CD4543BM/CD4543BC BCD-to-7-Segment Latch/Decoder/Driver for Liquid Crystals

General Description

The CD4543BM/CD4543BC is a monolithic CMOS BCD-to-7-segment latch/decoder/driver for use with liquid crystal and other types of displays. The circuit provides the functions of a 4-bit storage latch and an 8421 BCD-to-7-segment decoder and driver. The device has the capability to invert the logic levels of the output combination. The phase (Ph), blanking (Bl) and latch disable (LD) inputs are used to reverse the truth table phase, blank the display, and store a BCD code, respectively. For liquid crystal (LC) readouts, a square wave is applied to the Ph input of the circuit and the electrically common backplane of the display, and the outputs of the circuit are connected directly to the segments of the LC readout. For other types of readouts, such as light-emitting diode (LED), incandescent, gas discharge, and fluorescent readouts, connection diagrams are given on this data sheet.

All inputs are protected against static discharge by diode clamps to V_{DD} and V_{SS}.

Features

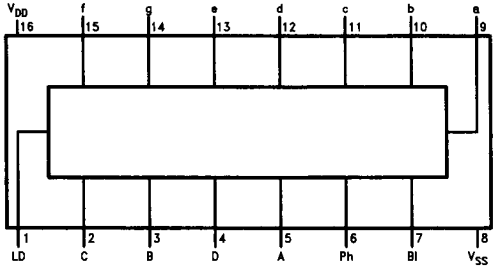
- Wide supply voltage range — 3.0V to 18V
- High noise immunity — 0.45 V_{DD} (typ.)
- Low power TTL compatibility — Fan out of 2 driving 74L or 1 driving 74LS
- Low power dissipation — 50 nA/package (typ.) at V_{DD} = 5.0V
- Latch storage
- Blanking input
- Blank for all illegal inputs
- Direct-drive LCD, LED and VF displays
- Pin-for-pin replacement for CD4056B (with pin 7 tied to V_{SS})
- Pin-for-pin replacement for Motorola MC14543B

Applications

- Instrument (e.g., counter, DVM, etc.) display driver
- Computer/calculator display driver
- Cockput display driver
- Various clock, watch, and timer users

Connection Diagram and Truth Table

Dual-In-Line Package



Top View

Order Number CD4543B*

*Please look into Section 8, Appendix D for availability of various package types.

Inputs							Outputs							
LD	Bl	Ph*	D	C	B	A	a	b	c	d	e	f	g	Display
X	1	0	X	X	X	X	0	0	0	0	0	0	0	Blank
1	0	0	0	0	0	0	1	1	1	1	1	1	0	0
1	0	0	0	0	0	1	0	1	1	0	0	0	0	1
1	0	0	0	0	1	0	1	1	0	1	1	0	1	2
1	0	0	0	0	1	1	1	1	1	1	0	0	1	3
1	0	0	0	1	0	0	0	1	1	0	0	1	1	4
1	0	0	0	1	0	1	1	0	1	1	0	1	1	5
1	0	0	0	1	1	0	1	0	1	1	1	1	1	6
1	0	0	0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	0	0	1	1	1	1	1	0	1	1	9
1	0	0	1	0	1	0	0	0	0	0	0	0	0	Blank
1	0	0	1	0	1	1	0	0	0	0	0	0	0	Blank
1	0	0	1	1	0	0	0	0	0	0	0	0	0	Blank
1	0	0	1	1	0	1	0	0	0	0	0	0	0	Blank
1	0	0	1	1	1	0	0	0	0	0	0	0	0	Blank
1	0	0	1	1	1	1	0	0	0	0	0	0	0	Blank
0	0	0	X	X	X	X	**							**
†	†	1	†				Inverse of Output Combinations Above							Display as Above

X = Don't care
† = Above combinations
* = For liquid crystal readouts, apply a square wave to Ph.
For common cathode LED readouts, select Ph = 0.
For common anode LED readouts, select Ph = 1.
** = Depends upon the BCD code previously applied when LD = 1.

Display Format

Absolute Maximum Ratings (Notes 1 & 2)

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

DC Supply Voltage (V_{DD})	$-0.5\ V_{DC}$ to $+18\ V_{DC}$
Input Voltage (V_{IN})	$-0.5\ V_{DC}$ to $V_{DD} + 0.5\ V_{DC}$
Storage Temp. 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})	$3\ V_{DC}$ to $15\ V_{DC}$
Input Voltage (V_{IN})	$0\ V_{DC}$ to $V_{DD}\ V_{DC}$
Operating Temperature Range (T_A)	
CD4543BM	$-55°C$ to $+125°C$
CD4543BC	$-40°C$ to $+85°C$

DC Electrical Characteristics CD4543BM (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			5 10 20		150 300 600	μA μA μA
V_{OL}	Low Level Output Voltage	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$ } $\lvert I_O \rvert < 1\ \mu A$		0.05 0.05 0.05		0 0 0	0.05 0.05 0.05		0.05 0.05 0.05	V V V
V_{OH}	High Level Output Voltage	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$ } $\lvert I_O \rvert < 1\ \mu A$	4.95 9.95 14.95		4.95 9.95 14.95	5 10 15		4.95 9.95 14.95		V V V
V_{IL}	Low Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ $V_{DD} = 10V, V_O = 1V$ or $9V$ $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$		1.5 3.0 4.0			1.5 3.0 4.0		1.5 3.0 4.0	V V V
V_{IH}	High Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ $V_{DD} = 10V, V_O = 1V$ or $9V$ $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$	3.5 7.0 11.0		3.5 7.0 11.0			3.5 7.0 11.0		V V V
I_{OL}	Low Level Output Current (Note 3)	$V_{DD} = 5V, V_O = 0.4V$ $V_{DD} = 10V, V_O = 0.5V$ $V_{DD} = 15V, V_O = 1.5V$	0.64 1.6 4.2		0.51 1.3 3.4			0.36 0.9 2.4		mA mA mA
I_{OH}	High Level Output Current (Note 3)	$V_{DD} = 5V, V_O = 4.6V$ $V_{DD} = 10V, V_O = 9.5V$ $V_{DD} = 15V, V_O = 13.5V$	−0.64 −1.6 −4.2		−0.51 −1.3 −3.4			−0.36 −0.9 −2.4		mA mA 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	μA μA

DC Electrical Characteristics CD4543BC (Note 2)

Symbol	Parameter	Conditions	−40°C		+25°C			+85°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}		20 40 80			20 40 80		150 300 600	μA μA μA
V_{OL}	Low Level Output Voltage	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$ } $\lvert I_O \rvert < 1\ \mu A$		0.05 0.05 0.05		0 0 0	0.05 0.05 0.05		0.05 0.05 0.05	V V V
V_{OH}	High Level Output Voltage	$V_{DD} = 5V$ $V_{DD} = 10V$ $V_{DD} = 15V$ } $\lvert I_O \rvert < 1\ \mu A$	4.95 9.95 14.95		4.95 9.95 14.95	5 10 15		4.95 9.95 14.95		V V V
V_{IL}	Low Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ $V_{DD} = 10V, V_O = 1V$ or $9V$ $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$		1.5 3.0 4.0			1.5 3.0 4.0		1.5 3.0 4.0	V V V
V_{IH}	High Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ $V_{DD} = 10V, V_O = 1V$ or $9V$ $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$	3.5 7.0 11.0		3.5 7.0 11.0			3.5 7.0 11.0		V V V
I_{OL}	Low Level Output Current (Note 3)	$V_{DD} = 5V, V_O = 0.4V$ $V_{DD} = 10V, V_O = 0.5V$ $V_{DD} = 15V, V_O = 1.5V$	0.52 1.3 3.6		0.44 1.1 3.0			0.36 0.9 2.4		mA mA mA

DC Electrical Characteristics CD4543BC (Note 2) (Continued)

Symbol	Parameter	Conditions	−40°C		+25°			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I_{OH}	High Level Output Current (Note 3)	V_{DD} = 5V, V_O = 4.6V V_{DD} = 10V, V_O = 9.5V V_{DD} = 15V, V_O = 13.5V	−0.52 −1.3 −3.6		−0.44 −1.1 −3.0			−0.36 −0.9 −2.4		mA mA mA
I_{IN}	Input Current	V_{DD} = 15V, V_{IN} = 0V V_{DD} = 15V, V_{IN} = 15V		−0.3 0.3		-10^{-5} 10^{-5}	−0.3 0.3		−1.0 1.0	μA μA

AC Electrical Characteristics* T_A = 25°C, C_L = 50 pF, V_{SS} = 0, unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_r	Output Rise Time	V_{DD} = 5V V_{DD} = 10V V_{DD} = 15V		100 50 40	200 100 80	ns ns ns
t_f	Output Fall Time	V_{DD} = 5V V_{DD} = 10V V_{DD} = 15V		100 50 40	200 100 80	ns ns ns
t_{PLH}	Turn-ON Propagation Delay Time	V_{DD} = 5V V_{DD} = 10V V_{DD} = 15V		450 170 110	1100 440 330	ns ns ns
t_{PHL}	Turn-OFF Propagation Delay Time	V_{DD} = 5V V_{DD} = 10V V_{DD} = 15V		500 180 120	1100 440 330	ns ns ns
t_{SET-UP}	Set-Up Time	V_{DD} = 5V V_{DD} = 10V V_{DD} = 15V		−5 −2 0	80 30 20	ns ns ns
t_{HOLD}	Hold Time	V_{DD} = 5V V_{DD} = 10V V_{DD} = 15V		30 20 15	120 45 30	ns ns ns
PW_{LD}	Latch Disable Pulse Width	V_{DD} = 5V V_{DD} = 10V V_{DD} = 15V		50 30 20	250 100 80	ns ns ns
C_{IN}	Input Capacitance	Per Input		5	7.5	pF
C_{PD}	Power Dissipation Capacitance	See C_{PD} Measurement Waveforms (Note 4)		300		pF

*AC Parameters are guaranteed by DC correlated testing.

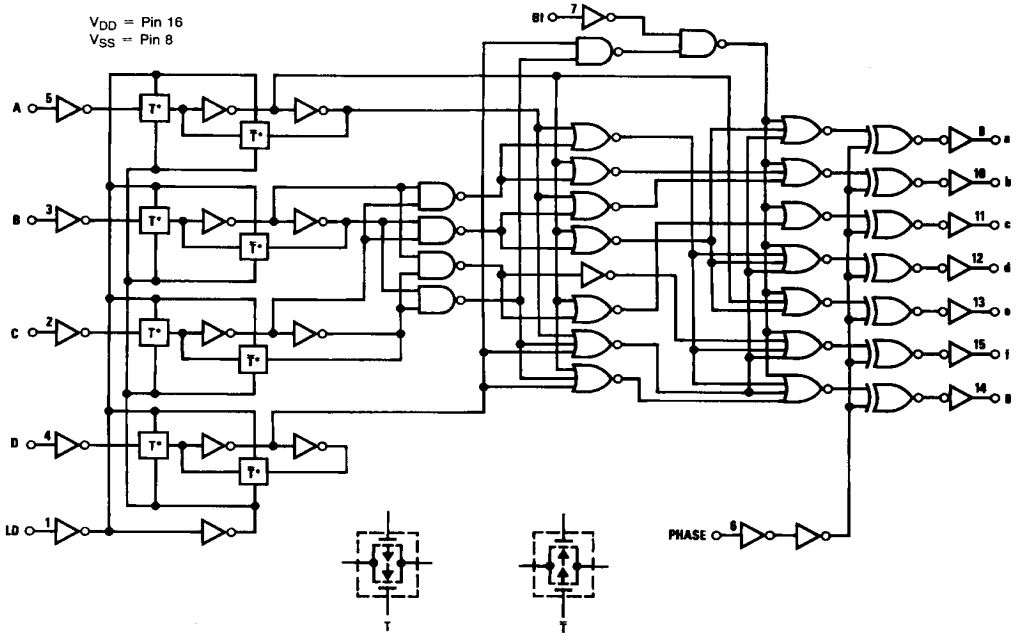
Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed; they are not meant to imply that the devices should be operated at these limits. The tables of "Recommended Operating Conditions" and Electrical Characteristics" provide conditions for actual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

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

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

Note 4: C_{PD} determines the no load AC power consumption of a CMOS device. For a complete explanation, see "MM54C/74C Family Characteristics" Application Note AN-90.

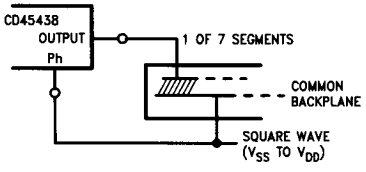
Logic Diagram



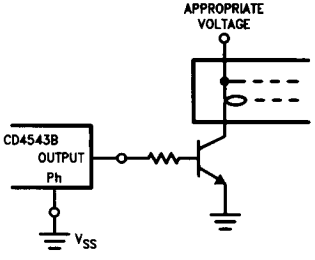
*Transmission gates

Typical Applications

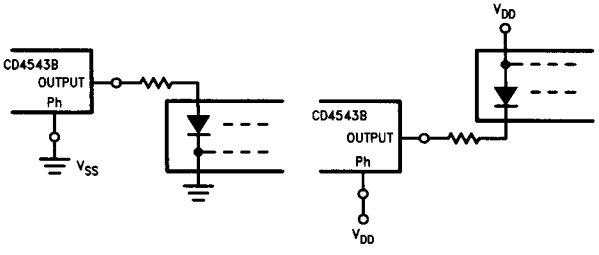
Liquid Crystal (LC) Readout



Incandescent Readout



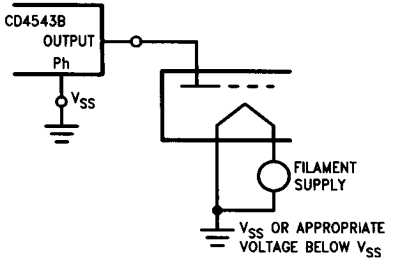
Light Emitting Diode (LED) Readout



Note: Bipolar transitors may be added for gain (for $V_{DD} \leq 10V$ or $I_{OUT} \geq 10$ mA)

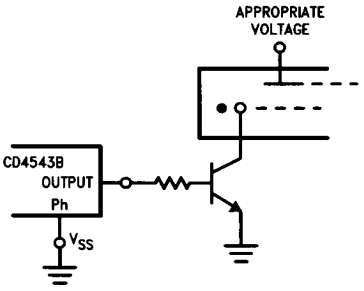
Typical Applications (Continued)

Fluorescent Readout

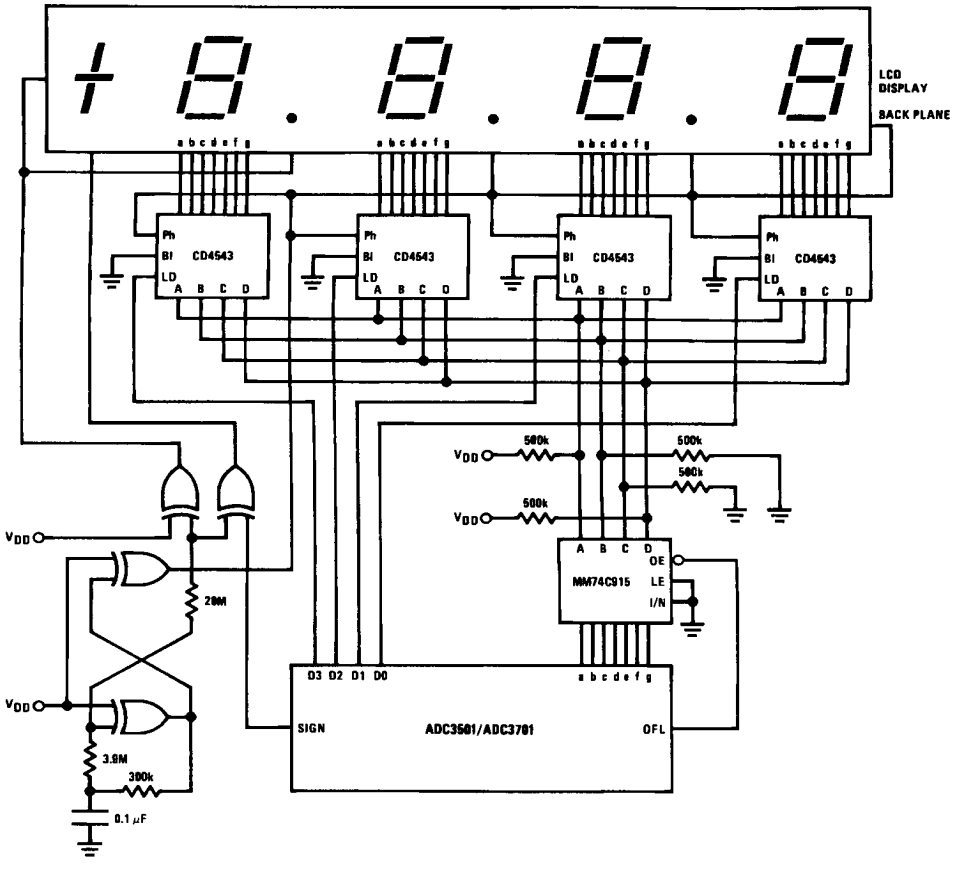


TL/F/6002–7

Gas Discharge Readout



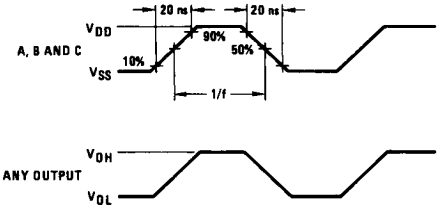
3½-Digit DVM with LCD Display



Display 9.999 when overflowed. All digits can also be blanked at overflow by typing OFL to BI on the CD4543's.

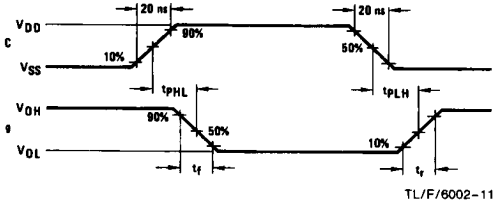
Switching Time Waveforms

C_{PD} Measurement Waveforms

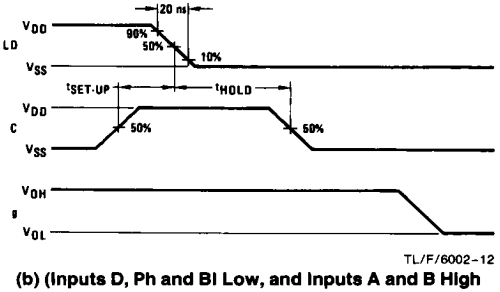


Inputs BI and Ph low, and inputs D and LD high. f in respect to a system clock.
All outputs connected to respective C_L loads.

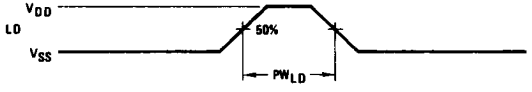
Dynamic Signal Waveforms



(a) Inputs D, Ph and BI Low, and Inputs A, B and LD High



(b) (Inputs D, Ph and BI Low, and Inputs A and B High



(c) Data DCBA Strobe into Latches

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