

74LVC16241A

16-bit buffer/line driver with 5 V tolerant inputs/outputs;
3-state

Rev. 03 — 16 February 2004

Product data sheet

1. General description

The 74LVC16241A 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 operation, outputs can handle 5 V. These features allow the use of these devices in a mixed 3.3 V and 5 V environment.

The 74LVC16241A is a 16-bit non-inverting buffer/line driver with 3-state outputs. The 3-state outputs are controlled by the output enable inputs ($1\overline{OE}$, $2OE$, $3OE$ and $4\overline{OE}$). Schmitt-trigger action at all inputs makes the circuit highly tolerant for slower input rise and fall times. The device can be used as four 4-bit buffers, two 8-bit buffers or one 16-bit buffer.

2. Features

- 5 V 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
- 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

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{PHL} , t_{PLH}	propagation delay nAn to nYn	$C_L = 50\text{ pF}$; $V_{CC} = 3.3\text{ V}$	-	2.4	-	ns
C_I	input capacitance		-	5.0	-	pF
C_{PD}	power dissipation capacitance per buffer	$V_{CC} = 3.3\text{ V}$ outputs enabled outputs disabled	[1] [2]	15 3	- -	pF 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	
74LVC16241ADL	-40 °C to +125 °C	SSOP48	plastic shrink small outline package; 48 leads; body width 7.5 mm	SOT370-1
74LVC16241ADGG	-40 °C to +125 °C	TSSOP48	plastic thin shrink small outline package; 48 leads; body width 6.1 mm	SOT362-1

5. Functional diagram

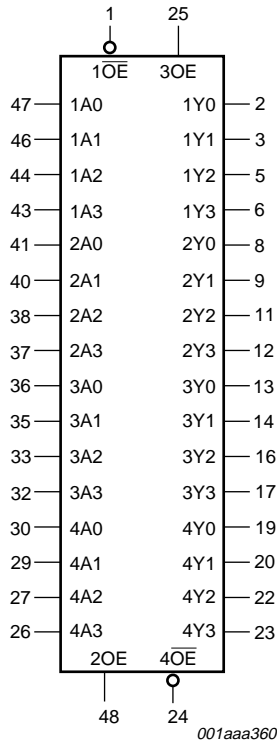


Fig 1. Logic symbol.

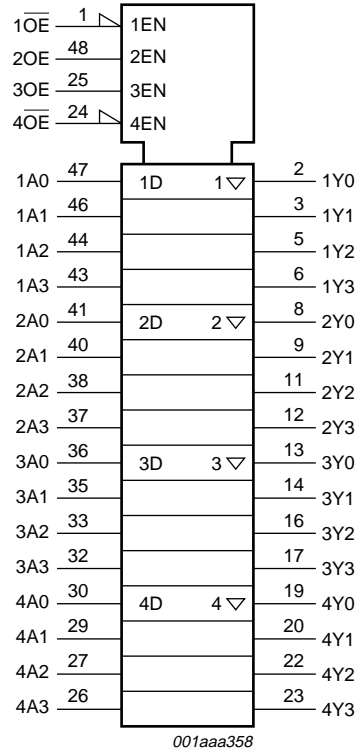


Fig 2. IEC logic symbol.

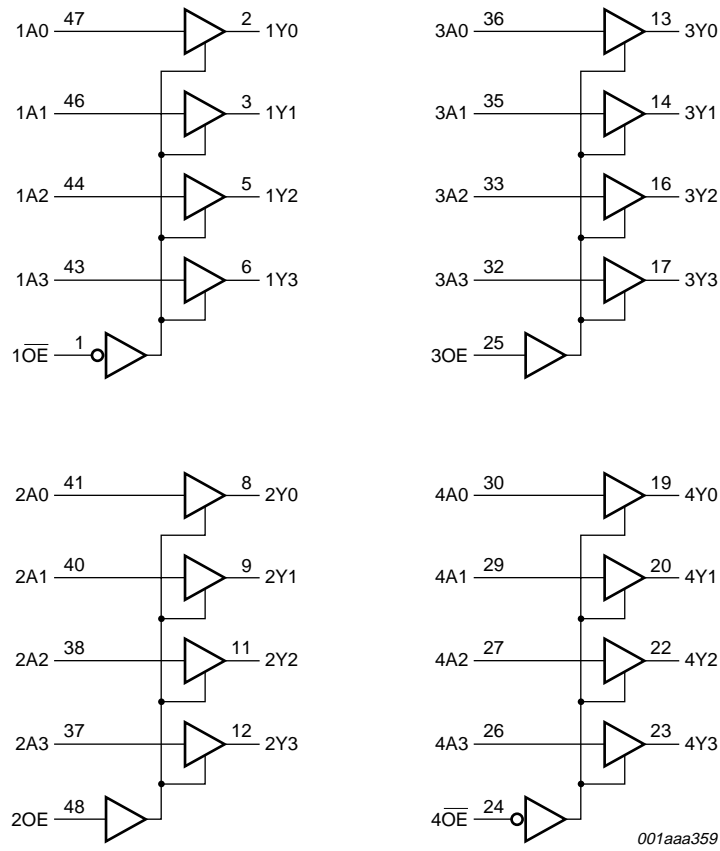


Fig 3. Logic diagram.

6. Pinning information

6.1 Pinning

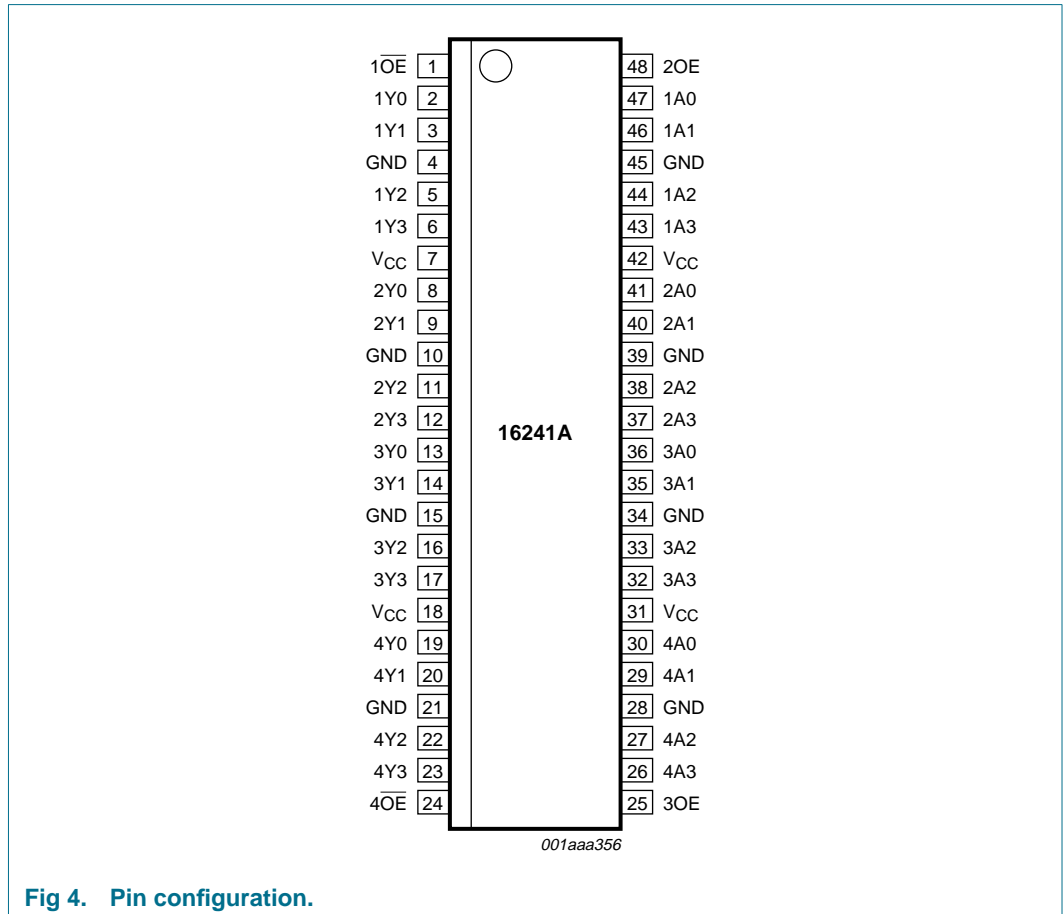


Fig 4. Pin configuration.

6.2 Pin description

Table 3: Pin description

Pin	Symbol	Description
1	1 \overline{OE}	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}	supply voltage
8	2Y0	data output
9	2Y1	data output
10	GND	ground (0 V)
11	2Y2	data output

Table 3: Pin description ...continued

Pin	Symbol	Description
12	2Y3	data output
13	3Y0	data output
14	3Y1	data output
15	GND	ground (0 V)
16	3Y2	data output
17	3Y3	data output
18	V _{CC}	supply voltage
19	4Y0	data output
20	4Y1	data output
21	GND	ground (0 V)
22	4Y2	data output
23	4Y3	data output
24	4 $\overline{\text{OE}}$	output enable input (active LOW)
25	3OE	output enable input (active HIGH)
26	4A3	data input
27	4A2	data input
28	GND	ground (0 V)
29	4A1	data input
30	4A0	data input
31	V _{CC}	supply voltage
32	3A3	data input
33	3A2	data input
34	GND	ground (0 V)
35	3A1	data input
36	3A0	data input
37	2A3	data input
38	2A2	data input
39	GND	ground (0 V)
40	2A1	data input
41	2A0	data input
42	V _{CC}	supply voltage
43	1A3	data input
44	1A2	data input
45	GND	ground (0 V)
46	1A1	data input
47	1A0	data input
48	2OE	output enable input (active HIGH)

7. Functional description

7.1 Function table

Table 4: Function table ^[1]

Input			Output
nAn	nOE	nOE	nYn
H	L	-	H
	-	H	H
L	L	-	L
	-	H	L
X	H	-	Z
	-	L	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
I _{IK}	input diode current	V _I < 0 V	-	-50	mA
V _I	input voltage		^[1] -0.5	+6.5	V
I _{OK}	output diode current	V _O > V _{CC} or V _O < 0 V	-	±50	mA
V _O	output voltage	HIGH or LOW state	^[1] -0.5	V _{CC} + 0.5	V
		3-state	^[1] -0.5	+6.5	V
I _O	output source or sink current	V _O = 0 V 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 conditions

Symbol	Parameter	Conditions	Min	Typ	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
V_O	output voltage	HIGH or LOW state	0	-	V_{CC}	V
		3-state	0	-	5.5	V
T_{amb}	operating ambient temperature	in free air	-40	-	+125	°C
t_r, t_f	input rise and fall times	$V_{CC} = 1.2\text{ V to }2.7\text{ V}$	0	-	20	ns/V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	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
$T_{amb} = -40\text{ °C to }+85\text{ °C}$ 						
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	$V_I = V_{IH}$ or V_{IL}				
		$I_O = -100\text{ }\mu\text{A}; V_{CC} = 2.7\text{ V to }3.6\text{ V}$	$V_{CC} - 0.2$	V_{CC}	-	V
		$I_O = -12\text{ mA}; V_{CC} = 2.7\text{ V}$	$V_{CC} - 0.5$	-	-	V
		$I_O = -18\text{ mA}; V_{CC} = 3.0\text{ V}$	$V_{CC} - 0.6$	-	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH}$ or V_{IL}				
		$I_O = 100\text{ }\mu\text{A}; V_{CC} = 2.7\text{ V to }3.6\text{ V}$	-	GND	0.2	V
		$I_O = 12\text{ mA}; V_{CC} = 2.7\text{ V}$	-	-	0.4	V
		$I_O = 24\text{ mA}; V_{CC} = 3.0\text{ V}$	-	-	0.55	V
I_{LI}	input leakage current	$V_I = 5.5\text{ V or GND}; V_{CC} = 3.6\text{ V}$	-	± 0.1	± 5	μA
I_{OZ}	3-state output OFF-state current	$V_I = V_{IH}$ or $V_{IL}; V_O = 5.5\text{ V or GND}; V_{CC} = 3.6\text{ V}$	-	± 0.1	± 5	μA
I_{off}	power-off leakage supply current	V_I or $V_O = 5.5\text{ V}; V_{CC} = 0\text{ V}$	-	± 0.1	± 10	μA
I_{CC}	quiescent supply current	$V_I = V_{CC}$ or GND; $I_O = 0\text{ A}; V_{CC} = 3.6\text{ V}$	-	0.1	20	μA
ΔI_{CC}	additional quiescent supply current per pin	$V_I = V_{CC} - 0.6\text{ V}; I_O = 0\text{ A}; V_{CC} = 2.7\text{ V to }3.6\text{ V}$	-	5	500	μA
C_I	input capacitance		-	5.0	-	pF

Table 7: Static characteristics ...continued

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T_{amb} = -40 °C to +125 °C						
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} - 0.3	-	-	V
		I _O = -12 mA; V _{CC} = 2.7 V	V _{CC} - 0.65	-	-	V
		I _O = -18 mA; V _{CC} = 3.0 V	V _{CC} - 0.75	-	-	V
V _{OL}	LOW-level output voltage	I _O = -24 mA; V _{CC} = 3.0 V	V _{CC} - 1.0	-	-	V
		V _I = V _{IH} or V _{IL}				
		I _O = 100 μA; V _{CC} = 2.7 V to 3.6 V	-	-	0.3	V
		I _O = 12 mA; V _{CC} = 2.7 V	-	-	0.6	V
	I _O = 24 mA; V _{CC} = 3.0 V	-	-	0.8	V	
I _{LI}	input leakage current	V _I = 5.5 V or GND; V _{CC} = 3.6 V	-	-	±20	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	-	-	±20	μA
I _{off}	power-off leakage supply current	V _I or V _O = 5.5 V; V _{CC} = 0 V	-	-	±20	μA
I _{CC}	quiescent supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 3.6 V	-	-	80	μA
ΔI _{CC}	additional quiescent supply current per pin	V _I = V _{CC} - 0.6 V; I _O = 0 A; V _{CC} = 2.7 V to 3.6 V	-	-	5000	μA

[1] Typical values are measured at V_{CC} = 3.3 V and T_{amb} = 25 °C.

11. Dynamic characteristics

Table 8: Dynamic characteristics

 At recommended operating conditions; see [Figure 8](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$T_{amb} = -40\text{ °C to }+85\text{ °C}$ [1]						
t_{PLH} , t_{PHL}	propagation delay nAn to nYn	see Figure 5 $V_{CC} = 1.2\text{ V}$	-	13	-	ns
		$V_{CC} = 2.7\text{ V}$	1.0	-	5.0	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ [2]	1.0	2.4	4.4	ns
t_{PZH} , t_{PZL}	3-state output enable time nOE to nYn	see Figure 6 $V_{CC} = 1.2\text{ V}$	-	17	-	ns
		$V_{CC} = 2.7\text{ V}$	1.0	-	6.0	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ [2]	1.0	2.5	5.5	ns
	3-state output enable time nOE to nYn	see Figure 7 $V_{CC} = 1.2\text{ V}$	-	19	-	ns
		$V_{CC} = 2.7\text{ V}$	1.5	-	6.0	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ [2]	1.5	3.3	5.5	ns
t_{PHZ} , t_{PLZ}	3-state output disable time nOE to nYn	see Figure 6 $V_{CC} = 1.2\text{ V}$	-	9.0	-	ns
		$V_{CC} = 2.7\text{ V}$	1.5	-	5.5	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ [2]	1.5	3.0	5.0	ns
	3-state output disable time nOE to nYn	see Figure 7 $V_{CC} = 1.2\text{ V}$	-	8.0	-	ns
		$V_{CC} = 2.7\text{ V}$	1.5	-	5.5	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$ [2]	1.0	2.6	5.0	ns
C_{PD}	power dissipation capacitance per buffer	$V_{CC} = 3.3\text{ V}$ [3] [4] outputs enabled	-	15	-	pF
		outputs disabled	-	3	-	pF
$T_{amb} = -40\text{ °C to }+125\text{ °C}$						
t_{PLH} , t_{PHL}	propagation delay nAn to nYn	see Figure 5 $V_{CC} = 1.2\text{ V}$	-	-	-	ns
		$V_{CC} = 2.7\text{ V}$	1.0	-	6.5	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	1.0	-	5.5	ns
t_{PZH} , t_{PZL}	3-state output enable time nOE to nYn	see Figure 6 $V_{CC} = 1.2\text{ V}$	-	-	-	ns
		$V_{CC} = 2.7\text{ V}$	1.0	-	7.5	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	1.0	-	7.0	ns
	3-state output enable time nOE to nYn	see Figure 7 $V_{CC} = 1.2\text{ V}$	-	-	-	ns
		$V_{CC} = 2.7\text{ V}$	1.5	-	7.5	ns
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	1.5	-	7.0	ns

Table 8: Dynamic characteristics ...continued
At recommended operating conditions; see [Figure 8](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t _{PHZ} , t _{PLZ}	3-state output disable time nOE to nYn	see Figure 6				
		V _{CC} = 1.2 V	-	-	-	ns
		V _{CC} = 2.7 V	1.5	-	7.0	ns
		V _{CC} = 3.0 V to 3.6 V	1.5	-	6.5	ns
	3-state output disable time nOE to nYn	see Figure 7				
		V _{CC} = 1.2 V	-	-	-	ns
		V _{CC} = 2.7 V	1.5	-	7.0	ns
		V _{CC} = 3.0 V to 3.6 V	1.0	-	6.5	ns

- [1] Typical values are measured at T_{amb} = 25 °C.
- [2] Typical values are measured at V_{CC} = 3.3 V.
- [3] 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 = total load switching outputs;
 Σ(C_L × V_{CC}² × f_o) = sum of the outputs.
- [4] The condition is V_I = GND to V_{CC}.

12. Waveforms

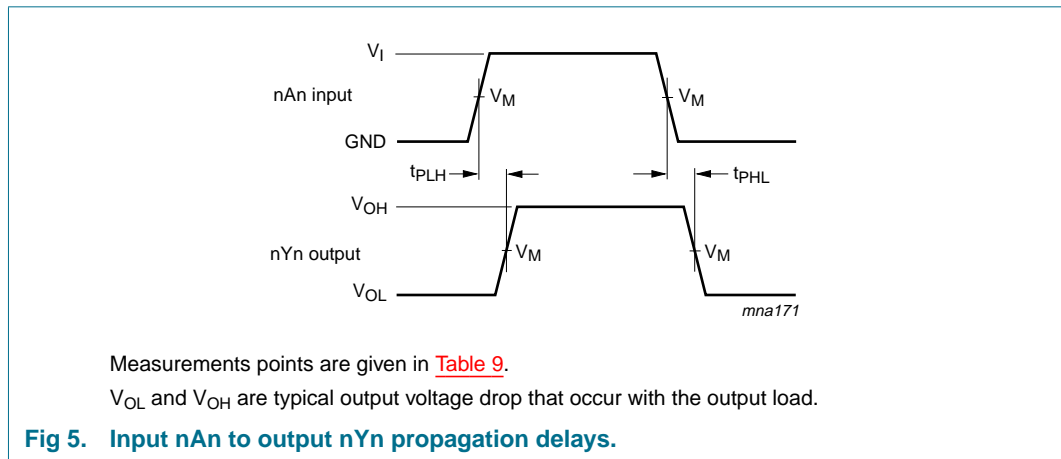


Table 9: Measurement points

Supply voltage	Input	Output
V _{CC}	V _M	V _M
1.2 V	0.5 × V _{CC}	0.5 × V _{CC}
2.7 V	1.5 V	1.5 V
3.0 V to 3.6 V	1.5 V	1.5 V

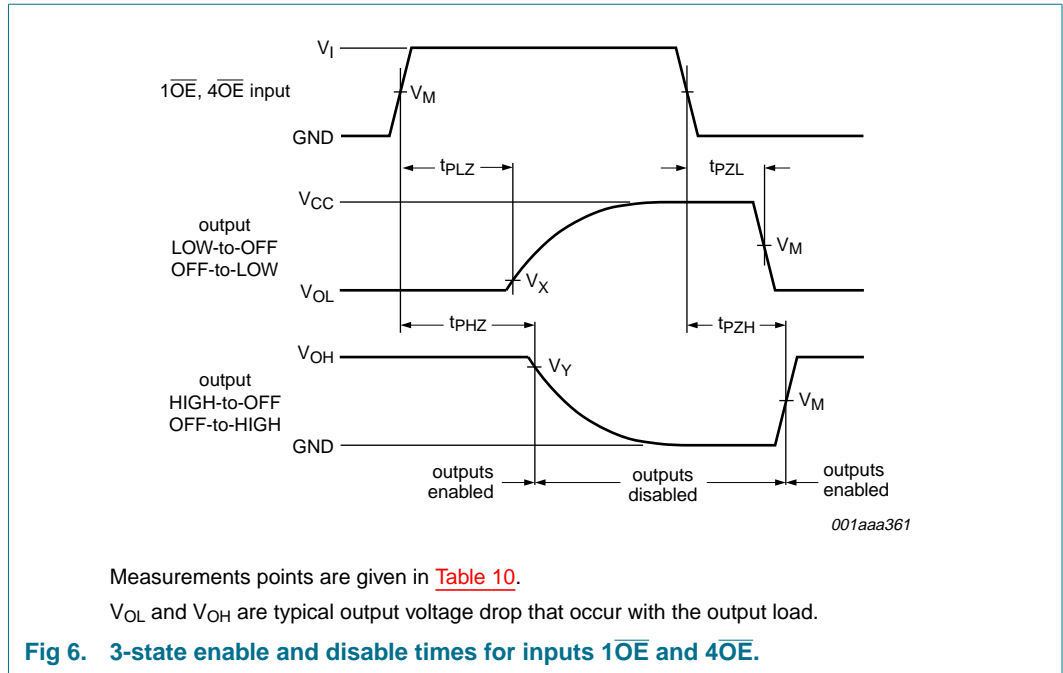


Table 10: Measurement points

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

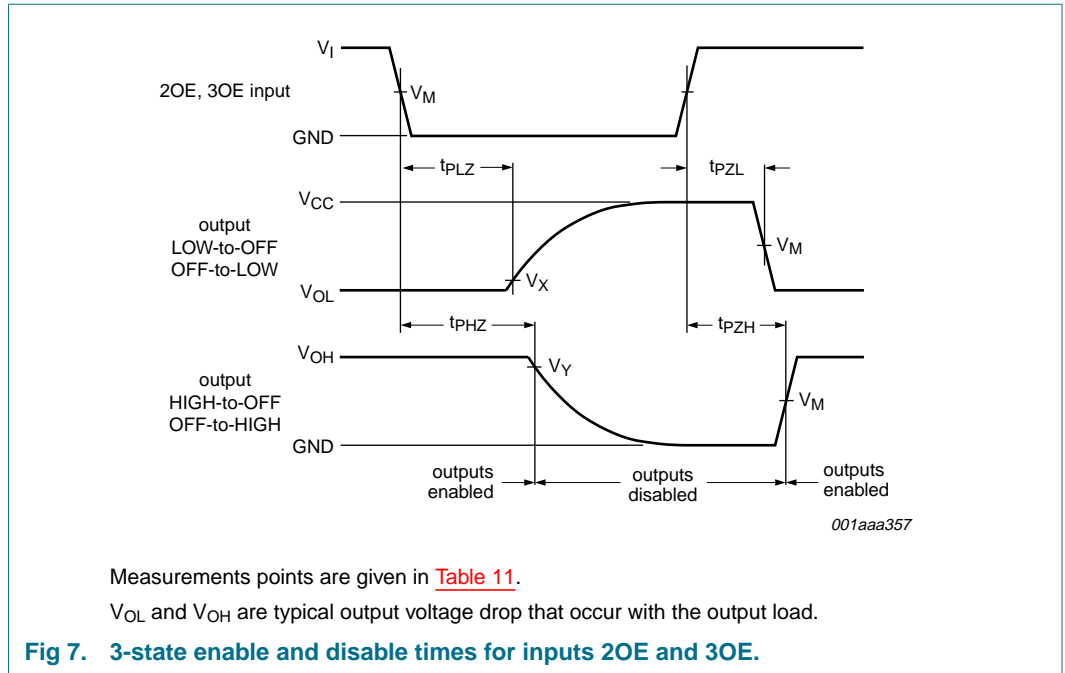


Table 11: Measurement points

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

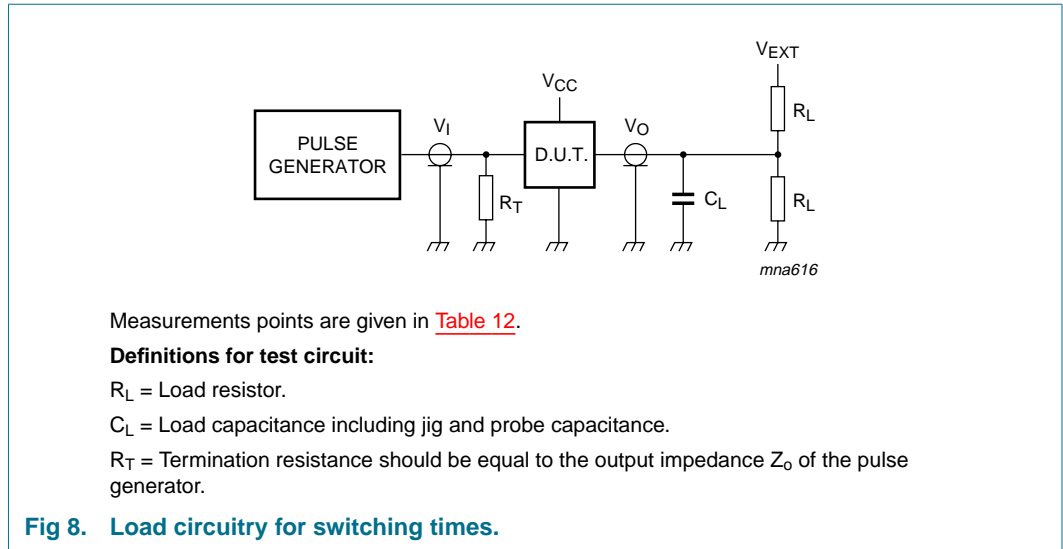


Table 12: Test data

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 × V _{CC}
2.7 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	open	GND	2 × V _{CC}
3.0 V to 3.6 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	open	GND	2 × V _{CC}

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

13. Package outline

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

SOT370-1

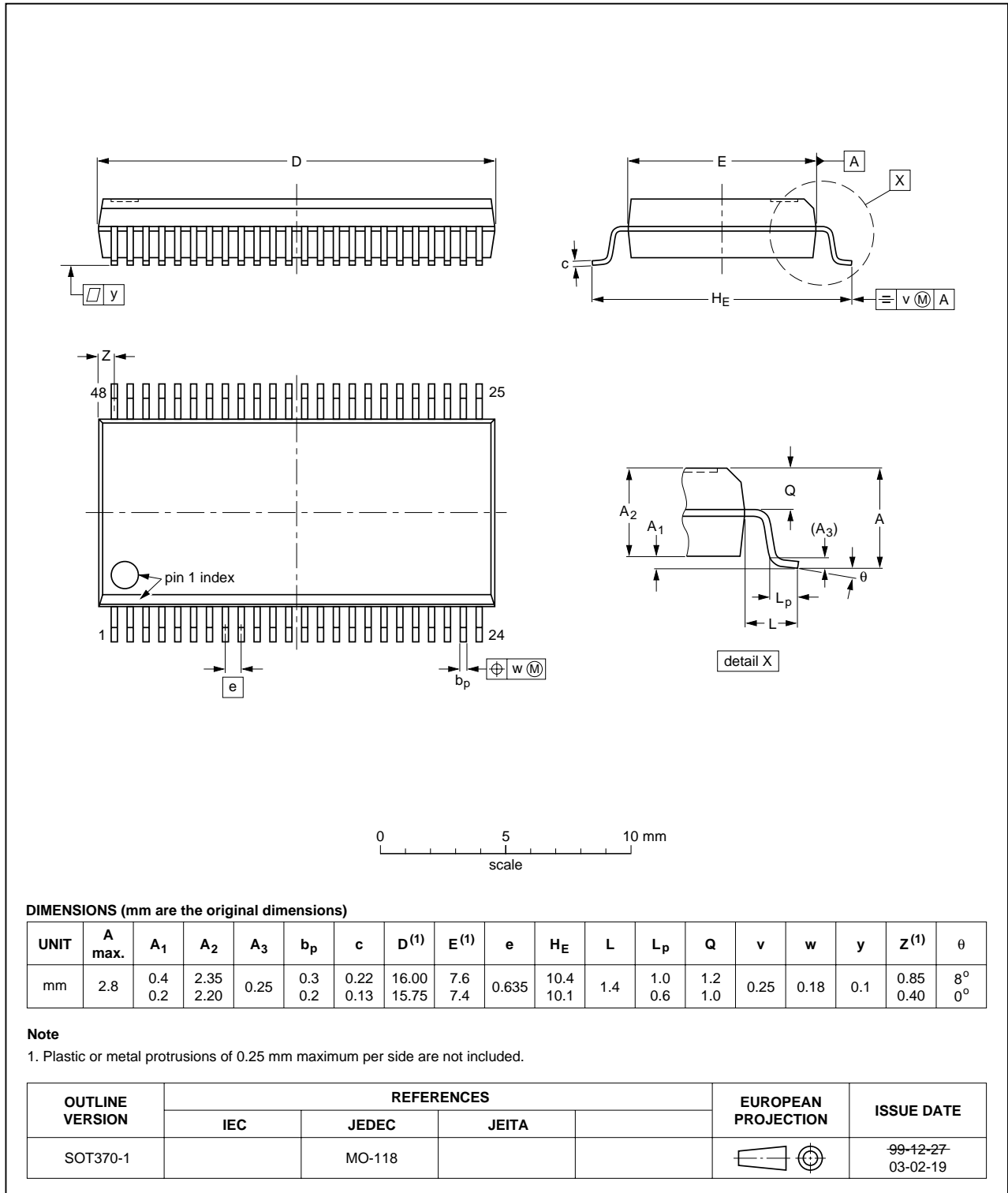


Fig 9. Package outline SOT370-1.

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

SOT362-1

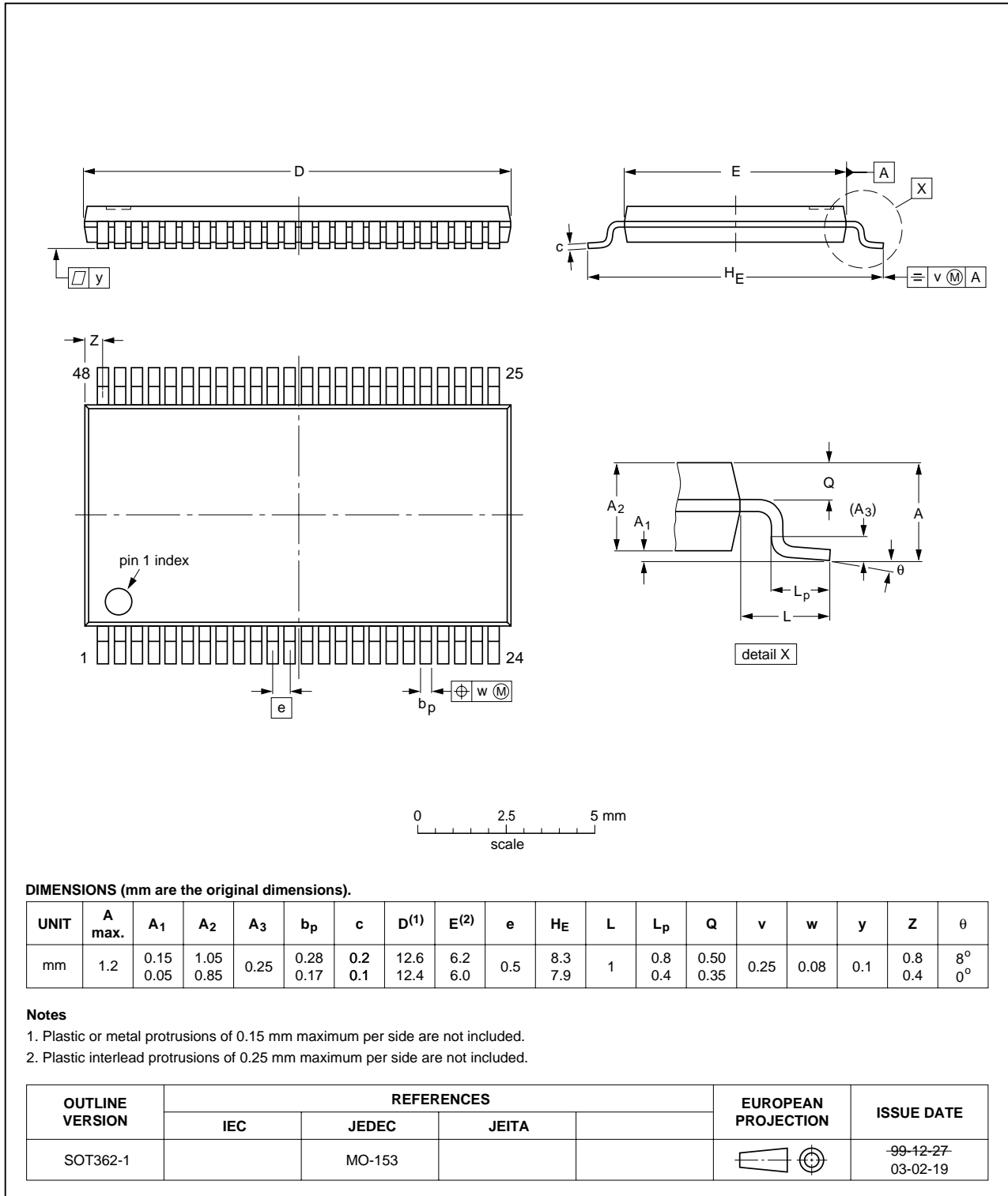


Fig 10. Package outline SOT362-1.

14. Revision history

Table 13: Revision history

Document ID	Release date	Data sheet status	Change notice	Order number	Supersedes
74LVC16241A_3	20040216	Product data	-	9397 750 12672	74LVC16241A_2
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: changed values for $T_{amb} = -40\text{ °C}$ to $+85\text{ °C}$ and added values for $T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$ 				
74LVC16241A_2	19970729	Product data	-	9397 750 04527	74LVC16241A_1
74LVC16241A_1	19951226	-	-	-	-

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.

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