

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 (BI) 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} .

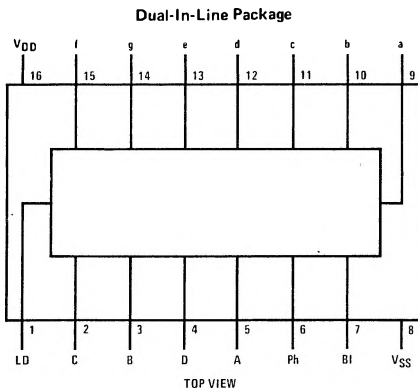
Features

- 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

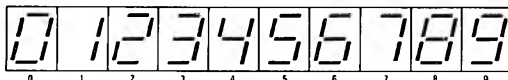
Applications

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

Connection Diagram and Truth Table



Display Format



INPUTS				OUTPUTS							DISPLAY
LD	BI	Ph*	D C B A	a	b	c	d	e	f	g	
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	**							**
†	†	†	†	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.

Absolute Maximum Ratings

(Notes 1 and 2)

V_{DD} DC Supply Voltage	-0.5 to +18 V _{DC}
V_{IN} Input Voltage	-0.5 to $V_{DD} + 0.5$ V _{DC}
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	3 V _{DC} to 15 V _{DC}
V_{IN} Input Voltage	0 to V_{DD} V _{DC}
T_A Operating Temperature Range	-55°C to +125°C
CD4543BM	-40°C to +85°C
CD4543BC	

DC Electrical Characteristics CD4543BM (Note 2)

PARAMETER	CONDITIONS	-55°C		25°C			125°C		UNITS
		MIN	MAX	MIN	TYP	MAX	MIN	MAX	
I_{DD} Quiescent Device Current	$V_{DD} = 5V$		5			5		150	μA
	$V_{DD} = 10V$		10			10		300	μA
	$V_{DD} = 15V$		20			20		600	μA
V_{OL} Low Level Output Voltage	$V_{DD} = 5V$		0.05		0	0.05		0.05	V
	$V_{DD} = 10V$		0.05		0	0.05		0.05	V
	$V_{DD} = 15V$		0.05		0	0.05		0.05	V
V_{OH} High Level Output Voltage	$V_{DD} = 5V$	4.95		4.95	5		4.95		V
	$V_{DD} = 10V$	9.95		9.95	10		9.95		V
	$V_{DD} = 15V$	14.95		14.95	15		14.95		V
V_{IL} Low Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or 4.5V		1.5			1.5		1.5	V
	$V_{DD} = 10V, V_O = 1V$ or 9V		3.0			3.0		3.0	V
	$V_{DD} = 15V, V_O = 1.5V$ or 13.5V		4.0			4.0		4.0	V
V_{IH} High Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or 4.5V	3.5		3.5			3.5		V
	$V_{DD} = 10V, V_O = 1V$ or 9V	7.0		7.0			7.0		V
	$V_{DD} = 15V, V_O = 1.5V$ or 13.5V	11.0		11.0			11.0		V
I_{OL} Low Level Output Current	$V_{DD} = 5V, V_O = 0.4V$	0.64		0.51		0.36			mA
	$V_{DD} = 10V, V_O = 0.5V$	1.6		1.3		0.9			mA
	$V_{DD} = 15V, V_O = 1.5V$	4.2		3.4		2.4			mA
I_{OH} High Level Output Current	$V_{DD} = 5V, V_O = 4.6V$	-0.64		-0.51		-0.36			mA
	$V_{DD} = 10V, V_O = 9.5V$	-1.6		-1.3		-0.9			mA
	$V_{DD} = 15V, V_O = 13.5V$	-4.2		-3.4		-2.4			mA
I_{IN} Input Current	$V_{DD} = 15V, V_{IN} = 0V$		-0.1		-10^{-5}	-0.1		-1.0	μA
	$V_{DD} = 15V, V_{IN} = 15V$		0.1		10^{-5}	0.1		1.0	μA

DC Electrical Characteristics CD4543BC (Note 2)

PARAMETER	CONDITIONS	-40°C		25°C			85°C		UNITS
		MIN	MAX	MIN	TYP	MAX	MIN	MAX	
I_{DD} Quiescent Device Current	$V_{DD} = 5V$		20			20		150	μA
	$V_{DD} = 10V$		40			40		300	μA
	$V_{DD} = 15V$		80			80		600	μA
V_{OL} Low Level Output Voltage	$V_{DD} = 5V$		0.05		0	0.05		0.05	V
	$V_{DD} = 10V$		0.05		0	0.05		0.05	V
	$V_{DD} = 15V$		0.05		0	0.05		0.05	V
V_{OH} High Level Output Voltage	$V_{DD} = 5V$	4.95		4.95	5		4.95		V
	$V_{DD} = 10V$	9.95		9.95	10		9.95		V
	$V_{DD} = 15V$	14.95		14.95	15		14.95		V
V_{IL} Low Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or 4.5V		1.5			1.5		1.5	V
	$V_{DD} = 10V, V_O = 1V$ or 9V		3.0			3.0		3.0	V
	$V_{DD} = 15V, V_O = 1.5V$ or 13.5V		4.0			4.0		4.0	V
V_{IH} High Level Input Voltage	$V_{DD} = 5V, V_O = 0.5V$ or 4.5V	3.5		3.5			3.5		V
	$V_{DD} = 10V, V_O = 1V$ or 9V	7.0		7.0			7.0		V
	$V_{DD} = 15V, V_O = 1.5V$ or 13.5V	11.0		11.0			11.0		V
I_{OL} Low Level Output Current	$V_{DD} = 5V, V_O = 0.4V$	0.52		0.44		0.36			mA
	$V_{DD} = 10V, V_O = 0.5V$	1.3		1.1		0.9			mA
	$V_{DD} = 15V, V_O = 1.5V$	3.6		3.0		2.4			mA

DC Electrical Characteristics CD4543BC (Note 2) (Continued)

PARAMETER	CONDITIONS	-40°C		25°C			85°C		UNITS
		MIN	MAX	MIN	TYP	MAX	MIN	MAX	
I_{OH} High Level Output Current	$V_{DD} = 5V, V_O = 4.6V$	-0.52		-0.44			-0.36		mA
	$V_{DD} = 10V, V_O = 9.5V$	-1.3		-1.1			-0.9		mA
	$V_{DD} = 15V, V_O = 13.5V$	-3.6		-3.0			-2.4		mA
I_{IN} Input Current	$V_{DD} = 15V, V_{IN} = 0V$		-0.3		10^{-5}	0.3		-1.0	μA
	$V_{DD} = 15V, V_{IN} = 15V$		0.3		10^{-5}	0.3		1.0	μA

AC Electrical Characteristics $T_A = 25^\circ C, C_L = 50\text{ pF}, V_{SS} = 0$, unless otherwise specified.

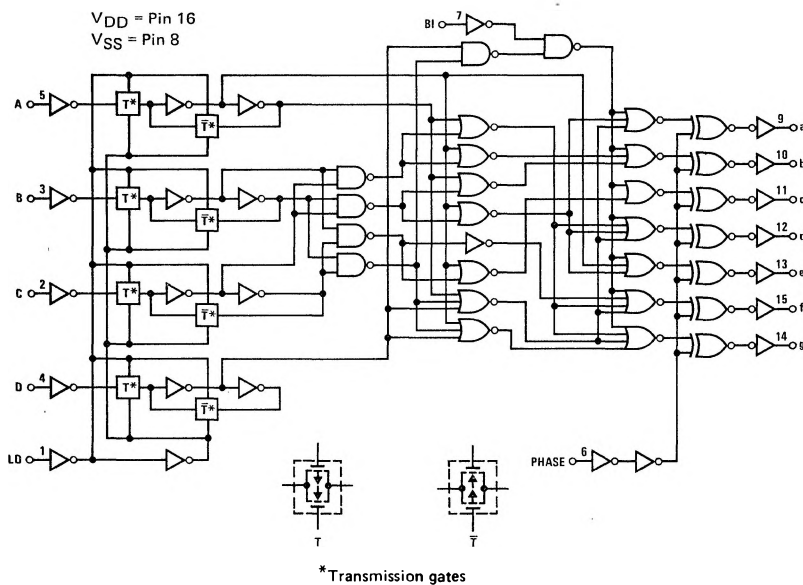
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
t_r Output Rise Time	$V_{DD} = 5V$		100	200	ns
	$V_{DD} = 10V$		50	100	ns
	$V_{DD} = 15V$		40	80	ns
t_f Output Fall Time	$V_{DD} = 5V$		100	200	ns
	$V_{DD} = 10V$		50	100	ns
	$V_{DD} = 15V$		40	80	ns
t_{PLH} Turn-ON Propagation Delay Time	$V_{DD} = 5V$		450	1100	ns
	$V_{DD} = 10V$		170	440	ns
	$V_{DD} = 15V$		110	330	ns
t_{PHL} Turn-OFF Propagation Delay Time	$V_{DD} = 5V$		500	1100	ns
	$V_{DD} = 10V$		180	440	ns
	$V_{DD} = 15V$		120	330	ns
t_{SET-UP} Set-Up Time	$V_{DD} = 5V$		-5	80	ns
	$V_{DD} = 10V$		-2	30	ns
	$V_{DD} = 15V$		0	20	ns
t_{HOLD} Hold Time	$V_{DD} = 5V$		30	120	ns
	$V_{DD} = 10V$		20	45	ns
	$V_{DD} = 15V$		15	30	ns
PW_{LD} Latch Disable Pulse Width	$V_{DD} = 5V$		50	250	ns
	$V_{DD} = 10V$		30	100	ns
	$V_{DD} = 15V$		20	80	ns
C_{IN} Input Capacitance	Per Input		5	7.5	pF
C_{PD} Power Dissipation Capacitance	See C_{PD} Measurement Waveforms, (Note 3)		300		pF

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.

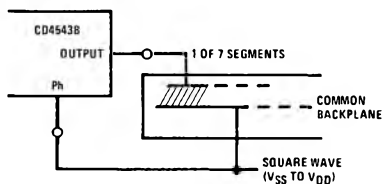
Note 3: C_{PD} determines the no load AC power consumption of a CMOS device. For a complete explanation, see "MM54C/74C Family Characteristics" application note AN-90.

Logic Diagram

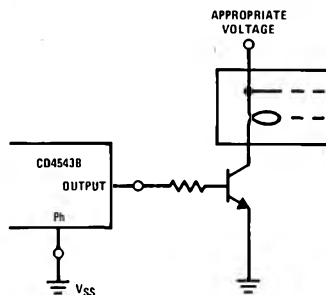


Typical Applications

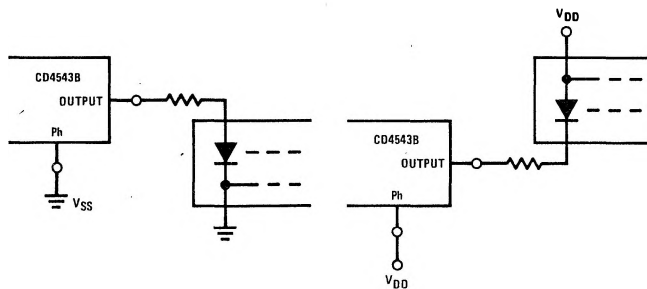
Liquid Crystal (LC) Readout



Incandescent Readout

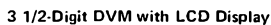
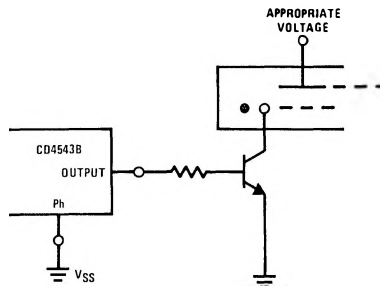
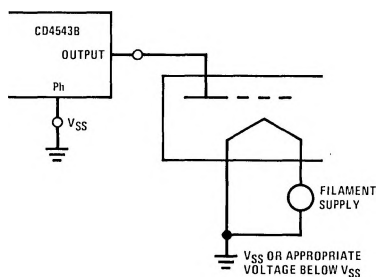


Light Emitting Diode (LED) Readout



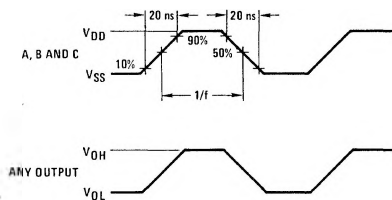
Note. Bipolar transistors may be added for gain (for $V_{DD} \leq 10V$ or $I_{OUT} \geq 10\text{ mA}$)

Gas Discharge Readout



Switching Time Waveforms

C_{PD} Measurement Waveforms

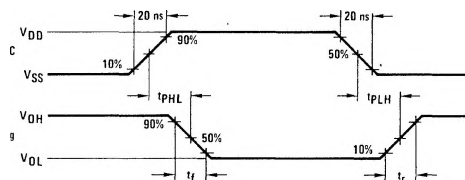


Inputs BI and Ph low, and inputs D and LD high. f in respect to a system clock.

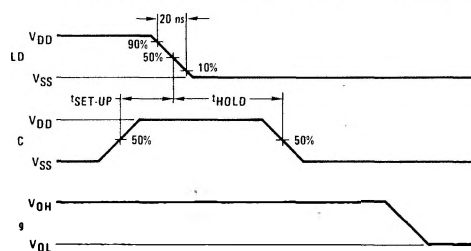
All outputs connected to respective C_L loads.

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

