

DATA SHEET

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74LVC16374A/74LVCH16374A

16-bit edge triggered D-type flip-flop with
5 Volt tolerant inputs/outputs (3-State)

Product specification
Supersedes data of 1997 Aug 22
IC24 Data Handbook

1998 Mar 17

16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/ 74LVCH16374A

FEATURES

- 5 volt tolerant inputs/outputs for interfacing with 5V logic
- Wide supply voltage range of 1.2 V to 3.6 V
- Complies with JEDEC standard no. 8-1A
- CMOS low power consumption
- MULTIBYTE™ flow-through standard pin-out architecture
- Low inductance multiple power and ground pins for minimum noise and ground bounce
- Direct interface with TTL levels
- All data inputs have bus hold (74LVCH16374A only)
- High impedance when $V_{CC} = 0$

DESCRIPTION

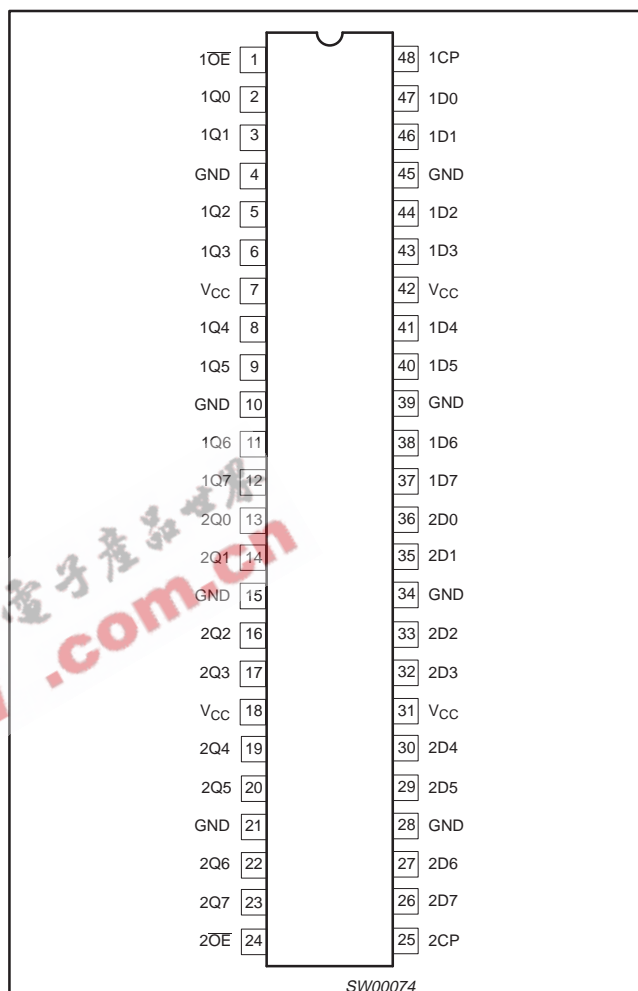
The 74LVC(H)16374A is a 16-bit edge-triggered flip-flop featuring separate D-type inputs for each flip-flop and 3-State outputs for bus oriented applications. The 74LVC16374A consists of 2 sections of eight positive edge-triggered flip-flops. A clock (CP) input and an output enable (\overline{OE}) are provided for each octal. Inputs can be driven from either 3.3V or 5V devices. In 3-State operation, outputs can handle 5V. These features allow the use of these devices in a mixed 3.3V/5V environment.

The flip-flops will store the state of their individual D-inputs that meet the set-up and hold time requirements on the LOW-to-HIGH CP transition.

When \overline{OE} is LOW, the contents of the flip-flops are available at the outputs. When \overline{OE} is HIGH, the outputs go to the high impedance OFF-state. Operation of the \overline{OE} input does not affect the state of the flip-flops.

The 74LVCH16374A bus hold data inputs eliminates the need for external pull up resistors to hold unused inputs.

PIN CONFIGURATION



QUICK REFERENCE DATA

GND = 0V; $T_{amb} = 25^{\circ}\text{C}$; $t_r = t_f \leq 2.5 \text{ ns}$

| SYMBOL | PARAMETER | CONDITIONS | TYPICAL | UNIT |
|-------------------|---|---|---------|------|
| t_{PHL}/t_{PLH} | Propagation delay Cp to Qn | $C_L = 50\text{pF}$ $V_{CC} = 3.3\text{V}$ | 3.8 | ns |
| f_{MAX} | Maximum clock frequency | | 150 | MHz |
| C_I | Input capacitance | | 5.0 | pF |
| C_{PD} | Power dissipation capacitance per flip-flop | $V_{CC} = 3.3\text{V}^1$ | 30 | pF |

NOTES:

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):
 $P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$ where:
 f_i = input frequency in MHz; C_L = output load capacity in pF;
 f_o = output frequency in MHz; V_{CC} = supply voltage in V;
 $\sum (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs.

ORDERING INFORMATION

| PACKAGES | TEMPERATURE RANGE | OUTSIDE NORTH AMERICA | NORTH AMERICA | DWG NUMBER |
|------------------------------|-------------------|-----------------------|---------------|------------|
| 48-Pin Plastic SSOP Type III | -40°C to +85°C | 74LVC16374A DL | VC16374A DL | SOT370-1 |
| 48-Pin Plastic TSSOP Type II | -40°C to +85°C | 74LVC16374A DGG | VC16374A DGG | SOT362-1 |
| 48-Pin Plastic SSOP Type III | -40°C to +85°C | 74LVCH16374A DL | VCH16374A DL | SOT370-1 |
| 48-Pin Plastic TSSOP Type II | -40°C to +85°C | 74LVCH16374A DGG | VCH16374A DGG | SOT362-1 |

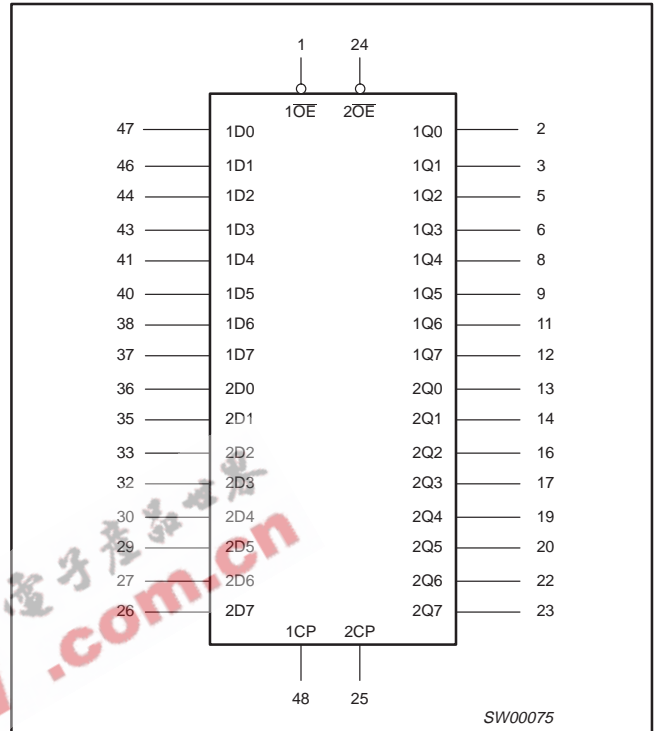
16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/
74LVCH16374A

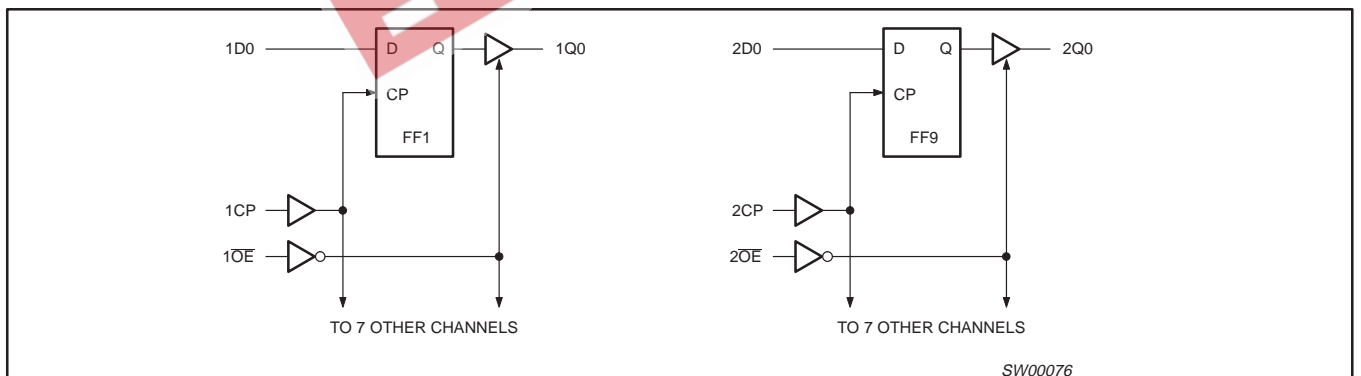
PIN DESCRIPTION

| PIN NUMBER | SYMBOL | NAME AND FUNCTION |
|--------------------------------|-------------------|----------------------------------|
| 1 | 1 \overline{OE} | Output enable input (active LOW) |
| 2, 3, 5, 6, 8, 9, 11, 12 | 1Q0 to 1Q7 | 3-State flip-flop outputs |
| 4, 10, 15, 21, 28, 34, 39, 45 | GND | Ground (0V) |
| 7, 18, 31, 42 | V _{CC} | Positive supply voltage |
| 13, 14, 16, 17, 19, 20, 22, 23 | 2Q0 to 2Q7 | 3-State flip-flop outputs |
| 24 | 2 \overline{OE} | Output enable input (active LOW) |
| 25 | 2CP | Clock input |
| 36, 35, 33, 32, 30, 29, 27, 26 | 2D0 to 2D7 | Data inputs |
| 47, 46, 44, 43, 41, 40, 38, 37 | 1D0 to 1D7 | Data inputs |
| 48 | 1CP | Clock input |

LOGIC SYMBOL



LOGIC DIAGRAM



FUNCTION TABLE

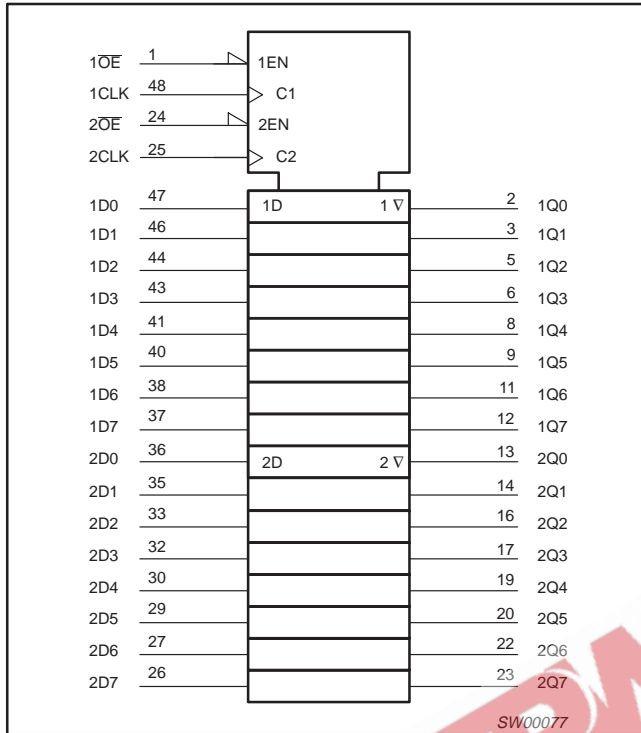
| OPERATING MODES | INPUTS | | | INTERNAL FLIP-FLOPS | OUTPUTS |
|-----------------------------------|-------------------|--------|--------|---------------------|----------|
| | n \overline{OE} | nCP | nDx | | Q0 to Q7 |
| Load and read register | L L | ↑ ↑ | l h | L H | L H |
| Load register and disable outputs | H H | ↑ ↑ | l h | L H | Z Z |

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

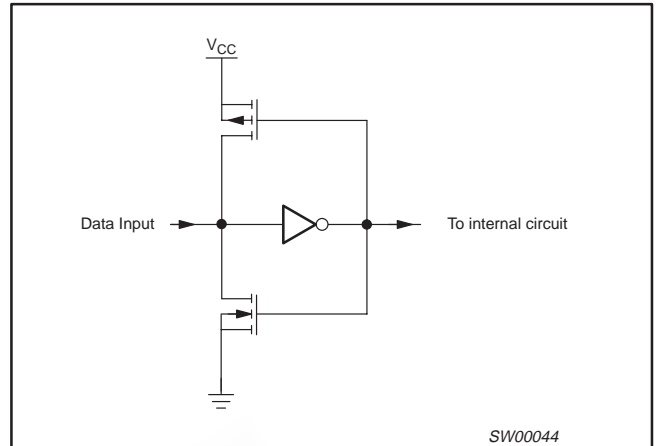
16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

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LOGIC SYMBOL (IEEE/IEC)



BUS HOLD CIRCUIT



RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | CONDITIONS | LIMITS | | UNIT |
|---------------------------------|--|-------------------------------|--------|-----------------|------|
| | | | MIN | MAX | |
| V _{CC} | DC supply voltage (for max. speed performance) | | 2.7 | 3.6 | V |
| | DC supply voltage (for low-voltage applications) | | 1.2 | 3.6 | |
| V _I | DC input voltage range | | 0 | 5.5 | V |
| V _O | DC input voltage range; output HIGH or LOW state | | 0 | V _{CC} | V |
| | DC output voltage range; output 3-State | | 0 | 5.5 | |
| T _{amb} | Operating free-air temperature range | | -40 | +85 | °C |
| t _r , t _f | Input rise and fall times | V _{CC} = 1.2 to 2.7V | 0 | 20 | ns/V |
| | | V _{CC} = 2.7 to 3.6V | 0 | 10 | |

16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

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ABSOLUTE MAXIMUM RATINGS¹

In accordance with the Absolute Maximum Rating System (IEC 134).

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

| SYMBOL | PARAMETER | CONDITIONS | RATING | UNIT |
|-------------------|--|---|------------------------|------|
| V_{CC} | DC supply voltage | | -0.5 to +6.5 | V |
| I_{IK} | DC input diode current | $V_I < 0$ | -50 | mA |
| V_I | DC input voltage | Note 2 | -0.5 to +6.5 | V |
| I_{OK} | DC output diode current | $V_O > V_{CC}$ or $V_O < 0$ | ± 50 | mA |
| V_O | DC output voltage; output HIGH or LOW state | Note 2 | -0.5 to $V_{CC} + 0.5$ | V |
| | DC output voltage; output 3-State | Note 2 | -0.5 to 6.5 | |
| I_O | DC output source or sink current | $V_O = 0$ to V_{CC} | ± 50 | mA |
| I_{GND}, I_{CC} | DC V_{CC} or GND current | | ± 100 | mA |
| T_{stg} | Storage temperature range | | -65 to +150 | °C |
| P_{TOT} | Power dissipation per package – plastic mini-pack (SO) – plastic shrink mini-pack (SSOP and TSSOP) | above +70°C derate linearly with 8 mW/K | 500 | mW |
| | | above +60°C derate linearly with 5.5 mW/K | 500 | |

NOTES:

- Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

DC ELECTRICAL CHARACTERISTICS

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

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | UNIT |
|-----------------|---|--|-----------------------|------------------|----------|---------|
| | | | Temp = -40°C to +85°C | | | |
| | | | MIN | TYP ¹ | MAX | |
| V_{IH} | HIGH level Input voltage | $V_{CC} = 1.2V$ | V_{CC} | | | V |
| | | $V_{CC} = 2.7$ to $3.6V$ | 2.0 | | | |
| V_{IL} | LOW level Input voltage | $V_{CC} = 1.2V$ | | | GND | V |
| | | $V_{CC} = 2.7$ to $3.6V$ | | | 0.8 | |
| V_{OH} | HIGH level output voltage | $V_{CC} = 2.7V; V_I = V_{IH}$ or $V_{IL}; I_O = -12mA$ | $V_{CC} - 0.5$ | | | V |
| | | $V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = -100\mu A$ | $V_{CC} - 0.2$ | V_{CC} | | |
| | | $V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = -18mA$ | $V_{CC} - 0.6$ | | | |
| | | $V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = -24mA$ | $V_{CC} - 0.8$ | | | |
| V_{OL} | LOW level output voltage | $V_{CC} = 2.7V; V_I = V_{IH}$ or $V_{IL}; I_O = 12mA$ | | | 0.40 | V |
| | | $V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = 100\mu A$ | | | 0.20 | |
| | | $V_{CC} = 3.0V; V_I = V_{IH}$ or $V_{IL}; I_O = 24mA$ | | | 0.55 | |
| I_I | Input leakage current | $V_{CC} = 3.6V; V_I = 5.5V$ or GND ⁶ | | ± 0.1 | ± 5 | μA |
| I_{OZ} | 3-State output OFF-state current | $V_{CC} = 3.6V; V_I = V_{IH}$ or $V_{IL}; V_O = 5.5V$ or GND | | 0.1 | ± 5 | μA |
| I_{off} | Power off leakage supply | $V_{CC} = 0.0V; V_I$ or $V_O = 5.5V$ | | | ± 10 | μA |
| I_{CC} | Quiescent supply current | $V_{CC} = 3.6V; V_I = V_{CC}$ or GND; $I_O = 0$ | | 0.1 | 20 | μA |
| ΔI_{CC} | Additional quiescent supply current per input pin | $V_{CC} = 2.7V$ to $3.6V; V_I = V_{CC} - 0.6V; I_O = 0$ | | 5 | 500 | μA |

16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/
74LVCH16374A

DC ELECTRICAL CHARACTERISTICS (Continued)

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

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | UNIT |
|-------------------|----------------------------------|--|-----------------------|------------------|-----|------|
| | | | Temp = -40°C to +85°C | | | |
| | | | MIN | TYP ¹ | MAX | |
| I _{BHL} | Bus hold LOW sustaining current | V _{CC} = 3.0V; V _I = 0.8V ^{2, 3, 4} | 75 | | | μA |
| I _{BHH} | Bus hold HIGH sustaining current | V _{CC} = 3.0V; V _I = 2.0V ^{2, 3, 4} | -75 | | | μA |
| I _{BHLO} | Bus hold LOW overdrive current | V _{CC} = 3.6V ^{2, 3, 5} | 500 | | | μA |
| I _{BHHO} | Bus hold HIGH overdrive current | V _{CC} = 3.6V ^{2, 3, 5} | -500 | | | μA |

NOTES:

- All typical values are at V_{CC} = 3.3V and T_{amb} = 25°C.
- Valid for data inputs of bus hold parts (LVCH16-A) only.
- For data inputs only, control inputs do not have a bus hold circuit.
- The specified sustaining current at the data input holds the input below the specified V_I level.
- The specified overdrive current at the data input forces the data input to the opposite logic input state.
- For bus hold parts, the bus hold circuit is switched off when V_I exceeds V_{CC} allowing 5.5V on the input terminal.

AC CHARACTERISTICS

GND = 0V; t_R = t_F = 2.5ns; C_L = 50pF; R_L = 500Ω; T_{amb} = -40°C to +85°C.

| SYMBOL | PARAMETER | WAVEFORM | LIMITS | | | | | | UNIT |
|--------------------------------------|---|----------|------------------------------|------------------|-----|------------------------|-----|------------------------|------|
| | | | V _{CC} = 3.3V ±0.3V | | | V _{CC} = 2.7V | | V _{CC} = 1.2V | |
| | | | MIN | TYP ¹ | MAX | MIN | MAX | MAX | |
| t _{PHL} t _{PLH} | Propagation delay CP to Qn | 1, 4 | 1.5 | 3.8 | 5.4 | 1.5 | 6.4 | 17 | ns |
| t _{PZH} t _{PZL} | 3-State output enable time OE to Qn | 2, 4 | 1.5 | 3.6 | 5.6 | 1.5 | 6.6 | 20 | ns |
| t _{PHZ} t _{PLZ} | 3-State output disable time OE to Qn | 2, 4 | 1.5 | 3.9 | 5.5 | 1.5 | 6.5 | 12 | ns |
| t _W | CP pulse width HIGH or LOW | 1 | 3.0 | 1.5 | - | 3.0 | - | - | ns |
| t _{SU} | Set-up time Dn to CP | 3 | 2.0 | 0.3 | - | 1.9 | - | - | ns |
| t _H | Hold time Dn to CP | 3 | 1.5 | -0.3 | - | 1.1 | - | - | ns |
| f _{max} | Maximum clock pulse frequency | 1 | 100 | - | - | 80 | - | - | MHz |

NOTE:

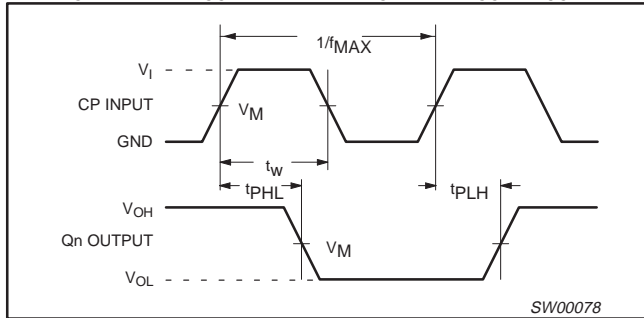
- All typical values are at V_{CC} = 3.3V and T_{amb} = 25°C.

16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

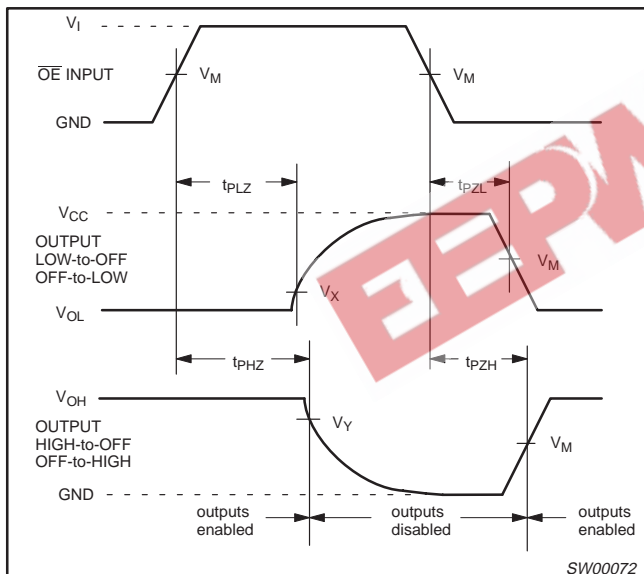
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AC WAVEFORMS

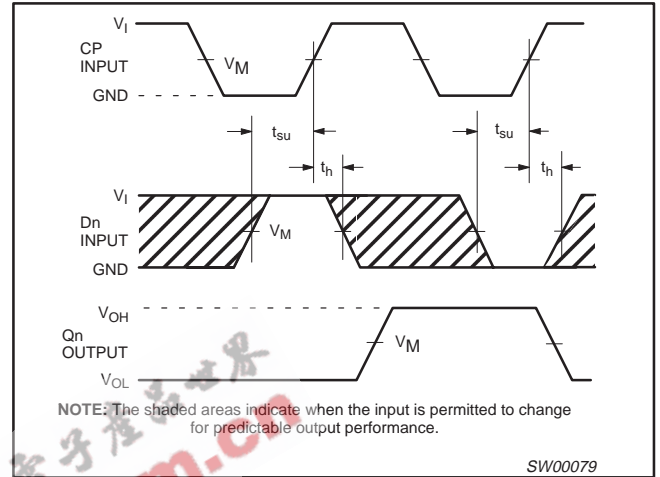
$V_M = 1.5V$ at $V_{CC} \geq 2.7V$; $V_M = 0.5 V_{CC}$ at $V_{CC} < 2.7V$.
 V_{OL} and V_{OH} are the typical output voltage drop that occur with the output load.
 $V_X = V_{OL} + 0.3V$ at $V_{CC} \geq 2.7V$; $V_X = V_{OL} + 0.1 V_{CC}$ at $V_{CC} < 2.7V$
 $V_Y = V_{OH} - 0.3V$ at $V_{CC} \geq 2.7V$; $V_Y = V_{OH} - 0.1 V_{CC}$ at $V_{CC} < 2.7V$



Waveform 1. Clock (CP) to output (Qn) propagation delays, the clock pulse width and the maximum clock pulse frequency

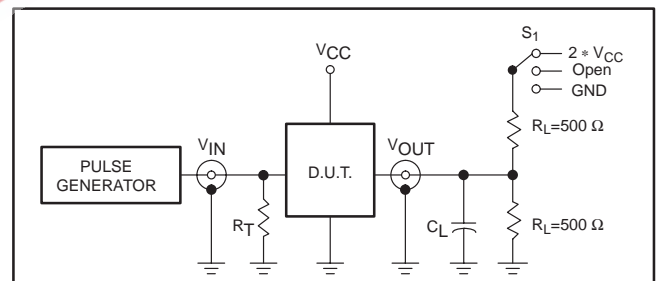


Waveform 2. 3-State enable and disable times



Waveform 3. Data set-up and hold times for the Dn input to the CP input

TEST CIRCUIT



Test Circuit for 3-State Outputs

SWITCH POSITION

| TEST | SWITCH |
|-------------------|--------------|
| t_{PLH}/t_{PHL} | Open |
| t_{PLZ}/t_{PZL} | $2 * V_{CC}$ |
| t_{PHZ}/t_{PZH} | GND |

| V_{CC} | V_{IN} |
|--------------|----------|
| $< 2.7V$ | V_{CC} |
| $2.7 - 3.6V$ | $2.7V$ |

DEFINITIONS

R_L = Load resistor
 C_L = Load capacitance includes jig and probe capacitance
 R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

SW00047

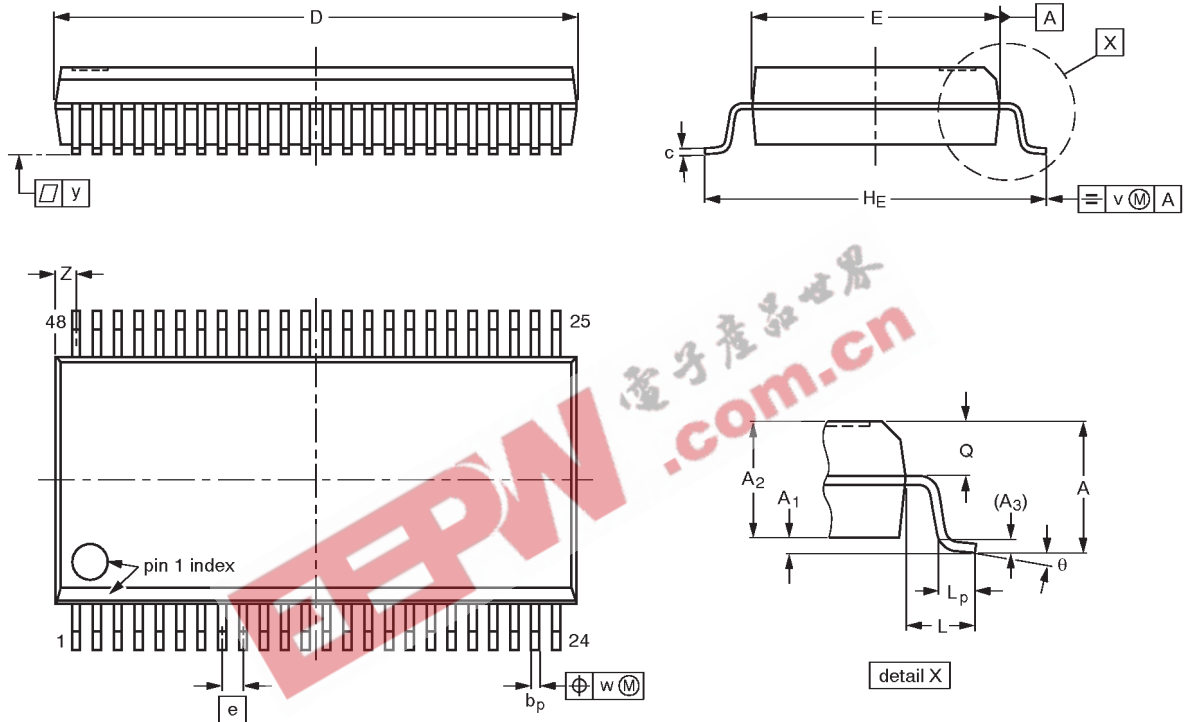
Waveform 4. Load circuitry for switching times

16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/
74LVCH16374A

SSOP48: plastic shrink small outline package; 48 leads; body width 7.5 mm

SOT370-1



DIMENSIONS (mm are the original dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _E | L | L _p | Q | v | w | y | z ⁽¹⁾ | θ |
|------|--------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|-------|----------------|-----|----------------|------------|------|------|-----|------------------|----------|
| mm | 2.8 | 0.4 0.2 | 2.35 2.20 | 0.25 | 0.3 0.2 | 0.22 0.13 | 16.00 15.75 | 7.6 7.4 | 0.635 | 10.4 10.1 | 1.4 | 1.0 0.6 | 1.2 1.0 | 0.25 | 0.18 | 0.1 | 0.85 0.40 | 8° 0° |

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

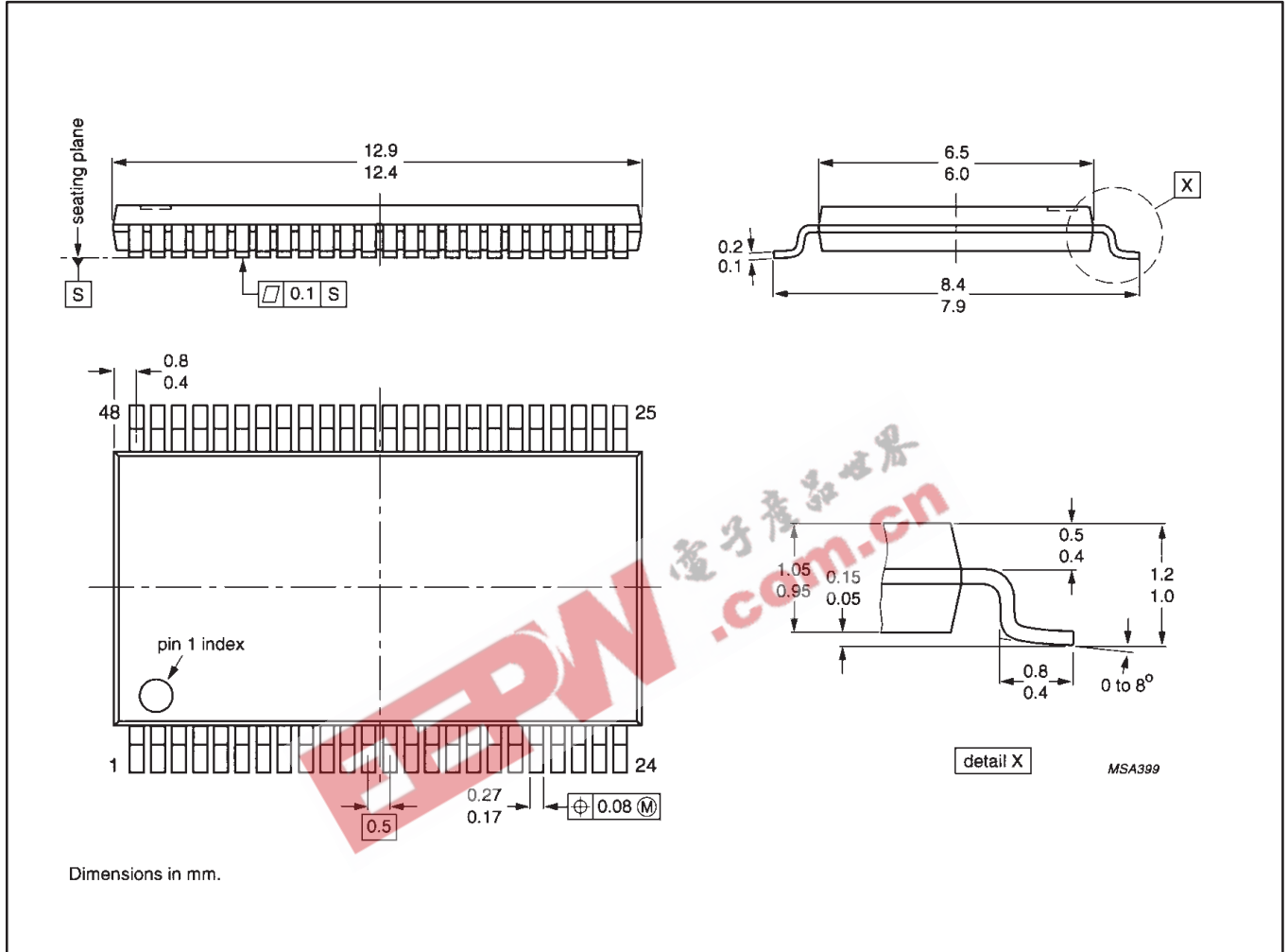
| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|----------|------|--|---------------------|----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT370-1 | | MO-118AA | | | | 93-11-02 95-02-04 |

16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/
74LVCH16374A

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

SOT362-1



16-bit edge triggered D-type flip-flop with 5 Volt tolerant inputs/outputs (3-State)

74LVC16374A/
74LVCH16374A

DEFINITIONS

| Data Sheet Identification | Product Status | Definition |
|----------------------------------|-------------------------------|--|
| <i>Objective Specification</i> | Formative or in Design | This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice. |
| <i>Preliminary Specification</i> | Preproduction Product | This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
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