

# 74AHC86; 74AHCT86

## Quad 2-input EXCLUSIVE-OR gate

Rev. 02 — 15 November 2007

Product data sheet

### 1. General description

The 74AHC86; 74AHCT86 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. 7A.

The 74AHC86; 74AHCT86 provides a 2-input exclusive-OR function.

### 2. Features

- Balanced propagation delays
- All inputs have a Schmitt-trigger action
- Inputs accepts voltages higher than  $V_{CC}$
- For 74AHC86 only: operates with CMOS input levels
- For 74AHCT86 only: operates with TTL input levels
- 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  |
| 74AHC86D<br>74AHCT86D   | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SO14     | plastic small outline package; 14 leads;<br>body width 3.9 mm                                                                                         | SOT108-1 |
| 74AHC86PW<br>74AHCT86PW | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | TSSOP14  | plastic thin shrink small outline package; 14 leads;<br>body width 4.4 mm                                                                             | SOT402-1 |
| 74AHC86BQ<br>74AHCT86BQ | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | DHVQFN14 | plastic dual in-line compatible thermal enhanced<br>very thin quad flat package; no leads; 14 terminals;<br>body $2.5 \times 3 \times 0.85\text{ mm}$ | SOT762-1 |

4. Functional diagram

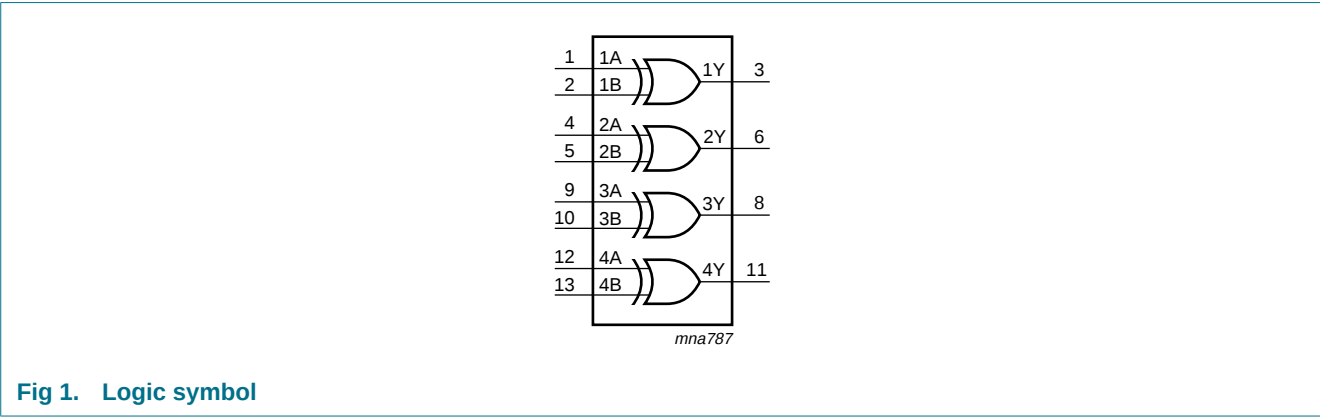


Fig 1. Logic symbol

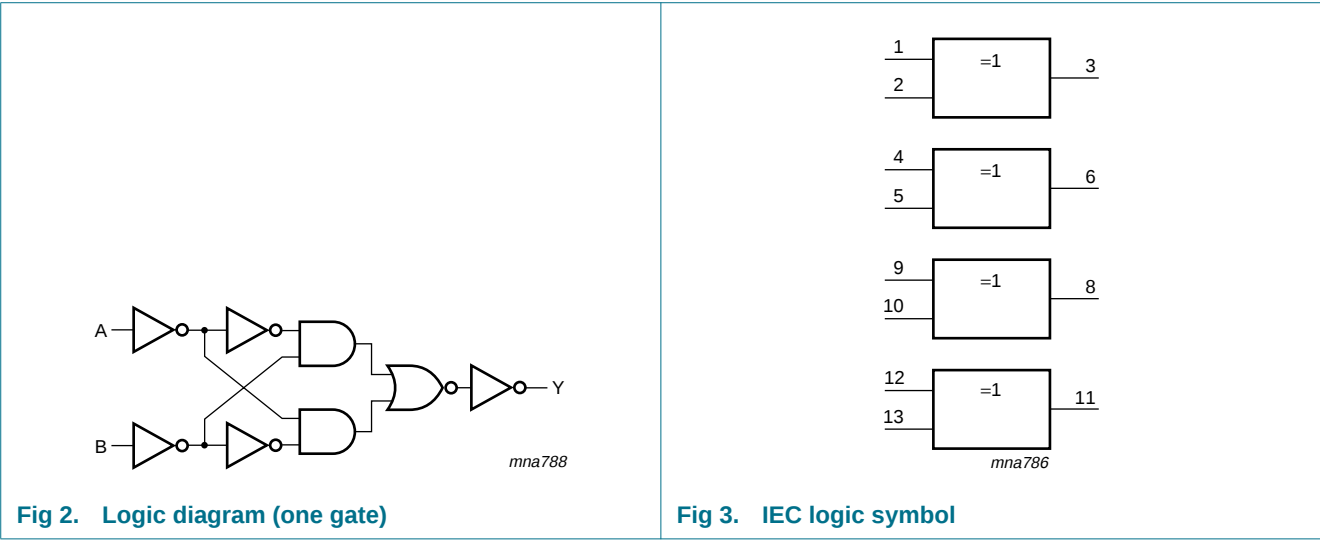
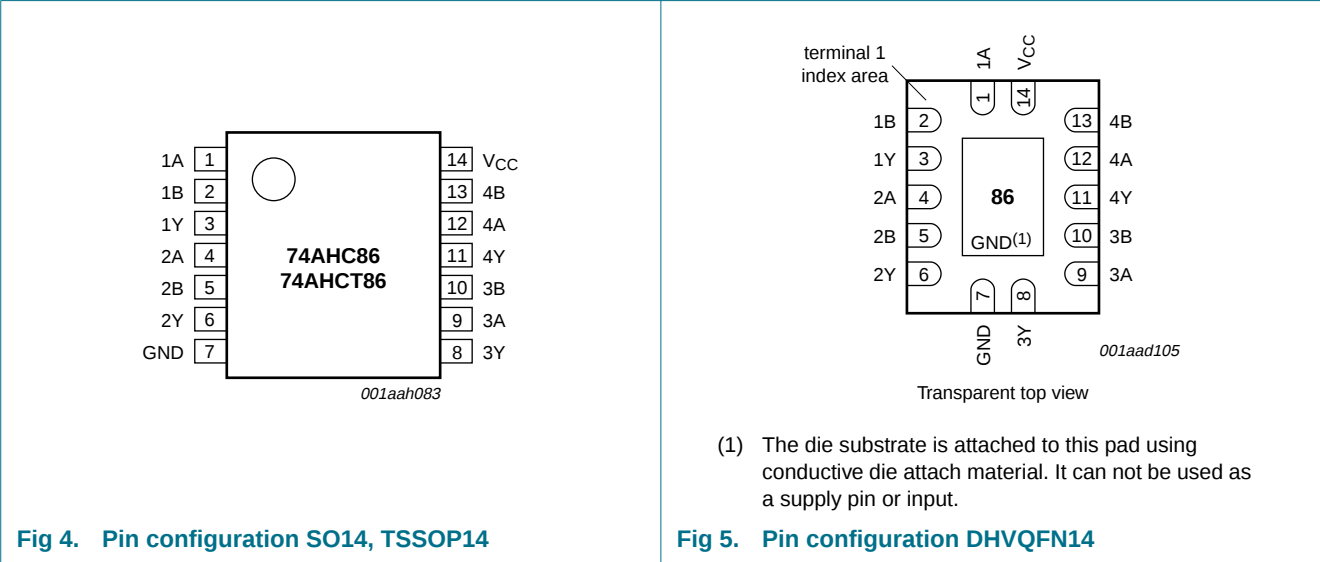


Fig 2. Logic diagram (one gate)

Fig 3. IEC logic symbol

5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

| Symbol          | Pin          | Description    |
|-----------------|--------------|----------------|
| 1A to 4A        | 1, 4, 9, 12  | data input     |
| 1B to 4B        | 2, 5, 10, 13 | data input     |
| 1Y to 4Y        | 3, 6, 8, 11  | data outputs   |
| GND             | 7            | ground (0 V)   |
| V <sub>CC</sub> | 14           | supply voltage |

6. Functional description

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

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

[1] H = HIGH voltage level;  
L = LOW voltage level.

## 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  | mA   |
| $I_O$     | output current          | $V_O = -0.5$ V to $(V_{CC} + 0.5$ V)     | -       | ±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            |         |      |      |
|           | SO14 package            |                                          | [2] -   | 500  | mW   |
|           | TSSOP14 package         |                                          | [3] -   | 500  | mW   |
|           | DHVQFN14 package        |                                          | [4] -   | 500  | mW   |

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

[2]  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.

[3]  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °C.

[4]  $P_{tot}$  derates linearly with 4.5 mW/K above 60 °C.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

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

| Symbol              | Parameter                           | Conditions               | 74AHC86 |     |          | 74AHCT86 |     |          | Unit |
|---------------------|-------------------------------------|--------------------------|---------|-----|----------|----------|-----|----------|------|
|                     |                                     |                          | Min     | Typ | Max      | Min      | Typ | Max      |      |
| $V_{CC}$            | supply voltage                      |                          | 2.0     | 5.0 | 5.5      | 4.5      | 5.0 | 5.5      | V    |
| $V_I$               | input voltage                       |                          | 0       | -   | 5.5      | 0        | -   | 5.5      | V    |
| $V_O$               | output voltage                      |                          | 0       | -   | $V_{CC}$ | 0        | -   | $V_{CC}$ | V    |
| $T_{amb}$           | ambient temperature                 |                          | -40     | +25 | +125     | -40      | +25 | +125     | °C   |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 3.3$ V ± 0.3 V | -       | -   | 100      | -        | -   | -        | ns/V |
|                     |                                     | $V_{CC} = 5.0$ V ± 0.5 V | -       | -   | 20       | -        | -   | 20       | ns/V |

## 9. Static characteristics

**Table 6. Static characteristics**

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  |      |
| For type 74AHC86  |                           |                                                                                        |       |     |      |                  |      |                   |      |      |
| 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  | -   | -    | 3.8              | -    | 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; 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; V <sub>CC</sub> = 5.5 V | -     | -   | 2.0  | -                | 20   | -                 | 40   | μA   |
| C <sub>I</sub>    | input capacitance         |                                                                                        | -     | 3.0 | 10   | -                | 10   | -                 | 10   | pF   |
| C <sub>O</sub>    | output capacitance        |                                                                                        | -     | 4.0 | -    | -                | -    | -                 | -    | pF   |
| For type 74AHCT86 |                           |                                                                                        |       |     |      |                  |      |                   |      |      |
| 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  | -   | -    | 3.8              | -    | 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    |

**Table 6. Static characteristics ...continued**  
 Voltages are referenced to GND (ground = 0 V).

| Symbol          | Parameter                 | Conditions                                                                                                                             | 25 °C |     |      | –40 °C to +85 °C |     | –40 °C to +125 °C |     | Unit          |
|-----------------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-------|-----|------|------------------|-----|-------------------|-----|---------------|
|                 |                           |                                                                                                                                        | Min   | Typ | Max  | Min              | Max | Min               | Max |               |
| $I_I$           | input leakage current     | $V_I = 5.5 \text{ V}$ or GND; $V_{CC} = 0 \text{ V}$ to 5.5 V                                                                          | -     | -   | 0.1  | -                | 1.0 | -                 | 2.0 | $\mu\text{A}$ |
| $I_{CC}$        | supply current            | $V_I = V_{CC}$ or GND; $I_O = 0 \text{ A}$ ; $V_{CC} = 5.5 \text{ V}$                                                                  | -     | -   | 2.0  | -                | 20  | -                 | 40  | $\mu\text{A}$ |
| $\Delta I_{CC}$ | additional supply current | per input pin; $V_I = V_{CC} - 2.1 \text{ V}$ ; $I_O = 0 \text{ A}$ ; other pins at $V_{CC}$ or GND; $V_{CC} = 4.5 \text{ V}$ to 5.5 V | -     | -   | 1.35 | -                | 1.5 | -                 | 1.5 | mA            |
| $C_I$           | input capacitance         |                                                                                                                                        | -     | 3   | 10   | -                | 10  | -                 | 10  | pF            |
| $C_O$           | output capacitance        |                                                                                                                                        | -     | 4.0 | -    | -                | -   | -                 | -   | pF            |

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**  
 GND = 0 V; For test circuit see [Figure 7](#).

| Symbol           | Parameter                     | Conditions                                                                                                | 25 °C |                    |      | −40 °C to +85 °C |      | −40 °C to +125 °C |      | Unit |
|------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------|-------|--------------------|------|------------------|------|-------------------|------|------|
|                  |                               |                                                                                                           | Min   | Typ <sup>[1]</sup> | Max  | Min              | Max  | Min               | Max  |      |
| For type 74AHC86 |                               |                                                                                                           |       |                    |      |                  |      |                   |      |      |
| 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                                                                                    | -     | 4.8                | 11.0 | 1.0              | 13.0 | 1.0               | 14.0 | ns   |
|                  |                               | C <sub>L</sub> = 50 pF                                                                                    | -     | 6.8                | 14.5 | 1.0              | 16.5 | 1.0               | 18.5 | ns   |
|                  |                               | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                          |       |                    |      |                  |      |                   |      |      |
|                  |                               | C <sub>L</sub> = 15 pF                                                                                    | -     | 3.4                | 6.8  | 1.0              | 8.0  | 1.0               | 8.5  | ns   |
| C <sub>PD</sub>  | power dissipation capacitance | C <sub>L</sub> = 50 pF; f <sub>i</sub> = 1 MHz; <sup>[3]</sup><br>V <sub>I</sub> = GND to V <sub>CC</sub> | -     | 10.0               | -    | -                | -    | -                 | -    | pF   |

**Table 7. Dynamic characteristics ...continued**  
*GND = 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  |      |
| For type 74AHCT86 |                               |                                                                                                        |       |                    |     |                  |      |                   |      |      |
| t <sub>pd</sub>   | propagation delay             | nA, nB to nY; see <a href="#">Figure 6</a> <sup>[2]</sup>                                              |       |                    |     |                  |      |                   |      |      |
|                   |                               | V <sub>CC</sub> = 4.5 V to 5.5 V                                                                       |       |                    |     |                  |      |                   |      |      |
|                   |                               | C <sub>L</sub> = 15 pF                                                                                 | -     | 3.4                | 6.9 | 1.0              | 8.0  | 1.0               | 9.0  | ns   |
|                   |                               | C <sub>L</sub> = 50 pF                                                                                 | -     | 4.9                | 8.8 | 1.0              | 10.0 | 1.0               | 11.0 | 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> | -     | 12.0               | -   | -                | -    | -                 | -    | pF   |

[1] Typical values are measured at nominal supply voltage ( $V_{CC} = 3.3\text{ V}$  and  $V_{CC} = 5.0\text{ V}$ ).

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

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

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

$f_i$  = input frequency in MHz,  $f_o$  = output frequency in MHz

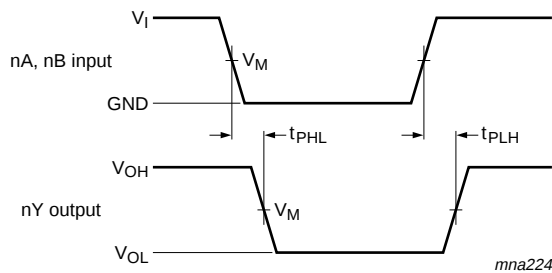
$C_L$  = output load capacitance in pF

$V_{CC}$  = supply voltage in Volts

$N$  = number of inputs switching

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

## 11. Waveforms



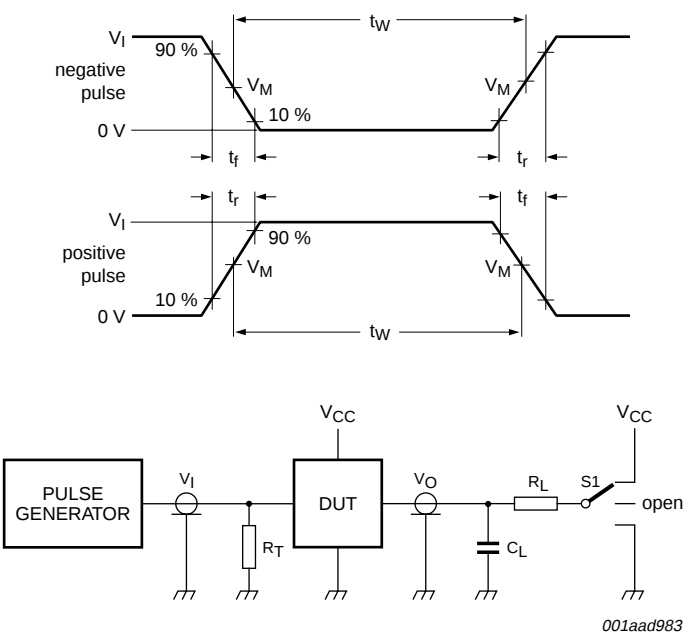
Measurement points are given in Table 8.

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

**Fig 6. Propagation delay input (nA, nB) to output (nY)**

**Table 8. Measurement points**

| Type     | Input          | Output      |
|----------|----------------|-------------|
|          | $V_M$          | $V_M$       |
| 74AHC86  | $0.5V_{CC}$    | $0.5V_{CC}$ |
| 74AHCT86 | $1.5\text{ V}$ | $0.5V_{CC}$ |



Test data is given in [Table 9](#).  
Definitions test circuit:  
 $R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator  
 $C_L$  = Load capacitance including jig and probe capacitance  
 $R_L$  = Load resistor  
 $S1$  = Test selection switch

Fig 7. Load circuitry for switching times

Table 9. Test data

| Type     | Input    |            | Load         |              | S1 position        |                    |                    |
|----------|----------|------------|--------------|--------------|--------------------|--------------------|--------------------|
|          | $V_I$    | $t_r, t_f$ | $C_L$        | $R_L$        | $t_{PHL}, t_{PLH}$ | $t_{PZH}, t_{PHZ}$ | $t_{PZL}, t_{PLZ}$ |
| 74AHC86  | $V_{CC}$ | 3.0 ns     | 15 pF, 50 pF | 1 k $\Omega$ | open               | GND                | $V_{CC}$           |
| 74AHCT86 | 3.0 V    | 3.0 ns     | 15 pF, 50 pF | 1 k $\Omega$ | open               | GND                | $V_{CC}$           |

12. Package outline

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

SOT108-1

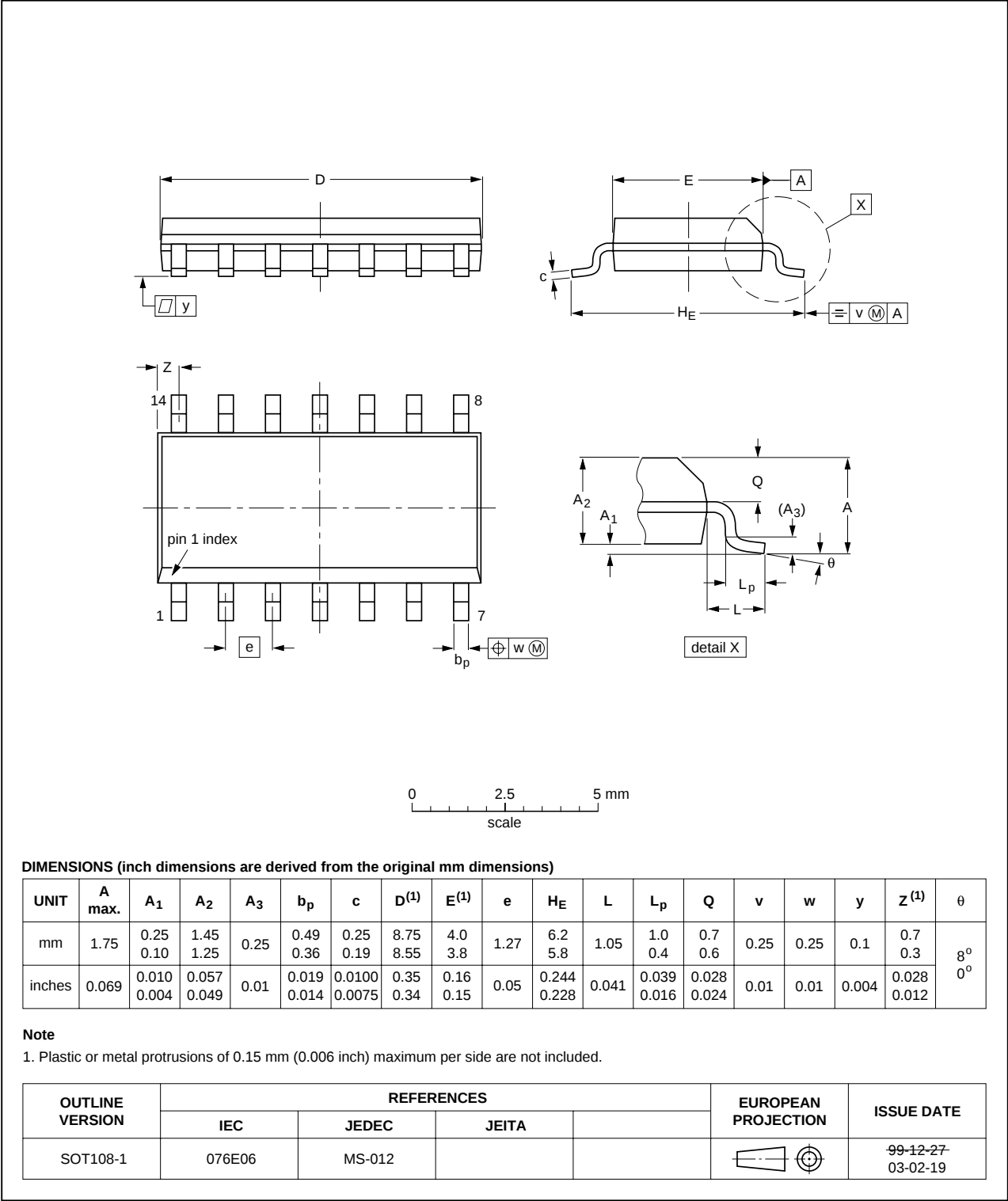


Fig 8. Package outline SOT108-1 (SO14)

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

SOT402-1

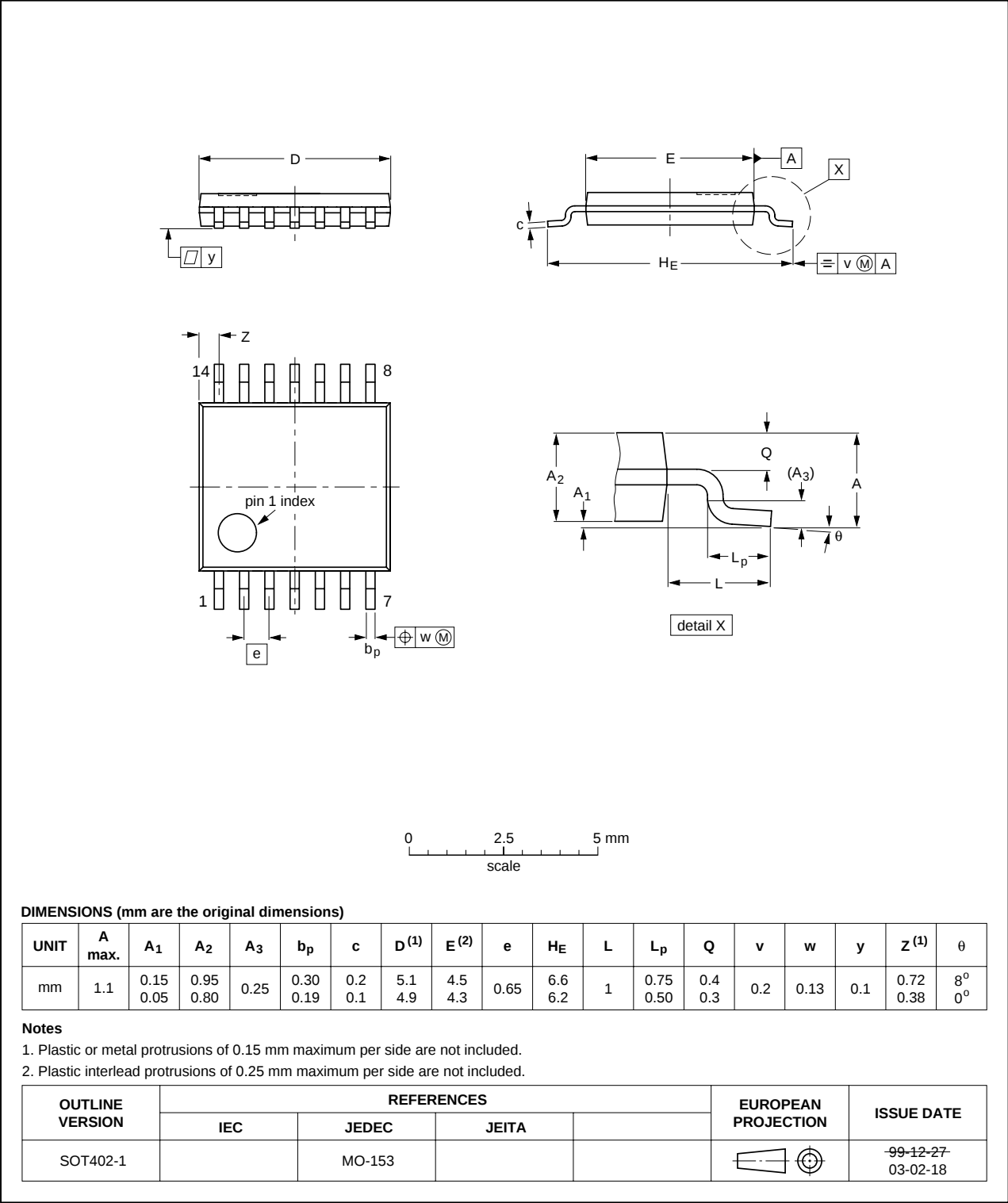


Fig 9. Package outline SOT402-1 (TSSOP14)

DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads;  
14 terminals; body 2.5 x 3 x 0.85 mm

SOT762-1

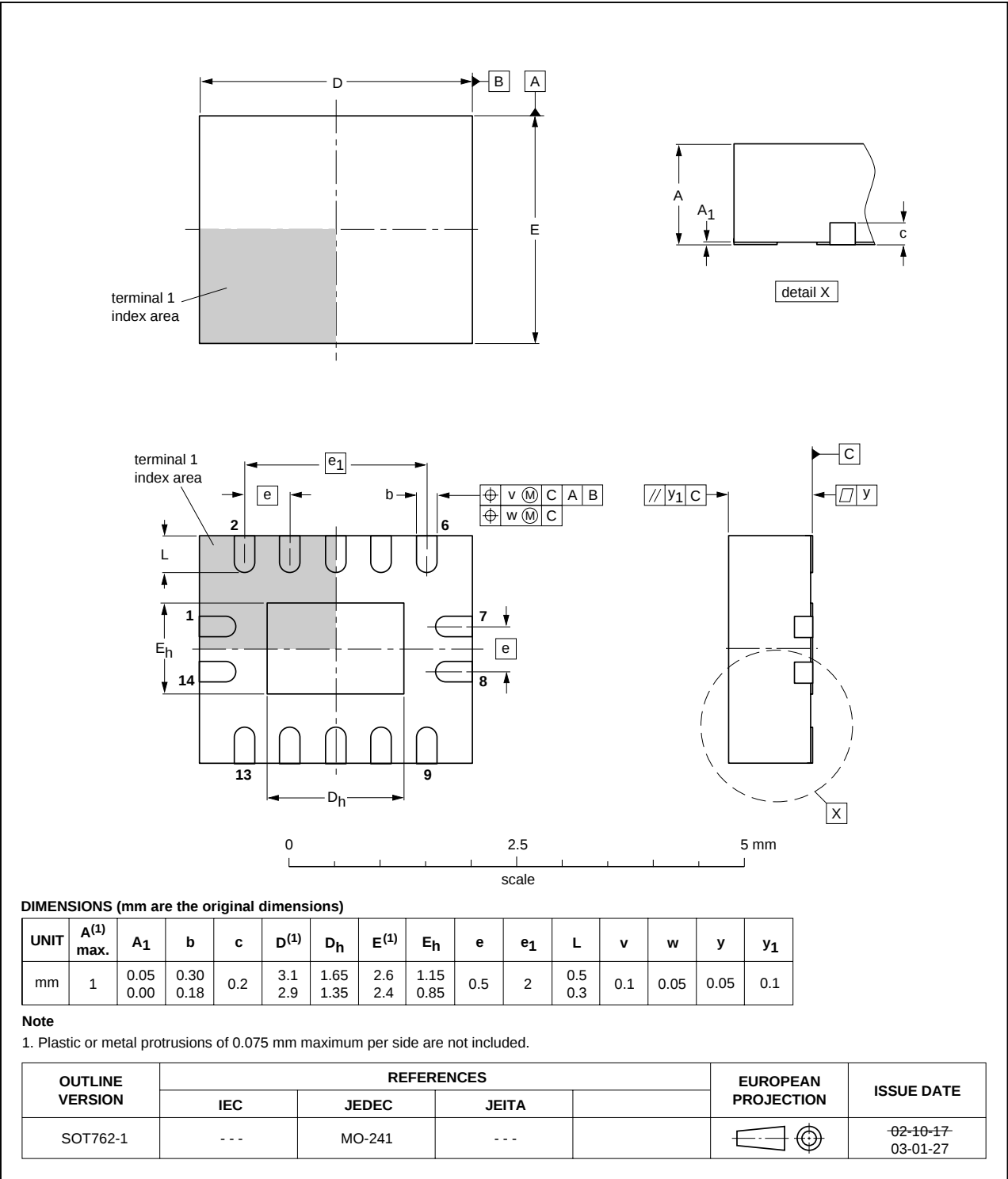


Fig 10. Package outline SOT762-1 (DHVQFN14)

## 13. Abbreviations

Table 10. Abbreviations

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

## 14. Revision history

Table 11. Revision history

| Document ID    | Release date                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Data sheet status     | Change notice | Supersedes     |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|----------------|
| 74AHC_AHCT86_2 | 20071115                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Product data sheet    | -             | 74AHC_AHCT86_1 |
| 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>• <a href="#">Section 3</a>: DHVQFN14 package added.</li><li>• <a href="#">Section 7</a>: derating values added for DHVQFN14 package.</li><li>• <a href="#">Section 12</a>: outline drawing added for DHVQFN14 package.</li></ul> |                       |               |                |
| 74AHC_AHCT86_1 | 19990917                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 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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