

# 74HC02; 74HCT02

## Quad 2-input NOR gate

Rev. 4 — 4 September 2012

Product data sheet

## 1. General description

The 74HC02; 74HCT02 are high-speed Si-gate CMOS devices that comply with JEDEC standard no. 7A. They are pin compatible with Low-power Schottky TTL (LSTTL).

The 74HC02; 74HCT02 provides a quad 2-input NOR function.

## 2. Features and benefits

- Input levels:
  - ◆ For 74HC02: CMOS level
  - ◆ For 74HCT02: TTL level
- ESD protection:
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from –40 °C to +85 °C and from –40 °C to +125 °C

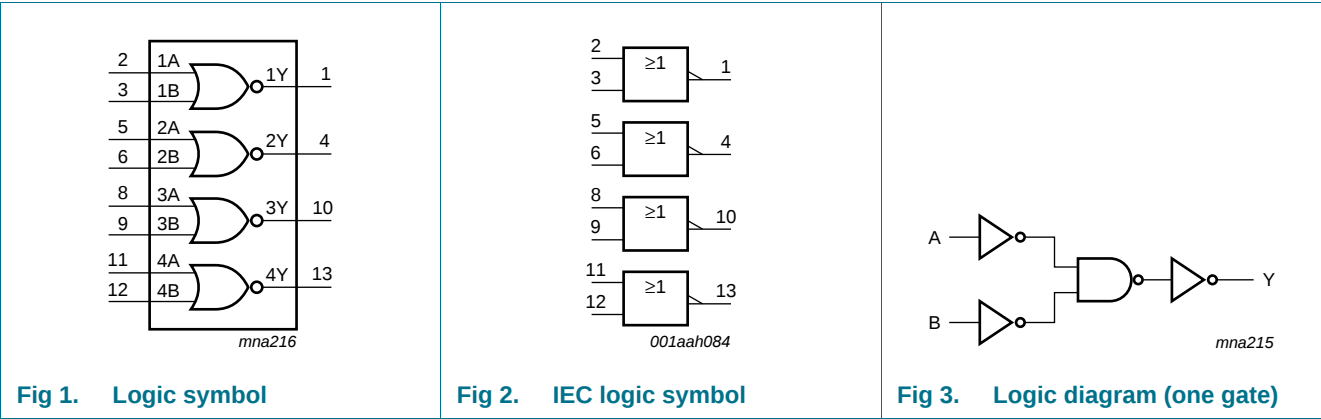
## 3. Ordering information

Table 1. Ordering information

| Type number | Package           |          |                                                                                                                              |          |
|-------------|-------------------|----------|------------------------------------------------------------------------------------------------------------------------------|----------|
|             | Temperature range | Name     | Description                                                                                                                  | Version  |
| 74HC02N     | –40 °C to +125 °C | DIP14    | plastic dual in-line package; 14 leads (300 mil)                                                                             | SOT27-1  |
| 74HCT02N    |                   |          |                                                                                                                              |          |
| 74HC02D     | –40 °C to +125 °C | SO14     | plastic small outline package; 14 leads; body width 3.9 mm                                                                   | SOT108-1 |
| 74HCT02D    |                   |          |                                                                                                                              |          |
| 74HC02DB    | –40 °C to +125 °C | SSOP14   | plastic shrink small outline package; 14 leads; body width 5.3 mm                                                            | SOT337-1 |
| 74HCT02DB   |                   |          |                                                                                                                              |          |
| 74HC02PW    | –40 °C to +125 °C | TSSOP14  | plastic thin shrink small outline package; 14 leads; body width 4.4 mm                                                       | SOT402-1 |
| 74HCT02PW   |                   |          |                                                                                                                              |          |
| 74HC02BQ    | –40 °C to +125 °C | DHVQFN14 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 × 3 × 0.85 mm | SOT762-1 |
| 74HCT02BQ   |                   |          |                                                                                                                              |          |

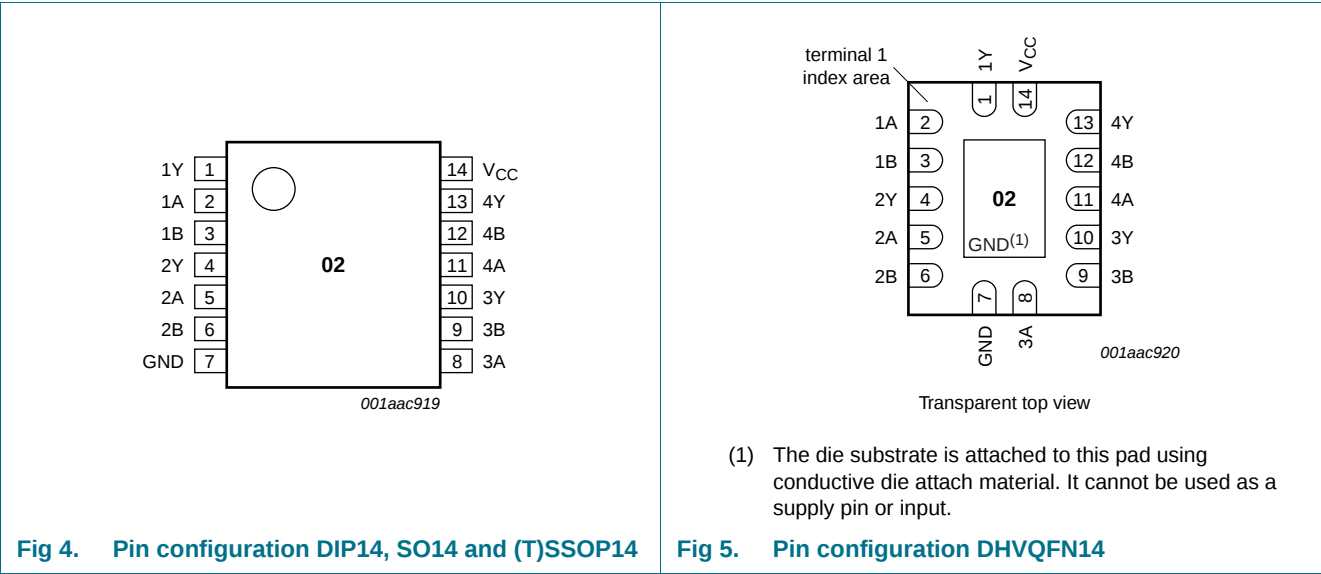


4. Functional diagram



5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

| Symbol          | Pin          | Description    |
|-----------------|--------------|----------------|
| 1Y to 4Y        | 1, 4, 10, 13 | data output    |
| 1A to 4A        | 2, 5, 8, 11  | data input     |
| 1B to 4B        | 3, 6, 9,12   | data input     |
| 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    | 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 <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   |
| I <sub>O</sub>   | output current                           | -0.5 V < V <sub>O</sub> < 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                  |                                                                     | <sup>[2]</sup>   |      |      |
|                  | DIP14 package                            |                                                                     | -                | 750  | mW   |
|                  | SO14, (T)SSOP14 and<br>DHVQFN14 packages |                                                                     | -                | 500  | mW   |

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

- [2] For DIP14 package: P<sub>tot</sub> derates linearly with 12 mW/K above 70 °C.  
For SO14 package: P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.  
For (T)SSOP14 packages: P<sub>tot</sub> derates linearly with 5.5 mW/K above 60 °C.  
For DHVQFN14 packages: P<sub>tot</sub> 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 | 74HC02 |     |                 | 74HCT02 |     |                 | Unit |
|------------------|---------------------|------------|--------|-----|-----------------|---------|-----|-----------------|------|
|                  |                     |            | Min    | Typ | Max             | Min     | Typ | Max             |      |
| V <sub>CC</sub>  | supply voltage      |            | 2.0    | 5.0 | 6.0             | 4.5     | 5.0 | 5.5             | V    |
| V <sub>I</sub>   | input voltage       |            | 0      | -   | V <sub>CC</sub> | 0       | -   | V <sub>CC</sub> | V    |
| V <sub>O</sub>   | output voltage      |            | 0      | -   | V <sub>CC</sub> | 0       | -   | V <sub>CC</sub> | V    |
| T <sub>amb</sub> | ambient temperature |            | -40    | -   | +125            | -40     | -   | +125            | °C   |

**Table 5. Recommended operating conditions ...continued**

Voltages are referenced to GND (ground = 0 V) ...continued

| Symbol              | Parameter                           | Conditions              | 74HC02 |      |     | 74HCT02 |      |     | Unit |
|---------------------|-------------------------------------|-------------------------|--------|------|-----|---------|------|-----|------|
|                     |                                     |                         | Min    | Typ  | Max | Min     | Typ  | Max |      |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.0\text{ V}$ | -      | -    | 625 | -       | -    | -   | ns/V |
|                     |                                     | $V_{CC} = 4.5\text{ V}$ | -      | 1.67 | 139 | -       | 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  |      |
| 74HC02          |                           |                                                                                        |       |      |      |                  |      |                   |      |      |
| V <sub>IH</sub> | HIGH-level input voltage  | V <sub>CC</sub> = 2.0 V                                                                | 1.5   | 1.2  | -    | 1.5              | -    | 1.5               | -    | V    |
|                 |                           | V <sub>CC</sub> = 4.5 V                                                                | 3.15  | 2.4  | -    | 3.15             | -    | 3.15              | -    | V    |
|                 |                           | V <sub>CC</sub> = 6.0 V                                                                | 4.2   | 3.2  | -    | 4.2              | -    | 4.2               | -    | V    |
| V <sub>IL</sub> | LOW-level input voltage   | V <sub>CC</sub> = 2.0 V                                                                | -     | 0.8  | 0.5  | -                | 0.5  | -                 | 0.5  | V    |
|                 |                           | V <sub>CC</sub> = 4.5 V                                                                | -     | 2.1  | 1.35 | -                | 1.35 | -                 | 1.35 | V    |
|                 |                           | V <sub>CC</sub> = 6.0 V                                                                | -     | 2.8  | 1.8  | -                | 1.8  | -                 | 1.8  | 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> = −20 μA; V <sub>CC</sub> = 2.0 V                                       | 1.9   | 2.0  | -    | 1.9              | -    | 1.9               | -    | V    |
|                 |                           | I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 4.5 V                                       | 4.4   | 4.5  | -    | 4.4              | -    | 4.4               | -    | V    |
|                 |                           | I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 6.0 V                                       | 5.9   | 6.0  | -    | 5.9              | -    | 5.9               | -    | V    |
|                 |                           | I <sub>O</sub> = −4.0 mA; V <sub>CC</sub> = 4.5 V                                      | 3.98  | 4.32 | -    | 3.84             | -    | 3.7               | -    | V    |
| V <sub>OL</sub> | LOW-level output voltage  | I <sub>O</sub> = −5.2 mA; V <sub>CC</sub> = 6.0 V                                      | 5.48  | 5.81 | -    | 5.34             | -    | 5.2               | -    | V    |
|                 |                           | 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    | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V                                        | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V                                        | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
| I <sub>I</sub>  | input leakage current     | I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V                                       | -     | 0.15 | 0.26 | -                | 0.33 | -                 | 0.4  | V    |
|                 |                           | I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V                                       | -     | 0.16 | 0.26 | -                | 0.33 | -                 | 0.4  | V    |
| I <sub>CC</sub> | supply current            | V <sub>I</sub> = V <sub>CC</sub> 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   |

**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 |      |
| 74HCT02          |                           |                                                                                                                                                         |       |      |      |                  |      |                   |     |      |
| V <sub>IH</sub>  | HIGH-level input voltage  | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                                                                        | 2.0   | 1.6  | -    | 2.0              | -    | 2.0               | -   | V    |
| V <sub>IL</sub>  | LOW-level input voltage   | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                                                                        | -     | 1.2  | 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> = –20 μA                                                                                                                                 | 4.4   | 4.5  | -    | 4.4              | -    | 4.4               | -   | V    |
|                  |                           | I <sub>O</sub> = –4.0 mA                                                                                                                                | 3.98  | 4.32 | -    | 3.84             | -    | 3.7               | -   | 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> = 20 μA                                                                                                                                  | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1 | V    |
|                  |                           | I <sub>O</sub> = 5.2 mA                                                                                                                                 | -     | 0.15 | 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> = 5.5 V                                                                                        | -     | -    | ±0.1 | -                | ±1   | -                 | ±1  | μA   |
| I <sub>CC</sub>  | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 5.5 V                                                                  | -     | -    | 2.0  | -                | 20   | -                 | 40  | μA   |
| ΔI <sub>CC</sub> | additional supply current | per input pin; V <sub>I</sub> = V <sub>CC</sub> – 2.1 V; I <sub>O</sub> = 0 A; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 4.5 V to 5.5 V | -     | 150  | 540  | -                | 675  | -                 | 735 | μA   |
| C <sub>I</sub>   | input capacitance         |                                                                                                                                                         | -     | 3.5  | -    | -                | -    | -                 | -   | pF   |

## 10. Dynamic characteristics

**Table 7.** Dynamic characteristicsGND = 0 V; C<sub>L</sub> = 50 pF; for load circuit see [Figure 7](#).

| Symbol          | Parameter                     | Conditions                                           | 25 °C               |     |     | –40 °C to +125 °C |              | Unit |
|-----------------|-------------------------------|------------------------------------------------------|---------------------|-----|-----|-------------------|--------------|------|
|                 |                               |                                                      | Min                 | Typ | Max | Max (85 °C)       | Max (125 °C) |      |
| 74HC02          |                               |                                                      |                     |     |     |                   |              |      |
| t <sub>pd</sub> | propagation delay             | nA, nB to nY; see <a href="#">Figure 6</a>           | <a href="#">[1]</a> |     |     |                   |              |      |
|                 |                               | V <sub>CC</sub> = 2.0 V                              | -                   | 25  | 90  | 115               | 135          | ns   |
|                 |                               | V <sub>CC</sub> = 4.5 V                              | -                   | 9   | 18  | 23                | 27           | ns   |
|                 |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF      | -                   | 7   | -   | -                 | -            | ns   |
|                 |                               | V <sub>CC</sub> = 6.0 V                              | -                   | 7   | 15  | 20                | 23           | ns   |
| t <sub>t</sub>  | transition time               | see <a href="#">Figure 6</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   |
| C <sub>PD</sub> | power dissipation capacitance | per package; V <sub>I</sub> = GND to V <sub>CC</sub> | <a href="#">[3]</a> | -   | 22  | -                 | -            | pF   |

**Table 7. Dynamic characteristics**GND = 0 V;  $C_L = 50$  pF; for load circuit see [Figure 7](#).

| Symbol          | Parameter                     | Conditions                                                      | 25 °C               |     |     | −40 °C to +125 °C |              | Unit |    |
|-----------------|-------------------------------|-----------------------------------------------------------------|---------------------|-----|-----|-------------------|--------------|------|----|
|                 |                               |                                                                 | Min                 | Typ | Max | Max (85 °C)       | Max (125 °C) |      |    |
| 74HCT02         |                               |                                                                 |                     |     |     |                   |              |      |    |
| t <sub>pd</sub> | propagation delay             | nA, nB to nY; see <a href="#">Figure 6</a>                      | <a href="#">[1]</a> |     |     |                   |              |      |    |
|                 |                               | V <sub>CC</sub> = 4.5 V                                         | -                   | 11  | 19  | 24                | 29           | ns   |    |
|                 |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF                 | -                   | 9   | -   | -                 | -            | ns   |    |
| t <sub>t</sub>  | transition time               | V <sub>CC</sub> = 4.5 V; see <a href="#">Figure 6</a>           | <a href="#">[2]</a> | -   | 7   | 15                | 19           | 22   | ns |
| C <sub>PD</sub> | power dissipation capacitance | per package;<br>V <sub>I</sub> = GND to V <sub>CC</sub> − 1.5 V | <a href="#">[3]</a> | -   | 24  | -                 | -            | -    | pF |

[1]  $t_{pd}$  is the same as  $t_{PHL}$  and  $t_{PLH}$ .

[2]  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$ .

[3]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ):

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

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

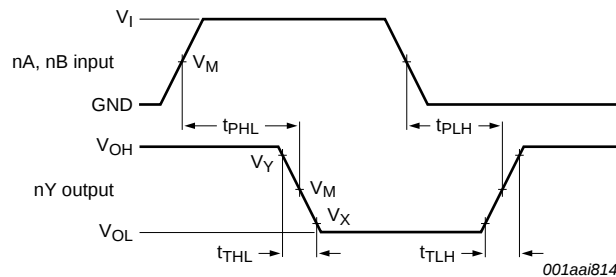
$C_L$  = output load capacitance in pF;

$V_{CC}$  = supply voltage in V;

$N$  = number of inputs switching;

$\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs.

## 11. Waveforms



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

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

**Fig 6. Input to output propagation delays****Table 8. Measurement points**

| Type    | Input       | Output      |             |             |
|---------|-------------|-------------|-------------|-------------|
|         | $V_M$       | $V_M$       | $V_X$       | $V_Y$       |
| 74HC02  | $0.5V_{CC}$ | $0.5V_{CC}$ | $0.1V_{CC}$ | $0.9V_{CC}$ |
| 74HCT02 | 1.3 V       | 1.3 V       | $0.1V_{CC}$ | $0.9V_{CC}$ |



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.

Fig 7. Load circuitry for measuring switching times

Table 9. Test data

| Type    | Input    |            | Load         | Test               |
|---------|----------|------------|--------------|--------------------|
|         | $V_I$    | $t_r, t_f$ | $C_L$        |                    |
| 74HC02  | $V_{CC}$ | 6.0 ns     | 15 pF, 50 pF | $t_{PLH}, t_{PHL}$ |
| 74HCT02 | 3.0 V    | 6.0 ns     | 15 pF, 50 pF | $t_{PLH}, t_{PHL}$ |

12. Package outline

DIP14: plastic dual in-line package; 14 leads (300 mil)

SOT27-1

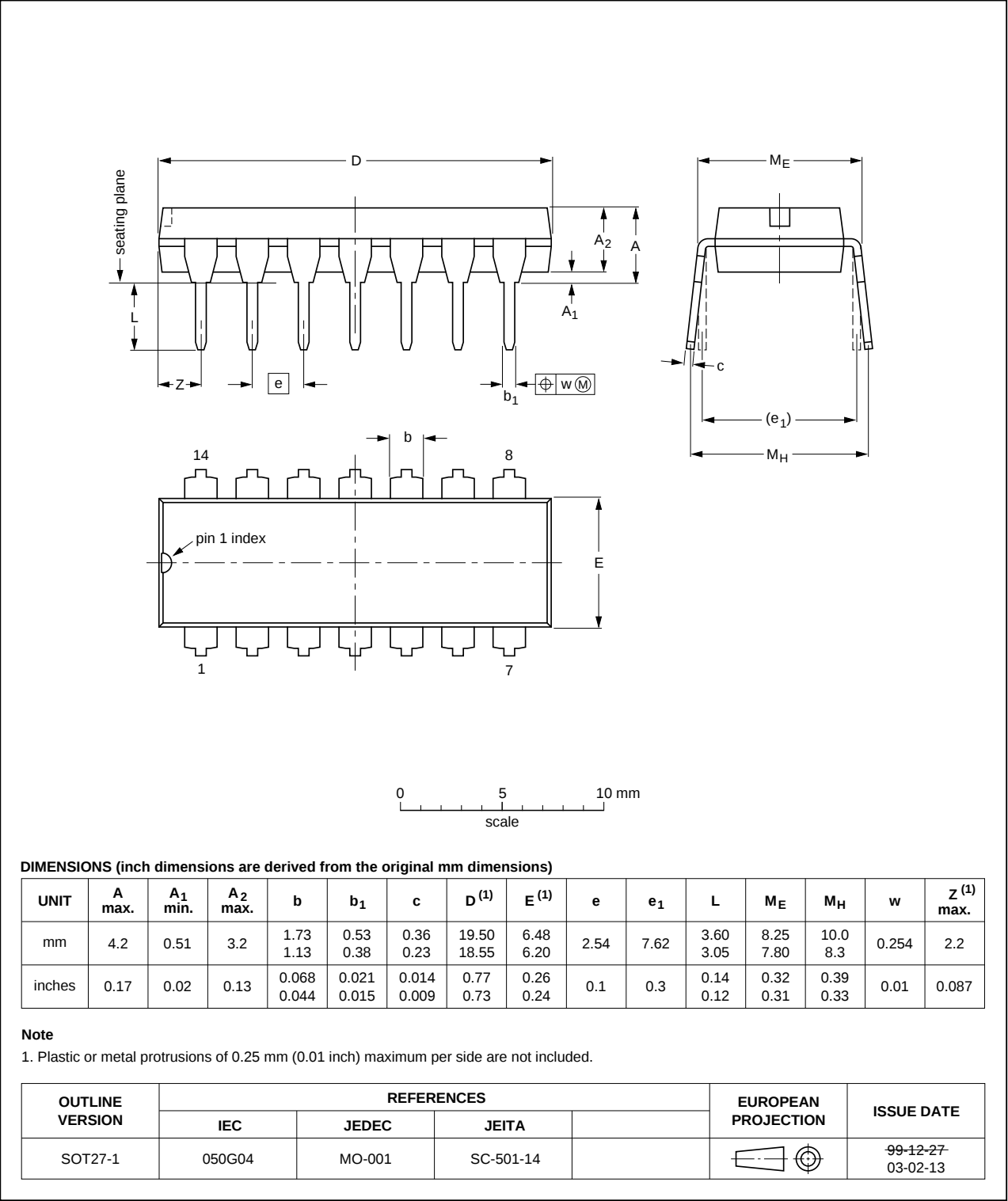


Fig 8. Package outline SOT27-1 (DIP14)

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

SOT108-1

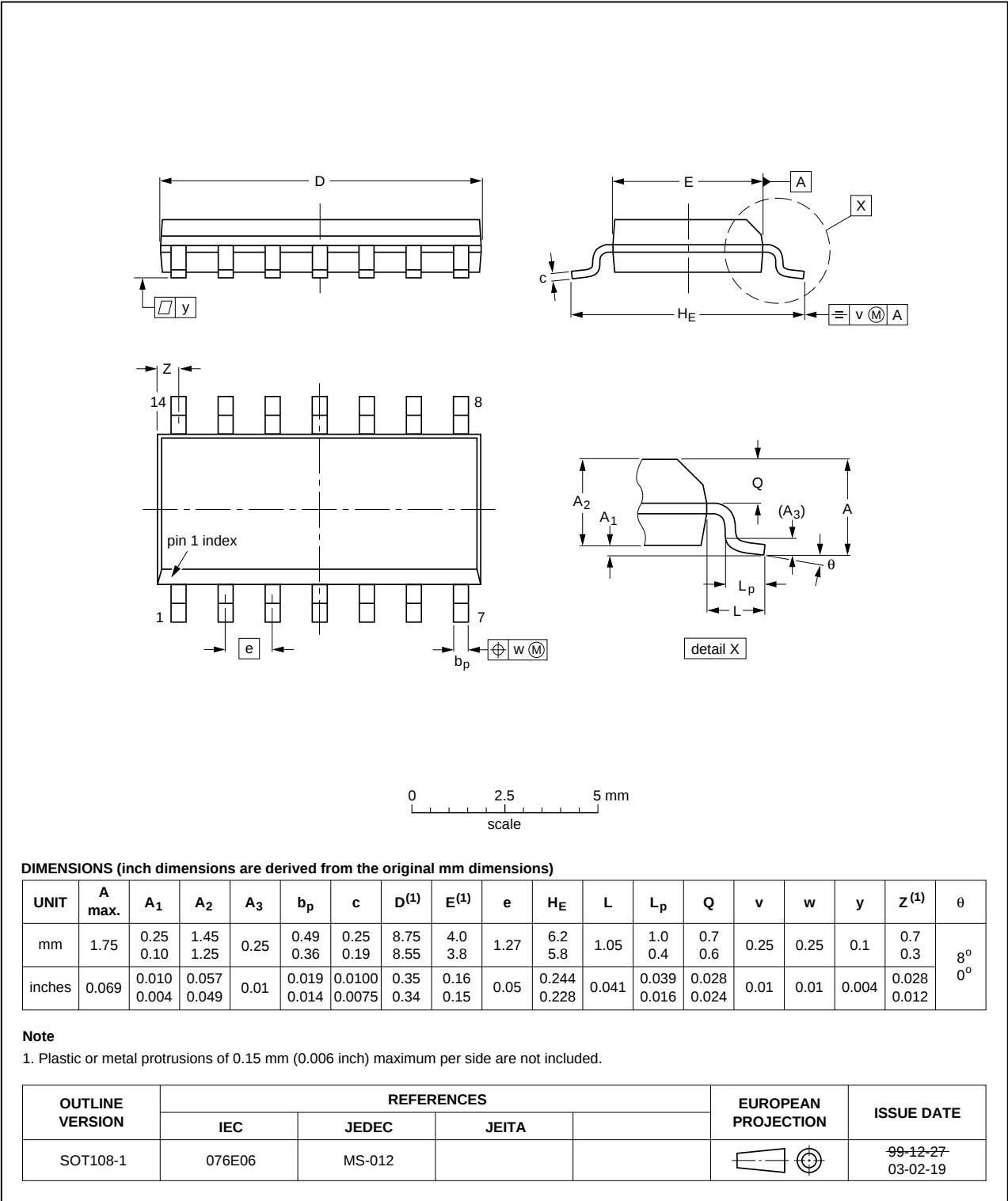


Fig 9. Package outline SOT108-1 (SO14)

SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm

SOT337-1

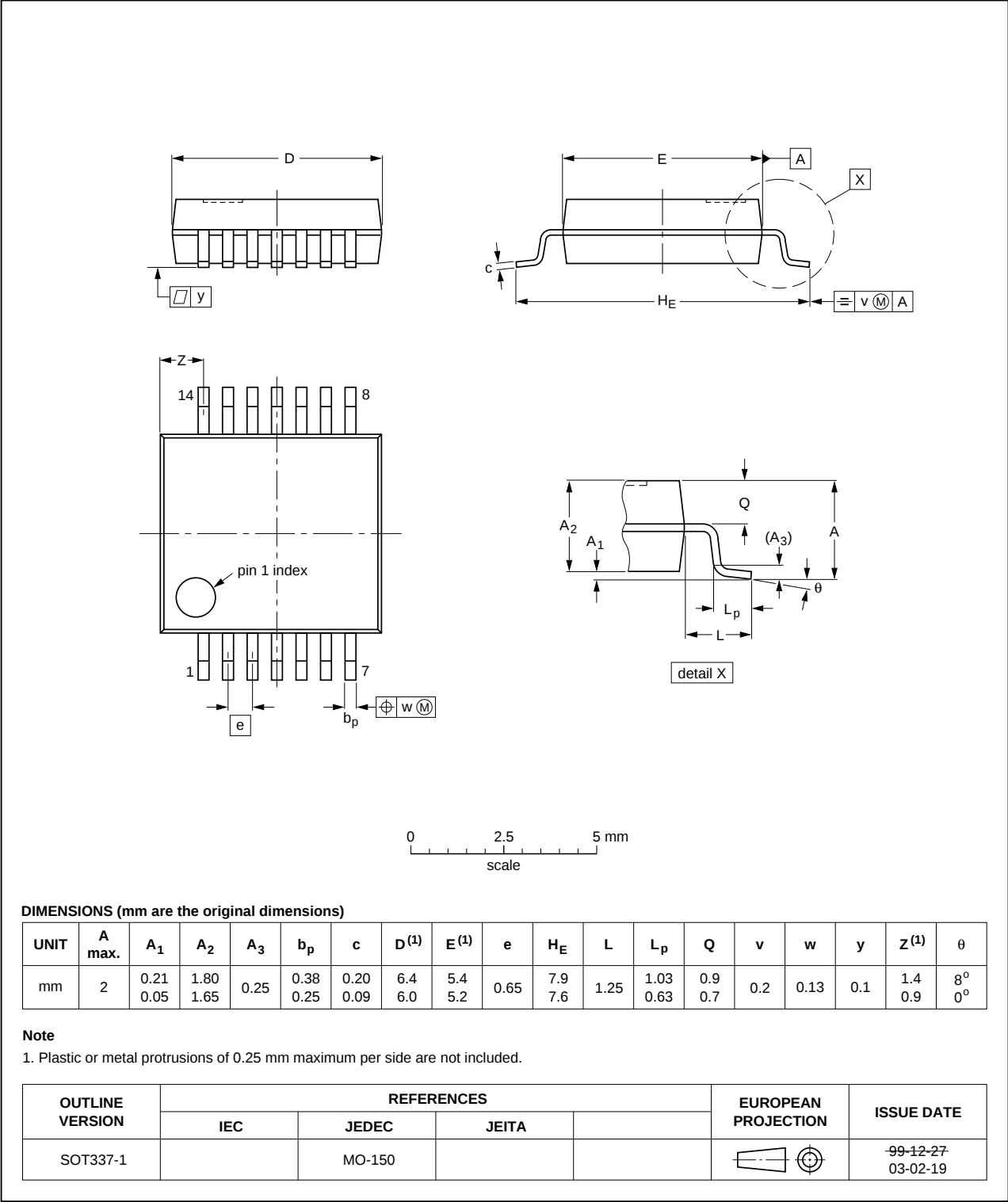


Fig 10. Package outline SOT337-1 (SSOP14)

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

SOT402-1



Fig 11. 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 12. Package outline SOT762-1 (DHVQFN14)

## 13. Abbreviations

Table 10. Abbreviations

| Acronym | Description                                    |
|---------|------------------------------------------------|
| 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                                  |
| TTL     | Transistor-Transistor Logic                    |

## 14. Revision history

Table 11. Revision history

| Document ID        | Release date                                                                                                                                                                                                                                                                                                              | Data sheet status     | Change notice | Supersedes         |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|--------------------|
| 74HC_HCT02 v.4     | 20120904                                                                                                                                                                                                                                                                                                                  | Product data sheet    | -             | 74HC_HCT02 v.3     |
| Modifications:     | <ul style="list-style-type: none"><li>Conditions for <math>V_{OH}</math>, <math>I_I</math> and <math>I_{CC}</math> updated to the family specification (errata).</li></ul>                                                                                                                                                |                       |               |                    |
| 74HC_HCT02 v.3     | 20080918                                                                                                                                                                                                                                                                                                                  | Product data sheet    | -             | 74HC_HCT02_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><li>Added type numbers 74HC02BQ and 74HCT02BQ (DHSVFN14 package)</li></ul> |                       |               |                    |
| 74HC_HCT02_CNV v.2 | 19970827                                                                                                                                                                                                                                                                                                                  | 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.nxp.com>.

### 15.2 Definitions

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For more information, please visit: <http://www.nxp.com>

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