

74LVCH32374A

32-bit edge-triggered D-type flip-flop with 5 V tolerant inputs/outputs; 3-state

Rev. 3 — 18 December 2012

Product data sheet

1. General description

The 74LVCH32374A is a 32-bit edge-triggered flip-flop featuring separate D-type inputs for each flip-flop and 3-state outputs for bus oriented applications. The device consists of 4 sections of 8 edge-triggered flip-flops. A clock (pin nCP) input and an output enable input (pin nOE) are provided per 8-bit section. The flip-flops will store the state of their individual D-inputs that meet the set-up and hold time requirements on the LOW-to-HIGH nCP transition. When pin nOE is LOW, the contents of the flip-flops are available at the outputs. When pin nOE is HIGH, the outputs go to the high-impedance OFF-state. Operation of pin nOE does not affect the state of the flip-flops. The inputs can be driven from either 3.3 V or 5 V devices. In 3-state operation, the outputs can handle 5 V. These features allow the use of these devices in a mixed 3.3 V or 5 V environment.

Bus hold on 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 pin-out architecture
- Multiple low inductance supply pins for minimum noise and ground bounce
- Direct interface with TTL levels
- All data inputs have bus hold
- High impedance when $V_{CC} = 0$ V
- Latch-up performance exceeds 500 mA per JESD 78 Class II
- 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
- Packaged in plastic fine-pitch ball grid array package



3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74LVCH32374AEC	-40 °C to +125 °C	LFBGA96	plastic low profile fine-pitch ball grid array package; 96 balls; body 13.5 × 5.5 × 1.05 mm	SOT536-1

4. Functional diagram

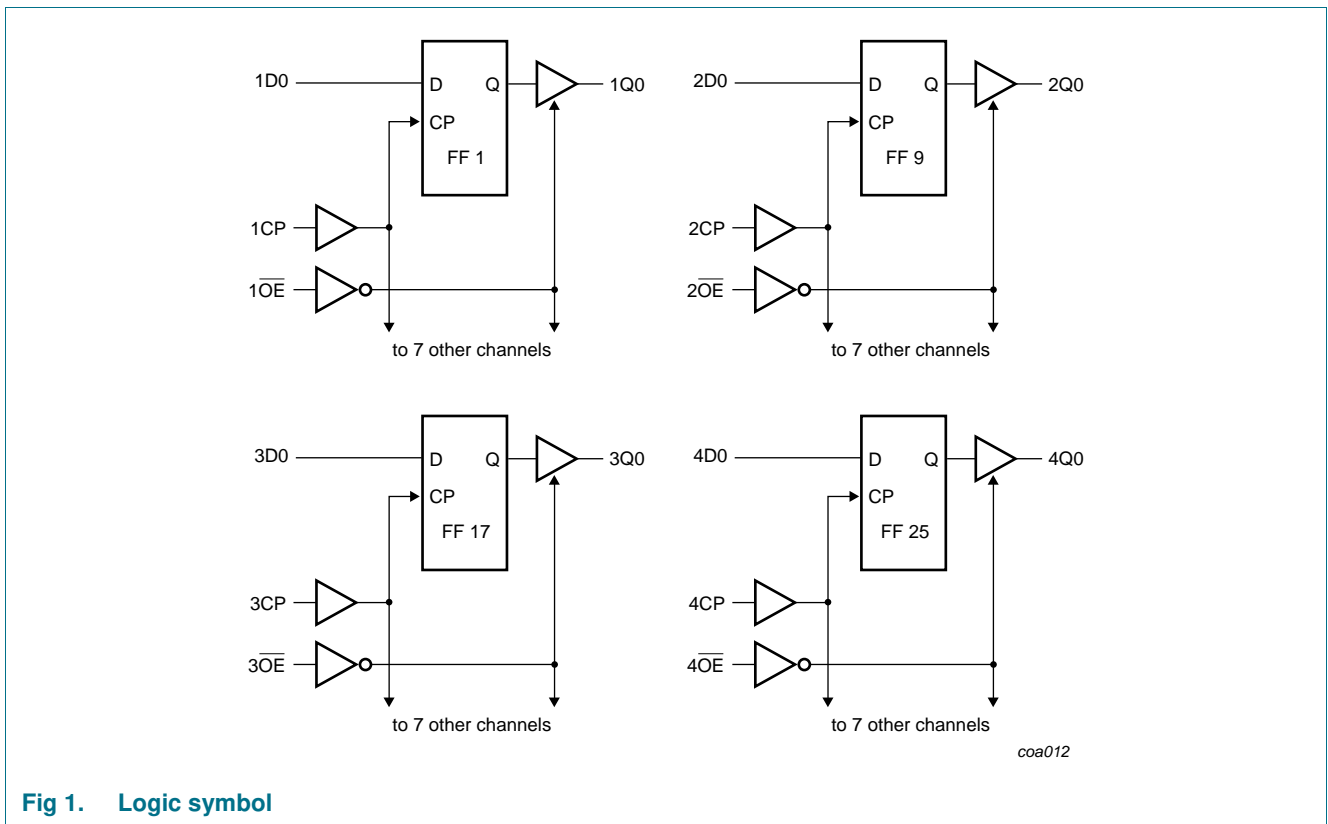


Fig 1. Logic symbol

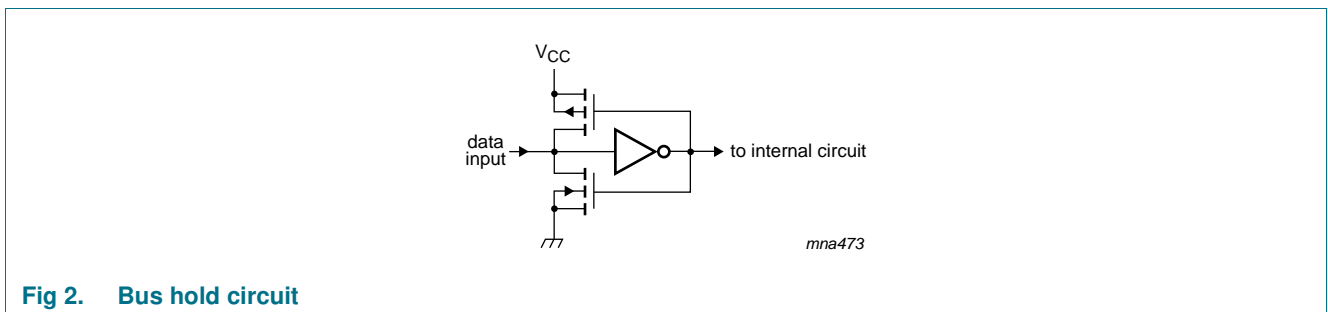


Fig 2. Bus hold circuit

5. Pinning information

5.1 Pinning

001aah180

6	1D1	1D3	1D5	1D7	2D1	2D3	2D5	2D6	3D1	3D3	3D5	3D7	4D1	4D3	4D5	4D6
5	1D0	1D2	1D4	1D6	2D0	2D2	2D4	2D7	3D0	3D2	3D4	3D6	4D0	4D2	4D4	4D7
4	1CP	GND	V _{CC}	GND	GND	V _{CC}	GND	2CP	3CP	GND	V _{CC}	GND	GND	V _{CC}	GND	4CP
3	1 $\overline{\text{OE}}$	GND	V _{CC}	GND	GND	V _{CC}	GND	2 $\overline{\text{OE}}$	3 $\overline{\text{OE}}$	GND	V _{CC}	GND	GND	V _{CC}	GND	4 $\overline{\text{OE}}$
2	1Q0	1Q2	1Q4	1Q6	2Q0	2Q2	2Q4	2Q7	3Q0	3Q2	3Q4	3Q6	4Q0	4Q2	4Q4	4Q7
1	1Q1	1Q3	1Q5	1Q7	2Q1	2Q3	2Q5	2Q6	3Q1	3Q3	3Q5	3Q7	4Q1	4Q3	4Q5	4Q6
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	T

Fig 3. Pin configuration

5.2 Pin description

Table 2. Pin description

Symbol	Ball	Description
n $\overline{\text{OE}}$ (n = 1 to 4)	A3, H3, J3, T3	output enable input (active LOW)
nCP (n = 1 to 4)	A4, H4, J4, T4	clock input
1D[0:7]	A5, A6, B5, B6, C5, C6, D5, D6	data input
2D[0:7]	E5, E6, F5, F6, G5, G6, H6, H5	data input
3D[0:7]	J5, J6, K5, K6, L5, L6, M5, M6	data input
4D[0:7]	N5, N6, P5, P6, R5, R6, T6, T5	data input
1Q[0:7]	A2, A1, B2, B1, C2, C1, D2, D1	data output
2Q[0:7]	E2, E1, F2, F1, G2, G1, H1, H2	data output
3Q[0:7]	J2, J1, K2, K1, L2, L1, M2, M1	data output
4Q[0:7]	N2, N1, P2, P1, R2, R1, T1, T2	data output
GND	B3, B4, D3, D4, E3, E4, G3, G4, K3, K4, M3, M4, N3, N4, R3, R4	ground (0 V)
V _{CC}	C3, C4, F3, F4, L3, L4, P3, P4	supply voltage

6. Functional description

Table 3. Function table^[1]

Operating mode	Input			Internal flip-flop	Output nQn
	nOE	nCP	nDn		
Load and read register	L	↑	l	L	L
	L	↑	h	H	H
Load register and disable outputs	H	↑	l	L	Z
	H	↑	h	H	Z

- [1] H = HIGH voltage level
 L = LOW voltage level
 h = HIGH voltage level one set-up time prior to the HIGH-to-LOW CP transition
 l = LOW voltage level one set-up time prior to the HIGH-to-LOW CP transition
 Z = high-impedance OFF-state
 ↑ = LOW-to-HIGH CP transition

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)^[1]

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		^[2] -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	^[3] -0.5	V _{CC} + 0.5	V
		output 3-state	^[3] -0.5	+6.5	V
I _O	output current	V _O = 0 V to V _{CC}	-	±50	mA
I _{CC}	supply current		-	200	mA
I _{GND}	ground current		-200	-	mA
T _{stg}	storage temperature		-65	+150	°C
P _{tot}	total power dissipation	T _{amb} = -40 °C to +125 °C	^[4] -	1000	mW

- [1] All supply and ground pins connected externally to one voltage source.
 [2] The minimum input voltage ratings may be exceeded if the input current ratings are observed.
 [3] The output voltage ratings may be exceeded if the output current ratings are observed.
 [4] Above 70 °C the value of P_{tot} derate linearly with 1.8 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
Δt/ΔV	input transition rise and fall rate	V _{CC} = 1.65 V to 2.7 V	-	-	20	ns/V
		V _{CC} = 2.7 V to 3.6 V	-	-	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
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	40	-	160	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 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 only. Control inputs do not have a bus hold circuit.

[4] The specified sustaining current at the data input 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 7](#).

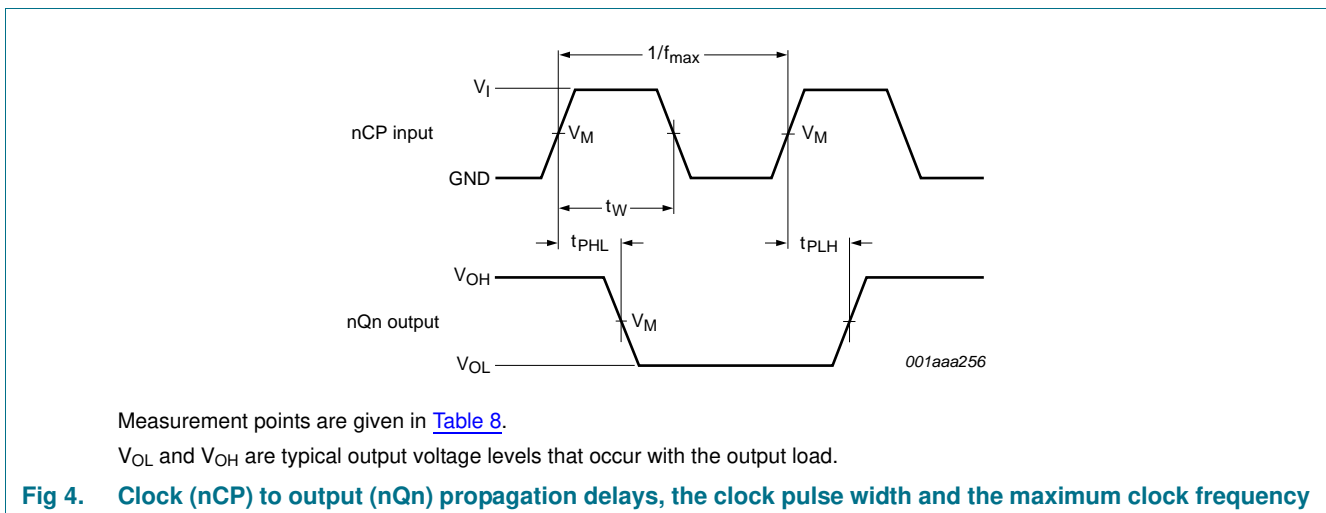
Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ ^[1]	Max	Min	Max	
t _{pd}	propagation delay	nCP to nQn; see Figure 4 ^[2]						
		V _{CC} = 1.2 V	-	14	-	-	-	ns
		V _{CC} = 1.65 V to 1.95 V	2.1	6.9	13.5	2.1	15.6	ns
		V _{CC} = 2.3 V to 2.7 V	1.5	3.7	6.7	1.5	7.7	ns
		V _{CC} = 2.7 V	1.5	3.4	6.0	1.5	7.5	ns
		V _{CC} = 3.0 V to 3.6 V	1.5	3.1	5.4	1.5	7.0	ns
t _{en}	enable time	nOE to nQn; see Figure 6 ^[2]						
		V _{CC} = 1.2 V	-	20	-	-	-	ns
		V _{CC} = 1.65 V to 1.95 V	1.5	5.9	13.1	1.5	15.1	ns
		V _{CC} = 2.3 V to 2.7 V	1.5	3.4	6.9	1.5	8.0	ns
		V _{CC} = 2.7 V	1.5	3.6	6.0	1.5	7.5	ns
		V _{CC} = 3.0 V to 3.6 V	1.0	2.7	5.2	1.0	6.5	ns
t _{dis}	disable time	nOE to nQn; see Figure 4 ^[2]						
		V _{CC} = 1.2 V	-	12	-	-	-	ns
		V _{CC} = 1.65 V to 1.95 V	2.8	4.6	9.1	2.8	10.5	ns
		V _{CC} = 2.3 V to 2.7 V	1.0	2.5	4.9	1.0	5.7	ns
		V _{CC} = 2.7 V	1.5	3.4	5.1	1.5	6.5	ns
		V _{CC} = 3.0 V to 3.6 V	1.5	3.1	4.9	1.5	6.5	ns
t _w	pulse width	nCP HIGH; see Figure 4						
		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	1.5	-	3.0	-	ns
t _{su}	set-up time	nDn to nCP; see Figure 5						
		V _{CC} = 1.65 V to 1.95 V	4.0	-	-	4.0	-	ns
		V _{CC} = 2.3 V to 2.7 V	3.0	-	-	3.0	-	ns
		V _{CC} = 2.7 V	1.9	-	-	1.9	-	ns
		V _{CC} = 3.0 V to 3.6 V	1.9	0.3	-	1.9	-	ns
t _h	hold time	nDn to nCP; see Figure 5						
		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	1.1	-	-	1.1	-	ns
		V _{CC} = 3.0 V to 3.6 V	1.5	-0.3	-	1.5	-	ns

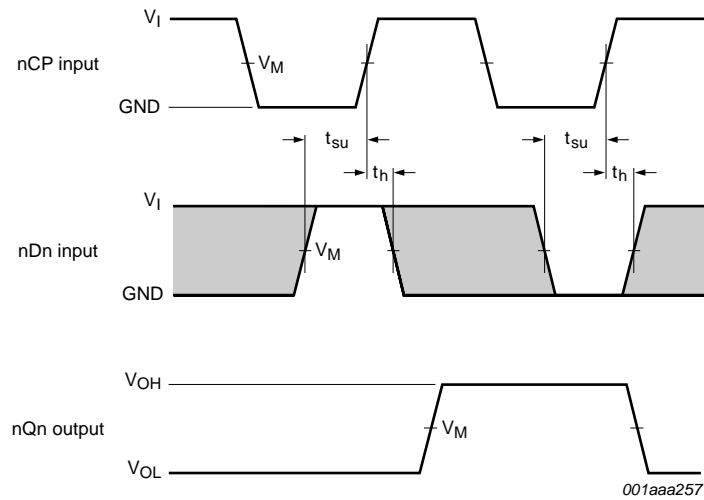
Table 7. Dynamic characteristics ...continued
 Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 7](#).

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit	
			Min	Typ ^[1]	Max	Min	Max		
f _{max}	maximum frequency	see Figure 4							
		V _{CC} = 1.65 V to 1.95 V	100	-	-	80	-	ns	
		V _{CC} = 2.3 V to 2.7 V	125	-	-	100	-	ns	
		V _{CC} = 2.7 V	150	-	-	120	-	MHz	
		V _{CC} = 3.0 V to 3.6 V	150	300	-	120	-	MHz	
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	-	14.1	-	-	-	pF	
		V _{CC} = 2.3 V to 2.7 V	-	16.4	-	-	-	pF	
		V _{CC} = 3.0 V to 3.6 V	-	18.5	-	-	-	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

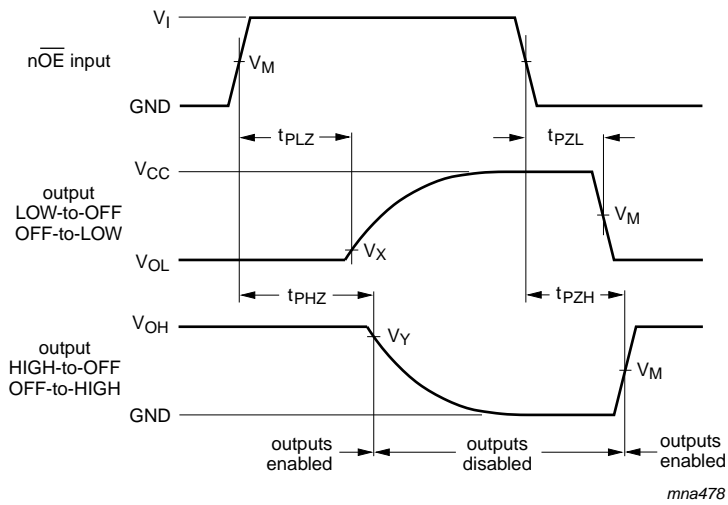
11. Waveforms





Measurement points are given in [Table 8](#).
 V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig 5. Set-up and hold times for inputs (nDn) to inputs (nCP)

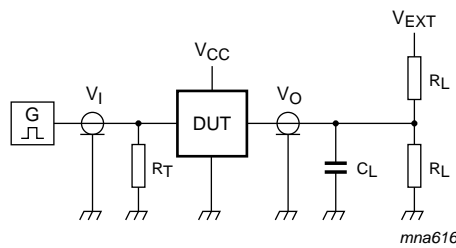


Measurement points are given in [Table 8](#).
 V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig 6. 3-state output enable and disable times

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 × V _{CC}	0.5 × V _{CC}	V _{OL} + 0.15 V	V _{OH} - 0.15 V
1.65 V to 1.95 V	V _{CC}	0.5 × V _{CC}	0.5 × V _{CC}	V _{OL} + 0.15 V	V _{OH} - 0.15 V
2.3 V to 2.7 V	V _{CC}	0.5 × V _{CC}	0.5 × 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 the output impedance Z_o of the pulse generator

Fig 7. Load circuitry for 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 × V _{CC}	GND
1.65 V to 1.95 V	V _{CC}	≤ 2 ns	30 pF	1 kΩ	open	2 × V _{CC}	GND
2.3 V to 2.7 V	V _{CC}	≤ 2 ns	30 pF	500 Ω	open	2 × V _{CC}	GND
2.7 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	open	2 × V _{CC}	GND
3.0 V to 3.6 V	2.7 V	≤ 2.5 ns	50 pF	500 Ω	open	2 × V _{CC}	GND

12. 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

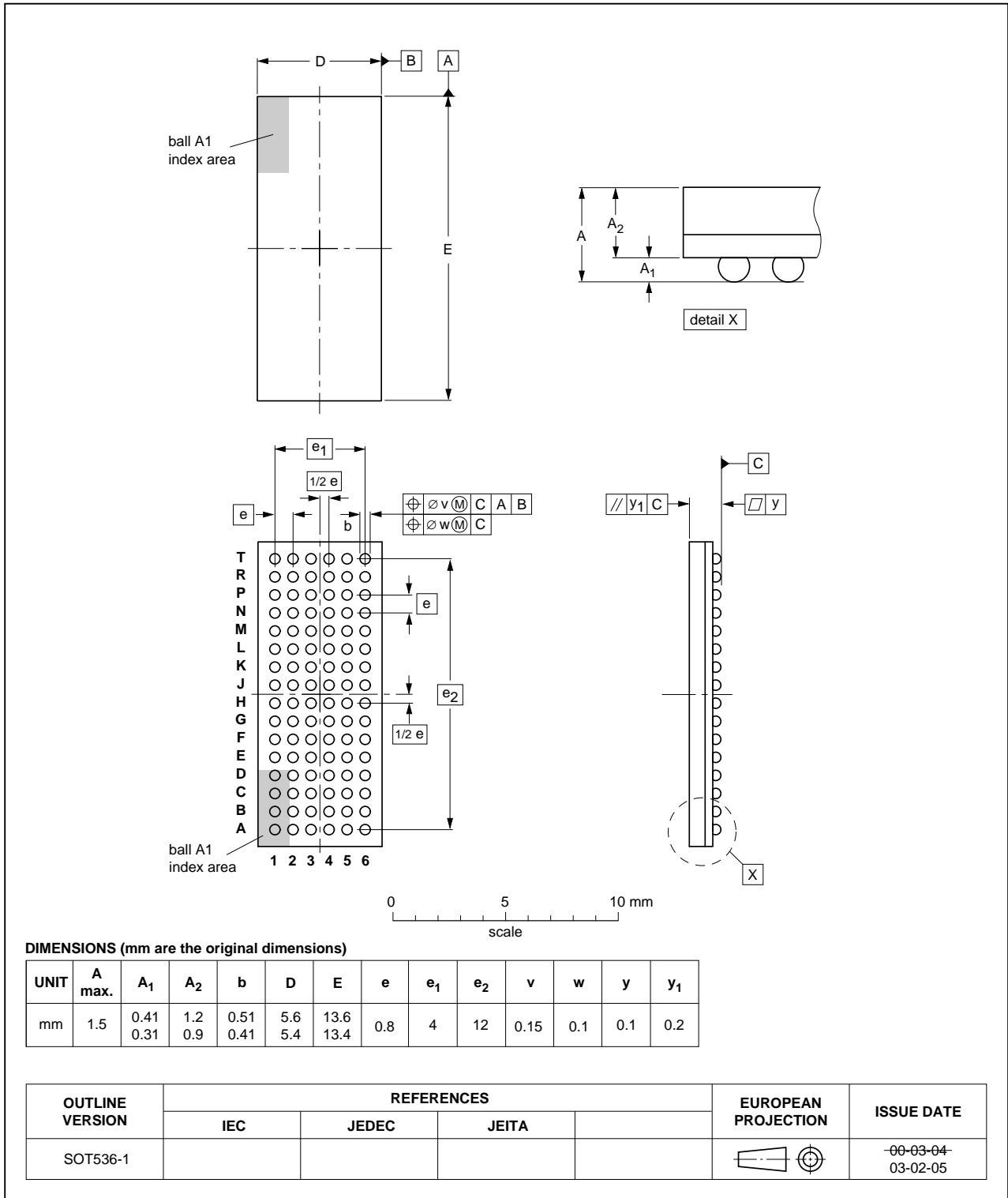


Fig 8. Package outline SOT536-1 (LFBGA96)

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
74LVCH32374A v.3	20121218	Product data sheet	-	74LVCH32374A v.2
Modifications:	<ul style="list-style-type: none"> 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 4, Table 5, Table 6, Table 7, Table 8 and Table 9: values added for lower voltage ranges. 			
74LVCH32374A v.2	20040519	Product specification	-	74LVCH32374A v.1
74LVCH32374A v.1	19991124	Product specification	-	-

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.nxp.com>.

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17. Contents

1 General description 1

2 Features and benefits 1

3 Ordering information 2

4 Functional diagram 2

5 Pinning information 3

5.1 Pinning 3

5.2 Pin description 3

6 Functional description 4

7 Limiting values 4

8 Recommended operating conditions 5

9 Static characteristics 5

10 Dynamic characteristics 7

11 Waveforms 8

12 Package outline 11

13 Abbreviations 12

14 Revision history 12

15 Legal information 13

15.1 Data sheet status 13

15.2 Definitions 13

15.3 Disclaimers 13

15.4 Trademarks 14

16 Contact information 14

17 Contents 15

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