



# 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  $V_{SS}$ .

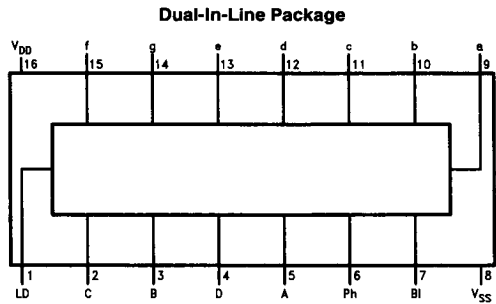
## Features

- 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



Top View

Order Number CD4543B\*

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

Inputs				Outputs								
LD	BI	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	0	Blank
1	0	0	0 0 0 0	1	1	1	1	1	1	0	0	0
1	0	0	0 0 0 1	0	1	1	0	0	0	0	0	1
1	0	0	0 0 1 0	1	1	0	1	1	0	1	0	2
1	0	0	0 0 1 1	1	1	1	1	1	0	0	1	3
1	0	0	0 1 0 0	0	1	1	0	0	1	1	1	4
1	0	0	0 1 0 1	1	0	1	1	0	1	1	1	5
1	0	0	0 1 1 0	1	0	1	1	1	1	1	1	6
1	0	0	0 1 1 1	1	1	1	0	0	0	0	0	7
1	0	0	1 0 0 0	1	1	1	1	1	1	1	1	8
1	0	0	1 0 0 1	1	1	1	1	0	1	1	1	9
1	0	0	1 0 1 0	0	0	0	0	0	0	0	0	Blank
1	0	0	1 0 1 1	0	0	0	0	0	0	0	0	Blank
1	0	0	1 1 0 0	0	0	0	0	0	0	0	0	Blank
1	0	0	1 1 0 1	0	0	0	0	0	0	0	0	Blank
1	0	0	1 1 1 0	0	0	0	0	0	0	0	0	Blank
1	0	0	1 1 1 1	0	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



TL/F/6002-2

**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 <sub>DD</sub> )	-0.5 V <sub>DC</sub> to +18 V <sub>DC</sub>
Input Voltage (V <sub>IN</sub> )	-0.5 V <sub>DC</sub> to V <sub>DD</sub> + 0.5 V <sub>DC</sub>
Storage Temp. Range (T <sub>S</sub> )	-65°C to +150°C
Power Dissipation (P <sub>D</sub> )	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature (T <sub>L</sub> )	
(Soldering, 10 seconds)	260°C

**Recommended Operating Conditions** (Note 2)

DC Supply Voltage (V <sub>DD</sub> )	3 V <sub>DC</sub> to 15 V <sub>DC</sub>
Input Voltage (V <sub>IN</sub> )	0 V <sub>DC</sub> to V <sub>DD</sub> V <sub>DC</sub>
Operating Temperature Range (T <sub>A</sub> )	
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 <sub>DD</sub>	Quiescent Device Current	V <sub>DD</sub> = 5V, V <sub>IN</sub> = V <sub>DD</sub> or V <sub>SS</sub>		5			5		150	μA
		V <sub>DD</sub> = 10V, V <sub>IN</sub> = V <sub>DD</sub> or V <sub>SS</sub>		10			10		300	μA
		V <sub>DD</sub> = 15V, V <sub>IN</sub> = V <sub>DD</sub> or V <sub>SS</sub>		20			20		600	μA
V <sub>OL</sub>	Low Level Output Voltage	V <sub>DD</sub> = 5V } V <sub>DD</sub> = 10V } V <sub>DD</sub> = 15V }  I <sub>O</sub>   < 1 μA		0.05		0	0.05		0.05	V
				0.05		0	0.05		0.05	V
				0.05		0	0.05		0.05	V
V <sub>OH</sub>	High Level Output Voltage	V <sub>DD</sub> = 5V } V <sub>DD</sub> = 10V } V <sub>DD</sub> = 15V }  I <sub>O</sub>   < 1 μA	4.95		4.95	5		4.95		V
			9.95		9.95	10		9.95		V
			14.95		14.95	15		14.95		V
V <sub>IL</sub>	Low Level Input Voltage	V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V		1.5			1.5		1.5	V
				3.0			3.0		3.0	V
				4.0			4.0		4.0	V
V <sub>IH</sub>	High Level Input Voltage	V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V	3.5		3.5			3.5		V
			7.0		7.0			7.0		V
			11.0		11.0			11.0		V
I <sub>OL</sub>	Low Level Output Current (Note 3)	V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V	0.64		0.51			0.36		mA
			1.6		1.3			0.9		mA
			4.2		3.4			2.4		mA
I <sub>OH</sub>	High Level Output Current (Note 3)	V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V	-0.64		-0.51			-0.36		mA
			-1.6		-1.3			-0.9		mA
			-4.2		-3.4			-2.4		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		-0.1		-10 <sup>-5</sup>	-0.1		-1.0	μA
				0.1		10 <sup>-5</sup>	0.1		1.0	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 <sub>DD</sub>	Quiescent Device Current	V <sub>DD</sub> = 5V, V <sub>IN</sub> = V <sub>DD</sub> or V <sub>SS</sub> V <sub>DD</sub> = 10V, V <sub>IN</sub> = V <sub>DD</sub> or V <sub>SS</sub> V <sub>DD</sub> = 15V, V <sub>IN</sub> = V <sub>DD</sub> or V <sub>SS</sub>		20			20		150	μA
				40			40		300	μA
				80			80		600	μA
V <sub>OL</sub>	Low Level Output Voltage	V <sub>DD</sub> = 5V } V <sub>DD</sub> = 10V } V <sub>DD</sub> = 15V }  I <sub>O</sub>   < 1 μA		0.05		0	0.05		0.05	V
				0.05		0	0.05		0.05	V
				0.05		0	0.05		0.05	V
V <sub>OH</sub>	High Level Output Voltage	V <sub>DD</sub> = 5V } V <sub>DD</sub> = 10V } V <sub>DD</sub> = 15V }  I <sub>O</sub>   < 1 μA	4.95		4.95	5		4.95		V
			9.95		9.95	10		9.95		V
			14.95		14.95	15		14.95		V
V <sub>IL</sub>	Low Level Input Voltage	V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V		1.5			1.5		1.5	V
				3.0			3.0		3.0	V
				4.0			4.0		4.0	V
V <sub>IH</sub>	High Level Input Voltage	V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V V <sub>DD</sub> = 10V, V <sub>O</sub> = 1V or 9V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V	3.5		3.5			3.5		V
			7.0		7.0			7.0		V
			11.0		11.0			11.0		V
I <sub>OL</sub>	Low Level Output Current (Note 3)	V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V	0.52		0.44			0.36		mA
			1.3		1.1			0.9		mA
			3.6		3.0			2.4		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)	$V_{DD} = 5V, V_O = 4.6V$	-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	$\mu A$
		$V_{DD} = 15V, V_{IN} = 15V$		0.3		$10^{-5}$	0.3		1.0	$\mu A$

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

Symbol	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 4)		300		pF

\*AC Parameters are guaranteed by DC correlated testing.

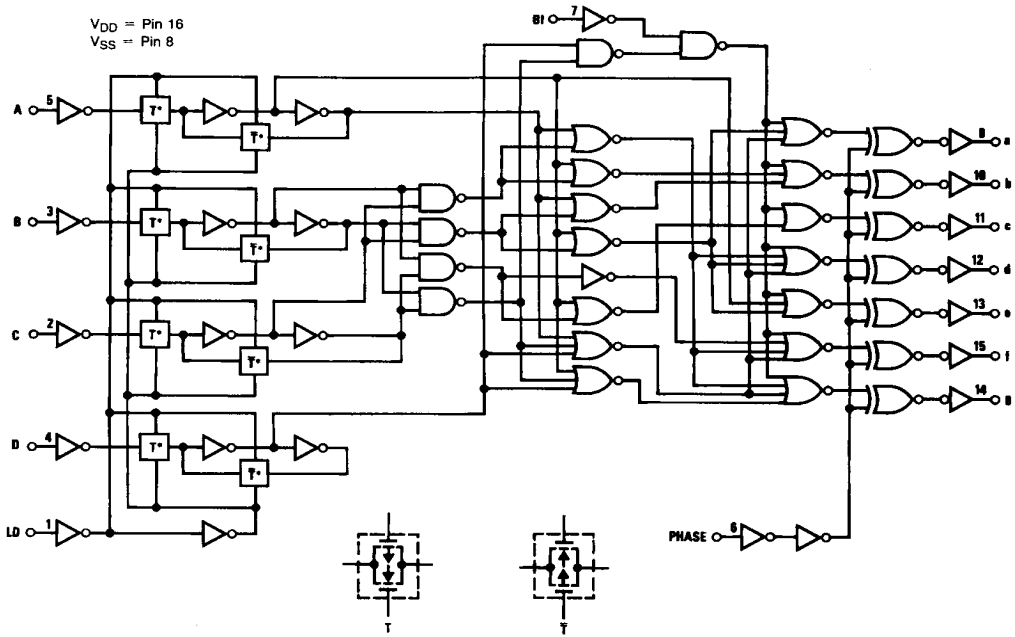
**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed; they are not meant to imply that the devices should be operated at these limits. The tables of "Recommended Operating Conditions" and Electrical Characteristics" provide conditions for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

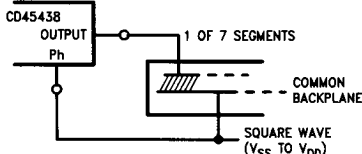


\*Transmission gates

TL/F/6002-3

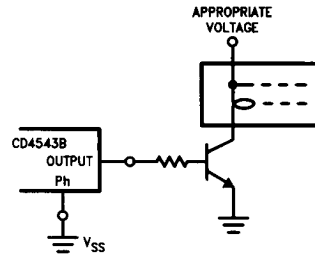
## Typical Applications

### Liquid Crystal (LC) Readout



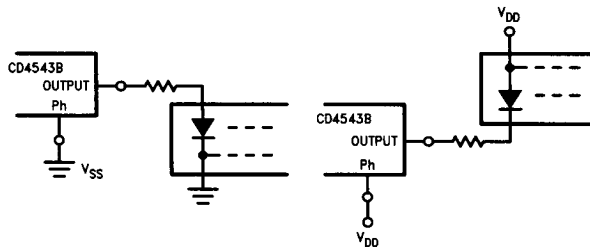
TL/F/6002-4

### Incandescent Readout



TL/F/6002-5

### Light Emitting Diode (LED) Readout

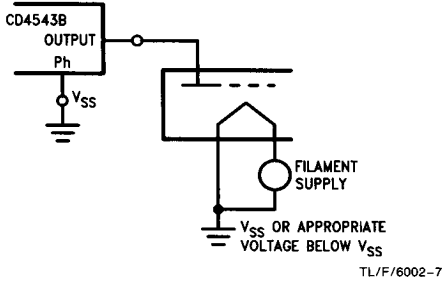


TL/F/6002-6

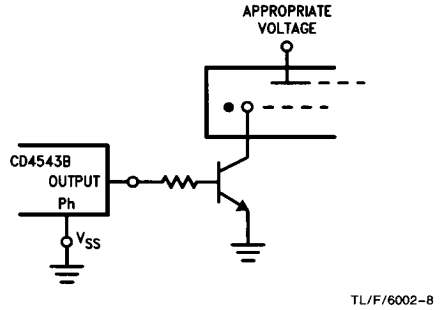
**Note:** Bipolar transistors may be added for gain (for  $V_{DD} \leq 10V$  or  $I_{OUT} \geq 10\text{ mA}$ )

**Typical Applications** (Continued)

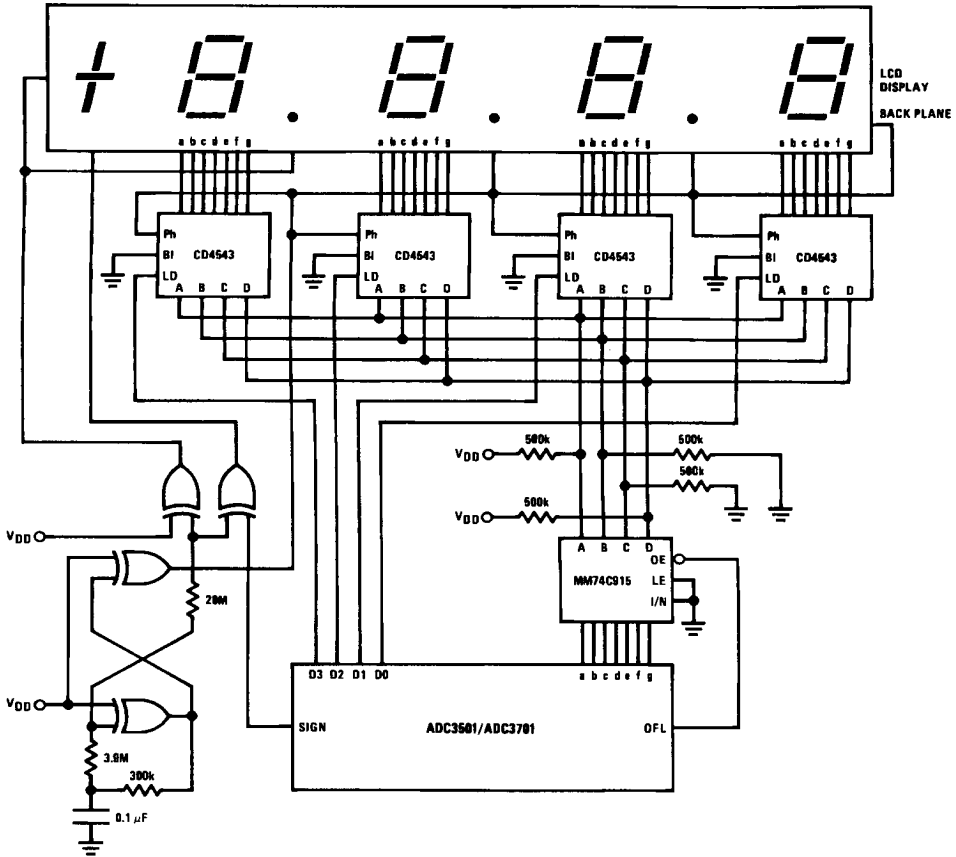
**Fluorescent Readout**



**Gas Discharge Readout**

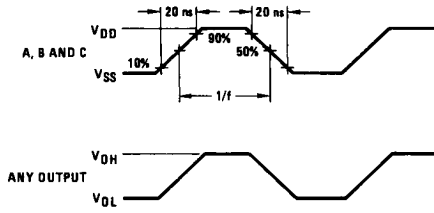


**3½-Digit DVM with LCD Display**



# Switching Time Waveforms

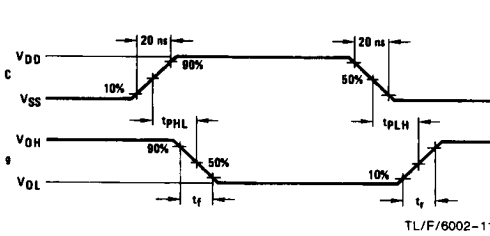
## C<sub>PD</sub> Measurement Waveforms



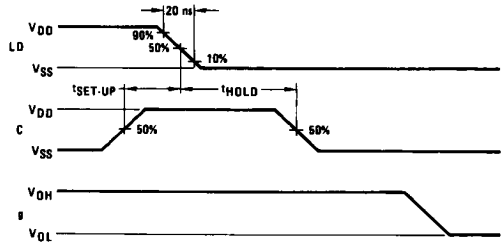
TL/F/6002-10

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.

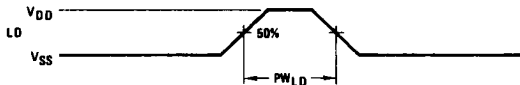
## Dynamic Signal Waveforms



(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

TL/F/6002-13