

HEF4027B

Dual JK flip-flop

Rev. 05 — 10 November 2008

Product data sheet

1. General description

The HEF4027B is a edge-triggered dual JK flip-flop which features independent set-direct (SD), clear-direct (CD), clock (CP) inputs and outputs (Q, \bar{Q}). Data is accepted when CP is LOW, and transferred to the output on the positive-going edge of the clock. The active HIGH asynchronous clear-direct (CD) and set-direct (SD) inputs are independent and override the J, K, and CP inputs. The outputs are buffered for best system performance. Schmitt trigger action makes the clock input highly tolerant of slower rise and fall times.

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

- Registers
- Counters
- Control circuits

4. Ordering information

Table 1. Ordering information

T_{amb} from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$.

| Type number | Package | | Version |
|-------------|---------|--|----------|
| | Name | Description | |
| HEF4027BP | DIP16 | plastic dual in-line package; 16-leads (300 mil) | SOT38-4 |
| HEF4027BT | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |

5. Functional diagram

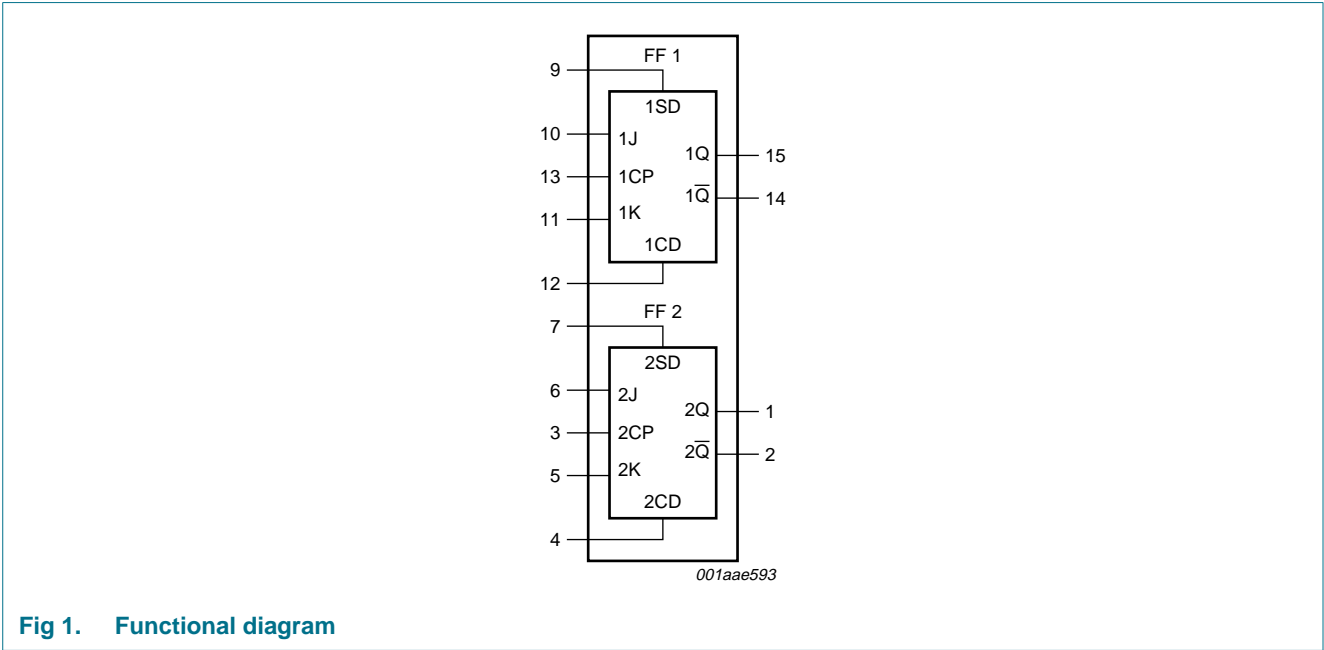


Fig 1. Functional diagram

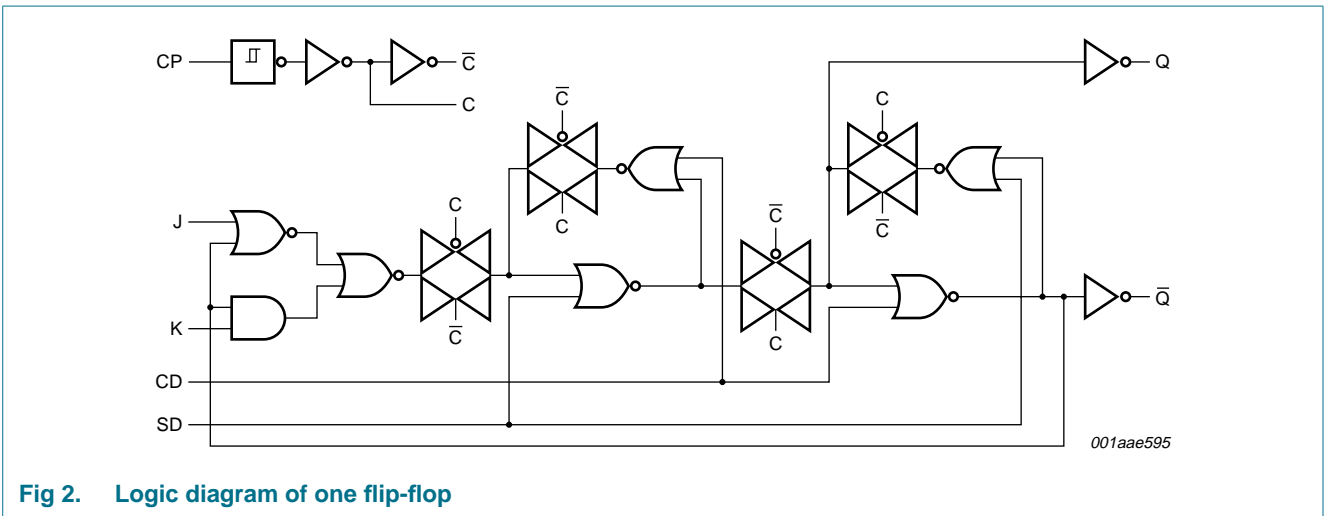


Fig 2. Logic diagram of one flip-flop

6. Pinning information

6.1 Pinning

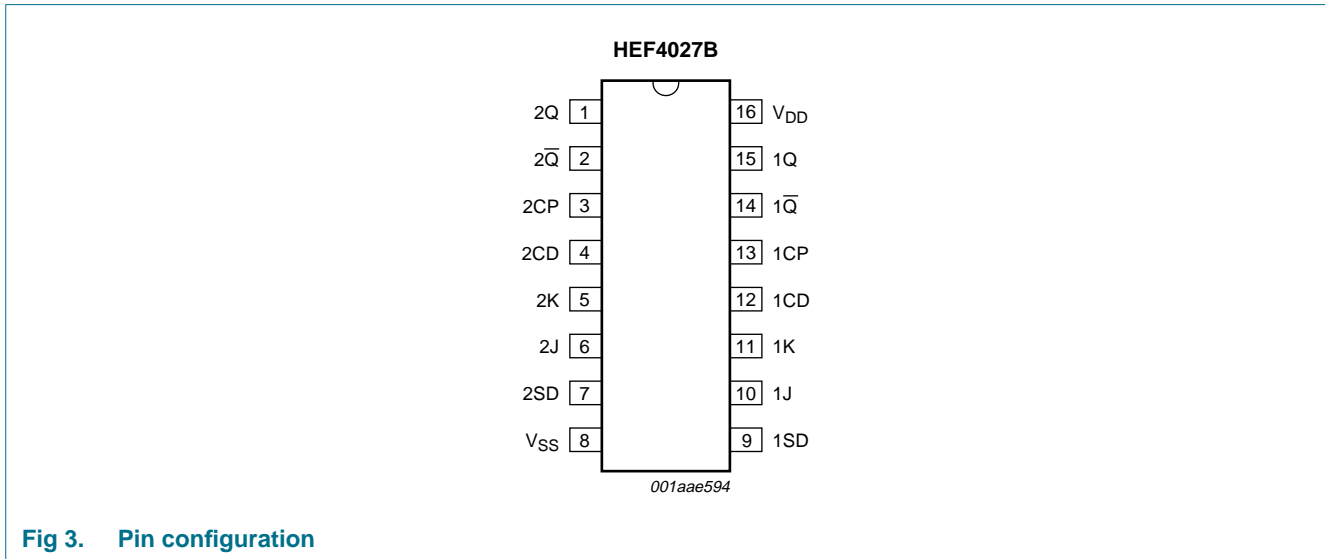


Fig 3. Pin configuration

6.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|-----------------|-------|---|
| V _{SS} | 8 | ground supply voltage |
| 1SD, 2SD | 9, 7 | asynchronous set-direct input (active HIGH) |
| 1J, 2J | 10, 6 | synchronous input |
| 1K, 2K | 11, 5 | synchronous input |
| 1CD, 2CD | 12, 4 | asynchronous clear-direct input (active HIGH) |
| 1CP, 2CP | 13, 3 | clock input (LOW-to-HIGH edge-triggered) |
| 1Q-bar, 2Q-bar | 14, 2 | complement output |
| 1Q, 2Q | 15, 1 | true output |
| V _{DD} | 16 | supply voltage |

7. Functional description

Table 3. Function table^[1]

| Inputs | | | | | | Outputs | |
|--------|-----|-----|----|----|----|---------|--|
| nSD | nCD | nCP | nJ | nK | nQ | nQ-bar | |
| H | L | X | X | X | H | L | |
| L | H | X | X | X | L | H | |
| H | H | X | X | X | H | H | |

Table 3. Function table^[1] ...continued

| Inputs | | | | | Outputs | |
|--------|-----|-----|----|----|-----------|-----------|
| nSD | nCD | nCP | nJ | nK | nQ | nQ̄ |
| L | L | ↑ | L | L | no change | no change |
| L | L | ↑ | H | L | H | L |
| L | L | ↑ | L | H | L | H |
| L | L | ↑ | H | H | nQ̄ | nQ |

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

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 |
| I _{IK} | input clamping current | V _I < 0.5 V or V _I > V _{DD} + 0.5 V | - | ±10 | mA |
| V _I | input voltage | | -0.5 | V _{DD} + 0.5 | V |
| I _{OK} | output clamping current | V _O < 0.5 V or V _O > V _{DD} + 0.5 V | - | ±10 | mA |
| I _{I/O} | input/output current | | - | ±10 | mA |
| I _{DD} | supply current | | - | 50 | mA |
| T _{stg} | storage temperature | | -65 | +150 | °C |
| T _{amb} | ambient temperature | in free air | -40 | +85 | °C |
| P _{tot} | total power dissipation | T _{amb} -40 °C to +125 °C | | | |
| | | 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 | 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 |
| Δt/ΔV | input transition rise and fall rate | V _{DD} = 5 V | - | 3.75 | ns/V |
| | | V _{DD} = 10 V | - | 0.5 | ns/V |
| | | V _{DD} = 15 V | - | 0.08 | ns/V |

10. 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} | $T_{amb} = -40\text{ }^{\circ}\text{C}$ | | $T_{amb} = 25\text{ }^{\circ}\text{C}$ | | $T_{amb} = 85\text{ }^{\circ}\text{C}$ | | 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 | - | 4.0 | - | 4.0 | - | 30 | μA |
| | | | 10 V | - | 8.0 | - | 8.0 | - | 60 | μA |
| | | | 15 V | - | 16.0 | - | 16.0 | - | 120 | μA |
| C_I | input capacitance | | - | - | - | - | 7.5 | - | - | pF |

11. Dynamic characteristics

Table 7. Dynamic characteristics

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

| Symbol | Parameter | Conditions | V_{DD} | Extrapolation formula ^[1] | Min | Typ | Max | Unit |
|-----------|-------------------------------|--|----------|--|-----|-----|-----|------|
| t_{PHL} | HIGH to LOW propagation delay | CP \rightarrow Q, \bar{Q} ; see Figure 4 | 5 V | $78\text{ ns} + (0.55\text{ ns/pF})C_L$ | - | 105 | 210 | ns |
| | | | 10 V | $29\text{ ns} + (0.23\text{ ns/pF})C_L$ | - | 40 | 80 | ns |
| | | | 15 V | $22\text{ ns} + (0.16\text{ ns/pF})C_L$ | - | 30 | 60 | ns |
| | | CD \rightarrow Q; see Figure 4 | 5 V | $93\text{ ns} + (0.55\text{ ns/pF})C_L$ | - | 120 | 240 | ns |
| | | | 10 V | $33\text{ ns} + (0.23\text{ ns/pF})C_L$ | - | 45 | 90 | ns |
| | | | 15 V | $27\text{ ns} + (0.16\text{ ns/pF})C_L$ | - | 35 | 70 | ns |
| | | SD \rightarrow \bar{Q} ; see Figure 4 | 5 V | $113\text{ ns} + (0.55\text{ ns/pF})C_L$ | - | 140 | 280 | ns |
| | | | 10 V | $44\text{ ns} + (0.23\text{ ns/pF})C_L$ | - | 55 | 110 | ns |
| | | | 15 V | $32\text{ ns} + (0.16\text{ ns/pF})C_L$ | - | 40 | 80 | ns |
| t_{PLH} | LOW to HIGH propagation delay | CP \rightarrow Q, \bar{Q} ; see Figure 4 | 5 V | $58\text{ ns} + (0.55\text{ ns/pF})C_L$ | - | 85 | 170 | ns |
| | | | 10 V | $27\text{ ns} + (0.23\text{ ns/pF})C_L$ | - | 35 | 70 | ns |
| | | | 15 V | $22\text{ ns} + (0.16\text{ ns/pF})C_L$ | - | 30 | 60 | ns |
| | | CD \rightarrow \bar{Q} ; see Figure 4 | 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 |
| | | SD \rightarrow Q; see Figure 4 | 5 V | $43\text{ ns} + (0.55\text{ ns/pF})C_L$ | - | 70 | 140 | ns |
| | | | 10 V | $19\text{ ns} + (0.23\text{ ns/pF})C_L$ | - | 30 | 60 | ns |
| | | | 15 V | $17\text{ ns} + (0.16\text{ ns/pF})C_L$ | - | 25 | 50 | ns |
| t_t | transition time | see Figure 4 | 5 V | ^[2] $10\text{ ns} + (1.00\text{ ns/pF})C_L$ | - | 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 | J, K \rightarrow CP; see Figure 5 | 5 V | | 50 | 25 | - | ns |
| | | | 10 V | | 30 | 10 | - | ns |
| | | | 15 V | | 20 | 5 | - | ns |
| t_h | hold time | J, K \rightarrow CP; see Figure 5 | 5 V | | 25 | 0 | - | ns |
| | | | 10 V | | 20 | 0 | - | ns |
| | | | 15 V | | 15 | 5 | - | ns |
| t_w | pulse width | CP LOW; minimum width see Figure 5 | 5 V | | 80 | 40 | - | ns |
| | | | 10 V | | 30 | 15 | - | ns |
| | | | 15 V | | 24 | 12 | - | ns |
| | | SD, CD HIGH; minimum width see Figure 6 | 5 V | | 90 | 45 | - | ns |
| | | | 10 V | | 40 | 20 | - | ns |
| | | | 15 V | | 30 | 15 | - | ns |
| t_{rec} | recovery time | SD, CD inputs; see Figure 6 | 5 V | | +20 | -15 | - | ns |
| | | | 10 V | | +15 | -10 | - | ns |
| | | | 15 V | | +10 | -5 | - | 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.

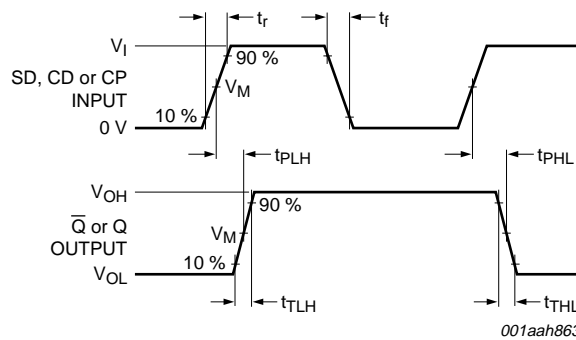
| Symbol | Parameter | Conditions | V_{DD} | Extrapolation formula ^[1] | Min | Typ | Max | Unit |
|-----------|-------------------|------------------------------|----------|--------------------------------------|-----|-----|-----|------|
| f_{max} | maximum frequency | CP input; | 5 V | | 4 | 8 | - | MHz |
| | | J = K = HIGH; | 10 V | | 12 | 25 | - | MHz |
| | | see Figure 5 | 15 V | | 15 | 30 | - | MHz |

- [1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).
- [2] t_t is the same as t_{TLH} and t_{THL} .

Table 8. Dynamic power dissipation P_D
 P_D can be calculated from the formulas shown. $V_{SS} = 0\text{ V}$; $t_r = t_f \leq 20\text{ ns}$; $T_{amb} = 25\text{ }^\circ\text{C}$.

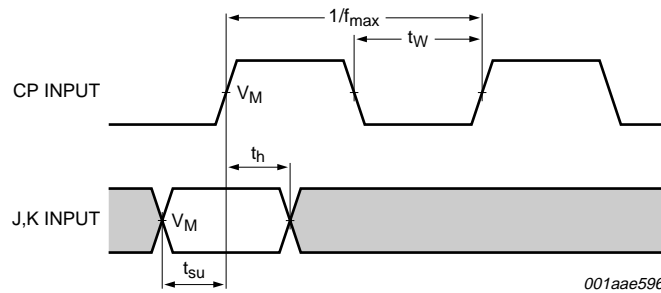
| Symbol | Parameter | V_{DD} | Typical formula for P_D (μW) | Where: |
|--------|---------------------------|----------|---|--|
| P_D | dynamic power dissipation | 5 V | $P_D = 900 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ | f_i = input frequency in MHz; |
| | | 10 V | $P_D = 4500 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ | f_o = output frequency in MHz; |
| | | 15 V | $P_D = 13200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ | 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



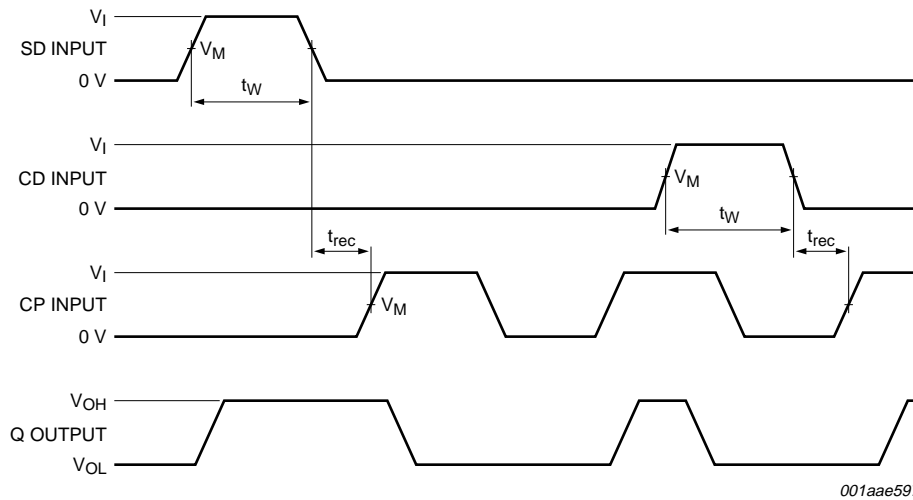
V_{OH} and V_{OL} are typical output voltages levels that occur with the output load.
 Measurement points are given in [Table 9](#).

Fig 4. Waveforms showing rise, fall and transition times and propagation delays



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

Fig 5. Waveforms showing set-up and hold times and minimum clock pulse width

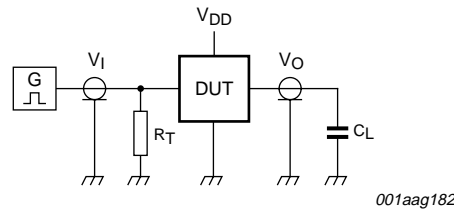


V_{OH} and V_{OL} are typical output voltages levels that occur with the output load.
Measurement points are given in [Table 9](#).

Fig 6. Waveforms showing pulse widths and recovery times

Table 9. Measurement points

| Supply voltage | Input | Output |
|----------------|-------------|-------------|
| V_{DD} | V_M | V_M |
| 5 V to 15 V | $0.5V_{DD}$ | $0.5V_{DD}$ |



Test data is given in [Table 10](#).

Definitions for test circuit:

DUT = Device Under Test.

C_L = load capacitance including jig and probe capacitance.

R_T = termination resistance should be equal to the output impedance Z_o of the pulse generator.

Fig 7. Test circuit

Table 10. Test data

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

13. Package outline

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

SOT38-4

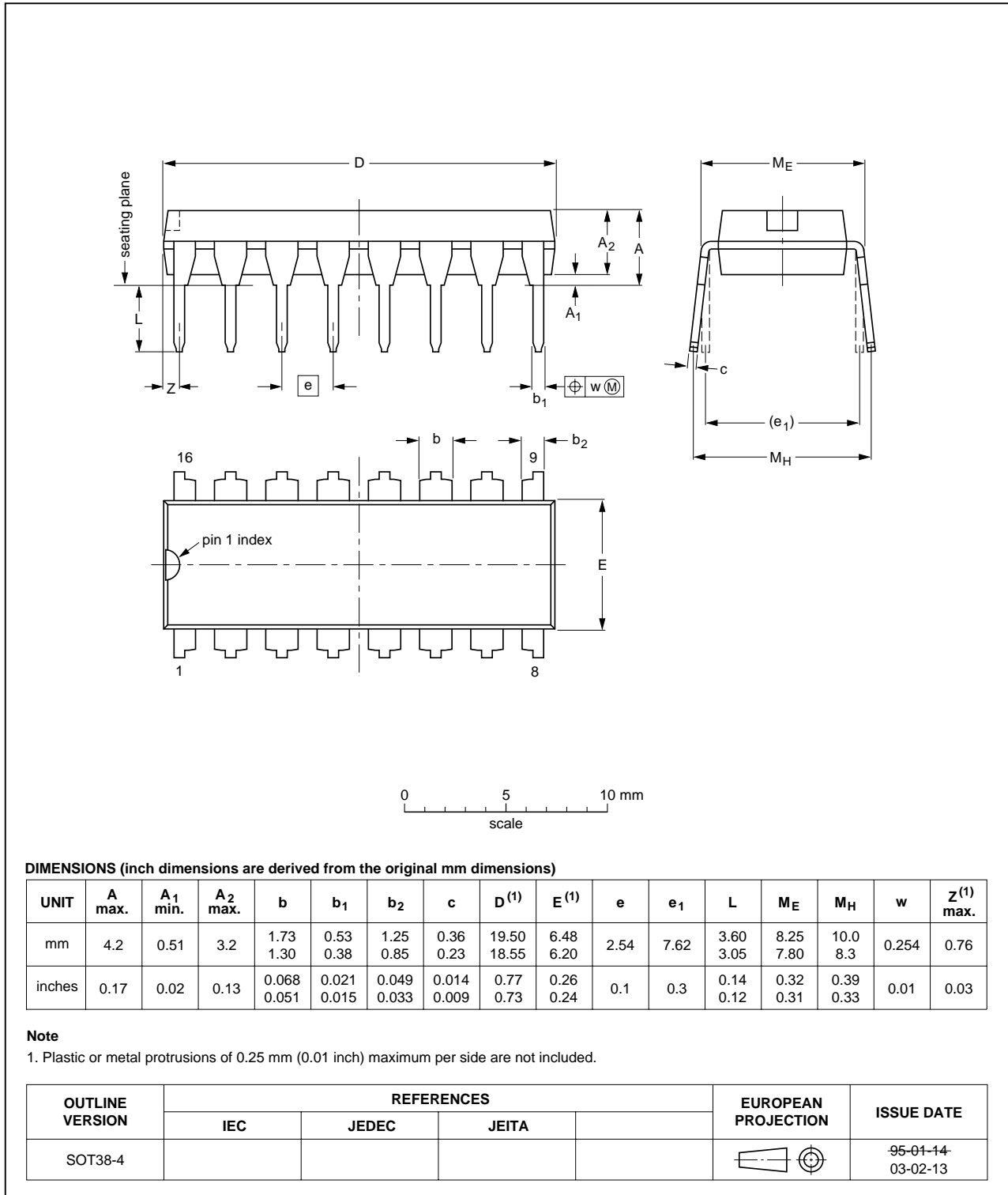


Fig 8. Package outline SOT38-4 (DIP16)

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

SOT109-1

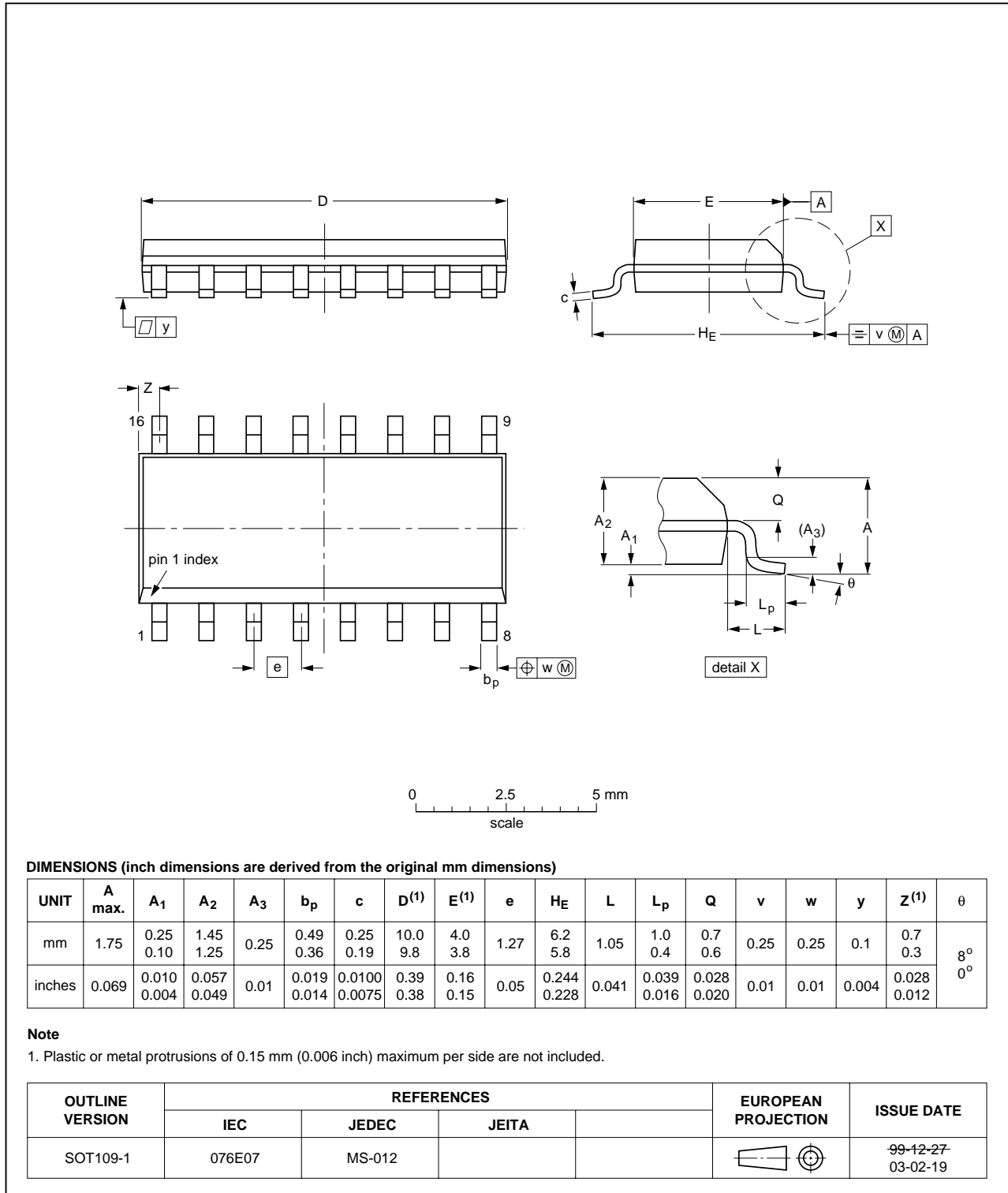


Fig 9. Package outline SOT109-1 (SO16)

14. Abbreviations

Table 11. Abbreviations

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

15. Revision history

Table 12. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------|---|-----------------------|---------------|----------------|
| HEF4027B_5 | 20081110 | Product data sheet | - | HEF4027B_4 |
| Modifications: | <ul style="list-style-type: none"> • Maximum T_{amb} changed to 85 °C and $T_{amb} = 125$ °C parameter data removed throughout. • Section 1 “General description” temperature range statement modified. • Section 10 “Static characteristics” I_{DD}, I_{OL}, I_{OH} and I_I values revised. | | | |
| HEF4027B_4 | 20080703 | Product specification | - | HEF4027B_CNV_3 |
| HEF4027B_CNV_3 | 19950101 | Product specification | - | HEF4027B_CNV_2 |
| HEF4027B_CNV_2 | 19950101 | Product specification | - | - |

16. Legal information

16.1 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. |
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[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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