

# 74HC4050

## Hex non-inverting HIGH-to-LOW level shifter

Rev. 4 — 5 February 2016

Product data sheet

### 1. General description

The 74HC4050 is a hex buffer with over-voltage tolerant inputs. Inputs are overvoltage tolerant to 15 V which enables the device to be used in HIGH-to-LOW level shifting applications.

### 2. Features and benefits

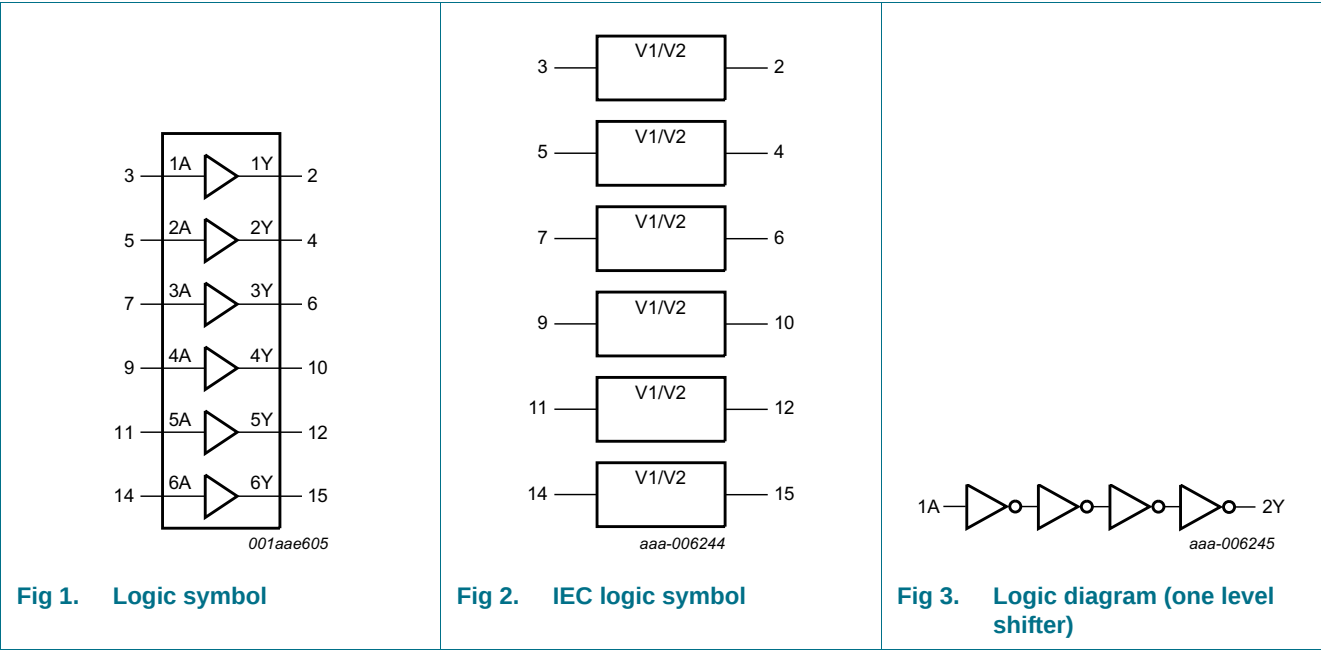
- Low-power dissipation
- Complies with JEDEC standard no. 7A
- ESD protection:
  - ◆ HBM JESD22-A114F exceeds 2 000 V
  - ◆ MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

### 3. Ordering information

Table 1. Ordering information

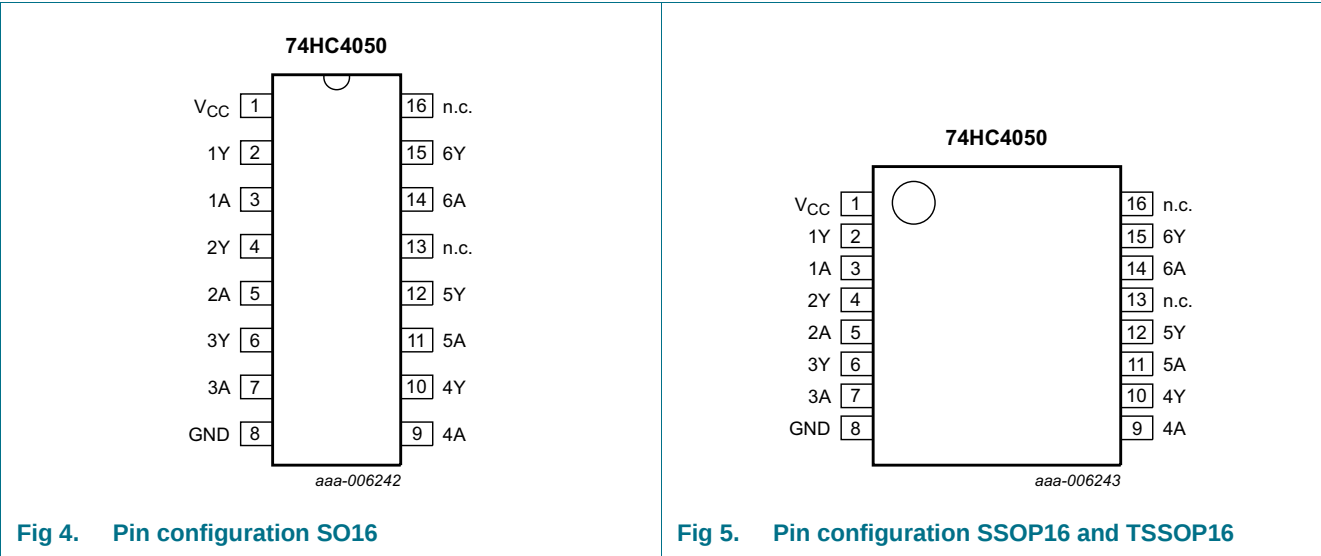
| Type number | Package                                                         |         |                                                                        |          |
|-------------|-----------------------------------------------------------------|---------|------------------------------------------------------------------------|----------|
|             | Temperature range                                               | Name    | Description                                                            | Version  |
| 74HC4050D   | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SO16    | plastic small outline package; 16 leads; body width 3.9 mm             | SOT109-1 |
| 74HC4050DB  | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SSOP16  | plastic shrink small outline package; 16 leads; body width 5.3 mm      | SOT338-1 |
| 74HC4050PW  | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | TSSOP16 | plastic thin shrink small outline package; 16 leads; body width 4.4 mm | SOT403-1 |

4. Functional diagram



5. Pinning information

5.1 Pinning



## 5.2 Pin description

Table 2. Pin description

| Symbol          | Pin                 | Description    |
|-----------------|---------------------|----------------|
| V <sub>CC</sub> | 1                   | supply voltage |
| 1Y to 6Y        | 2, 4, 6, 10, 12, 15 | output         |
| 1A to 6A        | 3, 5, 7, 9, 11, 14  | input          |
| GND             | 8                   | ground (0 V)   |
| n.c.            | 13, 16              | not connected  |

## 6. Functional description

Table 3. Function table [\[1\]](#)

| Input | Output |
|-------|--------|
| nA    | nY     |
| L     | L      |
| H     | H      |

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF-state.

## 7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

| Symbol           | Parameter               | Conditions                                                          | Min  | Max  | Unit |
|------------------|-------------------------|---------------------------------------------------------------------|------|------|------|
| V <sub>CC</sub>  | supply voltage          |                                                                     | −0.5 | +7   | V    |
| V <sub>IK</sub>  | input clamping voltage  |                                                                     | −0.5 | +16  | V    |
| I <sub>IK</sub>  | input clamping current  | V <sub>I</sub> < −0.5 V                                             | −20  | -    | mA   |
| I <sub>OK</sub>  | output clamping current | V <sub>O</sub> < −0.5 V or V <sub>O</sub> > V <sub>CC</sub> + 0.5 V | -    | ±20  | mA   |
| I <sub>O</sub>   | output current          | V <sub>O</sub> = −0.5 V to (V <sub>CC</sub> + 0.5 V)                | -    | ±25  | mA   |
| I <sub>CC</sub>  | supply current          |                                                                     | -    | +50  | mA   |
| I <sub>GND</sub> | ground current          |                                                                     | -    | −50  | mA   |
| T <sub>stg</sub> | storage temperature     |                                                                     | −65  | +150 | °C   |
| P <sub>tot</sub> | total power dissipation | SO16, SSOP16 and TSSOP16 packages <a href="#">[1]</a>               | -    | 500  | mW   |

[1] For SO16 packages: P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.  
For SSOP16 and TSSOP16 packages: P<sub>tot</sub> derates linearly with 5.5 mW/K above 60 °C.

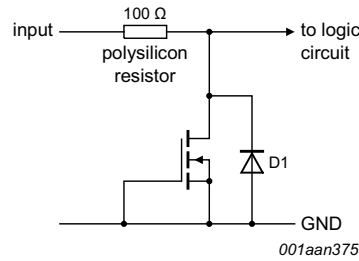


Fig 6. Input protection for the 74HC4050

## 8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

| Symbol              | Parameter                           | Conditions                                     | Min | Typ  | Max      | Unit |
|---------------------|-------------------------------------|------------------------------------------------|-----|------|----------|------|
| $V_{CC}$            | supply voltage                      |                                                | 2.0 | 5.0  | 6.0      | V    |
| $V_I$               | input voltage                       |                                                | 0   | -    | 15       | V    |
| $V_O$               | output voltage                      |                                                | 0   | -    | $V_{CC}$ | V    |
| $T_{amb}$           | ambient temperature                 |                                                | -40 | +25  | +125     | °C   |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.0 \text{ V}; V_I = 2.0 \text{ V}$  | -   | -    | 625      | ns/V |
|                     |                                     | $V_{CC} = 4.5 \text{ V}; V_I = 4.5 \text{ V}$  | -   | 1.67 | 139      | ns/V |
|                     |                                     | $V_{CC} = 6.0 \text{ V}; V_I = 6.0 \text{ V}$  | -   | -    | 83       | ns/V |
|                     |                                     | $V_{CC} = 6.0 \text{ V}; V_I = 10.0 \text{ V}$ | -   | -    | 81       | ns/V |
|                     |                                     | $V_{CC} = 6.0 \text{ V}; V_I = 15.0 \text{ V}$ | -   | -    | 83       | ns/V |

## 9. Static characteristics

Table 6. Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

| Symbol   | Parameter                 | Conditions                                               | $T_{amb} = 25 \text{ °C}$ |     |      | $T_{amb} = -40 \text{ °C to } +85 \text{ °C}$ |      | $T_{amb} = -40 \text{ °C to } +125 \text{ °C}$ |      | Unit |
|----------|---------------------------|----------------------------------------------------------|---------------------------|-----|------|-----------------------------------------------|------|------------------------------------------------|------|------|
|          |                           |                                                          | Min                       | Typ | Max  | Min                                           | Max  | Min                                            | Max  |      |
| $V_{IH}$ | HIGH-level input voltage  | $V_{CC} = 2.0 \text{ V}$                                 | 1.5                       | 1.3 | -    | 1.5                                           | -    | 1.5                                            | -    | V    |
|          |                           | $V_{CC} = 4.5 \text{ V}$                                 | 3.15                      | 2.4 | -    | 3.15                                          | -    | 3.15                                           | -    | V    |
|          |                           | $V_{CC} = 6.0 \text{ V}$                                 | 4.2                       | 3.1 | -    | 4.2                                           | -    | 4.2                                            | -    | V    |
| $V_{IL}$ | LOW-level input voltage   | $V_{CC} = 2.0 \text{ V}$                                 | -                         | 0.7 | 0.5  | -                                             | 0.5  | -                                              | 0.5  | V    |
|          |                           | $V_{CC} = 4.5 \text{ V}$                                 | -                         | 1.8 | 1.35 | -                                             | 1.35 | -                                              | 1.35 | V    |
|          |                           | $V_{CC} = 6.0 \text{ V}$                                 | -                         | 2.3 | 1.8  | -                                             | 1.8  | -                                              | 1.8  | V    |
| $V_{OH}$ | HIGH-level output voltage | $V_I = V_{IH} \text{ or } V_{IL}$                        |                           |     |      |                                               |      |                                                |      |      |
|          |                           | $I_O = -20 \text{ } \mu\text{A}; V_{CC} = 2.0 \text{ V}$ | 1.9                       | 2.0 | -    | 1.9                                           | -    | 1.9                                            | -    | V    |
|          |                           | $I_O = -20 \text{ } \mu\text{A}; V_{CC} = 4.5 \text{ V}$ | 4.4                       | 4.5 | -    | 4.4                                           | -    | 4.4                                            | -    | V    |
|          |                           | $I_O = -20 \text{ } \mu\text{A}; V_{CC} = 6.0 \text{ V}$ | 5.9                       | 6.0 | -    | 5.9                                           | -    | 5.9                                            | -    | V    |
|          |                           | $I_O = -4.0 \text{ mA}; V_{CC} = 4.5 \text{ V}$          | 3.98                      | -   | -    | 3.84                                          | -    | 3.7                                            | -    | V    |
|          |                           | $I_O = -5.2 \text{ mA}; V_{CC} = 6.0 \text{ V}$          | 5.48                      | -   | -    | 5.34                                          | -    | 5.2                                            | -    | V    |

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

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

| Symbol          | Parameter                | Conditions                                                                  | T <sub>amb</sub> = 25 °C |     |      | T <sub>amb</sub> = –40 °C to +85 °C |      | T <sub>amb</sub> = –40 °C to +125 °C |      | Unit |
|-----------------|--------------------------|-----------------------------------------------------------------------------|--------------------------|-----|------|-------------------------------------|------|--------------------------------------|------|------|
|                 |                          |                                                                             | Min                      | Typ | Max  | Min                                 | Max  | Min                                  | Max  |      |
| V <sub>OL</sub> | LOW-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                         |                          |     |      |                                     |      |                                      |      |      |
|                 |                          | I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 2.0 V                             | -                        | -   | 0.1  | -                                   | 0.1  | -                                    | 0.1  | V    |
|                 |                          | I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 4.5 V                             | -                        | -   | 0.1  | -                                   | 0.1  | -                                    | 0.1  | V    |
|                 |                          | I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 6.0 V                             | -                        | -   | 0.1  | -                                   | 0.1  | -                                    | 0.1  | V    |
|                 |                          | I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V                            | -                        | -   | 0.26 | -                                   | 0.33 | -                                    | 0.4  | V    |
|                 |                          | I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V                            | -                        | -   | 0.26 | -                                   | 0.33 | -                                    | 0.4  | V    |
| I <sub>I</sub>  | input leakage current    | V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V            | -                        | -   | ±0.1 | -                                   | ±1.0 | -                                    | ±1.0 | µA   |
|                 |                          | V <sub>I</sub> = 15 V; V <sub>CC</sub> = 2.0 V to 6.0 V                     | -                        | -   | ±0.5 | -                                   | ±5.0 | -                                    | ±5.0 | µA   |
| I <sub>CC</sub> | supply current           | V <sub>I</sub> = 15 V or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V | -                        | -   | 2.0  | -                                   | 20   | -                                    | 40   | µA   |
| C <sub>I</sub>  | input capacitance        |                                                                             | -                        | 3.5 | -    | -                                   | -    | -                                    | -    | pF   |

## 10. Dynamic characteristics

**Table 7.** Dynamic characteristicsVoltages are referenced to GND (ground = 0 V); C<sub>L</sub> = 50 pF unless otherwise specified; for test circuit see [Figure 8](#).

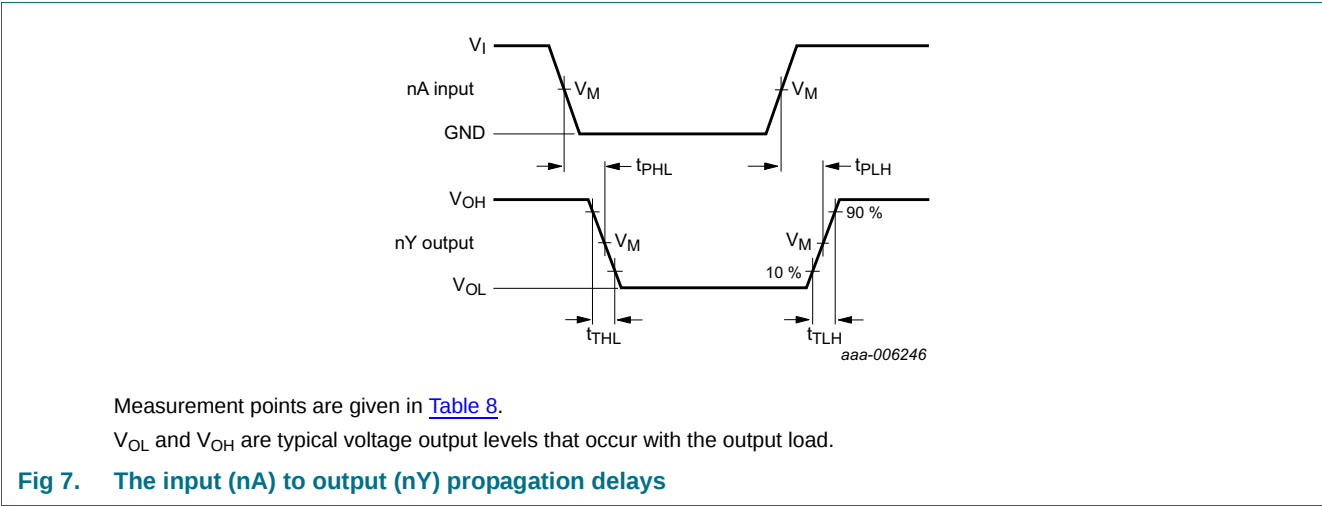
| Symbol          | Parameter         | Conditions                                                 | T <sub>amb</sub> = 25 °C |     |     | T <sub>amb</sub> = –40 °C to +85 °C |     | T <sub>amb</sub> = –40 °C to +125 °C |     | Unit |
|-----------------|-------------------|------------------------------------------------------------|--------------------------|-----|-----|-------------------------------------|-----|--------------------------------------|-----|------|
|                 |                   |                                                            | Min                      | Typ | Max | Min                                 | Max | Min                                  | Max |      |
| t <sub>pd</sub> | propagation delay | nA to nY; see <a href="#">Figure 7</a> <a href="#">[1]</a> |                          |     |     |                                     |     |                                      |     |      |
|                 |                   | V <sub>CC</sub> = 2.0 V                                    | -                        | 25  | 85  | -                                   | 105 | -                                    | 130 | ns   |
|                 |                   | V <sub>CC</sub> = 4.5 V                                    | -                        | 9   | 17  | -                                   | 21  | -                                    | 26  | ns   |
|                 |                   | V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF              | -                        | 7   | -   | -                                   | -   | -                                    | -   | ns   |
|                 |                   | V <sub>CC</sub> = 6.0 V                                    | -                        | 7   | 14  | -                                   | 18  | -                                    | 22  | ns   |
| t <sub>t</sub>  | transition time   | Yn; see <a href="#">Figure 7</a> <a href="#">[2]</a>       |                          |     |     |                                     |     |                                      |     |      |
|                 |                   | V <sub>CC</sub> = 2.0 V                                    | -                        | 19  | 75  | -                                   | 95  | -                                    | 110 | ns   |
|                 |                   | V <sub>CC</sub> = 4.5 V                                    | -                        | 7   | 15  | -                                   | 19  | -                                    | 22  | ns   |
|                 |                   | V <sub>CC</sub> = 6.0 V                                    | -                        | 6   | 13  | -                                   | 16  | -                                    | 19  | ns   |

**Table 7. Dynamic characteristics ...continued**  
Voltages are referenced to GND (ground = 0 V);  $C_L = 50\text{ pF}$  unless otherwise specified; for test circuit see [Figure 8](#).

| Symbol          | Parameter                     | Conditions                                                                                     | T <sub>amb</sub> = 25 °C |     |     | T <sub>amb</sub> = –40 °C to +85 °C |     | T <sub>amb</sub> = –40 °C to +125 °C |     | Unit |
|-----------------|-------------------------------|------------------------------------------------------------------------------------------------|--------------------------|-----|-----|-------------------------------------|-----|--------------------------------------|-----|------|
|                 |                               |                                                                                                | Min                      | Typ | Max | Min                                 | Max | Min                                  | Max |      |
| C <sub>PD</sub> | power dissipation capacitance | C <sub>L</sub> = 50 pF; f = 1 MHz; V <sub>I</sub> = GND to V <sub>CC</sub> <a href="#">[3]</a> | -                        | 14  | -   | -                                   | -   | -                                    | -   | pF   |

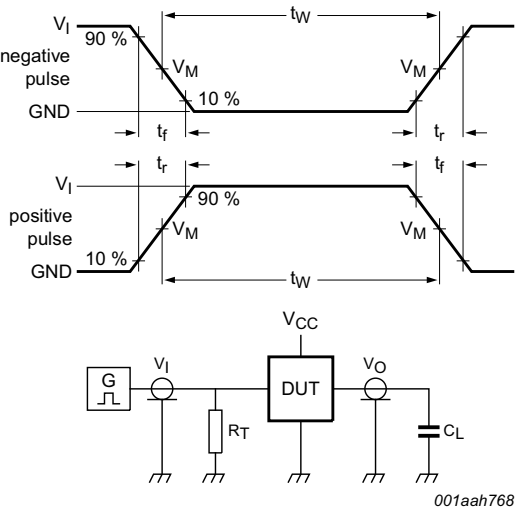
- [1]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .  
[2]  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$ .  
[3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).  
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$  where:  
 $f_i$  = input frequency in MHz;  
 $f_o$  = output frequency in MHz;  
 $C_L$  = output load capacitance in pF;  
 $V_{CC}$  = supply voltage in V;  
 $N$  = number of inputs switching;  
 $\Sigma(C_L \times V_{CC}^2 \times f_o)$  = sum of outputs.

11. Waveforms



**Table 8. Measurement points**

| Type     | Input              | Output             |
|----------|--------------------|--------------------|
|          | V <sub>M</sub>     | V <sub>M</sub>     |
| 74HC4050 | 0.5V <sub>CC</sub> | 0.5V <sub>CC</sub> |



Test data is given in [Table 9](#).  
Definitions test circuit:  
 $R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.  
 $C_L$  = Load capacitance including jig and probe capacitance.  
 $R_L$  = Load resistance.  
 $S1$  = Test selection switch.

Fig 8. Test circuit for measuring switching times

Table 9. Test data

| Type     | Input    |            | Load         | Test               |
|----------|----------|------------|--------------|--------------------|
|          | $V_I$    | $t_r, t_f$ | $C_L$        |                    |
| 74HC4050 | $V_{CC}$ | 6.0 ns     | 15 pF, 50 pF | $t_{PLH}, t_{PHL}$ |

12. Package outline

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

SOT109-1

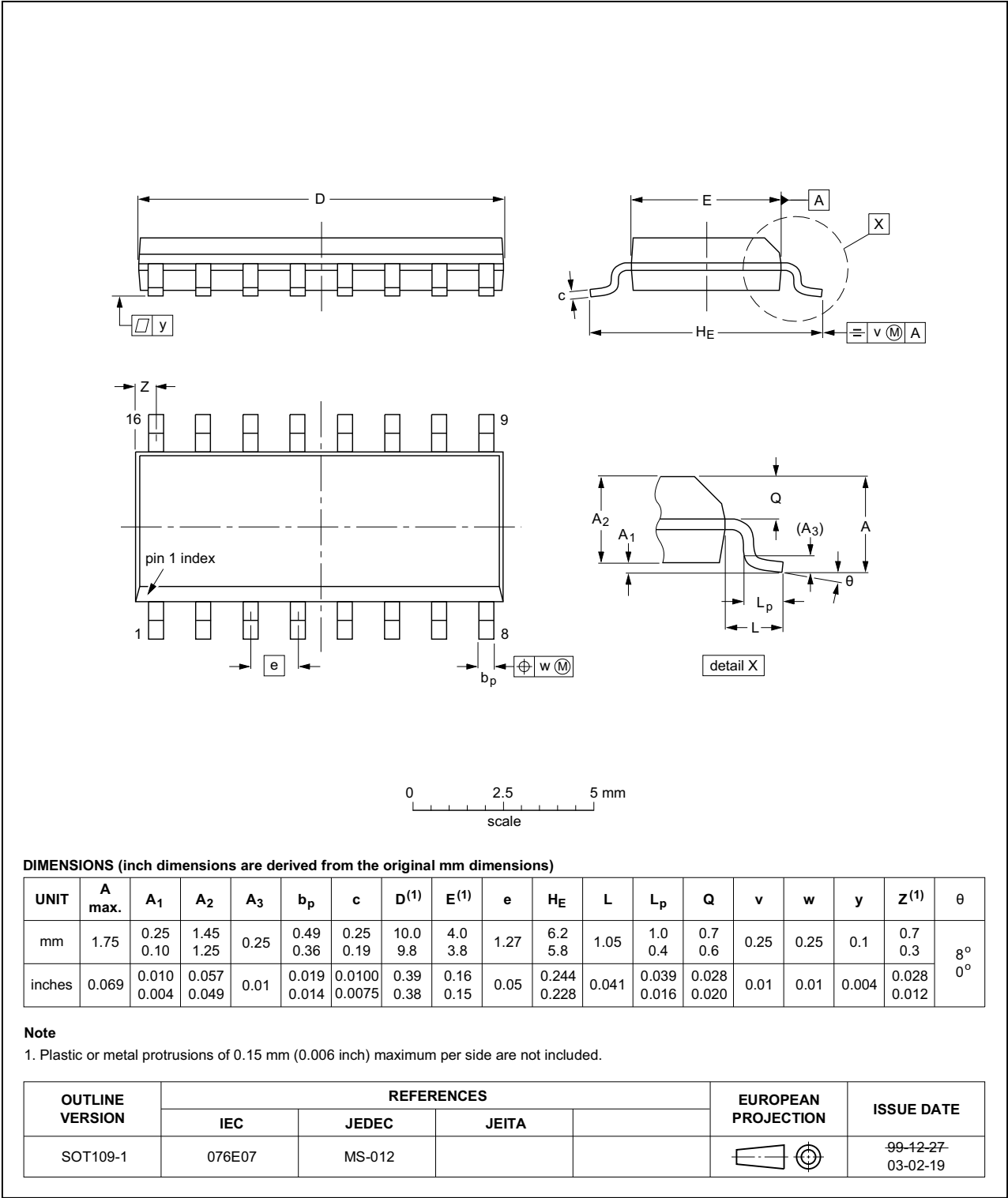


Fig 9. Package outline SOT109-1 (SO16)

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1

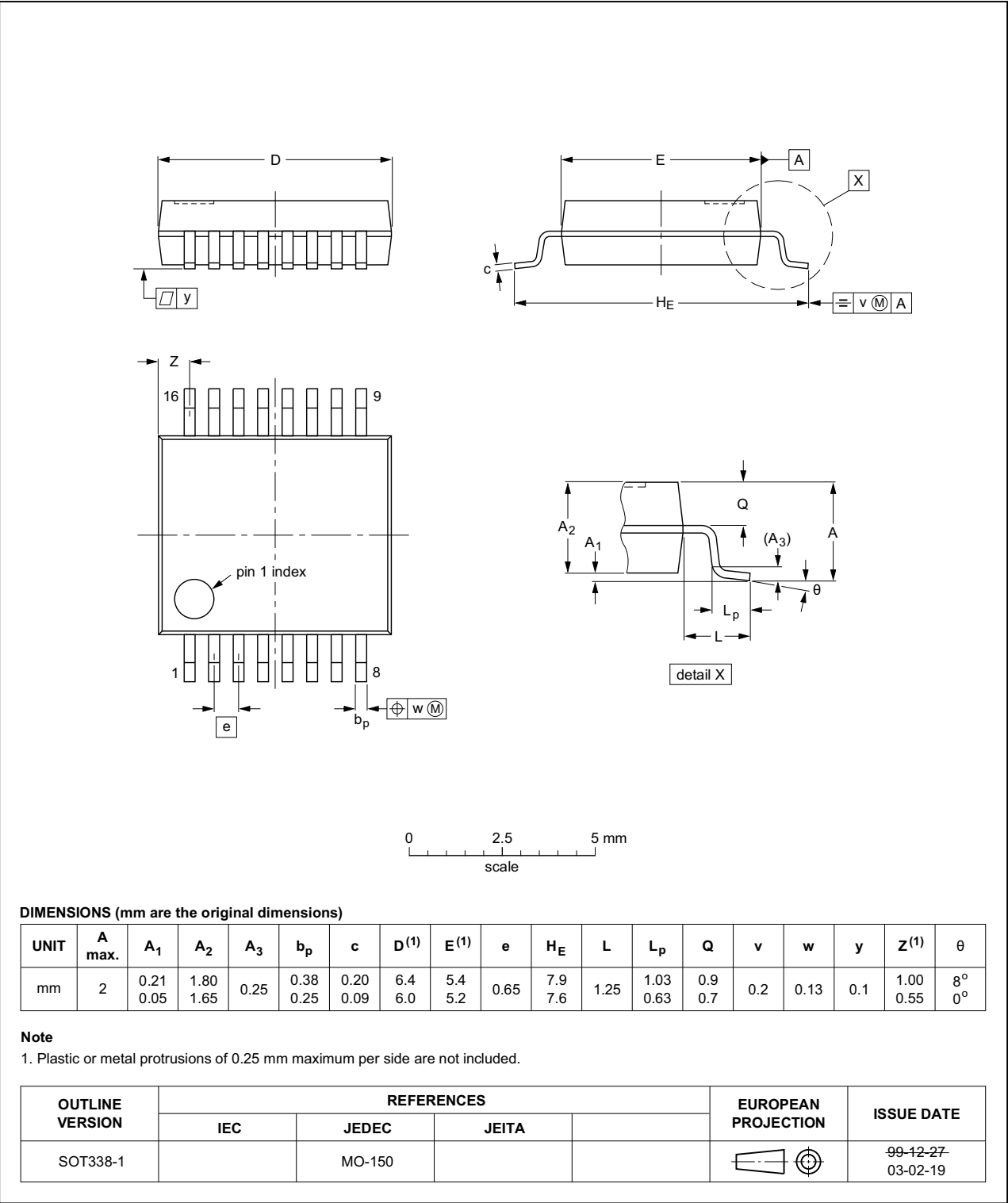


Fig 10. Package outline SOT338-1 (SSOP16)

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

SOT403-1

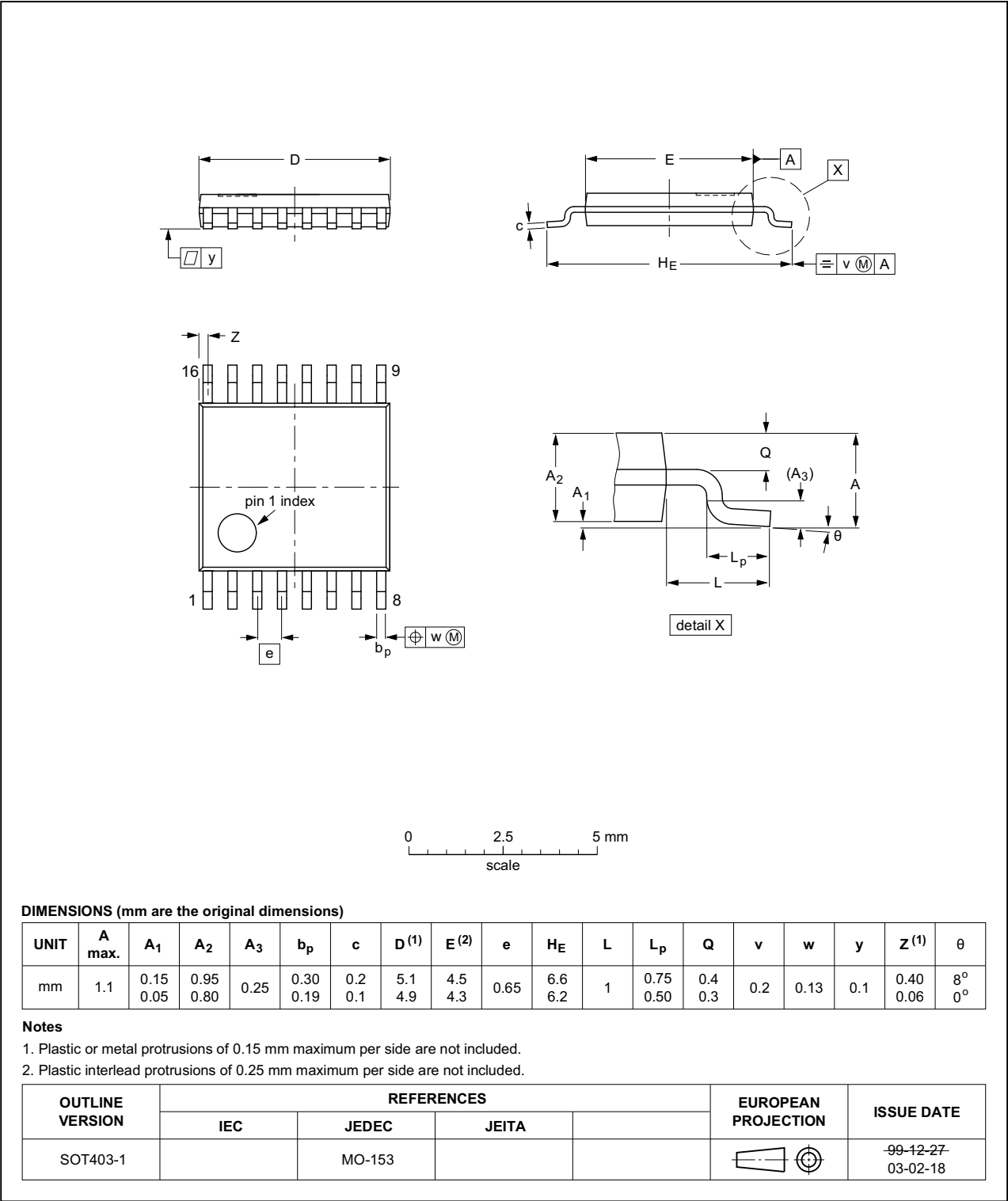


Fig 11. Package outline SOT403-1 (TSSOP16)

## 13. Abbreviations

Table 10. Abbreviations

| Acronym | Description                             |
|---------|-----------------------------------------|
| CMOS    | Complementary Metal Oxide Semiconductor |
| DUT     | Device Under Test                       |
| ESD     | ElectroStatic Discharge                 |
| HBM     | Human Body Model                        |
| MM      | Machine Model                           |

## 14. Revision history

Table 11. Revision history

| Document ID      | Release date                                                                                                                                                                                                                                         | Data sheet status     | Change notice | Supersedes       |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|------------------|
| 74HC4050 v.4     | 20160205                                                                                                                                                                                                                                             | Product data sheet    | -             | 74HC4050 v.3     |
| Modifications:   | <ul style="list-style-type: none"><li>Type number 74HC4050N (SOT38-4) removed.</li></ul>                                                                                                                                                             |                       |               |                  |
| 74HC4050 v.3     | 20130131                                                                                                                                                                                                                                             | Product data sheet    | -             | 74HC4050_CNV v.2 |
| Modifications:   | <ul style="list-style-type: none"><li>The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>Legal texts have been adapted to the new company name where appropriate.</li></ul> |                       |               |                  |
| 74HC4050_CNV v.2 | 19970826                                                                                                                                                                                                                                             | Product specification | -             | -                |

## 15. Legal information

### 15.1 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.nexperia.com>.

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