

DATA SHEET

74AVC16374

**16-bit edge triggered D-type
flip-flop; 3.6 V tolerant; 3-state**

Product Specification
Supersedes data of 1998 Dec 11
File under Integrated Circuits, IC24

2000 Mar 09

**16-bit edge triggered D-type flip-flop; 3.6 V tolerant;
3-state**

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FEATURES

- Wide supply voltage range from 1.2 to 3.6 V
- Complies with JEDEC standard no. 8-1A/5/7
- CMOS low power consumption
- Input/output tolerant up to 3.6 V
- DCO (Dynamic Controlled Output) circuit dynamically changes output impedance, resulting in noise reduction without speed degradation
- Low inductance multiple V_{CC} and GND pins to minimize noise and ground bounce
- Supports Live Insertion.

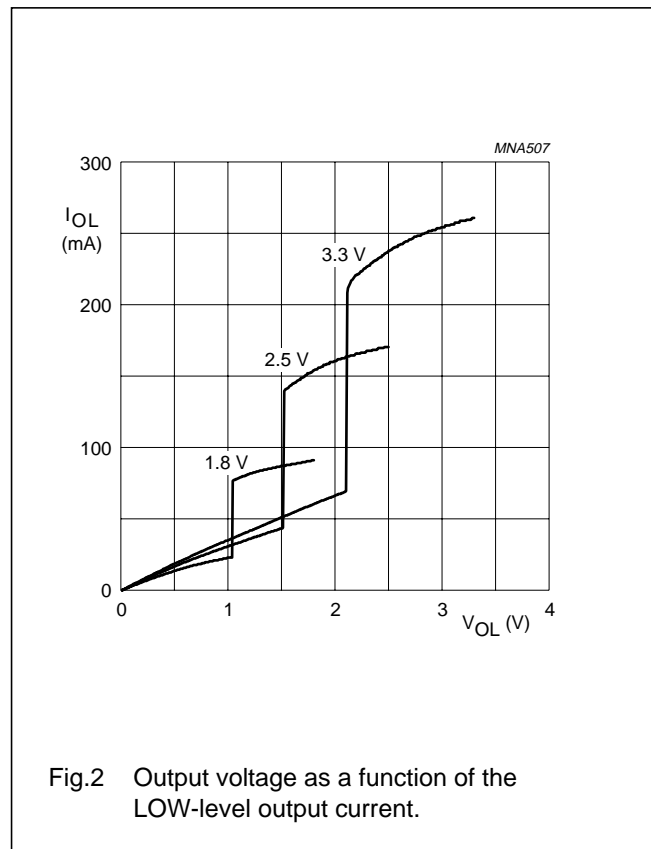
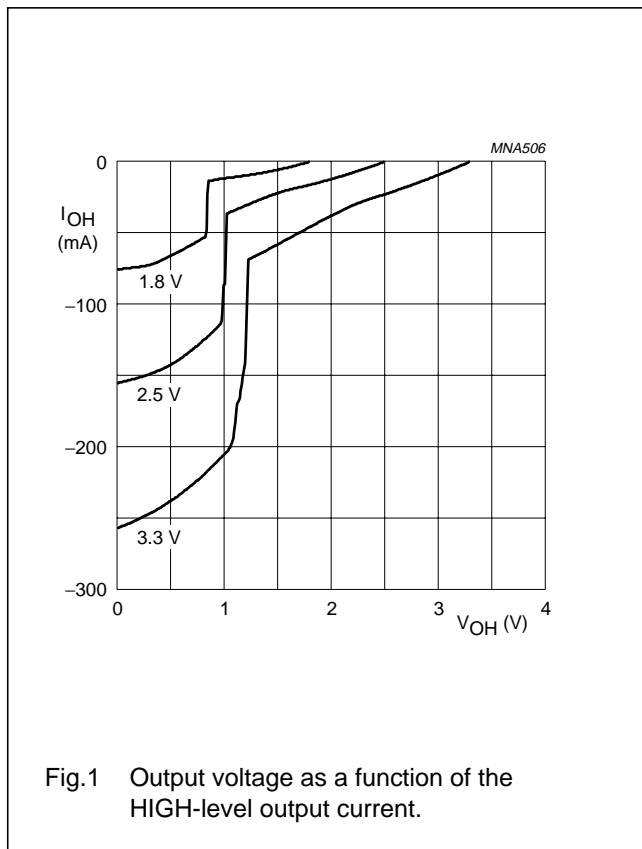
DESCRIPTION

The 74AVC16374 is a 16-bit edge triggered flip-flop featuring separate D-type inputs for each flip-flop and 3-state outputs for bus oriented applications. The 74AVC16374 consist of 2 sections of eight edge triggered flip-flops. A clock input (CP) and an output enable (\overline{OE}) are provided per 8-bit section.

The 74AVC16374 is designed to have an extremely fast propagation delay and a minimum amount of power consumption.

To ensure the high-impedance output state during power-up or power-down, $n\overline{OE}$ should be tied to V_{CC} through a pull-up resistor (Live Insertion).

A Dynamic Controlled Output (DCO) circuitry is implemented to support termination line drive during transient (see Figs 1 and 2).



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QUICK REFERENCE DATAGND = 0 V; $T_{amb} = 25\text{ }^{\circ}\text{C}$; $t_r = t_f \leq 2.0\text{ ns}$.

| SYMBOL | PARAMETER | CONDITIONS | TYP. | UNIT |
|-------------------|---|----------------------------------|------|------|
| t_{PHL}/t_{PLH} | propagation delay nCP to nQ _n | $V_{CC} = 1.2\text{ V}$ | 3.1 | ns |
| | | $V_{CC} = 1.5\text{ V}$ | 2.4 | ns |
| | | $V_{CC} = 1.8\text{ V}$ | 2.0 | ns |
| | | $V_{CC} = 2.5\text{ V}$ | 1.5 | ns |
| | | $V_{CC} = 3.3\text{ V}$ | 1.3 | ns |
| f_{max} | maximum clock pulse frequency | $V_{CC} = 1.2\text{ V}$ | 250 | MHz |
| | | $V_{CC} = 1.5\text{ V}$ | 300 | MHz |
| | | $V_{CC} = 1.8\text{ V}$ | 320 | MHz |
| | | $V_{CC} = 2.5\text{ V}$ | 350 | MHz |
| | | $V_{CC} = 3.3\text{ V}$ | 350 | MHz |
| C_I | input capacitance | | 5.0 | pF |
| C_{PD} | power dissipation capacitance per buffer | notes 1 and 2 outputs enabled | 66 | pF |
| | | outputs disabled | 1 | pF |

Notes

- C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

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

f_i = input frequency in MHz; f_o = output frequency in MHz;

C_L = output load capacitance in pF;

V_{CC} = supply voltage in Volts;

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

- The condition is $V_I = \text{GND to } V_{CC}$.

FUNCTION TABLE

See note 1.

| OPERATING MODES | INPUTS | | | INTERNAL FLIP-FLOPS | OUTPUTS |
|-----------------------------------|--------|-----|-----------------|------------------------|-----------------|
| | nOE | nCP | nD _n | | nQ _n |
| Load and read register | L | ↑ | l | L | L |
| | L | ↑ | h | H | H |
| Load register and disable outputs | H | ↑ | l | L | Z |
| | H | ↑ | h | H | Z |

Note

- H = HIGH voltage level;
h = HIGH voltage level one set-up time prior to the LOW-to-HIGH CP transition;
L = LOW voltage level;
l = LOW voltage level one set-up time prior to the LOW-to-HIGH CP transition;
Z = high impedance OFF-state;
↑ = LOW-to-HIGH CP transition.

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ORDERING AND PACKAGE INFORMATION

| TYPE NUMBER | PACKAGE | | | | |
|---------------|-------------------|------|---------|----------|----------|
| | TEMPERATURE RANGE | PINS | PACKAGE | MATERIAL | CODE |
| 74AVC16374DGG | -40 to +85 °C | 48 | TSSOP | plastic | SOT362-1 |

PINNING

| PIN | SYMBOL | DESCRIPTION |
|-----------------------------------|------------------|----------------------------------|
| 1 | $1\overline{OE}$ | output enable input (active LOW) |
| 2, 3, 5, 6, 8, 9, 11 and 12 | $1Q_0$ to $1Q_7$ | 3-state flip-flop outputs |
| 4, 10, 15, 21, 28, 34, 39 and 45 | GND | ground (0 V) |
| 7, 18, 31 and 42 | V_{CC} | DC supply voltage |
| 13, 14, 16, 17, 19, 20, 22 and 23 | $2Q_0$ to $2Q_7$ | 3-state flip-flop outputs |
| 24 | $2\overline{OE}$ | output enable input (active LOW) |
| 25 | 2CP | clock input |
| 26, 27, 29, 30, 32, 33, 35 and 36 | $2D_7$ to $2D_0$ | data inputs |
| 37, 38, 40, 41, 43, 44, 46 and 47 | $1D_7$ to $1D_0$ | data inputs |
| 48 | 1CP | clock input |

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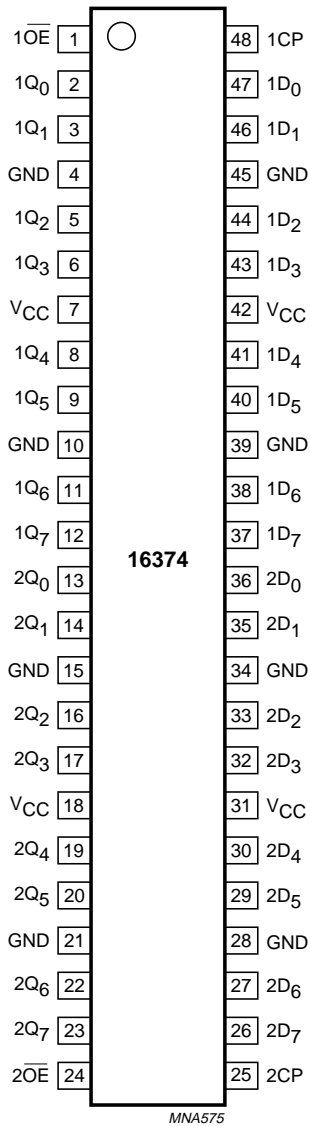


Fig.3 Pin configuration.

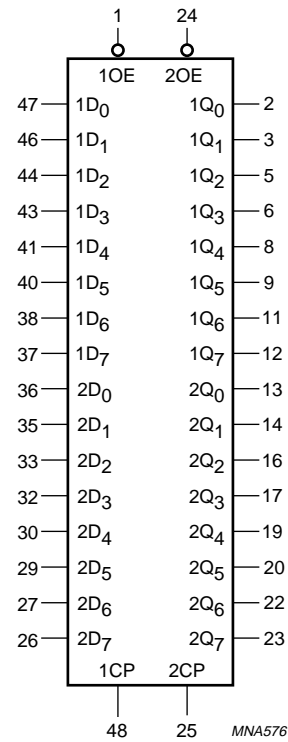


Fig.4 Logic symbol.

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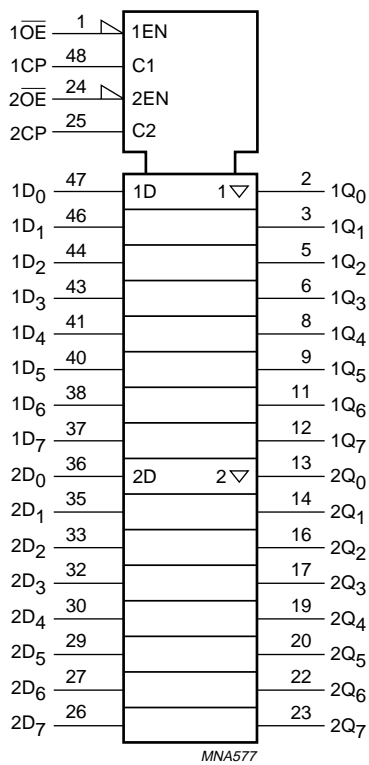


Fig.5 IEEE/IEC logic symbol.

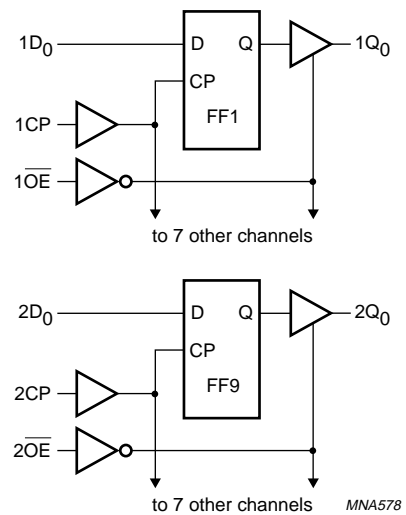


Fig.6 Logic diagram.

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RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|------------|---------------------------------|--|------|----------|------|
| V_{CC} | DC supply voltage | according to JEDEC Low Voltage Standards | 1.4 | 1.6 | V |
| | | | 1.65 | 1.95 | V |
| | | | 2.3 | 2.7 | V |
| | | | 3.0 | 3.6 | V |
| | | for low-voltage applications | 1.2 | 3.6 | V |
| V_I | DC input voltage | | 0 | 3.6 | V |
| V_O | DC output voltage | output 3-state | 0 | 3.6 | V |
| | | output HIGH or LOW state | 0 | V_{CC} | V |
| T_{amb} | operating ambient temperature | in free air | -40 | +85 | °C |
| t_r, t_f | input rise and fall time ratios | $V_{CC} = 1.4$ to 1.6 V | 0 | 40 | ns/V |
| | | $V_{CC} = 1.65$ to 2.3 V | 0 | 30 | ns/V |
| | | $V_{CC} = 2.3$ to 3.0 V | 0 | 20 | ns/V |
| | | $V_{CC} = 3.0$ to 3.6 V | 0 | 10 | ns/V |

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} | DC supply voltage | | -0.5 | +4.6 | V |
| I_{IK} | DC input diode current | $V_I < 0$ | - | -50 | mA |
| V_I | DC input voltage | for inputs; note 1 | -0.5 | +4.6 | V |
| I_{OK} | DC output clamping diode current | $V_O < 0$ | - | -50 | mA |
| V_O | DC output voltage | output HIGH or LOW state; note 1 | -0.5 | $V_{CC} + 0.5$ | V |
| | | output 3-state; note 1 | -0.5 | +4.6 | V |
| I_O | DC output sink current | $V_O = 0$ to V_{CC} | - | 50 | mA |
| I_{CC}, I_{GND} | DC V_{CC} or GND current | | - | ±100 | mA |
| T_{stg} | storage temperature | | -65 | +150 | °C |
| P_D | power dissipation per package | for temperature range: -40 to +85 °C; note 2 | - | 500 | mW |

Notes

1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. Above 60 °C the value of P_D derates linearly with 5.5 mW/K.

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DC CHARACTERISTICS

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

| SYMBOL | PARAMETER | TEST CONDITIONS | | $T_{amb} = -40 \text{ to } +85 \text{ } ^\circ\text{C}$ | | | UNIT |
|-------------------|-----------------------------------|--|--------------|---|---------------------|----------------------|---------------|
| | | OTHER | V_{CC} (V) | MIN. | TYP. ⁽¹⁾ | MAX. | |
| V_{IH} | HIGH-level input voltage | | 1.2 | V_{CC} | – | – | V |
| | | | 1.4 to 1.6 | $0.65 \times V_{CC}$ | 0.9 | – | V |
| | | | 1.65 to 1.95 | $0.65 \times V_{CC}$ | 0.9 | – | V |
| | | | 2.3 to 2.7 | 1.7 | 1.2 | – | V |
| | | | 3.0 to 3.6 | 2.0 | 1.5 | – | V |
| V_{IL} | LOW-level input voltage | | 1.2 | – | – | GND | V |
| | | | 1.4 to 1.6 | – | 0.9 | $0.35 \times V_{CC}$ | V |
| | | | 1.65 to 1.95 | – | 0.9 | $0.35 \times V_{CC}$ | V |
| | | | 2.3 to 2.7 | – | 1.2 | 0.7 | V |
| | | | 3.0 to 3.6 | – | 1.5 | 0.8 | V |
| V_{OH} | HIGH-level output voltage | $V_I = V_{IH}$ or V_{IL} $I_O = -100 \mu\text{A}$ | 1.65 to 3.6 | $V_{CC} - 0.20$ | V_{CC} | – | V |
| | | $I_O = -3 \text{ mA}$ | 1.4 | $V_{CC} - 0.35$ | $V_{CC} - 0.23$ | – | V |
| | | $I_O = -4 \text{ mA}$ | 1.65 | $V_{CC} - 0.45$ | $V_{CC} - 0.25$ | – | V |
| | | $I_O = -8 \text{ mA}$ | 2.3 | $V_{CC} - 0.55$ | $V_{CC} - 0.38$ | – | V |
| | | $I_O = -12 \text{ mA}$ | 3.0 | $V_{CC} - 0.70$ | $V_{CC} - 0.48$ | – | V |
| V_{OL} | LOW-level output voltage | $V_I = V_{IH}$ or V_{IL} $I_O = 100 \mu\text{A}$ | 1.65 to 3.6 | – | GND | 0.20 | V |
| | | $I_O = 3 \text{ mA}$ | 1.4 | – | 0.10 | 0.35 | V |
| | | $I_O = 4 \text{ mA}$ | 1.65 | – | 0.10 | 0.45 | V |
| | | $I_O = 8 \text{ mA}$ | 2.3 | – | 0.26 | 0.55 | V |
| | | $I_O = 12 \text{ mA}$ | 3.0 | – | 0.36 | 0.70 | V |
| I_I | input leakage current per pin | $V_I = V_{CC}$ or GND | 1.4 to 3.6 | – | 0.1 | 2.5 | μA |
| I_{off} | power-off leakage current | V_I or $V_O = 3.6 \text{ V}$ | 0 | – | 0.1 | ± 10 | μA |
| I_{IHZ}/I_{ILZ} | input current for common I/O pins | $V_I = V_{CC}$ or GND | 1.4 to 3.6 | – | 0.1 | 12.5 | μA |
| I_{OZ} | 3-state output OFF-state current | $V_I = V_{IH}$ or V_{IL} ; $V_O = V_{CC}$ or GND | 1.4 to 2.7 | – | 0.1 | 5 | μA |
| | | | 3.0 to 3.6 | – | 0.1 | 10 | μA |
| I_{CC} | quiescent supply current | $V_I = V_{CC}$ or GND; $I_O = 0$ | 1.4 to 2.7 | – | 0.1 | 20 | μA |
| | | | 3.0 to 3.6 | – | 0.2 | 40 | μA |

Note

1. All typical values are measured at $T_{amb} = 25 \text{ } ^\circ\text{C}$.

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74AVC16374**AC CHARACTERISTICS**GND = 0 V; $t_r = t_f \leq 2.0$ ns.

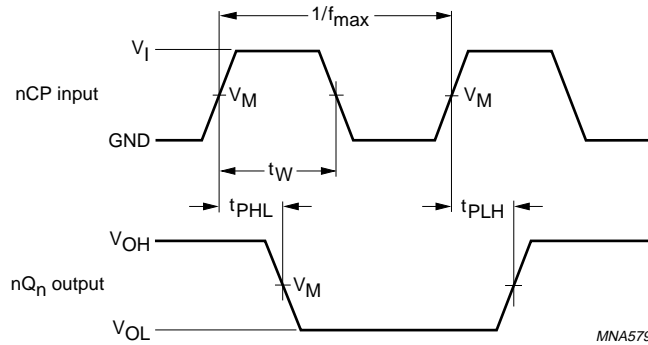
| SYMBOL | PARAMETER | TEST CONDITIONS | | $T_{amb} = -40$ to $+85$ °C | | | UNIT |
|-------------------|---|-------------------|--------------|-----------------------------|---------------------|------|------|
| | | WAVEFORMS | V_{CC} (V) | MIN. | TYP. ⁽¹⁾ | MAX. | |
| t_{PHL}/t_{PLH} | propagation delay nCP to nQ _n | see Figs 7 and 10 | 1.2 | – | 3.1 | – | ns |
| | | | 1.40 to 1.60 | 1.2 | 2.4 | 8.4 | ns |
| | | | 1.65 to 1.95 | 1.0 | 2.0 | 6.7 | ns |
| | | | 2.3 to 2.7 | 0.8 | 1.5 | 4.1 | ns |
| | | | 3.0 to 3.6 | 0.7 | 1.3 | 3.3 | ns |
| t_{PZH}/t_{PZL} | 3-state output enable time nOE to nQ _n | see Figs 8 and 10 | 1.2 | – | 5.4 | – | ns |
| | | | 1.40 to 1.60 | 1.6 | 3.9 | 8.5 | ns |
| | | | 1.65 to 1.95 | 2.3 | 3.3 | 6.7 | ns |
| | | | 2.3 to 2.7 | 0.9 | 2.3 | 4.3 | ns |
| | | | 3.0 to 3.6 | 0.7 | 2.0 | 3.4 | ns |
| t_{PHZ}/t_{PLZ} | 3-state output disable time nOE to nQ _n | see Figs 8 and 10 | 1.2 | – | 5.6 | – | ns |
| | | | 1.40 to 1.60 | 2.5 | 4.5 | 9.4 | ns |
| | | | 1.65 to 1.95 | 1.8 | 3.3 | 7.8 | ns |
| | | | 2.3 to 2.7 | 1.0 | 1.8 | 4.2 | ns |
| | | | 3.0 to 3.6 | 1.2 | 2.0 | 3.9 | ns |
| t_w | nCP pulse width HIGH | see Figs 7 and 10 | 1.2 | – | 0.8 | – | ns |
| | | | 1.40 to 1.60 | – | 0.5 | – | ns |
| | | | 1.65 to 1.95 | 3.1 | 0.3 | – | ns |
| | | | 2.3 to 2.7 | 2.5 | 0.2 | – | ns |
| | | | 3.0 to 3.6 | 2.5 | 0.2 | – | ns |
| t_{su} | set-up time nD _n to nCP | see Figs 9 and 10 | 1.2 | – | –0.6 | – | ns |
| | | | 1.40 to 1.60 | 2.7 | –0.3 | – | ns |
| | | | 1.65 to 1.95 | 1.9 | –0.3 | – | ns |
| | | | 2.3 to 2.7 | 1.4 | –0.2 | – | ns |
| | | | 3.0 to 3.6 | 1.4 | –0.1 | – | ns |
| t_h | hold time nD _n to nCP | see Figs 9 and 10 | 1.2 | – | 0.8 | – | ns |
| | | | 1.40 to 1.60 | 1.3 | 0.7 | – | ns |
| | | | 1.65 to 1.95 | 1.2 | 0.6 | – | ns |
| | | | 2.3 to 2.7 | 1.1 | 0.5 | – | ns |
| | | | 3.0 to 3.6 | 1.1 | 0.4 | – | ns |
| f_{max} | maximum clock pulse frequency | see Figs 7 and 10 | 1.2 | – | 250 | – | MHz |
| | | | 1.40 to 1.60 | – | 300 | – | MHz |
| | | | 1.65 to 1.95 | 160 | 320 | – | MHz |
| | | | 2.3 to 2.7 | 200 | 350 | – | MHz |
| | | | 3.0 to 3.6 | 200 | 350 | – | MHz |

Note1. All typical values are measured at $T_{amb} = 25$ °C and at V_{CC} respectively 1.2, 1.5, 1.8, 2.5 and 3.3 V.

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AC WAVEFORMS

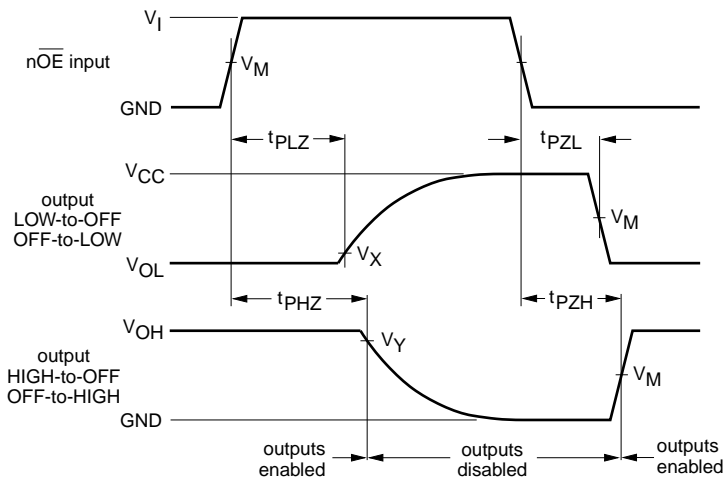


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| V _{CC} | V _M | V _I |
|-----------------|-----------------------|-----------------|
| ≤2.3 to 2.7 V | 0.5 × V _{CC} | V _{CC} |
| 3.0 to 3.6 V | 0.5 × V _{CC} | V _{CC} |

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

Fig.7 Clock input (nCP) to output (nQ_n) propagation delays.



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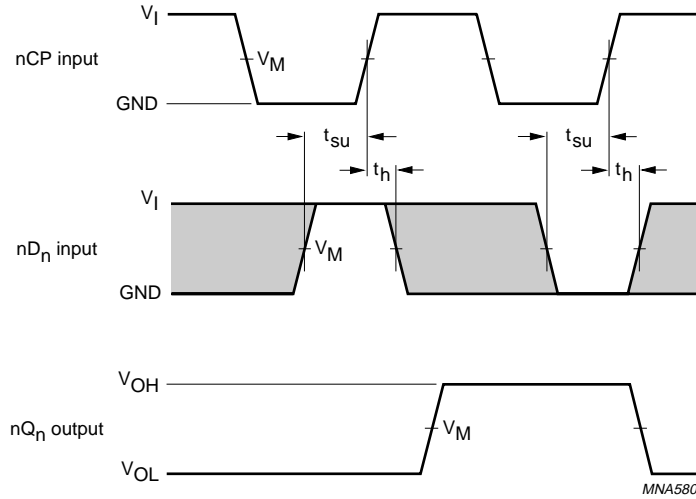
| V _{CC} | V _M | V _X | V _Y | V _I |
|-----------------|-----------------------|--------------------------|--------------------------|-----------------|
| ≤2.3 to 2.7 V | 0.5 × V _{CC} | V _{OL} + 0.15 V | V _{OH} - 0.15 V | V _{CC} |
| 3.0 to 3.6 V | 0.5 × V _{CC} | V _{OL} + 0.3 V | V _{OH} - 0.3 V | V _{CC} |

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

Fig.8 3-state enable and disable times.

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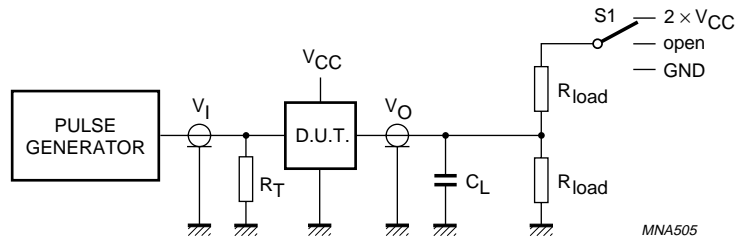


The shaded areas indicate when the input is permitted to change for predictable output performance.

| V _{CC} | V _M | V _I |
|-----------------|-----------------------|-----------------|
| ≤2.3 to 2.7 V | 0.5 × V _{CC} | V _{CC} |
| 3.0 to 3.6 V | 0.5 × V _{CC} | V _{CC} |

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

Fig.9 Data set-up and hold times for nD_n input to nCP input.



| TEST | S1 | V _{CC} (V) | V _I | R _{load} | C _L |
|------------------------------------|---------------------|---------------------|-----------------|-------------------|----------------|
| t _{PLH} /t _{PHL} | open | 1.2 | V _{CC} | 2000 Ω | 15 pF |
| t _{PLZ} /t _{PZL} | 2 × V _{CC} | 1.4 – 1.6 | V _{CC} | 2000 Ω | 15 pF |
| t _{PHZ} /t _{PZH} | GND | 1.65 – 1.95 | V _{CC} | 1000 Ω | 30 pF |
| | | 2.3 – 2.7 | V _{CC} | 500 Ω | 30 pF |
| | | 3.0 – 3.6 | V _{CC} | 500 Ω | 30 pF |

Fig.10 Load circuitry for switching times.

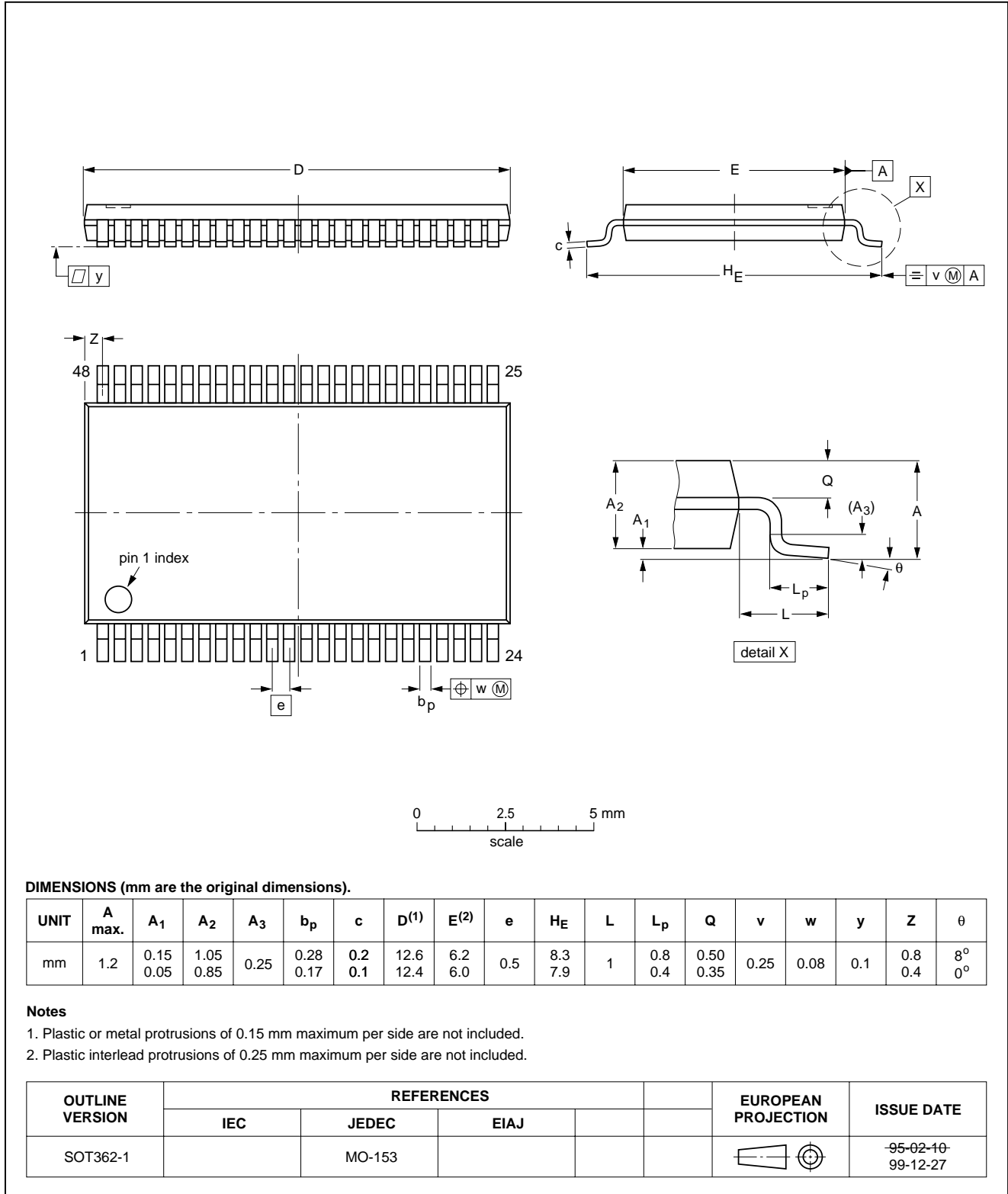
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PACKAGE OUTLINE

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

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SOLDERING

Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
 - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
 - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

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Suitability of surface mount IC packages for wave and reflow soldering methods

| PACKAGE | SOLDERING METHOD | |
|--|-----------------------------------|-----------------------|
| | WAVE | REFLOW ⁽¹⁾ |
| BGA, LFBGA, SQFP, TFBGA | not suitable | suitable |
| HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS | not suitable ⁽²⁾ | suitable |
| PLCC ⁽³⁾ , SO, SOJ | suitable | suitable |
| LQFP, QFP, TQFP | not recommended ⁽³⁾⁽⁴⁾ | suitable |
| SSOP, TSSOP, VSO | not recommended ⁽⁵⁾ | suitable |

Notes

- All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the "Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods".
- These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
- If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
- Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
- Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

DEFINITIONS

| Data sheet status | |
|---|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| Limiting values | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| Application information | |
| Where application information is given, it is advisory and does not form part of the specification. | |

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

16-bit edge triggered D-type flip-flop; 3.6 V tolerant;
3-state

74AVC16374

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