National Semiconductor

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

General Description

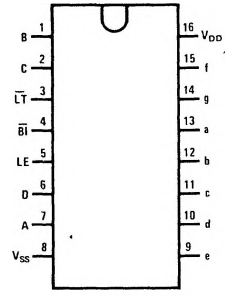
The CD4511BM/CD4511BC BCD-to-seven segment latch/decoder/driver is constructed with complementary MOS (CMOS) enhancement mode devices and NPN bipolar output drivers in a single monolithic structure. The circuit provides the functions of a 4-bit storage latch, an 8421 BCD-to-seven segment decoder, and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

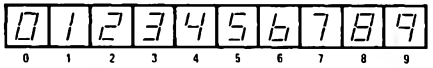
- Low logic circuit power dissipation
- High current sourcing outputs (up to 25mA)
- Latch storage of code
- Blanking input
- Lamp test provision
- Readout blanking on all illegal input combinations
- Lamp intensity modulation capability
- Time share (multiplexing) facility
- Equivalent to Motorola MC14511

Connection Diagram

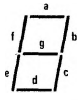


TOP VIEW

Display



Segment Identification



Truth Table

INPUTS							OUTPUTS							
LE	$\overline{BI}$	$\overline{LT}$	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	8
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	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	
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 and 2)

V_{DD} dc Supply Voltage	−0.5V to +18V
V_{IN} Input Voltage	−0.5V to V_{DD} +0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 seconds)	300°C

Recommended Operating Conditions

(Note 2)

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

DC Electrical Characteristics CD4511BM

PARAMETER	CONDITIONS	−55°C			+25°C			+125°C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Output Voltage	V_{DD} = 5V			0.01		0	0.01			0.05	V
Logical "0"	V_{DD} = 10V			0.01		0	0.01			0.05	V
Level (V_{OUT})	V_{DD} = 15V					0					V
Output Voltage	V_{DD} = 5V	4.1			4.1	4.57		4.1			V
Logical "1"	V_{DD} = 10V	9.1			9.1	9.58		9.1			V
Level (V_{OUT})	V_{DD} = 15V	14.1			14.1	14.59		14.1			V
Low Level	V_{DD} = 5V, V_{OUT} = 3.8V or 0.5V			1.5		2	1.5			1.5	V
Input Voltage	V_{DD} = 10V, V_{OUT} = 8.8V or 1.0V			3.0		4	3.0			3.0	V
(V_{IL})	V_{DD} = 15V, V_{OUT} = 13.8V or 1.5V			4.0		6	4.0			4.0	V
High Level	V_{DD} = 5V, V_{OUT} = 0.5V or 3.8V	3.5			3.5	3		3.5			V
Input Voltage	V_{DD} = 10V, V_{OUT} = 1.0V or 8.8V	7.0			7.0	6		7.0			V
(V_{IH})	V_{DD} = 15V, V_{OUT} = 1.5V or 13.8V	11.0			11.0	9		11.0			V
Output (Source)	V_{DD} = 5V, I_{OH} = 0 mA	4.1			4.1	4.57		4.1			V
Drive Voltage	V_{DD} = 5V, I_{OH} = 5 mA					4.24					V
(V_{OH})	V_{DD} = 5V, I_{OH} = 10 mA	3.9			3.9	4.12		3.5			V
	V_{DD} = 5V, I_{OH} = 15 mA					3.94					V
	V_{DD} = 5V, I_{OH} = 20 mA	3.4			3.4	3.75		3.0			V
	V_{DD} = 5V, I_{OH} = 25 mA					3.54					V
	V_{DD} = 10V, I_{OH} = 0 mA	9.1			9.1	9.58		9.1			V
	V_{DD} = 10V, I_{OH} = 5 mA					9.26					V
	V_{DD} = 10V, I_{OH} = 10 mA	9.0			9.0	9.17		8.6			V
	V_{DD} = 10V, I_{OH} = 15 mA					9.04					V
	V_{DD} = 10V, I_{OH} = 20 mA	8.6			8.6	8.9		8.2			V
	V_{DD} = 10V, I_{OH} = 25 mA					8.75					V
	V_{DD} = 15V, I_{OH} = 0 mA	14.1			14.1	14.59		14.1			V
	V_{DD} = 15V, I_{OH} = 5 mA					14.27					V
	V_{DD} = 15V, I_{OH} = 10 mA	14.0			14.0	14.18		13.6			V
	V_{DD} = 15V, I_{OH} = 15 mA					14.07					V
	V_{DD} = 15V, I_{OH} = 20 mA	13.6			13.6	13.95		13.2			V
	V_{DD} = 15V, I_{OH} = 25 mA					13.8					V
Low Level	V_{DD} = 5V, V_{OL} = 0.4V	0.64			0.51	0.88		0.36			mA
Output Current	V_{DD} = 10V, V_{OL} = 0.5V	1.6			1.3	2.25		0.9			mA
(I_{OL})	V_{DD} = 15V, V_{OL} = 1.5V	4.2			3.4	8.8		2.4			mA
Input Current	V_{DD} = 15V, V_{IN} = 0V			−0.10		-10^{-5}	−0.10			−1.0	μA
(I_{IN})	V_{DD} = 15V, V_{IN} = 15V			0.10		10^{-5}	0.10			1.0	μA

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

DC Electrical Characteristics CD4511BC

PARAMETER	CONDITIONS	−40°C			+25°C			+85°C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Output Voltage Logical "0" Level (V_{OUT})	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					V
Output Voltage Logical "1" Level (V_{OUT})	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
Low Level Input Voltage (V_{IL})	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
High Level Input Voltage (V_{IH})	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
Output (Source) Drive Voltage (V_{OH})	V_{DD} = 5V, I_{OH} = 0 mA	4.1			4.1	4.57		4.1			V
	V_{DD} = 5V, I_{OH} = 5 mA					4.24					V
	V_{DD} = 5V, I_{OH} = 10 mA	3.6			3.6	4.12		3.3			V
	V_{DD} = 5V, I_{OH} = 15 mA					3.94					V
	V_{DD} = 5V, I_{OH} = 20 mA	2.8			2.8	3.75		2.5			V
	V_{DD} = 5V, I_{OH} = 25 mA					3.54					V
	V_{DD} = 10V, I_{OH} = 0 mA	9.1			9.1	9.58		9.1			V
	V_{DD} = 10V, I_{OH} = 5 mA					9.26					V
	V_{DD} = 10V, I_{OH} = 10 mA	8.75			8.75	9.17		8.45			V
	V_{DD} = 10V, I_{OH} = 15 mA					9.04					V
	V_{DD} = 10V, I_{OH} = 20 mA	8.1			8.1	8.9		7.8			V
	V_{DD} = 10V, I_{OH} = 25 mA					8.75					V
	V_{DD} = 15V, I_{OH} = 0 mA	14.1			14.1	14.59		14.1			V
	V_{DD} = 15V, I_{OH} = 5 mA					14.27					V
	V_{DD} = 15V, I_{OH} = 10 mA	13.75			13.75	14.18		13.45			V
	V_{DD} = 15V, I_{OH} = 15 mA					14.07					V
	V_{DD} = 15V, I_{OH} = 20 mA	13.1			13.1	13.95		12.8			V
	V_{DD} = 15V, I_{OH} = 25 mA					13.8					V
Low Level Output Current (I_{OL})	V_{DD} = 5V, V_{OL} = 0.4V	0.52			0.44	0.88		0.36			mA
	V_{DD} = 10V, V_{OL} = 0.5V	1.3			1.1	2.25		0.9			mA
	V_{DD} = 15V, V_{OL} = 1.5V	3.6			3.0	8.8		2.4			mA
Input Current (I_{IN})	V_{DD} = 15V, V_{IN} = 0V			−0.30		-10^{-5}	−0.30			−1.0	μA
	V_{DD} = 15V, V_{IN} = 15V			0.30		10^{-5}	0.30			1.0	μA

AC Electrical Characteristics

T_A = 25°C and C_L = 50 pF, typical temperature coefficient for all values of V_{DD} = 0.3%/°C.

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

Switching Time Waveforms

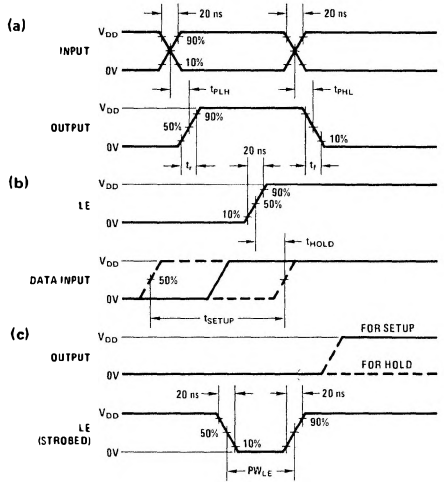
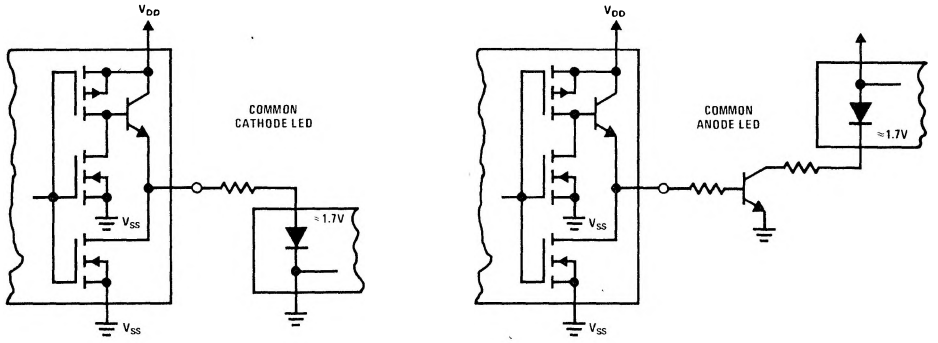


FIGURE 1.

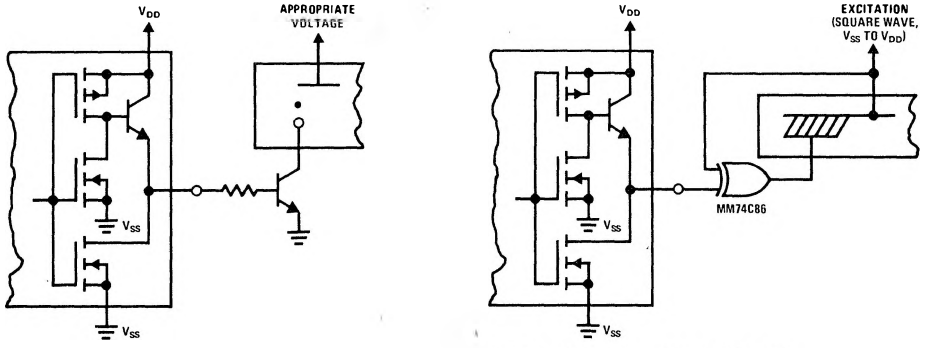
Typical Applications

Light Emitting Diode (LED) Readout



Gas Discharge Readout

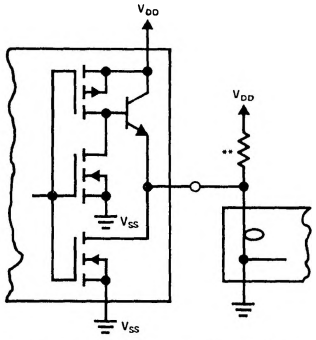
Liquid Crystal (LC) Readout



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

Typical Applications (Cont'd.)

Incandescent Readout



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

Fluorescent Readout