# 74AHC02; 74AHCT02

### **Quad 2-input NOR gate**

Rev. 5 — 11 May 2020

**Product data sheet** 

### 1. General description

The 74AHC02; 74AHCT02 is a high-speed Si-gate CMOS device and is pin compatible with Low-power Schottky TTL (LSTTL). It is specified in compliance with JEDEC standard No. 7-A.

The 74AHC02; 74AHCT02 provides a quad 2-input NOR function.

#### 2. Features and benefits

- · Balanced propagation delays
- · All inputs have a Schmitt-trigger action
- Inputs accept voltages higher than V<sub>CC</sub>
- Input levels:
  - For 74AHC02: CMOS level
  - For 74AHCT02: TTL level
- ESD protection:
  - HBM EIA/JESD22-A114E exceeds 2000 V
  - MM EIA/JESD22-A115-A exceeds 200 V
  - CDM EIA/JESD22-C101C exceeds 1000 V
- Multiple package options
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

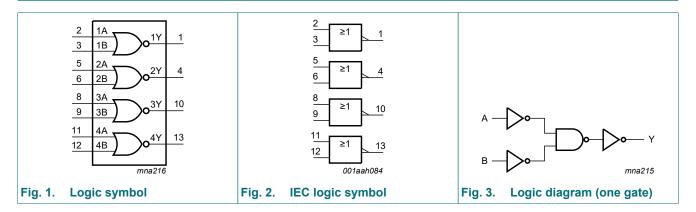
### 3. Ordering information

**Table 1. Ordering information** 

| Type number | Package           |          |   |          |
|-------------|-------------------|----------|---|----------|
|             | Temperature range | Name     | Description   | Version  |
| 74AHC02D    | -40 °C to +125 °C | SO14     | plastic small outline package; 14 leads;                                    | SOT108-1 |
| 74AHCT02D   | -                 |          | body width 3.9 mm   |          |
| 74AHC02PW   | -40 °C to +125 °C | TSSOP14  | plastic thin shrink small outline package; 14 leads;                        | SOT402-1 |
| 74AHCT02PW  | -                 |          | body width 4.4 mm   |          |
| 74AHC02BQ   | -40 °C to +125 °C | DHVQFN14 | plastic dual in-line compatible thermal enhanced                            | SOT762-1 |
| 74AHCT02BQ  |                   |          | very thin quad flat package; no leads; 14 terminals; body 2.5 × 3 × 0.85 mm |          |

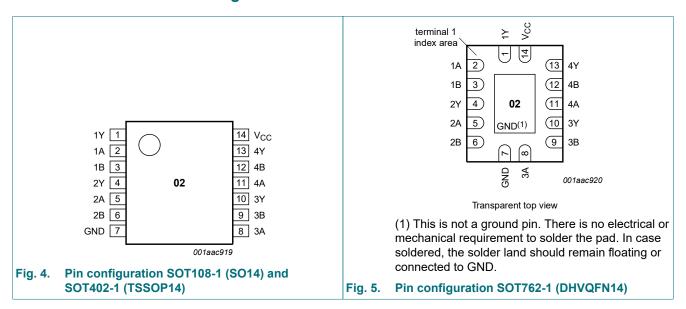


### 4. Functional diagram



### 5. Pinning information

### 5.1. Pinning



### 5.2. Pin description

Table 2. Pin description

| Symbol          | Pin          | Description    |
|-----------------|--------------|----------------|
| 1Y, 2Y, 3Y, 4Y  | 1, 4, 10, 13 | data output    |
| 1A, 2A, 3A, 4A  | 2, 5, 8, 11  | data input     |
| 1B, 2B, 3B, 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  | Н      |
| X     | Н  | L      |
| Н     | 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 <sub>CC</sub>  | supply voltage          |   |     | -0.5 | +7.0 | V    |
| VI               | input voltage           |   |     | -0.5 | +7.0 | V    |
| I <sub>IK</sub>  | input clamping current  | V <sub>I</sub> < -0.5 V                                     | [1] | -20  | -    | mA   |
| I <sub>OK</sub>  | output clamping current | $V_{O} < -0.5 \text{ V or } V_{O} > V_{CC} + 0.5 \text{ V}$ | [1] | -20  | +20  | mA   |
| Io               | output current          | $V_{O} = -0.5 \text{ V to } (V_{CC} + 0.5 \text{ V})$       |     | -25  | +25  | mA   |
| I <sub>CC</sub>  | supply current          |   |     | -    | +75  | mA   |
| I <sub>GND</sub> | ground current          |   |     | -75  | -    | mA   |
| T <sub>stg</sub> | storage temperature     |   |     | -65  | +150 | °C   |
| P <sub>tot</sub> | total power dissipation | T <sub>amb</sub> = -40 °C to +125 °C                        | [2] | -    | 500  | mW   |

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

### 8. Recommended operating conditions

**Table 5. Operating conditions** 

| Symbol           | Parameter                           | Conditions                       | •   | 74AHC0 | 2               | 7   | Unit |                 |      |
|------------------|-------------------------------------|----------------------------------|-----|--------|-----------------|-----|------|-----------------|------|
|                  |                                     |                                  | Min | Тур    | Max             | Min | Тур  | Max             |      |
| V <sub>CC</sub>  | supply voltage                      |                                  | 2.0 | 5.0    | 5.5             | 4.5 | 5.0  | 5.5             | V    |
| VI               | input voltage                       |                                  | 0   | -      | 5.5             | 0   | -    | 5.5             | V    |
| Vo               | output voltage                      |                                  | 0   | -      | V <sub>CC</sub> | 0   | -    | V <sub>CC</sub> | V    |
| T <sub>amb</sub> | ambient temperature                 |                                  | -40 | +25    | +125            | -40 | +25  | +125            | °C   |
| Δt/ΔV            | input transition rise and fall rate | V <sub>CC</sub> = 3.0 V to 3.6 V | -   | -      | 100             | -   | -    | -               | ns/V |
|                  |                                     | V <sub>CC</sub> = 4.5 V to 5.5 V | -   | -      | 20              | -   | -    | 20              | ns/V |

<sup>[2]</sup> For SOT108-1 (SO14) package: Ptot derates linearly with 10.1 mW/K above 100 °C.

For SOT402-1 (TSSOP14) package: Ptot derates linearly with 7.3 mW/K above 81 °C.

For SOT762-1 (DHVQFN14) package: Ptot derates linearly with 9.6 mW/K above 98 °C.

### 9. Static characteristics

#### **Table 6. Static characteristics**

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

| Symbol          | Parameter                | Conditions   |      | 25 °C |      |      | °C to<br>5 °C |      | °C to<br>5 °C | Unit |
|-----------------|--------------------------|--|------|-------|------|------|---------------|------|---------------|------|
|                 |                          |  | Min  | Тур   | Max  | Min  | Max           | Min  | Max           |      |
| 74AHC0          | )2                       |  |      |       | •    | •    |               |      |               |      |
| V <sub>IH</sub> | HIGH-level               | V <sub>CC</sub> = 2.0 V  | 1.5  | -     | -    | 1.5  | -             | 1.5  | -             | V    |
|                 | input voltage            | 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                | V <sub>CC</sub> = 2.0 V  | -    | -     | 0.5  | -    | 0.5           | -    | 0.5           | V    |
|                 | input voltage            | 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               | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>              |      |       |      |      |               |      |               |      |
|                 | output voltage           | 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    |
|                 |                          | $I_{O}$ = -8.0 mA; $V_{CC}$ = 4.5 V                              | 3.94 | -     | -    | 3.80 | -             | 3.70 | -             | V    |
| V <sub>OL</sub> | LOW-level                | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>              |      |       |      |      |               |      |               |      |
|                 | output voltage           | 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    |
| l <sub>l</sub>  | input leakage<br>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           | μΑ   |
| I <sub>CC</sub> | supply current           | $V_I = V_{CC}$ or GND; $I_O = 0$ A;<br>$V_{CC} = 5.5 \text{ V}$  | -    | -     | 2.0  | -    | 20            | -    | 40            | μΑ   |
| Cı              | input<br>capacitance     |  | -    | 3     | 10   | -    | 10            | -    | 10            | pF   |
| 74АНСТ          | 02                       |  |      |       |      |      |               |      |               |      |
| 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               | $V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5 \text{ V}$            |      |       |      |      |               |      |               |      |
|                 | output voltage           | Ι <sub>Ο</sub> = -50 μΑ  | 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                | $V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5 \text{ V}$            |      |       |      |      |               |      |               |      |
|                 | output voltage           | Ι <sub>Ο</sub> = 50 μΑ   | -    | 0     | 0.1  | -    | 0.1           | -    | 0.1           | V    |
|                 |                          | I <sub>O</sub> = 8.0 mA  | -    | -     | 0.36 | -    | 0.44          | -    | 0.55          | V    |

| Symbol Parameter |                           | Conditions   | 25 °C |     |      |     | °C to | -40 °<br>+12 | Unit |    |
|------------------|---------------------------|--|-------|-----|------|-----|-------|--------------|------|----|
|                  |                           |  | Min   | Тур | Max  | Min | Max   | Min          | Max  |    |
| II               | input leakage<br>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  | μΑ |
| I <sub>CC</sub>  | supply current            | $V_I = V_{CC}$ or GND; $I_O = 0$ A;<br>$V_{CC} = 5.5 \text{ V}$  | -     | -   | 2.0  | -   | 20    | -            | 40   | μΑ |
| ΔI <sub>CC</sub> | additional supply current | per input pin; $V_I = V_{CC} - 2.1 \text{ V}$ ;<br>other pins at $V_{CC}$ or GND;<br>$I_O = 0 \text{ A}$ ; $V_{CC} = 4.5 \text{ V}$ to 5.5 V | -     | -   | 1.35 | -   | 1.5   | -            | 1.5  | mA |
| Cı               | input<br>capacitance      |  | -     | 3   | 10   | -   | 10    | -            | 10   | pF |

### 10. Dynamic characteristics

#### **Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 7.

| Symbol          | Parameter                           | Conditions   |     |     | 25 °C  |      |     | °C to | -   | °C to<br>5 °C | Unit |
|-----------------|-------------------------------------|--|-----|-----|--------|------|-----|-------|-----|---------------|------|
|                 |                                     |  |     | Min | Typ[1] | Max  | Min | Max   | Min | Max           |      |
| 74AHC0          | 2                                   |  |     |     |        |      | •   |       |     |               | •    |
| t <sub>pd</sub> | propagation                         | nA, nB to nY; see Fig. 6                                 | [2] |     |        |      |     |       |     |               |      |
|                 | delay                               | 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   |
|                 |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V; 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   |
|                 |                                     | V <sub>CC</sub> = 4.5 V to 5.5 V; C <sub>L</sub> = 50 pF |     | -   | 4.2    | 7.5  | 1.0 | 8.5   | 1.0 | 9.5           | ns   |
| C <sub>PD</sub> | power<br>dissipation<br>capacitance | $C_L$ = 50 pF; $f_i$ = 1 MHz;<br>$V_I$ = GND to $V_{CC}$ | [3] | -   | 7.0    | -    | -   | -     | -   | -             | pF   |
| 74AHCT          | 02                                  |  |     |     |        |      | •   |       |     |               | •    |
| t <sub>pd</sub> | propagation                         | nA, nB to nY; see Fig. 6                                 | [2] |     |        |      |     |       |     |               |      |
|                 | delay                               | V <sub>CC</sub> = 4.5 V to 5.5 V; C <sub>L</sub> = 15 pF |     | -   | 3.8    | 5.5  | 1.0 | 6.5   | 1.0 | 7.0           | ns   |
|                 |                                     | V <sub>CC</sub> = 4.5 V to 5.5 V; C <sub>L</sub> = 50 pF |     | -   | 5.1    | 7.5  | 1.0 | 8.5   | 1.0 | 9.5           | ns   |
| C <sub>PD</sub> | power<br>dissipation<br>capacitance | $C_L$ = 50 pF; $f_i$ = 1 MHz;<br>$V_I$ = GND to $V_{CC}$ | [3] | -   | 8.0    | -    | -   | -     | -   | -             | pF   |

- [1] Typical values are measured at nominal supply voltage ( $V_{CC}$  = 3.3 V and  $V_{CC}$  = 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).

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

 $f_i$  = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

C<sub>L</sub> = output load capacitance in pF;

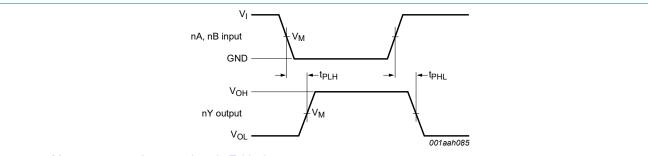
V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

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

5/12

#### 10.1. Waveforms



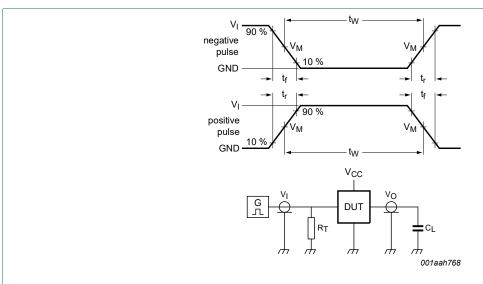
Measurement points are given in <u>Table 8</u>.

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

Fig. 6. Input to output propagation delays

**Table 8. Measurement points** 

| Туре     | Input                 | Output                |
|----------|-----------------------|-----------------------|
|          | V <sub>M</sub>        | V <sub>M</sub>        |
| 74AHC02  | 0.5 × V <sub>CC</sub> | 0.5 × V <sub>CC</sub> |
| 74AHCT02 | 1.5 V                 | 0.5 × V <sub>CC</sub> |



Test data is given in Table 9.

Definitions test circuit:

 $R_{T}$  = termination resistance should be equal to output impedance  $Z_{\text{o}}$  of the pulse generator.

C<sub>L</sub> = load capacitance including jig and probe capacitance.

Fig. 7. Test circuit for measuring switching times

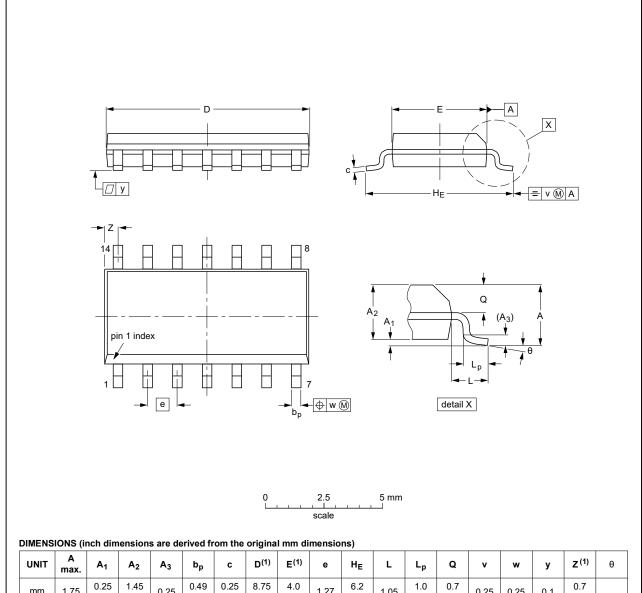
Table 9. Test data

| Туре     | Input           |                                 | Load         | Test                                |
|----------|-----------------|---------------------------------|--------------|-------------------------------------|
|          | VI              | t <sub>r</sub> , t <sub>f</sub> | CL           |                                     |
| 74AHC02  | V <sub>CC</sub> | ≤ 3.0 ns                        | 15 pF, 50 pF | t <sub>PLH</sub> , t <sub>PHL</sub> |
| 74AHCT02 | 3.0 V           | ≤ 3.0 ns                        | 15 pF, 50 pF | t <sub>PLH</sub> , t <sub>PHL</sub> |

### 11. Package outline

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

SOT108-1



| UNIT   | A<br>max. | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | bp           | С                | D <sup>(1)</sup> | E <sup>(1)</sup> | е    | HE             | L     | Lp             | Q              | v    | w    | у     | Z <sup>(1)</sup> | θ  |
|--------|-----------|----------------|----------------|----------------|--------------|------------------|------------------|------------------|------|----------------|-------|----------------|----------------|------|------|-------|------------------|----|
| mm     | 1.75      | 0.25<br>0.10   | 1.45<br>1.25   | 0.25           | 0.49<br>0.36 | 0.25<br>0.19     | 8.75<br>8.55     | 4.0<br>3.8       | 1.27 | 6.2<br>5.8     | 1.05  | 1.0<br>0.4     | 0.7<br>0.6     | 0.25 | 0.25 | 0.1   | 0.7<br>0.3       | 8° |
| inches | 0.069     | 0.010<br>0.004 | 0.057<br>0.049 | 0.01           |              | 0.0100<br>0.0075 | 0.35<br>0.34     | 0.16<br>0.15     | 0.05 | 0.244<br>0.228 | 0.041 | 0.039<br>0.016 | 0.028<br>0.024 | 0.01 | 0.01 | 0.004 | 0.028<br>0.012   | 0° |

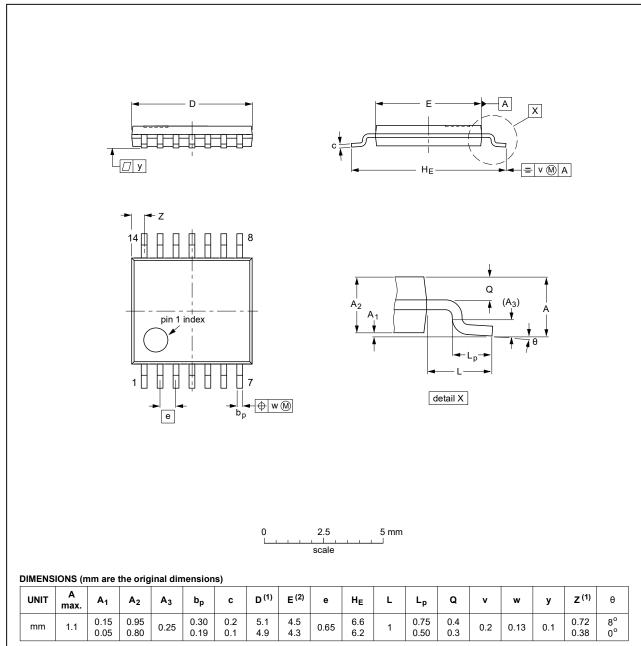
1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

| OUTLINE  |        | REFER  | ENCES | EUROPEAN   | ISSUE DATE                      |
|----------|--------|--------|-------|------------|---------------------------------|
| VERSION  | IEC    | JEDEC  | JEITA | PROJECTION | ISSUE DATE                      |
| SOT108-1 | 076E06 | MS-012 |       |            | <del>99-12-27</del><br>03-02-19 |

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

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

SOT402-1



#### Notes

- 1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
- 2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

| OUTLINE<br>VERSION | REFERENCES |        |       |  | EUROPEAN   | ISSUE DATE                      |
|--------------------|------------|--------|-------|--|------------|---------------------------------|
|                    | IEC        | JEDEC  | JEITA |  | PROJECTION | ISSUE DATE                      |
| SOT402-1           |            | MO-153 |       |  |            | <del>99-12-27</del><br>03-02-18 |

Fig. 9. Package outline SOT402-1 (TSSOP14)

8 / 12

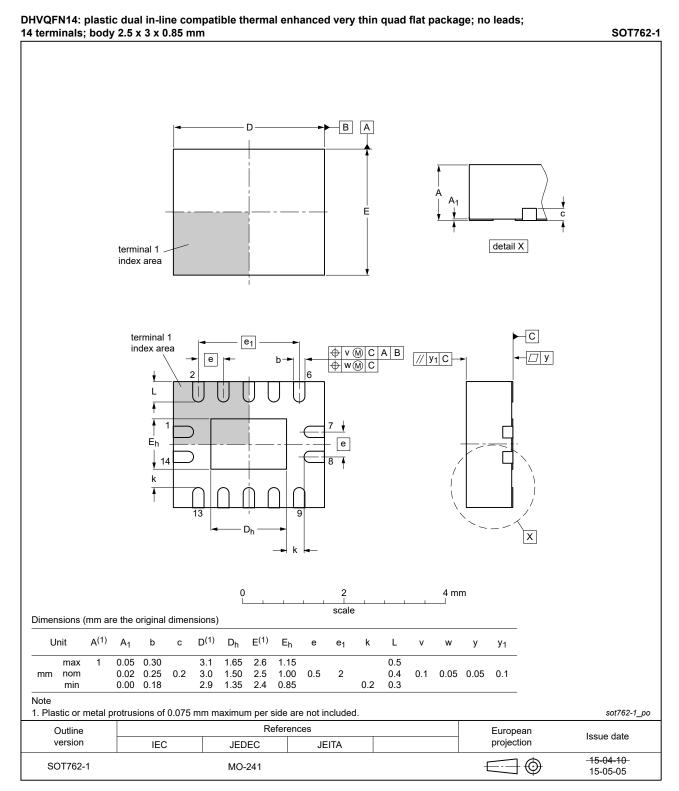


Fig. 10. Package outline SOT762-1 (DHVQFN14)

9 / 12

### 12. Abbreviations

#### **Table 10. Abbreviations**

| Acronym | Description                                    |
|---------|--|
| CDM     | Charged Device Model                           |
| CMOS    | Complementary Metal-Oxide Semiconductor        |
| DUT     | Device Under Test                              |
| ESD     | ElectroStatic Discharge                        |
| НВМ     | Human Body Model                               |
| LSTTL   | Low-power Schottky Transistor-Transistor Logic |
| MM      | Machine Model                                  |
| TTL     | Transistor-Transistor Logic                    |

## 13. Revision history

#### Table 11. Revision history

| Document ID    | Release date   | Data sheet status     | Change notice | Supersedes     |  |
|----------------|--|-----------------------|---------------|----------------|--|
| 74AHC_AHCT02_5 | 20200511   | Product data sheet    | -             | 74AHC_AHCT02_4 |  |
| Modifications: | <ul> <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>Table 4: Derating values for P<sub>tot</sub> total power dissipation updated.</li> <li>Package outline drawing SOT762-1 (DHVQFN14) updated.</li> </ul> |                       |               |                |  |
| 74AHC_AHCT02_4 | 20080521   | Product data sheet    | -             | 74AHC_AHCT02_3 |  |
| Modifications: | <ul> <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>Table 6: the conditions for input leakage current have been changed.</li> </ul>  |                       |               |                |  |
| 74AHC_AHCT02_3 | 20080107   | Product data sheet    | -             | 74AHC_AHCT02_2 |  |
| 74AHC_AHCT02_2 | 19990923   | Product specification | -             | 74AHC_AHCT02_1 |  |
| 74AHC_AHCT02_1 | 19981218   | Product specification | -             | -              |  |

### 14. Legal information

#### **Data sheet status**

| Document status [1][2]         | Product<br>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]<br>data sheet  | Production            | This document contains the product specification.                                     |

- Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- 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 <a href="https://www.nexperia.com">https://www.nexperia.com</a>.

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### **Contents**

| 1. General description              | 1  |
|-------------------------------------|----|
| 2. Features and benefits            | 1  |
| 3. Ordering information             | 1  |
| 4. Functional diagram               | 2  |
| 5. Pinning information              | 2  |
| 5.1. Pinning                        | 2  |
| 5.2. Pin description                | 2  |
| 6. Functional description           | 3  |
| 7. Limiting values                  | 3  |
| 8. Recommended operating conditions | 3  |
| 9. Static characteristics           | 4  |
| 10. Dynamic characteristics         | 5  |
| 10.1. Waveforms                     | 6  |
| 11. Package outline                 | 7  |
| 12. Abbreviations                   | 10 |
| 13. Revision history                |    |
| 14. Legal information               |    |
| -                                   |    |

For more information, please visit: http://www.nexperia.com For sales office addresses, please send an email to: salesaddresses@nexperia.com Date of release: 11 May 2020

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