

74LVCH16541A

16-bit buffer/line driver; 3-state

Rev. 02 — 18 February 2004

Product data sheet

1. General description

The 74LVCH16541A is a high-performance, low-power and low-voltage Si-gate CMOS device and superior to most advanced CMOS compatible TTL families.

Inputs can be driven from either 3.3 V or 5 V devices. In 3-state operating, outputs can handle 5 V. These features allow the use of these devices in a mixed 3.3 V and 5 V environment.

The 74LVCH16541A is a 16-bit buffer/line driver with 3-state outputs. The 3-state outputs are controlled by the output enable inputs ($1\overline{OEn}$ and $2\overline{OEn}$). A HIGH on $n\overline{OEn}$ causes the outputs to assume a high-impedance OFF-state.

2. Features

- 5 Volt tolerant inputs and 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 pin-out architecture
- Low inductance multiple power and ground pins for minimum noise and ground bounce
- Direct interface with TTL levels
- High-impedance outputs when $V_{CC} = 0$ V
- Complies with JEDEC standard no. 8-1A
- All data inputs have bushold
- ESD protection:
 - ◆ HBM EIA/JESD22-A114-A exceeds 2000 V
 - ◆ MM EIA/JESD22-A115-A exceeds 200 V.
- Specified from -40 °C to $+85$ °C and -40 °C to $+125$ °C.

PHILIPS

3. Quick reference data

Table 1: Quick reference data

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
t_{PHL}, t_{PLH}	propagation delay nAn to nYn	$V_{CC} = 3.3\text{ V}$; $C_L = 50\text{ pF}$	1.0	2.3	4.2	ns	
t_{PZH}, t_{PZL}	3-state output enable time nOEn to 1Yn	$V_{CC} = 3.3\text{ V}$; $C_L = 50\text{ pF}$	1.0	2.9	5.6	ns	
t_{PHZ}, t_{PLZ}	3-state output disable time nOEn to nYn	$V_{CC} = 3.3\text{ V}$; $C_L = 50\text{ pF}$	1.5	3.2	5.5	ns	
C_I	input capacitance		-	5.0	-	pF	
C_{PD}	power dissipation capacitance per buffer	outputs enabled	[1][2]	-	16	-	pF
		outputs disabled	[1][2]	-	4	-	pF

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

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

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;

N = total load switching outputs;

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

[2] The condition is $V_I = GND$ to V_{CC} .

4. Ordering information

Table 2: Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74LVCH16541ADGG	-40 to +125 °C	TSSOP48	plastic thin shrink small outline package; 48 leads; body width 6.1 mm	SOT362-1
74LVCH16541ADL	-40 to +125 °C	SSOP48	plastic shrink small outline package; 48 leads; body width 7.5 mm	SOT370-1

5. Functional diagram

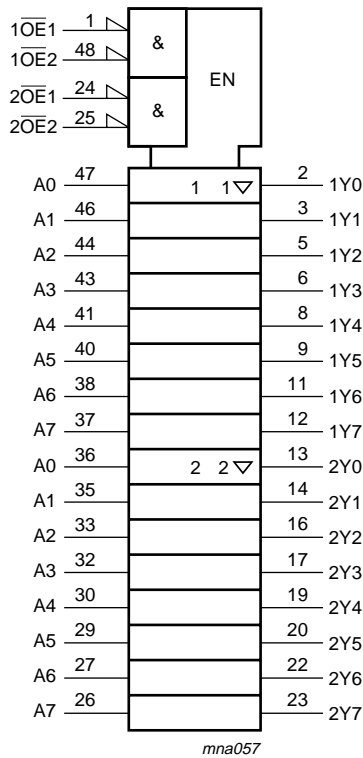


Fig 1. IEC logic symbol.

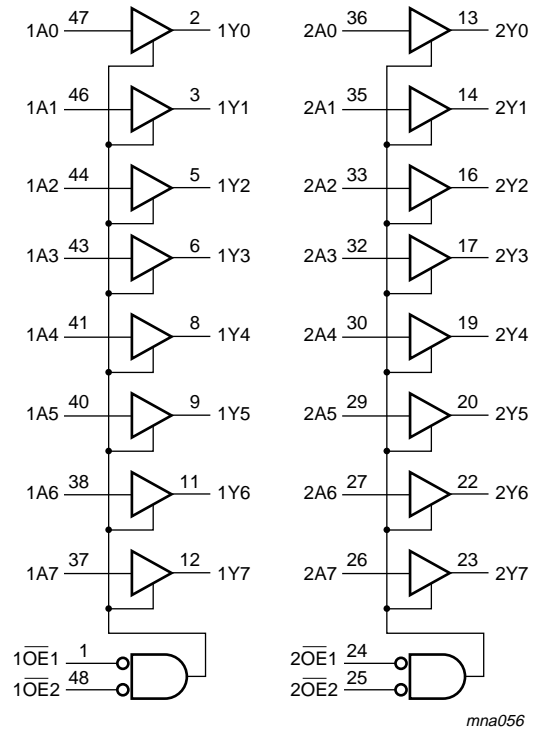


Fig 2. Logic diagram.

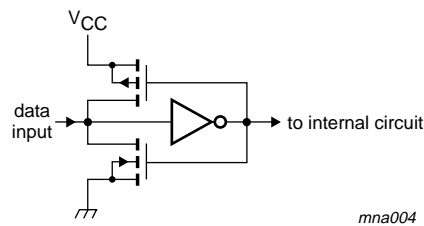
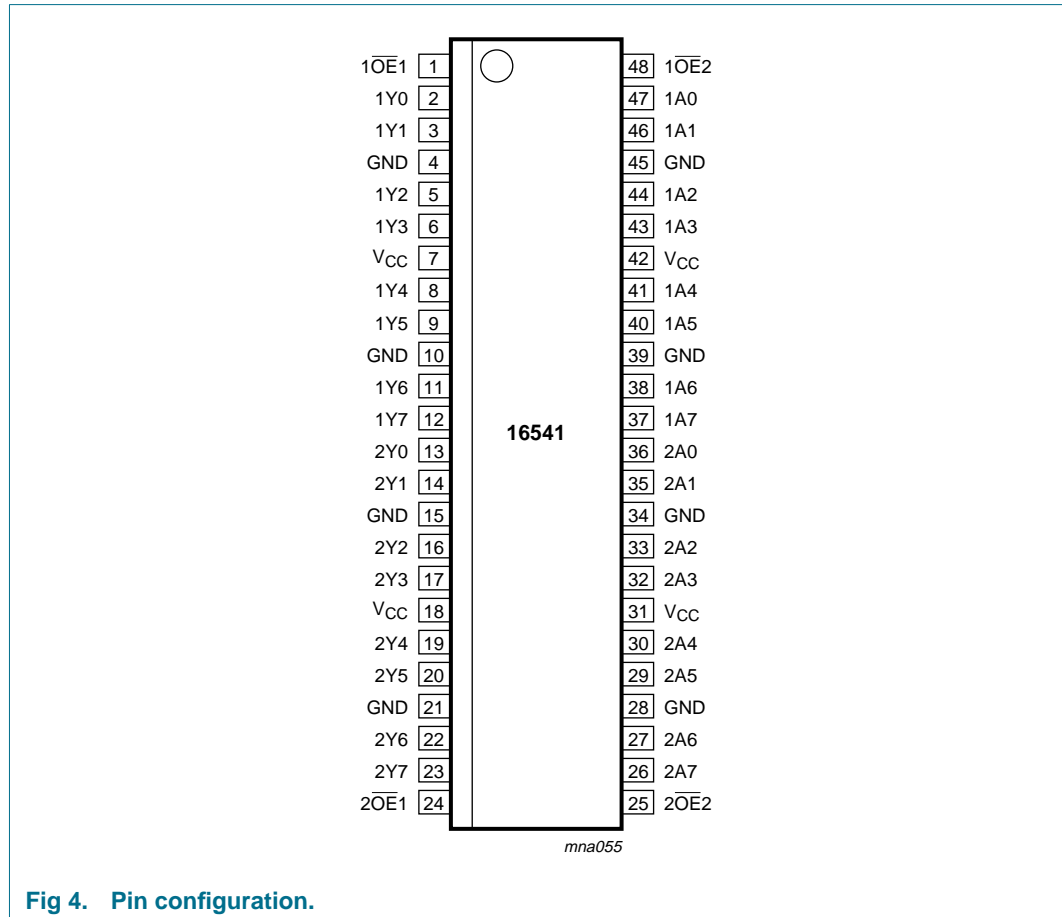


Fig 3. Bushold circuit.

6. Pinning information

6.1 Pinning



6.2 Pin description

Table 3: Pin description

Pin	Symbol	Description
1	$1\overline{OE}1$	output enable input (active LOW)
2	1Y0	data output
3	1Y1	data output
4	GND	ground (0 V)
5	1Y2	data output
6	1Y3	data output
7	V _{CC}	positive supply voltage
8	1Y4	data output
9	1Y5	data output
10	GND	ground (0 V)
11	1Y6	data output

Table 3: Pin description ...continued

Pin	Symbol	Description
12	1Y7	data output
13	2Y0	data output
14	2Y1	data output
15	GND	ground (0 V)
16	2Y2	data output
17	2Y3	data output
18	V _{CC}	positive supply voltage
19	2Y4	data output
20	2Y5	data output
21	GND	ground (0 V)
22	2Y6	data output
23	2Y7	data output
24	2 $\overline{\text{OE}}$ 1	output enable input (active LOW)
25	2 $\overline{\text{OE}}$ 2	output enable input (active LOW)
26	2A7	data input
27	2A6	data input
28	GND	ground (0 V)
29	2A5	data input
30	2A4	data input
31	V _{CC}	positive supply voltage
32	2A3	data input
33	2A2	data input
34	GND	ground (0 V)
35	2A1	data input
36	2A0	data input
37	1A7	data input
38	1A6	data input
39	GND	ground (0 V)
40	1A5	data input
41	1A4	data input
42	V _{CC}	positive supply voltage
43	1A3	data input
44	1A2	data input
45	GND	ground (0 V)
46	1A1	data input
47	1A0	data input
48	1 $\overline{\text{OE}}$ 2	output enable input (active LOW)

7. Functional description

7.1 Function table

Table 4: Function table ^[1]

Input			Output
nOE1	nOE2	nAn	nYn
L	L	L	L
L	L	H	H
X	H	X	Z
H	X	X	Z

[1] H = HIGH voltage level;
L = LOW voltage level;
X = don't care;
Z = high-impedance OFF-state.

8. Limiting values

Table 5: 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
V_I	input voltage		^[1] -0.5	+6.5	V
I_{IK}	input diode current	$V_I < 0$	-	-50	mA
I_{OK}	output diode current	$V_O > V_{CC}$ or $V_O < 0$	-	±50	mA
V_O	output voltage	output HIGH or LOW state	^[1] -0.5	$V_{CC} + 0.5$	V
		output 3-state	^[1] -0.5	+6.5	V
I_O	output source or sink current	$V_O = 0$ to V_{CC}	-	±50	mA
I_{CC}, I_{GND}	V_{CC} or GND current		-	±100	mA
T_{stg}	storage temperature		-65	+150	°C
P_{tot}	power dissipation	$T_{amb} = -40$ °C to +125 °C	^[2] -	500	mW

[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_{tot} derates linearly with 5.5 mW/K.

9. Recommended operating conditions

Table 6: Recommended operating operations

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage	for maximum speed performance	2.7	3.6	V
		for low-voltage applications	1.2	3.6	V
V_I	input voltage		0	5.5	V

Table 6: Recommended operating operations ...continued

Symbol	Parameter	Conditions	Min	Max	Unit
V _O	output voltage	output HIGH or LOW state	0	V _{CC}	V
		output 3-state or V _{CC} = 0 V	0	5.5	V
T _{amb}	operating ambient temperature	in free air	-40	+125	°C
t _r , t _f	input rise and fall times	V _{CC} = 1.2 V to 2.7 V	0	20	ns/V
		V _{CC} = 2.7 V to 3.6 V	0	10	ns/V

10. Static characteristics

Table 7: Static characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T_{amb} = -40 °C to +85 °C [1]						
V _{IH}	HIGH-level input voltage	V _{CC} = 1.2 V	V _{CC}	-	-	V
		V _{CC} = 2.7 V to 3.6 V	2.0	-	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 1.2 V	-	-	GND	V
		V _{CC} = 2.7 V to 3.6 V	-	-	0.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL}				
		I _O = -100 μA; V _{CC} = 2.7 V to 3.6 V	V _{CC} - 0.2	V _{CC}	-	V
		I _O = -12 mA; V _{CC} = 2.7 V	V _{CC} - 0.5	-	-	V
		I _O = -18 mA; V _{CC} = 3.0 V	V _{CC} - 0.6	-	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}				
		I _O = 100 μA; V _{CC} = 2.7 V to 3.6 V	-	0	0.20	V
		I _O = 12 mA; V _{CC} = 2.7 V	-	-	0.40	V
		I _O = 24 mA; V _{CC} = 3.0 V	-	-	0.55	V
I _{LI}	input leakage current	V _I = 5.5 V or GND; V _{CC} = 3.6 V	[2] -	±0.1	±5	μA
I _{OZ}	3-state output OFF-state current	V _I = V _{IH} or V _{IL} ; V _O = 5.5 V or GND; V _{CC} = 3.6 V	[2] -	±0.1	±5	μA
I _{off}	power-off leakage supply current	V _I or V _O = 5.5 V; V _{CC} = 0	-	±0.1	±10	μA
I _{CC}	quiescent supply current	V _I = V _{CC} or GND; I _O = 0; V _{CC} = 3.6 V	-	0.1	20	μA
ΔI _{CC}	additional quiescent supply current per input pin	V _I = V _{CC} - 0.6 V; I _O = 0; V _{CC} = 2.7 V to 3.6 V	-	5	500	μA
C _I	input capacitance		-	5.0	-	pF
I _{BHL}	bushold LOW sustaining current	V _I = 0.8 V; V _{CC} = 3.0 V	[3] [4] 75	-	-	μA
I _{BHH}	bushold HIGH sustaining current	V _I = 2.0 V; V _{CC} = 3.0 V	[3] [4] -75	-	-	μA
I _{BHLO}	bushold LOW overdrive current	V _{CC} = 3.6 V	[3] [5] 500	-	-	μA

Table 7: Static characteristics ...continued

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{BHHO}	bushold HIGH overdrive current	$V_{CC} = 3.6\text{ V}$	[3] [5] -500	-	-	μA
$T_{amb} = -40\text{ }^{\circ}\text{C to }+125\text{ }^{\circ}\text{C}$						
V_{IH}	HIGH-level input voltage	$V_{CC} = 1.2\text{ V}$	V_{CC}	-	-	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	2.0	-	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 1.2\text{ V}$	-	-	GND	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	-	-	0.8	V
V_{OH}	HIGH-level output voltage	$V_I = V_{IH}\text{ or }V_{IL}$				
		$I_O = -100\text{ }\mu\text{A}; V_{CC} = 2.7\text{ V to }3.6\text{ V}$	$V_{CC} - 0.3$	-	-	V
		$I_O = -12\text{ mA}; V_{CC} = 2.7\text{ V}$	$V_{CC} - 0.65$	-	-	V
		$I_O = -18\text{ mA}; V_{CC} = 3.0\text{ V}$	$V_{CC} - 0.75$	-	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH}\text{ or }V_{IL}$				
		$I_O = 100\text{ }\mu\text{A}; V_{CC} = 2.7\text{ V to }3.6\text{ V}$	-	-	0.3	V
		$I_O = 12\text{ mA}; V_{CC} = 2.7\text{ V}$	-	-	0.6	V
		$I_O = 24\text{ mA}; V_{CC} = 3.0\text{ V}$	-	-	0.8	V
I_{LI}	input leakage current	$V_I = 5.5\text{ V or GND}; V_{CC} = 3.6\text{ V}$	[2] -	-	± 20	μA
I_{OZ}	3-state output OFF-state current	$V_I = V_{IH}\text{ or }V_{IL}; V_O = 5.5\text{ V or GND}; V_{CC} = 3.6\text{ V}$	[2] -	-	± 20	μA
I_{off}	power-off leakage supply current	$V_I\text{ or }V_O = 5.5\text{ V}; V_{CC} = 0$	-	-	± 20	μA
I_{CC}	quiescent supply current	$V_I = V_{CC}\text{ or GND}; I_O = 0; V_{CC} = 3.6\text{ V}$	-	-	80	μA
ΔI_{CC}	additional quiescent supply current per input pin	$V_I = V_{CC} - 0.6\text{ V}; I_O = 0; V_{CC} = 2.7\text{ V to }3.6\text{ V}$	-	-	5000	μA
I_{BHL}	bushold LOW sustaining current	$V_I = 0.8\text{ V}; V_{CC} = 3.0\text{ V}$	[3] [4] 60	-	-	μA
I_{BHH}	bushold HIGH sustaining current	$V_I = 2.0\text{ V}; V_{CC} = 3.0\text{ V}$	[3] [4] -60	-	-	μA
I_{BHLO}	bushold LOW overdrive current	$V_{CC} = 3.6\text{ V}$	[3] [5] 500	-	-	μA
I_{BHHO}	bushold HIGH overdrive current	$V_{CC} = 3.6\text{ V}$	[3] [5] -500	-	-	μA

[1] All typical values are measured at $V_{CC} = 3.3\text{ V}$ and $T_{amb} = 25\text{ }^{\circ}\text{C}$.

[2] For bushold parts, the bushold 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 bushold 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.

11. Dynamic characteristics

Table 8: Dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); see [Figure 7](#)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T_{amb} = -40 °C to +85 °C [1]						
t _{PHL} , t _{PLH}	propagation delay nAn to nYn	see Figure 5				
		V _{CC} = 1.2 V	-	-	-	ns
		V _{CC} = 2.7 V	1.0	-	5.0	ns
		V _{CC} = 3.0 V to 3.6 V [2]	1.0	2.3	4.2	ns
t _{PZH} , t _{PZL}	3-state output enable time nOEn to nYn	see Figure 6				
		V _{CC} = 1.2 V	-	17	-	ns
		V _{CC} = 2.7 V	1.5	-	6.9	ns
		V _{CC} = 3.0 V to 3.6 V [2]	1.0	2.9	5.6	ns
t _{PHZ} , t _{PLZ}	3-state output disable time nOEn to nYn	see Figure 6				
		V _{CC} = 1.2 V	-	9.0	-	ns
		V _{CC} = 2.7 V	1.5	-	6.5	ns
		V _{CC} = 3.0 V to 3.6 V [2]	1.5	3.2	5.5	ns
t _{sk(0)}	skew	V _{CC} = 3.0 V to 3.6 V [3]	-	-	1.0	ns
C _{PD}	power dissipation capacitance per buffer	outputs enabled	[4] [5]	16	-	pF
		outputs disabled	[4] [5]	4	-	pF
T_{amb} = -40 °C to +125 °C						
t _{PHL} , t _{PLH}	propagation delay nAn to nYn	see Figure 5				
		V _{CC} = 1.2 V	-	-	-	ns
		V _{CC} = 2.7 V	1.0	-	6.5	ns
		V _{CC} = 3.0 V to 3.6 V	1.0	-	5.5	ns
t _{PZH} , t _{PZL}	3-state output enable time nOEn to nYn	see Figure 6				
		V _{CC} = 1.2 V	-	-	-	ns
		V _{CC} = 2.7 V	1.0	-	9.0	ns
		V _{CC} = 3.0 V to 3.6 V	1.0	-	7.0	ns
t _{PHZ} , t _{PLZ}	3-state output disable time nOEn to nYn	see Figure 6				
		V _{CC} = 1.2 V	-	-	-	ns
		V _{CC} = 2.7 V	1.5	-	8.5	ns
		V _{CC} = 3.0 V to 3.6 V	1.5	-	7.0	ns
t _{sk(0)}	skew	V _{CC} = 3.0 V to 3.6 V [3]	-	-	1.5	ns

[1] All typical values are measured at T_{amb} = 25 °C.

[2] These typical values are measured at V_{CC} = 3.3 V.

[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).

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

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;

N = total load switching outputs;

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

[5] The condition is $V_I = GND$ to V_{CC} .

12. Waveforms

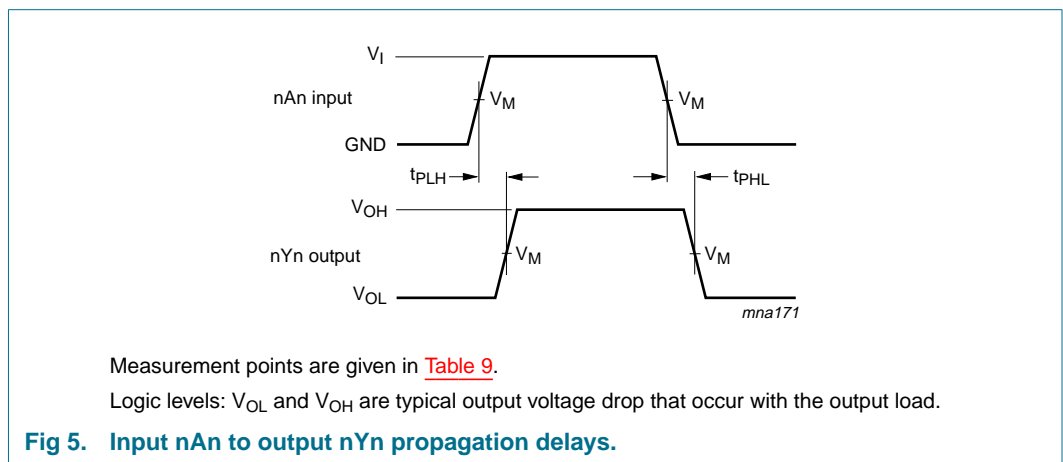


Table 9: Measurement points

Supply voltage	Input	Output
V_{CC}	V_M	V_M
1.2 V	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$
2.7 V	1.5 V	1.5 V
3.0 V to 3.6 V	1.5 V	1.5 V

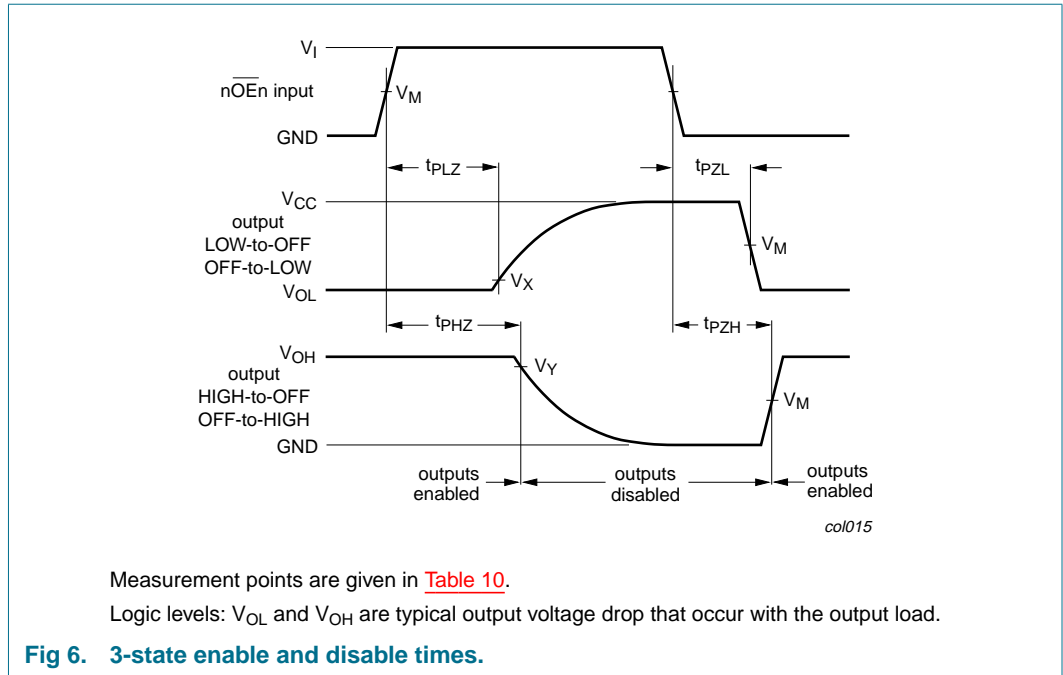


Table 10: Measurement points

Supply voltage	Input	Output		
V_{CC}	V_M	V_M	V_X	V_Y
1.2 V	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	$V_{OL} + 0.1 \times V_{CC}$	$V_{OH} - 0.1 \times V_{CC}$
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	1.5 V	1.5 V	$V_{OL} + 0.3 V$	$V_{OH} - 0.3 V$

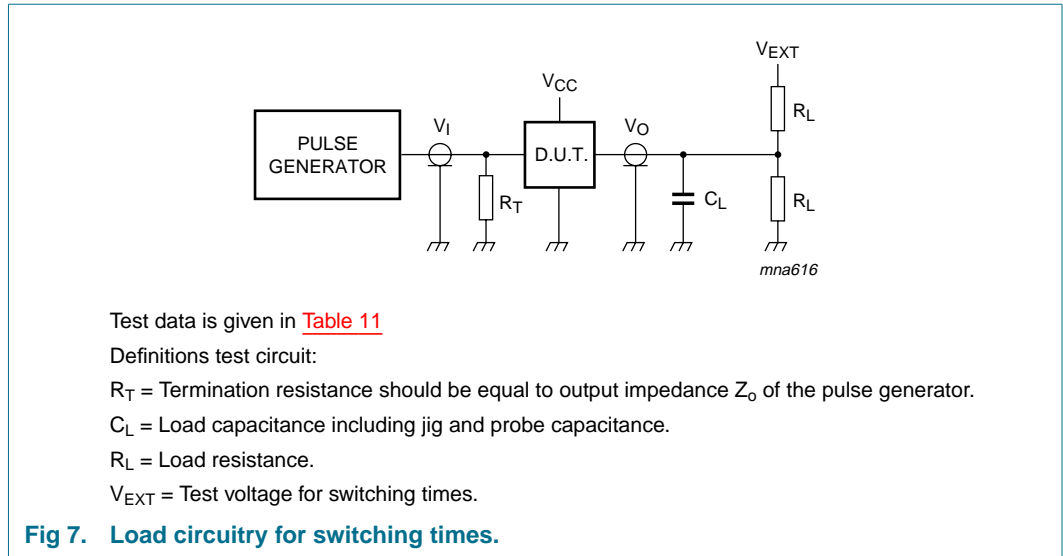


Table 11: Test data

Supply voltage	Input		Load		V_{EXT}		
V_{CC}	V_I	t_r, t_f	C_L	R_L	t_{PLH}, t_{PHL}	t_{PZH}, t_{PHZ}	t_{PZL}, t_{PLZ}
1.2 V	V_{CC}	≤ 2.5 ns	50 pF	500 Ω [1]	open	GND	$2 \times V_{CC}$
2.7 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	open	GND	$2 \times V_{CC}$
3.0 V to 3.6 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	open	GND	$2 \times V_{CC}$

[1] The circuit performs better when $R_L = 1000 \Omega$.

13. Package outline

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

SOT362-1

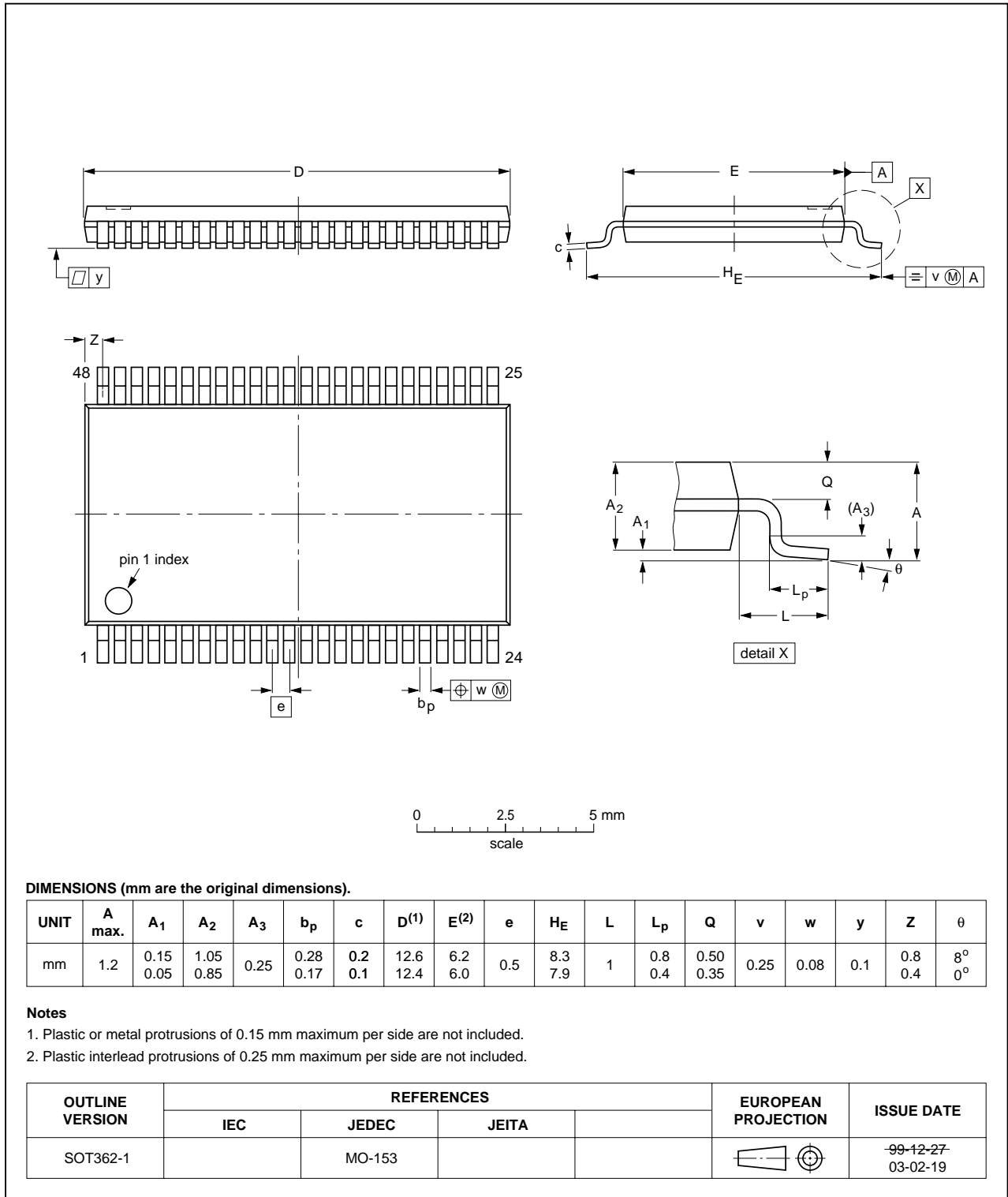


Fig 8. Package outline TSSOP48.

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

SOT370-1

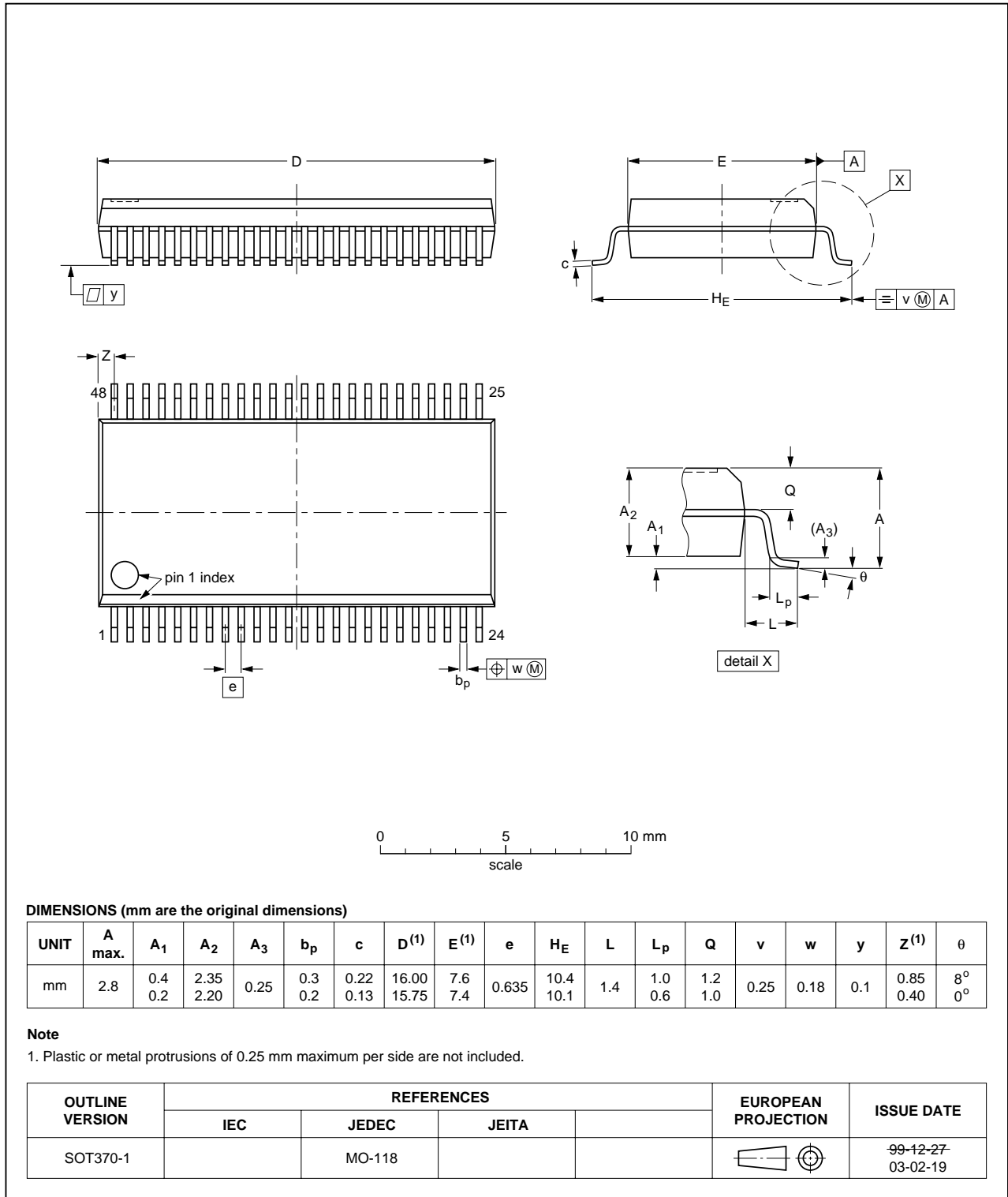


Fig 9. Package outline SSOP48.

14. Revision history

Table 12: Revision history

Document ID	Release date	Data sheet status	Change notice	Order number	Supersedes
74LVCH16541A_2	20040218	Product data	-	9397 750 12699	74LVCH16541A_1
Modifications:					
					<ul style="list-style-type: none">• The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors.• Table 7: added values for $T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$• Table 8: added values for $T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$
74LVCH16541A_1	19980519	Product specification	-	9397 750 04535	-

15. Data sheet status

Level	Data sheet status ^[1]	Product status ^[2] ^[3]	Definition
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
III	Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN).

[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

16. Definitions

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — 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 — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

17. Disclaimers

Life support — 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 Semiconductors customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips Semiconductors for any damages resulting from such application.

Right to make changes — Philips Semiconductors reserves the right to make changes in the products - including circuits, standard cells, and/or software - described or contained herein in order to improve design and/or performance. When the product is in full production (status 'Production'), relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN). Philips Semiconductors assumes no responsibility or liability for the use of any of these products, conveys no license or title under any patent, copyright, or mask work right to these products, and makes no representations or warranties that these products are free from patent, copyright, or mask work right infringement, unless otherwise specified.

18. Contact information

For additional information, please visit: <http://www.semiconductors.philips.com>

For sales office addresses, send an email to: sales.addresses@www.semiconductors.philips.com

19. Contents

1	General description	1
2	Features	1
3	Quick reference data	2
4	Ordering information	2
5	Functional diagram	3
6	Pinning information	4
6.1	Pinning	4
6.2	Pin description	4
7	Functional description	6
7.1	Function table	6
8	Limiting values	6
9	Recommended operating conditions	6
10	Static characteristics	7
11	Dynamic characteristics	9
12	Waveforms	10
13	Package outline	13
14	Revision history	15
15	Data sheet status	16
16	Definitions	16
17	Disclaimers	16
18	Contact information	16



© Koninklijke Philips Electronics N.V. 2004

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner. The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Date of release: 18 February 2004
Document order number: 9397 750 12699

Published in The Netherlands