

# 74LVT162374

3.3 V 16-bit edge-triggered D-type flip-flop with 30  $\Omega$  termination resistors; 3-state

Rev. 4 — 1 October 2018

Product data sheet

## 1. General description

The 74LVT162374 is a high performance BiCMOS product designed for  $V_{CC}$  operation at 3.3 V.

The 74LVT162374 is designed with 30  $\Omega$  series resistance in both the HIGH and LOW states of the output. This design reduces line noise in applications such as memory address drivers, clock drivers, and bus receivers/transmitters.

This device is a 16-bit edge-triggered D-type flip-flop featuring non-inverting 3-state outputs. The device can be used as two 8-bit flip-flops or one 16-bit flip-flop. On the positive transition of the clock (CP), the Q outputs of the flip-flop take on the logic levels set up at the D inputs.

## 2. Features and benefits

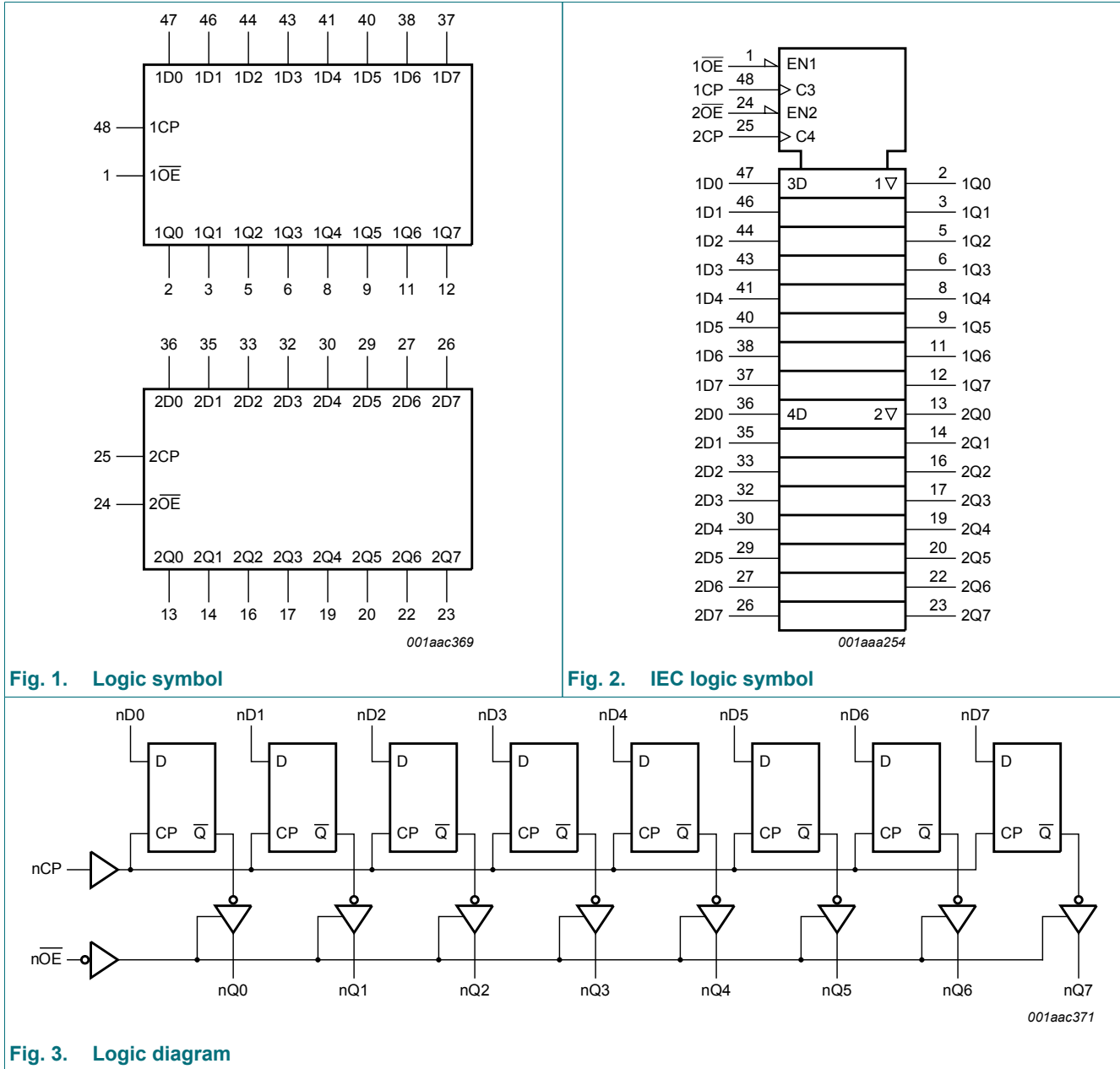
- 16-bit edge-triggered flip-flop
- 3-state buffers
- Output capability: +12 mA and -12 mA
- TTL input and output switching levels
- Input and output interface capability to systems at 5 V supply
- Bus-hold data inputs eliminate the need for external pull-up resistors to hold unused inputs
- Live insertion and extraction permitted
- Outputs include series resistance of 30  $\Omega$  making external resistors unnecessary
- Power-up reset
- Power-up 3-state
- No bus current loading when output is tied to 5 V bus
- Latch-up protection:
  - JESD78B Class II exceeds 500 mA
- ESD protection:
  - HBM: JESD22-A114F exceeds 2000 V
  - MM: JESD22-A115-A exceeds 200 V

## 3. Ordering information

Table 1. Ordering information

| Type number    | Package           |         |  |          |
|----------------|-------------------|---------|--|----------|
|                | Temperature range | Name    | Description  | Version  |
| 74LVT162374DGG | -40 °C to +85 °C  | TSSOP48 | plastic thin shrink small outline package; 48 leads; body width 6.1 mm | SOT362-1 |

### 4. Functional diagram



3.3 V 16-bit edge-triggered D-type flip-flop with 30 Ω termination resistors; 3-state

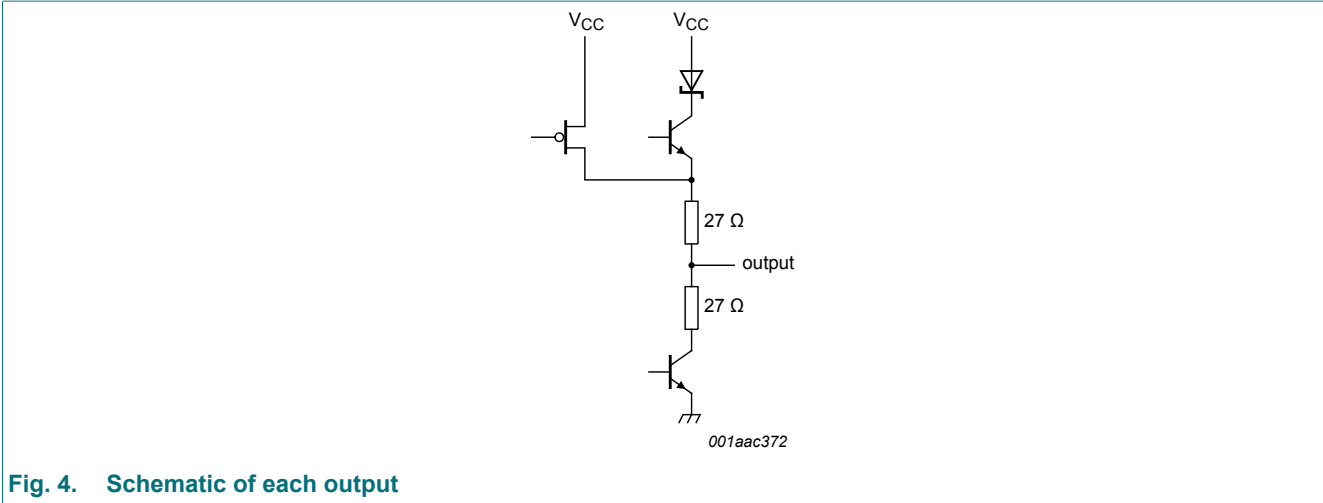


Fig. 4. Schematic of each output

5. Pinning information

5.1. Pinning

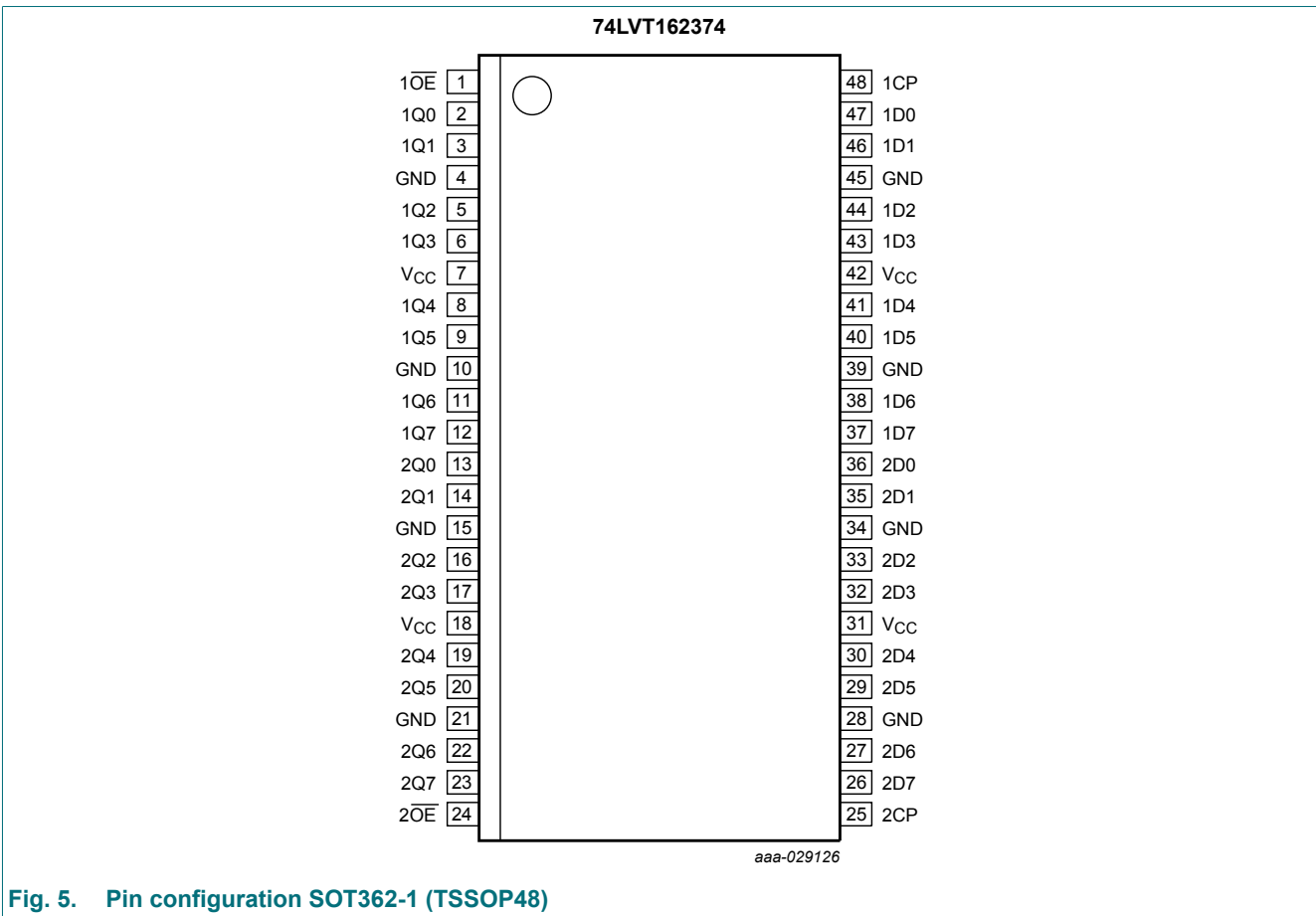


Fig. 5. Pin configuration SOT362-1 (TSSOP48)

## 5.2. Pin description

Table 2. Pin description

| Symbol                                 | Pin                            | Description                             |
|--|--------------------------------|---|
| 1D0, 1D1, 1D2, 1D3, 1D4, 1D5, 1D6, 1D7 | 47, 46, 44, 43, 41, 40, 38, 37 | data inputs                             |
| 2D0, 2D1, 2D2, 2D3, 2D4, 2D5, 2D6, 2D7 | 36, 35, 33, 32, 30, 29, 27, 26 | data inputs                             |
| 1Q0, 1Q1, 1Q2, 1Q3, 1Q4, 1Q5, 1Q6, 1Q7 | 2, 3, 5, 6, 8, 9, 11, 12       | data outputs                            |
| 2Q0, 2Q1, 2Q2, 2Q3, 2Q4, 2Q5, 2Q6, 2Q7 | 13, 14, 16, 17, 19, 20, 22, 23 | data outputs                            |
| 1OE, 2OE                               | 1, 24                          | output enable inputs (active LOW)       |
| 1CP, 2CP                               | 48, 25                         | clock pulse inputs (active rising edge) |
| GND                                    | 4, 10, 15, 21, 28, 34, 39, 45  | ground (0 V)                            |
| V <sub>CC</sub>                        | 7, 18, 31, 42                  | supply voltage                          |

## 6. Functional description

Table 3. Function table [1]

| Operating mode         | Input |     |     | Internal flip-flops | Output nQn |
|------------------------|-------|-----|-----|---------------------|------------|
|                        | nOE   | nCP | nDn |                     |            |
| Load and read register | L     | ↑   | l   | L                   | L          |
|                        | L     | ↑   | h   | H                   | H          |
| Hold                   | L     | NC  | X   | NC                  | NC         |
| Disable outputs        | H     | NC  | X   | NC                  | Z          |
|                        | H     | ↑   | nDn | nDn                 | Z          |

- [1] H = HIGH voltage level;  
 L = LOW voltage level;  
 h = HIGH voltage level one set-up time prior to the LOW-to-HIGH clock transition;  
 l = LOW voltage level one set-up time prior to the LOW-to-HIGH clock transition;  
 NC = no change;  
 X = don't care;  
 Z = high-impedance OFF-state;  
 ↑ = LOW-to-HIGH clock transition.

## 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     | +4.6 | V    |
| V <sub>I</sub>   | input voltage           |                                   | [1] -0.5 | +7.0 | V    |
| V <sub>O</sub>   | output voltage          | output in OFF-state or HIGH-state | [1] -0.5 | +7.0 | V    |
| I <sub>IK</sub>  | input clamping current  | V <sub>I</sub> < 0 V              | -50      | -    | mA   |
| I <sub>OK</sub>  | output clamping current | V <sub>O</sub> < 0 V              | -50      | -    | mA   |
| I <sub>O</sub>   | output current          | output in LOW-state               | -        | 128  | mA   |
|                  |                         | output in HIGH-state              | -64      | -    | mA   |
| T <sub>stg</sub> | storage temperature     |                                   | -65      | +150 | °C   |

3.3 V 16-bit edge-triggered D-type flip-flop with 30  $\Omega$  termination resistors; 3-state

| Symbol | Parameter            | Conditions | Min | Max  | Unit               |
|--------|----------------------|------------|-----|------|--------------------|
| $T_j$  | junction temperature | [2]        |     | +150 | $^{\circ}\text{C}$ |

- [1] The input and output negative voltage ratings may be exceeded if the input and output clamp current ratings are observed.  
 [2] The performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability.

## 8. Recommended operating conditions

Table 5. Recommended operating conditions

| Symbol              | Parameter                           | Conditions      | Min | Typ | Max | Unit               |
|---------------------|-------------------------------------|-----------------|-----|-----|-----|--------------------|
| $V_{CC}$            | supply voltage                      |                 | 2.7 | -   | 3.6 | V                  |
| $V_I$               | input voltage                       |                 | 0   | -   | 5.5 | V                  |
| $\Delta t/\Delta V$ | input transition rise and fall rate | outputs enabled | -   | -   | 10  | ns/V               |
| $T_{amb}$           | ambient temperature                 |                 | -40 | -   | +85 | $^{\circ}\text{C}$ |

## 9. Static characteristics

Table 6. Static characteristics

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

| Symbol         | Parameter                          | Conditions  | Min  | Typ[1] | Max           | Unit          |
|----------------|------------------------------------|---|------|--------|---------------|---------------|
| $V_{IK}$       | input clamping voltage             | $V_{CC} = 2.7\text{ V}$ ; $I_{IK} = -18\text{ mA}$  | -    | -0.85  | -1.2          | V             |
| $V_{IH}$       | HIGH-level input voltage           |   | 2.0  | -      | -             | V             |
| $V_{IL}$       | LOW-level input voltage            |   | -    | -      | 0.8           | V             |
| $V_{OH}$       | HIGH-level output voltage          | $V_{CC} = 3.0\text{ V}$ ; $I_{OH} = -12\text{ mA}$  | 2.0  | -      | -             | V             |
| $V_{OL}$       | LOW-level output voltage           | $V_{CC} = 3.0\text{ V}$ ; $I_{OL} = 12\text{ mA}$   | -    | -      | 0.8           | V             |
| $I_{OH}$       | HIGH-level output current          |   | -    | -      | -12           | mA            |
| $I_{OL}$       | LOW-level output current           |   | -    | -      | 12            | mA            |
| $V_{OL(pu)}$   | power-up LOW-level output voltage  | $V_{CC} = 3.6\text{ V}$ ; $I_O = 1\text{ mA}$ ; $V_I = \text{GND or } V_{CC}$ [2]   | -    | 0.1    | 0.55          | V             |
| $I_I$          | input leakage current              | all input pins [3]  |      |        |               |               |
|                |                                    | $V_{CC} = 0\text{ V or } 3.6\text{ V}$ ; $V_I = 5.5\text{ V}$   | -    | 0.4    | 10            | $\mu\text{A}$ |
|                |                                    | control pins [3]  |      |        |               |               |
|                |                                    | $V_{CC} = 3.6\text{ V}$ ; $V_I = V_{CC}$ or GND   | -    | 0.1    | $\pm 1$       | $\mu\text{A}$ |
|                |                                    | I/O data pins; $V_{CC} = 3.6\text{ V}$ [3]  |      |        |               |               |
|                | $V_I = V_{CC}$                     | -   | 0.1  | 1      | $\mu\text{A}$ |               |
|                | $V_I = 0\text{ V}$                 | -   | -0.4 | -5     | $\mu\text{A}$ |               |
| $I_{OFF}$      | power-off leakage current          | $V_{CC} = 0\text{ V}$ ; $V_I$ or $V_O = 0\text{ V to } 4.5\text{ V}$  | -    | 0.1    | $\pm 100$     | $\mu\text{A}$ |
| $I_{BHL}$      | bus hold LOW current               | nDn inputs; $V_{CC} = 3\text{ V}$ ; $V_I = 0.8\text{ V}$  | 75   | 135    | -             | $\mu\text{A}$ |
| $I_{BHH}$      | bus hold HIGH current              | nDn inputs; $V_{CC} = 3\text{ V}$ ; $V_I = 2.0\text{ V}$  | -75  | -135   | -             | $\mu\text{A}$ |
| $I_{BHLO}$     | bus hold LOW overdrive current     | nDn inputs; $V_{CC} = 3.6\text{ V}$ ; $V_I = 0\text{ V to } 3.6\text{ V}$ [4]   | 500  | -      | -             | $\mu\text{A}$ |
| $I_{BHHO}$     | bus hold HIGH overdrive current    | nDn inputs; $V_{CC} = 3.6\text{ V}$ ; $V_I = 0\text{ V to } 3.6\text{ V}$ [4]   | -    | -      | -500          | $\mu\text{A}$ |
| $I_{CEX}$      | output high leakage current        | output in HIGH-state when $V_O > V_{CC}$ ;<br>$V_O = 5.5\text{ V}$ ; $V_{CC} = 3.0\text{ V}$  | -    | 50     | 125           | $\mu\text{A}$ |
| $I_{O(pu/pd)}$ | power-up/power-down output current | $V_{CC} \leq 1.2\text{ V}$ ; $V_O = 5.0\text{ V to } V_{CC}$ ;<br>$V_I = \text{GND or } V_{CC}$ ; n $\overline{\text{OE}}$ = don't care [5] | -    | 1      | $\pm 100$     | $\mu\text{A}$ |

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| Symbol                   | Parameter                 | Conditions  | Min | Typ[1] | Max  | Unit    |
|--------------------------|---------------------------|---|-----|--------|------|---------|
| I <sub>OZ</sub>          | OFF-state output current  | V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>  |     |        |      |         |
|                          |                           | V <sub>O</sub> = 3.0 V  | -   | 0.5    | 5    | $\mu$ A |
|                          |                           | V <sub>O</sub> = 0.5 V  | -   | 0.5    | -5   | $\mu$ A |
| I <sub>CC</sub>          | supply current            | V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = GND or V <sub>CC</sub> ; I <sub>O</sub> = 0 A   |     |        |      |         |
|                          |                           | outputs HIGH  | -   | 0.07   | 0.12 | mA      |
|                          |                           | outputs LOW   | -   | 4      | 6    | mA      |
|                          |                           | outputs disabled [6]  | -   | 0.07   | 0.12 | mA      |
| $\Delta$ I <sub>CC</sub> | additional supply current | per input pin; V <sub>CC</sub> = 3 V to 3.6 V;<br>one input at V <sub>CC</sub> - 0.6 V;<br>other inputs at V <sub>CC</sub> or GND [7] | -   | 0.1    | 0.2  | mA      |
| C <sub>I</sub>           | input capacitance         | V <sub>I</sub> = 0 V or 3.0 V   | -   | 3      | -    | pF      |
| C <sub>O</sub>           | output capacitance        | outputs disabled; V <sub>O</sub> = 0 V or 3.0 V   | -   | 9      | -    | pF      |

[1] All typical values are measured at V<sub>CC</sub> = 3.3 V and T<sub>amb</sub> = 25 °C.

[2] For valid test results, data must not be loaded into the flip-flops after applying power.

[3] Unused pins at V<sub>CC</sub> or GND.

[4] This is the bus-hold overdrive current required to force the input to the opposite logic state.

[5] This parameter is valid for any V<sub>CC</sub> between 0 V and 1.2 V with a transition time of up to 10 ms. From V<sub>CC</sub> = 1.2 V to V<sub>CC</sub> = 3.3 V  $\pm$  0.3 V a transition time of 100  $\mu$ s is permitted. This parameter is valid for T<sub>amb</sub> = 25 °C only.

[6] I<sub>CC</sub> is measured with outputs pulled to V<sub>CC</sub> or GND.

[7] This is the increase in supply current for each input at the specified voltage level other than V<sub>CC</sub> or GND.

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

At recommended operating conditions; Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 9.

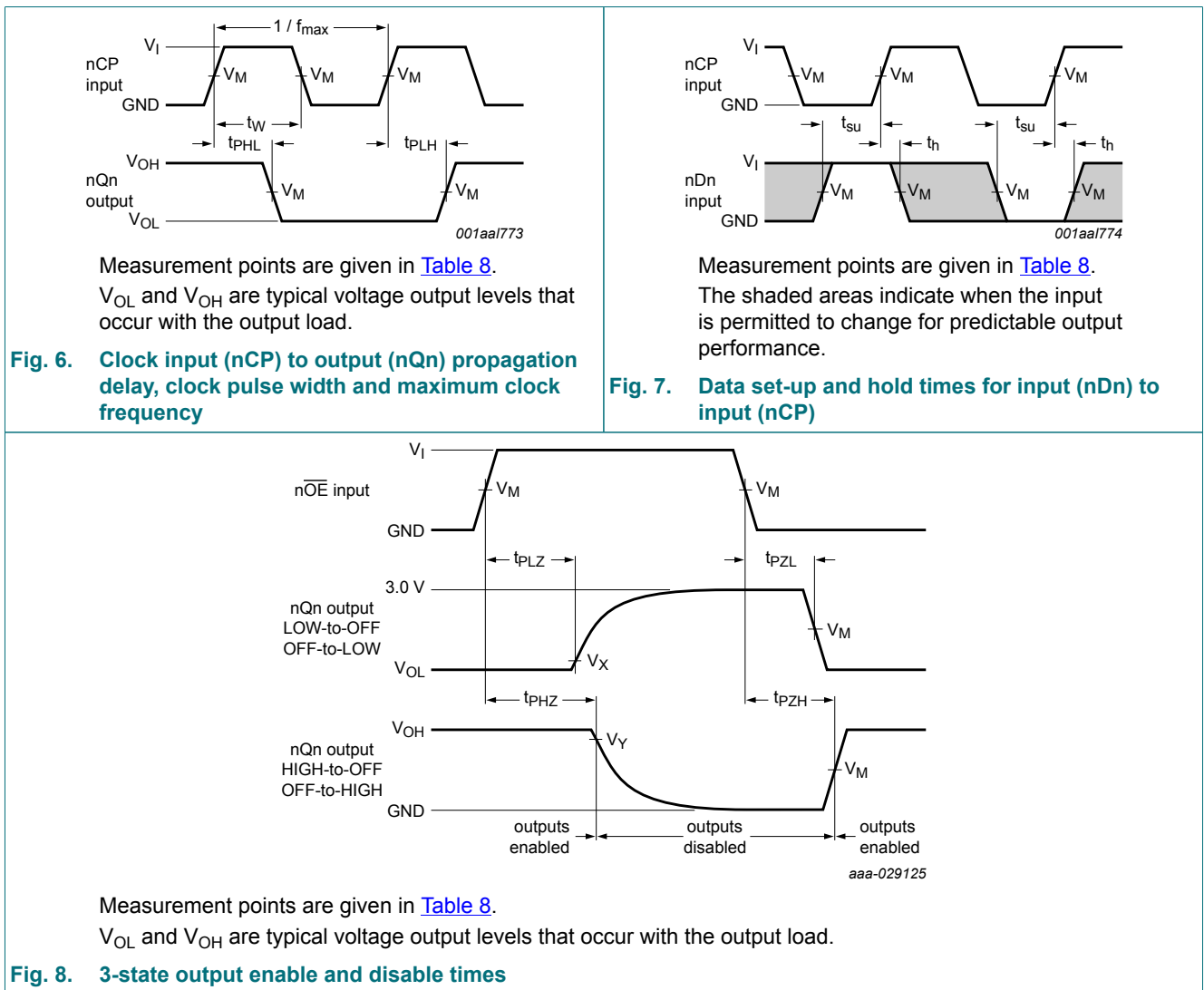
| Symbol           | Parameter                           | Conditions  | Min | Typ[1] | Max | Unit |
|------------------|-------------------------------------|---|-----|--------|-----|------|
| f <sub>max</sub> | maximum frequency                   | nCP; V <sub>CC</sub> = 3.0 V to 3.6 V; see Fig. 6 | 150 | -      | -   | MHz  |
| t <sub>PLH</sub> | LOW to HIGH propagation delay       | nCP to nQn; see Fig. 6                            |     |        |     |      |
|                  |                                     | V <sub>CC</sub> = 2.7 V                           | -   | -      | 6.2 | ns   |
|                  |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V                  | 1.5 | 3.0    | 5.3 | ns   |
| t <sub>PHL</sub> | HIGH to LOW propagation delay       | nCP to nQn; see Fig. 6                            |     |        |     |      |
|                  |                                     | V <sub>CC</sub> = 2.7 V                           | -   | -      | 5.1 | ns   |
|                  |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V                  | 1.5 | 3.0    | 4.9 | ns   |
| t <sub>PZH</sub> | OFF-state to HIGH propagation delay | n $\overline$ O $\overline$ E to nQn; see Fig. 8  |     |        |     |      |
|                  |                                     | V <sub>CC</sub> = 2.7 V                           | -   | -      | 6.9 | ns   |
|                  |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V                  | 1.5 | 3.5    | 5.6 | ns   |
| t <sub>PZL</sub> | OFF-state to LOW propagation delay  | n $\overline$ O $\overline$ E to nQn; see Fig. 8  |     |        |     |      |
|                  |                                     | V <sub>CC</sub> = 2.7 V                           | -   | -      | 6.0 | ns   |
|                  |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V                  | 1.5 | 3.2    | 4.9 | ns   |
| t <sub>PHZ</sub> | HIGH to OFF-state propagation delay | n $\overline$ O $\overline$ E to nQn; see Fig. 8  |     |        |     |      |
|                  |                                     | V <sub>CC</sub> = 2.7 V                           | -   | -      | 5.7 | ns   |
|                  |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V                  | 1.5 | 3.5    | 5.4 | ns   |
| t <sub>PLZ</sub> | LOW to OFF-state propagation delay  | n $\overline$ O $\overline$ E to nQn; see Fig. 8  |     |        |     |      |
|                  |                                     | V <sub>CC</sub> = 2.7 V                           | -   | -      | 5.1 | ns   |
|                  |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V                  | 1.5 | 3.2    | 5.0 | ns   |

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| Symbol          | Parameter        | Conditions                       | Min | Typ[1] | Max | Unit |
|-----------------|------------------|----------------------------------|-----|--------|-----|------|
| t <sub>su</sub> | set-up time      | nDn to nCP; see Fig. 7           |     |        |     |      |
|                 |                  | V <sub>CC</sub> = 2.7 V          | 2.0 | -      | -   | ns   |
|                 |                  | V <sub>CC</sub> = 3.0 V to 3.6 V | 2.0 | 0.7    | -   | ns   |
| t <sub>h</sub>  | hold time        | nDn to nCP; see Fig. 7           |     |        |     |      |
|                 |                  | V <sub>CC</sub> = 2.7 V          | 0.1 | -      | -   | ns   |
|                 |                  | V <sub>CC</sub> = 3.0 V to 3.6 V | 0.8 | 0      | -   | ns   |
| t <sub>WH</sub> | pulse width HIGH | nCP; see Fig. 6                  |     |        |     |      |
|                 |                  | V <sub>CC</sub> = 2.7 V          | 1.5 | -      | -   | ns   |
|                 |                  | V <sub>CC</sub> = 3.0 V to 3.6 V | 1.5 | 0.6    | -   | ns   |
| t <sub>WL</sub> | pulse width LOW  | nCP                              |     |        |     |      |
|                 |                  | V <sub>CC</sub> = 2.7 V          | 3.0 | -      | -   | ns   |
|                 |                  | V <sub>CC</sub> = 3.0 V to 3.6 V | 3.0 | 1.6    | -   | ns   |

[1] Typical values are measured at V<sub>CC</sub> = 3.3 V and T<sub>amb</sub> = 25 °C.

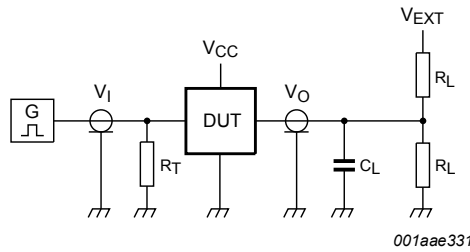
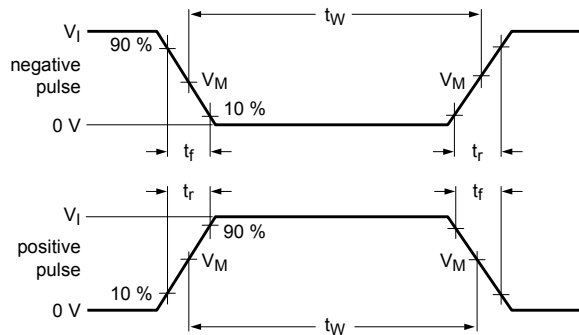
10.1. Waveforms and test circuit



3.3 V 16-bit edge-triggered D-type flip-flop with 30 Ω termination resistors; 3-state

Table 8. Measurement points

| Input |       | Output |                  |                  |
|-------|-------|--------|------------------|------------------|
| $V_I$ | $V_M$ | $V_M$  | $V_X$            | $V_Y$            |
| 2.7 V | 1.5 V | 1.5 V  | $V_{OL} + 0.3 V$ | $V_{OH} - 0.3 V$ |



001aee331

Test data is given in [Table 9](#).

Definitions:

$R_L$  = Load resistance.

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

$R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.

$V_{EXT}$  = Test voltage for switching times.

Fig. 9. Test circuit for measuring switching times

Table 9. Test data

| Input |                       |        |                       | Load  |       | $V_{EXT}$          |                    |                    |
|-------|-----------------------|--------|-----------------------|-------|-------|--------------------|--------------------|--------------------|
| $V_I$ | $f_i$                 | $t_w$  | $t_r, t_f$            | $C_L$ | $R_L$ | $t_{PHZ}, t_{PZH}$ | $t_{PLZ}, t_{PZL}$ | $t_{PLH}, t_{PHL}$ |
| 2.7 V | $\leq 10 \text{ MHz}$ | 500 ns | $\leq 2.5 \text{ ns}$ | 50 pF | 500 Ω | GND                | 6 V                | open               |



### 11. Package outline

TSSOP48: plastic thin shrink small outline package; 48 leads; body width 6.1 mm

SOT362-1

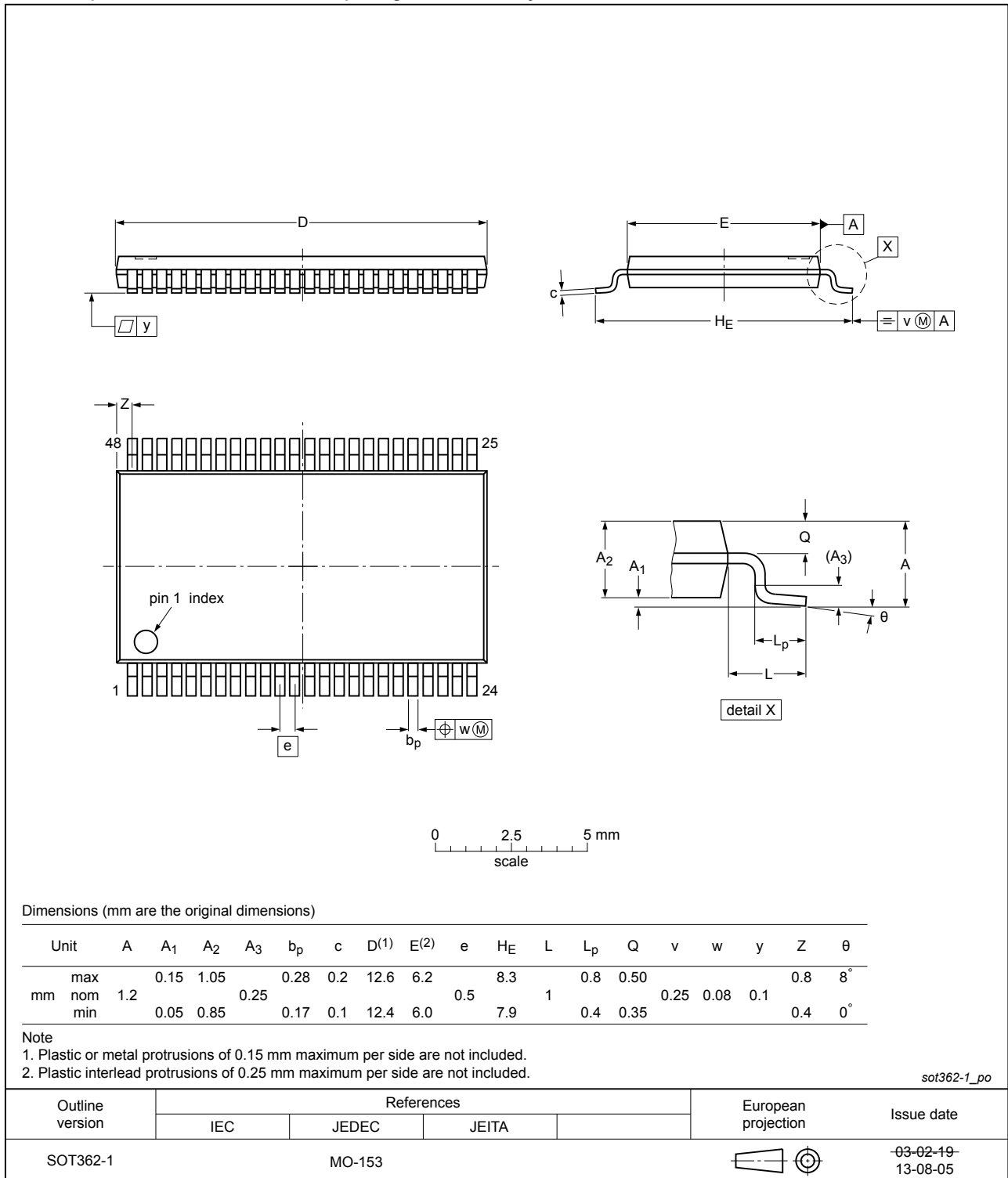


Fig. 10. Package outline SOT362-1 (TSSOP48)

## 12. Abbreviations

Table 10. Abbreviations

| Acronym | Description                                     |
|---------|---|
| BiCMOS  | Bipolar Complementary Metal Oxide Semiconductor |
| DUT     | Device Under Test                               |
| ESD     | ElectroStatic Discharge                         |
| MIL     | Military  |
| MM      | Machine Model                                   |
| TTL     | Transistor-Transistor Logic                     |

## 13. Revision history

Table 11. Revision history

| Document ID     | Release date   | Data sheet status     | Change notice | Supersedes      |
|-----------------|--|-----------------------|---------------|-----------------|
| 74LVT162374 v.4 | 20181001   | Product data sheet    | -             | 74LVT162374 v.3 |
| 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 74LVT162374DL (SOT370-1) removed</li> <li>Section "Quick reference data" removed</li> </ul>  |                       |               |                 |
| 74LVT162374 v.3 | 20050117   | Product data sheet    | -             | 74LVT162374 v.2 |
| Modifications:  | <ul style="list-style-type: none"> <li>The format of this data sheet is redesigned to comply with the current presentation and information standard of Philips Semiconductors.</li> <li><a href="#">Section 2</a>: Changed JEDEC Std 17 into JESD78</li> <li>Table 1 "Quick reference data": Changed <math>t_{PLH}</math> and <math>t_{PHL}</math> propagation delays nCP to nQn to 3.0 ns</li> <li><a href="#">Table 7</a>: Changed the minimum values of <math>t_{h(H)}</math> and <math>t_{h(L)}</math> hold time nDn to nCP to 0.8 ns</li> </ul> |                       |               |                 |
| 74LVT162374 v.2 | 20040922   | Product specification | -             | 74LVT162374 v.1 |
| 74LVT162374 v.1 | 19990923   | Product specification | -             | -               |

3.3 V 16-bit edge-triggered D-type flip-flop with 30  $\Omega$  termination resistors; 3-state

## 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. |
| 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 <https://www.nexperia.com>.

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