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Team Nexperia

# 74LVCH162374A

16-bit edge-triggered D-type flip-flop with 30  $\Omega$  series termination resistors; 5 V input/output tolerant; 3-state

Rev. 4 — 22 January 2013

Product data sheet

## 1. General description

The 74LVCH162374A 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 device consists of two sections of 8 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 3.3 V or 5 V devices. When disabled, up to 5.5 V can be applied to the outputs. These features allow the use of these devices in mixed 3.3 V and 5 V applications. The flip-flops 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.

Bus hold on data inputs eliminates the need for external pull-up resistors to hold unused inputs.

To reduce line noise, 30  $\Omega$  series termination resistors are included in both high and low output stages.

## 2. Features and benefits

- 5 V tolerant inputs/outputs for interfacing with 5 V logic
- Wide supply voltage range from 1.2 V to 3.6 V
- CMOS low power consumption
- Multibyte flow-through standard pinout architecture
- Multiple low inductance supply pins for minimum noise and ground bounce
- Direct interface with TTL levels
- All data inputs have bus hold
- High-impedance outputs when  $V_{CC} = 0$  V
- Complies with JEDEC standard:
  - ◆ JESD8-7A (1.65 V to 1.95 V)
  - ◆ JESD8-5A (2.3 V to 2.7 V)
  - ◆ JESD8-C/JESD36 (2.7 V to 3.6 V)
- ESD protection:
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-B exceeds 200 V
  - ◆ CDM JESD22-C101E exceeds 1000 V
- Specified from  $-40$  °C to  $+85$  °C and  $-40$  °C to  $+125$  °C



### 3. Ordering information

Table 1. Ordering information

Type number	Package	Temperature range	Name	Description	Version
74LVCH162374ADGG	TSSOP48	−40 °C to +125 °C		plastic thin shrink small outline package; 48 leads; body width 6.1 mm	SOT362-1
74LVCH162374ADL	SSOP48	−40 °C to +125 °C		plastic shrink small outline package; 48 leads; body width 7.5 mm	SOT370-1

### 4. Functional diagram

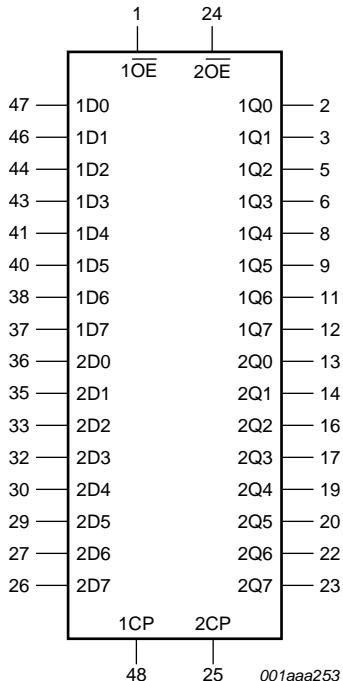


Fig 1. Logic symbol

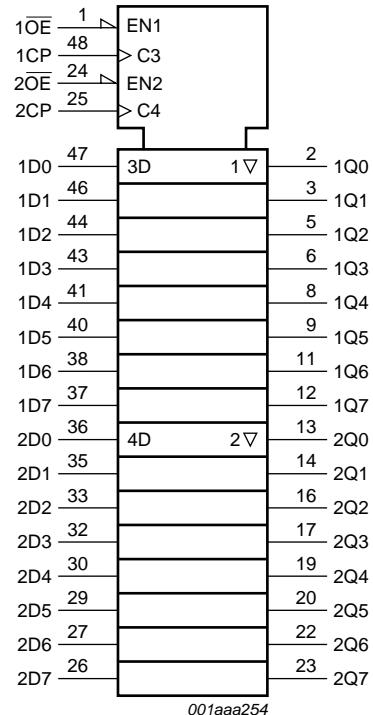


Fig 2. IEC logic symbol

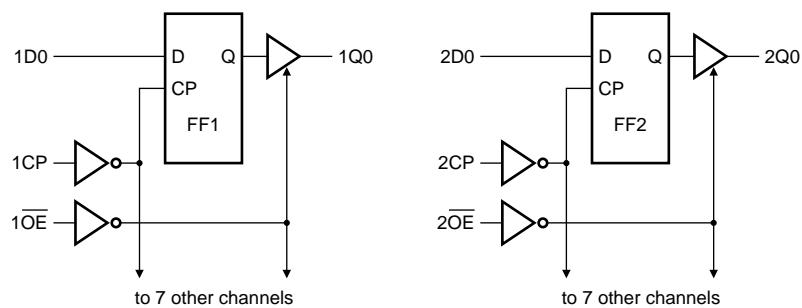


Fig 3. Logic diagram

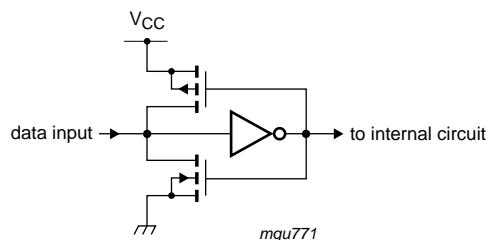


Fig 4. Bus hold circuit

## 5. Pinning information

### 5.1 Pinning

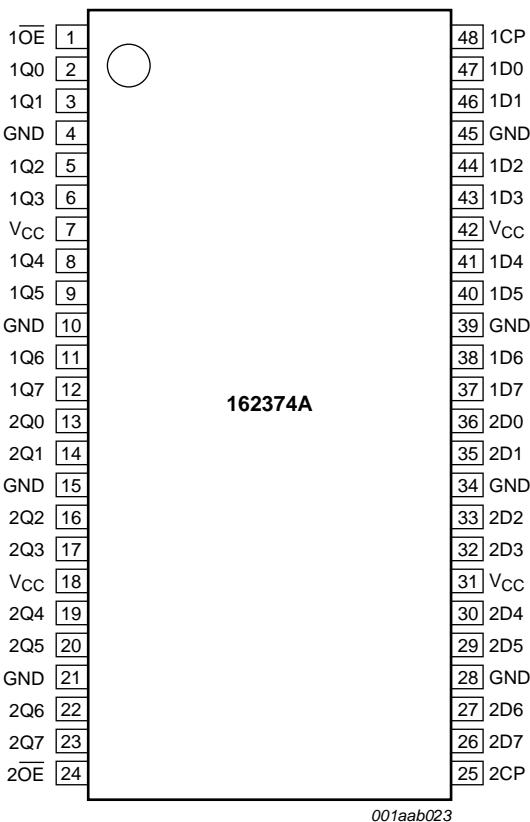


Fig 5. Pin configuration SSOP48 and TSSOP48

### 5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1OE	1	output enable input (active LOW)
2OE	24	output enable input (active LOW)
1CP	48	clock input
2CP	25	clock input
GND	4, 10, 15, 21, 28, 34, 39, 45	ground (0 V)
V <sub>CC</sub>	7, 18, 31, 42	supply voltage
1Q[0:7]	2, 3, 5, 6, 8, 9, 11, 12	data output
2Q[0:7]	13, 14, 16, 17, 19, 20, 22, 23	data output
1D[0:7]	47, 46, 44, 43, 41, 40, 38, 37	data input
2D[0:7]	36, 35, 33, 32, 30, 29, 27, 26	data input

## 6. Functional description

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

Operation modes	Input			Internal flip-flop	Output
	nOE	nCP	nD0 to nD7		
Load and read register	L	↑	l	L	L
	L	↑	h	H	H
Latch register and disable outputs	H	↑	l	L	Z
	H	↑	h	H	Z

[1] 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

## 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	+6.5	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < 0 V	-50	-	mA
V <sub>I</sub>	input voltage		[1] -0.5	+6.5	V
I <sub>OK</sub>	output clamping current	V <sub>O</sub> > V <sub>CC</sub> or V <sub>O</sub> < 0 V	-	$\pm 50$	mA
V <sub>O</sub>	output voltage	output HIGH or LOW state	[2] -0.5	V <sub>CC</sub> + 0.5	V
		output 3-state	[2] -0.5	+6.5	V
I <sub>O</sub>	output current	V <sub>O</sub> = 0 V to V <sub>CC</sub>	-	$\pm 50$	mA
I <sub>CC</sub>	supply current		-	100	mA
I <sub>GND</sub>	ground current		-100	-	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	[3] -	500	mW

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

[2] The output voltage ratings may be exceeded if the output current ratings are observed.

[3] Above 60 °C, the value of P<sub>tot</sub> derates linearly with 5.5 mW/K.

## 8. Recommended operating conditions

Table 5. Operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC}$	supply voltage		1.65	-	3.6	V
		functional	1.2	-	3.6	V
$V_I$	input voltage		0	-	5.5	V
$V_O$	output voltage	output HIGH or LOW state	0	-	$V_{CC}$	V
		output 3-state	0	-	5.5	V
$T_{amb}$	ambient temperature	in free air	-40	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 1.65$ V to 2.7 V	0	-	20	ns/V
		$V_{CC} = 2.7$ V to 3.6 V	0	-	10	ns/V

## 9. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 1.2$ V	1.08	-	-	1.08	-	V
		$V_{CC} = 1.65$ V to 1.95 V	$0.65 \times V_{CC}$	-	-	$0.65 \times V_{CC}$	-	V
		$V_{CC} = 2.3$ V to 2.7 V	1.7	-	-	1.7	-	V
		$V_{CC} = 2.7$ V to 3.6 V	2.0	-	-	2.0	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 1.2$ V	-	-	0.12	-	0.12	V
		$V_{CC} = 1.65$ V to 1.95 V	-	-	$0.35 \times V_{CC}$	-	$0.35 \times V_{CC}$	V
		$V_{CC} = 2.3$ V to 2.7 V	-	-	0.7	-	0.7	V
		$V_{CC} = 2.7$ V to 3.6 V	-	-	0.8	-	0.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$						
		$I_O = -100 \mu A$ ; $V_{CC} = 1.65$ V to 3.6 V	$V_{CC} - 0.2$	-	-	$V_{CC} - 0.3$	-	V
		$I_O = -2$ mA; $V_{CC} = 1.65$ V	1.2	-	-	1.05	-	V
		$I_O = -4$ mA; $V_{CC} = 2.3$ V	1.7	-	-	1.55	-	V
		$I_O = -6$ mA; $V_{CC} = 2.7$ V	2.2	-	-	2.05	-	V
		$I_O = -12$ mA; $V_{CC} = 3.0$ V	2.2	-	-	2.0	-	V
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH}$ or $V_{IL}$						
		$I_O = 100 \mu A$ ; $V_{CC} = 1.65$ V to 3.6 V	-	-	0.2	-	0.3	V
		$I_O = 2$ mA; $V_{CC} = 1.65$ V	-	-	0.45	-	0.65	V
		$I_O = 4$ mA; $V_{CC} = 2.3$ V	-	-	0.6	-	0.8	V
		$I_O = 6$ mA; $V_{CC} = 2.7$ V	-	-	0.4	-	0.6	V
		$I_O = 12$ mA; $V_{CC} = 3.0$ V	-	-	0.55	-	0.8	V
$I_I$	input leakage current	$V_{CC} = 3.6$ V; $V_I = 5.5$ V or GND <sup>[2]</sup>	-	$\pm 0.1$	$\pm 5$	-	$\pm 20$	$\mu A$

**Table 6. Static characteristics ...continued**

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

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
$I_{OZ}$	OFF-state output current	$V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 3.6$ V; $V_O = 5.5$ V or GND <sup>[2]</sup>	-	$\pm 0.1$	$\pm 5$	-	$\pm 20$	$\mu A$
$I_{OFF}$	power-off leakage current	$V_{CC} = 0$ V; $V_I$ or $V_O = 5.5$ V	-	$\pm 0.1$	$\pm 10$	-	$\pm 20$	$\mu A$
$I_{CC}$	supply current	$V_{CC} = 3.6$ V; $V_I = V_{CC}$ or GND; $I_O = 0$ A	-	0.1	20	-	80	$\mu A$
$\Delta I_{CC}$	additional supply current	per input pin; $V_{CC} = 2.7$ V to 3.6 V; $V_I = V_{CC} - 0.6$ V; $I_O = 0$ A	-	5	500	-	5000	$\mu A$
$C_I$	input capacitance	$V_{CC} = 0$ V to 3.6 V; $V_I = GND$ to $V_{CC}$	-	5.0	-	-	-	$pF$
$I_{BHL}$	bus hold LOW current	$V_{CC} = 1.65$ ; $V_I = 0.58$ V <sup>[3][4]</sup>	10	-	-	10	-	$\mu A$
		$V_{CC} = 2.3$ ; $V_I = 0.7$ V	30	-	-	25	-	$\mu A$
		$V_{CC} = 3.0$ ; $V_I = 0.8$ V	75	-	-	60	-	$\mu A$
$I_{BHH}$	bus hold HIGH current	$V_{CC} = 1.65$ ; $V_I = 1.07$ V <sup>[3][4]</sup>	-10	-	-	-10	-	$\mu A$
		$V_{CC} = 2.3$ ; $V_I = 1.7$ V	-30	-	-	-25	-	$\mu A$
		$V_{CC} = 3.0$ ; $V_I = 2.0$ V	-75	-	-	-60	-	$\mu A$
$I_{BHLO}$	bus hold LOW overdrive current	$V_{CC} = 1.95$ V <sup>[3][5]</sup>	200	-	-	200	-	$\mu A$
		$V_{CC} = 2.7$ V	300	-	-	300	-	$\mu A$
		$V_{CC} = 3.6$ V	500	-	-	500	-	$\mu A$
$I_{BHHO}$	bus hold HIGH overdrive current	$V_{CC} = 1.95$ V <sup>[3][5]</sup>	-200	-	-	-200	-	$\mu A$
		$V_{CC} = 2.7$ V	-300	-	-	-300	-	$\mu A$
		$V_{CC} = 3.6$ V	-500	-	-	-500	-	$\mu A$

[1] All typical values are measured at  $V_{CC} = 3.3$  V (unless stated otherwise) and  $T_{amb} = 25$  °C.[2] The bus hold circuit is switched off when  $V_I > V_{CC}$  allowing 5.5 V on the input pin.

[3] For data inputs only; control inputs do not have a bus hold circuit.

[4] The specified sustaining current at the data inputs do not have a bus hold circuit.

[5] The specified overdrive current at the data input forces the data input to the opposite logic input state.

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	$T_{amb} = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$		$-40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	
$t_{pd}$	propagation delay	nCP to nQn; see <a href="#">Figure 6</a>	[2]				ns
$t_{en}$	enable time	$\overline{nOE}$ to nQn; see <a href="#">Figure 8</a>	[2]				ns
$t_{dis}$	disable time	$\overline{nOE}$ to nQn; see <a href="#">Figure 8</a>	[2]				ns
$t_w$	pulse width	nCP HIGH; see <a href="#">Figure 6</a>					ns
$t_{su}$	set-up time	nDn to nCP; see <a href="#">Figure 7</a>					ns
$t_h$	hold time	nDn to nCP; see <a href="#">Figure 7</a>					ns

**Table 7. Dynamic characteristics ...continued**Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	T <sub>amb</sub> = -40 °C to +85 °C		-40 °C to +125 °C		Unit	
			Min	Typ <sup>[1]</sup>	Max	Min		
f <sub>max</sub>	maximum frequency	see <a href="#">Figure 6</a>						
		V <sub>CC</sub> = 1.65 V to 1.95 V	100	-	-	80	-	MHz
		V <sub>CC</sub> = 2.3 V to 2.7 V	125	-	-	100	-	MHz
		V <sub>CC</sub> = 2.7 V	150	-	-	120	-	MHz
t <sub>sk(o)</sub>	output skew time	V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	-	-	1.0	-	1.5 ns
		per input; V <sub>I</sub> = GND to V <sub>CC</sub>	[4]					
		V <sub>CC</sub> = 1.65 V to 1.95 V	-	9.6	-	-	-	pF
		V <sub>CC</sub> = 2.3 V to 2.7 V	-	11.7	-	-	-	pF
C <sub>PD</sub>	power dissipation capacitance	V <sub>CC</sub> = 3.0 V to 3.6 V	-	13.5	-	-	-	pF

[1] Typical values are measured at T<sub>amb</sub> = 25 °C and V<sub>CC</sub> = 1.2 V, 1.8 V, 2.5 V, 2.7 V and 3.3 V respectively.[2] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.t<sub>en</sub> is the same as t<sub>PZL</sub> and t<sub>PZH</sub>.t<sub>dis</sub> is the same as t<sub>PLZ</sub> and t<sub>PHZ</sub>.

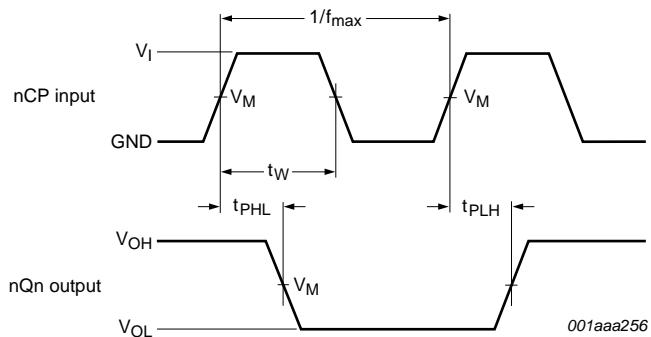
[3] Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.

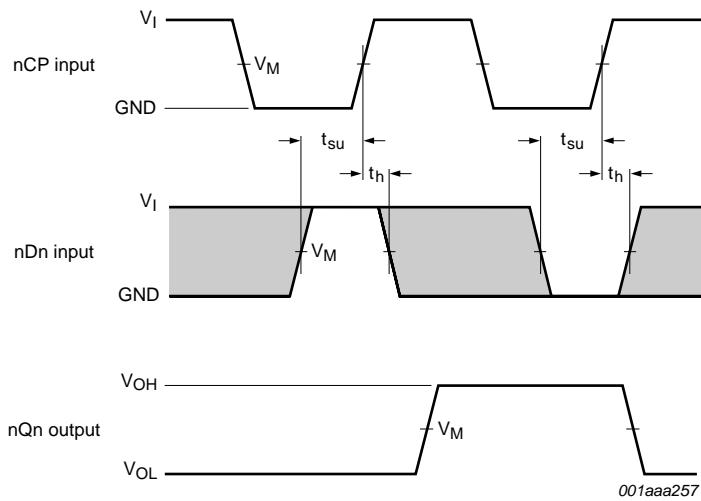
[4] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in  $\mu$ W).P<sub>D</sub> = C<sub>PD</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>i</sub> × N +  $\Sigma$ (C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) where:f<sub>i</sub> = input frequency in MHz; f<sub>o</sub> = output frequency in MHzC<sub>L</sub> = output load capacitance in pFV<sub>CC</sub> = supply voltage in Volts

N = number of inputs switching

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

## 11. AC waveforms

Measurement points are given in [Table 8](#).V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage levels that occur with the output load.**Fig 6. Clock input (nCP) to output (nQn) propagation delay, the clock pulse width, and the maximum frequency**

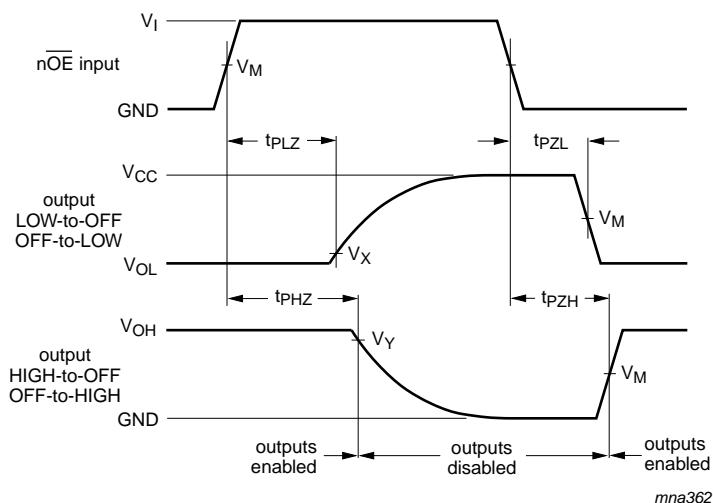


Measurement points are given in [Table 8](#).

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

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

**Fig 7. Data set-up and hold times for the nDn input to the nCP input**



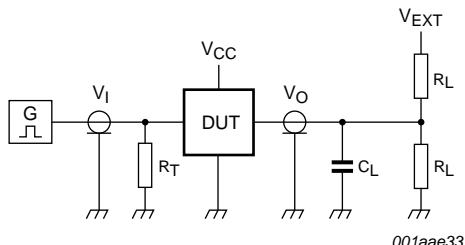
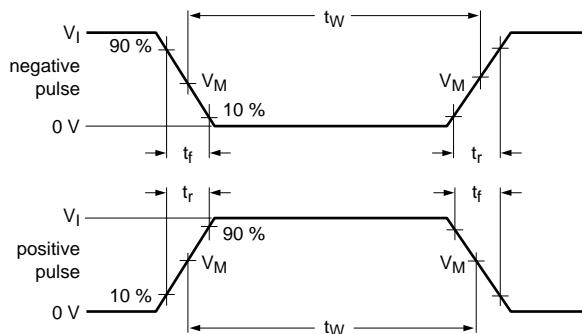
Measurement points are given in [Table 8](#).

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

**Fig 8. 3-state enable and disable times**

Table 8. Measurement points

Supply voltage	Input		Output		
$V_{CC}$	$V_I$	$V_M$	$V_M$	$V_X$	$V_Y$
1.2 V	$V_{CC}$	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	$V_{OL} + 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$
1.65 V to 1.95 V	$V_{CC}$	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	$V_{OL} + 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$
2.3 V to 2.7 V	$V_{CC}$	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	$V_{OL} + 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$
2.7 V	2.7 V	1.5 V	1.5 V	$V_{OL} + 0.3 \text{ V}$	$V_{OH} - 0.3 \text{ V}$
3.0 V to 3.6 V	2.7 V	1.5 V	1.5 V	$V_{OL} + 0.3 \text{ V}$	$V_{OH} - 0.3 \text{ V}$



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

Definitions for test circuit:

$R_L$  = 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.

$V_{EXT}$  = External voltage for measuring switching times.

Fig 9. Test circuit for measuring switching times

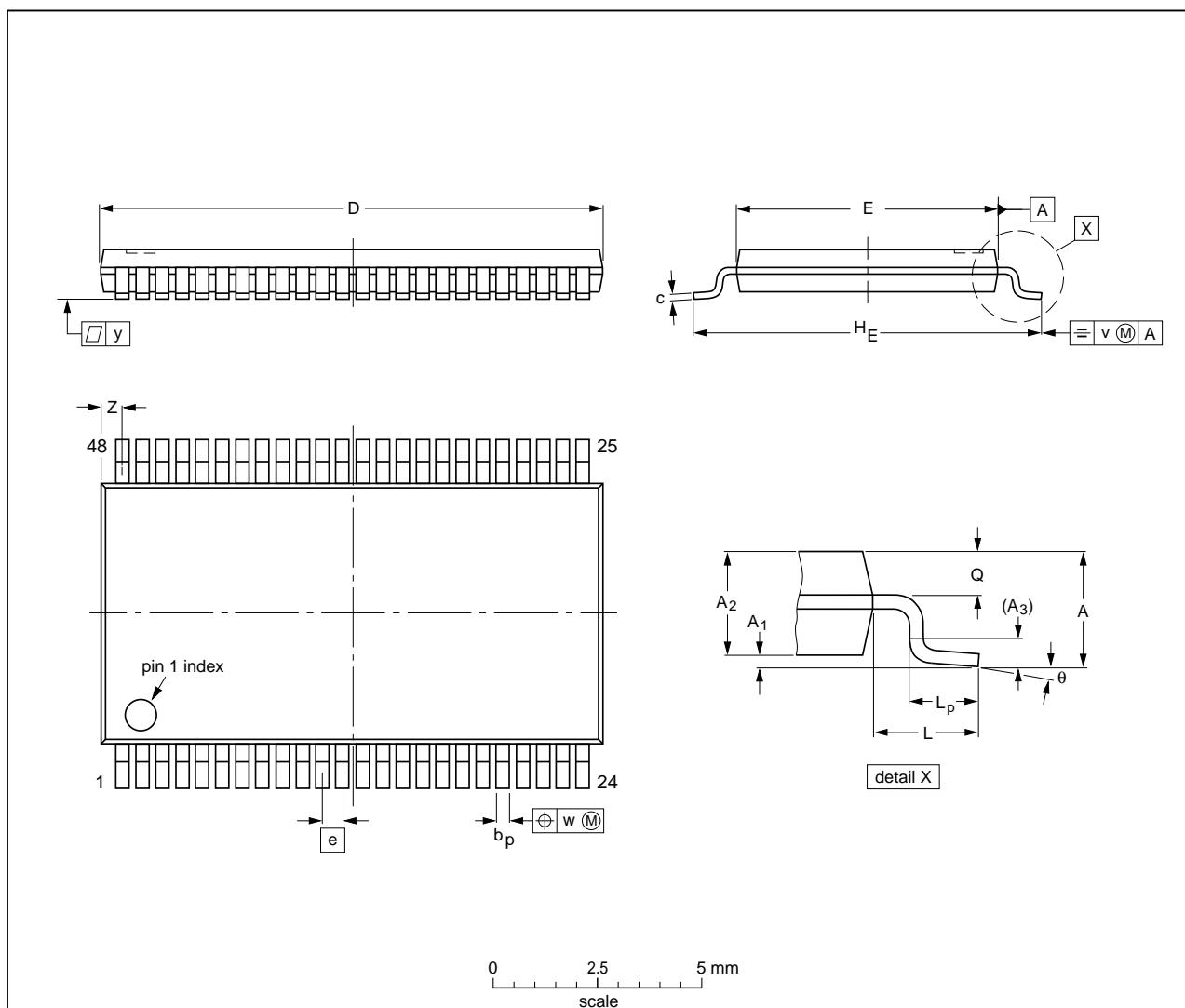
Table 9. Test data

Supply voltage	Input		Load		$V_{EXT}$		
	$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PLH}, t_{PHL}$	$t_{PLZ}, t_{PZL}$	$t_{PHZ}, t_{PZH}$
1.2 V	$V_{CC}$	$\leq 2 \text{ ns}$	30 pF	1 k $\Omega$	open	$2 \times V_{CC}$	GND
1.65 V to 1.95 V	$V_{CC}$	$\leq 2 \text{ ns}$	30 pF	1 k $\Omega$	open	$2 \times V_{CC}$	GND
2.3 V to 2.7 V	$V_{CC}$	$\leq 2 \text{ ns}$	30 pF	500 $\Omega$	open	$2 \times V_{CC}$	GND
2.7 V	2.7 V	$\leq 2.5 \text{ ns}$	50 pF	500 $\Omega$	open	$2 \times V_{CC}$	GND
3.0 V to 3.6 V	2.7 V	$\leq 2.5 \text{ ns}$	50 pF	500 $\Omega$	open	$2 \times V_{CC}$	GND

## 12. Package outline

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

SOT362-1



### DIMENSIONS (mm are the original dimensions).

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	z	θ
mm	1.2 0.05	0.15 0.85	1.05	0.25	0.28 0.17	0.2 0.1	12.6 12.4	6.2 6.0	0.5	8.3 7.9	1	0.8 0.4	0.50 0.35	0.25	0.08	0.1	0.8 0.4	8° 0°

### Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA		
SOT362-1		MO-153			99-12-27 03-02-19

Fig 10. Package outline SOT362-1 (TSSOP48)

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

SOT370-1

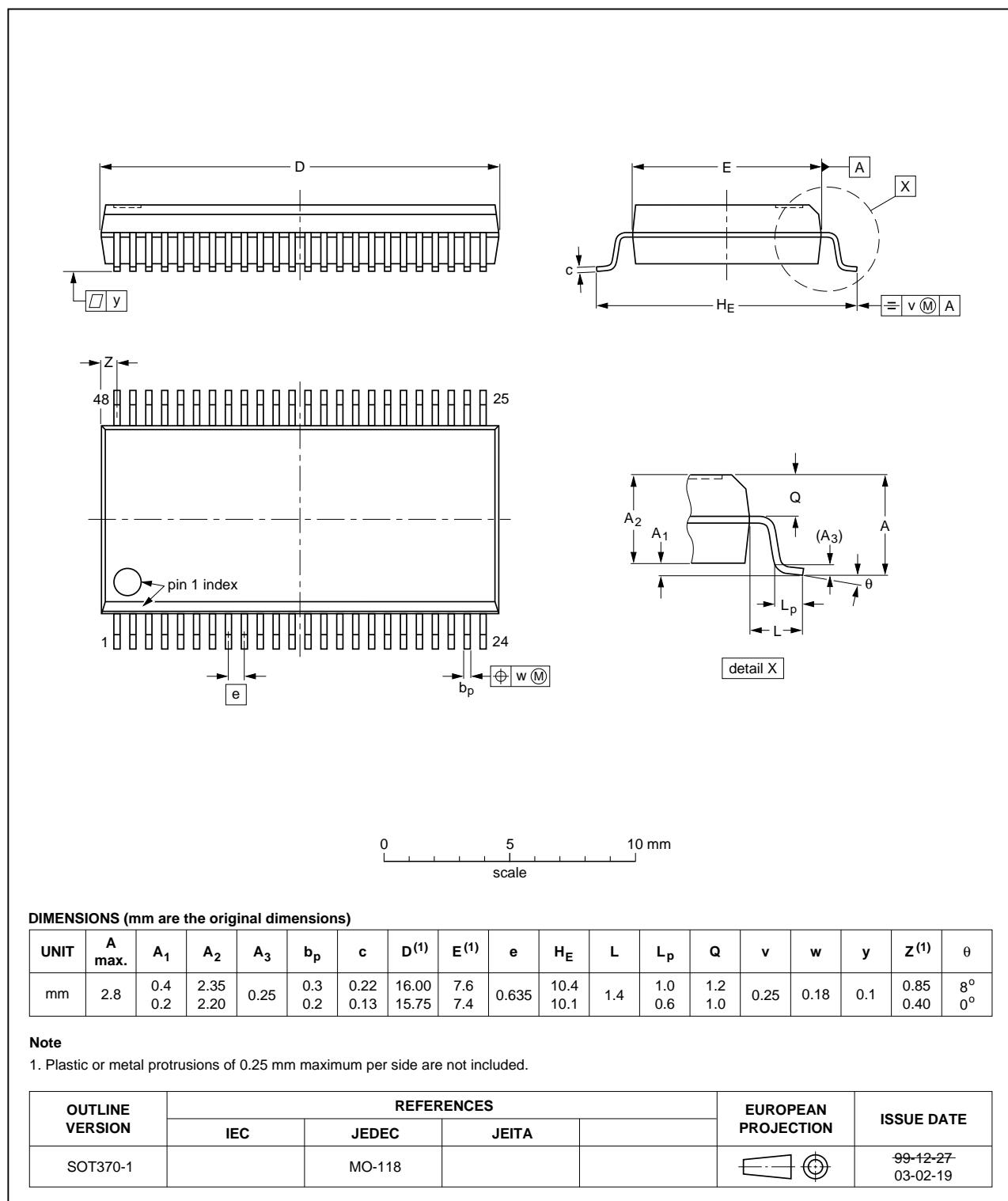


Fig 11. Package outline SOT370-1 (SSOP48)

## 13. Abbreviations

**Table 10. Abbreviations**

Acronym	Description
CDM	Charged Device Model
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
74LVCH162374A v.4	20130122	Product data sheet	-	74LVCH162374A v.3
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="#">Table 4</a>, <a href="#">Table 5</a>, <a href="#">Table 6</a>, <a href="#">Table 7</a>, <a href="#">Table 8</a> and <a href="#">Table 9</a>: values added for lower voltage ranges.</li></ul>			
74LVCH162374A v.3	20040519	Product specification	-	74LVC_LVCH162374A v.2
74LVC_LVCH162374A v.2	20040325	Product specification	-	74LVC_LVCH162374A v.1
74LVC_LVCH162374A v.1	19990805	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.

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[2] The term 'short data sheet' is explained in section "Definitions".

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