

# 74HC05

## Hex inverter with open-drain outputs

Rev. 02 — 18 June 2009

Product data sheet

### 1. General description

The 74HC05 is a high-speed Si-gate CMOS device that complies with JEDEC standard no. 7A.

The 74HC05 contains six inverters. The outputs of the 74HC05 are open-drain and can be connected to other open-drain outputs to implement active-LOW wired-OR or active-HIGH wired-AND functions. The open-drain outputs require pull-up resistors to perform correctly.

### 2. Features

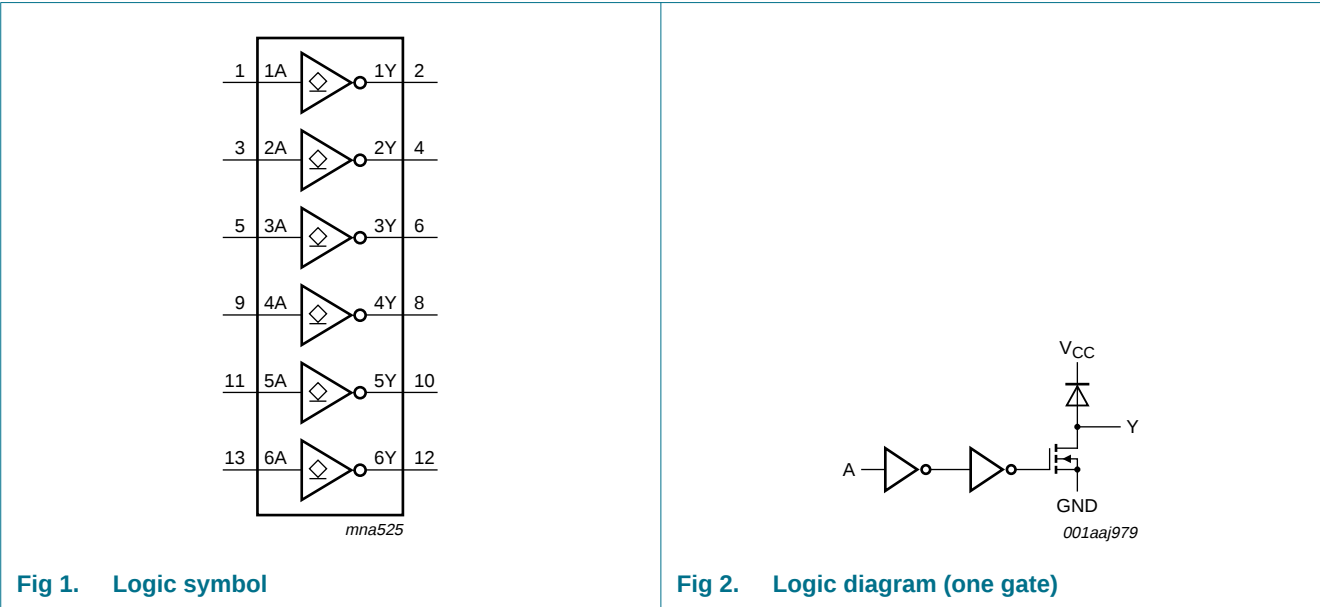
- Wide operating voltage 2.0 V to 6.0 V
- Input levels:
  - ◆ For 74HC05: CMOS level
- Latch-up performance exceeds 100 mA per JESD 78 Class II level A
- ESD protection:
  - ◆ HBM JESD22-A114E exceeds 2000 V
  - ◆ CDM JESD22-C101C exceeds 1000 V
- Multiple package options
- Specified from  $-40\text{ }^{\circ}\text{C}$  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

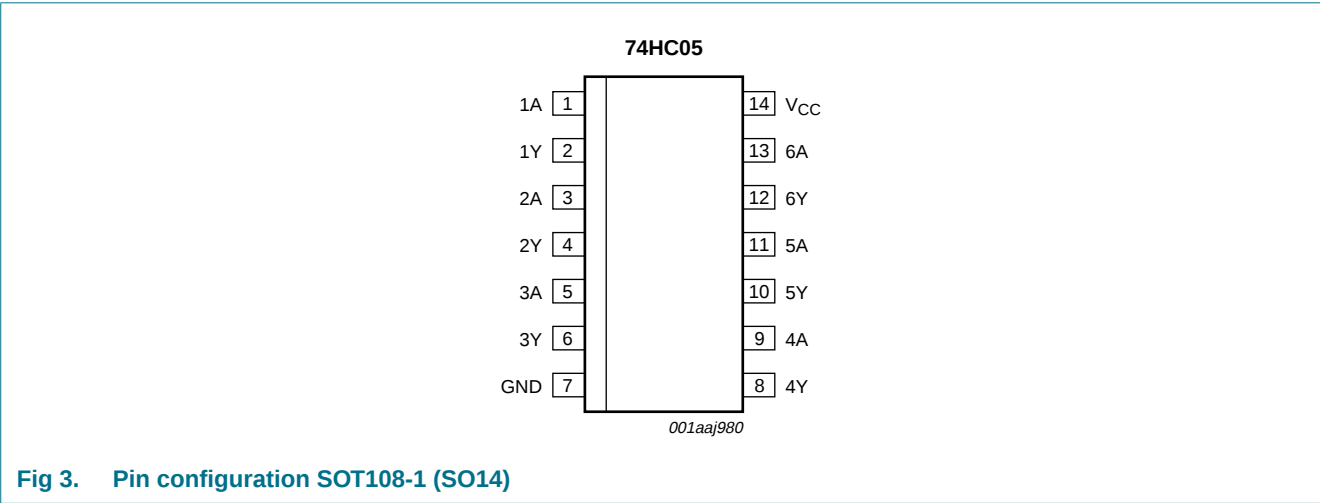
| Type number | Package                                                         |          |                                                                                                                                                 |          |
|-------------|-----------------------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|             | Temperature range                                               | Name     | Description                                                                                                                                     | Version  |
| 74HC05D     | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SO14     | plastic small outline package; 14 leads; body width 3.9 mm                                                                                      | SOT108-1 |
| 74HC05PW    | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | TSSOP14  | plastic thin shrink small outline package; 14 leads; body width 4.4 mm                                                                          | SOT402-1 |
| 74HC05BQ    | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | DHVQFN14 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body $2.5 \times 3 \times 0.85\text{ mm}$ | SOT762-1 |

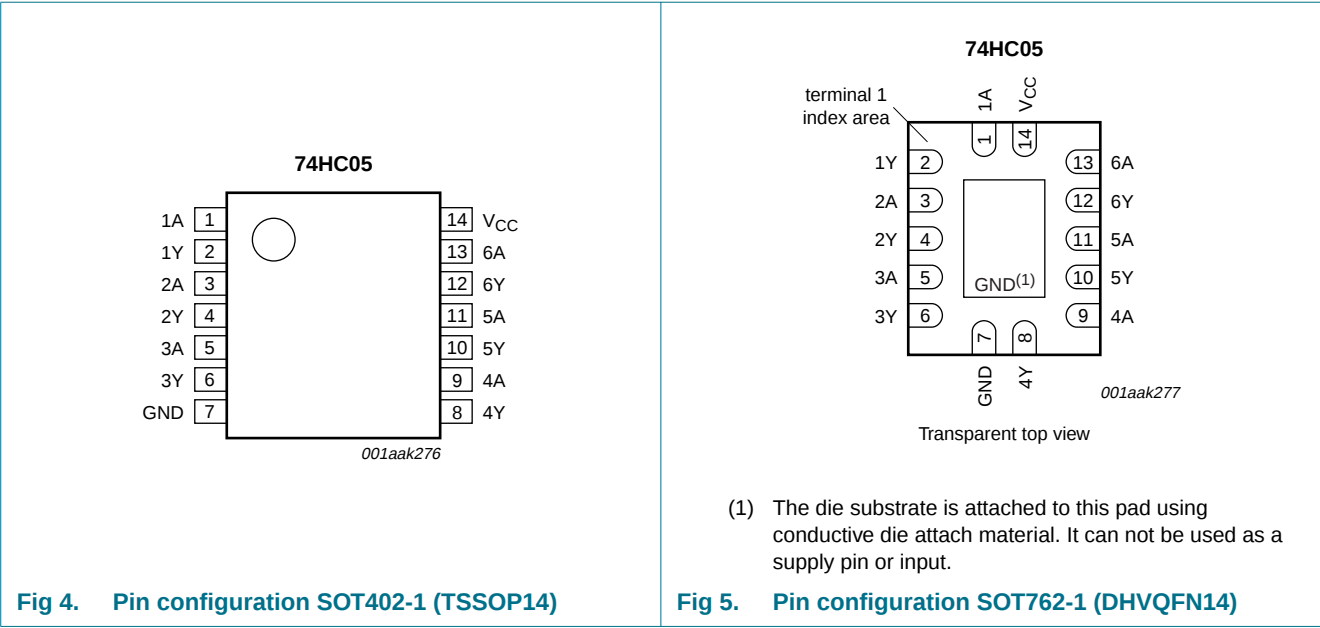
4. Functional diagram



5. Pinning information

5.1 Pinning





5.2 Pin description

Table 2. Pin description

| Symbol          | Pin                | Description    |
|-----------------|--------------------|----------------|
| 1A to 6A        | 1, 3, 5, 9, 11, 13 | data input     |
| 1Y to 6Y        | 2, 4, 6, 8, 10, 12 | data output    |
| GND             | 7                  | ground (0 V)   |
| V <sub>CC</sub> | 14                 | supply voltage |

6. Functional description

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

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

[1] H = HIGH voltage level; L = LOW voltage level; 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    |
| I <sub>IK</sub> | input clamping current  | V <sub>I</sub> < −0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V | <sup>[1]</sup> -    | 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 | <sup>[1]</sup> -    | 20                      | mA   |
| V <sub>O</sub>  | output voltage          |                                                                     | <sup>[1]</sup> −0.5 | V <sub>CC</sub> + 0.5 V | V    |

**Table 4.** Limiting values ...continued

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

| Symbol    | Parameter               | Conditions                     | Min   | Max  | Unit |
|-----------|-------------------------|--------------------------------|-------|------|------|
| $I_O$     | output current          | $V_O < V_{CC} + 0.5 \text{ V}$ | -     | 25   | mA   |
| $I_{CC}$  | supply current          |                                | -     | 50   | mA   |
| $I_{GND}$ | ground current          |                                | -50   | -    | mA   |
| $T_{stg}$ | storage temperature     |                                | -65   | +150 | °C   |
| $P_{tot}$ | total power dissipation |                                | [2] - | 500  | mW   |

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] For SO14 package:  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.For TSSOP14 packages:  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °C.For DHVQFN14 packages:  $P_{tot}$  derates linearly with 4.5 mW/K above 60 °C.

## 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   | -    | $V_{CC}$ | V    |
| $V_O$               | output voltage                      |                          | 0   | -    | $V_{CC}$ | V    |
| $T_{amb}$           | ambient temperature                 |                          | -40 | -    | +125     | °C   |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.0 \text{ V}$ | -   | -    | 625      | ns/V |
|                     |                                     | $V_{CC} = 4.5 \text{ V}$ | -   | 1.67 | 139      | ns/V |
|                     |                                     | $V_{CC} = 6.0 \text{ V}$ | -   | -    | 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                                     | 25 °C |      |      | -40 °C to +85 °C |      | -40 °C to +125 °C |      | Unit |
|----------|--------------------------|------------------------------------------------|-------|------|------|------------------|------|-------------------|------|------|
|          |                          |                                                | Min   | Typ  | Max  | Min              | Max  | Min               | Max  |      |
| $V_{IH}$ | HIGH-level input voltage | $V_{CC} = 2.0 \text{ V}$                       | 1.5   | 1.2  | -    | 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   | 3.2  | -    | 4.2              | -    | 4.2               | -    | V    |
| $V_{IL}$ | LOW-level input voltage  | $V_{CC} = 2.0 \text{ V}$                       | -     | 0.8  | 0.5  | -                | 0.5  | -                 | 0.5  | V    |
|          |                          | $V_{CC} = 4.5 \text{ V}$                       | -     | 2.1  | 1.35 | -                | 1.35 | -                 | 1.35 | V    |
|          |                          | $V_{CC} = 6.0 \text{ V}$                       | -     | 2.8  | 1.8  | -                | 1.8  | -                 | 1.8  | V    |
| $V_{OL}$ | LOW-level output voltage | $V_I = V_{IH} \text{ or } V_{IL}$              |       |      |      |                  |      |                   |      |      |
|          |                          | $I_O = 20 \mu\text{A}; V_{CC} = 2.0 \text{ V}$ | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|          |                          | $I_O = 20 \mu\text{A}; V_{CC} = 4.5 \text{ V}$ | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|          |                          | $I_O = 20 \mu\text{A}; V_{CC} = 6.0 \text{ V}$ | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|          |                          | $I_O = 4.0 \text{ mA}; V_{CC} = 4.5 \text{ V}$ | -     | 0.15 | 0.26 | -                | 0.33 | -                 | 0.4  | V    |
|          |                          | $I_O = 5.2 \text{ mA}; V_{CC} = 6.0 \text{ V}$ | -     | 0.16 | 0.26 | -                | 0.33 | -                 | 0.4  | V    |

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

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

| Symbol          | Parameter                | Conditions                                                                                                                                                                                | 25 °C |     |     | –40 °C to +85 °C |     | –40 °C to +125 °C |     | Unit |
|-----------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----|-----|------------------|-----|-------------------|-----|------|
|                 |                          |                                                                                                                                                                                           | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| I <sub>I</sub>  | input leakage current    | V <sub>I</sub> = V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 6.0 V                                                                                                                       | -     | -   | 0.1 | -                | 1   | -                 | 1   | μA   |
| I <sub>OZ</sub> | OFF-state output current | per input pin; V <sub>I</sub> = V <sub>IL</sub> ;<br>V <sub>O</sub> = V <sub>CC</sub> or GND;<br>other inputs at V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 6.0 V; I <sub>O</sub> = 0 A | -     | -   | 0.5 | -                | 5.0 | -                 | 10  | μA   |
| I <sub>CC</sub> | supply current           | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A;<br>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 characteristicsGND = 0 V; for test circuit see [Figure 7](#).

| Symbol           | Parameter                          | Conditions                                                                         | 25 °C |     |     | –40 °C to +125 °C |              | Unit |
|------------------|------------------------------------|------------------------------------------------------------------------------------|-------|-----|-----|-------------------|--------------|------|
|                  |                                    |                                                                                    | Min   | Typ | Max | Max (85 °C)       | Max (125 °C) |      |
| t <sub>PLZ</sub> | LOW to OFF-state propagation delay | nA to nY; see <a href="#">Figure 6</a>                                             |       |     |     |                   |              |      |
|                  |                                    | V <sub>CC</sub> = 2.0 V                                                            | -     | 20  | 90  | 115               | 135          | ns   |
|                  |                                    | V <sub>CC</sub> = 4.5 V                                                            | -     | 11  | 18  | 23                | 27           | ns   |
|                  |                                    | V <sub>CC</sub> = 6.0 V                                                            | -     | 10  | 15  | 20                | 23           | ns   |
| t <sub>PZL</sub> | OFF-state to LOW propagation delay | nA to nY; see <a href="#">Figure 6</a>                                             |       |     |     |                   |              |      |
|                  |                                    | V <sub>CC</sub> = 2.0 V                                                            | -     | 22  | 90  | 115               | 135          | ns   |
|                  |                                    | V <sub>CC</sub> = 4.5 V                                                            | -     | 9   | 18  | 23                | 27           | ns   |
|                  |                                    | V <sub>CC</sub> = 6.0 V                                                            | -     | 8   | 15  | 20                | 23           | ns   |
| t <sub>THL</sub> | HIGH to LOW output transition time | see <a href="#">Figure 6</a>                                                       |       |     |     |                   |              |      |
|                  |                                    | V <sub>CC</sub> = 2.0 V                                                            | -     | 18  | 75  | 95                | 110          | ns   |
|                  |                                    | V <sub>CC</sub> = 4.5 V                                                            | -     | 6   | 15  | 19                | 22           | ns   |
|                  |                                    | V <sub>CC</sub> = 6.0 V                                                            | -     | 5   | 13  | 16                | 19           | ns   |
| C <sub>PD</sub>  | power dissipation capacitance      | per inverter; V <sub>I</sub> = GND to V <sub>CC</sub> ;<br>V <sub>CC</sub> = 5.0 V | [1]   | -   | 4   | -                 | -            | pF   |

[1] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(0.5 \times C_L \times V_O^2 \times f_o) \text{ where:}$$

f<sub>i</sub> = input frequency in MHz;f<sub>o</sub> = output frequency in MHz;V<sub>O</sub> = output voltage in V (output HIGH);V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

R<sub>L</sub> = load resistance in MΩ;C<sub>L</sub> = load capacitance in pF;

11. Waveforms

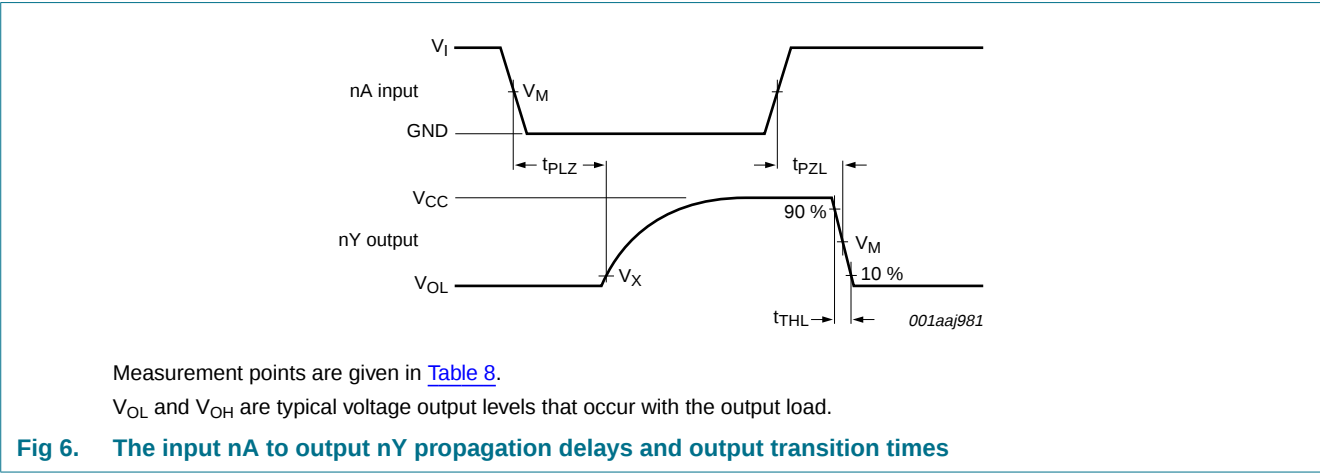


Table 8. Measurement points

| Input       | Output      |             |
|-------------|-------------|-------------|
| $V_M$       | $V_M$       | $V_X$       |
| $0.5V_{CC}$ | $0.5V_{CC}$ | $0.1V_{CC}$ |

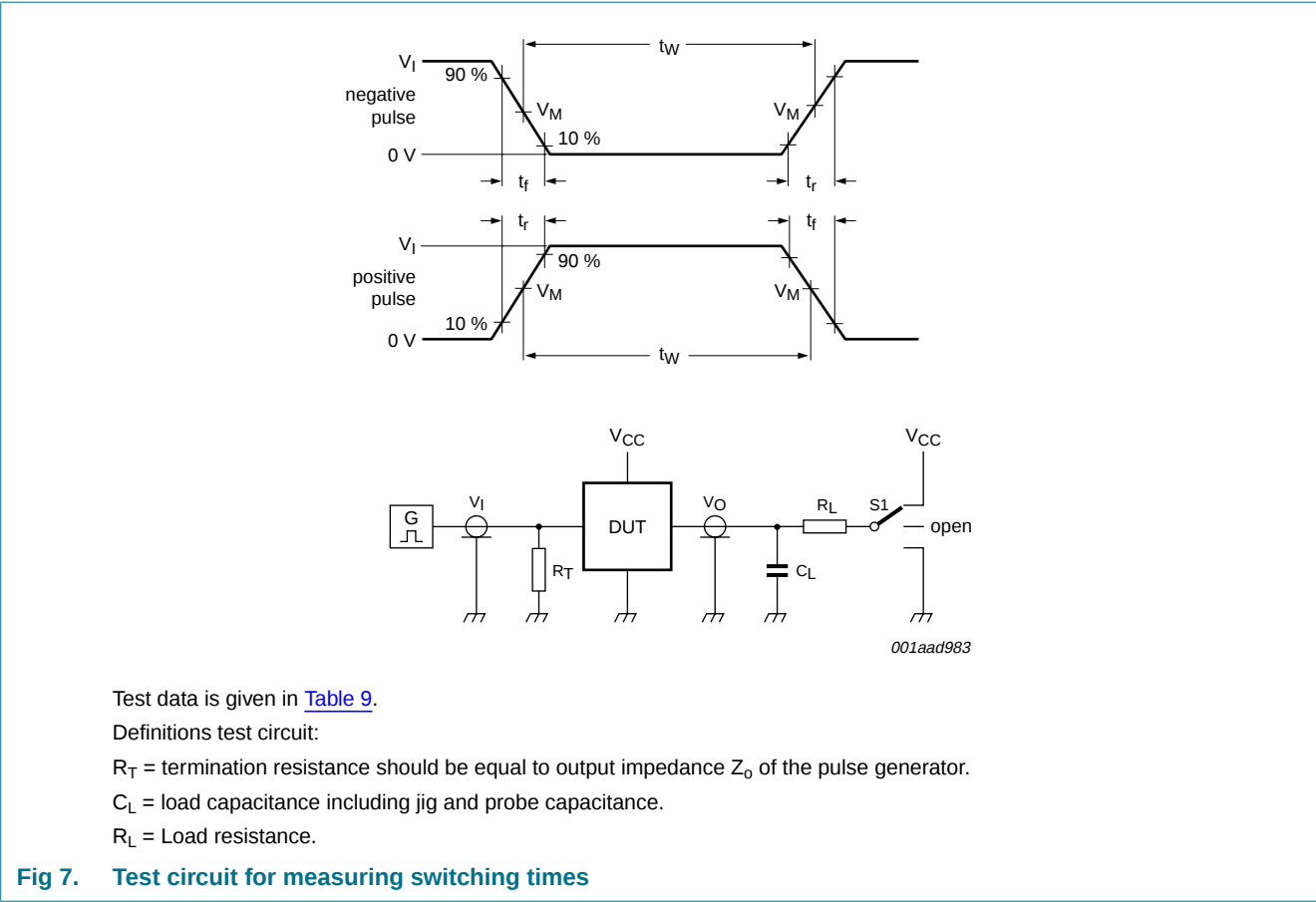


Table 9. Test data

| Input    |            | Load  |              | S1 position        |
|----------|------------|-------|--------------|--------------------|
| $V_I$    | $t_r, t_f$ | $C_L$ | $R_L$        | $t_{pZL}, t_{pLZ}$ |
| $V_{CC}$ | 6 ns       | 50 pF | 1 k $\Omega$ | $V_{CC}$           |

12. Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1

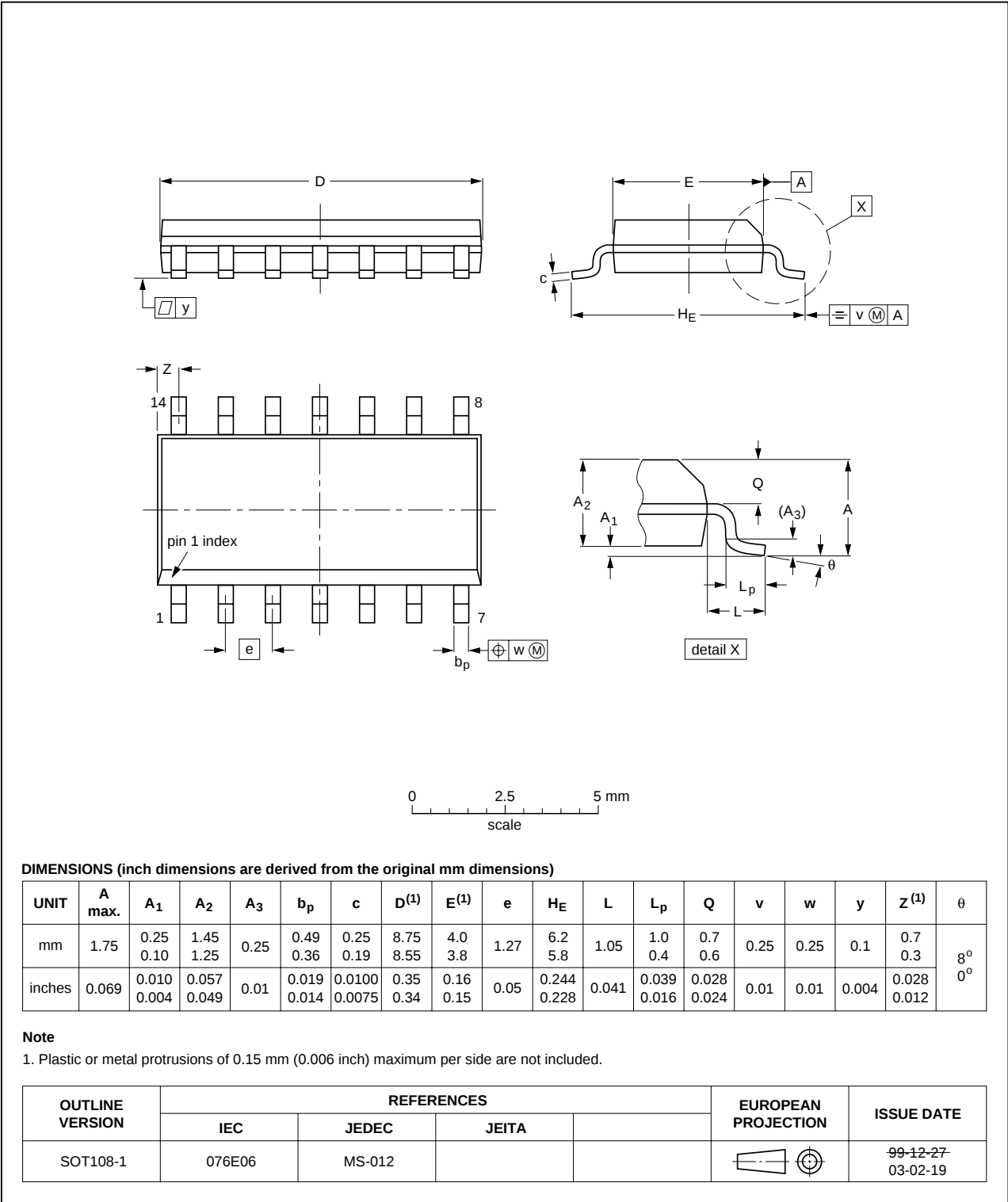


Fig 8. Package outline SOT108-1 (SO14)

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1

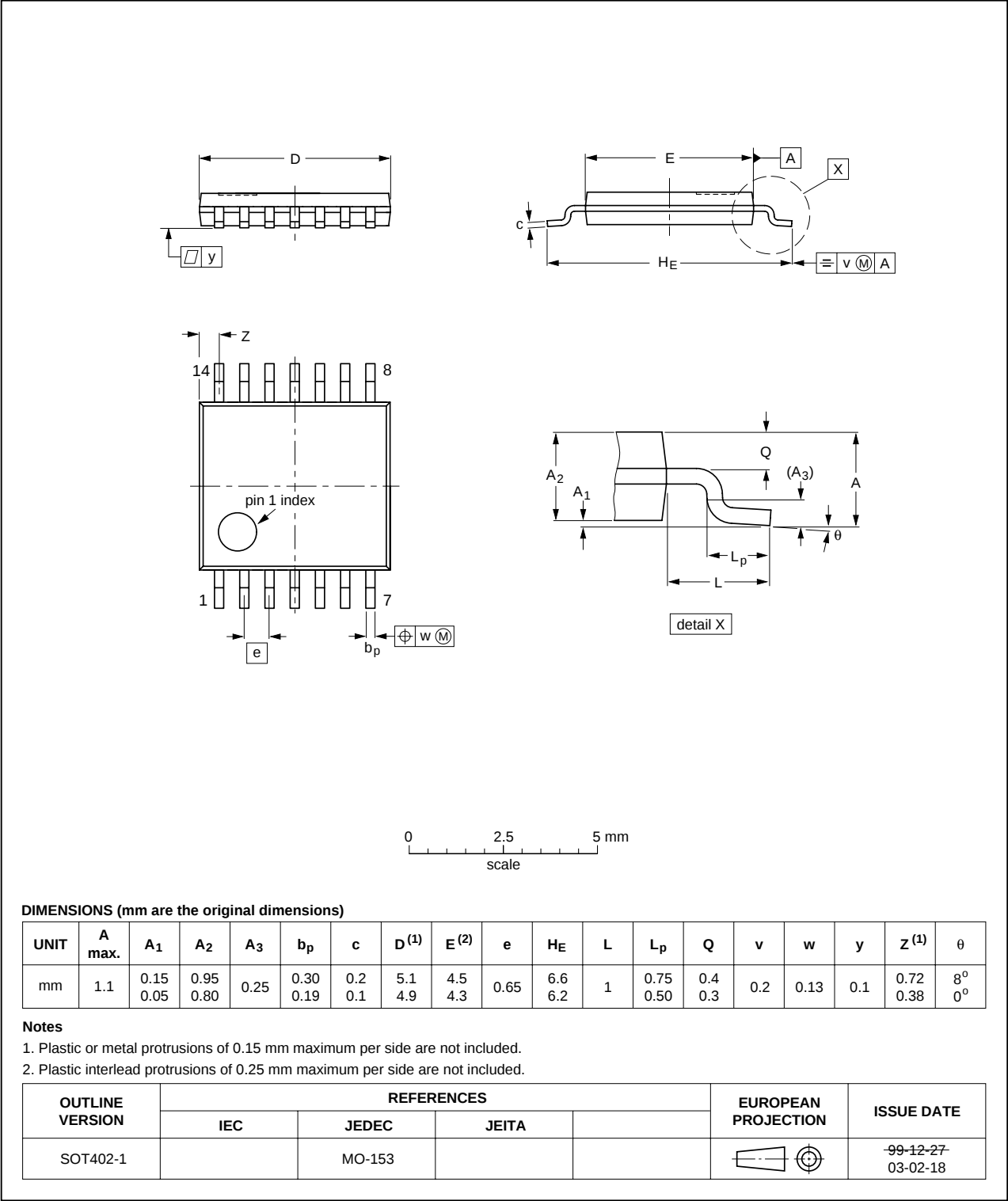


Fig 9. Package outline SOT402-1 (TSSOP14)

DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads;  
14 terminals; body 2.5 x 3 x 0.85 mm

SOT762-1

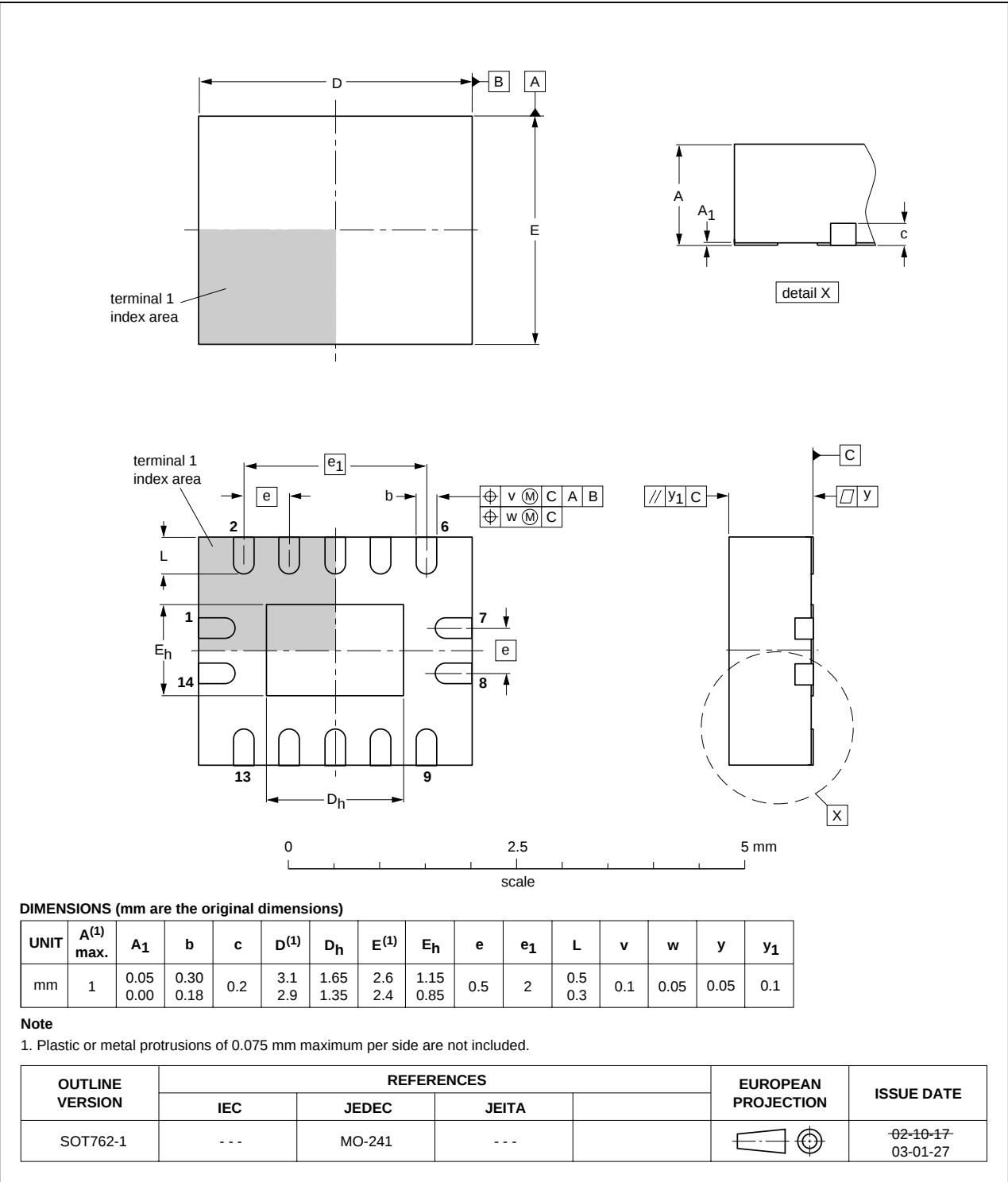


Fig 10. Package outline SOT762-1 (DHVQFN14)

## 13. Abbreviations

Table 10. Abbreviations

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

## 14. Revision history

Table 11. Revision history

| Document ID    | Release date                                                                                                                  | Data sheet status  | Change notice | Supersedes |
|----------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------|------------|
| 74HC05_2       | 20090618                                                                                                                      | Product data sheet | -             | 74HC05_1   |
| Modifications: | <ul style="list-style-type: none"><li>Added type numbers 74HC05PW (TSSOP14 package) and 74HC05BQ (DHVQFN14 package)</li></ul> |                    |               |            |
| 74HC05_1       | 20090427                                                                                                                      | Product data sheet | -             | -          |

## 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. |
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| 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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