

# DATA SHEET

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**74LVC16244A; 74LVCH16244A**  
16-bit buffer/line driver; 5 V  
input/output tolerant; 3-state

Product specification  
Supersedes data of 2003 Jan 30

2003 Dec 08

## 16-bit buffer/line driver; 5 V input/output tolerant; 3-state

## 74LVC16244A; 74LVCH16244A

### FEATURES

- 5 V tolerant inputs/outputs for interfacing with 5 V logic
- Wide supply voltage range from 1.2 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
- All data inputs have bushold (74LVCH16244A only).
- 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 to +85 °C and –40 to +125 °C.

### DESCRIPTION

The 74LVC(H)16244A is a high-performance, low power, low voltage, Si-gate CMOS device, superior to most advanced CMOS compatible TTL families. Inputs can be driven from either 3.3 or 5 V devices. In 3-state operation, outputs can handle 5 Volt. These features allow the use of these devices as a mixed 3.3 and 5 V environment.

The 74LVC(H)16244A is a 16-bit non-inverting buffer/line driver with 3-state outputs. The device can be used as four 4-bit buffers, two 8-bit buffers or one 16-bit buffer. The device features four Output Enables (1OE, 2OE, 3OE and 4OE), each controlling four of the 3-state outputs. A HIGH on nOE causes the outputs to assume a high-impedance OFF-state.

The 74LVC(H)16244A is identical to the 74LVC16240A but has non-inverting outputs.

The 74LVCH16244A bushold data inputs eliminates the need for external pull-up resistors to hold unused inputs.

### QUICK REFERENCE DATA

GND = 0 V; T<sub>amb</sub> = 25 °C; t<sub>r</sub> = t<sub>f</sub> ≤ 2.5 ns.

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	UNIT
t <sub>PHL</sub> /t <sub>PLH</sub>	propagation delay nAn to nYn	C <sub>L</sub> = 50 pF; V <sub>CC</sub> = 3.3 V	3.0	ns
t <sub>PZH</sub> /t <sub>PZL</sub>	3-state output enable time nOE to nYn	C <sub>L</sub> = 50 pF; V <sub>CC</sub> = 3.3 V	3.5	ns
t <sub>PHZ</sub> /t <sub>PLZ</sub>	3-state output disable time nOE to nYn	C <sub>L</sub> = 50 pF; V <sub>CC</sub> = 3.3 V	3.7	ns
C <sub>I</sub>	input capacitance		5.0	pF
C <sub>PD</sub>	power dissipation capacitance per gate	V <sub>CC</sub> = 3.3 V; notes 1 and 2		
		outputs enabled	12	pF
		outputs disabled	4.0	pF

### Notes

1. C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> 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<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in Volts;

N = total load switching outputs;

Σ(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of the outputs.

2. The condition is V<sub>i</sub> = GND to V<sub>CC</sub>.

16-bit buffer/line driver; 5 V input/output  
tolerant; 3-state

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### FUNCTION TABLE

See note 1.

INPUT		OUTPUT
$\overline{\text{nOE}}$	nAn	nYn
L	L	L
L	H	H
H	X	Z

### Note

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

### ORDERING INFORMATION

TYPE NUMBER	PACKAGE				
	TEMPERATURE RANGE	PINS	PACKAGE	MATERIAL	CODE
74LVC16244ADL	-40 to +125 °C	48	SSOP48	plastic	SOT370-1
74LVCH16244ADL	-40 to +125 °C	48	SSOP48	plastic	SOT370-1
74LVC16244ADGG	-40 to +125 °C	48	TSSOP48	plastic	SOT362-1
74LVCH16244ADGG	-40 to +125 °C	48	TSSOP48	plastic	SOT362-1
74LVC16244AEV	-40 to +125 °C	56	VFBGA56	plastic	SOT702-1
74LVCH16244AEV	-40 to +125 °C	56	VFBGA56	plastic	SOT702-1

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## PINNING

SYMBOL	PIN	BALL	DESCRIPTION
1 $\overline{OE}$	1	A1	output enable input (active LOW)
n.c.	–	A2, A3, A4, A5, K2, K3, K4, K5	not connected
1Y0	2	B2	data output
1Y1	3	B1	data output
GND	4, 10, 15, 21, 28, 34, 39, 45	B3, B4, D3, D4, G3, G4, J3, J4	ground (0 V)
1Y2	5	C2	data output
1Y3	6	C1	data output
V <sub>CC</sub>	7, 18, 31, 42	C3, H3, C4, H4	supply voltage
2Y0	8	D2	data output
2Y1	9	D1	data output
2Y2	11	E2	data output
2Y3	12	E1	data output
3Y0	13	F1	data output
3Y1	14	F2	data output
3Y2	16	G1	data output
3Y3	17	G2	data output
4Y0	19	H1	data output
4Y1	20	H2	data output
4Y2	22	J1	data output
4Y3	23	J2	data output
4 $\overline{OE}$	24	K1	output enable input (active LOW)
3 $\overline{OE}$	25	K6	output enable input (active LOW)
4A3	26	J5	data input
4A2	27	J6	data input
4A1	29	H5	data input
4A0	30	H6	data input
3A3	32	G5	data input
3A2	33	G6	data input
3A1	35	F5	data input
3A0	36	F6	data input
2A3	37	E6	data input
2A2	38	E5	data input
2A1	40	D6	data input
2A0	41	D5	data input
1A3	43	C6	data input
1A2	44	C5	data input
1A1	46	B6	data input
1A0	47	B5	data input
2 $\overline{OE}$	48	A6	output enable input (active LOW)

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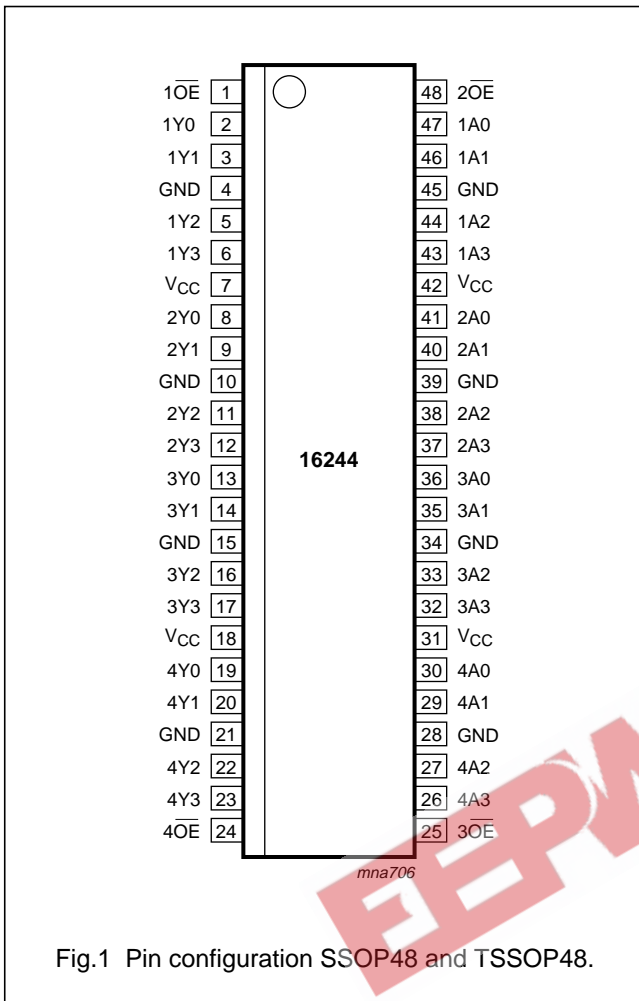


Fig.1 Pin configuration SSOP48 and TSSOP48.

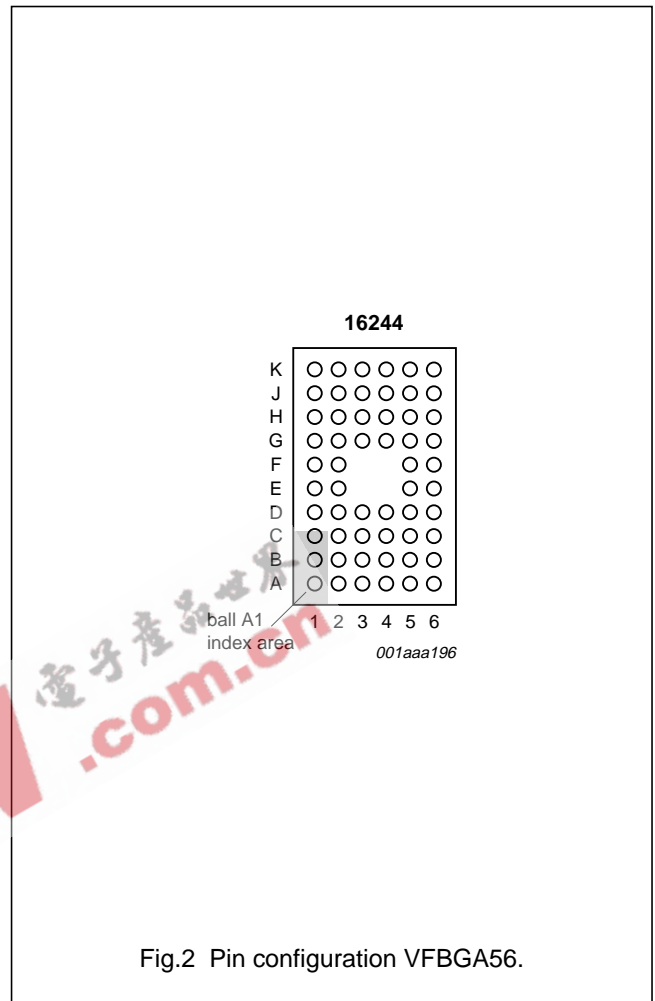
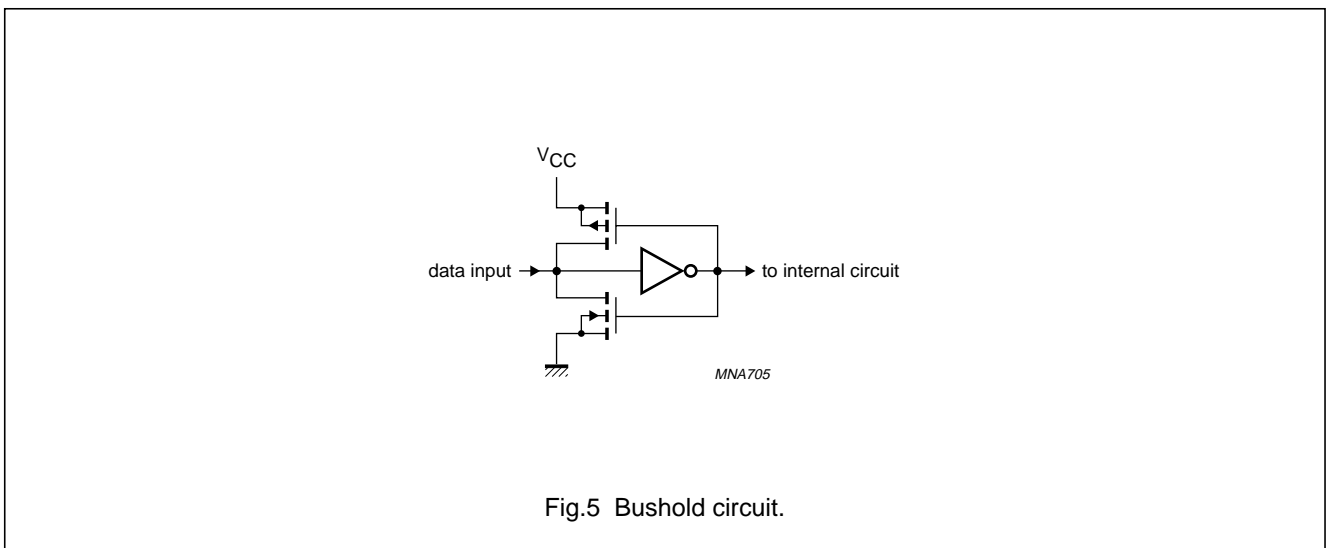
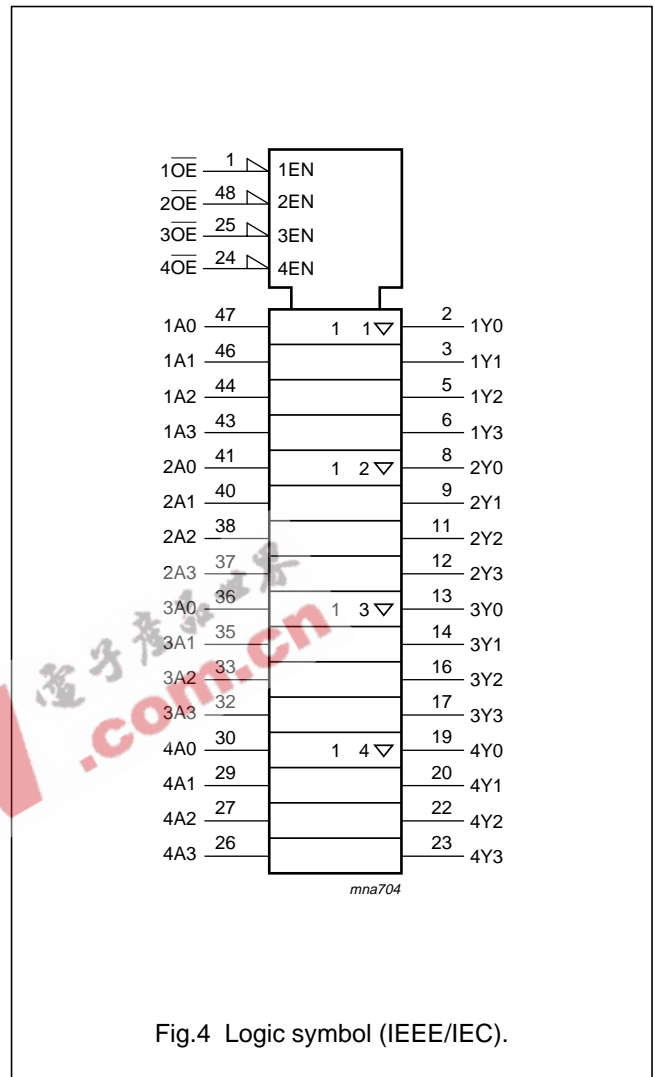
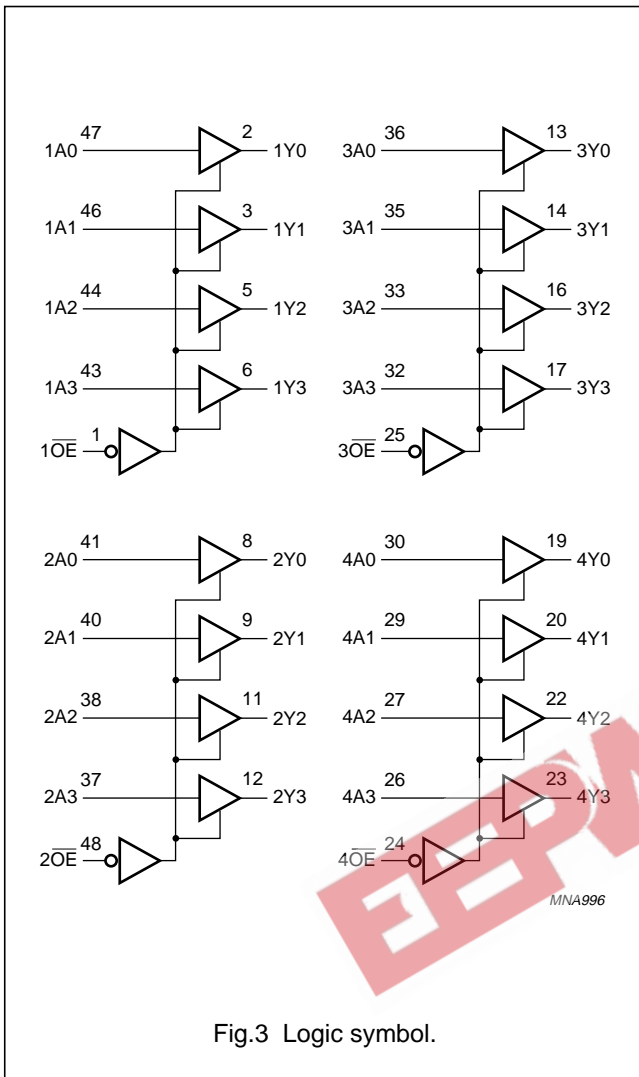


Fig.2 Pin configuration VFBGA56.

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### RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V <sub>CC</sub>	supply voltage	for maximum speed performance	2.7	3.6	V
		for low voltage applications	1.2	3.6	V
V <sub>I</sub>	input voltage		0	5.5	V
V <sub>O</sub>	output voltage	output HIGH or LOW state	0	V <sub>CC</sub>	V
		output 3-state	0	5.5	V
T <sub>amb</sub>	operating ambient temperature	in free air	-40	+125	°C
t <sub>r</sub> , t <sub>f</sub>	input rise and fall times	V <sub>CC</sub> = 1.2 to 2.7 V	0	20	ns/V
		V <sub>CC</sub> = 2.7 to 3.6 V	0	10	ns/V

### 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 diode current	V <sub>I</sub> < 0	-	-50	mA
V <sub>I</sub>	input voltage	note 1	-0.5	+6.5	V
I <sub>OK</sub>	output diode current	V <sub>O</sub> > V <sub>CC</sub> or V <sub>O</sub> < 0	-	±50	mA
V <sub>O</sub>	output voltage	output HIGH or LOW state; note 1	-0.5	V <sub>CC</sub> + 0.5	V
		output 3-state; note 1	-0.5	+6.5	V
I <sub>O</sub>	output source or sink current	V <sub>O</sub> = 0 to V <sub>CC</sub>	-	±50	mA
I <sub>CC</sub> , I <sub>GND</sub>	V <sub>CC</sub> or GND current		-	±100	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
P <sub>tot</sub>	power dissipation SSOP and TSSOP package VFBGA package	T <sub>amb</sub> = -40 to +125 °C; note 2	-	500	mW
		T <sub>amb</sub> = -40 to +125 °C; note 3	-	1000	mW

### Notes

- The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
- Above 60 °C the value of P<sub>tot</sub> derates linearly with 5.5 mW/K.
- Above 70 °C the value of P<sub>tot</sub> derates linearly with 1.8 mW/K.

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## DC CHARACTERISTICS

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

SYMBOL	PARAMETER	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
		OTHER	V <sub>CC</sub> (V)				
<b>T<sub>amb</sub> = -40 to +85 °C; note 1</b>							
V <sub>IH</sub>	HIGH-level input voltage		1.2	V <sub>CC</sub>	–	–	V
			2.7 to 3.6	2.0	–	–	V
V <sub>IL</sub>	LOW-level input voltage		1.2	–	–	0	V
			2.7 to 3.6	–	–	0.8	V
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>O</sub> = -100 µA	2.7 to 3.6	V <sub>CC</sub> - 0.2	V <sub>CC</sub>	–	V
		I <sub>O</sub> = -12 mA	2.7	V <sub>CC</sub> - 0.5	–	–	V
		I <sub>O</sub> = -18 mA	3.0	V <sub>CC</sub> - 0.6	–	–	V
		I <sub>O</sub> = -24 mA	3.0	V <sub>CC</sub> - 0.8	–	–	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>O</sub> = 100 µA	2.7 to 3.6	–	0	0.20	V
		I <sub>O</sub> = 12 mA	2.7	–	–	0.40	V
		I <sub>O</sub> = 24 mA	3.0	–	–	0.55	V
I <sub>LI</sub>	input leakage current	V <sub>I</sub> = 5.5 V or GND; note 2	3.6	–	±0.1	±5	µA
I <sub>OZ</sub>	3-state output OFF-state current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = 5.5 V or GND; note 2	3.6	–	0.1	±5	µA
I <sub>off</sub>	power-off leakage supply current	V <sub>I</sub> or V <sub>O</sub> = 5.5 V	0.0	–	0.1	±10	µA
I <sub>CC</sub>	quiescent supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0	3.6	–	0.1	20	µA
ΔI <sub>CC</sub>	additional quiescent supply current per input pin	V <sub>I</sub> = V <sub>CC</sub> - 0.6 V; I <sub>O</sub> = 0	2.7 to 3.6	–	5	500	µA
I <sub>BH</sub>	bushold LOW sustaining current	V <sub>I</sub> = 0.8 V; notes 3 and 4	3.0	75	–	–	µA
I <sub>BHH</sub>	bushold HIGH sustaining current	V <sub>I</sub> = 2.0 V; notes 3 and 4	3.0	-75	–	–	µA
I <sub>BHLO</sub>	bushold LOW overdrive current	notes 3 and 5	3.6	500	–	–	µA
I <sub>BHHO</sub>	bushold HIGH overdrive current	notes 3 and 5	3.6	-500	–	–	µA



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SYMBOL	PARAMETER	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
		OTHER	V <sub>CC</sub> (V)				
<b>T<sub>amb</sub> = -40 to +125 °C</b>							
V <sub>IH</sub>	HIGH-level input voltage		1.2	V <sub>CC</sub>	-	-	V
			2.7 to 3.6	2.0	-	-	V
V <sub>IL</sub>	LOW-level input voltage		1.2	-	-	0	V
			2.7 to 3.6	-	-	0.8	V
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	2.7 to 3.6	V <sub>CC</sub> - 0.3	-	-	V
		I <sub>O</sub> = -100 μA	2.7	V <sub>CC</sub> - 0.65	-	-	V
		I <sub>O</sub> = -12 mA	3.0	V <sub>CC</sub> - 0.75	-	-	V
		I <sub>O</sub> = -18 mA	3.0	V <sub>CC</sub> - 1	-	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	2.7 to 3.6	-	-	0.3	V
		I <sub>O</sub> = 100 μA	2.7	-	-	0.6	V
		I <sub>O</sub> = 12 mA	3.0	-	-	0.8	V
		I <sub>O</sub> = 24 mA	3.0	-	-	0.8	V
I <sub>LI</sub>	input leakage current	V <sub>I</sub> = 5.5 V or GND; note 2	3.6	-	-	±20	μA
I <sub>OZ</sub>	3-state output OFF-state current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = 5.5 V or GND; note 2	3.6	-	-	±20	μA
I <sub>off</sub>	power-off leakage supply current	V <sub>I</sub> or V <sub>O</sub> = 5.5 V	0.0	-	-	±20	μA
I <sub>CC</sub>	quiescent supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0	3.6	-	-	80	μA
ΔI <sub>CC</sub>	additional quiescent supply current per input pin	V <sub>I</sub> = V <sub>CC</sub> - 0.6 V; I <sub>O</sub> = 0	2.7 to 3.6	-	-	5000	μA
I <sub>BH</sub>	bushold LOW sustaining current	V <sub>I</sub> = 0.8 V; notes 3 and 4	3.0	60	-	-	μA
I <sub>BHH</sub>	bushold HIGH sustaining current	V <sub>I</sub> = 2.0 V; notes 3 and 4	3.0	-60	-	-	μA
I <sub>BHLO</sub>	bushold LOW overdrive current	notes 3 and 5	3.6	500	-	-	μA
I <sub>BHHO</sub>	bushold HIGH overdrive current	notes 3 and 5	3.6	-500	-	-	μA

#### Notes

1. All typical values are measured at V<sub>CC</sub> = 3.3 V and T<sub>amb</sub> = 25 °C.
2. For bushold parts, the bushold circuit is switched off when V<sub>I</sub> > V<sub>CC</sub> allowing 5.5 V on the input pin.
3. Valid for data inputs of bushold parts (74LVCH16244A) only. 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<sub>I</sub> level.
5. The specified overdrive current at the data input forces the data input to the opposite logic input state.

16-bit buffer/line driver; 5 V input/output  
tolerant; 3-state

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### AC CHARACTERISTICS

GND = 0 V;  $t_r = t_f \leq 2.5$  ns;  $C_L = 50$  pF;  $R_L = 500$   $\Omega$ .

SYMBOL	PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNIT
		WAVEFORMS	V <sub>CC</sub> (V)				
<b>T<sub>amb</sub> = -40 to +85 °C; note1</b>							
t <sub>PHL</sub> /t <sub>PLH</sub>	propagation delay nAn to nYn	see Figs 6 and 8	1.2	–	11.0	–	ns
			2.7	1.0	–	4.7	ns
			3.0 to 3.6	1.1	3.0 <sup>(2)</sup>	4.1	ns
t <sub>PZH</sub> /t <sub>PZL</sub>	3-state output enable time n $\overline{OE}$ to nYn	see Figs 7 and 8	1.2	–	15.0	–	ns
			2.7	1.0	–	5.8	ns
			3.0 to 3.6	1.0	3.5 <sup>(2)</sup>	4.6	ns
t <sub>PHZ</sub> /t <sub>PLZ</sub>	3-state output disable time n $\overline{OE}$ to nYn	see Figs 7 and 8	1.2	–	10.0	–	ns
			2.7	1.0	–	6.2	ns
			3.0 to 3.6	1.8	3.7 <sup>(2)</sup>	5.2	ns
<b>T<sub>amb</sub> = -40 to +125 °C</b>							
t <sub>PHL</sub> /t <sub>PLH</sub>	propagation delay nAn to nYn	see Figs 6 and 8	1.2	–	–	–	ns
			2.7	1.0	–	6.0	ns
			3.0 to 3.6	1.1	–	5.5	ns
t <sub>PZH</sub> /t <sub>PZL</sub>	3-state output enable time n $\overline{OE}$ to nYn	see Figs 7 and 8	1.2	–	–	–	ns
			2.7	1.0	–	7.5	ns
			3.0 to 3.6	1.0	–	6.0	ns
t <sub>PHZ</sub> /t <sub>PLZ</sub>	3-state output disable time n $\overline{OE}$ to nYn	see Figs 7 and 8	1.2	–	–	–	ns
			2.7	1.0	–	8.0	ns
			3.0 to 3.6	1.8	–	6.5	ns

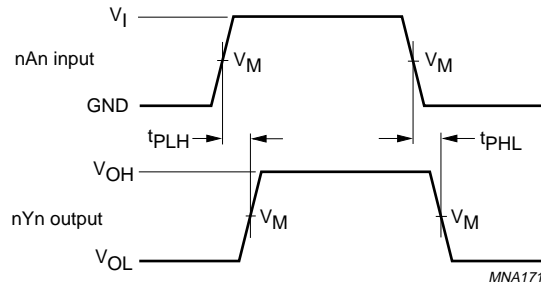
### Notes

1. All typical values are measured at T<sub>amb</sub> = 25 °C.
2. These typical values are measured at V<sub>CC</sub> = 3.3 V and T<sub>amb</sub> = 25 °C.

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AC WAVEFORMS



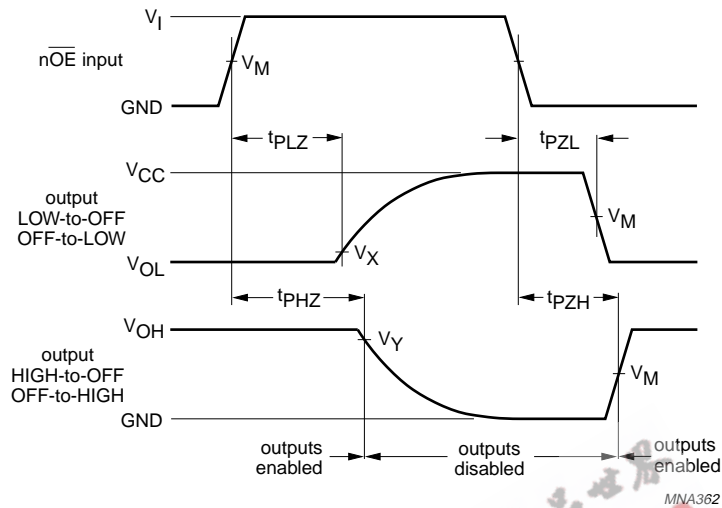
V <sub>CC</sub>	V <sub>M</sub>	INPUT	
		V <sub>I</sub>	t <sub>r</sub> = t <sub>f</sub>
1.2 V	0.5 × V <sub>CC</sub>	V <sub>CC</sub>	≤ 2.5 ns
2.7 V	1.5 V	2.7 V	≤ 2.5 ns
3.0 to 3.6 V	1.5 V	2.7 V	≤ 2.5 ns

V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage drop that occur with the output load.

Fig.6 The input nAn to output nYn propagation delays.

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V <sub>CC</sub>	V <sub>M</sub>	INPUT	
		V <sub>I</sub>	t <sub>r</sub> = t <sub>f</sub>
1.2 V	0.5 × V <sub>CC</sub>	V <sub>CC</sub>	≤ 2.5 ns
2.7 V	1.5 V	2.7 V	≤ 2.5 ns
3.0 to 3.6 V	1.5 V	2.7 V	≤ 2.5 ns

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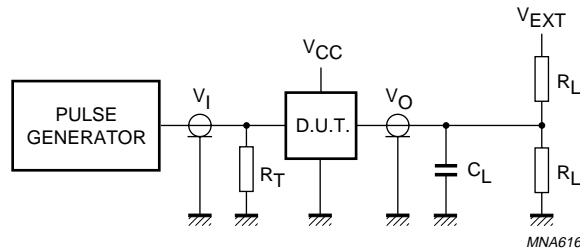
V<sub>X</sub> = V<sub>OL</sub> + 0.3 V at V<sub>CC</sub> ≥ 2.7 V;  
V<sub>X</sub> = V<sub>OL</sub> + 0.1 V at V<sub>CC</sub> < 2.7 V;  
V<sub>Y</sub> = V<sub>OH</sub> - 0.3 V at V<sub>CC</sub> ≥ 2.7 V;  
V<sub>Y</sub> = V<sub>OH</sub> - 0.1 V at V<sub>CC</sub> < 2.7 V.

V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage drop that occur with the output load.

Fig.7 3-state enable and disable times.

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V <sub>CC</sub>	V <sub>I</sub>	C <sub>L</sub>	R <sub>L</sub>	V <sub>EXT</sub>		
				t <sub>PLH</sub> /t <sub>PHL</sub>	t <sub>PZH</sub> /t <sub>PHZ</sub>	t <sub>PZL</sub> /t <sub>PLZ</sub>
1.2 V	V <sub>CC</sub>	50 pF	500 Ω <sup>(1)</sup>	open	GND	2 × V <sub>CC</sub>
2.7 V	2.7 V	50 pF	500 Ω	open	GND	2 × V <sub>CC</sub>
3.0 to 3.6 V	2.7 V	50 pF	500 Ω	open	GND	2 × V <sub>CC</sub>

**Note**

- The circuit performs better when R<sub>L</sub> = 1000 Ω.

Definitions for test circuits:

R<sub>L</sub> = Load resistor.

C<sub>L</sub> = Load capacitance including jig and probe capacitance.

R<sub>T</sub> = Termination resistance should be equal to the output impedance Z<sub>o</sub> of the pulse generator.

Fig.8 Load circuitry for switching times.

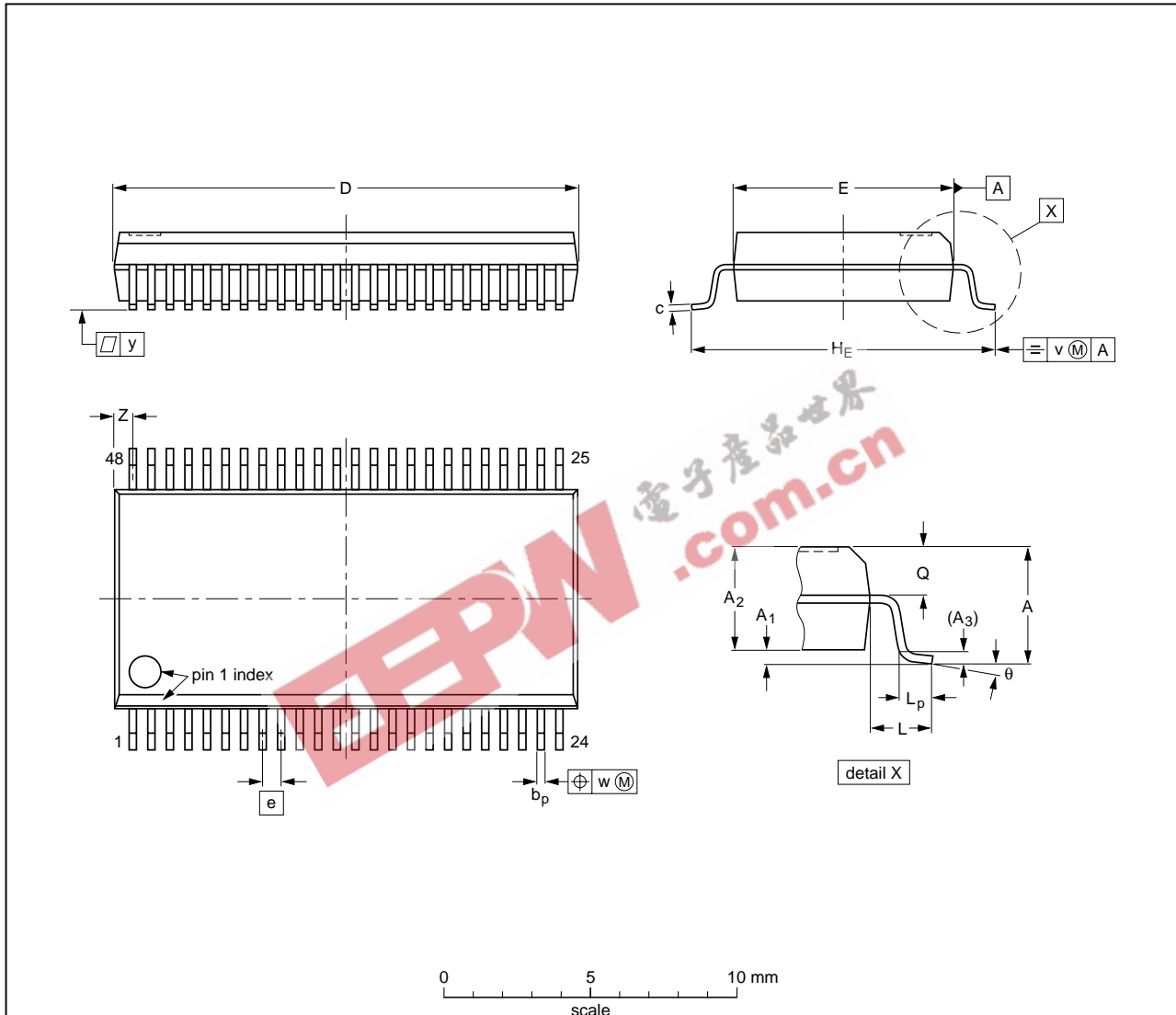
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74LVCH16244A

PACKAGE OUTLINES

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 <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	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.

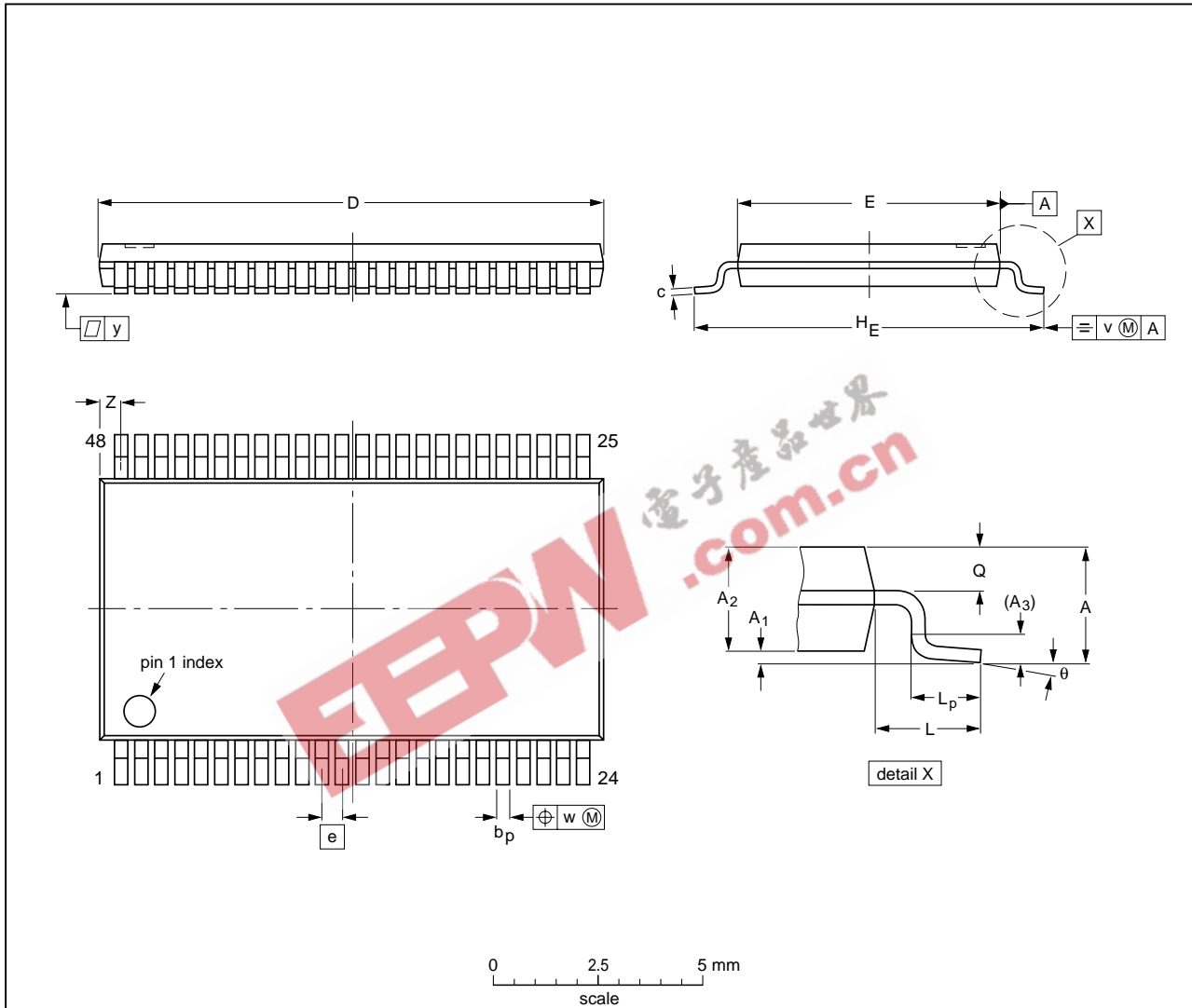
OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA		
SOT370-1		MO-118			99-12-27 03-02-19

16-bit buffer/line driver; 5 V input/output tolerant; 3-state

74LVC16244A;  
74LVCH16244A

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	0.15 0.05	1.05 0.85	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.

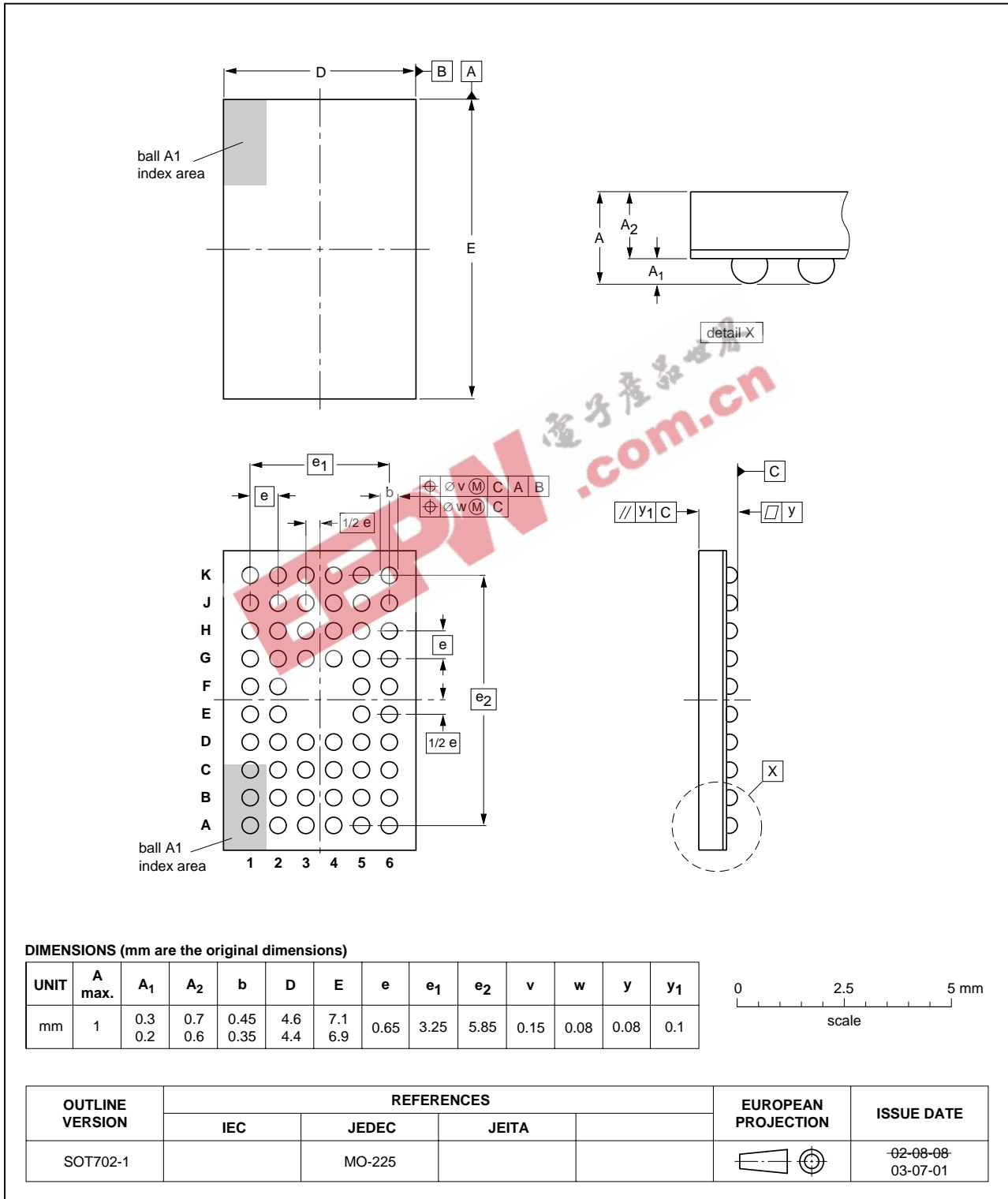
OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA		
SOT362-1		MO-153			99-12-27 03-02-19

16-bit buffer/line driver; 5 V input/output tolerant; 3-state

74LVC16244A;  
74LVCH16244A

VFBGA56: plastic very thin fine-pitch ball grid array package; 56 balls; body 4.5 x 7 x 0.65 mm

SOT702-1





16-bit buffer/line driver; 5 V input/output  
tolerant; 3-state

74LVC16244A;  
74LVCH16244A

#### DATA SHEET STATUS

LEVEL	DATA SHEET STATUS <sup>(1)</sup>	PRODUCT STATUS <sup>(2)(3)</sup>	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).

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