

# 74HC02; 74HCT02

## Quad 2-input NOR gate

Rev. 6 — 7 April 2020

Product data sheet

## 1. General description

The 74HC02; 74HCT02 is a quad 2-input NOR gate. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

## 2. Features and benefits

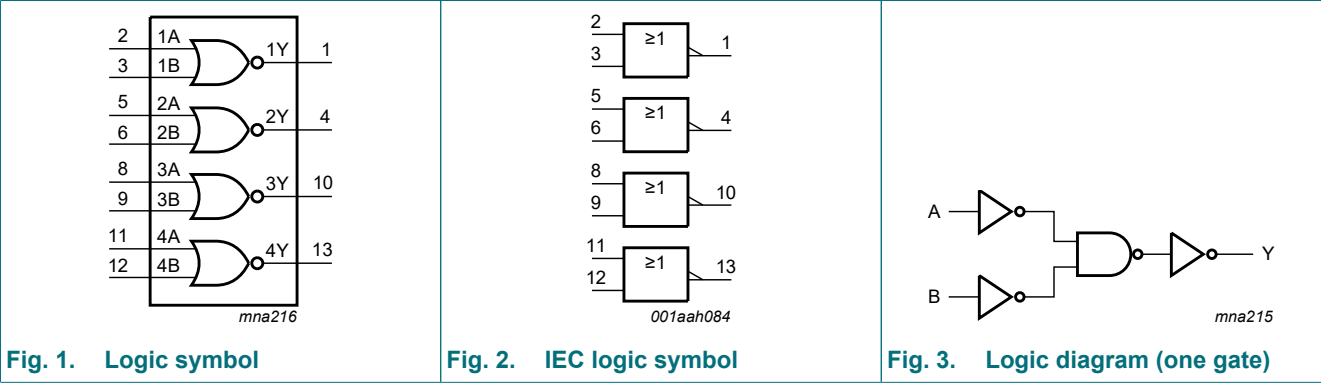
- Input levels:
  - For 74HC02: CMOS level
  - For 74HCT02: TTL level
- Complies with JEDEC standard no. 7A
- ESD protection:
  - HBM JESD22-A114F exceeds 2 000 V
  - MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

## 3. Ordering information

Table 1. Ordering information

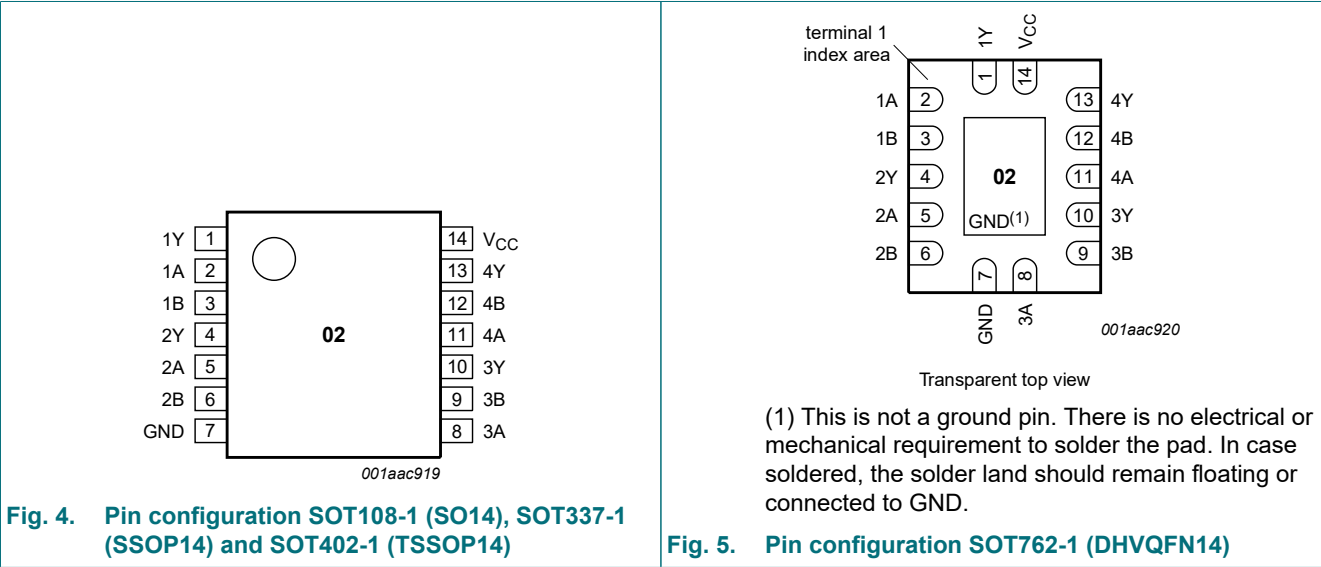
| Type number | Package           |          |                                                                                                                                    |          |
|-------------|-------------------|----------|------------------------------------------------------------------------------------------------------------------------------------|----------|
|             | Temperature range | Name     | Description                                                                                                                        | Version  |
| 74HC02D     | -40 °C to +125 °C | SO14     | plastic small outline package; 14 leads;<br>body width 3.9 mm                                                                      | SOT108-1 |
| 74HCT02D    |                   |          |                                                                                                                                    |          |
| 74HC02DB    | -40 °C to +125 °C | SSOP14   | plastic shrink small outline package; 14 leads;<br>body width 5.3 mm                                                               | SOT337-1 |
| 74HCT02DB   |                   |          |                                                                                                                                    |          |
| 74HC02PW    | -40 °C to +125 °C | TSSOP14  | plastic thin shrink small outline package;<br>14 leads; body width 4.4 mm                                                          | SOT402-1 |
| 74HCT02PW   |                   |          |                                                                                                                                    |          |
| 74HC02BQ    | -40 °C to +125 °C | DHVQFN14 | plastic dual in-line compatible thermal<br>enhanced very thin quad flat package; no leads;<br>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

| 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**

H = HIGH voltage level; L = LOW voltage level; X = don't care.

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

## 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  | $V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ [1] | -    | $\pm 20$ | mA   |
| $I_{OK}$  | output clamping current | $V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ [1] | -    | $\pm 20$ | mA   |
| $I_O$     | output current          | $-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$              | -    | $\pm 25$ | 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 SOT108-1 (SO14) package:  $P_{tot}$  derates linearly with 10.1 mW/K above 100 °C.

For SOT337-1 (SSOP14) package:  $P_{tot}$  derates linearly with 7.3 mW/K above 81 °C.

For SOT402-1 (TSSOP14) package:  $P_{tot}$  derates linearly with 7.3 mW/K above 81 °C.

For SOT762-1 (DHVQFN14) package:  $P_{tot}$  derates linearly with 9.6 mW/K above 98 °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      |      |
| $V_{CC}$            | supply voltage                      |                         | 2.0    | 5.0  | 6.0      | 4.5     | 5.0  | 5.5      | V    |
| $V_I$               | input voltage                       |                         | 0      | -    | $V_{CC}$ | 0       | -    | $V_{CC}$ | V    |
| $V_O$               | output voltage                      |                         | 0      | -    | $V_{CC}$ | 0       | -    | $V_{CC}$ | V    |
| $T_{amb}$           | ambient temperature                 |                         | -40    | -    | +125     | -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      | -       | 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    |
|                 |                           | 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>OL</sub> | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                    |       |      |      |                  |      |                   |      |      |
|                 |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 2.0 V                                        | -     | 0    | 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>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>I</sub>  | input leakage current     | V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V                       | -     | -    | ±0.1 | -                | ±1   | -                 | ±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> = 6.0 V | -     | -    | 2.0  | -                | 20   | -                 | 40   | μA   |
| C <sub>I</sub>  | input capacitance         |                                                                                        | -     | 3.5  | -    | -                | -    | -                 | -    | pF   |
| 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   |

| Symbol          | Parameter                 | Conditions                                                                                                                                                  | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit          |
|-----------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----|-----|------------------|-----|-------------------|-----|---------------|
|                 |                           |                                                                                                                                                             | Min   | Typ | Max | Min              | Max | Min               | Max |               |
| $\Delta I_{CC}$ | additional supply current | per input pin;<br>$V_I = V_{CC} - 2.1 \text{ V}$ ; $I_O = 0 \text{ A}$ ;<br>other inputs at $V_{CC}$ or GND;<br>$V_{CC} = 4.5 \text{ V}$ to $5.5 \text{ V}$ | -     | 150 | 540 | -                | 675 | -                 | 735 | $\mu\text{A}$ |
| $C_I$           | input capacitance         |                                                                                                                                                             | -     | 3.5 | -   | -                | -   | -                 | -   | pF            |

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

$GND = 0 \text{ V}$ ;  $C_L = 50 \text{ pF}$ ; for test circuit see Fig. 7.

| Symbol          | Parameter                     | Conditions                                                       | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|-----------------|-------------------------------|------------------------------------------------------------------|-------|-----|-----|------------------|-----|-------------------|-----|------|
|                 |                               |                                                                  | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| 74HC02          |                               |                                                                  |       |     |     |                  |     |                   |     |      |
| t <sub>pd</sub> | propagation delay             | nA, nB to nY; see Fig. 6 [1]                                     |       |     |     |                  |     |                   |     |      |
|                 |                               | 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 Fig. 6 [2]                                                   |       |     |     |                  |     |                   |     |      |
|                 |                               | 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> [3]         | -     | 22  | -   | -                | -   | -                 | -   | pF   |
| 74HCT02         |                               |                                                                  |       |     |     |                  |     |                   |     |      |
| t <sub>pd</sub> | propagation delay             | nA, nB to nY; see Fig. 6 [1]                                     |       |     |     |                  |     |                   |     |      |
|                 |                               | 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 Fig. 6 [2]                          | -     | 7   | 15  | -                | 19  | -                 | 22  | ns   |
| C <sub>PD</sub> | power dissipation capacitance | per package; V <sub>I</sub> = GND to V <sub>CC</sub> - 1.5 V [3] | -     | 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.

10.1. Waveforms

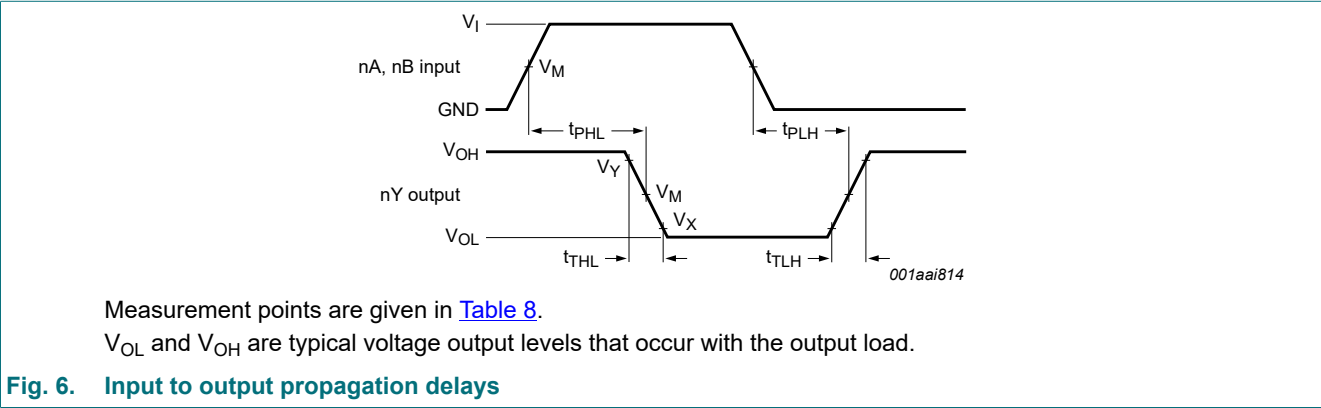


Table 8. Measurement points

| 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       | $0.1V_{CC}$ | $0.9V_{CC}$ |



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 | $t_{PLH}, t_{PHL}$ |

11. Package outline

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

SOT108-1



Fig. 8. Package outline SOT108-1 (SO14)

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

SOT337-1

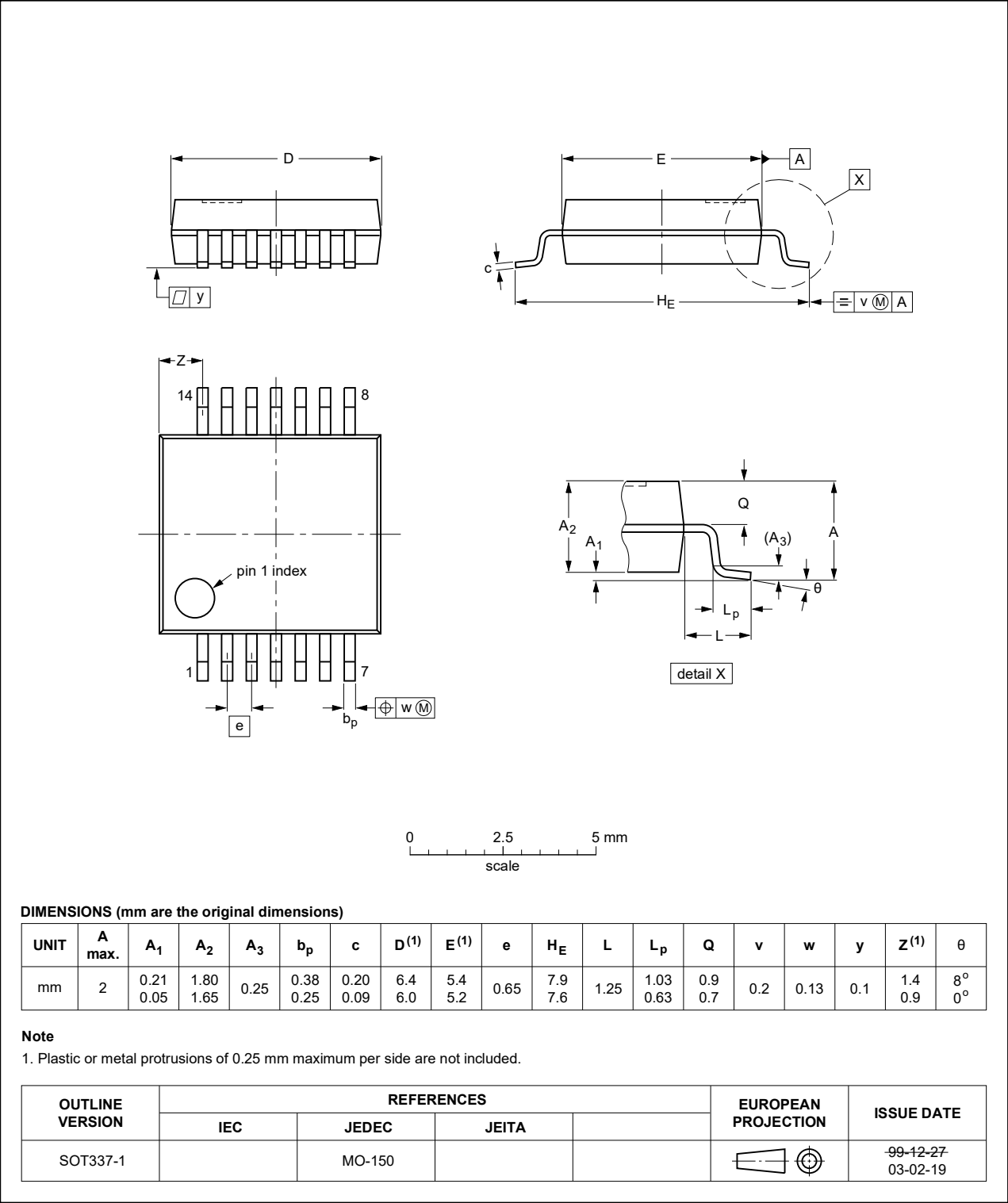


Fig. 9. Package outline SOT337-1 (SSOP14)

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

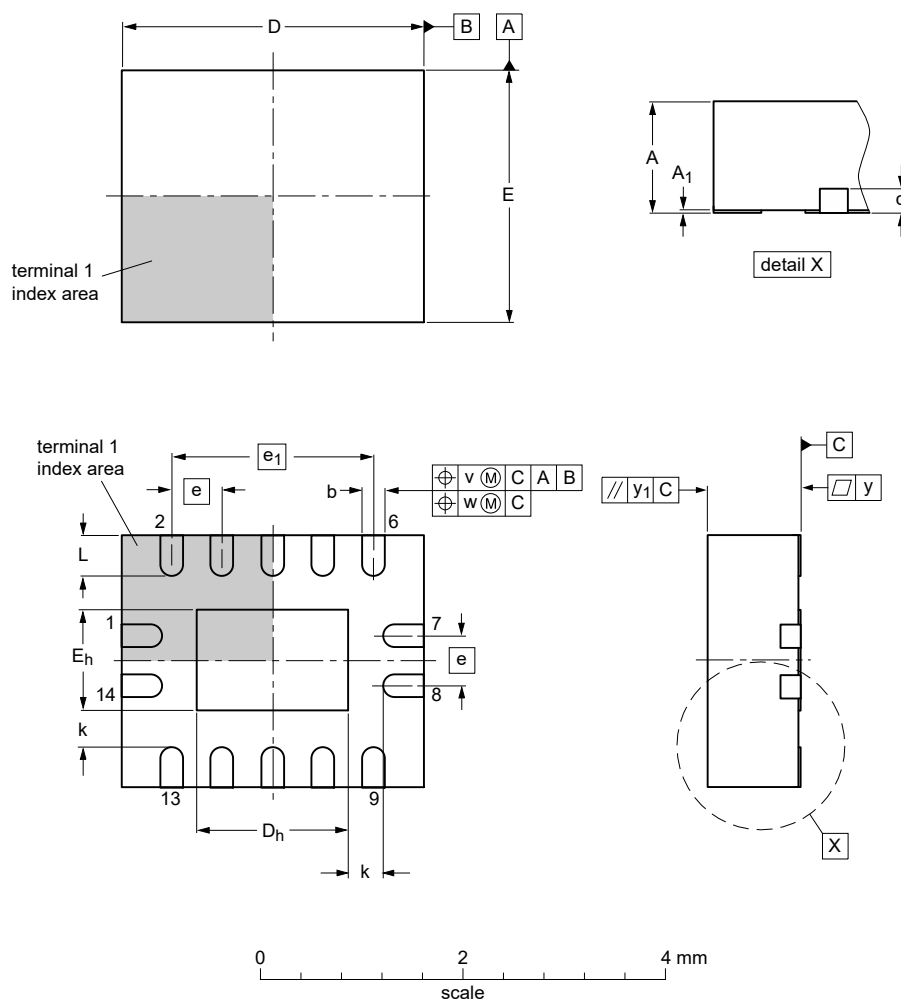
SOT402-1



Fig. 10. 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**



Dimensions (mm are the original dimensions)

| Unit |     | A <sup>(1)</sup> | A <sub>1</sub> | b    | c   | D <sup>(1)</sup> | D <sub>h</sub> | E <sup>(1)</sup> | E <sub>h</sub> | e   | e <sub>1</sub> | k   | L   | v   | w    | y    | y <sub>1</sub> |
|------|-----|------------------|----------------|------|-----|------------------|----------------|------------------|----------------|-----|----------------|-----|-----|-----|------|------|----------------|
| mm   | max | 1                | 0.05           | 0.30 |     | 3.1              | 1.65           | 2.6              | 1.15           |     |                |     | 0.5 |     |      |      |                |
|      | nom |                  | 0.02           | 0.25 | 0.2 | 3.0              | 1.50           | 2.5              | 1.00           | 0.5 | 2              |     | 0.4 | 0.1 | 0.05 | 0.05 | 0.1            |
|      | min |                  | 0.00           | 0.18 |     | 2.9              | 1.35           | 2.4              | 0.85           |     |                | 0.2 | 0.3 |     |      |      |                |

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Note

1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

sot762-1\_po

| Outline version | References |        |       |  | European projection                                                                   | Issue date           |
|-----------------|------------|--------|-------|--|---------------------------------------------------------------------------------------|----------------------|
|                 | IEC        | JEDEC  | JEITA |  |                                                                                       |                      |
| SOT762-1        |            | MO-241 |       |  |  | 15-04-10<br>15-05-05 |

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

## 12. Abbreviations

Table 10. Abbreviations

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

## 13. Revision history

Table 11. Revision history

| Document ID        | Release date                                                                                                                                                                                                                                                                                                                                                    | Data sheet status     | Change notice | Supersedes         |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|--------------------|
| 74HC_HCT02 v.6     | 20200407                                                                                                                                                                                                                                                                                                                                                        | Product data sheet    | -             | 74HC_HCT02 v.5     |
| Modifications:     | <ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> <li><a href="#">Table 4</a>: Derating values for <math>P_{tot}</math> total power dissipation have been updated.</li> </ul> |                       |               |                    |
| 74HC_HCT02 v.5     | 20151126                                                                                                                                                                                                                                                                                                                                                        | Product data sheet    | -             | 74HC_HCT02 v.4     |
| Modifications:     | <ul style="list-style-type: none"> <li>Type numbers 74HC02N and 74HCT02N (SOT27-1) removed.</li> </ul>                                                                                                                                                                                                                                                          |                       |               |                    |
| 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 (DHVQFN14 package)</li> </ul>                                   |                       |               |                    |
| 74HC_HCT02_CNV v.2 | 19970827                                                                                                                                                                                                                                                                                                                                                        | Product specification | -             | -                  |

## 14. Legal information

### Data sheet status

| Document status<br>[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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For sales office addresses, please send an email to: [salesaddresses@nexperia.com](mailto:salesaddresses@nexperia.com)

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