

# 74VHC02; 74VHCT02

## Quad 2-input NOR gate

Rev. 01 — 13 August 2009

Product data sheet

## 1. General description

The 74VHC02; 74VHCT02 are high-speed Si-gate CMOS devices and are pin compatible with Low-power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard No. 7-A.

The 74VHC02; 74VHCT02 provide a quad 2-input NOR function.

## 2. Features

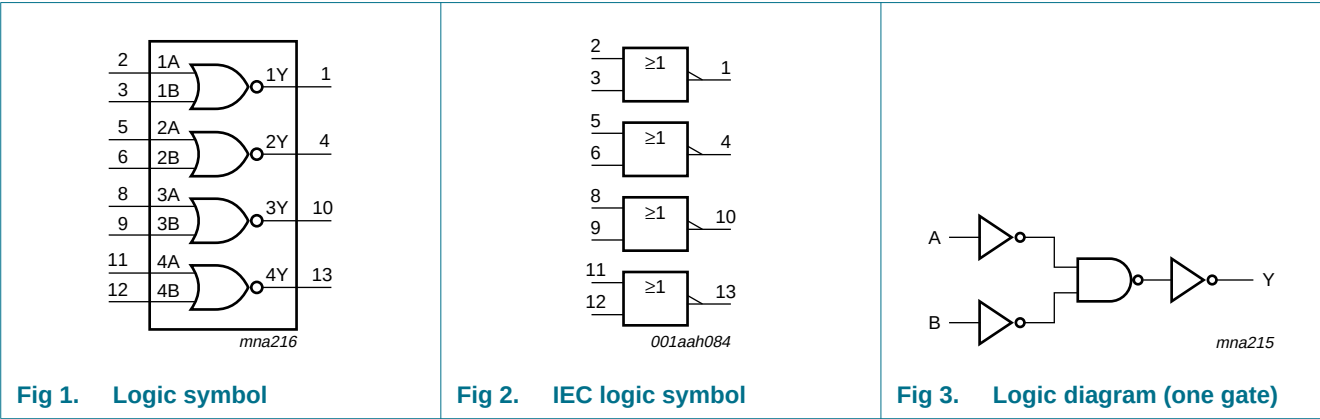
- Balanced propagation delays
- All inputs have a Schmitt-trigger action
- Inputs accept voltages higher than  $V_{CC}$
- Input levels:
  - ◆ The 74VHC02 operates with CMOS input level
  - ◆ The 74VHCT02 operates with TTL input level
- ESD protection:
  - ◆ HBM JESD22-A114E exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 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

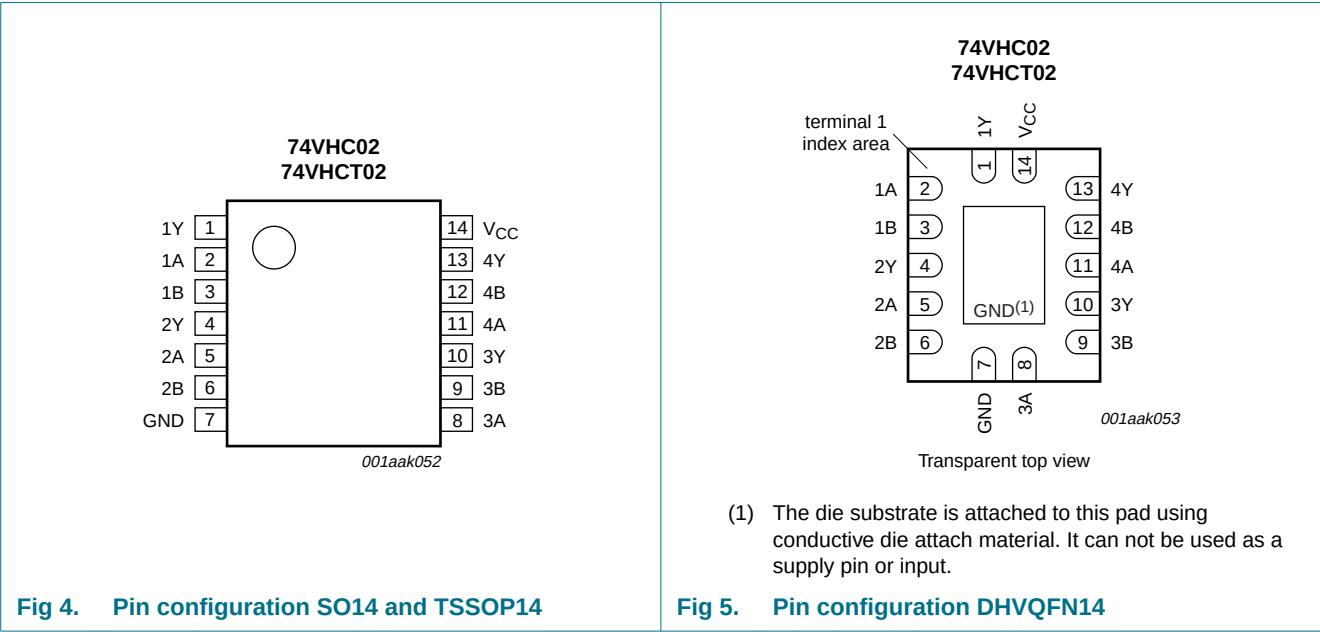
| Type number             | Package                                                         |          |                                                                                                                                                       |          |
|-------------------------|-----------------------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|                         | Temperature range                                               | Name     | Description                                                                                                                                           | Version  |
| 74VHC02D<br>74VHCT02D   | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SO14     | plastic small outline package; 14 leads;<br>body width 3.9 mm                                                                                         | SOT108-1 |
| 74VHC02PW<br>74VHCT02PW | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | TSSOP14  | plastic thin shrink small outline package; 14 leads;<br>body width 4.4 mm                                                                             | SOT402-1 |
| 74VHC02BQ<br>74VHCT02BQ | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | DHVQFN14 | plastic dual in-line compatible thermal enhanced very<br>thin quad flat package; no leads; 14 terminals;<br>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    |
|-----------------|-----|----------------|
| 1Y              | 1   | data output    |
| 1A              | 2   | data input     |
| 1B              | 3   | data input     |
| 2Y              | 4   | data output    |
| 2A              | 5   | data input     |
| 2B              | 6   | data input     |
| GND             | 7   | ground (0 V)   |
| 3A              | 8   | data input     |
| 3B              | 9   | data input     |
| 3Y              | 10  | data output    |
| 4A              | 11  | data input     |
| 4B              | 12  | data input     |
| 4Y              | 13  | data output    |
| V <sub>CC</sub> | 14  | supply voltage |

## 6. Functional description

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

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

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

## 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    | +7.0 | V    |
| $V_I$     | input voltage           |                                          | -0.5    | +7.0 | V    |
| $I_{IK}$  | input clamping current  | $V_I < -0.5$ V                           | [1] -20 | -    | mA   |
| $I_{OK}$  | output clamping current | $V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V | [1] -20 | +20  | mA   |
| $I_O$     | output current          | $V_O = -0.5$ V to $(V_{CC} + 0.5$ V)     | -25     | +25  | mA   |
| $I_{CC}$  | supply current          |                                          | -       | +75  | mA   |
| $I_{GND}$ | ground current          |                                          | -75     | -    | mA   |
| $T_{stg}$ | storage temperature     |                                          | -65     | +150 | °C   |
| $P_{tot}$ | total power dissipation | $T_{amb} = -40$ °C to +125 °C            | [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 packages: above 70 °C the value of  $P_{tot}$  derates linearly at 8 mW/K.

For TSSOP14 packages: above 60 °C the value of  $P_{tot}$  derates linearly at 5.5 mW/K.

For DHVQFN14 packages: above 60 °C the value of  $P_{tot}$  derates linearly at 4.5 mW/K.

## 8. Recommended operating conditions

**Table 5. Operating conditions**

| Symbol              | Parameter                           | Conditions                | Min | Typ | Max      | Unit |
|---------------------|-------------------------------------|---------------------------|-----|-----|----------|------|
| <b>74VHC02</b>      |                                     |                           |     |     |          |      |
| $V_{CC}$            | supply voltage                      |                           | 2.0 | 5.0 | 5.5      | V    |
| $V_I$               | input voltage                       |                           | 0   | -   | 5.5      | 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 | $V_{CC} = 3.0$ V to 3.6 V | -   | -   | 100      | ns/V |
|                     |                                     | $V_{CC} = 4.5$ V to 5.5 V | -   | -   | 20       | ns/V |
| <b>74VHCT02</b>     |                                     |                           |     |     |          |      |
| $V_{CC}$            | supply voltage                      |                           | 4.5 | 5.0 | 5.5      | V    |
| $V_I$               | input voltage                       |                           | 0   | -   | 5.5      | 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 | $V_{CC} = 4.5$ V to 5.5 V | -   | -   | 20       | 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  |      |
| 74VHC02         |                           |                                                                                           |       |     |      |                  |      |                   |      |      |
| V <sub>IH</sub> | HIGH-level input voltage  | V <sub>CC</sub> = 2.0 V                                                                   | 1.5   | -   | -    | 1.5              | -    | 1.5               | -    | V    |
|                 |                           | V <sub>CC</sub> = 3.0 V                                                                   | 2.1   | -   | -    | 2.1              | -    | 2.1               | -    | V    |
|                 |                           | V <sub>CC</sub> = 5.5 V                                                                   | 3.85  | -   | -    | 3.85             | -    | 3.85              | -    | V    |
| V <sub>IL</sub> | LOW-level input voltage   | V <sub>CC</sub> = 2.0 V                                                                   | -     | -   | 0.5  | -                | 0.5  | -                 | 0.5  | V    |
|                 |                           | V <sub>CC</sub> = 3.0 V                                                                   | -     | -   | 0.9  | -                | 0.9  | -                 | 0.9  | V    |
|                 |                           | V <sub>CC</sub> = 5.5 V                                                                   | -     | -   | 1.65 | -                | 1.65 | -                 | 1.65 | V    |
| V <sub>OH</sub> | HIGH-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                       |       |     |      |                  |      |                   |      |      |
|                 |                           | I <sub>O</sub> = –50 µA; V <sub>CC</sub> = 2.0 V                                          | 1.9   | 2.0 | -    | 1.9              | -    | 1.9               | -    | V    |
|                 |                           | I <sub>O</sub> = –50 µA; V <sub>CC</sub> = 3.0 V                                          | 2.9   | 3.0 | -    | 2.9              | -    | 2.9               | -    | V    |
|                 |                           | I <sub>O</sub> = –50 µA; V <sub>CC</sub> = 4.5 V                                          | 4.4   | 4.5 | -    | 4.4              | -    | 4.4               | -    | V    |
|                 |                           | I <sub>O</sub> = –4.0 mA; V <sub>CC</sub> = 3.0 V                                         | 2.58  | -   | -    | 2.48             | -    | 2.40              | -    | V    |
|                 |                           | I <sub>O</sub> = –8.0 mA; V <sub>CC</sub> = 4.5 V                                         | 3.94  | -   | -    | 3.80             | -    | 3.70              | -    | V    |
| 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> = 50 µA; V <sub>CC</sub> = 2.0 V                                           | -     | 0   | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 50 µA; V <sub>CC</sub> = 3.0 V                                           | -     | 0   | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 50 µA; V <sub>CC</sub> = 4.5 V                                           | -     | 0   | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 3.0 V                                          | -     | -   | 0.36 | -                | 0.44 | -                 | 0.55 | V    |
|                 |                           | I <sub>O</sub> = 8.0 mA; V <sub>CC</sub> = 4.5 V                                          | -     | -   | 0.36 | -                | 0.44 | -                 | 0.55 | V    |
| I <sub>I</sub>  | input leakage current     | V <sub>I</sub> = 5.5 V or GND;<br>V <sub>CC</sub> = 0 V to 5.5 V                          | -     | -   | 0.1  | -                | 1.0  | -                 | 2.0  | 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> = 5.5 V | -     | -   | 2.0  | -                | 20   | -                 | 40   | µA   |
| C <sub>I</sub>  | input capacitance         |                                                                                           | -     | 3   | 10   | -                | 10   | -                 | 10   | pF   |

**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  |      |
| 74VHCT02         |                           |                                                                                                                                                                |       |     |      |                  |      |                   |      |      |
| V <sub>IH</sub>  | HIGH-level input voltage  | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                                                                               | 2.0   | -   | -    | 2.0              | -    | 2.0               | -    | V    |
| V <sub>IL</sub>  | LOW-level input voltage   | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                                                                               | -     | -   | 0.8  | -                | 0.8  | -                 | 0.8  | V    |
| V <sub>OH</sub>  | HIGH-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V                                                                                  |       |     |      |                  |      |                   |      |      |
|                  |                           | I <sub>O</sub> = –50 µA                                                                                                                                        | 4.4   | 4.5 | -    | 4.4              | -    | 4.4               | -    | V    |
|                  |                           | I <sub>O</sub> = –8.0 mA                                                                                                                                       | 3.94  | -   | -    | 3.80             | -    | 3.70              | -    | V    |
| V <sub>OL</sub>  | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V                                                                                  |       |     |      |                  |      |                   |      |      |
|                  |                           | I <sub>O</sub> = 50 µA                                                                                                                                         | -     | 0   | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                  |                           | I <sub>O</sub> = 8.0 mA                                                                                                                                        | -     | -   | 0.36 | -                | 0.44 | -                 | 0.55 | V    |
| I <sub>I</sub>   | input leakage current     | V <sub>I</sub> = 5.5 V or GND;<br>V <sub>CC</sub> = 0 V to 5.5 V                                                                                               | -     | -   | 0.1  | -                | 1.0  | -                 | 2.0  | 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> = 5.5 V                                                                      | -     | -   | 2.0  | -                | 20   | -                 | 40   | µA   |
| ΔI <sub>CC</sub> | additional supply current | per input pin;<br>V <sub>I</sub> = V <sub>CC</sub> – 2.1 V;<br>other pins at V <sub>CC</sub> or GND;<br>I <sub>O</sub> = 0 A; V <sub>CC</sub> = 4.5 V to 5.5 V | -     | -   | 1.35 | -                | 1.5  | -                 | 1.5  | mA   |
| C <sub>I</sub>   | input capacitance         |                                                                                                                                                                | -     | 3   | 10   | -                | 10   | -                 | 10   | pF   |

## 10. Dynamic characteristics

**Table 7.** Dynamic characteristicsVoltages are referenced to GND (ground = 0 V); for test circuit see [Figure 7](#).

| Symbol          | Parameter                     | Conditions                                                                                             | 25 °C |                    |      | −40 °C to +85 °C |     | −40 °C to +125 °C |      | Unit |
|-----------------|-------------------------------|--------------------------------------------------------------------------------------------------------|-------|--------------------|------|------------------|-----|-------------------|------|------|
|                 |                               |                                                                                                        | Min   | Typ <sup>[1]</sup> | Max  | Min              | Max | Min               | Max  |      |
| 74VHC02         |                               |                                                                                                        |       |                    |      |                  |     |                   |      |      |
| t <sub>pd</sub> | propagation delay             | nA, nB to nY; see <a href="#">Figure 6</a> <sup>[2]</sup>                                              |       |                    |      |                  |     |                   |      |      |
|                 |                               | V <sub>CC</sub> = 3.0 V to 3.6 V                                                                       |       |                    |      |                  |     |                   |      |      |
|                 |                               | C <sub>L</sub> = 15 pF                                                                                 | -     | 3.9                | 7.9  | 1.0              | 9.5 | 1.0               | 10.0 | ns   |
|                 |                               | C <sub>L</sub> = 50 pF                                                                                 | -     | 5.5                | 11.4 | 1.0              | 13  | 1.0               | 14.5 | ns   |
|                 |                               | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                       |       |                    |      |                  |     |                   |      |      |
|                 |                               | C <sub>L</sub> = 15 pF                                                                                 | -     | 2.9                | 5.5  | 1.0              | 6.5 | 1.0               | 7.0  | ns   |
|                 |                               | C <sub>L</sub> = 50 pF                                                                                 |       | 4.2                | 7.5  | 1.0              | 8.5 | 1.0               | 9.5  | ns   |
| C <sub>PD</sub> | power dissipation capacitance | C <sub>L</sub> = 50 pF; f <sub>i</sub> = 1 MHz; V <sub>I</sub> = GND to V <sub>CC</sub> <sup>[3]</sup> | -     | 7.0                | -    | -                | -   | -                 | -    | pF   |

Table 7. Dynamic characteristics ...continued  
Voltages are referenced to GND (ground = 0 V); for test circuit see Figure 7.

| Symbol                                     | Parameter                     | Conditions                                                                                             | 25 °C |                    |     | −40 °C to +85 °C |     | −40 °C to +125 °C |     | Unit |
|--------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------|-------|--------------------|-----|------------------|-----|-------------------|-----|------|
|                                            |                               |                                                                                                        | Min   | Typ <sup>[1]</sup> | Max | Min              | Max | Min               | Max |      |
| 74VHCT02; V <sub>CC</sub> = 4.5 V to 5.5 V |                               |                                                                                                        |       |                    |     |                  |     |                   |     |      |
| t <sub>pd</sub>                            | propagation delay             | nA, nB to nY; see <a href="#">Figure 6</a> <sup>[2]</sup>                                              |       |                    |     |                  |     |                   |     |      |
|                                            |                               | C <sub>L</sub> = 15 pF                                                                                 | -     | 3.8                | 5.5 | 1.0              | 6.5 | 1.0               | 7.0 | ns   |
|                                            |                               | C <sub>L</sub> = 50 pF                                                                                 | -     | 5.1                | 7.5 | 1.0              | 8.5 | 1.0               | 9.5 | ns   |
| C <sub>PD</sub>                            | power dissipation capacitance | C <sub>L</sub> = 50 pF; f <sub>i</sub> = 1 MHz; V <sub>I</sub> = GND to V <sub>CC</sub> <sup>[3]</sup> | -     | 8.0                | -   | -                | -   | -                 | -   | pF   |

- [1] Typical values are measured at nominal supply voltage (V<sub>CC</sub> = 3.3 V and V<sub>CC</sub> = 5.0 V).
- [2] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.
- [3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).  
P<sub>D</sub> = C<sub>PD</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>i</sub> × N + Σ(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) where:  
f<sub>i</sub> = input frequency in MHz;  
f<sub>o</sub> = output frequency in MHz;  
C<sub>L</sub> = output load capacitance in pF;  
V<sub>CC</sub> = supply voltage in V;  
N = number of inputs switching;  
Σ(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of the outputs.

11. Waveforms

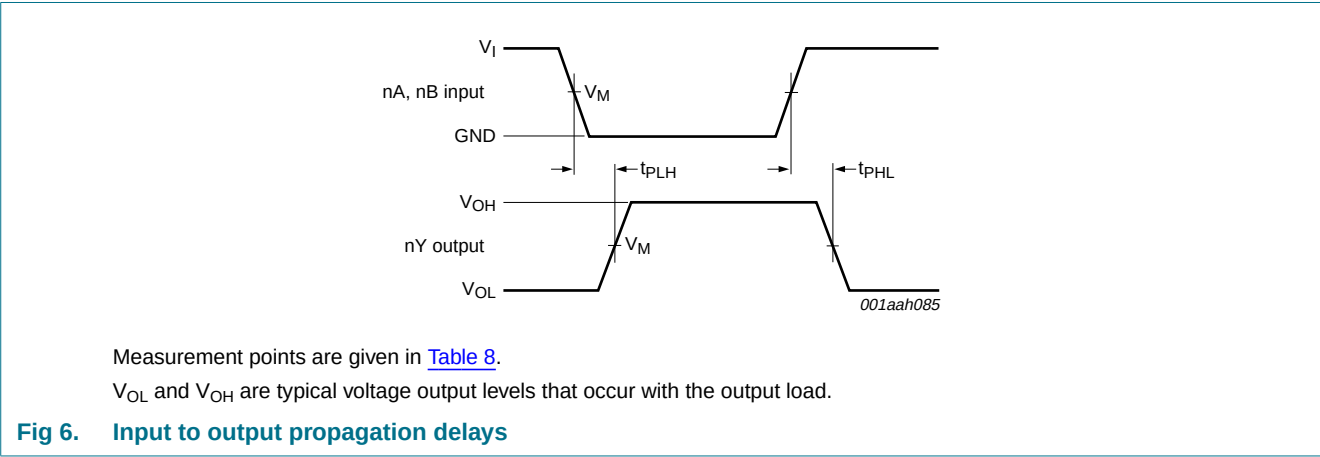
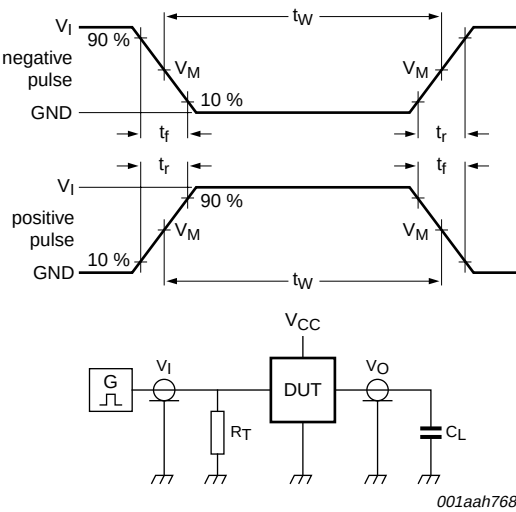


Table 8. Measurement points

| Type     | Input              | Output             |
|----------|--------------------|--------------------|
|          | V <sub>M</sub>     | V <sub>M</sub>     |
| 74VHC02  | 0.5V <sub>CC</sub> | 0.5V <sub>CC</sub> |
| 74VHCT02 | 1.5 V              | 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.

Fig 7. Load circuitry for measuring switching times

Table 9. Test data

| Type     | Input    |                       | Load         | Test               |
|----------|----------|-----------------------|--------------|--------------------|
|          | $V_I$    | $t_r, t_f$            | $C_L$        |                    |
| 74VHC02  | $V_{CC}$ | $\leq 3.0 \text{ ns}$ | 15 pF, 50 pF | $t_{PLH}, t_{PHL}$ |
| 74VHCT02 | 3.0 V    | $\leq 3.0 \text{ ns}$ | 15 pF, 50 pF | $t_{PLH}, t_{PHL}$ |



12. Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm SOT108-1

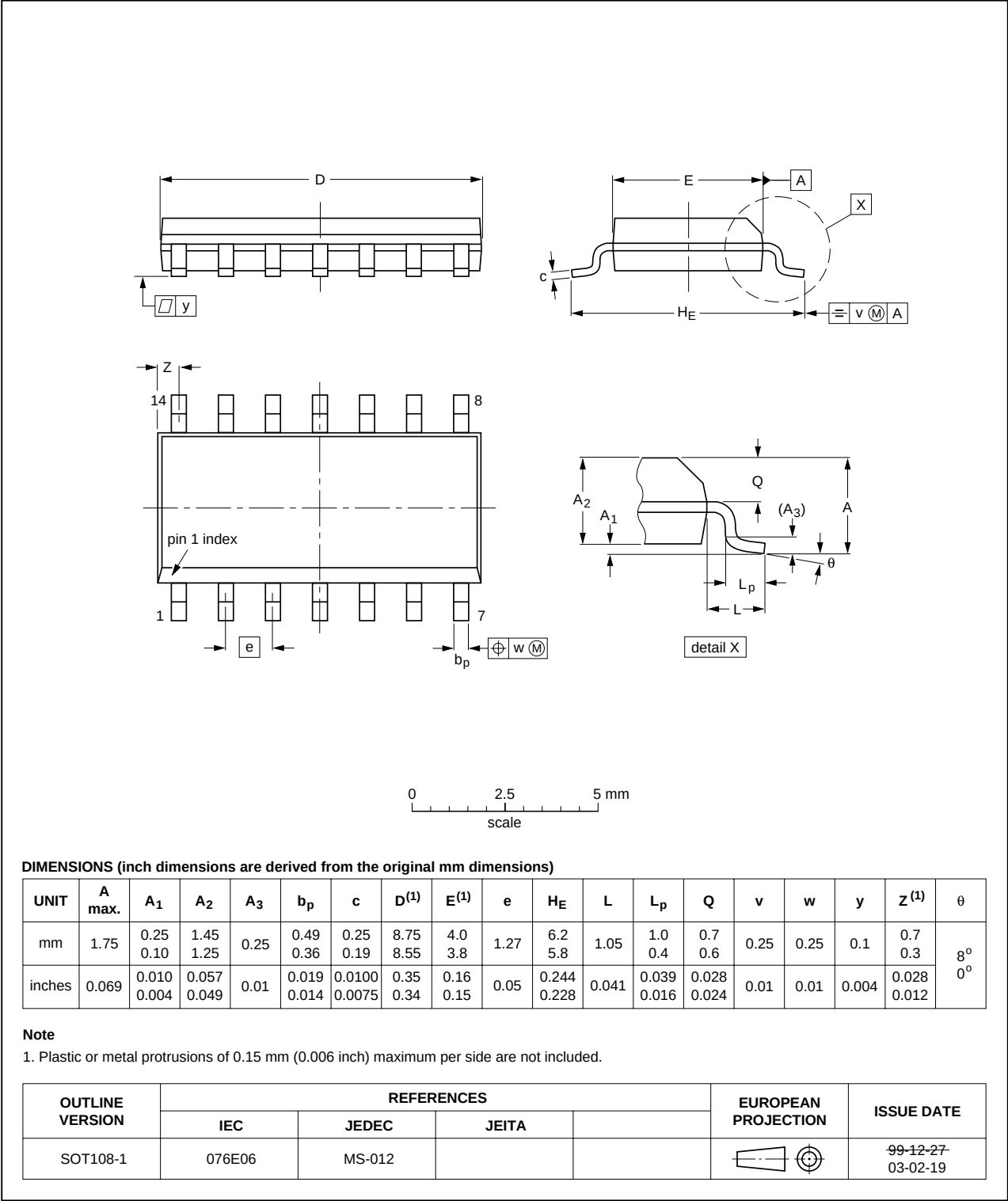


Fig 8. Package outline SOT108-1 (SO14)

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

SOT402-1

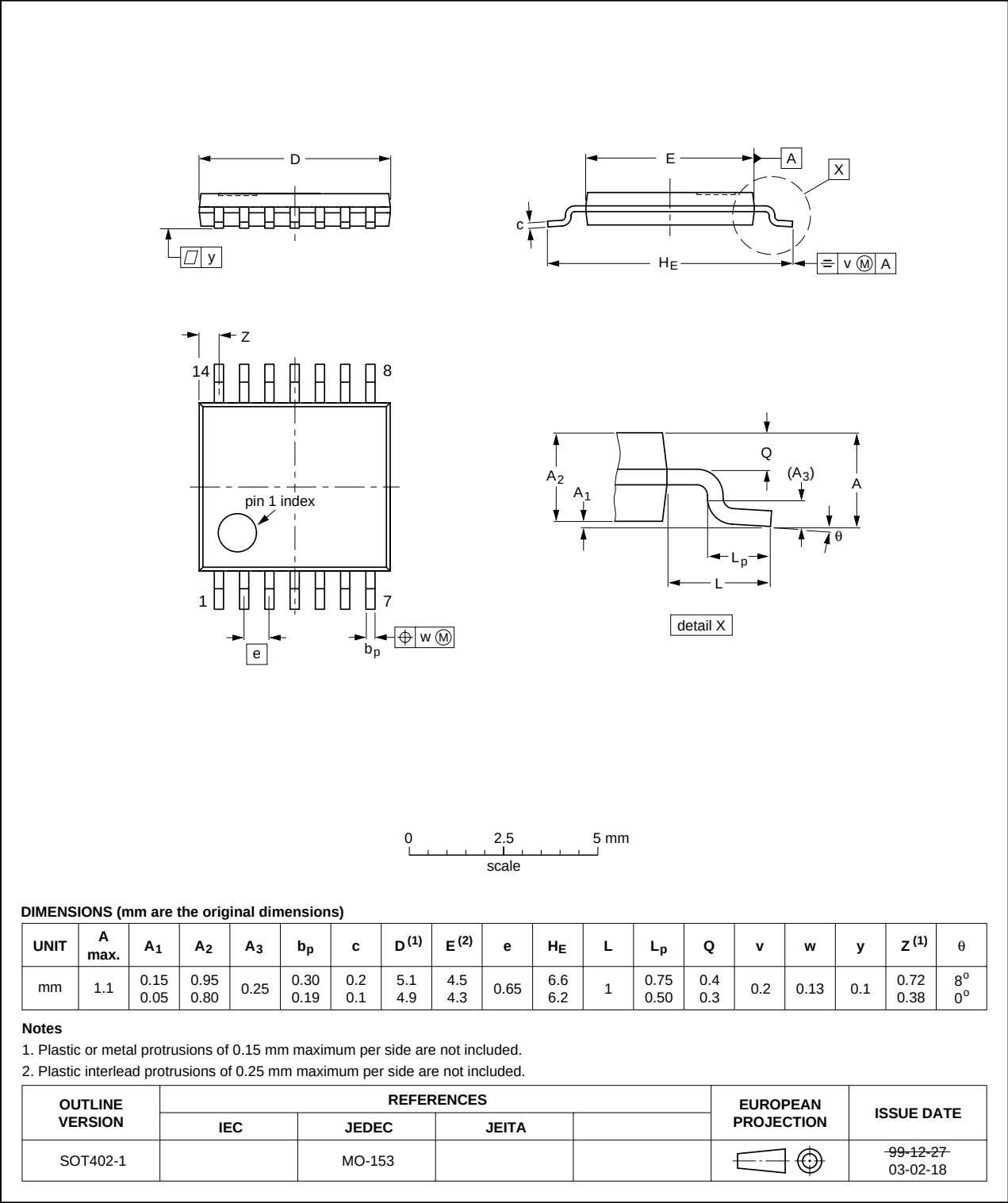


Fig 9. Package outline SOT402-1 (TSSOP14)

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

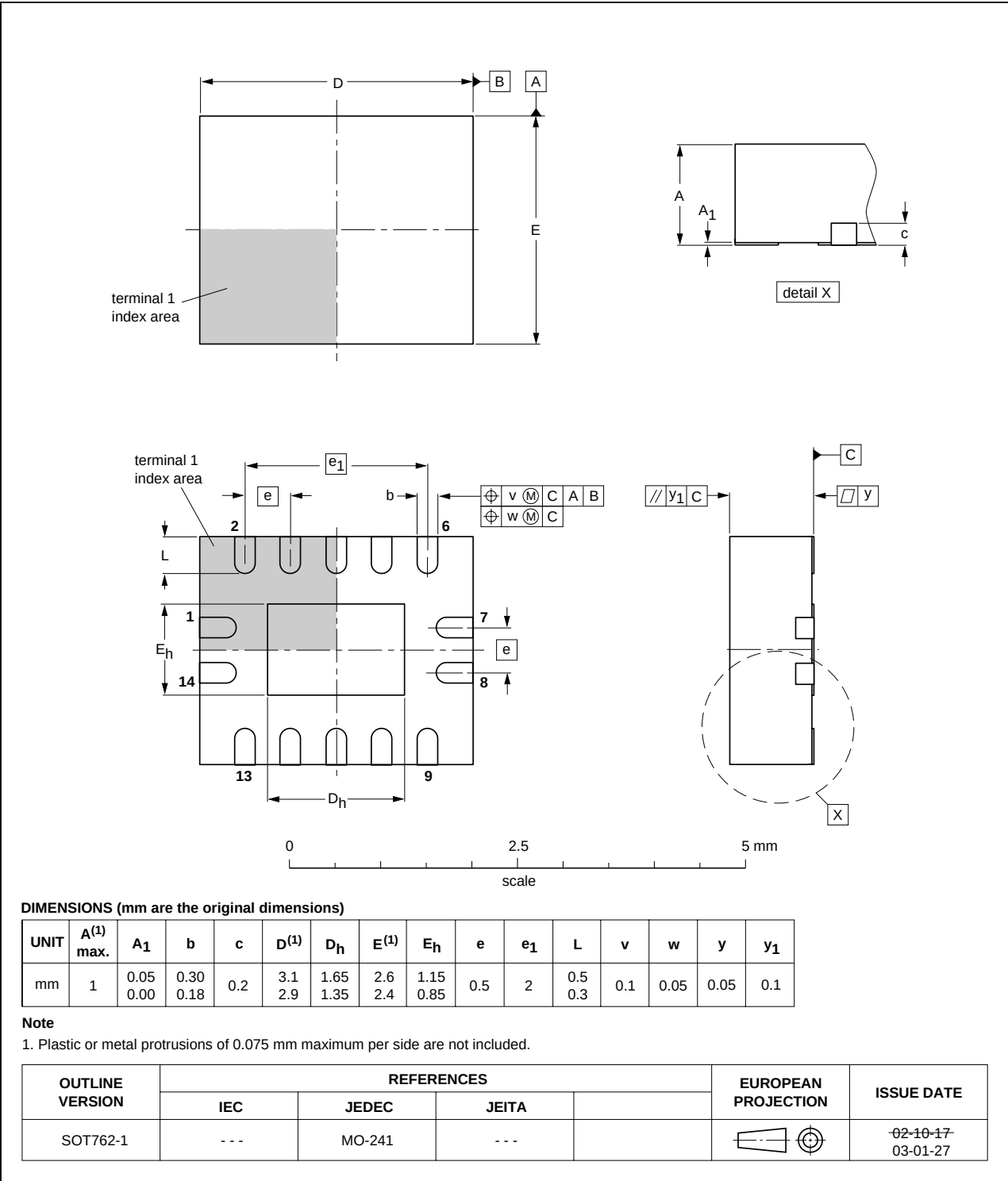


Fig 10. Package outline SOT762-1 (DHVQFN14)

## 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                               |
| LSTTL   | Low-power Schottky Transistor-Transistor Logic |
| MM      | Machine Model                                  |

## 14. Revision history

Table 11. Revision history

| Document ID    | Release date | Data sheet status  | Change notice | Supersedes |
|----------------|--------------|--------------------|---------------|------------|
| 74VHC_VHCT02_1 | 20090813     | 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. |
| 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.nxp.com>.

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