

# DATA SHEET

## **74LVCH32244A**

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

Product specification  
Supersedes data of 1999 Aug 31

2004 May 13

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

## 74LVCH32244A

### FEATURES

- 5 V tolerant inputs/outputs for interfacing with 5 V logic
- Wide supply voltage range of 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
- Inputs accept voltages up to 5.5 V
- All data inputs have bushold
- Complies with JEDEC standard JESD8-B/JESD36
- ESD protection:  
HBM EIA/JESD22-A114-B exceeds 2000 V  
MM EIA/JESD22-A115-A exceeds 200 V.
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$
- Packaged in plastic fine-pitch ball grid array package.

### DESCRIPTION

The 74LVCH32244A 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 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 74LVCH32244A is a 32-bit non-inverting buffer/line driver with 3-state outputs. The 3-state outputs are controlled by eight output enable inputs ( $1\overline{\text{OE}}$  to  $8\overline{\text{OE}}$ ). A HIGH on pin  $n\overline{\text{OE}}$  causes the outputs to assume a high-impedance OFF-state.

To ensure the high-impedance state during power up or power down, pin  $n\overline{\text{OE}}$  should be tied to  $V_{\text{CC}}$  through a pull-up resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

The 74LVCH32244A bushold data inputs eliminates the need for external pull-up resistors to hold unused or floating data inputs at a valid logic level.

### QUICK REFERENCE DATA

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

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	UNIT
$t_{\text{PHL}}/t_{\text{PLH}}$	propagation delay nAn to nYn	$C_L = 50\text{ pF}$ ; $V_{\text{CC}} = 3.3\text{ V}$	3.0	ns
$t_{\text{PZH}}/t_{\text{PZL}}$	3-state output enable time $n\overline{\text{OE}}$ to nYn	$C_L = 50\text{ pF}$ ; $V_{\text{CC}} = 3.3\text{ V}$	3.5	ns
$t_{\text{PHZ}}/t_{\text{PLZ}}$	3-state output disable time $n\overline{\text{OE}}$ to nYn	$C_L = 50\text{ pF}$ ; $V_{\text{CC}} = 3.3\text{ V}$	3.7	ns
$C_I$	input capacitance		5.0	pF
$C_{\text{PD}}$	power dissipation capacitance per gate	$V_{\text{CC}} = 3.3\text{ V}$ ; notes 1 and 2 outputs enabled outputs disabled	12 4.0	pF pF

### Notes

1.  $C_{\text{PD}}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).

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

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

$C_L$  = output load capacitance in pF;

$V_{\text{CC}}$  = supply voltage in Volts;

$N$  = total load switching outputs;

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

2. The condition is  $V_I = \text{GND to } V_{\text{CC}}$ .

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

74LVCH32244A

## 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	PACKAGES				
	TEMPERATURE RANGE	PINS	PACKAGE	MATERIAL	CODE
74LVCH32244AEC	-40 °C to +85 °C	96	LFBGA96	plastic	SOT536-1

## PINNING

BALL	SYMBOL	DESCRIPTION
A1	1Y1	data output
A2	1Y0	data output
A3	$1\overline{\text{OE}}$	3-state output enable input (active LOW)
A4	$2\overline{\text{OE}}$	3-state output enable input (active LOW)
A5	1A0	data input
A6	1A1	data input
B1	1Y3	data output
B2	1Y2	data output
B3	GND	ground (0 V)
B4	GND	ground (0 V)
B5	1A2	data input
B6	1A3	data input
C1	2Y1	data output
C2	2Y0	data output
C3	V <sub>CC</sub>	supply voltage
C4	V <sub>CC</sub>	supply voltage
C5	2A0	data input
C6	2A1	data input

BALL	SYMBOL	DESCRIPTION
D1	2Y3	data output
D2	2Y2	data output
D3	GND	ground (0 V)
D4	GND	ground (0 V)
D5	2A2	data input
D6	2A3	data input
E1	3Y1	data output
E2	3Y0	data output
E3	GND	ground (0 V)
E4	GND	ground (0 V)
E5	3A0	data input
E6	3A1	data input
F1	3Y3	data output
F2	3Y2	data output
F3	V <sub>CC</sub>	supply voltage
F4	V <sub>CC</sub>	supply voltage
F5	3A2	data input
F6	3A3	data input
G1	4Y1	data output
G2	4Y0	data output

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

74LVCH32244A

BALL	SYMBOL	DESCRIPTION
G3	GND	ground (0 V)
G4	GND	ground (0 V)
G5	4A0	data input
G6	4A1	data input
H1	4Y2	data output
H2	4Y3	data output
H3	4OE	output enable input (active LOW)
H4	3OE	output enable input (active LOW)
H5	4A3	data input
H6	4A2	data input
J1	5Y1	data output
J2	5Y0	data output
J3	5OE	3-state output enable input (active LOW)
J4	6OE	3-state output enable input (active LOW)
J5	5A0	data input
J6	5A1	data input
K1	5Y3	data output
K2	5Y2	data output
K3	GND	ground (0 V)
K4	GND	ground (0 V)
K5	5A2	data input
K6	5A3	data input
L1	6Y1	data output
L2	6Y0	data output
L3	V <sub>CC</sub>	supply voltage
L4	V <sub>CC</sub>	supply voltage
L5	6A0	data input
L6	6A1	data input
M1	6Y3	data output

BALL	SYMBOL	DESCRIPTION
M2	6Y2	data output
M3	GND	ground (0 V)
M4	GND	ground (0 V)
M5	6A2	data input
M6	6A3	data input
N1	7Y1	data output
N2	7Y0	data output
N3	GND	ground (0 V)
N4	GND	ground (0 V)
N5	7A0	data input
N6	7A1	data input
P1	7Y3	data output
P2	7Y2	data output
P3	V <sub>CC</sub>	supply voltage
P4	V <sub>CC</sub>	supply voltage
P5	7A2	data input
P6	7A3	data input
R1	8Y1	data output
R2	8Y0	data output
R3	GND	ground (0 V)
R4	GND	ground (0 V)
R5	8A0	data input
R6	8A1	data input
T1	8Y2	data output
T2	8Y3	data output
T3	8OE	3-state output enable input (active LOW)
T4	7OE	3-state output enable input (active LOW)
T5	8A3	data input
T6	8A2	data input

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

74LVCH32244A

*mna471*

6	1A1	1A3	2A1	2A3	3A1	3A3	4A1	4A2	5A1	5A3	6A1	6A3	7A1	7A3	8A1	8A2
5	1A0	1A2	2A0	2A2	3A0	3A2	4A0	4A3	5A0	5A2	6A0	6A2	7A0	7A2	8A0	8A3
4	$\overline{2OE}$	GND	V <sub>CC</sub>	GND	GND	V <sub>CC</sub>	GND	$\overline{3OE}$	$\overline{6OE}$	GND	V <sub>CC</sub>	GND	GND	V <sub>CC</sub>	GND	$\overline{7OE}$
3	$\overline{1OE}$	GND	V <sub>CC</sub>	GND	GND	V <sub>CC</sub>	GND	$\overline{4OE}$	$\overline{5OE}$	GND	V <sub>CC</sub>	GND	GND	V <sub>CC</sub>	GND	$\overline{8OE}$
2	1Y0	1Y2	2Y0	2Y2	3Y0	3Y2	4Y0	4Y3	5Y0	5Y2	6Y0	6Y2	7Y0	7Y2	8Y0	8Y3
1	1Y1	1Y3	2Y1	2Y3	3Y1	3Y3	4Y1	4Y2	5Y1	5Y3	6Y1	6Y3	7Y1	7Y3	8Y1	8Y2
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	T

Fig.1 Pin configuration.

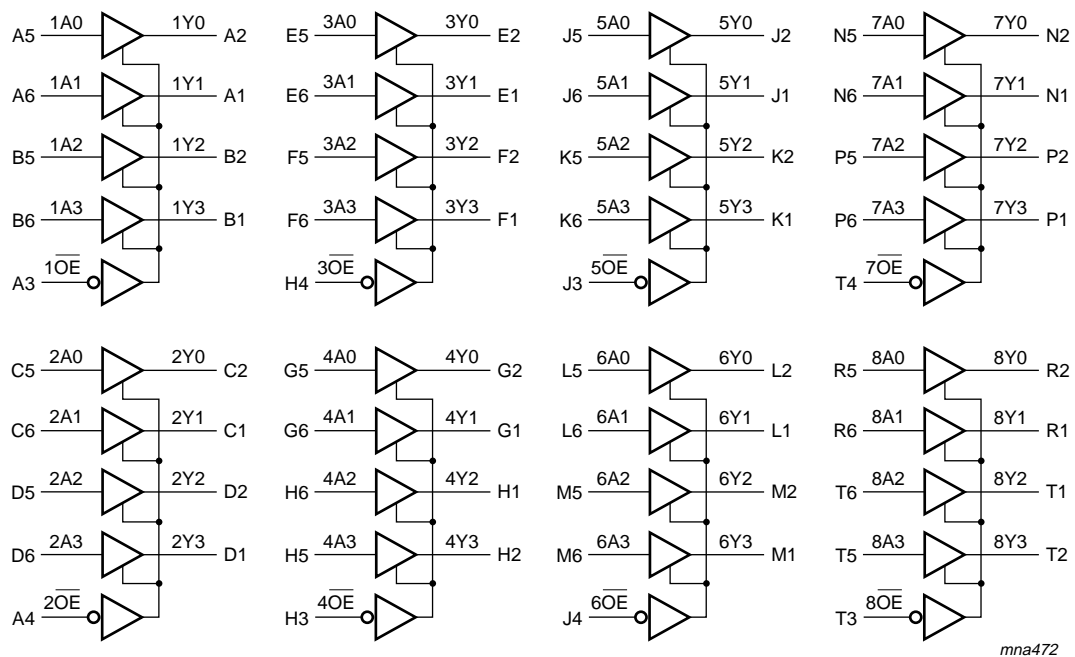


Fig.2 Logic symbol.

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

74LVCH32244A

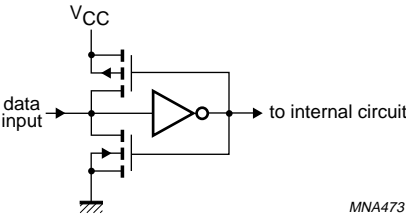


Fig.3 Bushold circuit.

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

74LVCH32244A

## 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	+85	°C
t <sub>r</sub> , t <sub>f</sub>	input rise and fall times	V <sub>CC</sub> = 1.2 V to 2.7 V	0	20	ns/V
		V <sub>CC</sub> = 2.7 V 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 V	-	-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 V	-	±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 V to V <sub>CC</sub>	-	±50	mA
I <sub>CC</sub> , I <sub>GND</sub>	V <sub>CC</sub> or GND current	note 2	-	±200	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
P <sub>tot</sub>	power dissipation	T <sub>amb</sub> = -40 °C to +85 °C; note 3	-	1000	mW

## Notes

1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. All supply and ground pins connected externally to one voltage source.
3. Above 70 °C the value of P<sub>tot</sub> derates linearly with 1.8 mW/K.

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

74LVCH32244A

### 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 °C 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	-	-	GND	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> - 0.2	V <sub>CC</sub>	-	V
		I <sub>O</sub> = -100 μA	2.7	V <sub>CC</sub> - 0.5	-	-	V
		I <sub>O</sub> = -12 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>	2.7 to 3.6	-	GND	0.20	V
		I <sub>O</sub> = 100 μA	2.7	-	-	0.40	V
		I <sub>O</sub> = 12 mA	3.0	-	-	0.55	V
		I <sub>O</sub> = 24 mA	3.0	-	-	-	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 A	3.6	-	0.1	40	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 A	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

### 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. 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.



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

74LVCH32244A

## 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 °C to +85 °C; note 1</b>							
t <sub>PHL</sub> /t <sub>PLH</sub>	propagation delay nAn to nYn	see Figs 4 and 6	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 5 and 6	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 5 and 6	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
t <sub>sk(0)</sub>	skew		3.0 to 3.6	–	–	1.0	ns

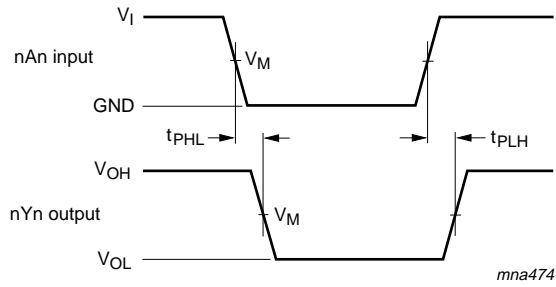
### Notes

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.

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

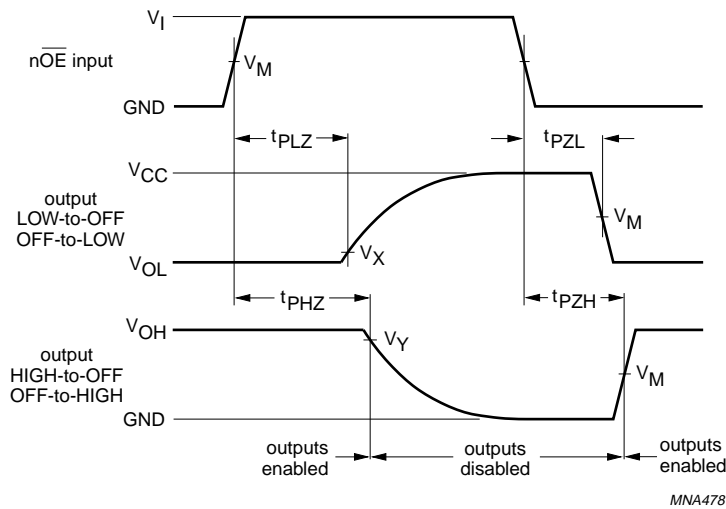
74LVCH32244A

AC WAVEFORMS



$V_M = 1.5\text{ V}$  at  $V_{CC} \geq 2.7\text{ V}$ ;  
 $V_M = 0.5 \times V_{CC}$  at  $V_{CC} < 2.7\text{ V}$ ;  
 $V_{OL}$  and  $V_{OH}$  are typical output voltage drop that occur with the output load.

Fig.4 Input nAn to output nYn propagation delay times.



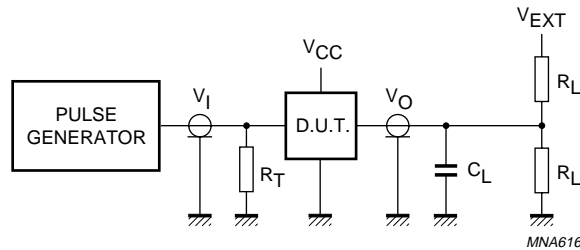
$V_M = 1.5\text{ V}$  at  $V_{CC} \geq 2.7\text{ V}$ ;  
 $V_M = 0.5 \times V_{CC}$  at  $V_{CC} < 2.7\text{ V}$ ;  
 $V_X = V_{OL} + 0.3\text{ V}$  at  $V_{CC} \geq 2.7\text{ V}$ ;  
 $V_X = V_{OL} + 0.1\text{ V}$  at  $V_{CC} < 2.7\text{ V}$ ;  
 $V_Y = V_{OH} - 0.3\text{ V}$  at  $V_{CC} \geq 2.7\text{ V}$ ;  
 $V_Y = V_{OH} - 0.1\text{ V}$  at  $V_{CC} < 2.7\text{ V}$

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

Fig.5 3-state enable and disable times.

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

74LVCH32244A



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**

1. 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.

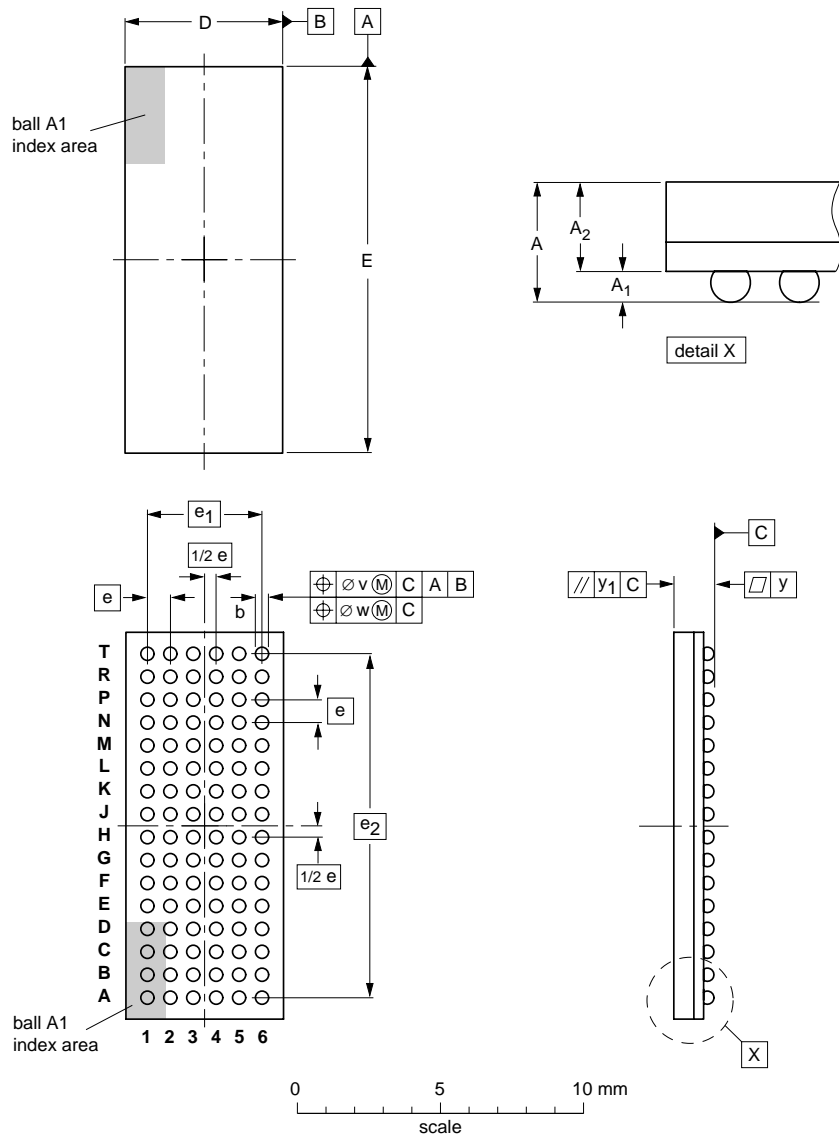
Fig.6 Load circuitry for switching times.

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

74LVCH32244A

PACKAGE OUTLINE

LFBGA96: plastic low profile fine-pitch ball grid array package; 96 balls; body 13.5 x 5.5 x 1.05 mm SOT536-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	b	D	E	e	e <sub>1</sub>	e <sub>2</sub>	v	w	y	y <sub>1</sub>
mm	1.5	0.41 0.31	1.2 0.9	0.51 0.41	5.6 5.4	13.6 13.4	0.8	4	12	0.15	0.1	0.1	0.2

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT536-1						00-03-04 03-02-05

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

74LVCH32244A

### 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).

### Notes

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.

### 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.

### DISCLAIMERS

**Life support applications** — 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 licence 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.

# ***Philips Semiconductors – a worldwide company***

## **Contact information**

For additional information please visit <http://www.semiconductors.philips.com>. Fax: +31 40 27 24825

For sales offices addresses send e-mail to: [sales.addresses@www.semiconductors.philips.com](mailto:sales.addresses@www.semiconductors.philips.com).

© Koninklijke Philips Electronics N.V. 2004

SCA76

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.

Printed in The Netherlands

R20/02/pp14

Date of release: 2004 May 13

Document order number: 9397 750 13224

*Let's make things better.*

**Philips  
Semiconductors**



**PHILIPS**