

HEF4543B

BCD to 7-segment latch/decoder/driver

Rev. 8 — 24 November 2021

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.

2. Features and benefits

- Wide supply voltage range from 3.0 V to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Complies with JEDEC standard JESD 13-B
- ESD protection:
 - HBM JESD22-A114F exceeds 2000 V
 - MM JESD22-A115-B exceeds 200 V
- Specified from -40 °C to +85 °C

3. Ordering information

Table 1. Ordering information

| Type number | Package | | | |
|-------------|-------------------|------|--|----------|
| | Temperature range | Name | Description | Version |
| HEF4543BT | -40 °C to +85 °C | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |

4. Functional diagram

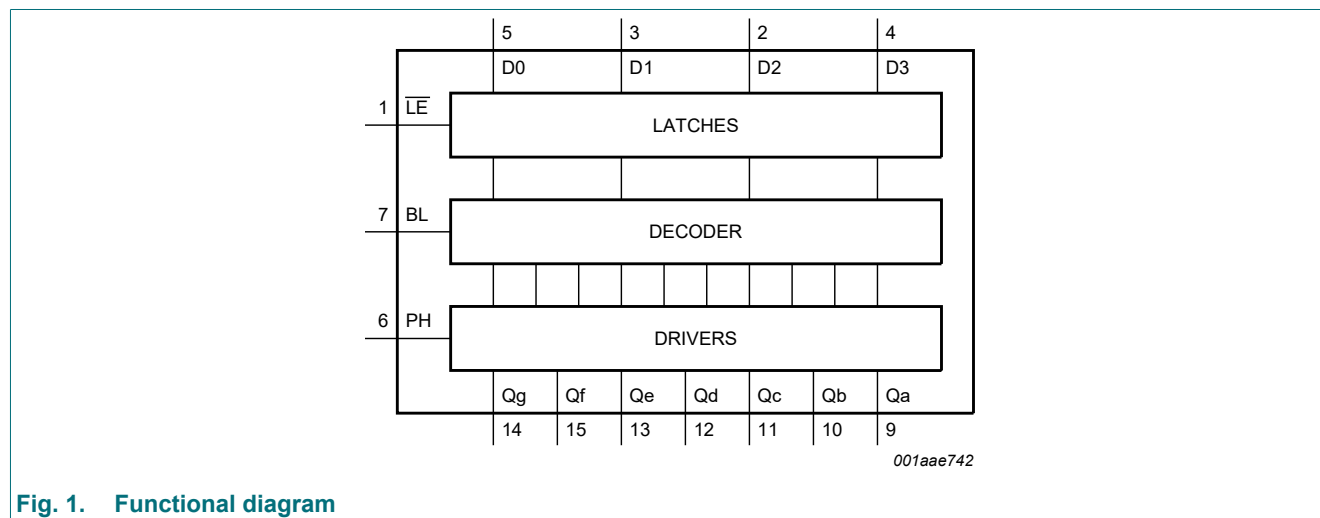


Fig. 1. Functional diagram

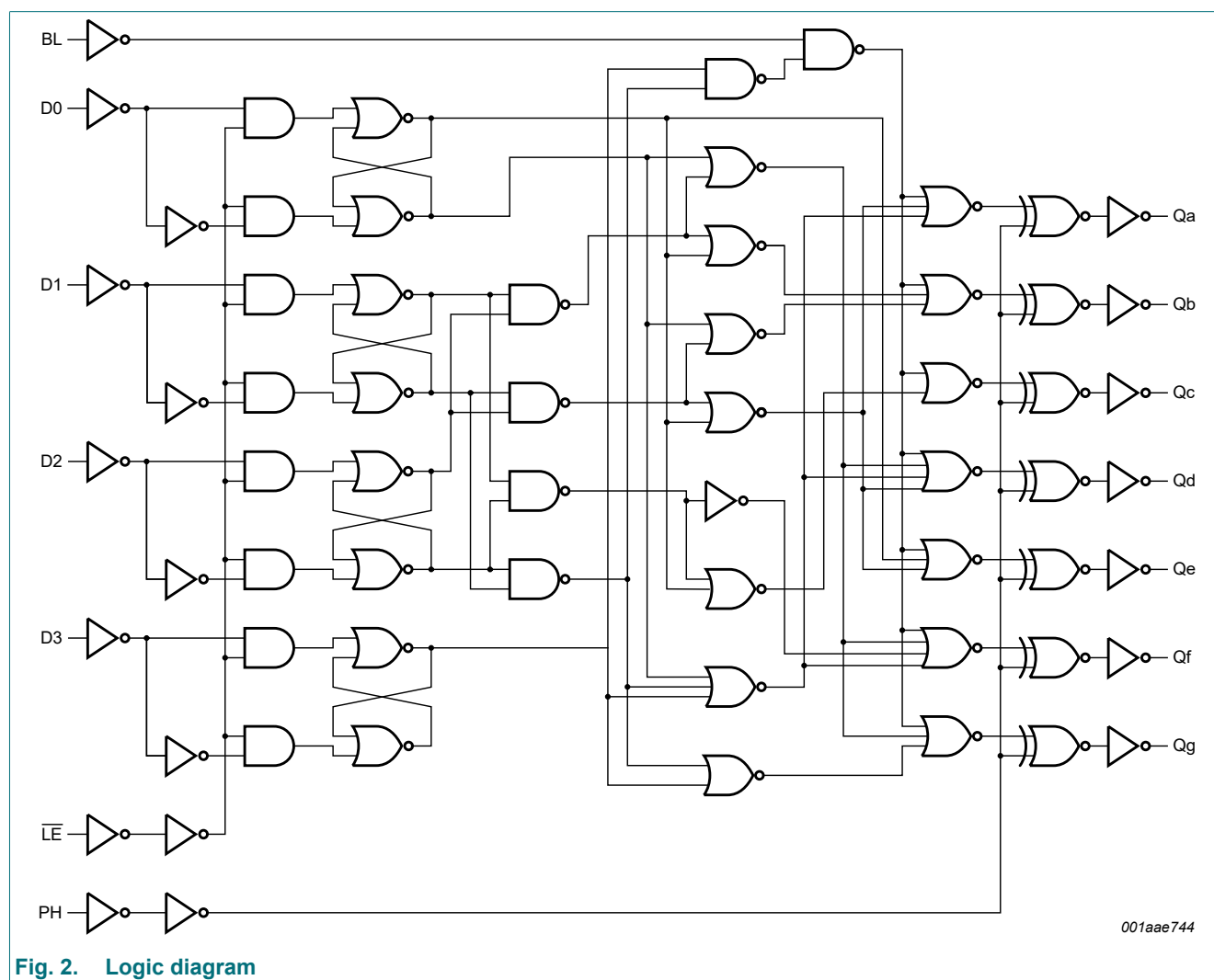


Fig. 2. Logic diagram

5. Pinning information

5.1. Pinning

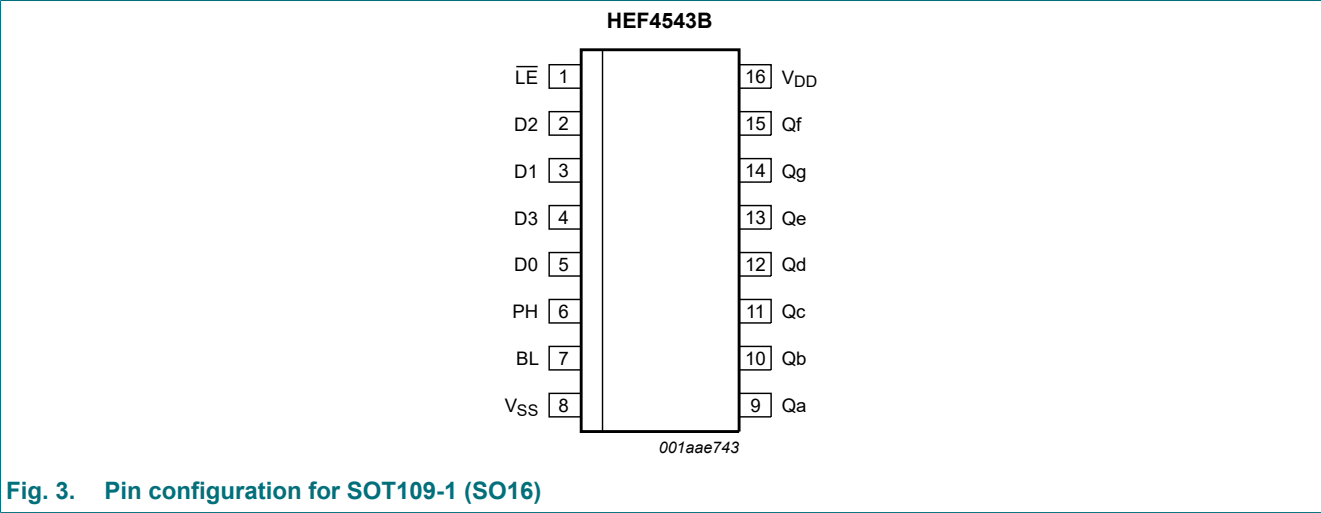


Fig. 3. Pin configuration for SOT109-1 (SO16)

5.2. Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|----------------------------|---------------------------|---------------------------------|
| LE | 1 | latch enable input (active LOW) |
| D0, D1, D2, 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, Qb, Qc, Qd, Qe, Qf, Qg | 9, 10, 11, 12, 13, 15, 14 | segment output |
| VDD | 16 | supply voltage |

6. Functional description

Table 3. Function table

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

| Inputs | | | | | | | Outputs | | | | | | | Display |
|----------|----|-------------------|----------|----|----|----|------------------|----|----|----|----|----|----|----------|
| LE | BL | PH ^[1] | 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] 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.

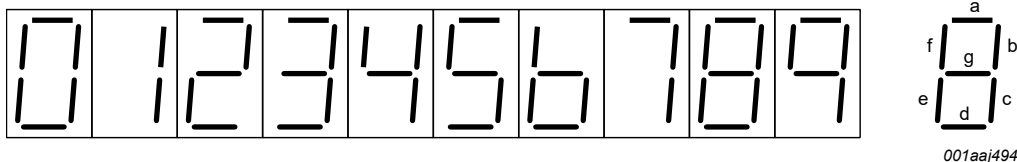


Fig. 4. Seven segment digital display with segment designation

7. 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 |
| P_{tot} | total power dissipation | | - | 500 | mW |
| P | power dissipation | per output | - | 100 | mW |

8. 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 | $V_{DD} = 5\text{ V}$ | - | - | 3.75 | $\mu\text{s/V}$ |
| | | $V_{DD} = 10\text{ V}$ | - | - | 0.5 | $\mu\text{s/V}$ |
| | | $V_{DD} = 15\text{ V}$ | - | - | 0.08 | $\mu\text{s/V}$ |

9. Static characteristics

Table 6. Static characteristics

$V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ 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 | |
| V_{IH} | HIGH-level input voltage | $ I_O < 1\text{ }\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_O < 1\text{ }\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 | $ I_O < 1\text{ }\mu\text{A}$ | 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\text{ }\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 | $V_O = 2.5\text{ V}$ | 5 V | - | -1.7 | - | -1.4 | - | -1.1 | mA |
| | | $V_O = 4.6\text{ V}$ | 5 V | - | -0.52 | - | -0.44 | - | -0.36 | mA |
| | | $V_O = 9.5\text{ V}$ | 10 V | - | -1.3 | - | -1.1 | - | -0.9 | mA |
| | | $V_O = 13.5\text{ V}$ | 15 V | - | -3.6 | - | -3.0 | - | -2.4 | mA |
| 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 |

10. Dynamic characteristics

Table 7. Dynamic characteristics

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$ unless otherwise specified; For test circuit see Fig. 7.

| Symbol | Parameter | Conditions | V_{DD} | Extrapolation formula[1] | Min | Typ | Max | Unit |
|-----------|-------------------------------|---|----------|--|-----|-----|-----|------|
| t_{PHL} | HIGH to LOW propagation delay | Dn to Qn; see Fig. 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 Fig. 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 Fig. 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 Fig. 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 Fig. 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 Fig. 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 Fig. 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 Fig. 6 | 5 V | | 40 | 20 | - | ns |
| | | | 10 V | | 20 | 5 | - | ns |
| | | | 15 V | | 15 | 0 | - | ns |
| t_h | hold time | Dn to \overline{LE} ; see Fig. 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 Fig. 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. $V_{SS} = 0\text{ V}$; $t_r = t_f \leq 20\text{ ns}$; $T_{amb} = 25\text{ °C}$.

| 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; f_o = output frequency in MHz; C_L = output load capacitance in pF; V_{DD} = supply voltage in V; $\Sigma(C_L \times f_o)$ = sum of the outputs. |
| | | 10 V | $P_D = 10400 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ | |
| | | 15 V | $P_D = 33000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ | |

10.1. Waveforms and test circuit

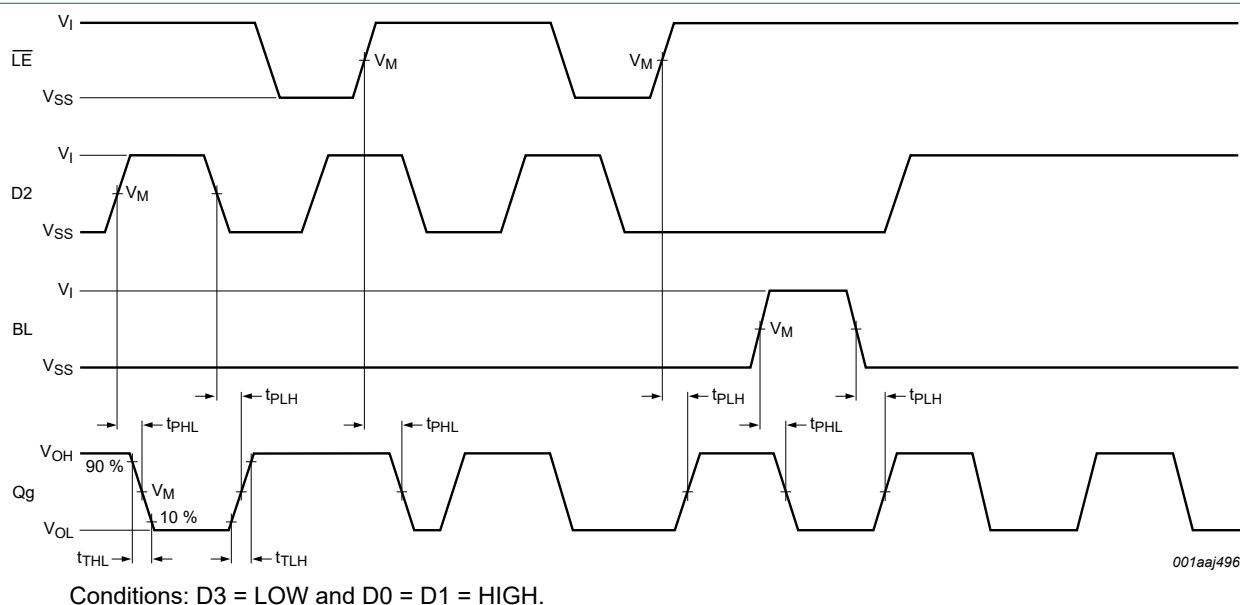
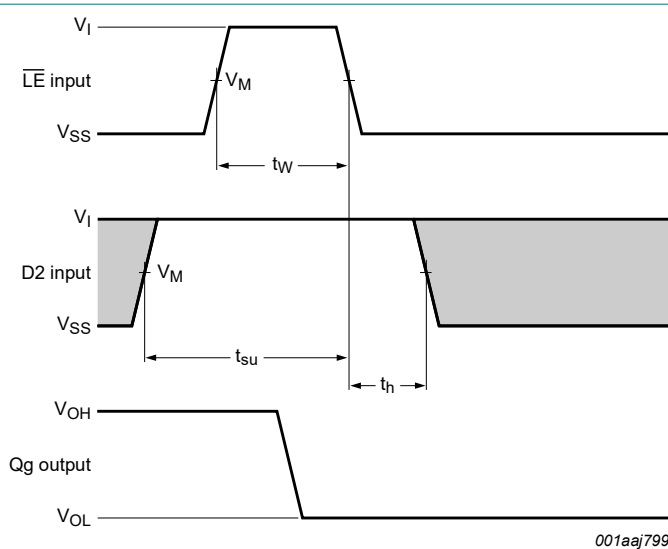


Fig. 5. Propagation delays and output transitions times



Conditions:
D3 = BL = LOW; D0 = D1 = \overline{LE} = HIGH

Fig. 6. Waveforms showing minimum $\overline{\text{LE}}$ pulse width, set-up, and hold time for DC to $\overline{\text{LE}}$

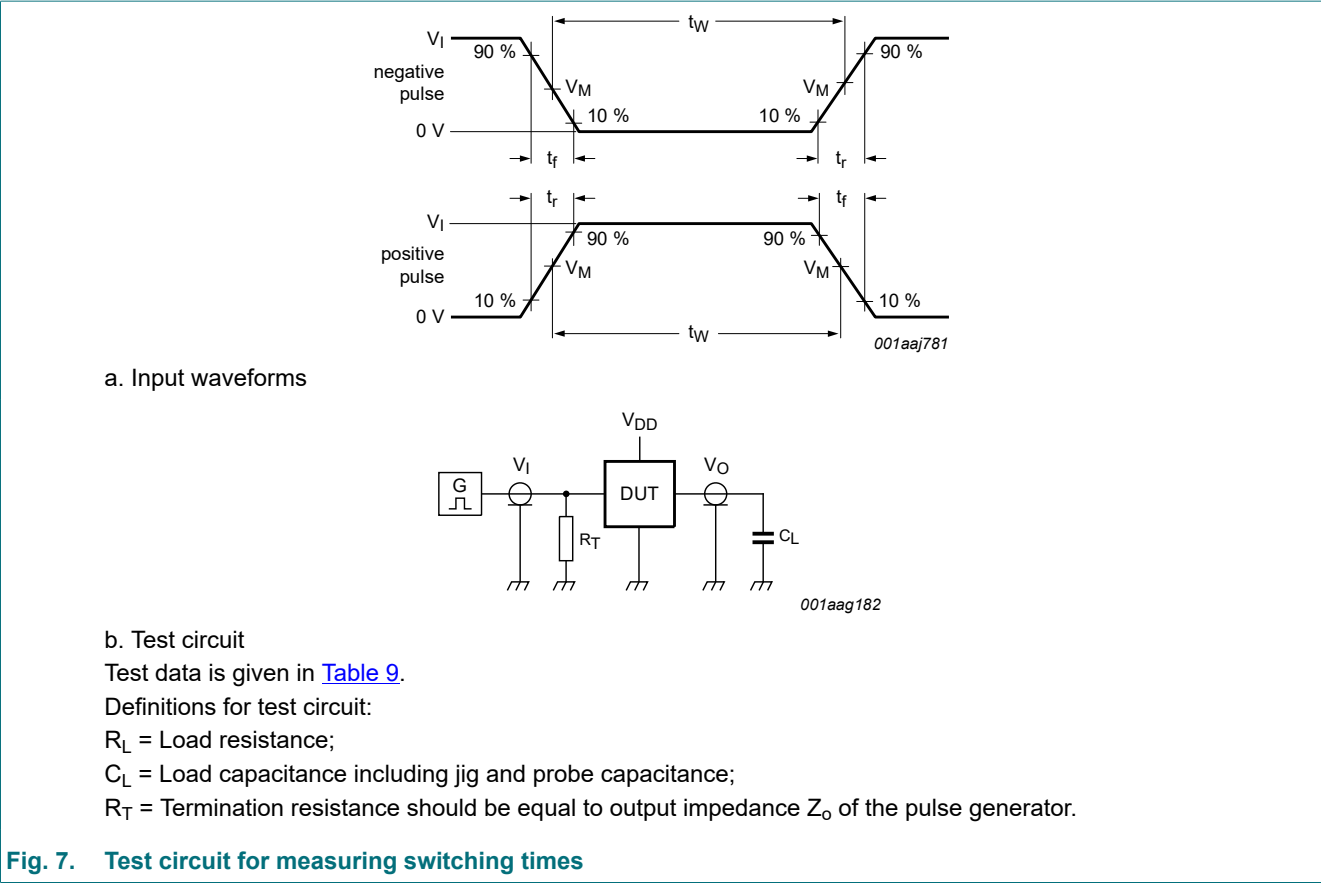


Fig. 7. Test circuit for measuring switching times

Table 9. Test data

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

11. 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

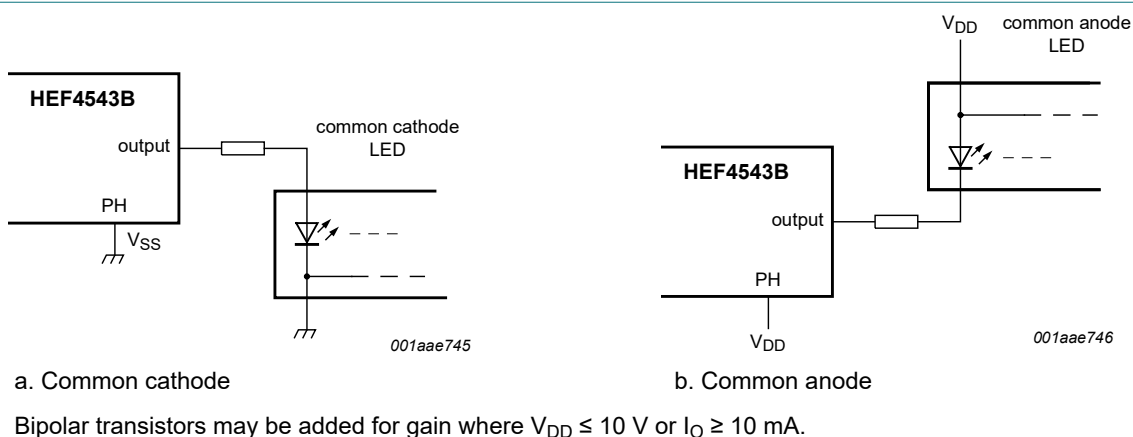


Fig. 8. Connection to LED display readout

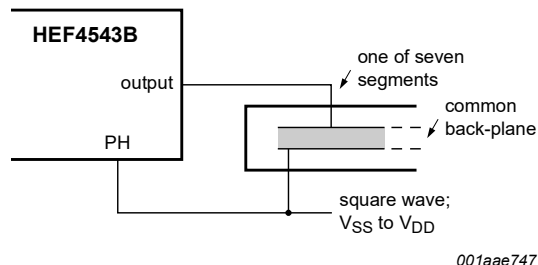


Fig. 9. Connection to LCD readout

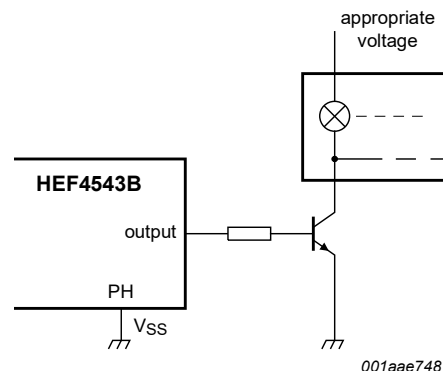


Fig. 10. Connection to incandescent display readout

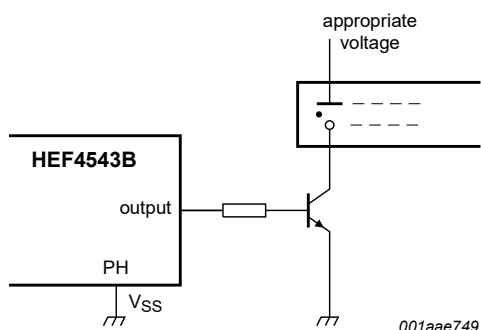


Fig. 11. Connection to gas discharge display readout

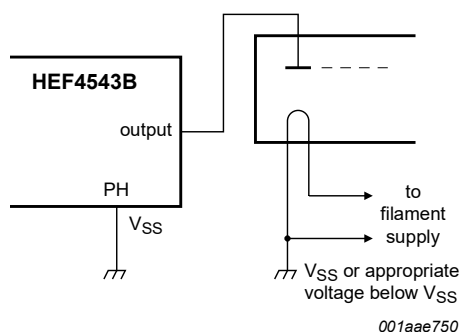


Fig. 12. Connection to fluorescent display readout

12. Package outline

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

SOT109-1

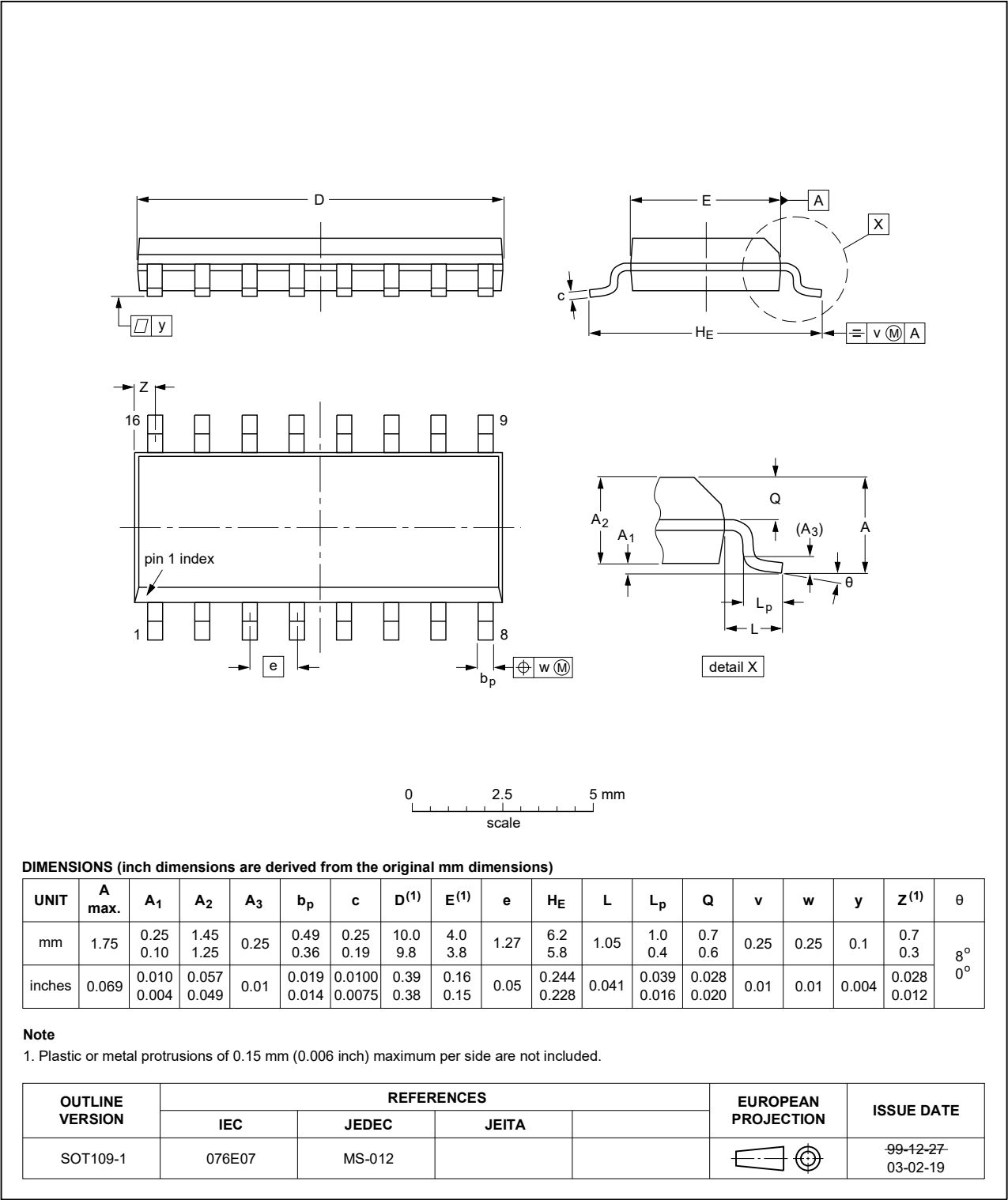


Fig. 13. Package outline SOT109-1 (SO16)

13. Abbreviations

Table 10. Abbreviations

| Acronym | Description |
|---------|---|
| CMOS | Complementary Metal-Oxide Semiconductor |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| LCD | Liquid Crystal Display |
| LED | Light Emitting Diode |
| MM | Machine Model |

14. Revision history

Table 11. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|------------------|---|-----------------------|---------------|------------------|
| HEF4543B v.8 | 20211124 | Product data sheet | - | HEF4543B v.7 |
| Modifications: | <ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. Section 2 updated. Table 6: V_{OH} condition added (errata). | | | |
| HEF4543B v.7 | 20160401 | Product data sheet | - | HEF4543B v.6 |
| Modifications: | <ul style="list-style-type: none"> Type number HEF4543BP (SOT38-4) removed. | | | |
| HEF4543B v.6 | 20111117 | Product data sheet | - | HEF4543B v.5 |
| Modifications: | <ul style="list-style-type: none"> Section Applications removed Table 6: I_{OH} minimum values changed to maximum Fig. 6: signal \overline{LT} removed; signal \overline{BL} replaced by BL (inverted) | | | |
| HEF4543B v.5 | 20091027 | Product data sheet | - | HEF4543B v.4 |
| HEF4543B v.4 | 20090317 | Product data sheet | - | HEF4543B_CNV v.3 |
| HEF4543B_CNV v.3 | 19950101 | Product specification | - | HEF4543B_CNV v.2 |
| HEF4543B_CNV v.2 | 19950101 | Product specification | - | - |

15. Legal information

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".
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