

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

### General Description

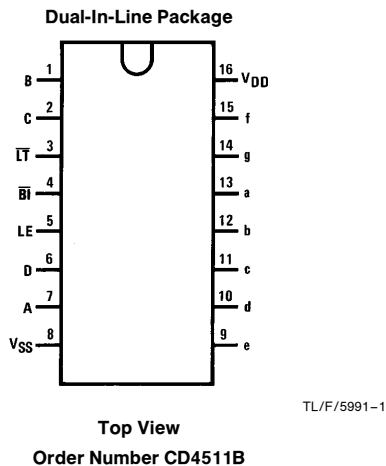
The CD4511BM/CD4511BC BCD-to-seven segment latch/decoder/driver is constructed with complementary MOS (CMOS) enhancement mode devices and NPN bipolar output drivers in a single monolithic structure. The circuit provides the functions of a 4-bit storage latch, an 8421 BCD-to-seven segment decoder, and 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.

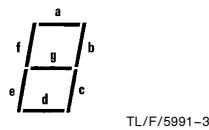
### Features

- 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



### Segment Identification

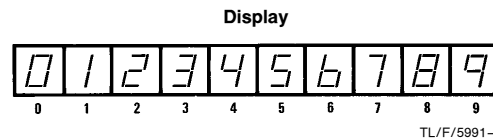


### Truth Table

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	1	1	0	0	0	0	1	1	1	1	1	1	0	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	1	0	0	0	0	0	0	0	
0	1	1	1	1	1	0	0	0	0	0	0	0	0	
0	1	1	1	1	1	1	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.



**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	$V_{DD} = 5V, I_{OH} = 0mA$	4.1		4.1	4.57		4.1		V
		$V_{DD} = 5V, I_{OH} = 5mA$				4.24				V
		$V_{DD} = 5V, I_{OH} = 10mA$	3.9		3.9	4.12		3.5		V
		$V_{DD} = 5V, I_{OH} = 15mA$				3.94				V
		$V_{DD} = 5V, I_{OH} = 20mA$	3.4		3.4	3.75		3.0		V
		$V_{DD} = 5V, I_{OH} = 25mA$				3.54				V
		$V_{DD} = 10V, I_{OH} = 0mA$	9.1		9.1	9.58		9.1		V
		$V_{DD} = 10V, I_{OH} = 5mA$				9.26				V
		$V_{DD} = 10V, I_{OH} = 10mA$	9.0		9.0	9.17		8.6		V
		$V_{DD} = 10V, I_{OH} = 15mA$				9.04				V
		$V_{DD} = 10V, I_{OH} = 20mA$	8.6		8.6	8.9		8.2		V
		$V_{DD} = 10V, I_{OH} = 25mA$				8.75				V
$V_{OL}$	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
		$V_{DD} = 5V, V_{IN} = 0V$		-0.10		$-10^{-5}$	-0.10		-1.0	$\mu A$
		$V_{DD} = 15V, V_{IN} = 15V$		0.10		$10^{-5}$	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		20				20		150	μA
		V <sub>DD</sub> = 10V		40				40		300	μA
		V <sub>DD</sub> = 15V		80				80		600	μA
V <sub>OL</sub>	Output Voltage Logical "0" Level	V <sub>DD</sub> = 5V		0.01		0	0.01		0.05		V
		V <sub>DD</sub> = 10V		0.01		0	0.01		0.05		V
		V <sub>DD</sub> = 15V		0.01		0	0.01		0.05		V
V <sub>OH</sub>	Output Voltage Logical "1" Level	V <sub>DD</sub> = 5V	4.1		4.1	4.57		4.1			V
		V <sub>DD</sub> = 10V	9.1		9.1	9.58		9.1			V
		V <sub>DD</sub> = 15V	14.1		14.1	14.59		14.1			V
V <sub>IL</sub>	Low Level Input Voltage	V <sub>DD</sub> = 5V, V <sub>OUT</sub> = 3.8V or 0.5V		1.5		2	1.5		1.5		V
		V <sub>DD</sub> = 10V, V <sub>OUT</sub> = 8.8V or 1.0V		3.0		4	3.0		3.0		V
		V <sub>DD</sub> = 15V, V <sub>OUT</sub> = 13.8V or 1.5V		4.0		6	4.0		4.0		V
V <sub>IH</sub>	High Level Input Voltage	V <sub>DD</sub> = 5V, V <sub>OUT</sub> = 0.5V or 3.8V	3.5		3.5	3		3.5			V
		V <sub>DD</sub> = 10V, V <sub>OUT</sub> = 1.0V or 8.8V	7.0		7.0	6		7.0			V
		V <sub>DD</sub> = 15V, V <sub>OUT</sub> = 1.5V or 13.8V	11.0		11.0	9		11.0			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>OH</sub>	Output (Source) Drive Voltage	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	0.52		0.44	0.88		0.36			mA
		V <sub>DD</sub> = 10V, V <sub>OL</sub> = 0.5V	1.3		1.1	2.25		0.9			mA
		V <sub>DD</sub> = 15V, V <sub>OL</sub> = 1.5V	3.6		3.0	8.8		2.4			mA
I <sub>IN</sub>	Input Current	V <sub>DD</sub> = 15V, V <sub>IN</sub> = 0V		-0.30		-10 <sup>-5</sup>	-0.30		-1.0		μA
		V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V		0.30		10 <sup>-5</sup>	0.30		1.0		μA

<b>AC Electrical Characteristics*</b>						
T <sub>A</sub> = 25°C and C <sub>L</sub> = 50 pF, typical temperature coefficient for all values of V <sub>DD</sub> = 0.3%/°C						
Symbol	Parameter	Conditions	CD4511BX			Units
			Min	Typ	Max	
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 0		5.0	7.5	pF
t <sub>r</sub>	Output Rise Time (Figure 1a)	V <sub>DD</sub> = 5V		40	80	ns
		V <sub>DD</sub> = 10V		30	60	ns
		V <sub>DD</sub> = 15V		25	50	ns
t <sub>f</sub>	Output Fall Time (Figure 1a)	V <sub>DD</sub> = 5V		125	250	ns
		V <sub>DD</sub> = 10V		75	150	ns
		V <sub>DD</sub> = 15V		65	130	ns
t <sub>PLH</sub>	Turn-Off Delay Time (Data) (Figure 1a)	V <sub>DD</sub> = 5V		640	1280	ns
		V <sub>DD</sub> = 10V		250	500	ns
		V <sub>DD</sub> = 15V		175	350	ns
t <sub>PHL</sub>	Turn-On Delay Time (Data) (Figure 1a)	V <sub>DD</sub> = 5V		720	1440	ns
		V <sub>DD</sub> = 10V		290	580	ns
		V <sub>DD</sub> = 15V		195	400	ns
t <sub>PLH</sub>	Turn-Off Delay Time (Blank) (Figure 1a)	V <sub>DD</sub> = 5V		320	640	ns
		V <sub>DD</sub> = 10V		130	260	ns
		V <sub>DD</sub> = 15V		100	200	ns
t <sub>PHL</sub>	Turn-On Delay Time (Blank) (Figure 1a)	V <sub>DD</sub> = 5V		485	970	ns
		V <sub>DD</sub> = 10V		200	400	ns
		V <sub>DD</sub> = 15V		160	320	ns
t <sub>PLH</sub>	Turn-Off Delay Time (Lamp Test) (Figure 1a)	V <sub>DD</sub> = 5V		313	625	ns
		V <sub>DD</sub> = 10V		125	250	ns
		V <sub>DD</sub> = 15V		90	180	ns
t <sub>PHL</sub>	Turn-On Delay Time (Lamp Test) (Figure 1a)	V <sub>DD</sub> = 5V		313	625	ns
		V <sub>DD</sub> = 10V		125	250	ns
		V <sub>DD</sub> = 15V		90	180	ns
t <sub>SETUP</sub>	Setup Time (Figure 1b)	V <sub>DD</sub> = 5V	180	90		ns
		V <sub>DD</sub> = 10V	76	38		ns
		V <sub>DD</sub> = 15V	40	20		ns
t <sub>HOLD</sub>	Hold Time (Figure 1b)	V <sub>DD</sub> = 5V	0	-90		ns
		V <sub>DD</sub> = 10V	0	-38		ns
		V <sub>DD</sub> = 15V	0	-20		ns
PW <sub>LE</sub>	Minimum Latch Enable Pulse Width (Figure 1c)	V <sub>DD</sub> = 5V	520	260		ns
		V <sub>DD</sub> = 10V	220	110		ns
		V <sub>DD</sub> = 15V	130	65		ns

\*AC Parameters are guaranteed by DC correlated testing.

**Switching Time Waveforms**

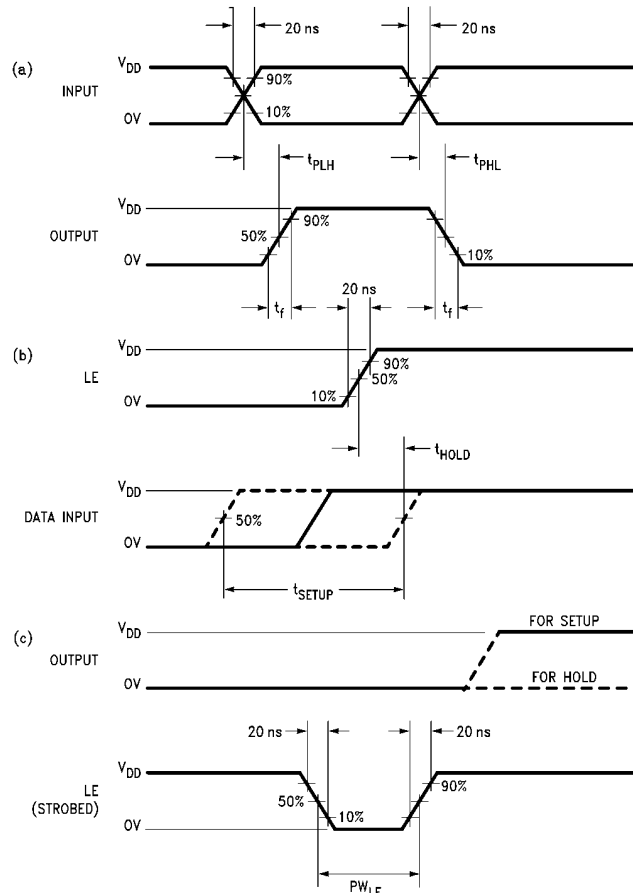
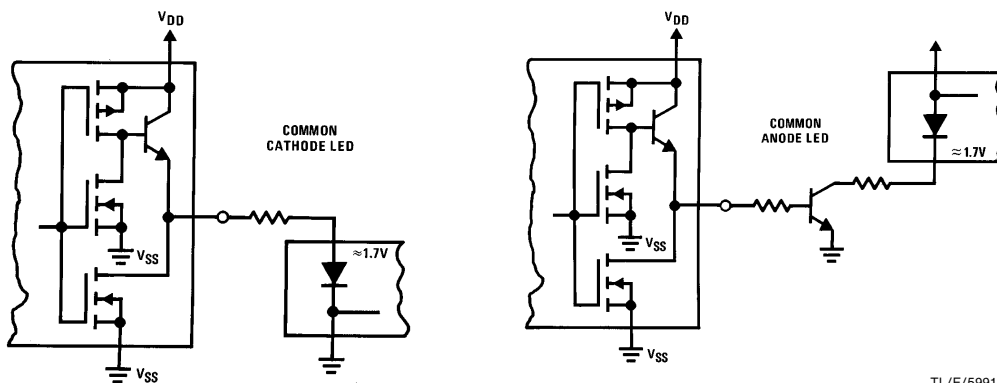


FIGURE 1

TL/F/5991-4

**Typical Applications**

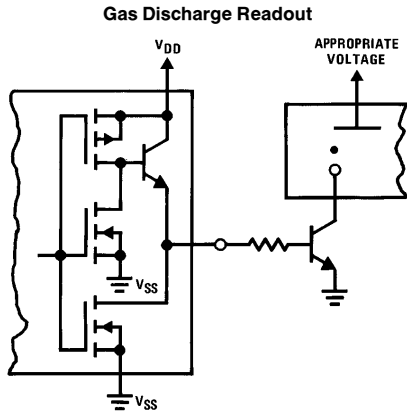
**Light Emitting Diode (LED) Readout**



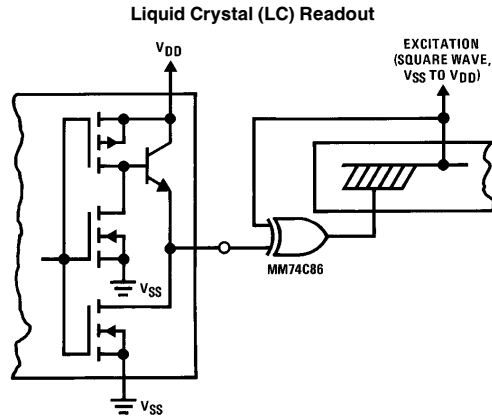
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Typical Applications (Continued)

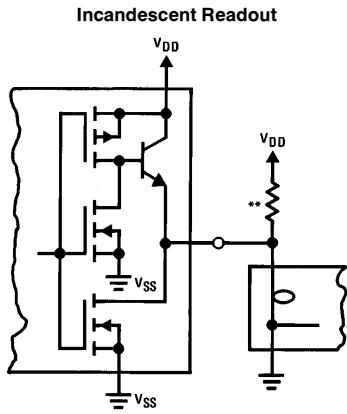


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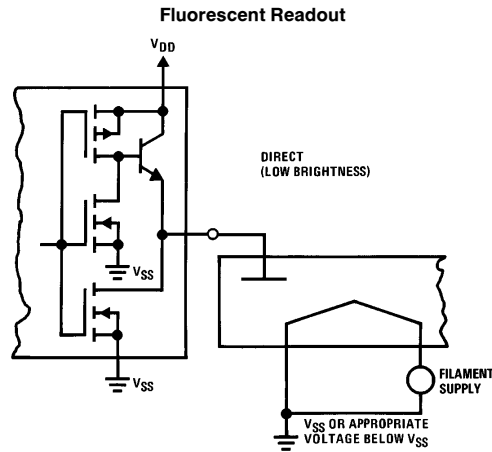
TL/F/5991-8

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



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.



TL/F/5991-10

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