



THE DATASHEET OF HEF40175BP



HEF40175B

Quad D-type flip-flop

Rev. 9 — 21 March 2016

Product data sheet

1. General description

The HEF40175B is a quad edge-triggered D-type flip-flop with four data inputs (D0 to D3), a clock input (CP), an overriding asynchronous master reset input (\overline{MR}), four buffered outputs (Q0 to Q3), and four complementary buffered outputs ($\overline{Q0}$ to $\overline{Q3}$). Information on D0 to D3 is transferred to Q0 to Q3 on the LOW-to-HIGH transition of CP if \overline{MR} is HIGH. When LOW, \overline{MR} resets all flip-flops (Q0 to Q3 = LOW; $\overline{Q0}$ to $\overline{Q3}$ = HIGH), independent of CP and D0 to D3.

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

- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B

3. Applications

- Shift registers
- Buffer/storage register
- Pattern generator

4. Ordering information

Table 1. Ordering information

All types operate from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$.

| Type number | Package | | Version |
|-------------|---------|--|----------|
| | Name | Description | |
| HEF40175BT | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |
| HEF40175BTT | TSSOP16 | plastic thin shrink small outline package; 16 leads; body width 4.4 mm | SOT403-1 |

5. Functional diagram

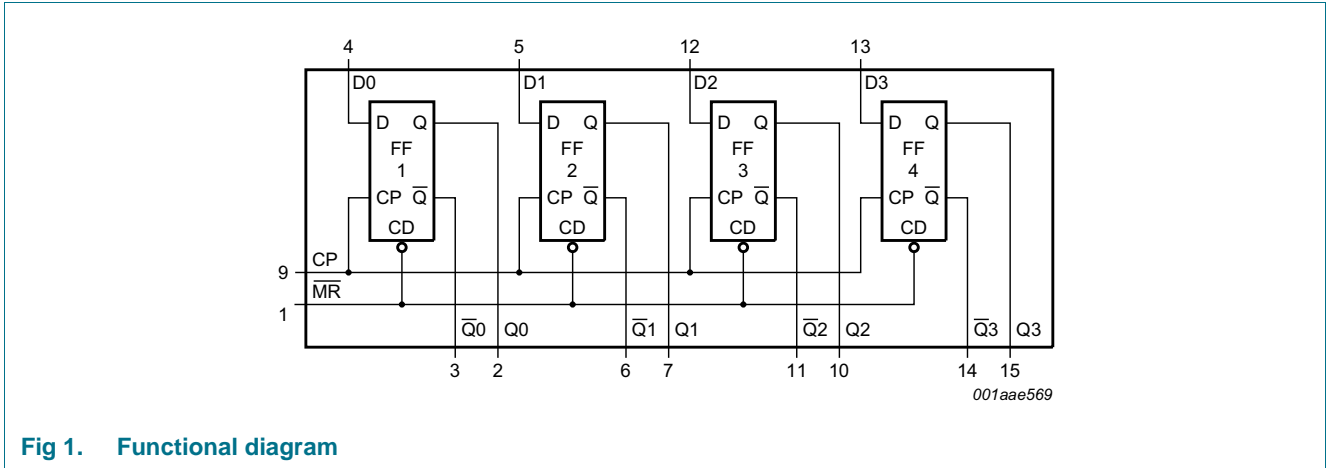


Fig 1. Functional diagram

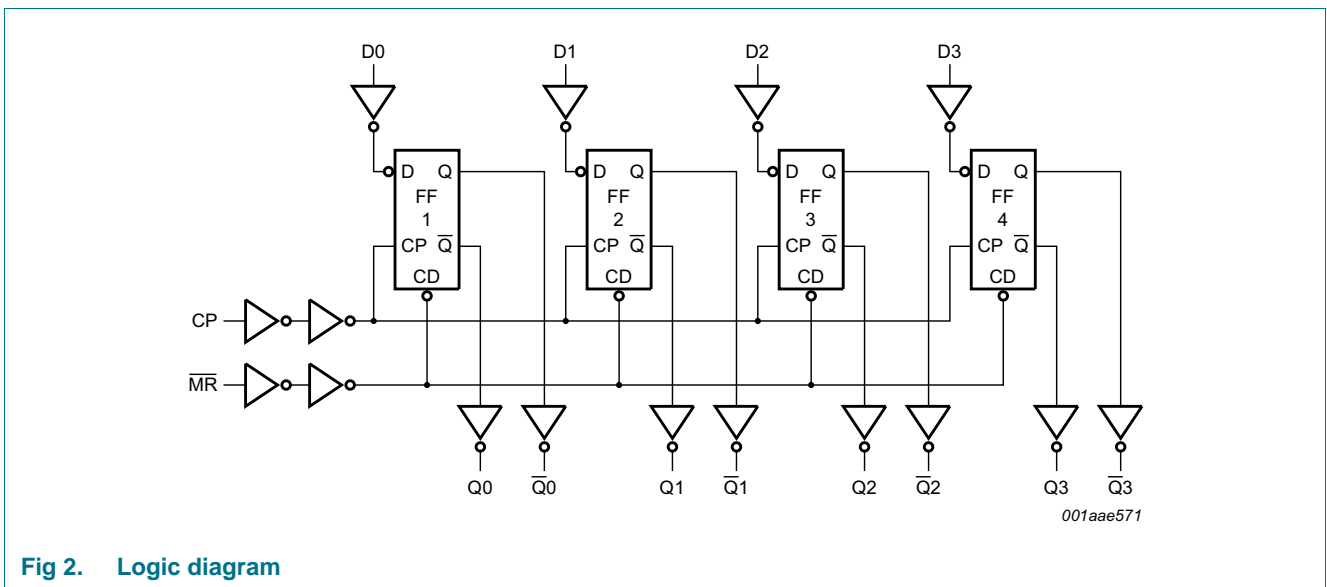
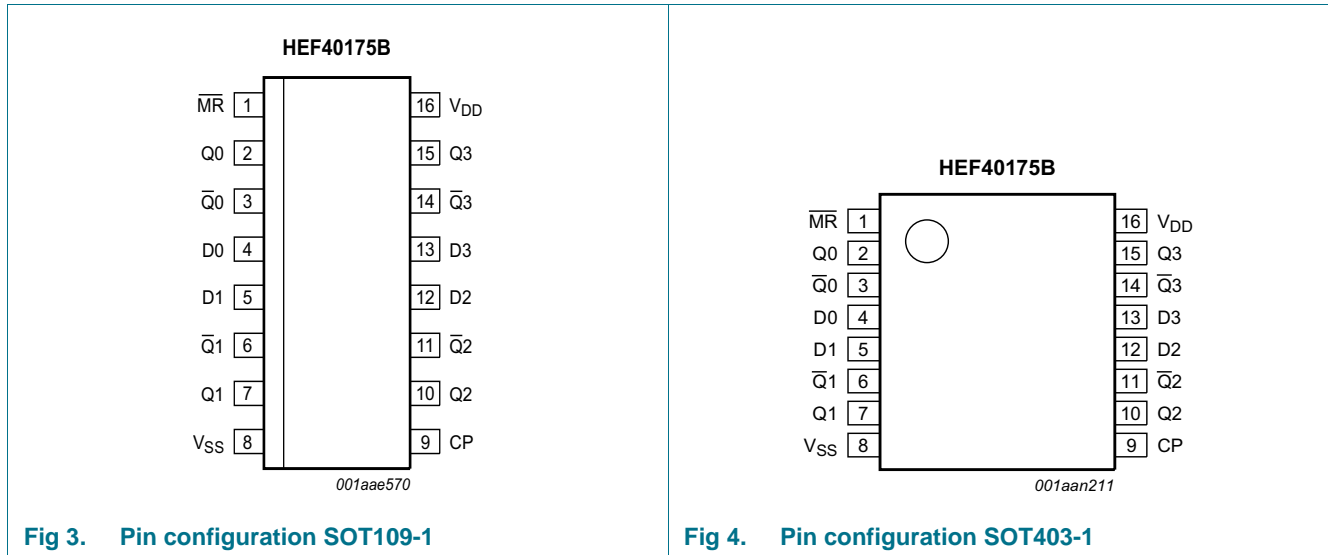


Fig 2. Logic diagram

6. Pinning information

6.1 Pinning



6.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|--|--------------|--|
| $\overline{\text{MR}}$ | 1 | master reset input (active LOW) |
| Q0 to Q3 | 2, 7, 10, 15 | buffered output |
| $\overline{\text{Q0}}$ to $\overline{\text{Q3}}$ | 3, 6, 11, 14 | complementary buffered output |
| D0 to D3 | 4, 5, 12, 13 | data input |
| VSS | 8 | ground supply voltage |
| CP | 9 | clock input (LOW-to-HIGH edge-triggered) |
| VDD | 16 | supply voltage |

7. Functional description

Table 3. Function table [1]

| Input | | | Output | |
|-------|----|------------------------|-----------|-----------|
| CP | Dn | $\overline{\text{MR}}$ | Qn | Qn |
| ↑ | H | H | H | L |
| ↑ | L | H | L | H |
| ↓ | X | H | no change | no change |
| X | X | L | L | H |

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = positive-going transition; ↓ = negative-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 | $V_I < -0.5\text{ V}$ or $V_I > V_{DD} + 0.5\text{ V}$ | - | ± 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 $V_O > V_{DD} + 0.5\text{ V}$ | - | ± 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 | | -40 | +125 | °C |
| P_{tot} | total power dissipation | $T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$ | | | |
| | | SO16 package [1] | - | 500 | mW |
| | | TSSOP16 package [2] | - | 500 | mW |
| P | power dissipation | per output | - | 100 | mW |

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

[2] For TSSOP16 package: P_{tot} derates linearly with 5.5 mW/K above 60 °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 | - | +125 | °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 | $\mu\text{s/V}$ |

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} | $T_{amb} = -40\text{ °C}$ | | $T_{amb} = +25\text{ °C}$ | | $T_{amb} = +85\text{ °C}$ | | $T_{amb} = +125\text{ °C}$ | | Unit |
|----------|---------------------------|---|----------|---------------------------|-----------|---------------------------|-----------|---------------------------|-----------|----------------------------|-----------|---------------|
| | | | | Min | Max | 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 | - | 3.5 | - | V |
| | | | 10 V | 7.0 | - | 7.0 | - | 7.0 | - | 7.0 | - | V |
| | | | 15 V | 11.0 | - | 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 | - | 1.5 | V |
| | | | 10 V | - | 3.0 | - | 3.0 | - | 3.0 | - | 3.0 | V |
| | | | 15 V | - | 4.0 | - | 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 | - | 4.95 | - | V |
| | | | 10 V | 9.95 | - | 9.95 | - | 9.95 | - | 9.95 | - | V |
| | | | 15 V | 14.95 | - | 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 | - | 0.05 | V |
| | | | 10 V | - | 0.05 | - | 0.05 | - | 0.05 | - | 0.05 | V |
| | | | 15 V | - | 0.05 | - | 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 | - | -1.1 | mA |
| | | $V_O = 4.6\text{ V}$ | 5 V | - | -0.64 | - | -0.5 | - | -0.36 | - | -0.36 | mA |
| | | $V_O = 9.5\text{ V}$ | 10 V | - | -1.6 | - | -1.3 | - | -0.9 | - | -0.9 | mA |
| | | $V_O = 13.5\text{ V}$ | 15 V | - | -4.2 | - | -3.4 | - | -2.4 | - | -2.4 | mA |
| I_{OL} | LOW-level output current | $V_O = 0.4\text{ V}$ | 5 V | 0.64 | - | 0.5 | - | 0.36 | - | 0.36 | - | mA |
| | | $V_O = 0.5\text{ V}$ | 10 V | 1.6 | - | 1.3 | - | 0.9 | - | 0.9 | - | mA |
| | | $V_O = 1.5\text{ V}$ | 15 V | 4.2 | - | 3.4 | - | 2.4 | - | 2.4 | - | mA |
| I_I | input leakage current | | 15 V | - | ± 0.1 | - | ± 0.1 | - | ± 1.0 | - | ± 1.0 | μA |
| I_{DD} | supply current | all valid input combinations; $ I_O = 0\text{ A}$ | 5 V | - | 1.0 | - | 1.0 | - | 30 | - | 30 | μA |
| | | | 10 V | - | 2.0 | - | 2.0 | - | 60 | - | 60 | μA |
| | | | 15 V | - | 4.0 | - | 4.0 | - | 120 | - | 120 | μA |
| C_I | input capacitance | | - | - | - | 7.5 | - | - | - | - | pF | |

11. Dynamic characteristics

Table 7. Dynamic characteristics

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; 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 | CP to Q_n or \overline{Q}_n ; see Figure 5 | 5 V | $53\text{ ns} + (0.55\text{ ns/pF}) C_L$ | - | 80 | 160 | 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 |
| | | \overline{MR} to Q_n ; see Figure 5 | 5 V | $48\text{ ns} + (0.55\text{ ns/pF}) C_L$ | - | 75 | 155 | ns |
| | | | 10 V | $19\text{ ns} + (0.23\text{ ns/pF}) C_L$ | - | 30 | 65 | ns |
| | | | 15 V | $17\text{ ns} + (0.16\text{ ns/pF}) C_L$ | - | 25 | 50 | ns |

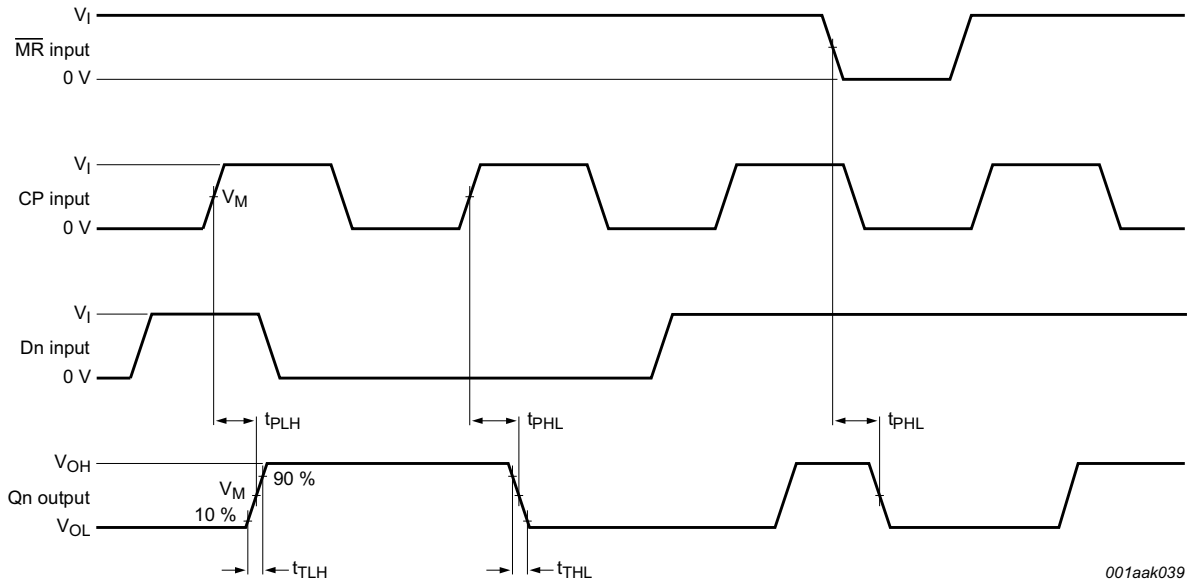
Table 7. Dynamic characteristics ...continued $V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; for test circuit see [Figure 6](#); unless otherwise specified.

| Symbol | Parameter | Conditions | V _{DD} | Extrapolation formula | Min | Typ | Max | Unit |
|------------------|-------------------------------|--|--------------------|-------------------------------------|-----|-----|-----|------|
| t _{PLH} | LOW to HIGH propagation delay | CP to Qn or \overline{Qn} ; see Figure 5 | 5 V ^[1] | 43 ns + (0.55 ns/pF) C _L | - | 70 | 140 | ns |
| | | | 10 V | 19 ns + (0.23 ns/pF) C _L | - | 30 | 65 | ns |
| | | | 15 V | 17 ns + (0.16 ns/pF) C _L | - | 25 | 45 | ns |
| | | \overline{MR} to \overline{Qn} ; see Figure 5 | 5 V | 43 ns + (0.55 ns/pF) C _L | - | 70 | 140 | ns |
| | | | 10 V | 19 ns + (0.23 ns/pF) C _L | - | 30 | 65 | ns |
| | | | 15 V | 17 ns + (0.16 ns/pF) C _L | - | 25 | 50 | ns |
| t _t | transition time | see Figure 5 | 5 V ^[1] | 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 CP; see Figure 5 | 5 V | | 60 | 30 | - | ns |
| | | | 10 V | | 20 | 10 | - | ns |
| | | | 15 V | | 15 | 5 | - | ns |
| t _h | hold time | Dn to CP; see Figure 5 | 5 V | | +25 | -5 | - | ns |
| | | | 10 V | | 10 | 0 | - | ns |
| | | | 15 V | | 10 | 0 | - | ns |
| t _w | pulse width; | CP input LOW; minimum pulse width see Figure 5 | 5 V | | 90 | 45 | - | ns |
| | | | 10 V | | 35 | 15 | - | ns |
| | | | 15 V | | 25 | 10 | - | ns |
| | | \overline{MR} input LOW; minimum pulse width see Figure 5 | 5 V | | 80 | 40 | - | ns |
| | | | 10 V | | 30 | 15 | - | ns |
| | | | 15 V | | 20 | 10 | - | ns |
| t _{rec} | recovery time | \overline{MR} input; see Figure 5 | 5 V | | 0 | -30 | - | ns |
| | | | 10 V | | 0 | -20 | - | ns |
| | | | 15 V | | 0 | -15 | - | ns |
| f _{max} | maximum frequency | | 5 V | | 5 | 11 | - | MHz |
| | | | 10 V | | 15 | 30 | - | MHz |
| | | | 15 V | | 20 | 45 | - | MHz |

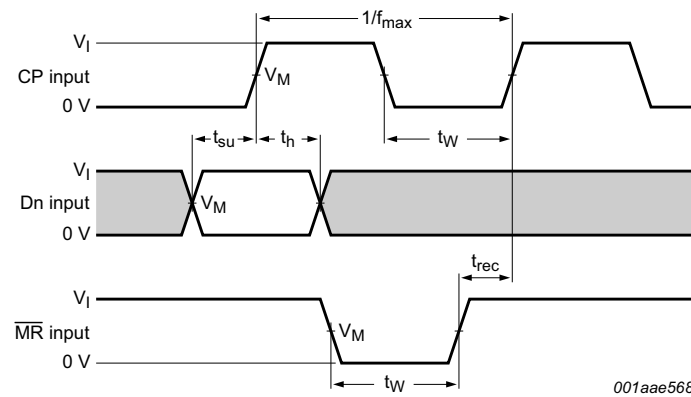
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formula shown (C_L in pF).**Table 8. Dynamic power dissipation P_D** P_D can be calculated from the formulas shown. $V_{SS} = 0\text{ V}$; $t_r = t_f \leq 20\text{ ns}$; $T_{amb} = 25\text{ °C}$.

| Symbol | Parameter | V _{DD} | Typical formula for P _D (μW) | where: |
|----------------|---------------------------|-----------------|---|---|
| P _D | dynamic power dissipation | 5 V | $P_D = 2000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ | 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, Σ(f _o × C _L) = sum of the outputs. |
| | | 10 V | $P_D = 8400 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ | |
| | | 15 V | $P_D = 22500 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ | |

12. Waveforms



a. CP and \overline{MR} to Qn Propagation delays and Qn transition times



b. Minimum pulse widths for CP and \overline{MR} , \overline{MR} to CP recovery time, and set-up and hold time for Dn to CP

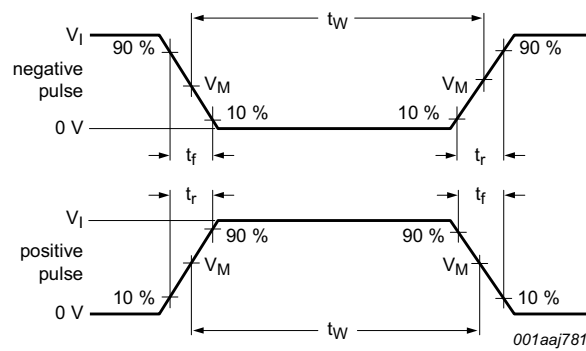
V_{OH} and V_{OL} are typical output voltage levels that occur with the output load.

Set-up and hold times are shown as positive values but may be specified as negative values.

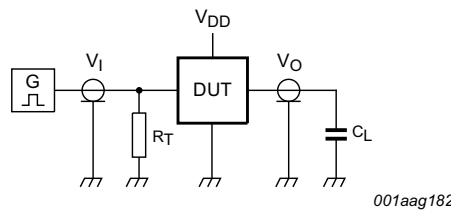
The shaded area are where input changes result in predicable output performance.

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

Fig 5. Waveforms showing switching times



a. Input waveforms



b. Test circuit

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

Definitions test circuit:

DUT = Device Under Test;

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator;

C_L = Load capacitance including jig and probe capacitance.

Fig 6. Test circuit for measuring switching times

Table 9. Measurement points and test data

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

13. Package outline

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

SOT109-1

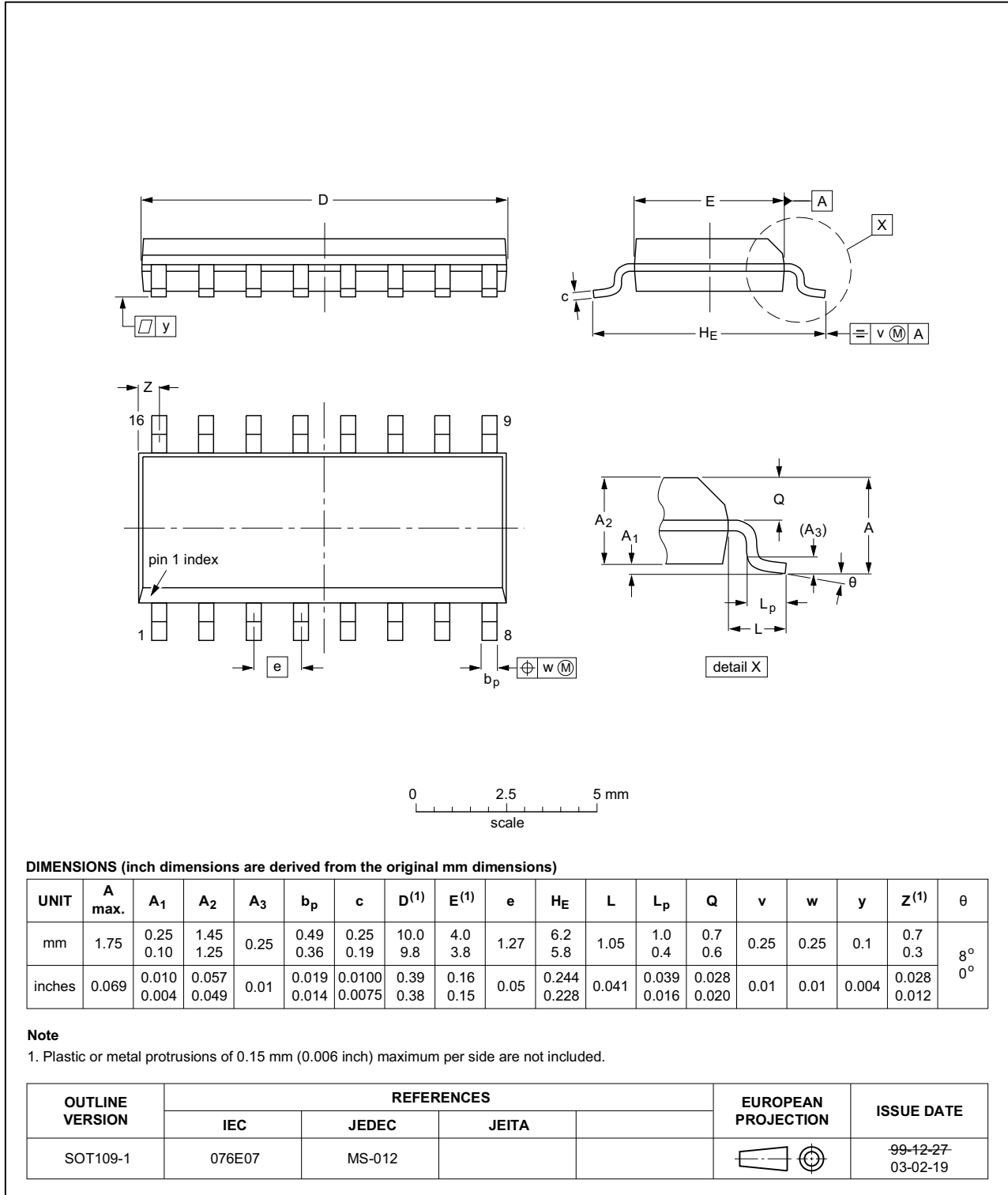


Fig 7. Package outline SOT109-1 (SO16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1

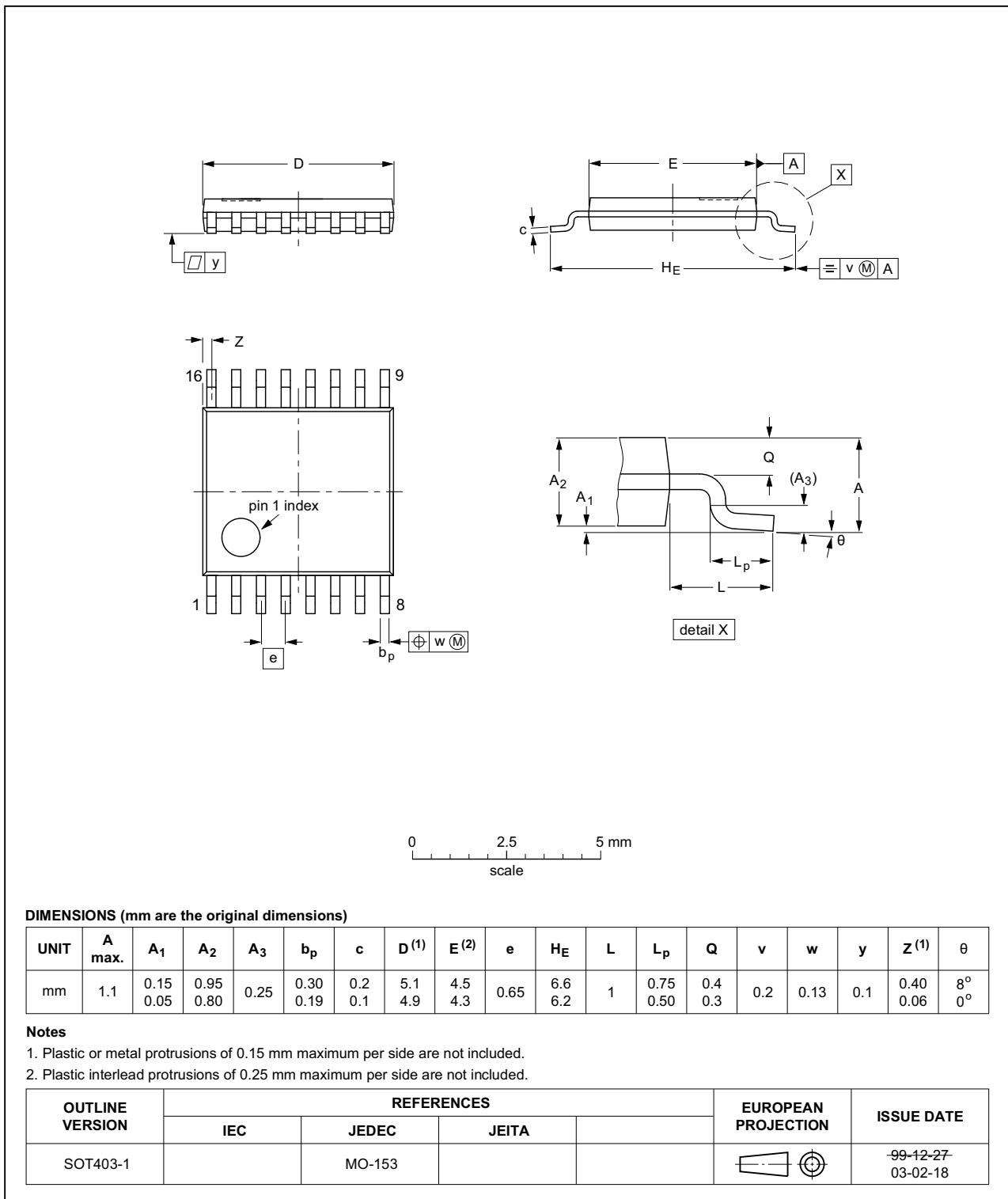


Fig 8. Package outline SOT403-1 (TSSOP16)

14. Revision history

Table 10. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|-------------------|---|-----------------------|---------------|-------------------|
| HEF40175B v.9 | 20160321 | Product data sheet | - | HEF40175B v.8 |
| Modifications: | <ul style="list-style-type: none"> Type number HEF40175BP (SOT38-4) removed. | | | |
| HEF40175B v.8 | 20111121 | Product data sheet | - | HEF40175B v.7 |
| Modifications: | <ul style="list-style-type: none"> Legal pages updated. Changes in “General description”, “Features and benefits” and “Applications”. | | | |
| HEF40175B v.7 | 20110503 | Product data sheet | - | HEF40175B v.6 |
| HEF40175B v.6 | 20101214 | Product data sheet | - | HEF40175B v.5 |
| HEF40175B v.5 | 20100105 | Product data sheet | - | HEF40175B v.4 |
| HEF40175B v.4 | 20090813 | Product data sheet | - | HEF40175B_CNV v.3 |
| HEF40175B_CNV v.3 | 19950101 | Product specification | - | HEF40175B_CNV v.2 |
| HEF40175B_CNV v.2 | 19950101 | Product specification | - | - |

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| Document status ^{[1][2]} | Product status ^[3] | Definition |
|-----------------------------------|-------------------------------|---|
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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".

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