

## CD4511BM/CD4511BC BCD-to-7 Segment Latch/Decoder/Driver

### General Description

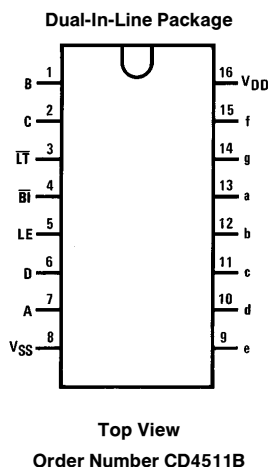
The CD4511BM/CD4511BC BCD-to-seven segment latch/decoder/driver is constructed with complementary MOS (CMOS) enhancement mode devices and NPN bipolar output drivers in a single monolithic structure. The circuit provides the functions of a 4-bit storage latch, an 8421 BCD-to-seven segment decoder, and an output drive capability. Lamp test (LT), blanking (BI), and latch enable (LE) inputs are used to test the display, to turn-off or pulse modulate the brightness of the display, and to store a BCD code, respectively. It can be used with seven-segment light emitting diodes (LED), incandescent, fluorescent, gas discharge, or liquid crystal readouts either directly or indirectly.

Applications include instrument (e.g., counter, DVM, etc.) display driver, computer/calculator display driver, cockpit display driver, and various clock, watch, and timer uses.

### Features

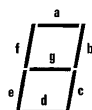
- Low logic circuit power dissipation
- High current sourcing outputs (up to 25 mA)
- Latch storage of code
- Blanking input
- Lamp test provision
- Readout blanking on all illegal input combinations
- Lamp intensity modulation capability
- Time share (multiplexing) facility
- Equivalent to Motorola MC14511

### Connection Diagram



TL/F/5991-1

### Segment Identification



TL/F/5991-3

### Truth Table

Inputs							Outputs							
LE	BI	LT	D	C	B	A	a	b	c	d	e	f	g	Display
X	X	0	X	X	X	X	1	1	1	1	1	1	1	B
X	0	1	X	X	X	X	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	1	1	1	1	1	1	0	
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	*
0	1	1	1	0	1	1	0	0	0	0	0	0	0	
0	1	1	1	1	0	0	0	0	0	0	0	0	0	
0	1	1	1	1	0	1	0	0	0	0	0	0	0	
0	1	1	1	1	1	0	0	0	0	0	0	0	0	
1	1	1	X	X	X	X				*				*

X = Don't Care

\*Depends upon the BCD code applied during the 0 to 1 transition of LE.

### Display



TL/F/5991-2

**Absolute Maximum Ratings** (Notes 1 & 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

DC 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)

DC Supply Voltage ( $V_{DD}$ )	3V to 15V
Input Voltage ( $V_{IN}$ )	0V to $V_{DD}$
Operating Temperature Range ( $T_A$ )	
CD4510BM, CD4516BM	–55°C to +125°C
CD4510BC, CD4516BC	–40°C to +85°C

**DC Electrical Characteristics** CD4511BM

Symbol	Parameter	Conditions	–55°C		+25°C			+125°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
$I_{DD}$	Quiescent Supply Current	$V_{DD} = 5V, V_{IN} = V_{DD}$ or $V_{SS}$		5			5		150	$\mu A$
		$V_{DD} = 10V, V_{IN} = V_{DD}$ or $V_{SS}$		10			10		300	$\mu A$
		$V_{DD} = 15V, V_{IN} = V_{DD}$ or $V_{SS}$		20			20		600	$\mu A$
$V_{OL}$	Output Voltage Logical “0” Level	$V_{DD} = 5V$		0.01		0	0.01		0.05	V
		$V_{DD} = 10V$		0.01		0	0.01		0.05	V
		$V_{DD} = 15V$		0.01		0	0.01		0.05	V
$V_{OH}$	Output Voltage Logical “1” Level	$V_{DD} = 5V$	4.1		4.1	4.57		4.1		V
		$V_{DD} = 10V$	9.1		9.1	9.58		9.1		V
		$V_{DD} = 15V$	14.1		14.1	14.59		14.1		V
$V_{IL}$	Low Level Input Voltage	$V_{DD} = 5V, V_{OUT} = 3.8V$ or $0.5V$		1.5		2	1.5		1.5	V
		$V_{DD} = 10V, V_{OUT} = 8.8V$ or $1.0V$		3.0		4	3.0		3.0	V
		$V_{DD} = 15V, V_{OUT} = 13.8V$ or $1.5V$		4.0		6	4.0		4.0	V
$V_{IH}$	High Level Input Voltage	$V_{DD} = 5V, V_{OUT} = 0.5V$ or $3.8V$	3.5		3.5	3		3.5		V
		$V_{DD} = 10V, V_{OUT} = 1.0V$ or $8.8V$	7.0		7.0	6		7.0		V
		$V_{DD} = 15V, V_{OUT} = 1.5V$ or $13.8V$	11.0		11.0	9		11.0		V
$V_{OH}$	Output (Source) Drive Voltage	$V_{DD} = 5V, I_{OH} = 0\text{ mA}$	4.1		4.1	4.57		4.1		V
		$V_{DD} = 5V, I_{OH} = 5\text{ mA}$				4.24				V
		$V_{DD} = 5V, I_{OH} = 10\text{ mA}$	3.9		3.9	4.12		3.5		V
		$V_{DD} = 5V, I_{OH} = 15\text{ mA}$				3.94				V
		$V_{DD} = 5V, I_{OH} = 20\text{ mA}$	3.4		3.4	3.75		3.0		V
		$V_{DD} = 5V, I_{OH} = 25\text{ mA}$				3.54				V
		$V_{DD} = 10V, I_{OH} = 0\text{ mA}$	9.1		9.1	9.58		9.1		V
		$V_{DD} = 10V, I_{OH} = 5\text{ mA}$				9.26				V
		$V_{DD} = 10V, I_{OH} = 10\text{ mA}$	9.0		9.0	9.17		8.6		V
		$V_{DD} = 10V, I_{OH} = 15\text{ mA}$				9.04				V
		$V_{DD} = 10V, I_{OH} = 20\text{ mA}$	8.6		8.6	8.9		8.2		V
		$V_{DD} = 10V, I_{OH} = 25\text{ mA}$				8.75				V
		$V_{DD} = 15V, I_{OH} = 0\text{ mA}$	14.1		14.1	9.58		14.1		V
		$V_{DD} = 15V, I_{OH} = 5\text{ mA}$				14.27				V
		$V_{DD} = 15V, I_{OH} = 10\text{ mA}$	14.0		14.0	14.17		13.6		V
		$V_{DD} = 15V, I_{OH} = 15\text{ mA}$				14.07				V
		$V_{DD} = 15V, I_{OH} = 20\text{ mA}$	13.6		13.6	13.95		13.2		V
		$V_{DD} = 15V, I_{OH} = 25\text{ mA}$				13.8				V
$I_{OL}$	Low Level Output Current	$V_{DD} = 5V, V_{OL} = 0.4V$	0.64		0.51	0.88		0.36		mA
		$V_{DD} = 10V, V_{OL} = 0.5V$	1.6		1.3	2.25		0.9		mA
		$V_{DD} = 15V, V_{OL} = 1.5V$	4.2		3.4	8.8		2.4		mA
$I_{IN}$	Input Current	$V_{DD} = 15V, V_{IN} = 0V$		–0.10		–10 <sup>–5</sup>	–0.10		–1.0	$\mu A$
		$V_{DD} = 15V, V_{IN} = 15V$		0.10		10 <sup>–5</sup>	0.10		1.0	$\mu A$

**Note 1:** Devices should not be connected with power on.

## DC Electrical Characteristics CD4511BC

Symbol	Parameter	Conditions	− 55°C		+ 25°C			+ 85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I <sub>DD</sub>	Quiescent Supply Current	V <sub>DD</sub> = 5V V <sub>DD</sub> = 10V V <sub>DD</sub> = 15V		20 40 80			20 40 80		150 300 600	μA μA μA
V <sub>OL</sub>	Output Voltage Logical "0" Level	V <sub>DD</sub> = 5V V <sub>DD</sub> = 10V V <sub>DD</sub> = 15V		0.01 0.01 0.01		0 0 0	0.01 0.01 0.01		0.05 0.05 0.05	V V V
V <sub>OH</sub>	Output Voltage Logical "1" Level	V <sub>DD</sub> = 5V V <sub>DD</sub> = 10V V <sub>DD</sub> = 15V	4.1 9.1 14.1		4.1 9.1 14.1	4.57 9.58 14.59		4.1 9.1 14.1		V V V
V <sub>IL</sub>	Low Level Input Voltage	V <sub>DD</sub> = 5V, V <sub>OUT</sub> = 3.8V or 0.5V V <sub>DD</sub> = 10V, V <sub>OUT</sub> = 8.8V or 1.0V V <sub>DD</sub> = 15V, V <sub>OUT</sub> = 13.8V or 1.5V		1.5 3.0 4.0		2 4 6	1.5 3.0 4.0		1.5 3.0 4.0	V V V
V <sub>IH</sub>	High Level Input Voltage	V <sub>DD</sub> = 5V, V <sub>OUT</sub> = 0.5V or 3.8V V <sub>DD</sub> = 10V, V <sub>OUT</sub> = 1.0V or 8.8V V <sub>DD</sub> = 15V, V <sub>OUT</sub> = 1.5V or 13.8V	3.5 7.0 11.0		3.5 7.0 11.0	3 6 9		3.5 7.0 11.0		V V V
V <sub>OH</sub>	Output (Source) Drive Voltage	V <sub>DD</sub> = 5V, I <sub>OH</sub> = 0 mA	4.1		4.1	4.57		4.1		V
		V <sub>DD</sub> = 5V, I <sub>OH</sub> = 5 mA				4.24				V
		V <sub>DD</sub> = 5V, I <sub>OH</sub> = 10 mA	3.6		3.6	4.12		3.3		V
		V <sub>DD</sub> = 5V, I <sub>OH</sub> = 15 mA				3.94				V
		V <sub>DD</sub> = 5V, I <sub>OH</sub> = 20 mA	2.8		2.8	3.75		2.5		V
		V <sub>DD</sub> = 5V, I <sub>OH</sub> = 25 mA				3.54				V
		V <sub>DD</sub> = 10V, I <sub>OH</sub> = 0 mA	9.1		9.1	9.58		9.1		V
		V <sub>DD</sub> = 10V, I <sub>OH</sub> = 5 mA				9.26				V
		V <sub>DD</sub> = 10V, I <sub>OH</sub> = 10 mA	8.75		8.75	9.17		8.45		V
		V <sub>DD</sub> = 10V, I <sub>OH</sub> = 15 mA				9.04				V
		V <sub>DD</sub> = 10V, I <sub>OH</sub> = 20 mA	8.1		8.1	8.9		7.8		V
		V <sub>DD</sub> = 10V, I <sub>OH</sub> = 25 mA				8.75				V
		V <sub>DD</sub> = 15V, I <sub>OH</sub> = 0 mA	14.1		14.1	14.59		14.1		V
		V <sub>DD</sub> = 15V, I <sub>OH</sub> = 5 mA				14.27				V
		V <sub>DD</sub> = 15V, I <sub>OH</sub> = 10 mA	13.75		13.75	14.18		13.45		V
		V <sub>DD</sub> = 15V, I <sub>OH</sub> = 15 mA				14.07				V
		V <sub>DD</sub> = 15V, I <sub>OH</sub> = 20 mA	13.1		13.1	13.95		12.8		V
		V <sub>DD</sub> = 15V, I <sub>OH</sub> = 25 mA				13.8				V
I <sub>OL</sub>	Low Level Output Current	V <sub>DD</sub> = 5V, V <sub>OL</sub> = 0.4V V <sub>DD</sub> = 10V, V <sub>OL</sub> = 0.5V V <sub>DD</sub> = 15V, V <sub>OL</sub> = 1.5V	0.52 1.3 3.6		0.44 1.1 3.0	0.88 2.25 8.8		0.36 0.9 2.4		mA mA mA
I <sub>IN</sub>	Input Current	V <sub>DD</sub> = 15V, V <sub>IN</sub> = 0V V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V		−0.30 0.30		−10 <sup>−5</sup> 10 <sup>−5</sup>	−0.30 0.30		−1.0 1.0	μA μA

## AC Electrical Characteristics\*

$T_A = 25^\circ\text{C}$  and  $C_L = 50\text{ pF}$ , typical temperature coefficient for all values of  $V_{DD} = 0.3\%/^\circ\text{C}$

Symbol	Parameter	Conditions	CD4511BX			Units
			Min	Typ	Max	
$C_{IN}$	Input Capacitance	$V_{IN} = 0$		5.0	7.5	pF
$t_r$	Output Rise Time (Figure 1a)	$V_{DD} = 5\text{V}$		40	80	ns
		$V_{DD} = 10\text{V}$		30	60	ns
		$V_{DD} = 15\text{V}$		25	50	ns
$t_f$	Output Fall Time (Figure 1a)	$V_{DD} = 5\text{V}$		125	250	ns
		$V_{DD} = 10\text{V}$		75	150	ns
		$V_{DD} = 15\text{V}$		65	130	ns
$t_{PLH}$	Turn-Off Delay Time (Data) (Figure 1a)	$V_{DD} = 5\text{V}$		640	1280	ns
		$V_{DD} = 10\text{V}$		250	500	ns
		$V_{DD} = 15\text{V}$		175	350	ns
$t_{PHL}$	Turn-On Delay Time (Data) (Figure 1a)	$V_{DD} = 5\text{V}$		720	1440	ns
		$V_{DD} = 10\text{V}$		290	580	ns
		$V_{DD} = 15\text{V}$		195	400	ns
$t_{PLH}$	Turn-Off Delay Time (Blank) (Figure 1a)	$V_{DD} = 5\text{V}$		320	640	ns
		$V_{DD} = 10\text{V}$		130	260	ns
		$V_{DD} = 15\text{V}$		100	200	ns
$t_{PHL}$	Turn-On Delay Time (Blank) (Figure 1a)	$V_{DD} = 5\text{V}$		485	970	ns
		$V_{DD} = 10\text{V}$		200	400	ns
		$V_{DD} = 15\text{V}$		160	320	ns
$t_{PLH}$	Turn-Off Delay Time (Lamp Test) (Figure 1a)	$V_{DD} = 5\text{V}$		313	625	ns
		$V_{DD} = 10\text{V}$		125	250	ns
		$V_{DD} = 15\text{V}$		90	180	ns
$t_{PHL}$	Turn-On Delay Time (Lamp Test) (Figure 1a)	$V_{DD} = 5\text{V}$		313	625	ns
		$V_{DD} = 10\text{V}$		125	250	ns
		$V_{DD} = 15\text{V}$		90	180	ns
$t_{SETUP}$	Setup Time (Figure 1b)	$V_{DD} = 5\text{V}$	180	90		ns
		$V_{DD} = 10\text{V}$	76	38		ns
		$V_{DD} = 15\text{V}$	40	20		ns
$t_{HOLD}$	Hold Time (Figure 1b)	$V_{DD} = 5\text{V}$	0	-90		ns
		$V_{DD} = 10\text{V}$	0	-38		ns
		$V_{DD} = 15\text{V}$	0	-20		ns
$PW_{LE}$	Minimum Latch Enable Pulse Width (Figure 1c)	$V_{DD} = 5\text{V}$	520	260		ns
		$V_{DD} = 10\text{V}$	220	110		ns
		$V_{DD} = 15\text{V}$	130	65		ns

\*AC Parameters are guaranteed by DC correlated testing.

## Switching Time Waveforms

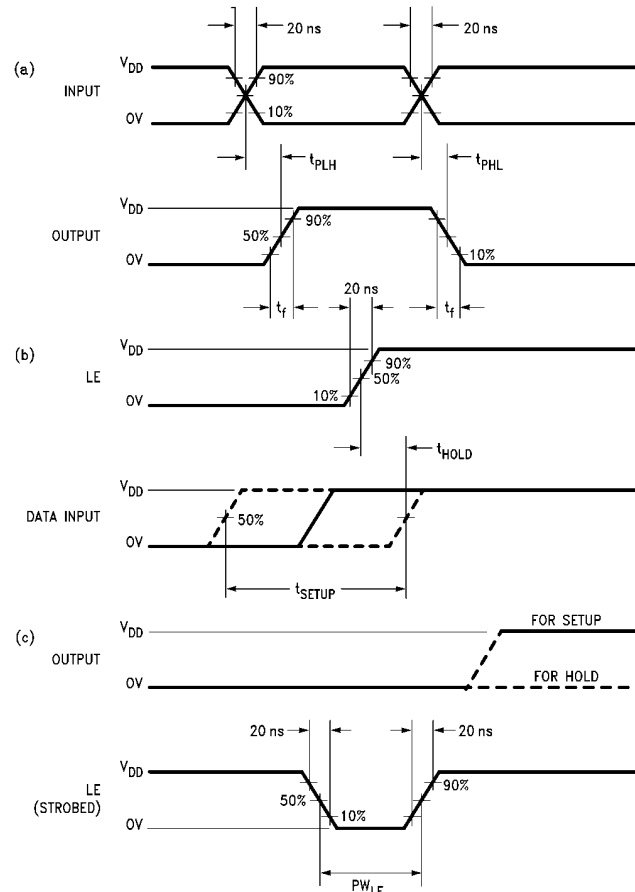
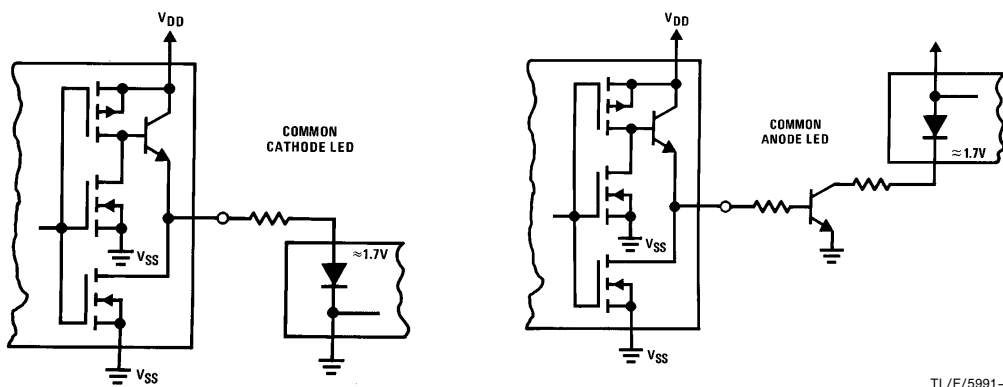


FIGURE 1

TL/F/5991-4

## Typical Applications

### Light Emitting Diode (LED) Readout

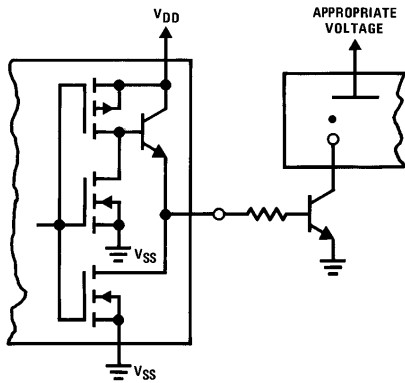


TL/F/5991-5

TL/F/5991-6

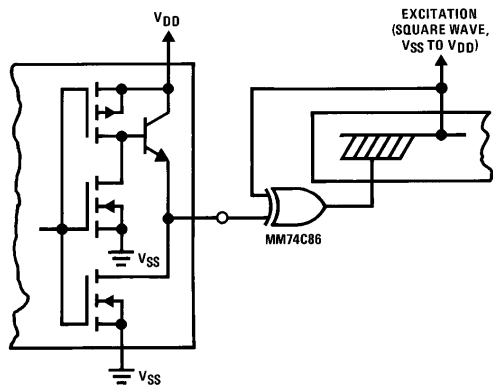
## Typical Applications (Continued)

**Gas Discharge Readout**



TL/F/5991-7

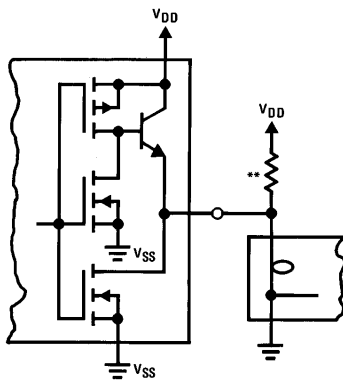
**Liquid Crystal (LC) Readout**



TL/F/5991-8

Direct DC drive of LC's not recommended for life of LC readouts.

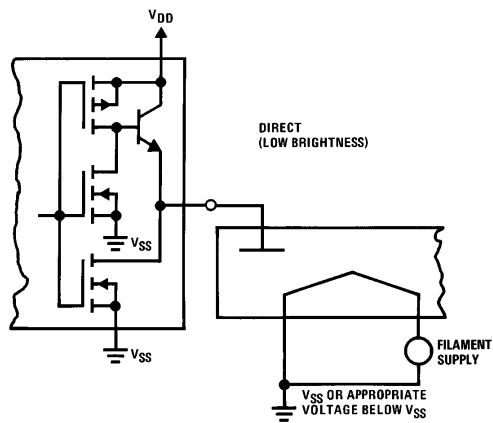
**Incandescent Readout**



TL/F/5991-9

\*\*A filament pre-warm resistor is recommended to reduce filament thermal shock and increase the effective cold resistance of the filament.

**Fluorescent Readout**



TL/F/5991-10

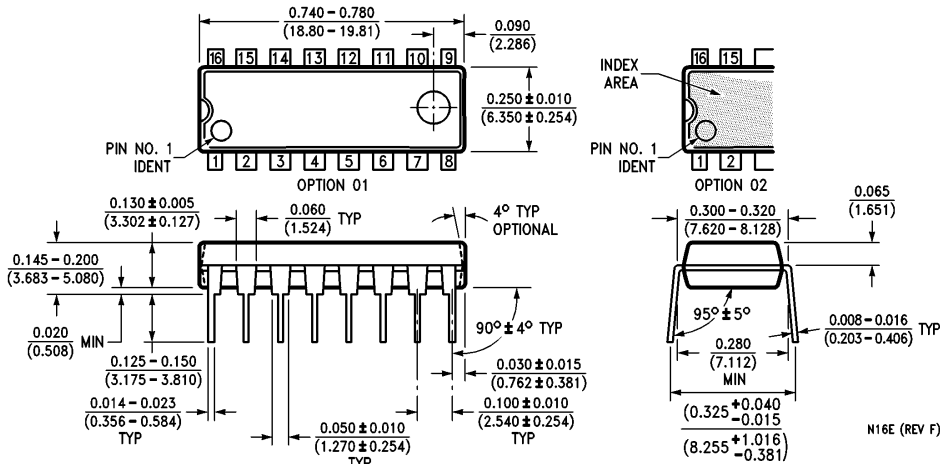
The image contains three mechanical drawings of the J16A package:

- Top View:** Shows a rectangular package with 16 pins (8 on each long side). Dimensions include a total width of  $0.785 \pm 0.005$  [19.94] MAX, a pin pitch of  $0.037 \pm 0.005$  [0.94] TYP, and a pin diameter of  $0.025$  [0.64]. The package body has a width of  $0.220-0.310$  [5.59-7.87] and a thickness of  $0.005-0.020$  TYP [0.13-0.51].
- Side View:** Shows the package height and pin dimensions. The package height is  $0.200$  [5.08] MAX TYP. The pin height is  $0.125-0.200$  [3.18-5.08] TYP. The pin diameter is  $0.080$  [2.03] MAX. The package body thickness is  $0.010 \pm 0.010$  [2.54 ± 0.25] TYP. The pin angle is  $90^\circ \pm 4^\circ$  TYP.
- Cross-sectional View:** Shows the package mounted on a substrate. The package height is  $0.290-0.320$  [7.37-8.13]. The pin height is  $0.180$  [4.57] MAX. The package body thickness is  $0.010 \pm 0.002$  [0.25 ± 0.05] TYP. The pin angle is  $95^\circ \pm 5^\circ$  TYP. The package is sealed with GLASS SEALANT. The substrate thickness is  $0.310-0.410$  [7.87-10.41].

J16A (REV L)

J16A (REV L)

## Physical Dimensions inches (millimeters) (Continued)



**Molded Dual-In-Line Package (N)**  
**Order Number CD4511BMN or CD4511BCN**  
**NS Package Number N16E**

### LIFE SUPPORT POLICY

NATIONAL'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 NATIONAL 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 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 is 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.



**National Semiconductor Corporation**  
 1111 West Bardin Road  
 Arlington, TX 76017  
 Tel: 1(800) 272-9959  
 Fax: 1(800) 737-7018

**National Semiconductor Europe**  
 Fax: (+49) 0-180-530 85 86  
 Email: [cnjwge@tevm2.nsc.com](mailto:cnjwge@tevm2.nsc.com)  
 Deutsch Tel: (+49) 0-180-530 85 85  
 English Tel: (+49) 0-180-532 78 32  
 Français Tel: (+49) 0-180-532 93 58  
 Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**  
 13th Floor, Straight Block,  
 Ocean Centre, 5 Canton Rd.  
 Tsimshatsui, Kowloon  
 Hong Kong  
 Tel: (852) 2737-1600  
 Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**  
 Tel: 81-043-299-2309  
 Fax: 81-043-299-2408

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