$  and  $T_A = 25^\circ$

RC Oscillator Frequency as a Function of  $R_{TC}$  and C

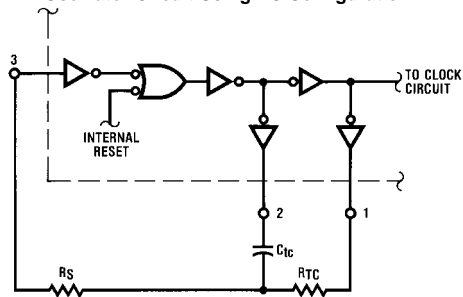


Line A:  $f$  as a function of C and ( $R_{TC} = 56 \text{ k}\Omega$ ;  $R_S = 120 \text{ k}\Omega$ )

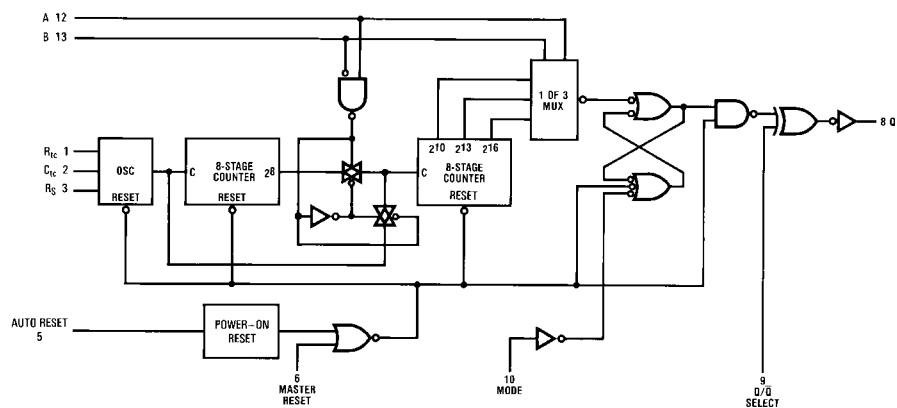
Line B:  $f$  as a function of  $R_{TC}$  and ( $C = 100 \text{ pF}$ ;  $R_S = 2 R_{TC}$ )

## Operating Characteristics (Continued)

### Oscillator Circuit Using RC Configuration



## Logic Diagram



$V_{DD}$  = Pin 14

$V_{SS}$  = Pin 7

**Absolute Maximum Ratings**(Note 1)

(Note 2)

Supply Voltage ( $V_{DD}$ )	–0.5V to +18V
Input Voltage ( $V_{IN}$ )	–0.5V to $V_{DD}$ +0.5V
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)

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

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "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	$V_{DD} = 5V, V_{IN} = V_{DD}$ or $V_{SS}$ $V_{DD} = 10V, V_{IN} = V_{DD}$ or $V_{SS}$ $V_{DD} = 15V, V_{IN} = V_{DD}$ or $V_{SS}$		5 10 20		0.005 0.010 0.015	5 10 20		150 300 600	$\mu A$
$V_{OL}$	LOW Level Output Voltage	$V_{DD} = 5V$ $V_{DD} = 10V \quad  I_{OL}  < 1\mu A$ $V_{DD} = 15V$		0.05 0.05 0.05		0 0 0	0.05 0.05 0.05		0.05 0.05 0.05	V
$V_{OH}$	HIGH Level Output Voltage	$V_{DD} = 5V$ $V_{DD} = 10V \quad  I_{OL}  < 1\mu A$ $V_{DD} = 15V$	4.95 9.95 14.95		4.95 9.95 14.95	5 10 15		4.95 9.95 14.95		V
$V_{IL}$	LOW Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ $V_{DD} = 10V, V_O = 1.0V$ or $9.0V$ $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$		1.5 3.0 4.0		2 4 6	1.5 3.0 4.0		1.5 3.0 4.0	V
$V_{IH}$	HIGH Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ $V_{DD} = 10V, V_O = 1.0V$ or $9.0V$ $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$	3.5 7.0 11.0		3.5 7.0 11.0	3 6 9		3.5 7.0 11.0		V
$I_{OL}$	LOW Level Output Current (Note 3)	$V_{DD} = 5V, V_O = 0.4V$ $V_{DD} = 10V, V_O = 0.5V$ $V_{DD} = 15V, V_O = 1.5V$	2.85 4.16 19.3		2.27 4.0 15.6	3.6 9.0 34.0		1.6 2.8 10.9		mA
$I_{OH}$	HIGH Level Output Current (Note 3)	$V_{DD} = 5V, V_O = 2.5V$ $V_{DD} = 10V, V_O = 9.5V$ $V_{DD} = 15V, V_O = 13.5V$	7.96 4.19 16.3		6.42 3.38 13.2	130 8.0 30.0		4.49 2.37 9.24		mA
$I_{IN}$	Input Current	$V_{DD} = 15V, V_{IN} = 0V$ $V_{DD} = 15V, V_{IN} = 15V$		–0.1 0.1		$-10^{-5}$ $10^{-5}$	–0.1 0.1		–1.0 1.0	$\mu A$

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

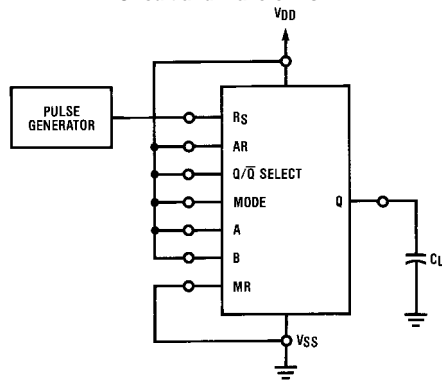
**AC Electrical Characteristics** (Note 4) $T_A = 25^\circ\text{C}$ ,  $C_L = 50\text{ pF}$  (refer to test circuits)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{TLH}$	Output Rise Time	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		50 30 25	200 100 80	ns
$t_{THL}$	Output Fall Time	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		50 30 25	200 100 80	ns
$t_{PLH}$ , $t_{PHL}$	Turn-Off, Turn-On Propagation Delay, Clock to Q ( $2^8$ Output)	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		1.8 0.6 0.4	4.0 1.5 1.0	$\mu\text{s}$
$t_{PHL}$ , $t_{PLH}$	Turn-On, Turn-Off Propagation Delay, Clock to Q ( $2^{16}$ Output)	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		3.2 1.5 1.0	8.0 3.0 2.0	$\mu\text{s}$
$t_{WH(CL)}$	Clock Pulse Width	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	400 200 150	200 100 70		ns
$f_{CL}$	Clock Pulse Frequency	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$		2.5 6.0 8.5	1.0 3.0 4.0	MHz
$t_{WH(R)}$	MR Pulse Width	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$	400 200 150	170 75 50		ns
$C_I$	Average Input Capacitance	Any Input		5.0	7.5	pF
$C_{PD}$	Power Dissipation Capacitance (Note 5)			100		pF

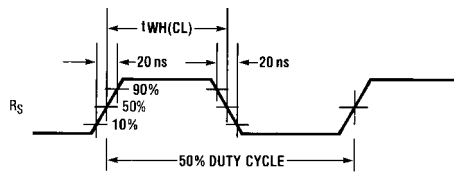
**Note 4:** AC Parameters are guaranteed by DC correlated testing.**Note 5:**  $C_{PD}$  determines the no load AC power consumption of any CMOS device. For complete explanation, see Family Characteristics application note: AN-90.

## Test Circuits and Waveforms

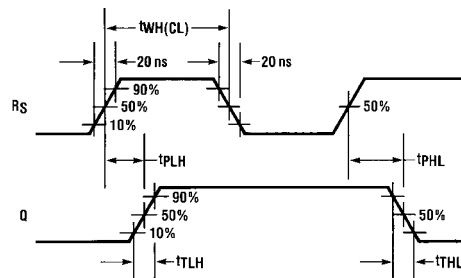
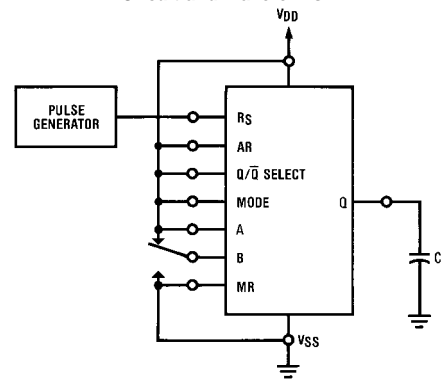
Power Dissipation Test  
Circuit and Waveforms

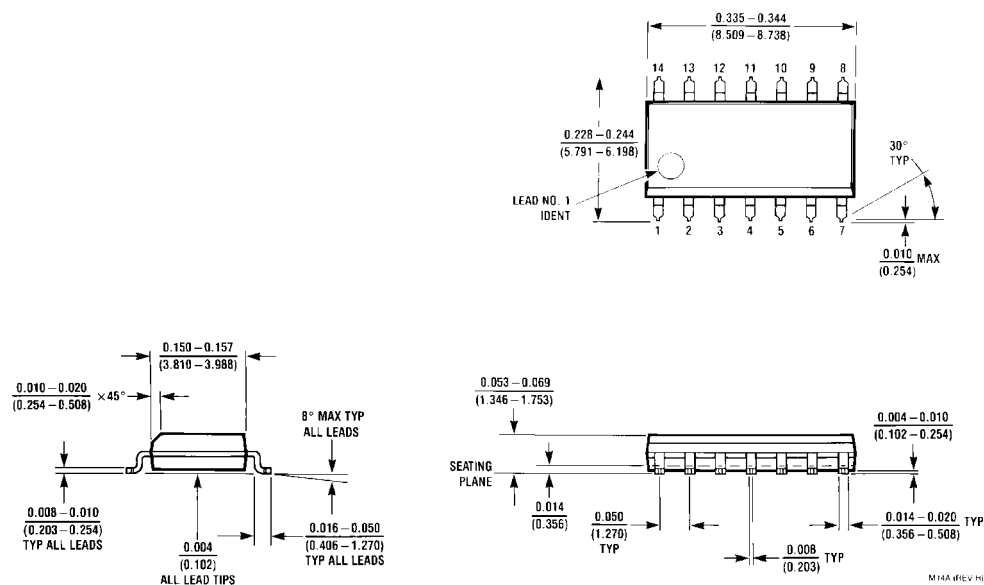


( $R_{TC}$  and  $C_{TC}$  outputs are left open)



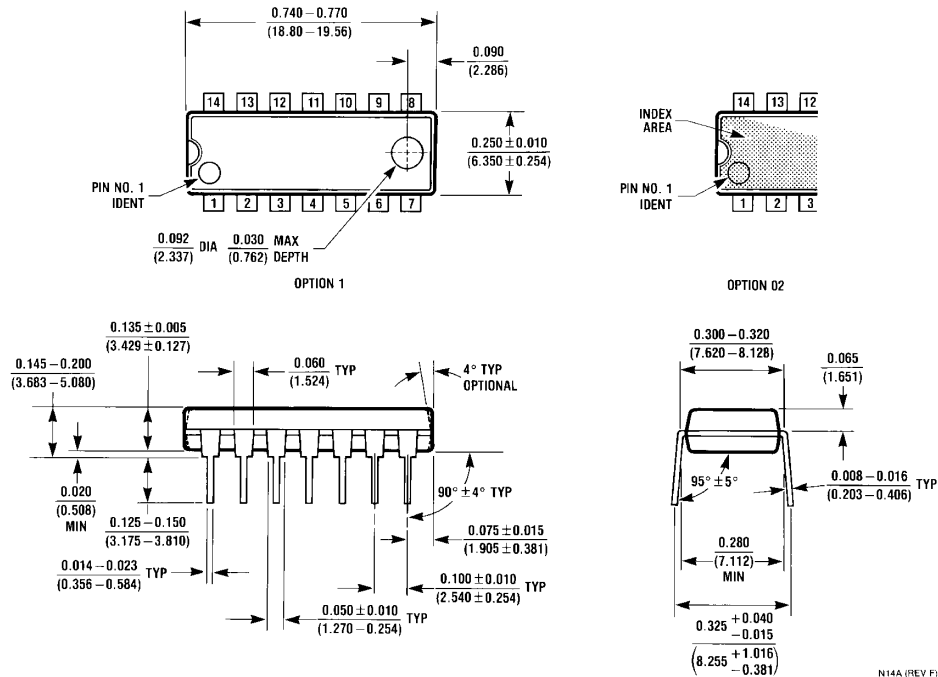
Switching Time Test  
Circuit and Waveforms



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


**16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow  
Package Number M16A**

## 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