

HEF4543B

BCD to 7-segment latch/decoder/driver

Rev. 04 — 17 March 2009

Product data sheet

1. General description

The HEF4543B is a BCD to 7-segment latch/decoder/driver for liquid crystal and LED displays. It has four address inputs (D0 to D3), an active LOW latch enable input ($\overline{\text{LE}}$), an active HIGH blanking input (BL), an active HIGH phase input (PH) and seven buffered segment outputs (Qa to Qg).

The circuit provides the function of a 4-bit storage latch and an 8-4-2-1 BCD to 7-segment decoder/driver. It can invert the logic levels of the output combination. The phase (PH), blanking (BL) and latch enable ($\overline{\text{LE}}$) inputs are used to reverse the function table phase, blank the display and store a BCD code, respectively.

For liquid crystal displays, a square-wave is applied to PH and the electrical common back-plane of the display. The outputs of the device are directly connected to the segments of the liquid crystal.

It operates over a recommended V_{DD} power supply range of 3 V to 15 V referenced to V_{SS} (usually ground). Unused inputs must be connected to V_{DD} , V_{SS} , or another input. It is also suitable for use over the full industrial ($-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$) temperature range.

2. Features

- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Operates across the full industrial temperature range $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B
- ESD protection:
 - ◆ HBM JESD22-A114E exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V

3. Applications

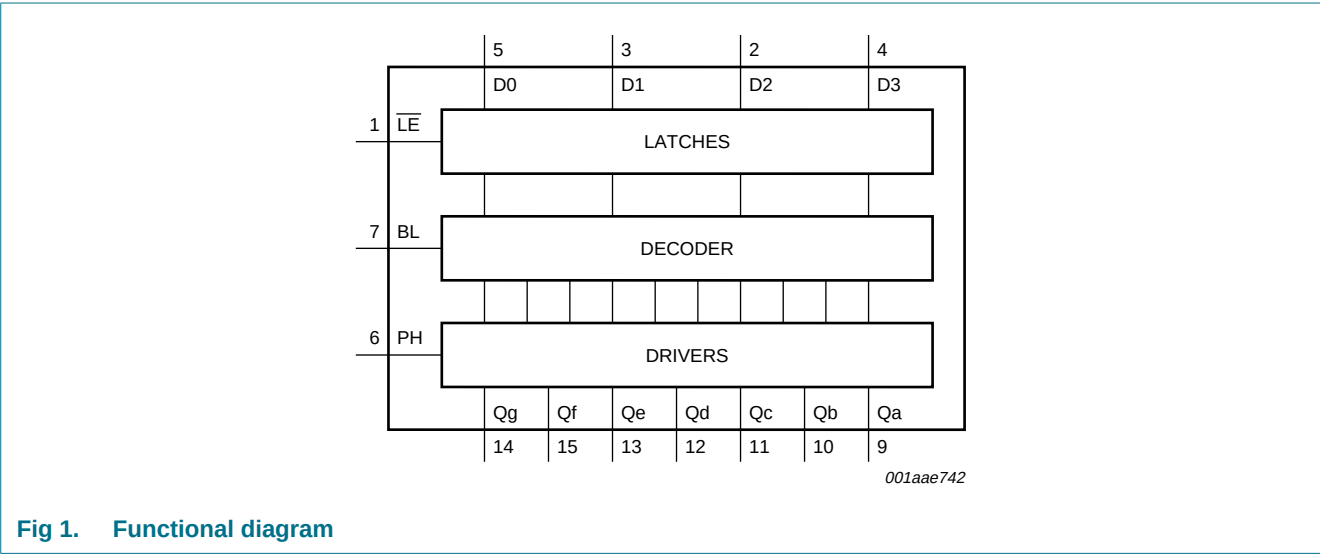
- Industrial

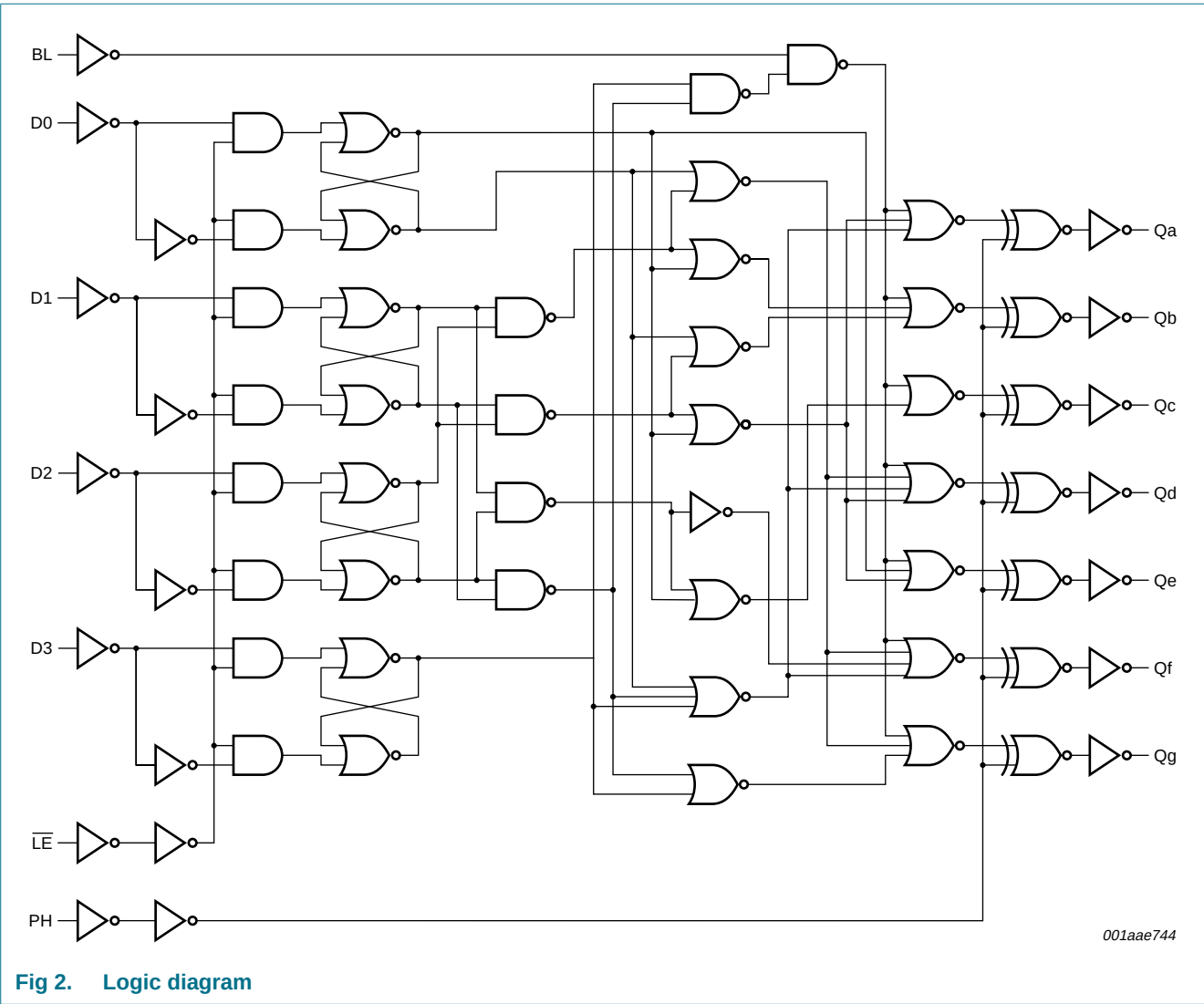
4. Ordering information

Table 1. Ordering information
All types operate from −40 °C to +85 °C

Type number	Package		
	Name	Description	Version
HEF4543BP	DIP16	plastic dual in-line package; 16-leads (300 mil)	SOT38-4
HEF4543BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

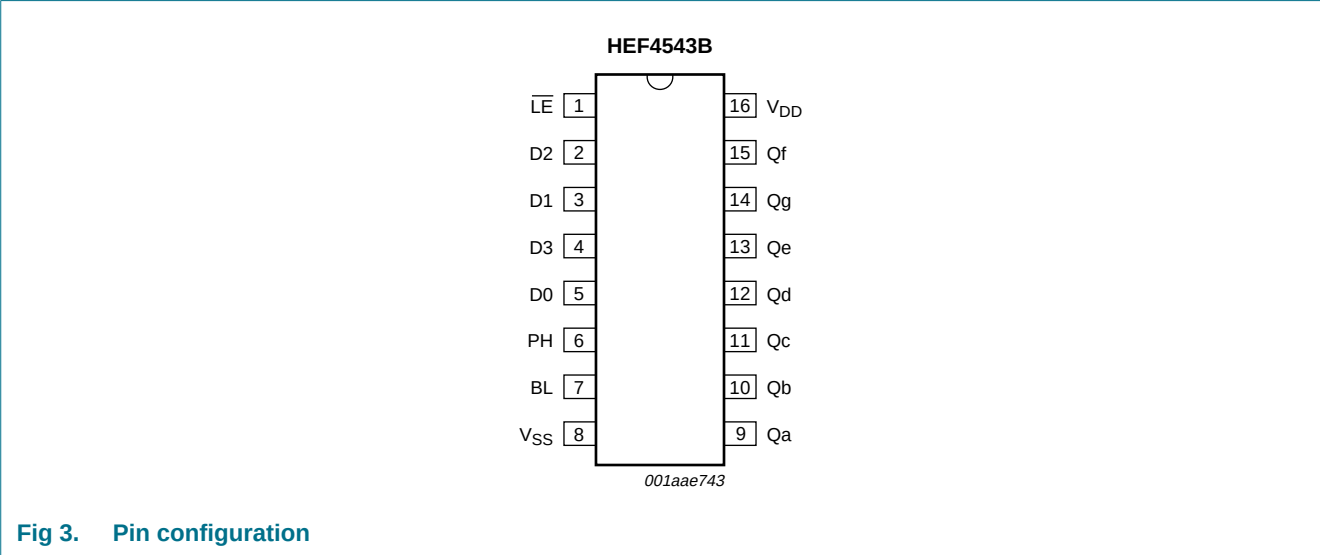
5. Functional diagram





6. Pinning information

6.1 Pinning



6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
LE	1	latch enable input (active LOW)
D0 to D3	5, 3, 2, 4	address (data) input
PH	6	phase input (active HIGH)
BL	7	blanking input (active HIGH)
VSS	8	ground supply voltage
Qa to Qg	9, 10, 11, 12, 13, 15, 14	segment output
VDD	16	supply voltage

7. Functional description

Table 3. Function table [1]

Inputs							Outputs							Display
$\overline{\text{LE}}$	BL	PH [2]	D3	D2	D1	D0	Qa	Qb	Qc	Qd	Qe	Qf	Qg	
X	H	L	X	X	X	X	L	L	L	L	L	L	L	blank
H	L	L	L	L	L	L	H	H	H	H	H	H	L	0
H	L	L	L	L	L	H	L	H	H	L	L	L	L	1
H	L	L	L	L	H	L	H	H	L	H	H	L	H	2
H	L	L	L	L	H	H	H	H	H	H	L	L	H	3
H	L	L	L	H	L	L	L	H	H	L	L	H	H	4
H	L	L	L	H	L	H	H	L	H	H	L	H	H	5
H	L	L	L	H	H	L	H	L	H	H	H	H	H	6
H	L	L	L	H	H	H	H	H	H	L	L	L	L	7
H	L	L	H	L	L	L	H	H	H	H	H	H	H	8
H	L	L	H	L	L	H	H	H	H	H	L	H	H	9
H	L	L	H	L	H	X	L	L	L	L	L	L	L	blank
H	L	L	H	H	X	X	L	L	L	L	L	L	L	blank
L	L	L	X	X	X	X	n.c.							n.c.
as above		H	as above				inverse of above							as above

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; n.c. = no change.

[2] For liquid crystal displays, apply a square-wave to PH;
 For common cathode LED displays, select PH = LOW;
 For common anode LED displays, select PH = HIGH.

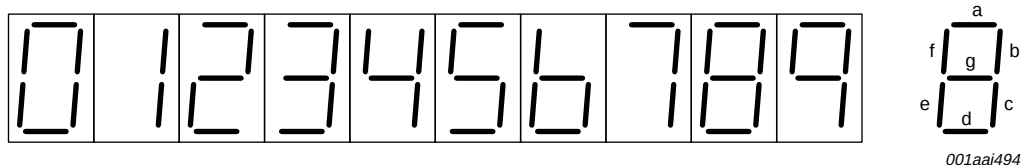


Fig 4. Seven segment digital display with segment designation

8. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DD}	supply voltage		-0.5	+18	V
V_I	input voltage		-0.5	$V_{DD} + 0.5$	V
$I_{I/O}$	input/output current		-	± 10	mA
T_{stg}	storage temperature		-65	+150	°C
T_{amb}	ambient temperature		-40	+85	°C

Table 4. Limiting values ...continued

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
P_{tot}	total power dissipation	DIP16 package	[1] -	750	mW
		SO16 package	[2] -	500	mW
P	power dissipation	per output	-	100	mW

[1] For DIP16 package: P_{tot} derates linearly with 12 mW/K above 70 °C.[2] For SO16 package: P_{tot} derates linearly with 8 mW/K above 70 °C.

9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DD}	supply voltage		3	-	15	V
V_{I}	input voltage		0	-	V_{DD}	V
T_{amb}	ambient temperature	in free air	-40	-	+85	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{\text{DD}} = 5 \text{ V}$	-	-	3.75	ns/V
		$V_{\text{DD}} = 10 \text{ V}$	-	-	0.5	ns/V
		$V_{\text{DD}} = 15 \text{ V}$	-	-	0.08	ns/V

10. Static characteristics

Table 6. Static characteristics $V_{\text{SS}} = 0 \text{ V}$; $V_{\text{I}} = V_{\text{SS}}$ or V_{DD} unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	$T_{\text{amb}} = -40 \text{ °C}$		$T_{\text{amb}} = 25 \text{ °C}$		$T_{\text{amb}} = 85 \text{ °C}$		Unit
				Min	Max	Min	Max	Min	Max	
V_{IH}	HIGH-level input voltage	$ I_{\text{O}} < 1 \mu\text{A}$	5 V	3.5	-	3.5	-	3.5	-	V
			10 V	7.0	-	7.0	-	7.0	-	V
			15 V	11.0	-	11.0	-	11.0	-	V
V_{IL}	LOW-level input voltage	$ I_{\text{O}} < 1 \mu\text{A}$	5 V	-	1.5	-	1.5	-	1.5	V
			10 V	-	3.0	-	3.0	-	3.0	V
			15 V	-	4.0	-	4.0	-	4.0	V
V_{OH}	HIGH-level output voltage		5 V	4.95	-	4.95	-	4.95	-	V
			10 V	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	14.95	-	14.95	-	V
V_{OL}	LOW-level output voltage	$ I_{\text{O}} < 1 \mu\text{A}$	5 V	-	0.05	-	0.05	-	0.05	V
			10 V	-	0.05	-	0.05	-	0.05	V
			15 V	-	0.05	-	0.05	-	0.05	V
I_{OH}	HIGH-level output current	$V_{\text{O}} = 2.5 \text{ V}$	5 V	-1.7	-	-1.4	-	-1.1	-	mA
		$V_{\text{O}} = 4.6 \text{ V}$	5 V	-0.52	-	-0.44	-	-0.36	-	mA
		$V_{\text{O}} = 9.5 \text{ V}$	10 V	-1.3	-	-1.1	-	-0.9	-	mA
		$V_{\text{O}} = 13.5 \text{ V}$	15 V	-3.6	-	-3.0	-	-2.4	-	mA

Table 6. Static characteristics ...continued $V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or V_{DD} unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	$T_{amb} = -40\text{ °C}$		$T_{amb} = 25\text{ °C}$		$T_{amb} = 85\text{ °C}$		Unit
				Min	Max	Min	Max	Min	Max	
I_{OL}	LOW-level output current	$V_O = 0.4\text{ V}$	5 V	0.52	-	0.44	-	0.36	-	mA
		$V_O = 0.5\text{ V}$	10 V	1.3	-	1.1	-	0.9	-	mA
		$V_O = 1.5\text{ V}$	15 V	3.6	-	3.0	-	2.4	-	mA
I_I	input leakage current		15 V	-	± 0.3	-	± 0.3	-	± 1.0	μA
I_{DD}	supply current	$I_O = 0\text{ A}$	5 V	-	20	-	20	-	150	μA
			10 V	-	40	-	40	-	300	μA
			15 V	-	80	-	80	-	600	μA
C_I	input capacitance		-	-	-	-	7.5	-	-	pF

11. Dynamic characteristics

Table 7. Dynamic characteristics $V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; For test circuit see [Figure 7](#); unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula ^[1]	Min	Typ	Max	Unit
t_{PHL}	HIGH to LOW propagation delay	Dn to Qn; see Figure 5	5 V	$153\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	180	360	ns
			10 V	$64\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	75	150	ns
			15 V	$47\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	55	110	ns
		$\overline{LE}$ to Qn; see Figure 5	5 V	$143\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	170	340	ns
			10 V	$69\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	80	160	ns
			15 V	$52\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	60	120	ns
		BL to Qn; see Figure 5	5 V	$118\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	145	290	ns
			10 V	$54\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	65	130	ns
			15 V	$37\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	45	90	ns
t_{PLH}	LOW to HIGH propagation delay	Dn to Qn; see Figure 5	5 V	$153\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	180	360	ns
			10 V	$64\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	75	150	ns
			15 V	$47\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	55	110	ns
		$\overline{LE}$ to Qn; see Figure 5	5 V	$163\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	190	380	ns
			10 V	$69\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	80	160	ns
			15 V	$52\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	60	120	ns
		BL to Qn; see Figure 5	5 V	$98\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	125	250	ns
			10 V	$54\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	55	110	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	40	80	ns
t_t	transition time	pin Qn; see Figure 5	5 V	$10\text{ ns} + (1.00\text{ ns/pF}) C_L$	-	60	120	ns
			10 V	$9\text{ ns} + (0.42\text{ ns/pF}) C_L$	-	30	60	ns
			15 V	$6\text{ ns} + (0.28\text{ ns/pF}) C_L$	-	20	40	ns
t_{su}	set-up time	Dn to $\overline{LE}$; see Figure 6	5 V		40	20	-	ns
			10 V		20	5	-	ns
			15 V		15	0	-	ns

Table 7. Dynamic characteristics ...continued

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; For test circuit see [Figure 7](#); unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula ^[1]	Min	Typ	Max	Unit
t_h	hold time	D_n to $\overline{LE}$; see Figure 6	5 V		0	-15	-	ns
			10 V		15	0	-	ns
			15 V		20	5	-	ns
t_W	pulse width	pin $\overline{LE}$ HIGH; minimum width; see Figure 6	5 V		60	30	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns

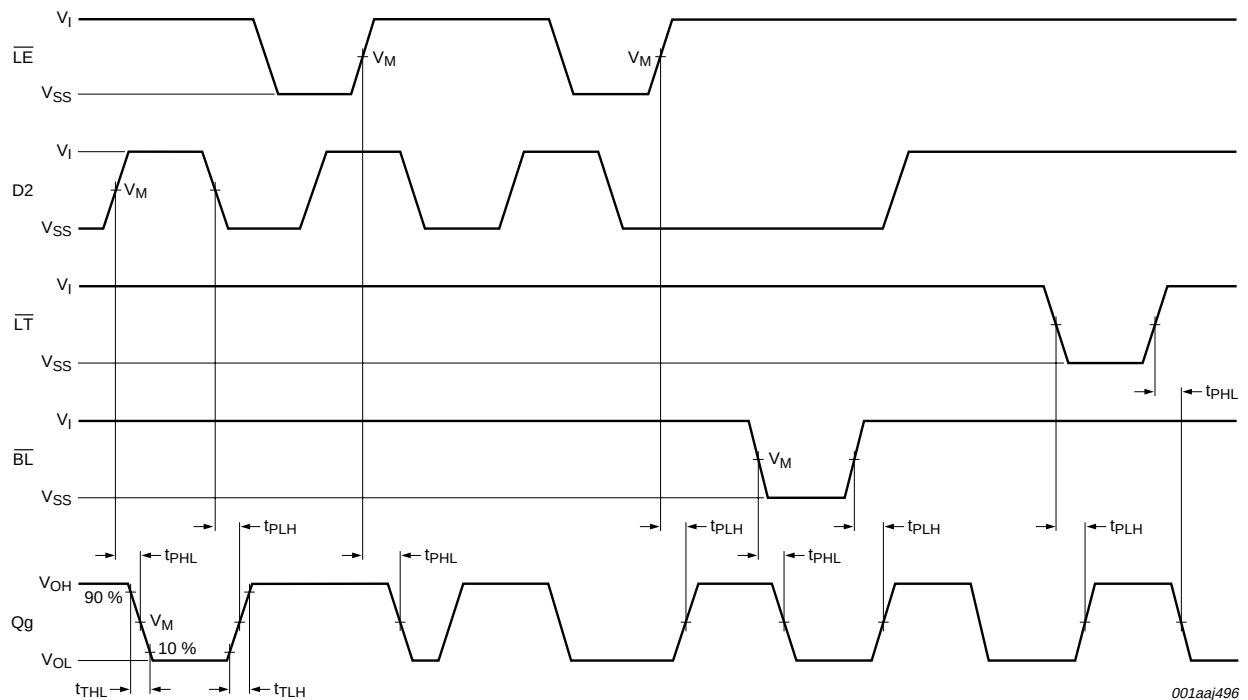
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).

Table 8. Dynamic power dissipation P_D

P_D can be calculated from the formulas shown. $V_{SS} = 0\text{ V}$; $t_r = t_f \leq 20\text{ ns}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$.

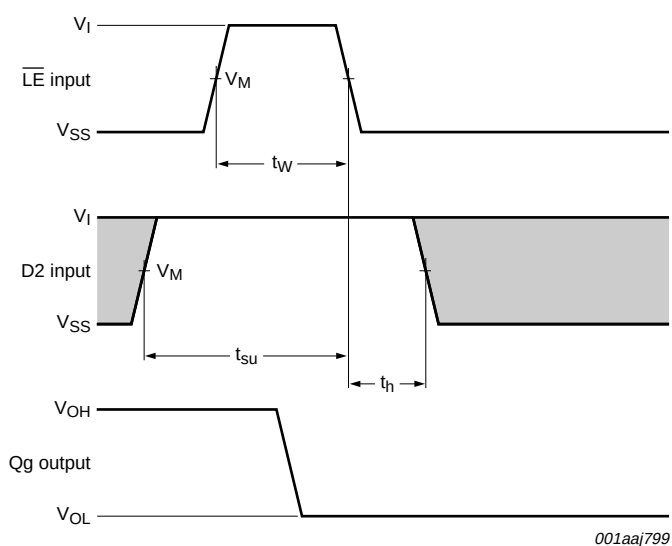
Symbol	Parameter	V_{DD}	Typical formula for P_D (μW)	where:
P_D	dynamic power dissipation	5 V	$P_D = 2200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_i = input frequency in MHz,
		10 V	$P_D = 10400 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_o = output frequency in MHz,
		15 V	$P_D = 33000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	C_L = output load capacitance in pF, V_{DD} = supply voltage in V, $\Sigma(C_L \times f_o)$ = sum of the outputs.

12. Waveforms



Conditions: $D3 = \text{LOW}$ and $D0 = D1 = \text{HIGH}$.

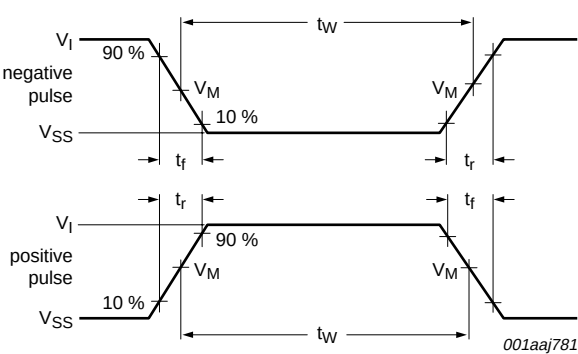
Fig 5. Propagation delays and output transitions times



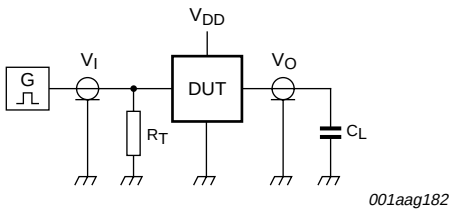
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Conditions:

D3 = BL = LOW; D0 = D1 = $\overline{LE}$ = HIGH**Fig 6. Waveforms showing minimum $\overline{LE}$ pulse width, set-up, and hold time for DC to $\overline{LE}$**



a. Input waveforms



b. Test circuit

Test data is given in [Table 9](#).
 Definitions for test circuit:
 R_L = Load resistance;
 C_L = Load capacitance including jig and probe capacitance;
 R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

Fig 7. Test circuit for switching times

Table 9. Test data

Supply voltage	Input			Load
	V_I	V_M	t_r, t_f	C_L
5 V to 15 V	V_{DD}	$0.5V_I$	$\leq 20\text{ ns}$	50 pF

13. Application information

Some examples of applications for the HEF4543B are:

- Driving LCD displays
- Driving LED displays
- Driving fluorescent displays
- Driving incandescent displays
- Driving gas discharge displays

Fig 9. Connection to LCD readout

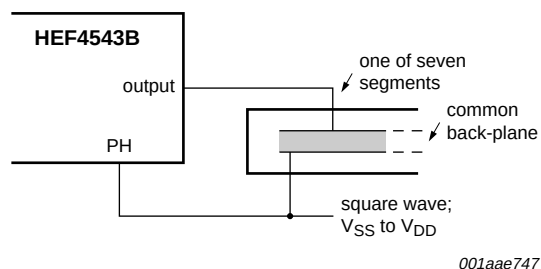


Fig 10. Connection to incandescent display readout

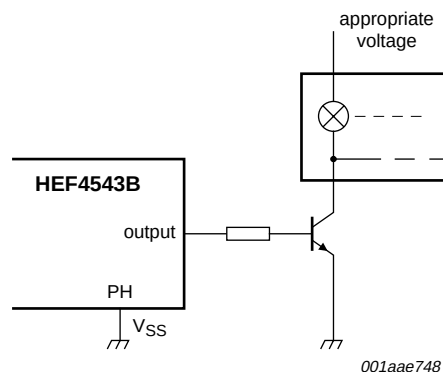


Fig 11. Connection to gas discharge display readout

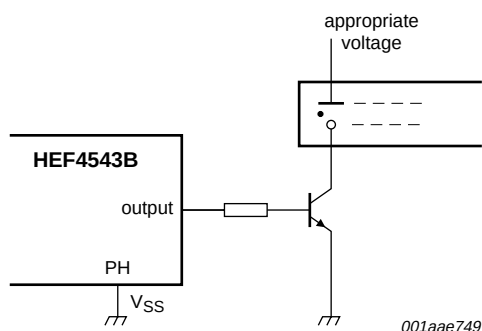
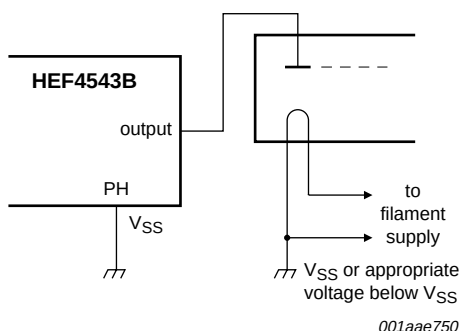


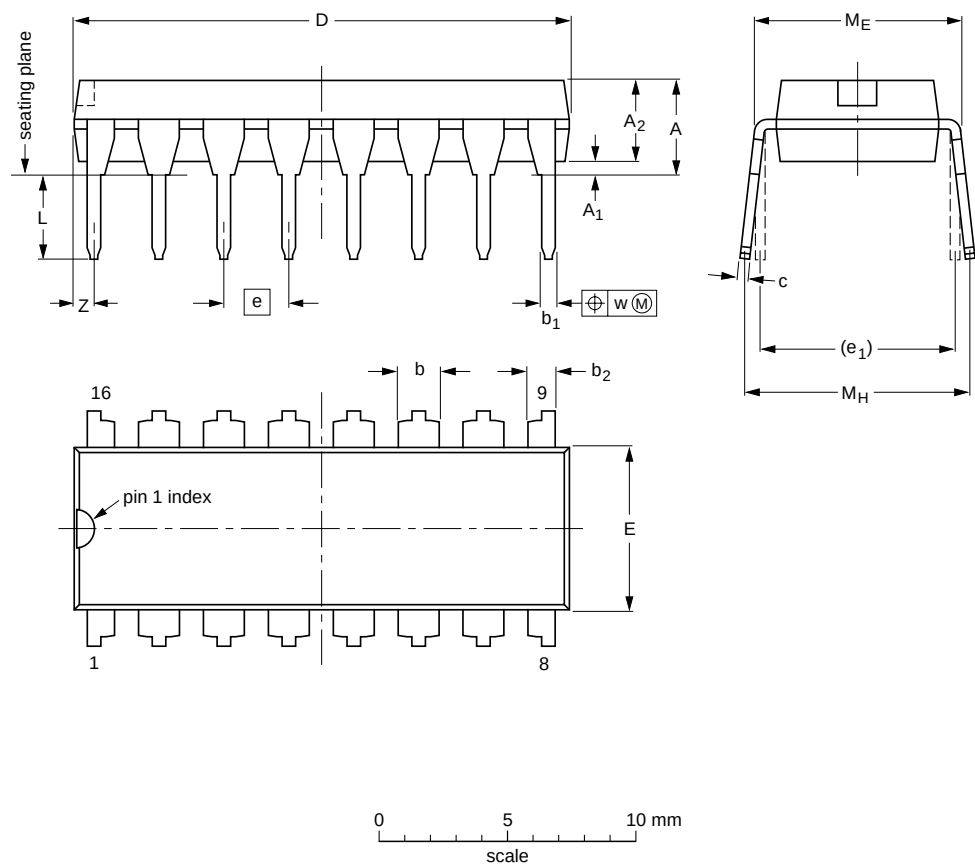
Fig 12. Connection to fluorescent display readout



14. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁ min.	A ₂ max.	b	b ₁	b ₂	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	L	M _E	M _H	w	Z ⁽¹⁾ max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	1.25 0.85	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	0.76
inches	0.17	0.02	0.13	0.068 0.051	0.021 0.015	0.049 0.033	0.014 0.009	0.77 0.73	0.26 0.24	0.1	0.3	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.03

Note

1. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

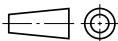
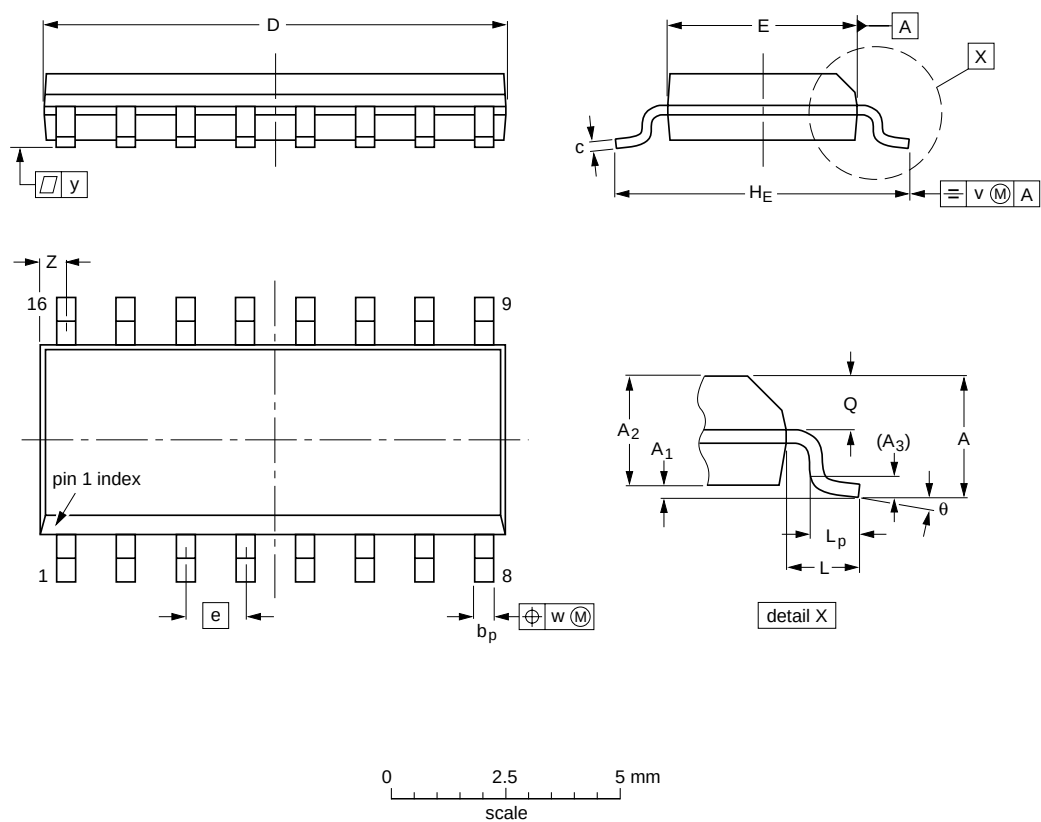
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT38-4						95-01-14- 03-02-13

Fig 13. Package outline SOT38-4 (DIP16)

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	z ⁽¹⁾	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT109-1	076E07	MS-012				99-12-27 03-02-19

Fig 14. Package outline SOT109-1 (SO16)

15. Abbreviations

Table 10. Abbreviations

Acronym	Description
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model

16. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4543B_4	20090317	Product data sheet	-	HEF4543B_CNV_3
Modifications:	• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate. • Pins renamed throughout. • Section 2 "Features" added. • Package version SOT38-1 changed to SOT38-4 in Section 4, and Figure 13. Package SOT74 removed from Section 4. • Table 1 "Ordering information" restructured. • Section 8 "Limiting values" and Section 10 "Static characteristics" added, taken from the HE4000B Family Specifications data sheet. • Section 9 "Recommended operating conditions" added. • Section 12 "Waveforms" added. • Section 15 "Abbreviations" added.			
HEF4543B_CNV_3	19950101	Product specification	-	HEF4543B_CNV_2
HEF4543B_CNV_2	19950101	Product specification	-	-

17. Legal information

17.1 Data sheet status

Document status ^{[1][2]}	Product status ^[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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Date of release: 17 March 2009

Document identifier: HEF4543B_4