# HEF4543B

## BCD to 7-segment latch/decoder/driver

Rev. 05 — 27 October 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 ($\overline{LE}$), 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 ($\overline{LE}$) 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 °C to +85 °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 °C to +85 °C
- Complies with JEDEC standard JESD 13-B

## 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

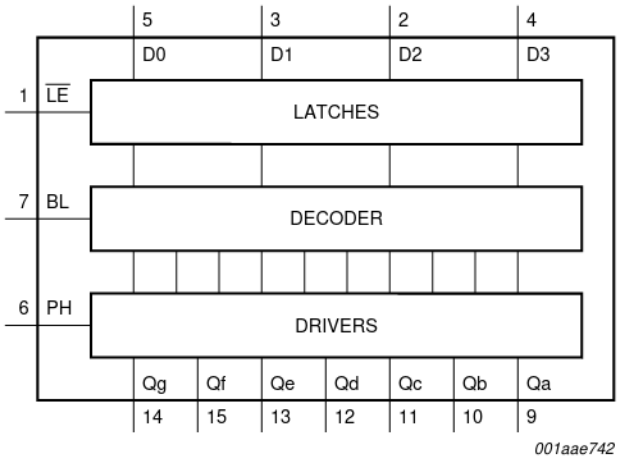



**Fig 1. Functional diagram**

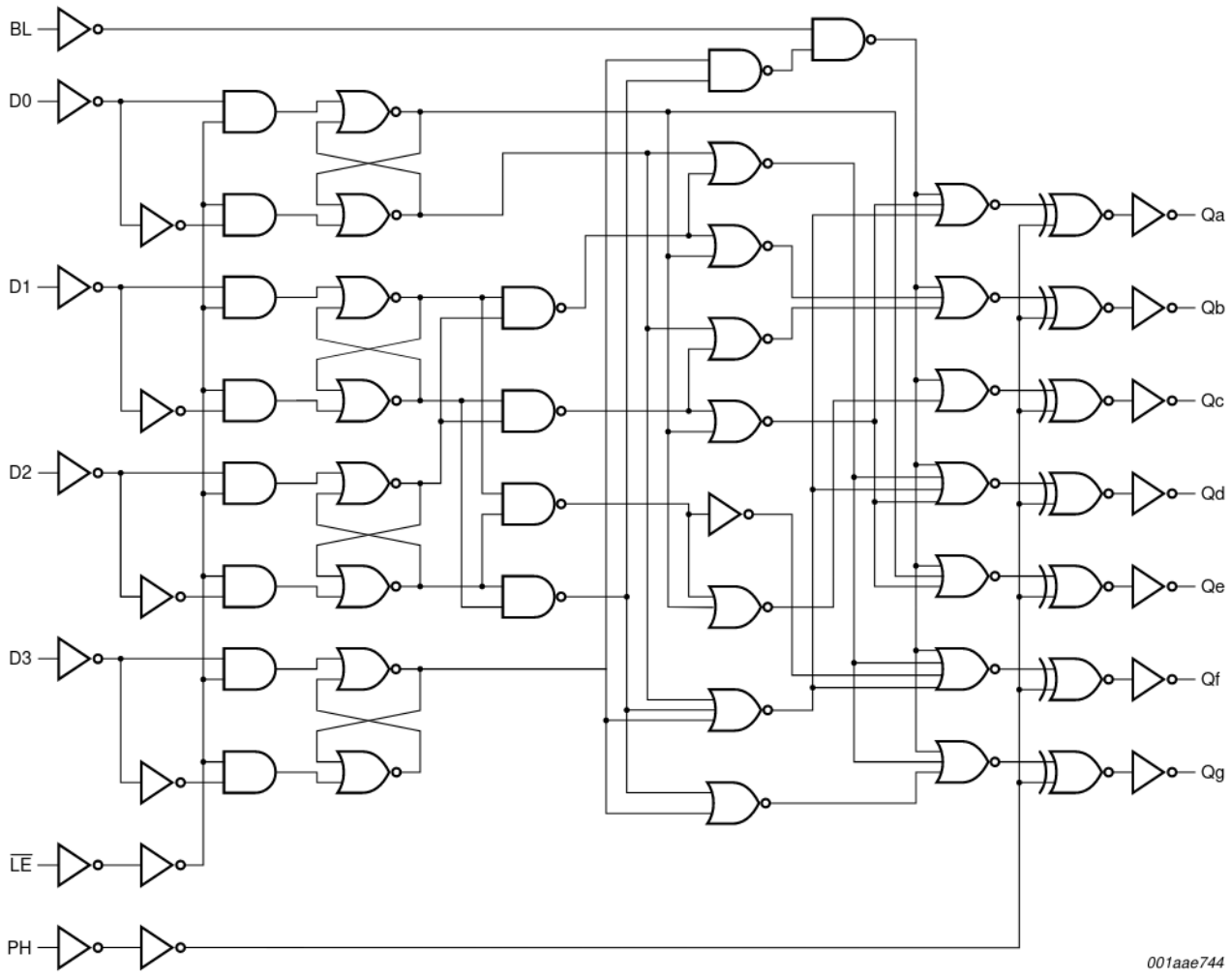



**Fig 2. Logic diagram**

# 6. Pinning information

## 6.1 Pinning

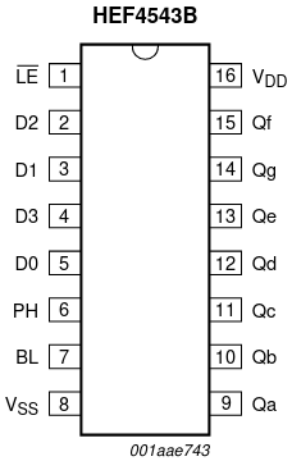



**Fig 3. Pin configuration**

## 6.2 Pin description

**Table 2. Pin description**

| Symbol | Pin | Description |
|---|---|---|
| $\overline{LE}$ | 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) |
| $V_{SS}$ | 8 | ground supply voltage |
| Qa to Qg | 9, 10, 11, 12, 13, 15, 14 | segment output |
| $V_{DD}$ | 16 | supply voltage |

## 7. Functional description

**Table 3. Function table [1]**

| Inputs | | | | | | | Outputs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\overline{LE}$ | BL | PH [2] | D3 | D2 | D1 | D0 | Qa | Qb | Qc | Qd | Qe | Qf | Qg | Display |
| 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.

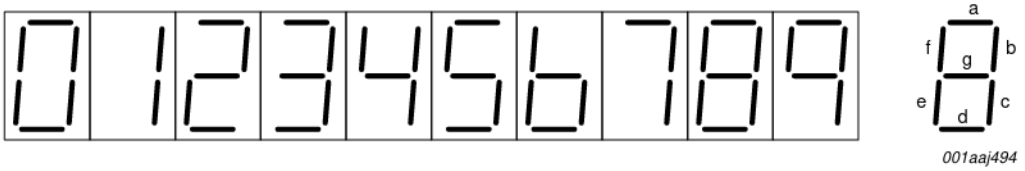



**Fig 4. Seven segment digital display with segment designation**

## 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 | $V_{DD}$ = 5 V | - | - | 3.75 | ∝s/V |
| | | $V_{DD}$ = 10 V | - | - | 0.5 | ∝s/V |
| | | $V_{DD}$ = 15 V | - | - | 0.08 | ∝s/V |

## 10. Static characteristics

**Table 6. Static characteristics**

*$V_{SS}$ = 0 V; $V_I$ = $V_{SS}$ or $V_{DD}$ unless otherwise specified.*

| Symbol | Parameter | Conditions | $V_{DD}$ | $T_{amb}$ = –40 °C | | $T_{amb}$ = 25 °C | | $T_{amb}$ = 85 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Max | Min | Max | Min | Max | |
| $V_{IH}$ | HIGH-level input voltage | $\|I_O\|$ < 1 ∝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 | $\|I_O\|$ < 1 ∝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 | $\|I_O\|$ < 1 ∝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 | $V_O$ = 2.5 V | 5 V | –1.7 | - | –1.4 | - | –1.1 | - | mA |
| | | $V_O$ = 4.6 V | 5 V | –0.52 | - | –0.44 | - | –0.36 | - | mA |
| | | $V_O$ = 9.5 V | 10 V | –1.3 | - | –1.1 | - | –0.9 | - | mA |
| | | $V_O$ = 13.5 V | 15 V | –3.6 | - | –3.0 | - | –2.4 | - | mA |

**Table 6. Static characteristics** *...continued*

*$V_{SS}$ = 0 V; $V_I$ = $V_{SS}$ or $V_{DD}$ unless otherwise specified.*

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

## 11. Dynamic characteristics

**Table 7. Dynamic characteristics**

*$V_{SS}$ = 0 V; $T_{amb}$ = 25 °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 ns + (0.55 ns/pF) $C_L$ | - | 180 | 360 | ns |
| | | | 10 V | 64 ns + (0.23 ns/pF) $C_L$ | - | 75 | 150 | ns |
| | | | 15 V | 47 ns + (0.16 ns/pF) $C_L$ | - | 55 | 110 | ns |
| | | $\overline{LE}$ to Qn; see Figure 5 | 5 V | 143 ns + (0.55 ns/pF) $C_L$ | - | 170 | 340 | ns |
| | | | 10 V | 69 ns + (0.23 ns/pF) $C_L$ | - | 80 | 160 | ns |
| | | | 15 V | 52 ns + (0.16 ns/pF) $C_L$ | - | 60 | 120 | ns |
| | | BL to Qn; see Figure 5 | 5 V | 118 ns + (0.55 ns/pF) $C_L$ | - | 145 | 290 | ns |
| | | | 10 V | 54 ns + (0.23 ns/pF) $C_L$ | - | 65 | 130 | ns |
| | | | 15 V | 37 ns + (0.16 ns/pF) $C_L$ | - | 45 | 90 | ns |
| $t_{PLH}$ | LOW to HIGH propagation delay | Dn to Qn; see Figure 5 | 5 V | 153 ns + (0.55 ns/pF) $C_L$ | - | 180 | 360 | ns |
| | | | 10 V | 64 ns + (0.23 ns/pF) $C_L$ | - | 75 | 150 | ns |
| | | | 15 V | 47 ns + (0.16 ns/pF) $C_L$ | - | 55 | 110 | ns |
| | | $\overline{LE}$ to Qn; see Figure 5 | 5 V | 163 ns + (0.55 ns/pF) $C_L$ | - | 190 | 380 | ns |
| | | | 10 V | 69 ns + (0.23 ns/pF) $C_L$ | - | 80 | 160 | ns |
| | | | 15 V | 52 ns + (0.16 ns/pF) $C_L$ | - | 60 | 120 | ns |
| | | BL to Qn; see Figure 5 | 5 V | 98 ns + (0.55 ns/pF) $C_L$ | - | 125 | 250 | ns |
| | | | 10 V | 54 ns + (0.23 ns/pF) $C_L$ | - | 55 | 110 | ns |
| | | | 15 V | 32 ns + (0.16 ns/pF) $C_L$ | - | 40 | 80 | ns |
| $t_t$ | transition time | pin Qn; see Figure 5 | 5 V | 10 ns + (1.00 ns/pF) $C_L$ | - | 60 | 120 | ns |
| | | | 10 V | 9 ns + (0.42 ns/pF) $C_L$ | - | 30 | 60 | ns |
| | | | 15 V | 6 ns + (0.28 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 V; $T_{amb}$ = 25 °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 |

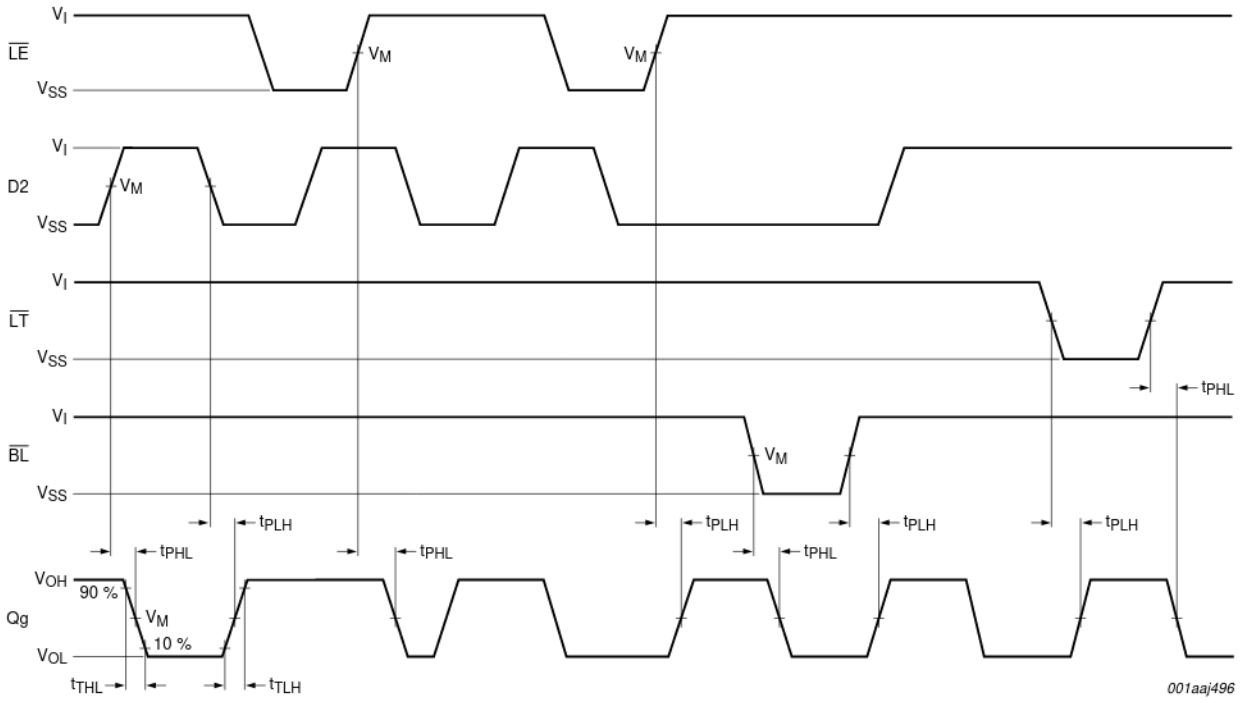
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown ($C_L$ in pF).

**Table 8. Dynamic power dissipation $P_D$**

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

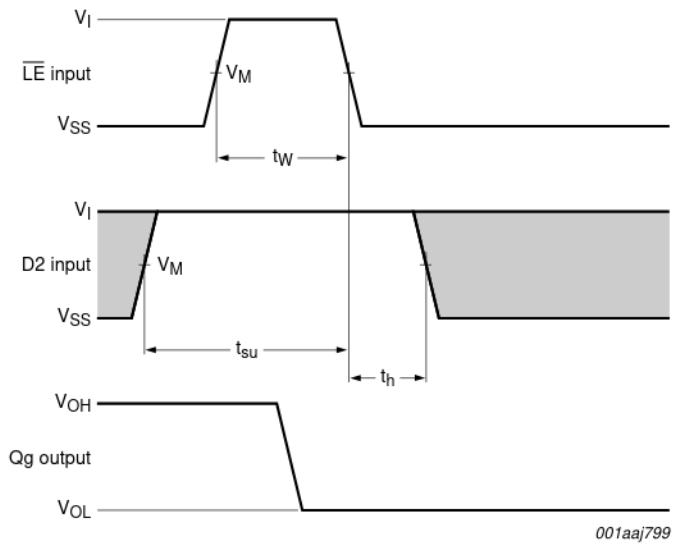
| Symbol | Parameter | $V_{DD}$ | Typical formula for $P_D$ (∝W) | where: |
|---|---|---|---|---|
| $P_D$ | dynamic power dissipation | 5 V | $P_D = 2200 \cdot f_i + \Sigma(f_o \cdot C_L) \cdot V_{DD}^2$ | $f_i$ = input frequency in MHz, |
| | | 10 V | $P_D = 10400 \cdot f_i + \Sigma(f_o \cdot C_L) \cdot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

## 12. Waveforms




Conditions: D3 = LOW and D0 = D1 =HIGH.

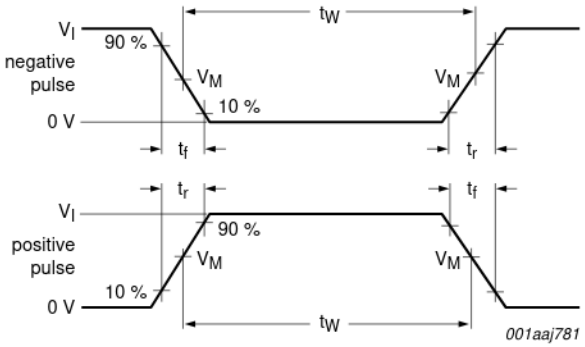
**Fig 5. Propagation delays and output transitions times**



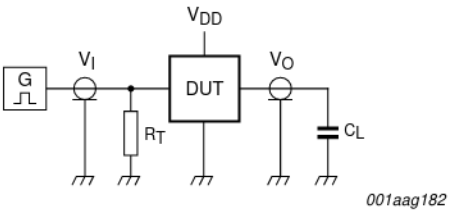

Conditions:

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**

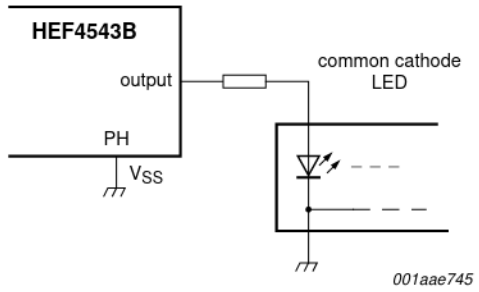
**Table 9. Test data**

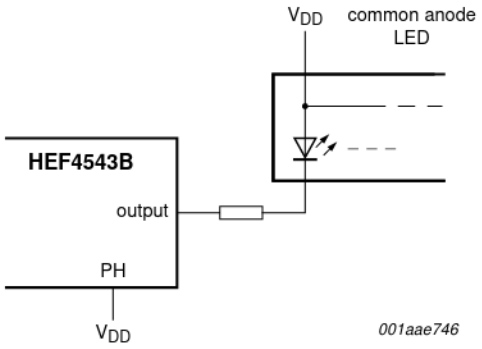
| Supply voltage | Input | | | Load |
|---|---|---|---|---|
| | $V_I$ | $V_M$ | $t_r$, $t_f$ | $C_L$ |
| 5 V to 15 V | $V_{DD}$ | $0.5V_I$ | ≤ 20 ns | 50 pF |

## 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




a. common cathode

b. common anode

Bipolar transistors may be added for gain where $V_{DD} \leq 10$ V or $I_O \geq 10$ mA.

**Fig 8. Connection to LED display readout**

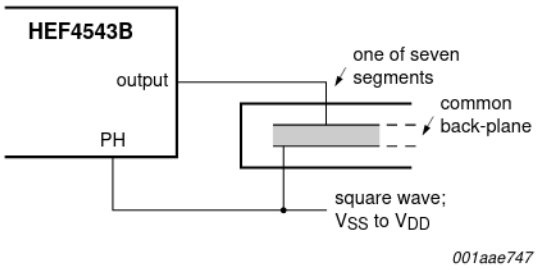



**Fig 9. Connection to LCD readout**

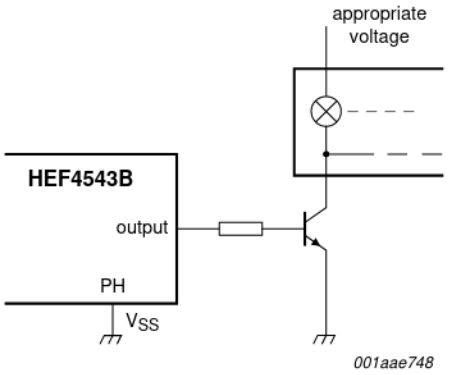



**Fig 10. Connection to incandescent display readout**

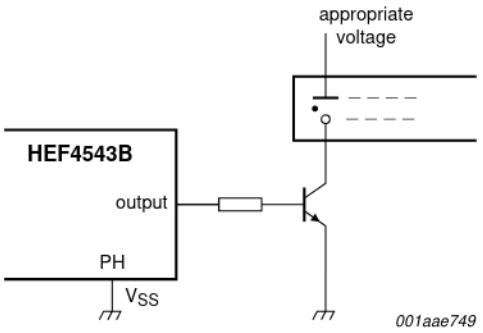



**Fig 11. Connection to gas discharge display readout**

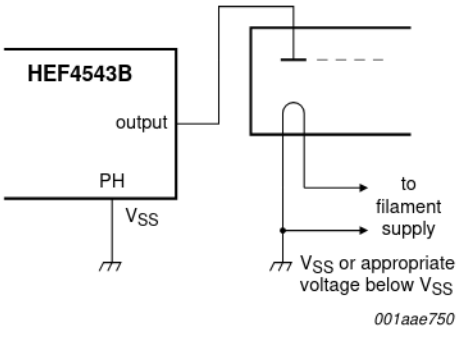
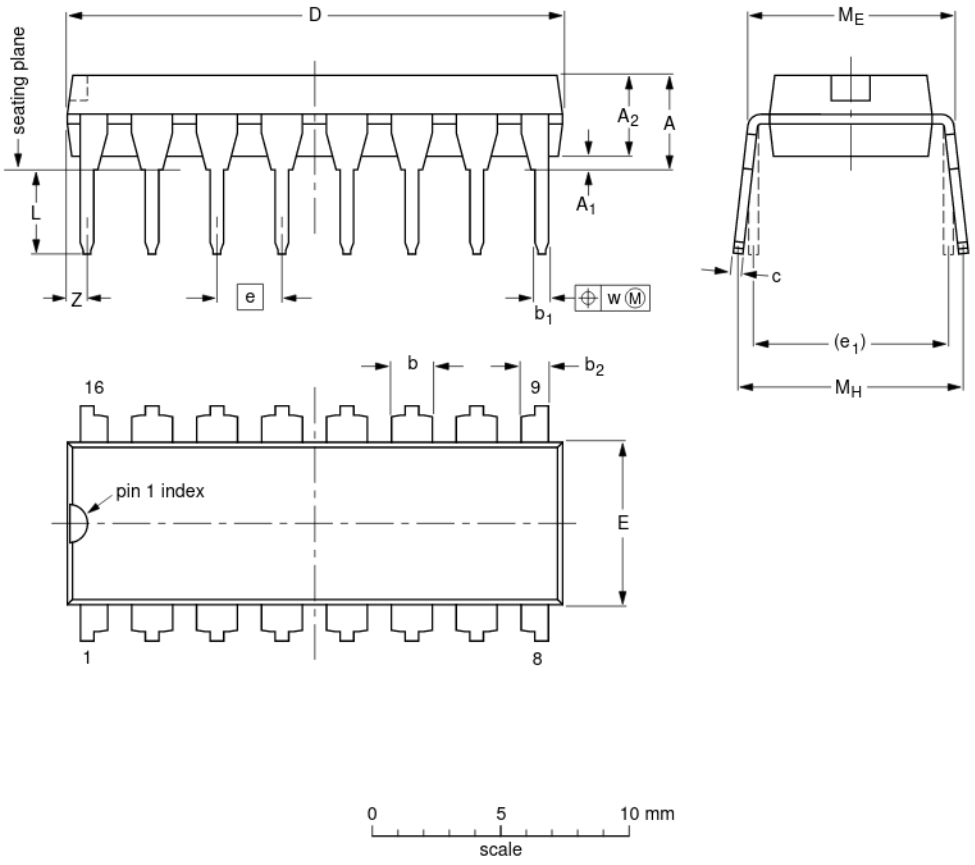



**Fig 12. Connection to fluorescent display readout**

## 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<br>1.30 | 0.53<br>0.38 | 1.25<br>0.85 | 0.36<br>0.23 | 19.50<br>18.55 | 6.48<br>6.20 | 2.54 | 7.62 | 3.60<br>3.05 | 8.25<br>7.80 | 10.0<br>8.3 | 0.254 | 0.76 |
| inches | 0.17 | 0.02 | 0.13 | 0.068<br>0.051 | 0.021<br>0.015 | 0.049<br>0.033 | 0.014<br>0.009 | 0.77<br>0.73 | 0.26<br>0.24 | 0.1 | 0.3 | 0.14<br>0.12 | 0.32<br>0.31 | 0.39<br>0.33 | 0.01 | 0.03 |

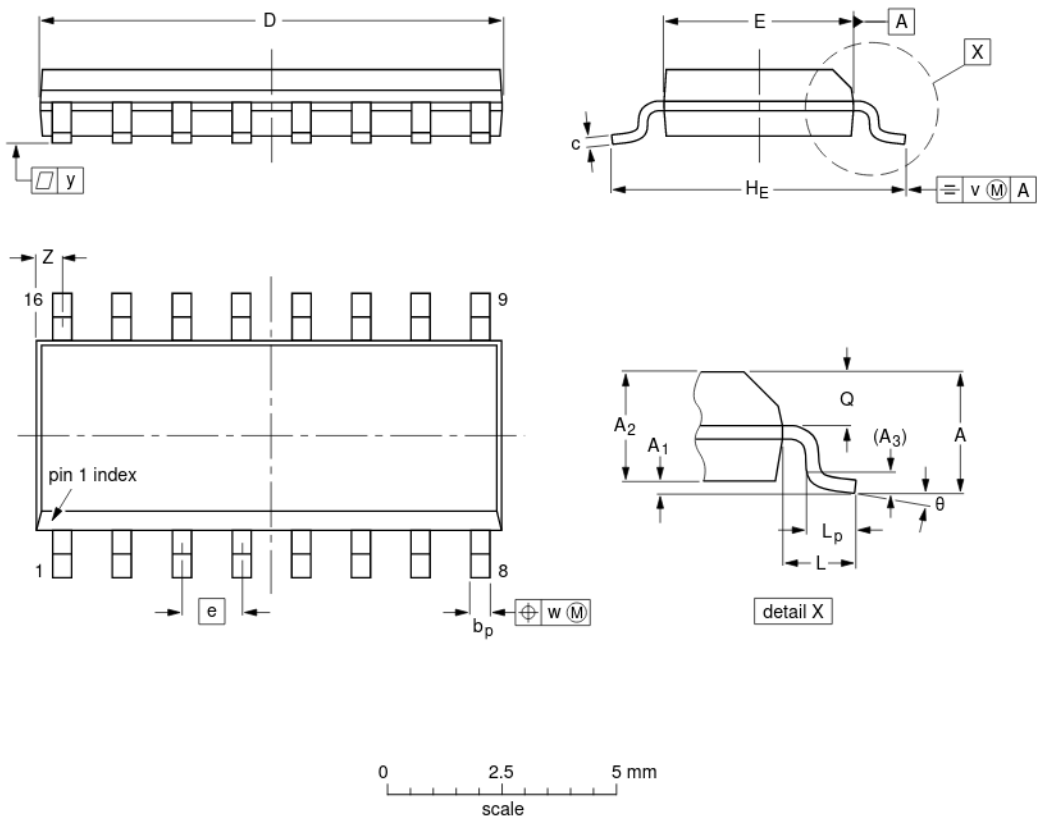
**Note**

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~~<br>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<br>0.10 | 1.45<br>1.25 | 0.25 | 0.49<br>0.36 | 0.25<br>0.19 | 10.0<br>9.8 | 4.0<br>3.8 | 1.27 | 6.2<br>5.8 | 1.05 | 1.0<br>0.4 | 0.7<br>0.6 | 0.25 | 0.25 | 0.1 | 0.7<br>0.3 | $8^o$<br>$0^o$ |
| inches | 0.069 | 0.010<br>0.004 | 0.057<br>0.049 | 0.01 | 0.019<br>0.014 | 0.0100<br>0.0075 | 0.39<br>0.38 | 0.16<br>0.15 | 0.05 | 0.244<br>0.228 | 0.041 | 0.039<br>0.016 | 0.028<br>0.020 | 0.01 | 0.01 | 0.004 | 0.028<br>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~~<br>03-02-19 |

**Fig 14. Package outline SOT109-1 (SO16)**

## 15. Abbreviations

**Table 10. Abbreviations**

| Acronym | Description |
|---|---|
| DUT | Device Under Test |

## 16. Revision history

**Table 11. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| HEF4543B_5 | 20091027 | Product data sheet | - | HEF4543B_4 |
| Modifications: | • Section 2 “Features” ESD entry removed.<br>• Section 9 “Recommended operating conditions” Δt/ΔV values updated.<br>• Section 15 “Abbreviations” ESD entries removed. | | | |
| HEF4543B_4 | 20090317 | Product data sheet | - | HEF4543B_CNV_3 |
| 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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## 19. Contents





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