

# 74LV04

## Hex inverter

Rev. 5 — 13 September 2021

Product data sheet

## 1. General description

The 74LV04 is a hex inverter. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess  $V_{CC}$ .

## 2. Features and benefits

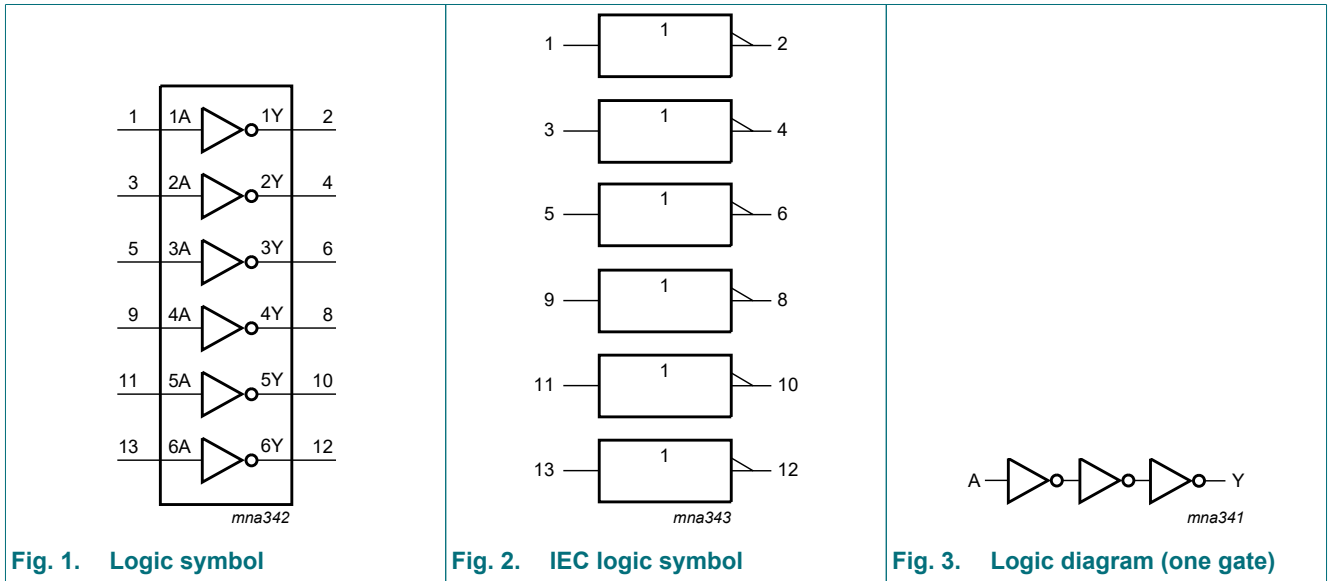
- Wide supply voltage range from 1.0 to 5.5 V
- CMOS low power dissipation
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Optimized for low voltage applications: 1.0 V to 3.6 V
- Accepts TTL input levels between  $V_{CC} = 2.7$  V and  $V_{CC} = 3.6$  V
- Typical output ground bounce  $< 0.8$  V at  $V_{CC} = 3.3$  V and  $T_{amb} = 25$  °C
- Typical HIGH-level output voltage ( $V_{OH}$ ) undershoot:  $> 2$  V at  $V_{CC} = 3.3$  V and  $T_{amb} = 25$  °C
- Complies with JEDEC standards:
  - JESD8-7 (1.65 V to 1.95 V)
  - JESD8-5 (2.3 V to 2.7 V)
  - JESD8C (2.7 V to 3.6 V)
  - JESD36 (4.5 V to 5.5 V)
- ESD protection:
  - HBM JESD22-A114E 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

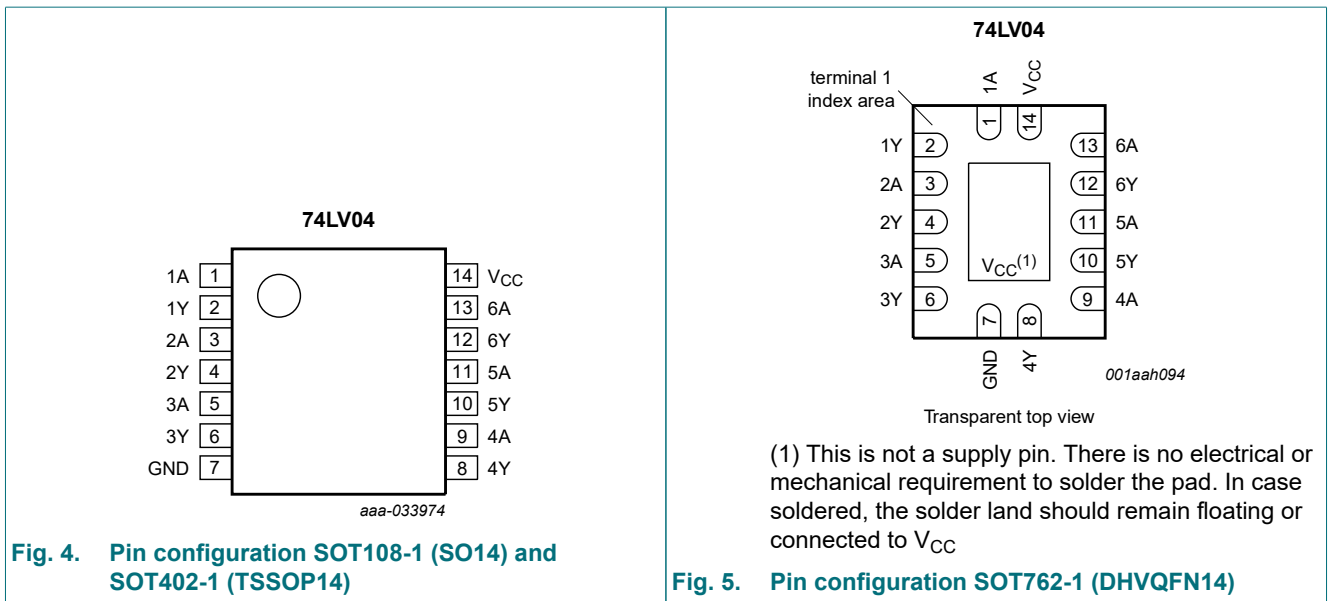
| Type number | Package               |          |  |          |
|-------------|-----------------------|----------|--|----------|
|             | Temperature range     | Name     | Description  | Version  |
| 74LV04D     | $-40$ °C to $+125$ °C | SO14     | plastic small outline package; 14 leads;<br>body width 3.9 mm  | SOT108-1 |
| 74LV04PW    | $-40$ °C to $+125$ °C | TSSOP14  | plastic thin shrink small outline package; 14 leads;<br>body width 4.4 mm  | SOT402-1 |
| 74LV04BQ    | $-40$ °C to $+125$ °C | DHVQFN14 | plastic dual in-line compatible thermal enhanced<br>very thin quad flat package; no leads; 14 terminals;<br>body $2.5 \times 3 \times 0.85$ mm | SOT762-1 |

### 4. Functional diagram



### 5. Pinning information

#### 5.1. Pinning



## 5.2. Pin description

Table 2. Pin description

| Symbol                 | Pin                | Description    |
|------------------------|--------------------|----------------|
| 1A, 2A, 3A, 4A, 5A, 6A | 1, 3, 5, 9, 11, 13 | data input     |
| 1Y, 2Y, 3Y, 4Y, 5Y, 6Y | 2, 4, 6, 8, 10, 12 | data output    |
| 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.

| Input nA | Output nY |
|----------|-----------|
| L        | H         |
| H        | 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    |
| 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 [1] | -    | ±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 [1] | -    | ±50  | mA   |
| I <sub>O</sub>   | output current          | V <sub>O</sub> = -0.5 V to (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 | T <sub>amb</sub> = -40 °C to +125 °C [2]                                | -    | 500  | mW   |

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

[2] For SOT108-1 (SO14) package: P<sub>tot</sub> derates linearly with 10.1 mW/K above 100 °C.  
 For SOT402-1 (TSSOP14) package: P<sub>tot</sub> derates linearly with 7.3 mW/K above 81 °C.  
 For SOT762-1 (DHVQFN14) package: P<sub>tot</sub> 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 | Min | Typ | Max             | Unit |
|------------------|---------------------|------------|-----|-----|-----------------|------|
| V <sub>CC</sub>  | supply voltage      | [1]        | 1.0 | 3.3 | 5.5             | V    |
| V <sub>I</sub>   | input voltage       |            | 0   | -   | V <sub>CC</sub> | V    |
| V <sub>O</sub>   | output voltage      |            | 0   | -   | V <sub>CC</sub> | V    |
| T <sub>amb</sub> | ambient temperature |            | -40 | +25 | +125            | °C   |

| Symbol              | Parameter                           | Conditions                                 | Min | Typ | Max | Unit |
|---------------------|-------------------------------------|--|-----|-----|-----|------|
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 1.0 \text{ V to } 2.0 \text{ V}$ | -   | -   | 500 | ns/V |
|                     |                                     | $V_{CC} = 2.0 \text{ V to } 2.7 \text{ V}$ | -   | -   | 200 | ns/V |
|                     |                                     | $V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$ | -   | -   | 100 | ns/V |
|                     |                                     | $V_{CC} = 3.6 \text{ V to } 5.5 \text{ V}$ | -   | -   | 50  | ns/V |

[1] The static characteristics are guaranteed from  $V_{CC} = 1.2 \text{ V to } V_{CC} = 5.5 \text{ V}$ , but LV devices are guaranteed to function down to  $V_{CC} = 1.0 \text{ V}$  (with input levels GND or  $V_{CC}$ ).

## 9. Static characteristics

**Table 6. Static characteristics**

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

| Symbol   | Parameter                 | Conditions  | -40 °C to +85 °C |        |             | -40 °C to +125 °C |             | Unit          |
|--|---------------------------|---|------------------|--------|-------------|-------------------|-------------|---------------|
|  |                           |   | Min              | Typ[1] | Max         | Min               | Max         |               |
| $V_{IH}$                                       | HIGH-level input voltage  | $V_{CC} = 1.2 \text{ V}$  | 0.9              | -      | -           | 0.9               | -           | V             |
|  |                           | $V_{CC} = 2.0 \text{ V}$  | 1.4              | -      | -           | 1.4               | -           | V             |
|  |                           | $V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$  | 2.0              | -      | -           | 2.0               | -           | V             |
|  |                           | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$  | $0.7V_{CC}$      | -      | -           | $0.7V_{CC}$       | -           | V             |
| $V_{IL}$                                       | LOW-level input voltage   | $V_{CC} = 1.2 \text{ V}$  | -                | -      | 0.3         | -                 | 0.3         | V             |
|  |                           | $V_{CC} = 2.0 \text{ V}$  | -                | -      | 0.6         | -                 | 0.6         | V             |
|  |                           | $V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$  | -                | -      | 0.8         | -                 | 0.8         | V             |
|  |                           | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$  | -                | -      | $0.3V_{CC}$ | -                 | $0.3V_{CC}$ | V             |
| $V_{OH}$                                       | HIGH-level output voltage | $V_I = V_{IH} \text{ or } V_{IL}$   |                  |        |             |                   |             |               |
|  |                           | $I_O = -100 \mu\text{A}; V_{CC} = 1.2 \text{ V}$                                    | -                | 1.2    | -           | -                 | -           | V             |
|  |                           | $I_O = -100 \mu\text{A}; V_{CC} = 2.0 \text{ V}$                                    | 1.8              | 2.0    | -           | 1.8               | -           | V             |
|  |                           | $I_O = -100 \mu\text{A}; V_{CC} = 2.7 \text{ V}$                                    | 2.5              | 2.7    | -           | 2.5               | -           | V             |
|  |                           | $I_O = -100 \mu\text{A}; V_{CC} = 3.0 \text{ V}$                                    | 2.8              | 3.0    | -           | 2.8               | -           | V             |
|  |                           | $I_O = -100 \mu\text{A}; V_{CC} = 4.5 \text{ V}$                                    | 4.3              | 4.5    | -           | 4.3               | -           | V             |
|  |                           | $I_O = -6 \text{ mA}; V_{CC} = 3.0 \text{ V}$                                       | 2.4              | 2.82   | -           | 2.2               | -           | V             |
| $I_O = -12 \text{ mA}; V_{CC} = 4.5 \text{ V}$ | 3.6                       | 4.2   | -                | 3.5    | -           | V                 |             |               |
| $V_{OL}$                                       | LOW-level output voltage  | $V_I = V_{IH} \text{ or } V_{IL}$   |                  |        |             |                   |             |               |
|  |                           | $I_O = 100 \mu\text{A}; V_{CC} = 1.2 \text{ V}$                                     | -                | 0      | -           | -                 | -           | V             |
|  |                           | $I_O = 100 \mu\text{A}; V_{CC} = 2.0 \text{ V}$                                     | -                | 0      | 0.2         | -                 | 0.2         | V             |
|  |                           | $I_O = 100 \mu\text{A}; V_{CC} = 2.7 \text{ V}$                                     | -                | 0      | 0.2         | -                 | 0.2         | V             |
|  |                           | $I_O = 100 \mu\text{A}; V_{CC} = 3.0 \text{ V}$                                     | -                | 0      | 0.2         | -                 | 0.2         | V             |
|  |                           | $I_O = 100 \mu\text{A}; V_{CC} = 4.5 \text{ V}$                                     | -                | 0      | 0.2         | -                 | 0.2         | V             |
|  |                           | $I_O = 6 \text{ mA}; V_{CC} = 3.0 \text{ V}$  | -                | 0.25   | 0.40        | -                 | 0.50        | V             |
| $I_O = 12 \text{ mA}; V_{CC} = 4.5 \text{ V}$  | -                         | 0.35  | 0.55             | -      | 0.65        | V                 |             |               |
| $I_I$  | input leakage current     | $V_I = V_{CC} \text{ or } \text{GND}; V_{CC} = 5.5 \text{ V}$                       | -                | -      | 1.0         | -                 | 1.0         | $\mu\text{A}$ |
| $I_{CC}$                                       | supply current            | $V_I = V_{CC} \text{ or } \text{GND}; I_O = 0 \text{ A}; V_{CC} = 5.5 \text{ V}$    | -                | -      | 20.0        | -                 | 40          | $\mu\text{A}$ |
| $\Delta I_{CC}$                                | additional supply current | per input; $V_I = V_{CC} - 0.6 \text{ V}; V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$ | -                | -      | 500         | -                 | 850         | $\mu\text{A}$ |
| $C_I$  | input capacitance         |   | -                | 3.5    | -           | -                 | -           | pF            |

[1] Typical values are measured at  $T_{amb} = 25 \text{ }^\circ\text{C}$ .

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

$GND = 0\text{ V}$ ; For test circuit see Fig. 7.

| Symbol   | Parameter                     | Conditions  | -40 °C to +85 °C |        |     | -40 °C to +125 °C |     | Unit |
|----------|-------------------------------|---|------------------|--------|-----|-------------------|-----|------|
|          |                               |   | Min              | Typ[1] | Max | Min               | Max |      |
| $t_{pd}$ | propagation delay             | nA to nY; see Fig. 6 [2]  |                  |        |     |                   |     |      |
|          |                               | $V_{CC} = 1.2\text{ V}$   | -                | 40     | -   | -                 | -   | ns   |
|          |                               | $V_{CC} = 2.0\text{ V}$   | -                | 14     | 20  | -                 | 25  | ns   |
|          |                               | $V_{CC} = 2.7\text{ V}$   | -                | 10     | 15  | -                 | 19  | ns   |
|          |                               | $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ ;<br>$C_L = 15\text{ pF}$ [3]             | -                | 6      | -   | -                 | -   | ns   |
|          |                               | $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ [3]                                       | -                | 8      | 12  | -                 | 15  | ns   |
|          |                               | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$   | -                | -      | 9   | -                 | 11  | ns   |
| $C_{PD}$ | power dissipation capacitance | $C_L = 50\text{ pF}$ ; $f_i = 1\text{ MHz}$ ;<br>$V_i = GND\text{ to }V_{CC}$ [4] | -                | 21     | -   | -                 | -   | pF   |

[1] All typical values are measured at  $T_{amb} = 25\text{ °C}$ .

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

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

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

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

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

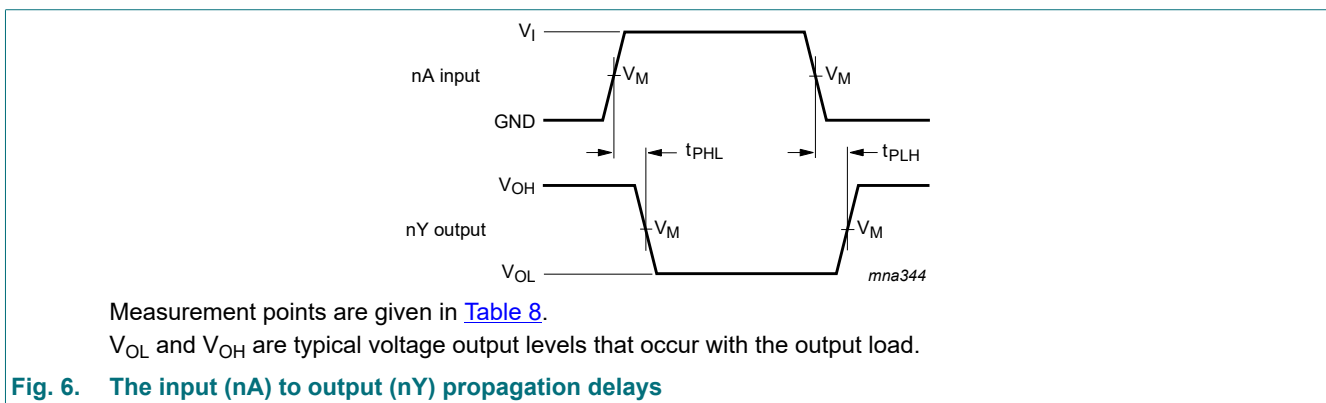
$C_L$  = output load capacitance in pF

$V_{CC}$  = supply voltage in V

$N$  = number of inputs switching

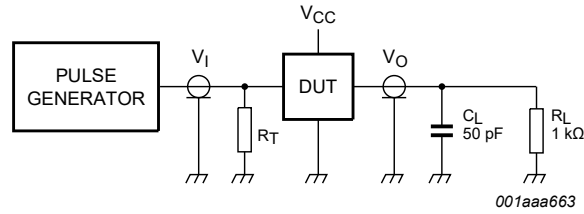
$\Sigma(C_L \times V_{CC}^2 \times f_o)$  = sum of the outputs.

### 10.1. Waveform and test circuit



**Table 8. Measurement points**

| Supply voltage      | Input       | Output      |
|---------------------|-------------|-------------|
| $V_{CC}$            | $V_M$       | $V_M$       |
| < 2.7 V             | $0.5V_{CC}$ | $0.5V_{CC}$ |
| 2.7 V to 3.6 V      | 1.5 V       | 1.5 V       |
| $\geq 4.5\text{ V}$ | $0.5V_{CC}$ | $0.5V_{CC}$ |



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.

$R_L$  = Load resistance.

$C_L$  = Load capacitance including jig and probe capacitance.

**Fig. 7. Test circuit for measuring switching times**

**Table 9. Test data**

| Supply voltage | Input    |               |
|----------------|----------|---------------|
| $V_{CC}$       | $V_I$    | $t_r, t_f$    |
| < 2.7 V        | $V_{CC}$ | $\leq 2.5$ ns |
| 2.7 V to 3.6 V | 2.7 V    | $\leq 2.5$ ns |
| $\geq 4.5$ V   | $V_{CC}$ | $\leq 2.5$ ns |

# 11. 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)

## 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 |
|----------------|--|-----------------------|---------------|------------|
| 74LV04 v.5     | 20210913   | Product data sheet    | -             | 74LV04 v.4 |
| 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>Type number 74LV04DB (SOT337-1/SSOP14) removed.</li> <li><a href="#">Section 1</a> and <a href="#">Section 2</a> updated.</li> <li><a href="#">Section 7</a>: Derating values for <math>P_{tot}</math> total power dissipation have been updated.</li> </ul> |                       |               |            |
| 74LV04 v.4     | 20151208   | Product data sheet    | -             | 74LV04 v.3 |
| Modifications: | <ul style="list-style-type: none"> <li>Type number 74LV04N (SOT27-1) removed.</li> </ul>   |                       |               |            |
| 74LV04 v.3     | 20071204   | Product data sheet    | -             | 74LV04 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><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 11</a>: outline drawing added for DHVQFN14 package.</li> </ul>                 |                       |               |            |
| 74LV04 v.2     | 19980420   | Product specification | -             | 74LV04 v.1 |
| 74LV04 v.1     | 19970203   | Product specification | -             | -          |

## 14. Legal information

### Data sheet status

| Document status [1][2]         | Product status [3] | Definition  |
|--------------------------------|--------------------|---|
| Objective [short] data sheet   | Development        | This document contains data from the objective specification for product development. |
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| 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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