

# HEF4520B

## Dual binary counter

Rev. 7 — 30 March 2016

Product data sheet

### 1. General description

The HEF4520B is a dual 4-bit internally synchronous binary counter. The counter has an active HIGH clock input (nCP0) and an active LOW clock input (nCP1), buffered outputs from all four bit positions (nQ0 to nQ3) and an active HIGH overriding asynchronous master reset input (nMR).

The counter advances on either the LOW-to-HIGH transition of the nCP0 input if  $\overline{\text{nCP1}}$  is HIGH or the HIGH-to-LOW transition of the  $\overline{\text{nCP1}}$  input if nCP0 is LOW. Either nCP0 or nCP1 may be used as the clock input to the counter while the other clock input may be used as a clock enable input. Schmitt trigger action makes the clock input highly tolerant of slower clock rise and fall times. A HIGH on nMR resets the counter (nQ0 to nQ3 = LOW) independent of nCP0 and nCP1.

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

- Tolerant of slow clock rise and fall times
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B

### 3. Ordering information

**Table 1.** Ordering information

All types operate from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ .

| Type number | Package |                                                            |          |
|-------------|---------|------------------------------------------------------------|----------|
|             | Name    | Description                                                | Version  |
| HEF4520BT   | SO16    | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |



4. Functional diagram

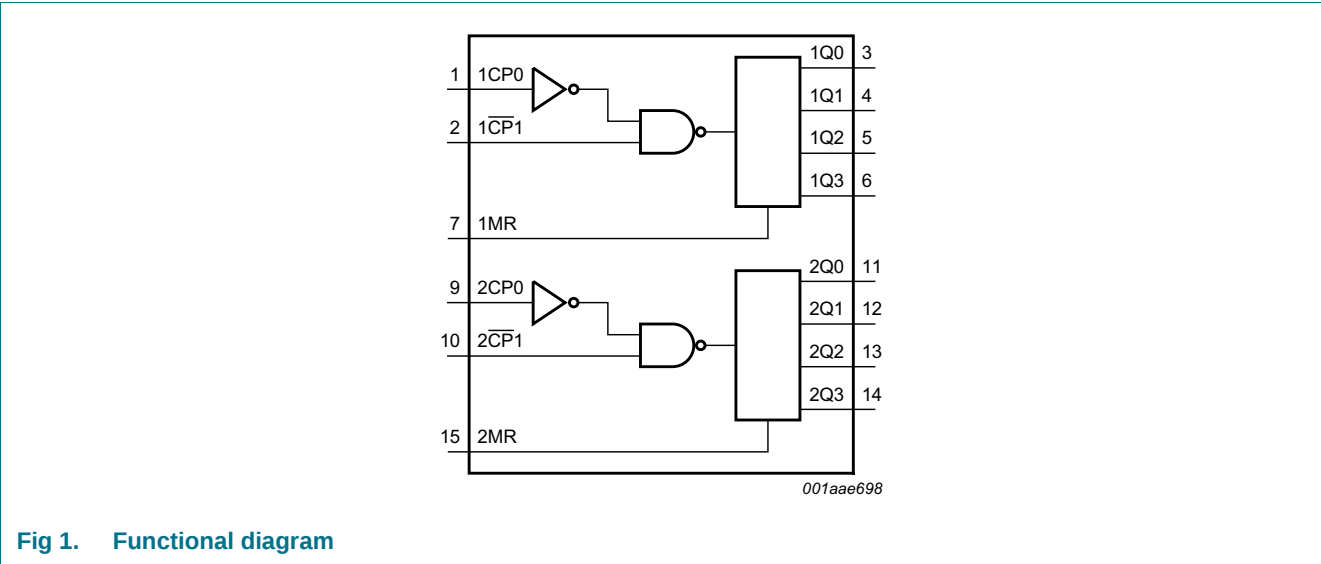


Fig 1. Functional diagram

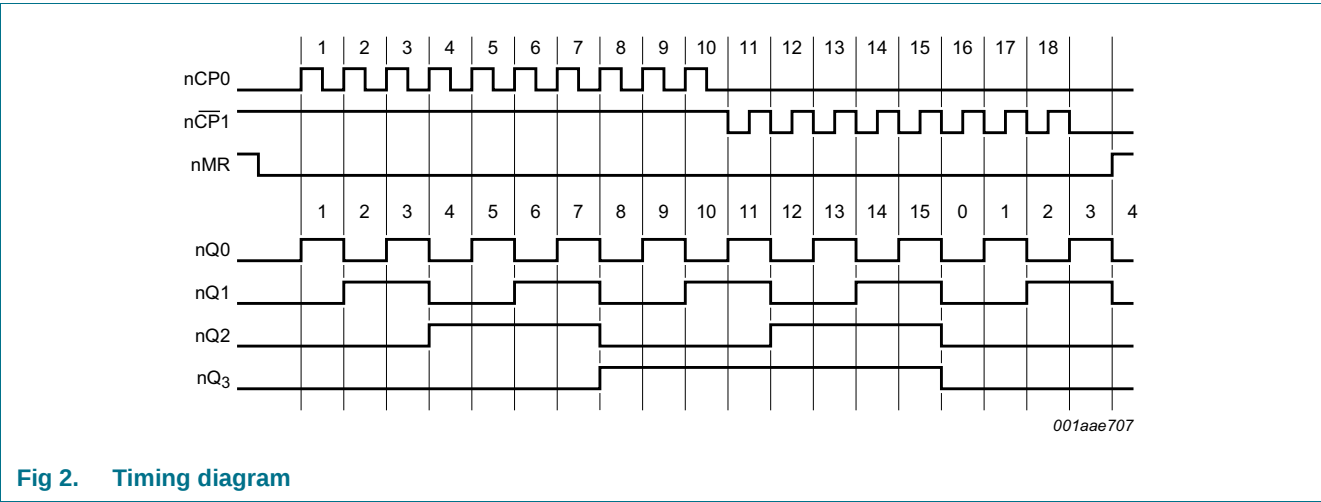


Fig 2. Timing diagram

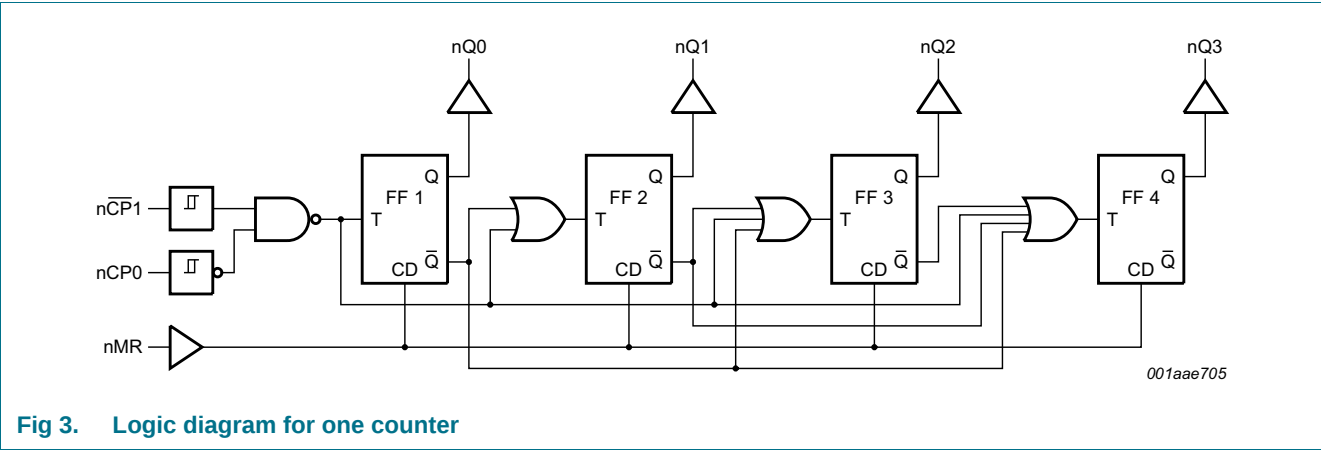


Fig 3. Logic diagram for one counter

5. Pinning information

5.1 Pinning

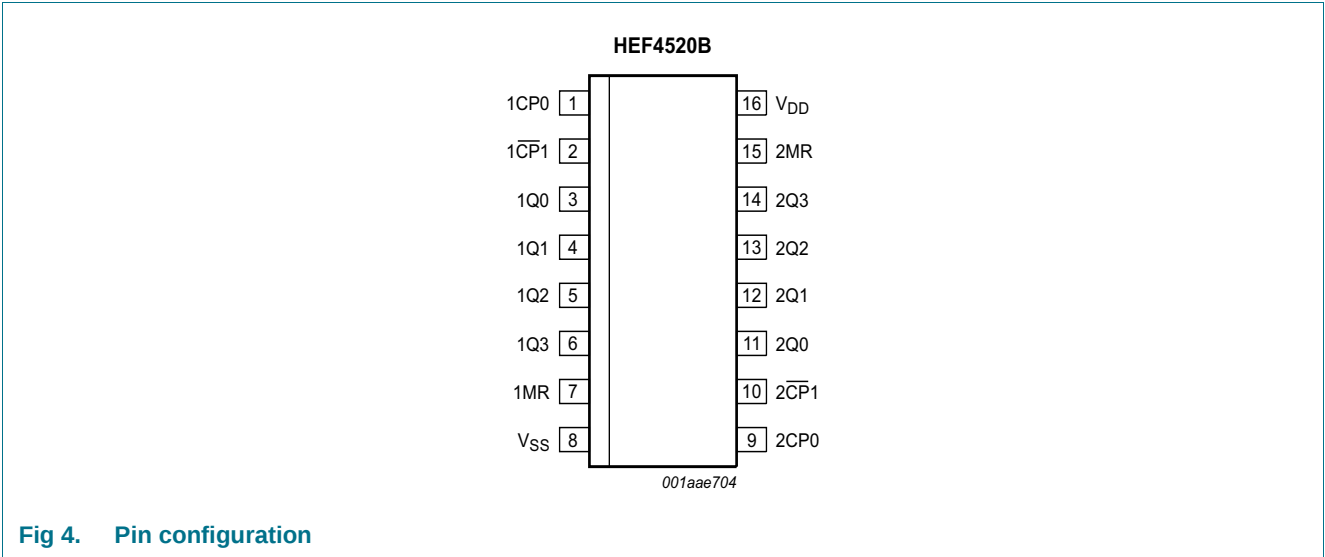


Fig 4. Pin configuration

5.2 Pin description

Table 2. Pin description

| Symbol     | Pin            | Description                         |
|------------|----------------|-------------------------------------|
| 1CP0, 2CP0 | 1, 9           | clock input (LOW-to-HIGH triggered) |
| 1CP1, 2CP1 | 2, 10          | clock input (HIGH-to-LOW triggered) |
| 1Q0 to 1Q3 | 3, 4, 5, 6     | output                              |
| 1MR, 2MR   | 7, 15          | master reset input                  |
| VSS        | 8              | ground supply voltage               |
| 2Q0 to 2Q3 | 11, 12, 13, 14 | output                              |
| VDD        | 16             | supply voltage                      |

6. Functional description

Table 3. Function table<sup>[1]</sup>

| nCP0 | nCP1 | nMR | Mode             |
|------|------|-----|------------------|
| ↑    | H    | L   | counter advances |
| L    | ↓    | L   | counter advances |
| ↓    | X    | L   | no change        |
| X    | ↑    | L   | no change        |
| ↑    | L    | L   | no change        |
| H    | ↓    | L   | no change        |
| X    | X    | H   | nQ0 to nQ3 = LOW |

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = positive-going transition; ↓ = negative-going transition.

## 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    |
| $I_{IK}$  | input clamping current  | $V_I < -0.5\text{ V}$ or $V_I > V_{DD} + 0.5\text{ V}$ | -    | $\pm 10$       | mA   |
| $V_I$     | input voltage           |                                                        | -0.5 | $V_{DD} + 0.5$ | V    |
| $I_{OK}$  | output clamping current | $V_O < -0.5\text{ V}$ or $V_O > V_{DD} + 0.5\text{ V}$ | -    | $\pm 10$       | mA   |
| $I_{I/O}$ | input/output current    |                                                        | -    | $\pm 10$       | mA   |
| $I_{DD}$  | supply current          |                                                        | -    | 50             | mA   |
| $T_{stg}$ | storage temperature     | per output                                             | -65  | +150           | °C   |
| $T_{amb}$ | ambient temperature     |                                                        | -40  | +85            | °C   |
| $P_{tot}$ | total power dissipation | SO16 package <a href="#">[1]</a>                       | -    | 500            | mW   |
| $P$       | power dissipation       |                                                        | -    | 100            | mW   |

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

## 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}$ ;<br>$V_I = V_{SS}$ or $V_{DD}$ | 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}$ ;<br>$V_I = V_{SS}$ or $V_{DD}$ | 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     | $V_{DD} = 15\text{ V}$                                         | 15 V     | -                         | $\pm 0.3$ | -                        | $\pm 0.3$ | -                        | $\pm 1.0$ | $\mu\text{A}$ |
| $I_{DD}$ | supply current            | $I_O = 0\text{ A}$ ;<br>$V_I = V_{SS}$ or $V_{DD}$             | 5 V      | -                         | 20        | -                        | 20        | -                        | 150       | $\mu\text{A}$ |
|          |                           |                                                                | 10 V     | -                         | 40        | -                        | 40        | -                        | 300       | $\mu\text{A}$ |
|          |                           |                                                                | 15 V     | -                         | 80        | -                        | 80        | -                        | 600       | $\mu\text{A}$ |
| $C_I$    | input capacitance         |                                                                | -        | -                         | -         | -                        | 7.5       | -                        | -         | pF            |

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

$V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; for test circuit see [Figure 6](#); unless otherwise specified.

| Symbol    | Parameter                     | Conditions                                                    | $V_{DD}$                | Extrapolation formula                   | Min | Typ | Max | Unit |
|-----------|-------------------------------|---------------------------------------------------------------|-------------------------|-----------------------------------------|-----|-----|-----|------|
| $t_{PHL}$ | HIGH to LOW propagation delay | nCP0, nCP1 $\rightarrow$ nQn;<br>see <a href="#">Figure 5</a> | 5 V <a href="#">[1]</a> | $83\text{ ns} + (0.55\text{ ns/pF})C_L$ | -   | 110 | 220 | ns   |
|           |                               |                                                               | 10 V                    | $39\text{ ns} + (0.23\text{ ns/pF})C_L$ | -   | 50  | 100 | ns   |
|           |                               |                                                               | 15 V                    | $32\text{ ns} + (0.16\text{ ns/pF})C_L$ | -   | 40  | 80  | ns   |
|           |                               | nMR $\rightarrow$ nQn;<br>see <a href="#">Figure 5</a>        | 5 V                     | $48\text{ ns} + (0.55\text{ ns/pF})C_L$ | -   | 75  | 150 | ns   |
|           |                               |                                                               | 10 V                    | $24\text{ ns} + (0.23\text{ ns/pF})C_L$ | -   | 35  | 70  | ns   |
|           |                               |                                                               | 15 V                    | $17\text{ ns} + (0.16\text{ ns/pF})C_L$ | -   | 25  | 50  | ns   |

**Table 7. Dynamic characteristics ...continued**

$V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ; for test circuit see [Figure 6](#); unless otherwise specified.

| Symbol    | Parameter                     | Conditions                                                                | $V_{DD}$           | Extrapolation formula                   | Min | Typ | Max | Unit |
|-----------|-------------------------------|---------------------------------------------------------------------------|--------------------|-----------------------------------------|-----|-----|-----|------|
| $t_{PLH}$ | LOW to HIGH propagation delay | nCP0, $\overline{nCP1} \rightarrow nQn$ ; see <a href="#">Figure 5</a>    | 5 V <sup>[1]</sup> | $83\text{ ns} + (0.55\text{ ns/pF})C_L$ | -   | 110 | 220 | ns   |
|           |                               |                                                                           | 10 V               | $39\text{ ns} + (0.23\text{ ns/pF})C_L$ | -   | 50  | 100 | ns   |
|           |                               |                                                                           | 15 V               | $32\text{ ns} + (0.16\text{ ns/pF})C_L$ | -   | 40  | 80  | ns   |
| $t_t$     | transition time               | nQn; see <a href="#">Figure 5</a>                                         | 5 V <sup>[1]</sup> | $10\text{ ns} + (1.00\text{ ns/pF})C_L$ | -   | 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   |
| $t_w$     | pulse width                   | nCP0 input LOW; minimum width; see <a href="#">Figure 5</a>               | 5 V                |                                         | 60  | 30  | -   | ns   |
|           |                               |                                                                           | 10 V               |                                         | 30  | 15  | -   | ns   |
|           |                               |                                                                           | 15 V               |                                         | 20  | 10  | -   | ns   |
|           |                               | $\overline{nCP1}$ input HIGH; minimum width; see <a href="#">Figure 5</a> | 5 V                |                                         | 60  | 30  | -   | ns   |
|           |                               |                                                                           | 10 V               |                                         | 30  | 15  | -   | ns   |
|           |                               |                                                                           | 15 V               |                                         | 20  | 10  | -   | ns   |
|           |                               | nMR input HIGH; minimum width; see <a href="#">Figure 5</a>               | 5 V                |                                         | 30  | 15  | -   | ns   |
|           |                               |                                                                           | 10 V               |                                         | 20  | 10  | -   | ns   |
|           |                               |                                                                           | 15 V               |                                         | 16  | 8   | -   | ns   |
| $t_{su}$  | set-up time                   | nCP0 $\rightarrow \overline{nCP1}$ ; see <a href="#">Figure 5</a>         | 5 V                |                                         | 50  | 25  | -   | ns   |
|           |                               |                                                                           | 10 V               |                                         | 30  | 15  | -   | ns   |
|           |                               |                                                                           | 15 V               |                                         | 20  | 10  | -   | ns   |
|           |                               | $\overline{nCP1} \rightarrow nCP0$ ; see <a href="#">Figure 5</a>         | 5 V                |                                         | 50  | 25  | -   | ns   |
|           |                               |                                                                           | 10 V               |                                         | 30  | 15  | -   | ns   |
|           |                               |                                                                           | 15 V               |                                         | 20  | 10  | -   | ns   |
| $t_{rec}$ | recovery time                 | see <a href="#">Figure 5</a>                                              | 5 V                |                                         | 50  | 25  | -   | ns   |
|           |                               |                                                                           | 10 V               |                                         | 30  | 15  | -   | ns   |
|           |                               |                                                                           | 15 V               |                                         | 20  | 10  | -   | ns   |
| $f_{max}$ | maximum frequency             | nCP0, $\overline{nCP1}$ ; see <a href="#">Figure 5</a>                    | 5 V                |                                         | 8   | 16  | -   | MHz  |
|           |                               |                                                                           | 10 V               |                                         | 15  | 30  | -   | MHz  |
|           |                               |                                                                           | 15 V               |                                         | 20  | 40  | -   | MHz  |

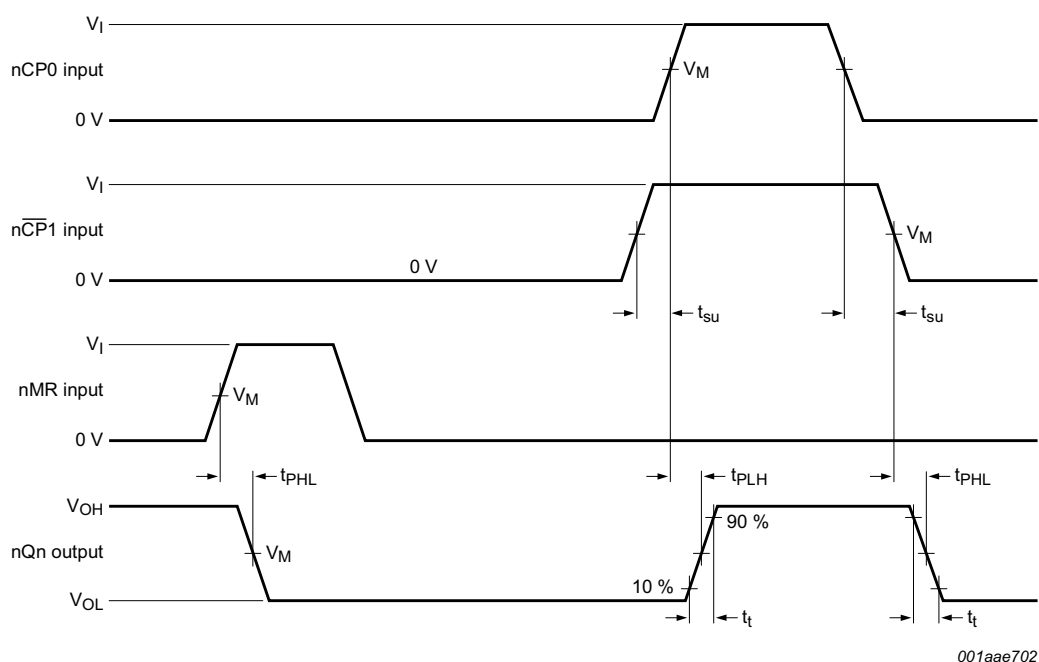
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown ( $C_L$  in pF).

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

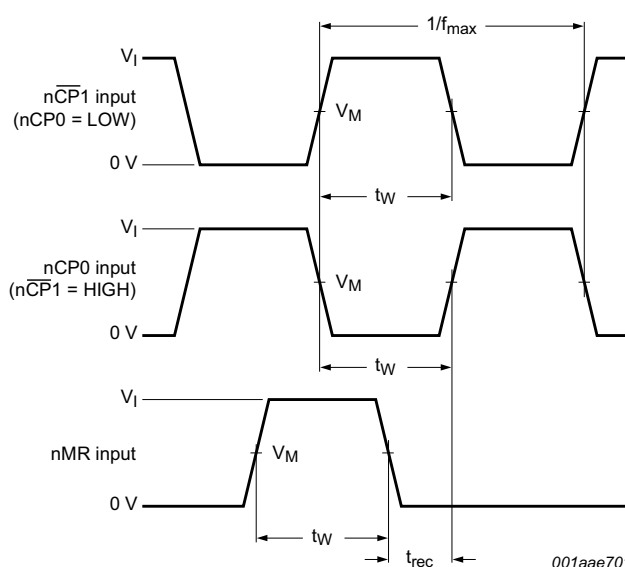
$P_D$  can be calculated from the formulas shown.  $V_{SS} = 0\text{ V}$ ;  $t_r = t_f \leq 20\text{ ns}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

| Symbol | Parameter                 | $V_{DD}$ | Typical formula for $P_D$ ( $\mu\text{W}$ )                       | Where:                                                                                                                                                                                             |
|--------|---------------------------|----------|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $P_D$  | dynamic power dissipation | 5 V      | $P_D = 850 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$   | $f_i$ = input frequency in MHz,<br>$f_o$ = output frequency in MHz,<br>$C_L$ = output load capacitance in pF,<br>$V_{DD}$ = supply voltage in V,<br>$\Sigma(f_o \times C_L)$ = sum of the outputs. |
|        |                           | 10 V     | $P_D = 3800 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$  |                                                                                                                                                                                                    |
|        |                           | 15 V     | $P_D = 10200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ |                                                                                                                                                                                                    |

## 11. Waveforms



a. nCP0 and nCP1 set-up times, propagation delays and output transition times

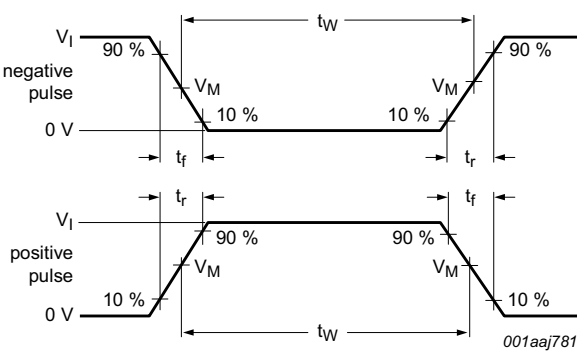


b. nMR recovery time, minimum nCP0, nCP1, and nMR pulse widths and maximum frequency

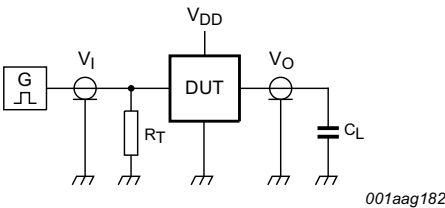
Measurement points are given in [Table 9](#).

The logic levels  $V_{OH}$  and  $V_{OL}$  are typical output voltage levels that occur with the output load.

**Fig 5. Waveforms showing measurements for switching times**



a. Input waveforms



b. Test circuit

Test data is given in [Table 9](#).

Definitions for test circuit:

DUT = Device Under Test;

C<sub>L</sub> = Load capacitance including jig and probe capacitance;

R<sub>T</sub> = Termination resistance should be equal to output impedance Z<sub>o</sub> of the pulse generator.

Fig 6. Test circuit for measuring switching times

Table 9. Measurement points and test data

| Supply voltage  | Input           |                   |                                 | Load           |
|-----------------|-----------------|-------------------|---------------------------------|----------------|
| V <sub>DD</sub> | V <sub>I</sub>  | V <sub>M</sub>    | t <sub>r</sub> , t <sub>f</sub> | C <sub>L</sub> |
| 5 V to 15 V     | V <sub>DD</sub> | 0.5V <sub>I</sub> | ≤ 20 ns                         | 50 pF          |

12. Package outline

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

SOT109-1

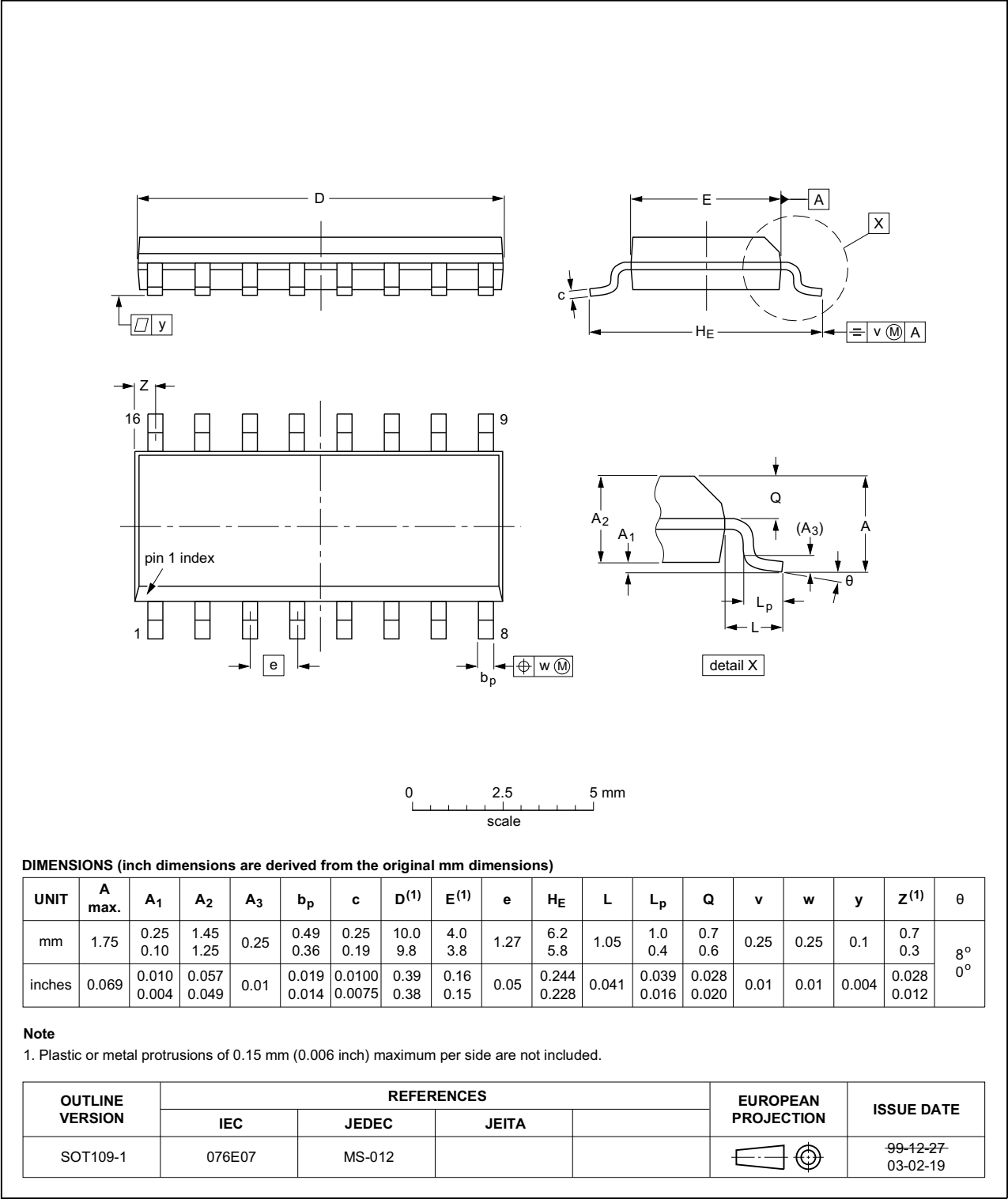


Fig 7. Package outline SOT109-1 (SO16)

## 13. Revision history

Table 10. Revision history

| Document ID      | Release date                                                                                                                                                        | Data sheet status     | Change notice | Supersedes       |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|------------------|
| HEF4520B v.7     | 20160330                                                                                                                                                            | Product data sheet    | -             | HEF4520B v.6     |
| Modifications:   | <ul style="list-style-type: none"><li>Type number HEF4520BP (SOT38-4) removed.</li></ul>                                                                            |                       |               |                  |
| HEF4520B v.6     | 20111118                                                                                                                                                            | Product data sheet    | -             | HEF4520B v.5     |
| Modifications:   | <ul style="list-style-type: none"><li>Section Applications removed</li><li><a href="#">Table 6</a>: <math>I_{OH}</math> minimum values changed to maximum</li></ul> |                       |               |                  |
| HEF4520B v.5     | 20091210                                                                                                                                                            | Product data sheet    | -             | HEF4520B v.4     |
| HEF4520B v.4     | 20090828                                                                                                                                                            | Product data sheet    | -             | HEF4520B_CNV v.3 |
| HEF4520B_CNV v.3 | 19950101                                                                                                                                                            | Product specification | -             | HEF4520B_CNV v.2 |
| HEF4520B_CNV v.2 | 19950101                                                                                                                                                            | Product specification | -             | -                |

## 14. Legal information

### 14.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | 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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