

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

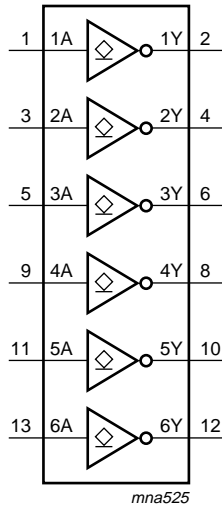


Fig 1. Logic symbol

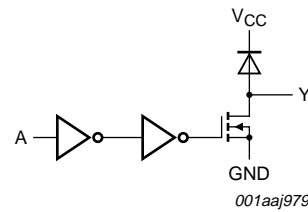


Fig 2. Logic diagram (one gate)

5. Pinning information

5.1 Pinning

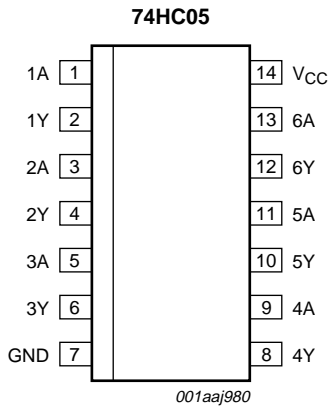
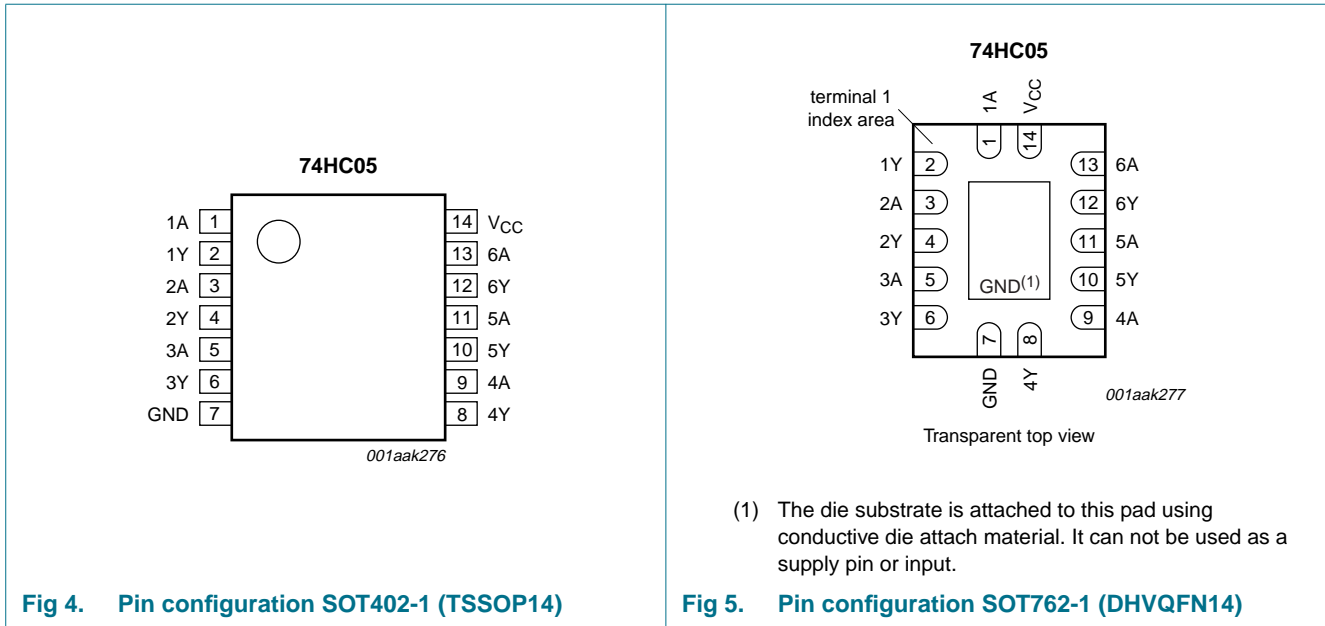


Fig 3. Pin configuration SOT108-1 (SO14)



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 _{CC} | 14 | supply voltage |

6. Functional description

Table 3. Function table^[1]

| 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 _{CC} | supply voltage | | -0.5 | +7 | V |
| I _{IK} | input clamping current | V _I < -0.5 V or V _I > V _{CC} + 0.5 V | [1] - | 20 | mA |
| I _{OK} | output clamping current | V _O < -0.5 V or V _O > V _{CC} + 0.5 V | [1] - | 20 | mA |
| V _O | output voltage | | [1] -0.5 | V _{CC} + 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 | $V_I = V_{IH}$ 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 _I | input leakage current | V _I = V _{CC} or GND; V _{CC} = 6.0 V | - | - | 0.1 | - | 1 | - | 1 | µA |
| I _{OZ} | OFF-state output current | per input pin; V _I = V _{IL} ; V _O = V _{CC} or GND; other inputs at V _{CC} or GND; V _{CC} = 6.0 V; I _O = 0 A | - | - | 0.5 | - | 5.0 | - | 10 | µA |
| I _{CC} | supply current | V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V | - | - | 2.0 | - | 20 | - | 40 | µA |
| C _I | input capacitance | | - | 3.5 | - | - | - | - | - | pF |

10. Dynamic characteristics

Table 7. Dynamic characteristics

GND = 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 _{PLZ} | LOW to OFF-state propagation delay | nA to nY; see Figure 6 V _{CC} = 2.0 V | - | 20 | 90 | 115 | 135 | ns |
| | | V _{CC} = 4.5 V | - | 11 | 18 | 23 | 27 | ns |
| | | V _{CC} = 6.0 V | - | 10 | 15 | 20 | 23 | ns |
| t _{PZL} | OFF-state to LOW propagation delay | nA to nY; see Figure 6 V _{CC} = 2.0 V | - | 22 | 90 | 115 | 135 | ns |
| | | V _{CC} = 4.5 V | - | 9 | 18 | 23 | 27 | ns |
| | | V _{CC} = 6.0 V | - | 8 | 15 | 20 | 23 | ns |
| t _{THL} | HIGH to LOW output transition time | see Figure 6 V _{CC} = 2.0 V | - | 18 | 75 | 95 | 110 | ns |
| | | V _{CC} = 4.5 V | - | 6 | 15 | 19 | 22 | ns |
| | | V _{CC} = 6.0 V | - | 5 | 13 | 16 | 19 | ns |
| C _{PD} | power dissipation capacitance | per inverter; V _I = GND to V _{CC} ; V _{CC} = 5.0 V | [1] | - | 4 | - | - | pF |

[1] C_{PD} is used to determine the dynamic power dissipation (P_D 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_i = input frequency in MHz;

f_o = output frequency in MHz;

V_O = output voltage in V (output HIGH);

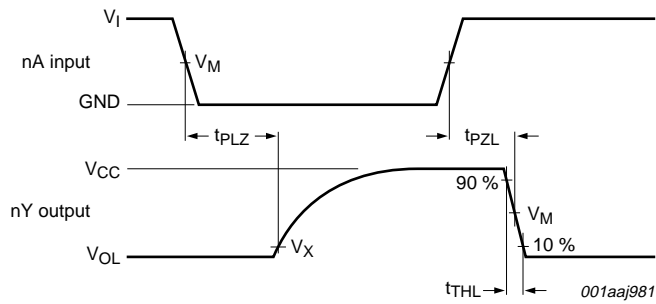
V_{CC} = supply voltage in V;

N = number of inputs switching;

R_L = load resistance in MΩ;

C_L = load capacitance in pF;

11. Waveforms



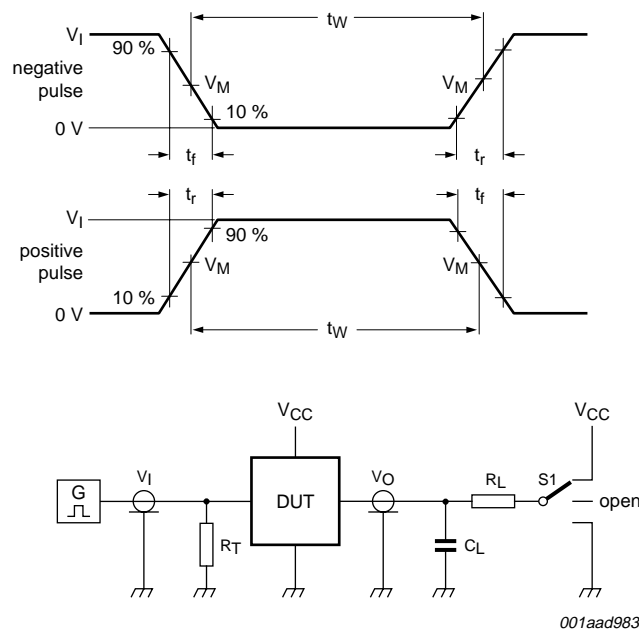
Measurement points are given in [Table 8](#).

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

Fig 6. The input nA to output nY propagation delays and output transition times

Table 8. Measurement points

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



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.

Fig 7. Test circuit for measuring switching times

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 Ω | V_{CC} |

12. Package outline

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

SOT108-1

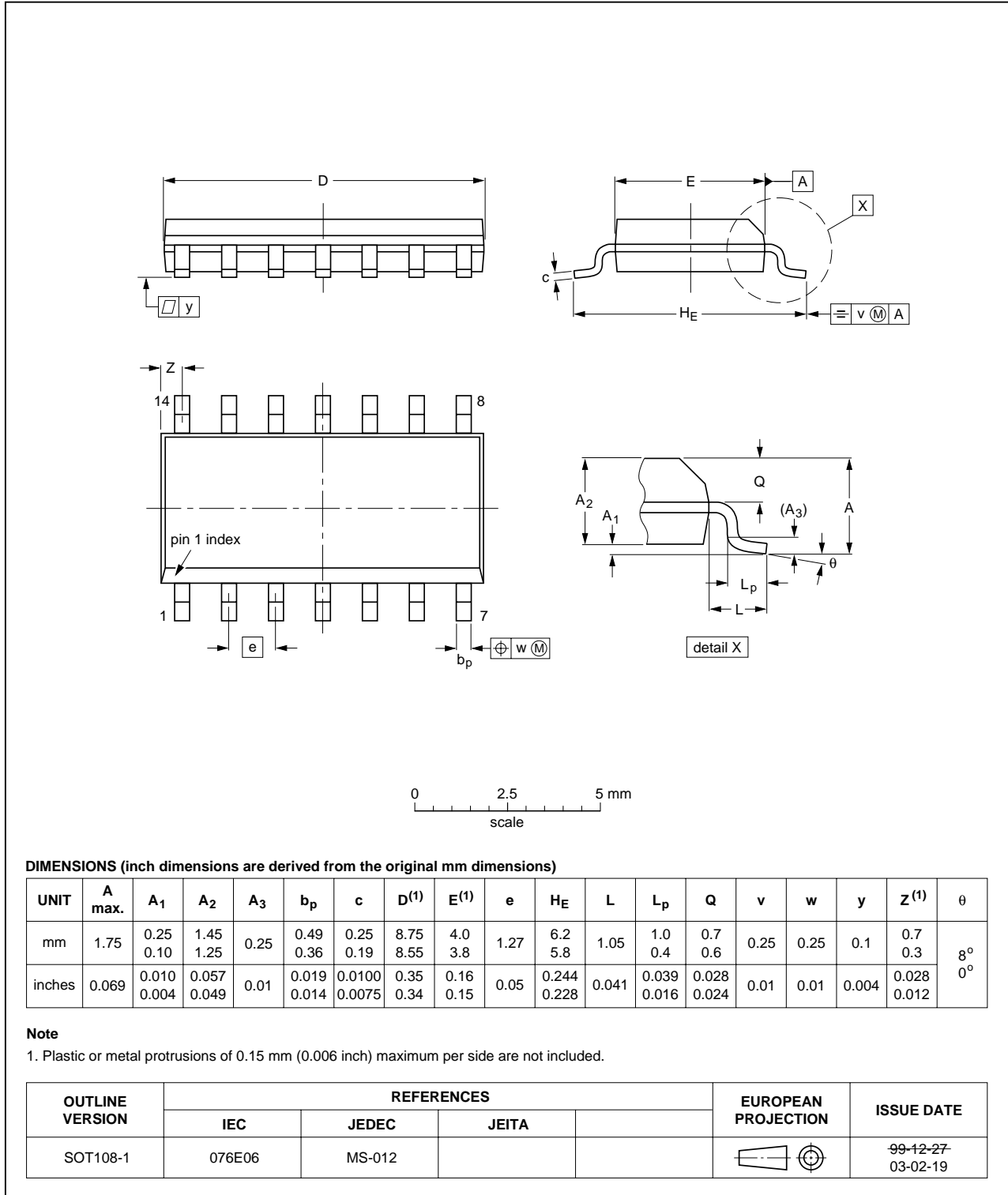


Fig 8. Package outline SOT108-1 (SO14)

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

SOT402-1

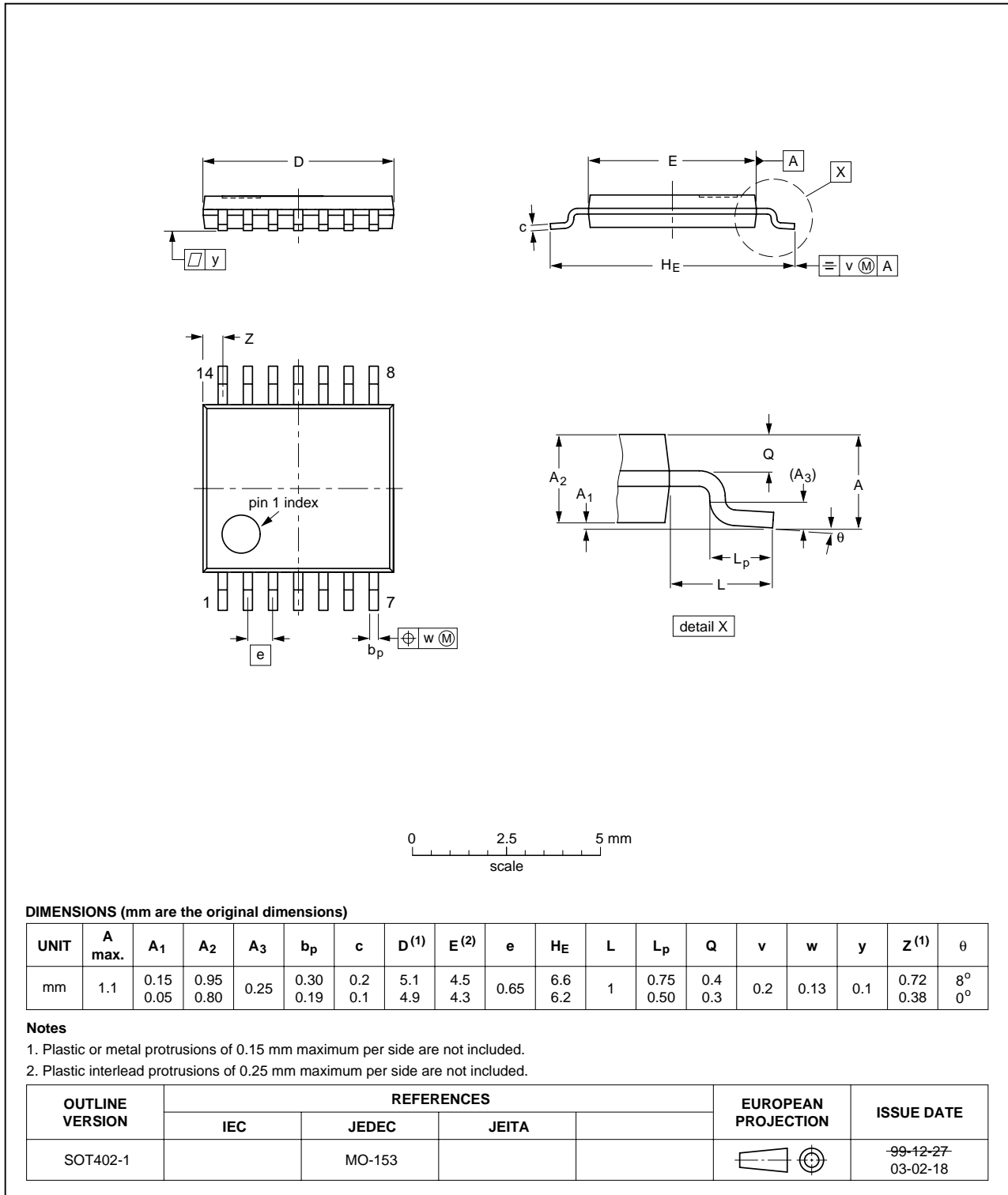


Fig 9. Package outline SOT402-1 (TSSOP14)

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

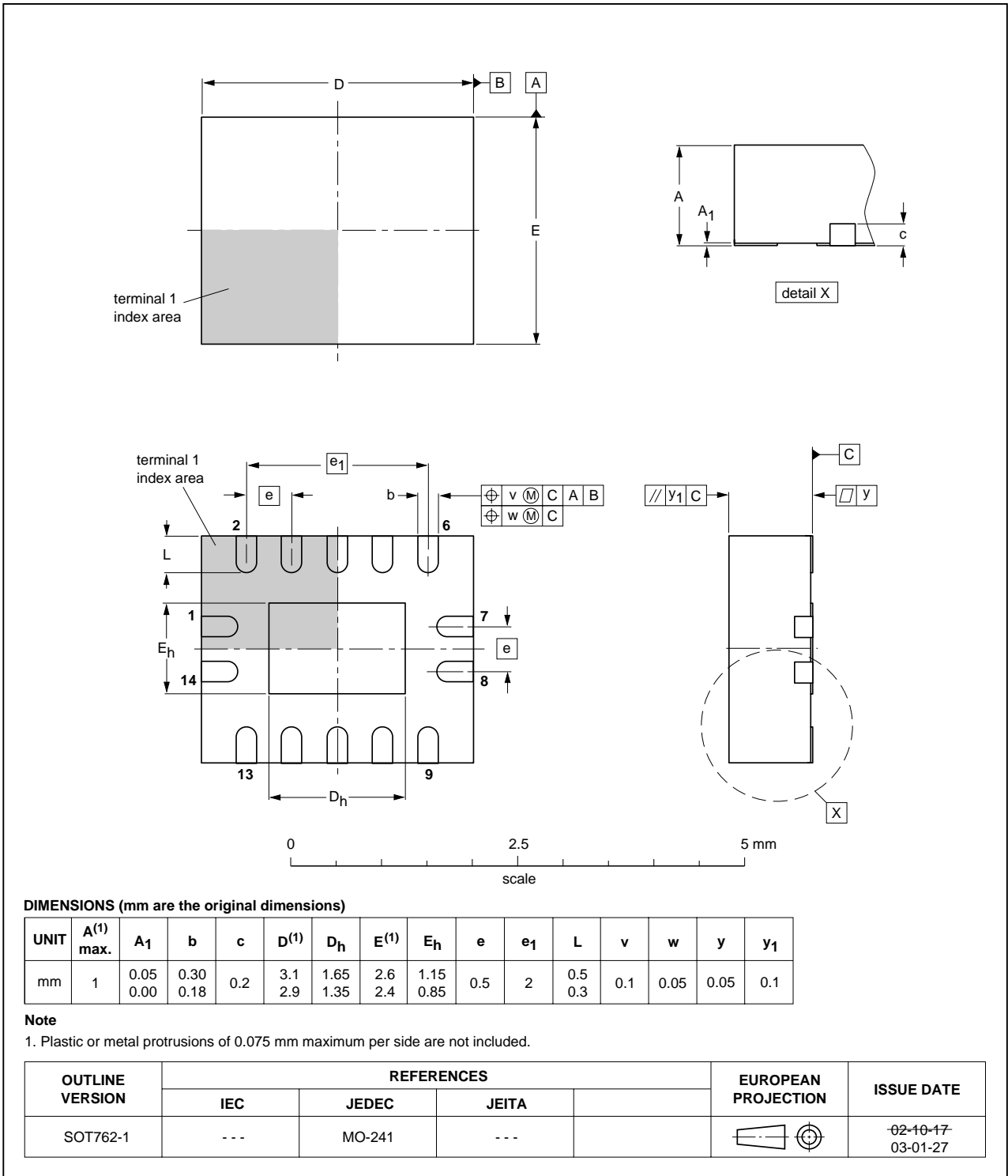


Fig 10. Package outline SOT762-1 (DHVQFN14)

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: | • Added type numbers 74HC05PW (TSSOP14 package) and 74HC05BQ (DHVQFN14 package) | | | |
| 74HC05_1 | 20090427 | Product data sheet | - | - |

15. Legal information

15.1 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. |
| 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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