74LVC16373A; 74LVCH16373A

16-bit D-type transparent latch with 5 V tolerant inputs/outputs; 3-state

Rev. 8 — 6 January 2014 Product data sheet

1. General description

The 74LVC16373A and 74LVCH16373A are 16-bit D-type transparent latches featuring separate D-type inputs with bus hold (74LVCH16373A only) for each latch and 3-state outputs for bus-oriented applications. One Latch Enable (LE) input and one 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 device consists of two sections of eight D-type transparent latches with 3-state true outputs. When LE is HIGH, data at the Dn inputs enter the latches. In this condition, the latches are transparent, that is, the latch outputs change each time its corresponding D-input changes. The latches store the information that was present at the D-inputs one set-up time (t_{su}) preceding the HIGH-to-LOW transition of LE. When $\overline{OE}$ is LOW, the contents of the eight latches 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 latches. Bus hold on the data inputs eliminates the need for external pull-up resistors to hold unused inputs.

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 (74LVCH16373A only)
- High-impedance 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
74LVC16373ADGG	–40 °C to +125 °C	TSSOP48	plastic thin shrink small outline package; 48 leads; body width 6.1 mm	SOT362-1
74LVCH16373ADGG				
74LVC16373ADL	–40 °C to +125 °C	SSOP48	plastic shrink small outline package; 48 leads; body width 7.5 mm	SOT370-1
74LVCH16373ADL				

4. Functional diagram

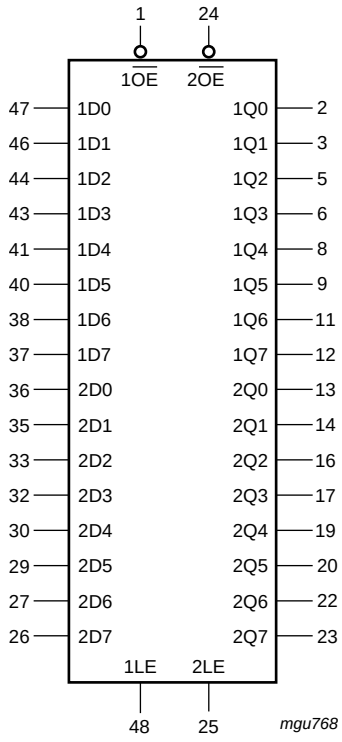


Fig 1. Logic symbol

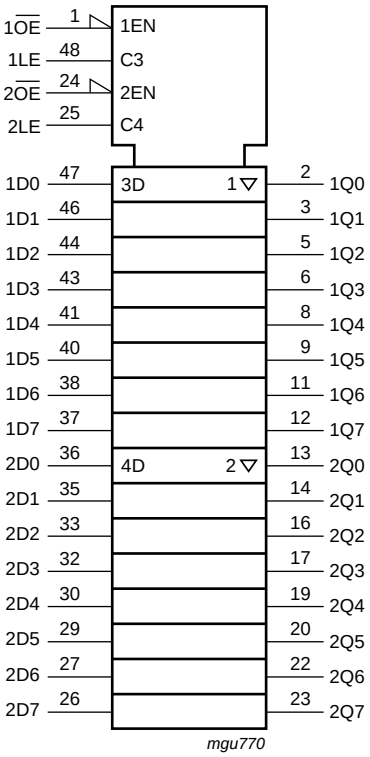


Fig 2. IEC logic symbol

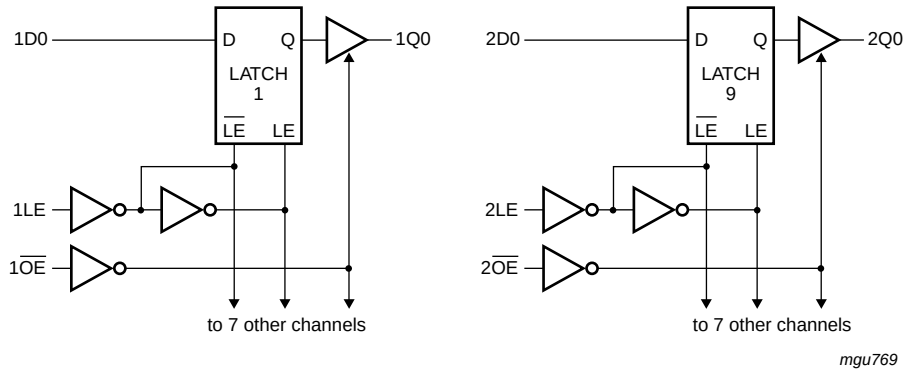


Fig 3. Logic diagram

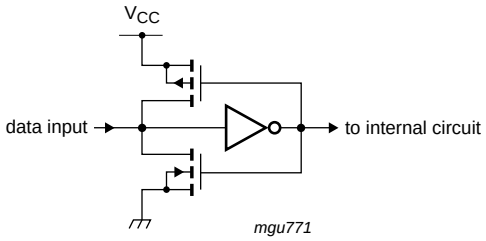


Fig 4. Bus hold circuit

5. Pinning information

5.1 Pinning

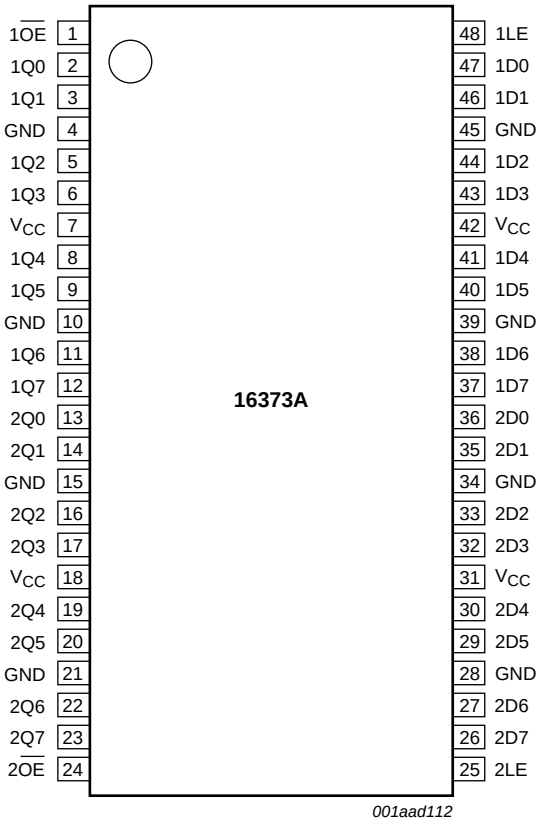


Fig 5. Pin configuration SSOP48 and TSSOP48

5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$1\overline{OE}$	1	output enable input (active LOW)
$2\overline{OE}$	24	output enable input (active LOW)
1LE	48	latch enable input (active HIGH)
2LE	25	latch enable input (active HIGH)
GND	4, 10, 15, 21, 28, 34, 39, 45	ground (0 V)
V_{CC}	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 table
Per section of eight bits [1]

Operating modes	Input			Internal latch	Output nQ0 to nQ7
	$\overline{nOE}$	nLE	nDn		
Enable and read register (transparent mode)	L	H	L	L	L
	L	H	H	H	H
Latch and read register	L	L	l	L	L
	L	L	h	H	H
Latch register and disable outputs	H	L	l	L	Z
	H	L	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

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_{CC}	supply voltage			−0.5	+6.5	V
I_{IK}	input clamping current	$V_I < 0$		−50	-	mA
V_I	input voltage		[1]	−0.5	+6.5	V
I_{OK}	output clamping current	$V_O > V_{CC}$ or $V_O < 0$		-	±50	mA
V_O	output voltage	output HIGH or LOW state	[2]	−0.5	V_{CC} + 0.5	V
		output 3-state	[2]	−0.5	+6.5	V
I_O	output current	V_O = 0 V to V_{CC}		-	±50	mA
I_{CC}	supply current			-	100	mA
I_{GND}	ground current			−100	-	mA
T_{stg}	storage temperature			−65	+150	°C
P_{tot}	total power dissipation	T_{amb} = −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_{tot} derates linearly with 5.5 mW/K.

8. Recommended operating conditions

Table 5. Recommended 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[1]	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 × V_{CC}	-	-	0.65 × 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 × V_{CC}	-	0.35 × 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 μA; V_{CC} = 1.65 V to 3.6 V	V_{CC} − 0.2	-	-	V_{CC} − 0.3	-	V
		I_O = −4 mA; V_{CC} = 1.65 V	1.2	-	-	1.05	-	V
		I_O = −8 mA; V_{CC} = 2.3 V	1.8	-	-	1.65	-	V
		I_O = −12 mA; V_{CC} = 2.7 V	2.2	-	-	2.05	-	V
		I_O = −18 mA; V_{CC} = 3.0 V	2.4	-	-	2.25	-	V
		I_O = −24 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 μA; V_{CC} = 1.65 V to 3.6 V	-	-	0.2	-	0.3	V
		I_O = 4 mA; V_{CC} = 1.65 V	-	-	0.45	-	0.65	V
		I_O = 8 mA; V_{CC} = 2.3 V	-	-	0.6	-	0.8	V
		I_O = 12 mA; V_{CC} = 2.7 V	-	-	0.4	-	0.6	V
		I_O = 24 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[2]	-	±0.1	±5	-	±20	μA

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[1]	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[2]	-	±0.1	±5	-	±20	µA
I_{OFF}	power-off leakage current	V_{CC} = 0 V; V_I or V_O = 5.5 V	-	±0.1	±10	-	±20	µA
I_{CC}	supply current	V_{CC} = 3.6 V; $V_I = V_{CC}$ or GND; I_O = 0 A	-	0.1	20	-	80	µA
ΔI_{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	µA
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[3][4]	10	-	-	10	-	µA
		V_{CC} = 2.3; V_I = 0.7 V	30	-	-	25	-	µA
		V_{CC} = 3.0; V_I = 0.8 V	75	-	-	60	-	µA
I_{BHH}	bus hold HIGH current	V_{CC} = 1.65; V_I = 1.07 V[3][4]	–10	-	-	–10	-	µA
		V_{CC} = 2.3; V_I = 1.7 V	–30	-	-	–25	-	µA
		V_{CC} = 3.0; V_I = 2.0 V	–75	-	-	–60	-	µA
I_{BHLO}	bus hold LOW overdrive current	V_{CC} = 1.95 V[3][5]	200	-	-	200	-	µA
		V_{CC} = 2.7 V	300	-	-	300	-	µA
		V_{CC} = 3.6 V	500	-	-	500	-	µA
I_{BHHO}	bus hold HIGH overdrive current	V_{CC} = 1.95 V[3][5]	–200	-	-	–200	-	µA
		V_{CC} = 2.7 V	–300	-	-	–300	-	µA
		V_{CC} = 3.6 V	–500	-	-	–500	-	µA

[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] Valid for data inputs (74LVCH16373A) only; control inputs do not have a bus hold circuit.

[4] The specified sustaining current at the data inputs holds the input below the specified V_I level.

[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 10.

Symbol	Parameter	Conditions	T_{amb} = –40 °C to +85 °C			–40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	
t_{pd}	propagation delay	Dn to Qn; see Figure 6 [2]						
		V_{CC} = 1.2 V	-	12	-	-	-	ns
		V_{CC} = 1.65 V to 1.95 V	1.5	5.4	11.4	1.5	13.2	ns
		V_{CC} = 2.3 V to 2.7 V	1.0	2.9	5.7	1.0	6.6	ns
		V_{CC} = 2.7 V	1.5	2.9	4.9	1.5	6.5	ns
		V_{CC} = 3.0 V to 3.6 V	1.0	2.4	4.4	1.0	5.5	ns
		LE to Qn; see Figure 7						
		V_{CC} = 1.2 V	-	14	-	-	-	ns
		V_{CC} = 1.65 V to 1.95 V	2.0	6.4	12.4	2.0	14.4	ns
		V_{CC} = 2.3 V to 2.7 V	1.5	3.4	6.1	1.5	7.1	ns
		V_{CC} = 2.7 V	1.5	3.0	5.3	1.5	7.0	ns
		V_{CC} = 3.0 V to 3.6 V	1.5	2.9	4.8	1.5	6.0	ns
t_{en}	enable time	$\overline{OE}$ to Qn; see Figure 8 [2]						
		V_{CC} = 1.2 V	-	18	-	-	-	ns
		V_{CC} = 1.65 V to 1.95 V	1.5	5.5	12.4	1.5	14.3	ns
		V_{CC} = 2.3 V to 2.7 V	1.0	3.1	6.6	1.0	7.6	ns
		V_{CC} = 2.7 V	1.5	3.3	5.7	1.5	7.5	ns
		V_{CC} = 3.0 V to 3.6 V	1.0	2.5	4.9	1.0	6.5	ns
t_{dis}	disable time	$\overline{OE}$ to Qn; see Figure 8 [2]						
		V_{CC} = 1.2 V	-	11	-	-	-	ns
		V_{CC} = 1.65 V to 1.95 V	2.8	4.5	9.1	2.8	10.5	ns
		V_{CC} = 2.3 V to 2.7 V	1.0	2.5	5.1	1.0	6.0	ns
		V_{CC} = 2.7 V	1.5	3.3	6.3	1.5	8.0	ns
		V_{CC} = 3.0 V to 3.6 V	1.5	3.1	5.4	1.5	7.0	ns
t_W	pulse width	LE HIGH; see Figure 7						
		V_{CC} = 1.65 V to 1.95 V	5.0	-	-	5.0	-	ns
		V_{CC} = 2.3 V to 2.7 V	4.0	-	-	4.0	-	ns
		V_{CC} = 2.7 V	3.0	-	-	3.0	-	ns
		V_{CC} = 3.0 V to 3.6 V	3.0	2.0	-	3.0	-	ns
t_{su}	set-up time	Dn to LE; see Figure 9						
		V_{CC} = 1.65 V to 1.95 V	3.0	-	-	3.0	-	ns
		V_{CC} = 2.3 V to 2.7 V	2.5	-	-	2.5	-	ns
		V_{CC} = 2.7 V	2.0	-	-	2.0	-	ns
		V_{CC} = 3.0 V to 3.6 V	2.0	1.0	-	2.0	-	ns

Table 7. Dynamic characteristics *...continued*

Voltages are referenced to GND (ground = 0 V). For test circuit see Figure 10.

Symbol	Parameter	Conditions		T_{amb} = –40 °C to +85 °C			–40 °C to +125 °C		Unit
				Min	Typ[1]	Max	Min	Max	
t_h	hold time	Dn to LE; see Figure 9							
		V_{CC} = 1.65 V to 1.95 V		2.5	-	-	2.5	-	ns
		V_{CC} = 2.3 V to 2.7 V		2.0	-	-	2.0	-	ns
		V_{CC} = 2.7 V		0.9	-	-	0.9	-	ns
		V_{CC} = 3.0 V to 3.6 V		+0.9	–1.0	-	+0.9	-	ns
$t_{sk(o)}$	output skew time	V_{CC} = 3.0 V to 3.6 V	[3]	-	-	1.0	-	1.5	ns
C_{PD}	power dissipation capacitance	per input; V_I = GND to V_{CC}	[4]						
		V_{CC} = 1.65 V to 1.95 V		-	10.8	-	-	-	pF
		V_{CC} = 2.3 V to 2.7 V		-	13.0	-	-	-	pF
		V_{CC} = 3.0 V to 3.6 V		-	15.0	-	-	-	pF

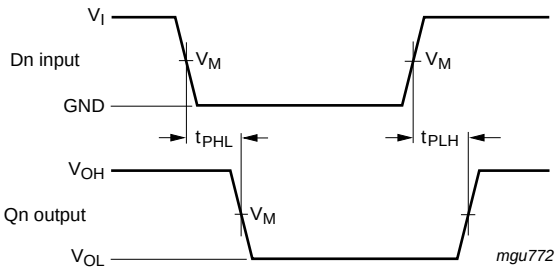
[1] Typical values are measured at T_{amb} = 25 °C and V_{CC} = 1.2 V, 1.8 V, 2.5 V, 2.7 V and 3.3 V respectively.

[2] t_{pd} is the same as t_{PLH} and t_{PHL}.
t_{en} is the same as t_{PZL} and t_{PZH}.
t_{dis} is the same as t_{PLZ} and t_{PHZ}.

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

[4] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ 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
N = number of inputs switching
$\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs

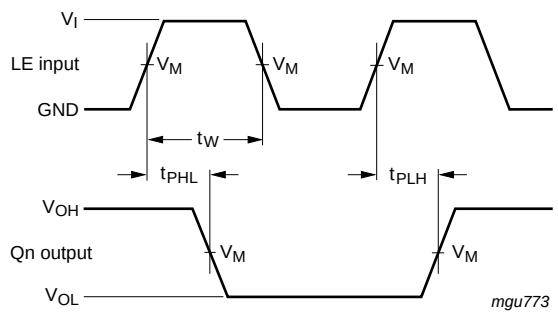
11. Waveforms



Measurement points are given in Table 8.

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

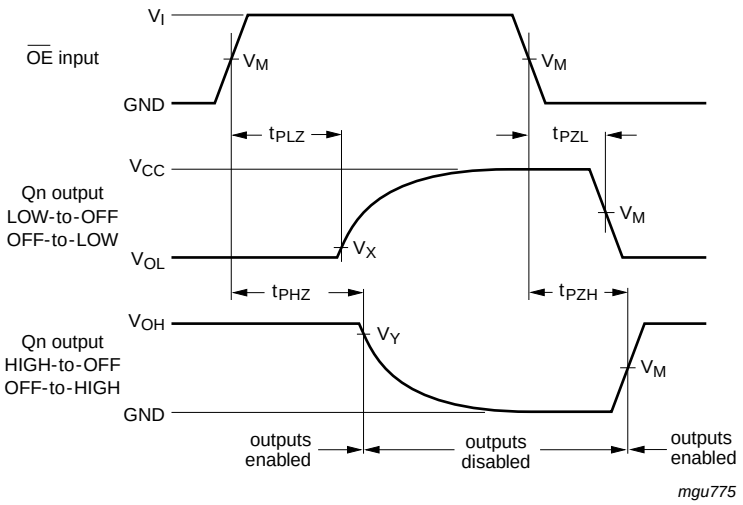
Fig 6. Input (Dn) to output (Qn) propagation delays



Measurement points are given in Table 8.

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

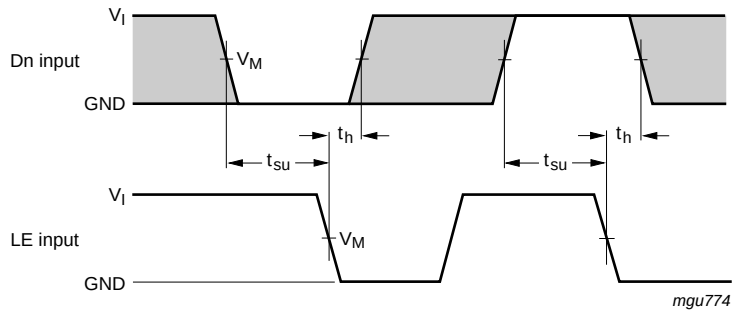
Fig 7. Latch enable input (LE) pulse width, and the latch enable input to output (Qn) propagation delays



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



Measurement points are given in Table 8.

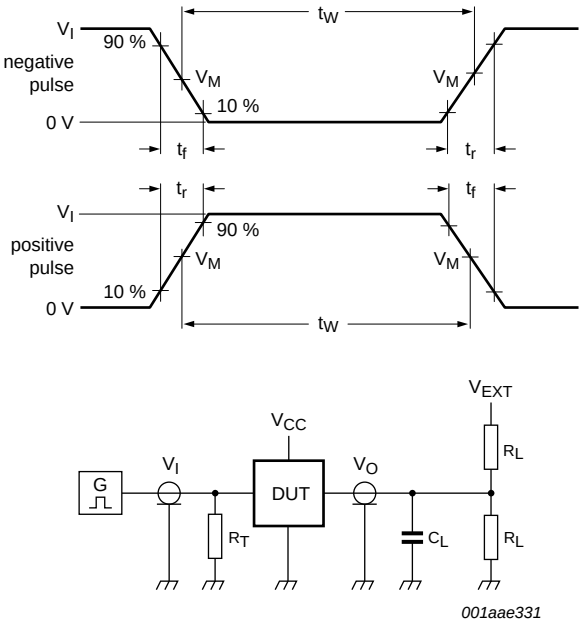
V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

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

Fig 9. Data set-up and hold times for the Dn input to the LE input

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 V	V_{OH} − 0.15 V
1.65 V to 1.95 V	V_{CC}	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	V_{OL} + 0.15 V	V_{OH} − 0.15 V
2.3 V to 2.7 V	V_{CC}	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	V_{OL} + 0.15 V	V_{OH} − 0.15 V
2.7 V	2.7 V	1.5 V	1.5 V	V_{OL} + 0.3 V	V_{OH} − 0.3 V
3.0 V to 3.6 V	2.7 V	1.5 V	1.5 V	V_{OL} + 0.3 V	V_{OH} − 0.3 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.

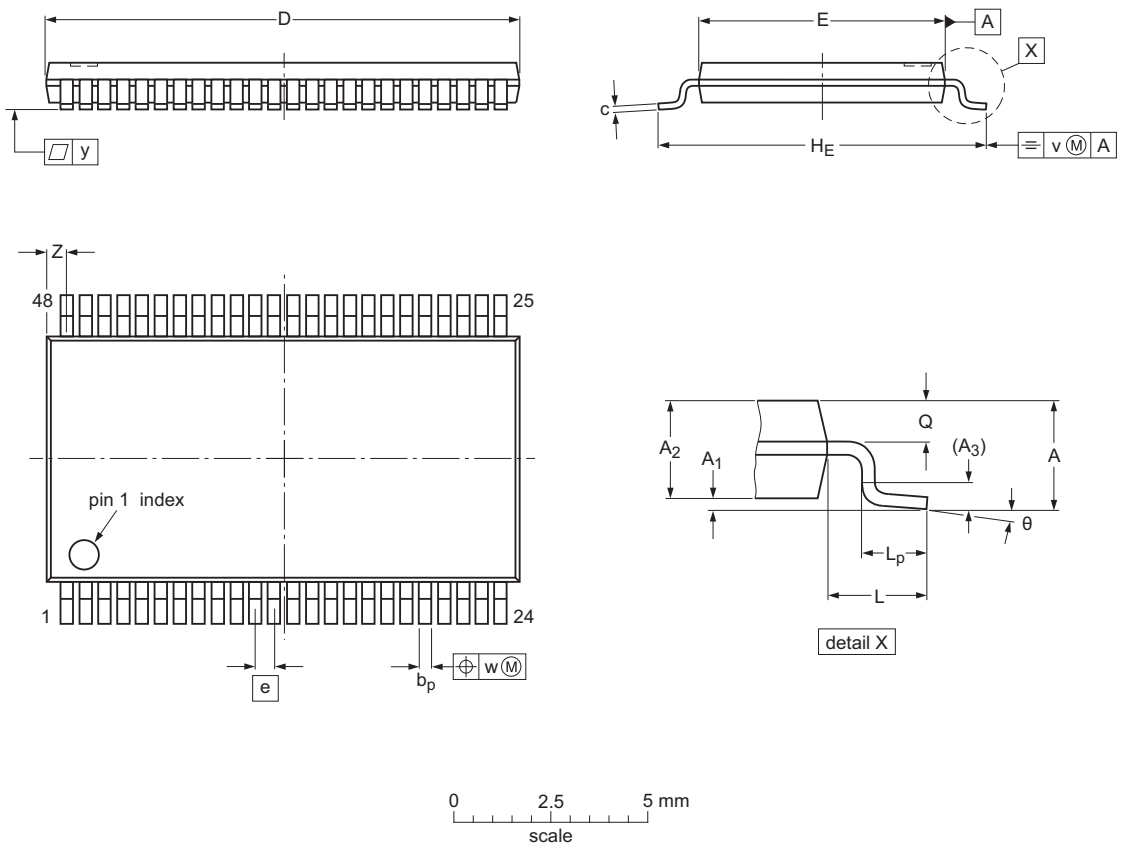
Fig 10. Test circuit for measuring switching times

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}	≤ 2 ns	30 pF	1 kΩ	open	$2 \times V_{CC}$	GND
1.65 V to 1.95 V	V_{CC}	≤ 2 ns	30 pF	1 kΩ	open	$2 \times V_{CC}$	GND
2.3 V to 2.7 V	V_{CC}	≤ 2 ns	30 pF	500 Ω	open	$2 \times V_{CC}$	GND
2.7 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	open	$2 \times V_{CC}$	GND
3.0 V to 3.6 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	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	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	Q	v	w	y	Z	θ
mm	max	1.2	0.15	1.05	0.25	0.28	0.2	12.6	6.2	0.5	8.3	1	0.8	0.50	0.25	0.08	0.1	0.8	8°
	nom																		
	min		0.05	0.85		0.17	0.1	12.4	6.0		7.9		0.4	0.35				0.4	0°

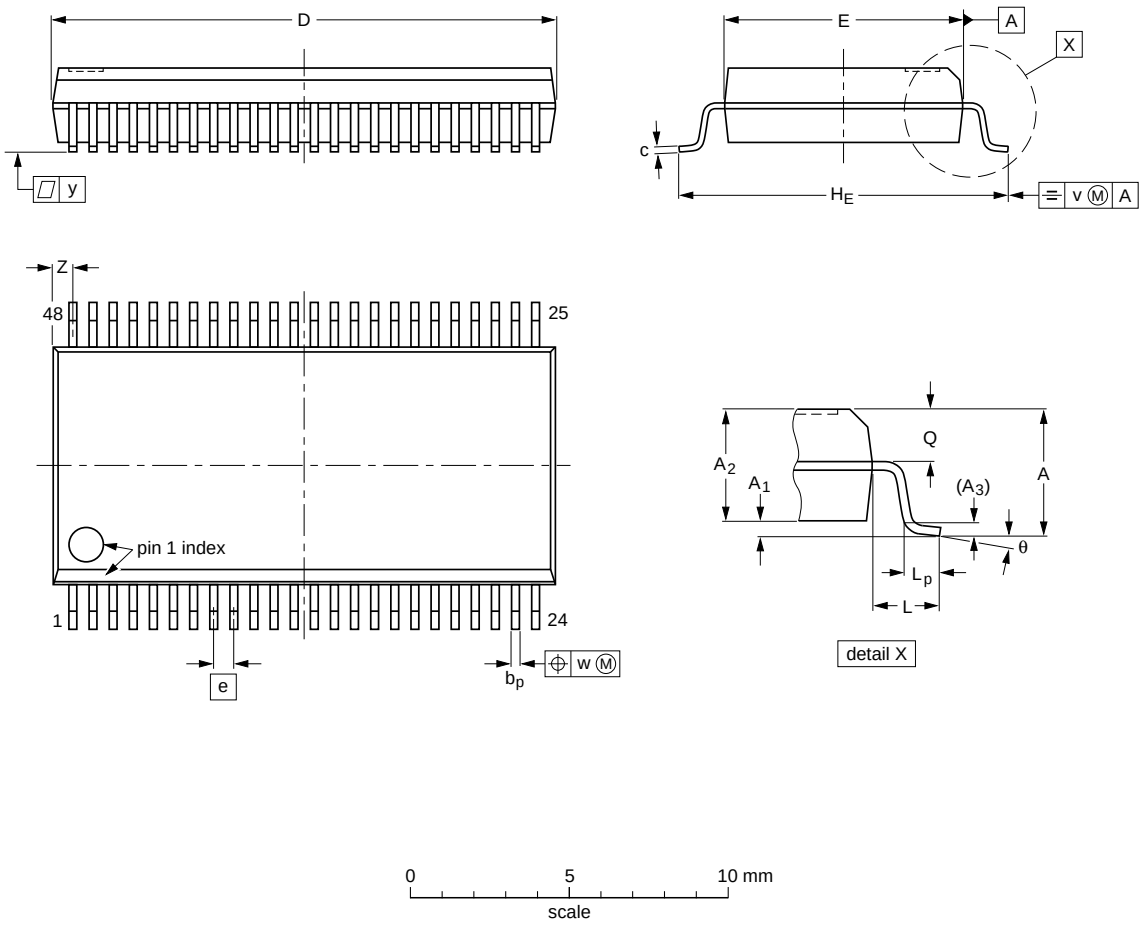
Note
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

sot362-1_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT362-1		MO-153				~~03-02-19~~ 13-08-05

Fig 11. Package outline SOT362-1 (TSSOP-48)

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^o 0^o

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	JEITA			
SOT370-1		MO-118				~~99-12-27~~ 03-02-19

Fig 12. 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
74LVC_LVCH16373A v.8	20140106	Product data sheet	-	74LVC_LVCH16373A v.7
Modifications:	• General description corrected (errata).			
74LVC_LVCH16373A v.7	20130118	Product data sheet	-	74LVC_LVCH16373A v.6
Modifications:	• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate. • Table 5, Table 6, Table 7, Table 8 and Table 9: values added for lower voltage ranges.			
74LVC_LVCH16373A v.6	20031208	Product specification	-	74LVC_LVCH16373A v.5
74LVC_LVCH16373A v.5	20021002	Product specification	-	74LVC_H16373A v.4
74LVC_H16373A v.4	19980317	Product specification	-	74LVC16373A_74LVCH16373A v.3
74LVC16373A_74LVCH16373A v.3	19980317	Product specification	-	74LVC16373A v.2
74LVC16373A v.2	19970822	Product specification	-	74LVC16373A v.1
74LVC16373A v.1	-	-	-	-

15. Legal information

15.1 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 URL http://www.nexperia.com.

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17. Contents

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