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Team Nexperia

74LVT16374A; 74LVTH16374A

3.3 V 16-bit edge-triggered D-type flip-flop; 3-state

Rev. 10 — 2 April 2012 Product data sheet

1. General description

The 74LVT16374A; 74LVTH16374A are high performance BiCMOS products designed for V_{CC} operation at 3.3 V.

This device is a 16-bit edge-triggered D-type flip-flop featuring non-inverting 3-state outputs. The device can be used as two 8-bit flip-flops or one 16-bit flip-flop. On the positive transition of the clock (nCP), the nQn outputs of the flip-flop take on the logic levels set up at the nDn inputs.

2. Features and benefits

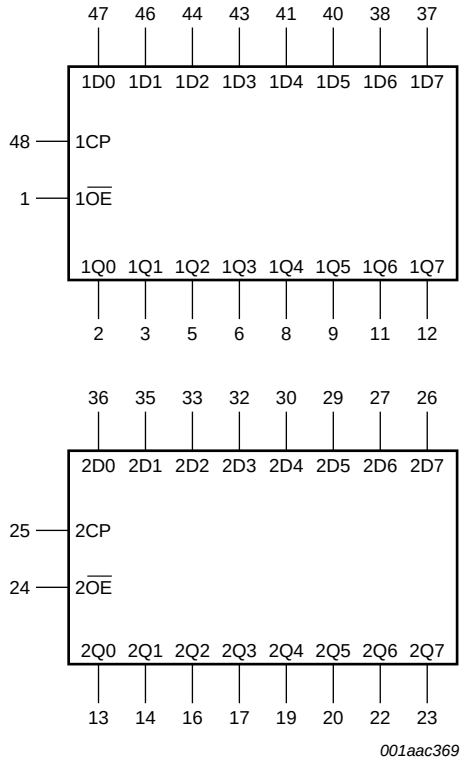
- 16-bit edge-triggered flip-flop
- 3-state buffers
- Output capability: +64 mA and −32 mA
- TTL input and output switching levels
- Input and output interface capability to systems at 5 V supply
- Bus-hold data inputs eliminate the need for external pull-up resistors to hold unused inputs
- Live insertion and extraction permitted
- Power-up reset
- Power-up 3-state
- No bus current loading when output is tied to 5 V bus
- Latch-up protection:
  - JESD78B Class II exceeds 500 mA
- ESD protection:
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V

3. Ordering information

Table 1. Ordering information

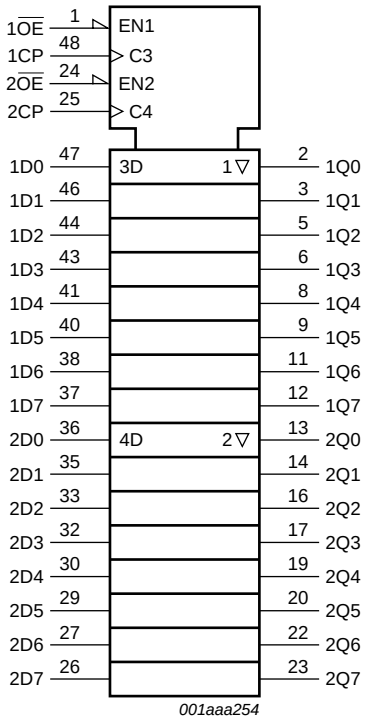
Type number	Package			
	Temperature range	Name	Description	Version
74LVT16374ADL	−40 °C to +85 °C	SSOP48	plastic shrink small outline package; 48 leads; body width 7.5 mm	SOT370-1
74LVT16374ADGG	−40 °C to +85 °C	TSSOP48	plastic thin shrink small outline package; 48 leads; body width 6.1 mm	SOT362-1
74LVTH16374ADGG				
74LVT16374AEV	−40 °C to +85 °C	VFBGA56	plastic very thin fine-pitch ball grid array package; 56 balls; body 4.5 × 7 × 0.65 mm	SOT702-1
74LVTH16374ABX	−40 °C to +125 °C	HXQFN60	plastic compatible thermal enhanced extremely thin quad flat package; no leads; 60 terminals; body 4 × 6 × 0.5 mm	SOT1134-2

4. Functional diagram



Pin numbers are shown for SSOP48 and TSSOP48 packages only.

Fig 1. Logic symbol



Pin numbers are shown for SSOP48 and TSSOP48 packages only.

Fig 2. IEC logic symbol

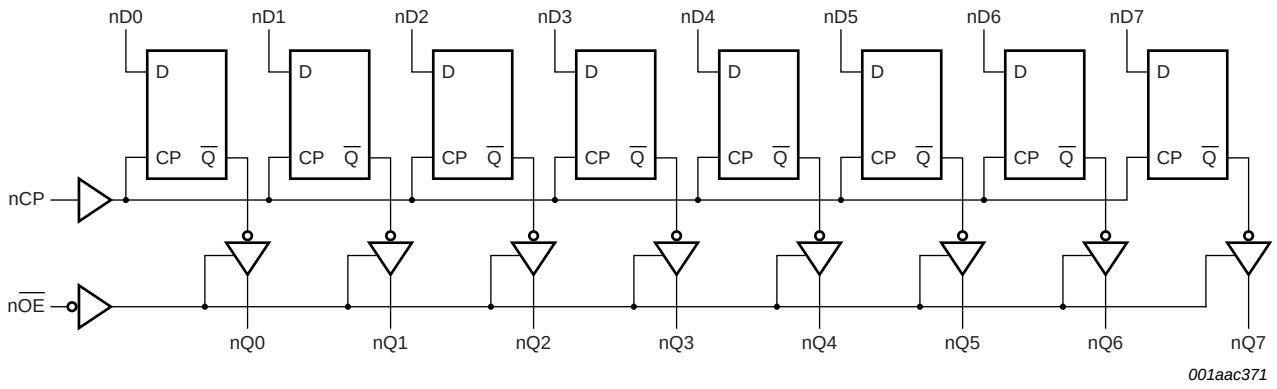


Fig 3. Logic diagram

5. Pinning information

5.1 Pinning

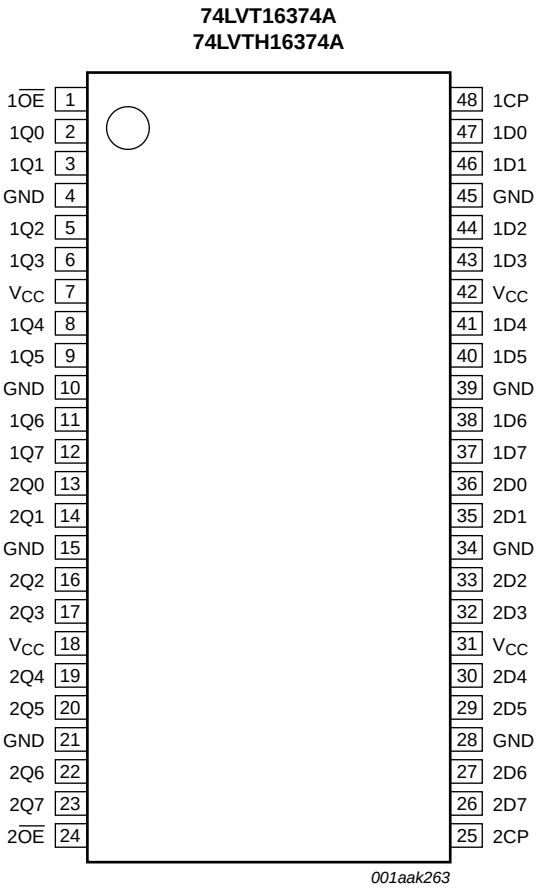
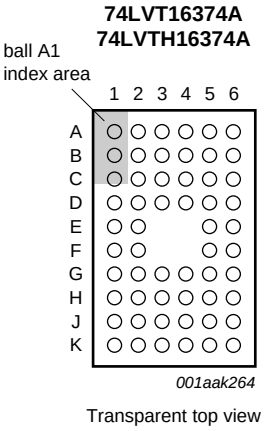
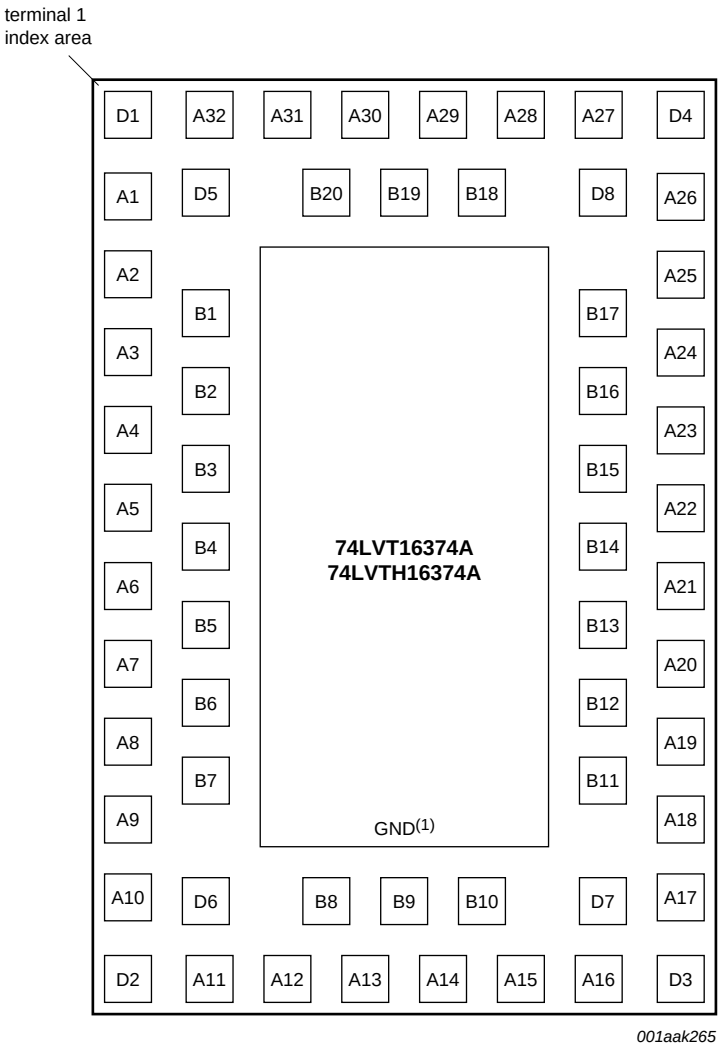


Fig 4. Pin configuration for SOT370-1 (SSOP48) and SOT362-1 (TSSOP48)



Transparent top view

Fig 5. Pin configuration for SOT702-1 (VFBGA56)



Transparent top view

(1) This is not a supply pin, the substrate is attached to this pad using conductive die attach material. There is no electrical or mechanical requirement to solder this pad however if it is soldered the solder land should remain floating or be connected to GND.

Fig 6. Pin configuration SOT1134-2 (HXQFN60)

5.2 Pin description

Table 2. Pin description

Symbol	Pin			Description
	SOT370-1 and SOT362-1	SOT702-1	SOT1134-2	
$1\overline{OE}$, $2\overline{OE}$	1, 24	A1, K1	A30, A13	output enable input (active LOW)
1CP, 2CP	48, 25	A6, K6	A29, A14	clock input
1Q0 to 1Q7	2, 3, 5, 6, 8, 9, 11, 12	B2, B1, C2, C1, D2, D1, E2, E1	B20, A31, D5, D1, A2, B2, B3, A5	data output
2Q0 to 2Q7	13, 14, 16, 17, 19, 20, 22, 23	F1, F2, G1, G2, H1, H2, J1, J2	A6, B5, B6, A9, D2, D6, A12, B8	data output
GND	4, 10, 15, 21, 28, 34, 39, 45	B3, D3, G3, J3, J4, G4, D4, B4	A32, A3, A8, A11, A16, A19, A24, A27	ground (0 V)
V_{CC}	7, 18, 31, 42	C3, H3, H4, C4	A1, A10, A17, A26	supply voltage
1D0 to 1D7	47, 46, 44, 43, 41, 40, 38, 37	B5, B6, C5, C6, D5, D6, E5, E6	B18, A28, D8, D4, A25, B16, B15, A22	data input
2D0 to 2D7	36, 35, 33, 32, 30, 29, 27, 26	F6, F5, G6, G5, H6, H5, J6, J5	A21, B13, B12, A18, D3, D7, A15, B10	data input
n.c.	-	A2, A3, A4, A5, K2, K3, K4, K5	A4, A7, A20, A23, B1, B4, B7, B9, B11, B14, B17, B19	not connected

6. Functional description

Table 3. Function table[1]

Operating mode	Input			Internal register	Output
	$n\overline{OE}$	nCP	nDn		nQ0 to nQ7
Load and read register	L	↑	l	L	L
	L	↑	h	H	H
Hold	L	NC	X	NC	NC
Disable outputs	H	NC	X	NC	Z
	H	↑	nDn	nDn	Z

[1] H = HIGH voltage level;
h = HIGH voltage level one set-up time prior to the HIGH-to-LOW clock transition;
L = LOW voltage level;
l = LOW voltage level one set-up time prior to the HIGH-to-LOW clock transition;
NC = no change;
X = don't care;
Z = high-impedance OFF-state;
↑ = LOW-to-HIGH clock 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).

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage			−0.5	+4.6	V
V_I	input voltage		[1]	−0.5	+7.0	V
V_O	output voltage	output in OFF-state or HIGH-state	[1]	−0.5	+7.0	V
I_{IK}	input clamping current	$V_I < 0$ V		−50	-	mA
I_{OK}	output clamping current	$V_O < 0$ V		−50	-	mA
I_O	output current	output in LOW-state		-	128	mA
		output in HIGH-state		−64	-	mA
T_{stg}	storage temperature			−65	+150	°C
T_j	junction temperature		[2]	-	150	°C
P_{tot}	total power dissipation	T_{amb} = −40 °C to +85 °C				
		(T)SSOP48 package	[3]	-	500	mW
		VFBGA56 and HXQFN60 package	[4]	-	1000	mW

[1] The input and output negative voltage ratings may be exceeded if the input and output clamp current ratings are observed.

[2] The performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability.

[3] Above 60 °C the value of P_{tot} derates linearly with 5.5 mW/K.

[4] Above 70 °C the value of P_{tot} derates 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		2.7	-	3.6	V
V_I	input voltage		0	-	5.5	V
V_{IH}	HIGH-level input voltage		2.0	-	-	V
V_{IL}	LOW-level input voltage		-	-	0.8	V
I_{OH}	HIGH-level output current		−32	-	-	mA
I_{OL}	LOW-level output current	none	-	-	32	mA
		current duty cycle ≤ 50 %; $f_i \geq 1$ kHz	-	-	64	mA
T_{amb}	ambient temperature	in free-air	−40	-	+85	°C
$\Delta t/\Delta V$	input transition rise and fall rate	outputs enabled	-	-	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		Min	Typ[1]	Max	Unit
T_{amb} = −40 °C to +85 °C							
V_{IK}	input clamping voltage	V_{CC} = 2.7 V; I_{IK} = −18 mA		−1.2	−0.85	-	V
V_{OH}	HIGH-level output voltage	I_{OH} = −100 µA; V_{CC} = 2.7 V to 3.6 V		V_{CC} − 0.2	V_{CC}	-	V
		I_{OH} = −8 mA; V_{CC} = 2.7 V		2.4	2.5	-	V
		I_{OH} = −32 mA; V_{CC} = 3.0 V		2.0	2.3	-	V
V_{OL}	LOW-level output voltage	V_{CC} = 2.7 V					
		I_{OL} = 100 µA		-	0.07	0.2	V
		I_{OL} = 24 mA		-	0.3	0.5	V
		V_{CC} = 3.0 V					
		I_{OL} = 16 mA		-	0.25	0.4	V
		I_{OL} = 32 mA		-	0.3	0.5	V
		I_{OL} = 64 mA		-	0.4	0.55	V
$V_{OL(pu)}$	power-up LOW-level output voltage	V_{CC} = 3.6 V; I_O = 1 mA; V_I = V_{CC} or GND	[2]	-	0.1	0.55	V
I_I	input leakage current	control pins					
		V_{CC} = 3.6 V; V_I = V_{CC} or GND		-	0.1	±1	µA
		V_{CC} = 0 V or 3.6 V; V_I = 5.5 V		-	0.4	10	µA
		input data pins	[3]				
		V_{CC} = 0 V or 3.6 V; V_I = 5.5 V		-	0.4	10	µA
		V_{CC} = 3.6 V; V_I = V_{CC}		-	0.1	1	µA
		V_{CC} = 3.6 V; V_I = 0 V		−5	−0.4	-	µA
I_{OFF}	power-off leakage current	V_{CC} = 0 V; V_I or V_O = 0 V to 4.5 V		-	0.1	±100	µA
I_{BHL}	bus hold LOW current	V_{CC} = 3 V; V_I = 0.8 V		75	135	-	µA
I_{BHH}	bus hold HIGH current	V_{CC} = 3 V; V_I = 2.0 V		-	−135	−75	µA
I_{BHLO}	bus hold LOW overdrive current	input data pins; V_I = 0 V to 3.6 V; V_{CC} = 3.6 V	[4]	500	-	-	µA
I_{BHHO}	bus hold HIGH overdrive current	input data pins; V_I = 0 V to 3.6 V; V_{CC} = 3.6 V	[4]	-	-	−500	µA
I_{LO}	output leakage current	output in HIGH-state when V_O > V_{CC}; V_O = 5.5 V; V_{CC} = 3.0 V		-	50	125	µA
$I_{O(pu/pd)}$	power-up/power-down output current	V_{CC} ≤ 1.2 V; V_O = 0.5 V to V_{CC}; V_I = GND or V_{CC}; $\overline{nOE}$ = don't care	[5]	-	1	±100	µA
I_{OZ}	OFF-state output current	V_{CC} = 3.6 V; V_I = V_{IH} or V_{IL}					
		output HIGH: V_O = 3.0 V		-	0.5	5	µA
		output LOW: V_O = 0.5 V		−5	0.5	-	µA
I_{CC}	supply current	V_{CC} = 3.6 V; V_I = GND or V_{CC}; I_O = 0 A					
		outputs HIGH		-	0.07	0.12	mA
		outputs LOW		-	4.0	6.0	mA
		outputs disabled	[6]	-	0.07	0.12	mA

Table 6. Static characteristics *...continued*

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

Symbol	Parameter	Conditions		Min	Typ[1]	Max	Unit
ΔI_{CC}	additional supply current	per input pin; V_{CC} = 3.0 V to 3.6 V; one input at V_{CC} − 0.6 V, other inputs at V_{CC} or GND	[7]	-	0.1	0.2	mA
C_I	input capacitance	input pins; V_I = 0 V or 3.0 V		-	3	-	pF
C_O	output capacitance	output pins nQn; outputs disabled; V_O = 0 V or V_{CC}		-	9	-	pF

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

[2] For valid test results, data must not be loaded into the flips-flops (or latches) after applying power.

[3] Unused pins at V_{CC} or GND.

[4] This is the bus hold overdrive current required to force the input to the opposite logic state.

[5] This parameter is valid for any V_{CC} between 0 V and 1.2 V with a transition time of up to 10 ms. From V_{CC} = 1.2 V to V_{CC} = 3.3 V ± 0.3 V a transition time of 100 μs is permitted. This parameter is valid for T_{amb} = 25 °C only.

[6] I_{CC} is measured with outputs pulled to V_{CC} or GND.

[7] This is the increase in supply current for each input at the specified voltage level other than V_{CC} or GND.

10. Dynamic characteristics

Table 7. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); for test circuit see Figure 10.

Symbol	Parameter	Conditions	Min	Typ[1]	Max	Unit
T_{amb} = −40 °C to +85 °C						
f_{max}	maximum frequency	nCP; V_{CC} = 3.3 V ± 0.3 V; see Figure 7	150	-	-	MHz
t_{PLH}	LOW to HIGH propagation delay	nCP to nQn; see Figure 7				
		V_{CC} = 3.3 V ± 0.3 V	1.5	2.9	5.0	ns
		V_{CC} = 2.7 V	-	-	5.6	ns
t_{PHL}	HIGH to LOW propagation delay	nCP to nQn; see Figure 7				
		V_{CC} = 3.3 V ± 0.3 V	1.5	3.0	5.0	ns
		V_{CC} = 2.7 V	-	-	5.6	ns
t_{PZH}	OFF-state to HIGH propagation delay	$\overline{nOE}$ to nQn; see Figure 8				
		V_{CC} = 3.3 V ± 0.3 V	1.5	3.2	4.8	ns
		V_{CC} = 2.7 V	-	-	6.0	ns
t_{PZL}	OFF-state to LOW propagation delay	$\overline{nOE}$ to nQn; see Figure 8				
		V_{CC} = 3.3 V ± 0.3 V	1.5	3.0	4.6	ns
		V_{CC} = 2.7 V	-	-	5.2	ns
t_{PHZ}	HIGH to OFF-state propagation delay	$\overline{nOE}$ to nQn; see Figure 8				
		V_{CC} = 3.3 V ± 0.3 V	1.5	3.9	5.4	ns
		V_{CC} = 2.7 V	-	-	6.0	ns
t_{PLZ}	LOW to OFF-state propagation delay	$\overline{nOE}$ to nQn; see Figure 8				
		V_{CC} = 3.3 V ± 0.3 V	1.5	3.4	4.6	ns
		V_{CC} = 2.7 V	-	-	5.0	ns

Table 7. Dynamic characteristics *...continued*

Voltages are referenced to GND (ground = 0 V); for test circuit see Figure 10.

Symbol	Parameter	Conditions		Min	Typ[1]	Max	Unit
t_{su}	set-up time	nDn to nCP; HIGH or LOW; see Figure 9	[2]				
		V_{CC} = 3.3 V ± 0.3 V		2.0	0.7	-	ns
		V_{CC} = 2.7 V		2.0	-	-	ns
t_h	hold time	nDn to nCP; HIGH or LOW; see Figure 9	[3]				
		V_{CC} = 3.3 V ± 0.3 V		0.8	0	-	ns
		V_{CC} = 2.7 V		0.1	-	-	ns
t_W	pulse width	nCP HIGH; see Figure 7	[4]				
		V_{CC} = 3.3 V ± 0.3 V		1.5	0.6	-	ns
		V_{CC} = 2.7 V		1.5	-	-	ns
		nCP LOW; see Figure 7					
		V_{CC} = 3.3 V ± 0.3 V		3.0	1.6	-	ns
		V_{CC} = 2.7 V		3.0	-	-	ns

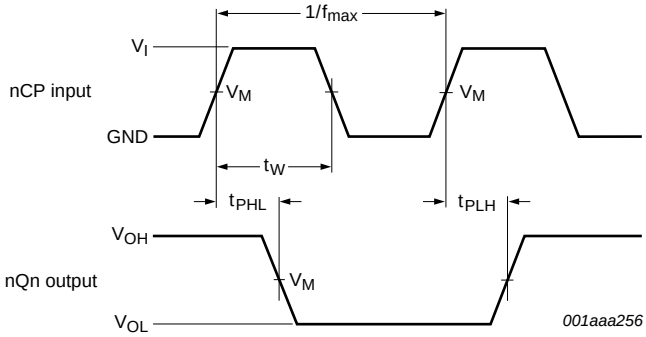
[1] All typical values are at V_{CC} = 3.3 V and T_{amb} = 25 °C.

[2] t_{su} is the same as $t_{su(H)}$ and $t_{su(L)}$.

[3] t_h is the same as $t_{h(H)}$ and $t_{h(L)}$.

[4] t_W is the same as $t_{W(H)}$ and $t_{W(L)}$.

11. Waveforms



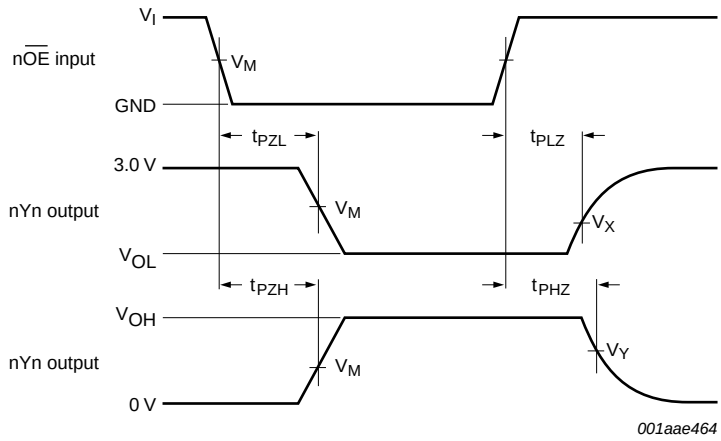
Measurement points are given in Table 8.

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

Fig 7. Propagation delay clock input to output, clock pulse width and maximum clock frequency

Table 8. Measurement points

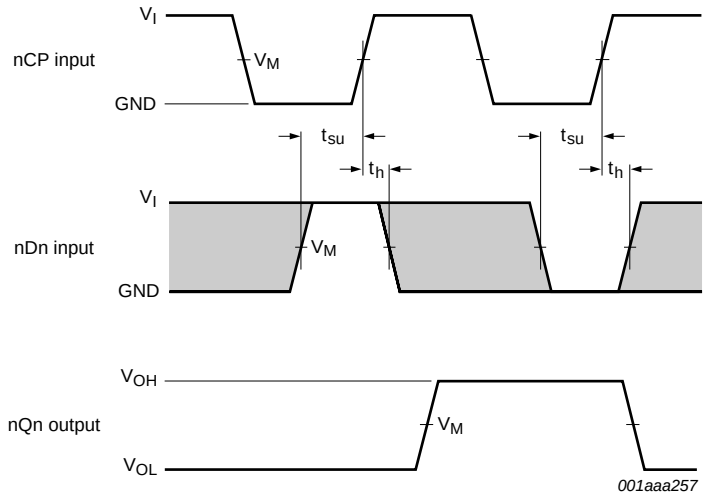
Input	Output		
V_M	V_M	V_X	V_Y
1.5 V	1.5 V	V_{OL} + 0.3 V	V_{OH} − 0.3 V



Measurements points are given in Table 8.

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

Fig 8. Enable and disable times

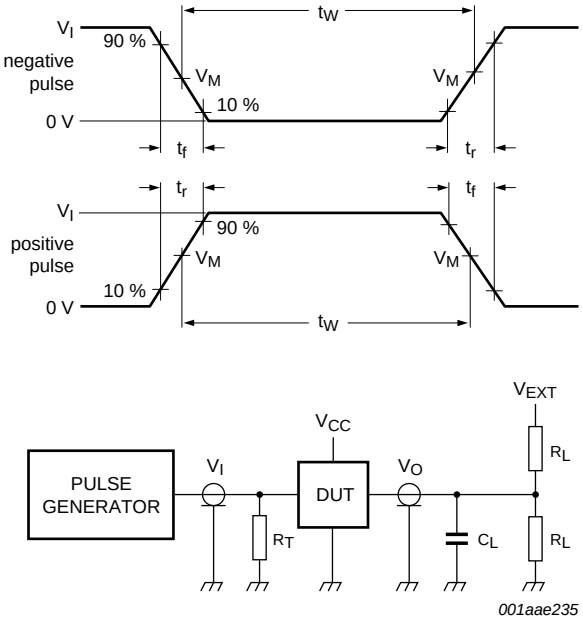


Measurement points are given in Table 8.

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

Remark: The shaded areas indicate when the input is permitted to change for predictable output performance.

Fig 9. Data set-up and hold times



Test data is given in Table 9.

Definitions test circuit:

R_L = Load resistance.

C_L = Load capacitance including jig and probe capacitance.

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

V_{EXT} = Test voltage for switching times.

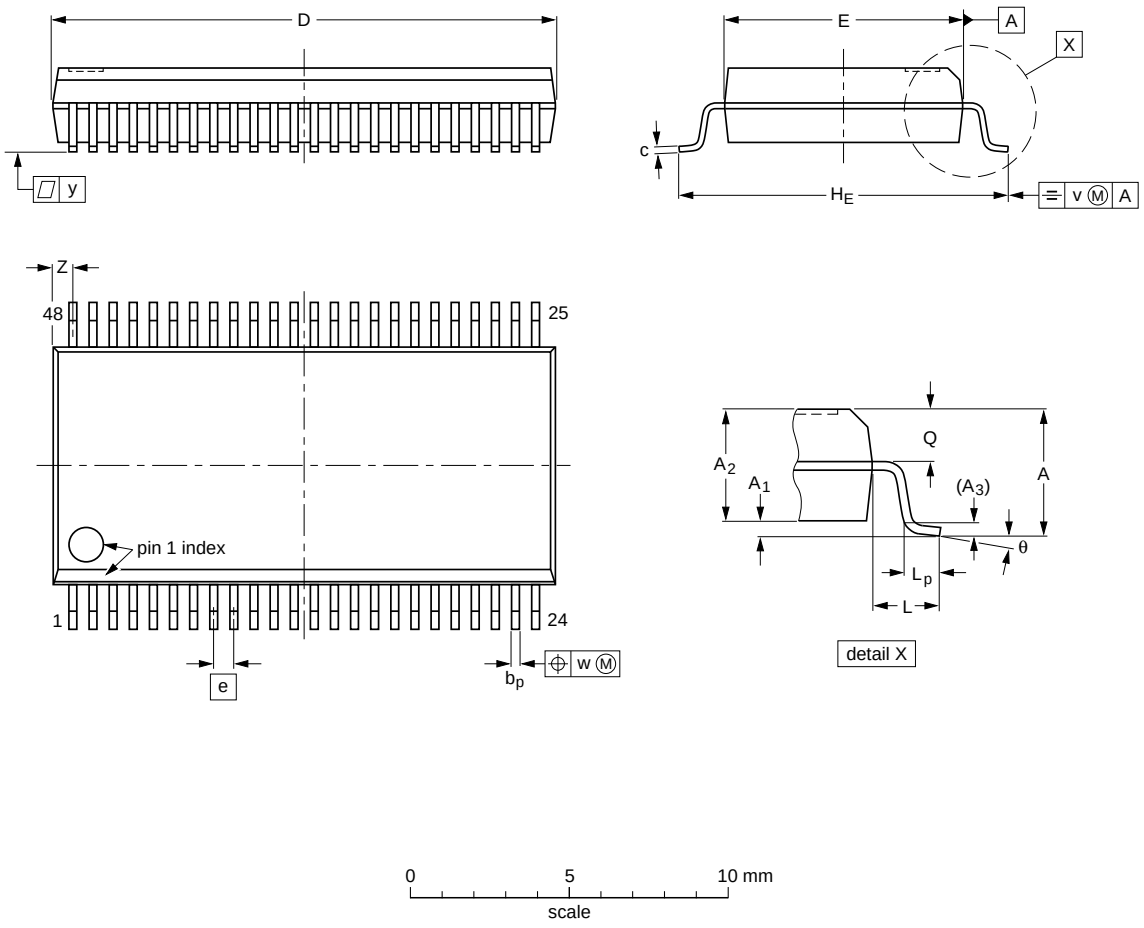
Fig 10. Test circuit for measuring switching times

Table 9. Test data

Input				Load		V_{EXT}		
V_I	f_i	t_W	t_r, t_f	C_L	R_L	t_{PHZ}, t_{PZH}	t_{PLZ}, t_{PZL}	t_{PLH}, t_{PHL}
2.7 V	≤ 10 MHz	500 ns	≤ 2.5 ns	50 pF	500 Ω	GND	6 V	open

12. Package outline

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_1	A_2	A_3	b_p	c	D (1)	E (1)	e	H_E	L	L_p	Q	v	w	y	Z (1)	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^o 0^o

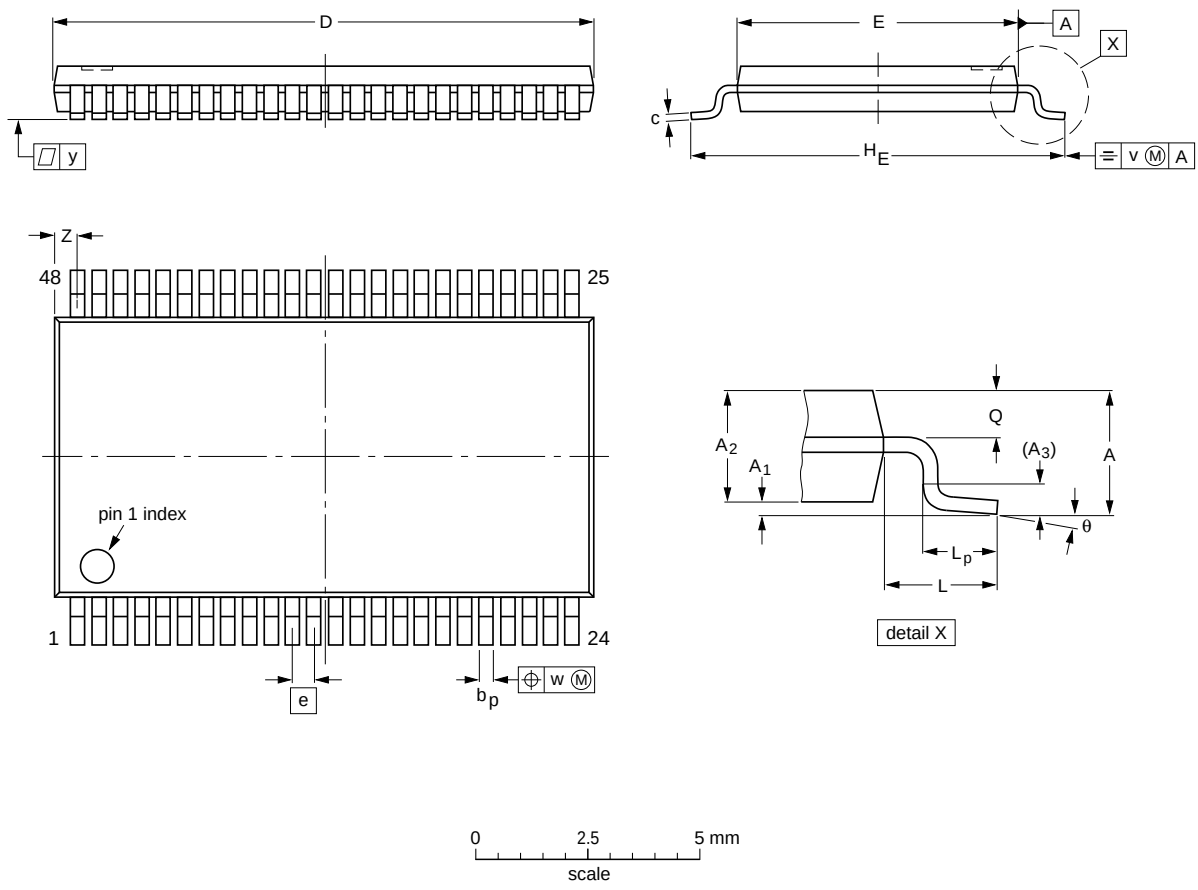
Note

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

Fig 11. Package outline SOT370-1 (SSOP48)

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_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	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^o 0^o

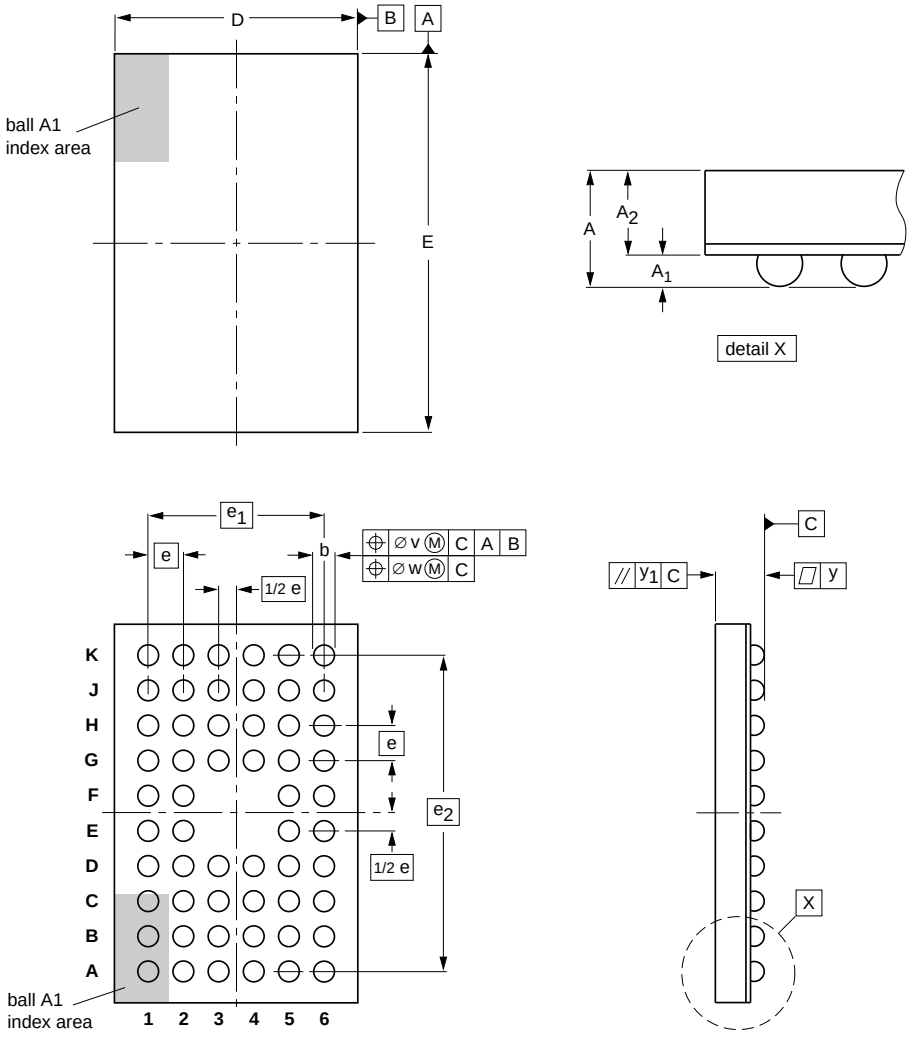
Notes

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

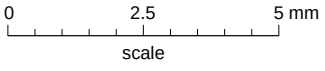
Fig 12. Package outline SOT362-1 (TSSOP48)

VFBGA56: plastic very thin fine-pitch ball grid array package; 56 balls; body 4.5 x 7 x 0.65 mm **SOT702-1**



DIMENSIONS (mm are the original dimensions)

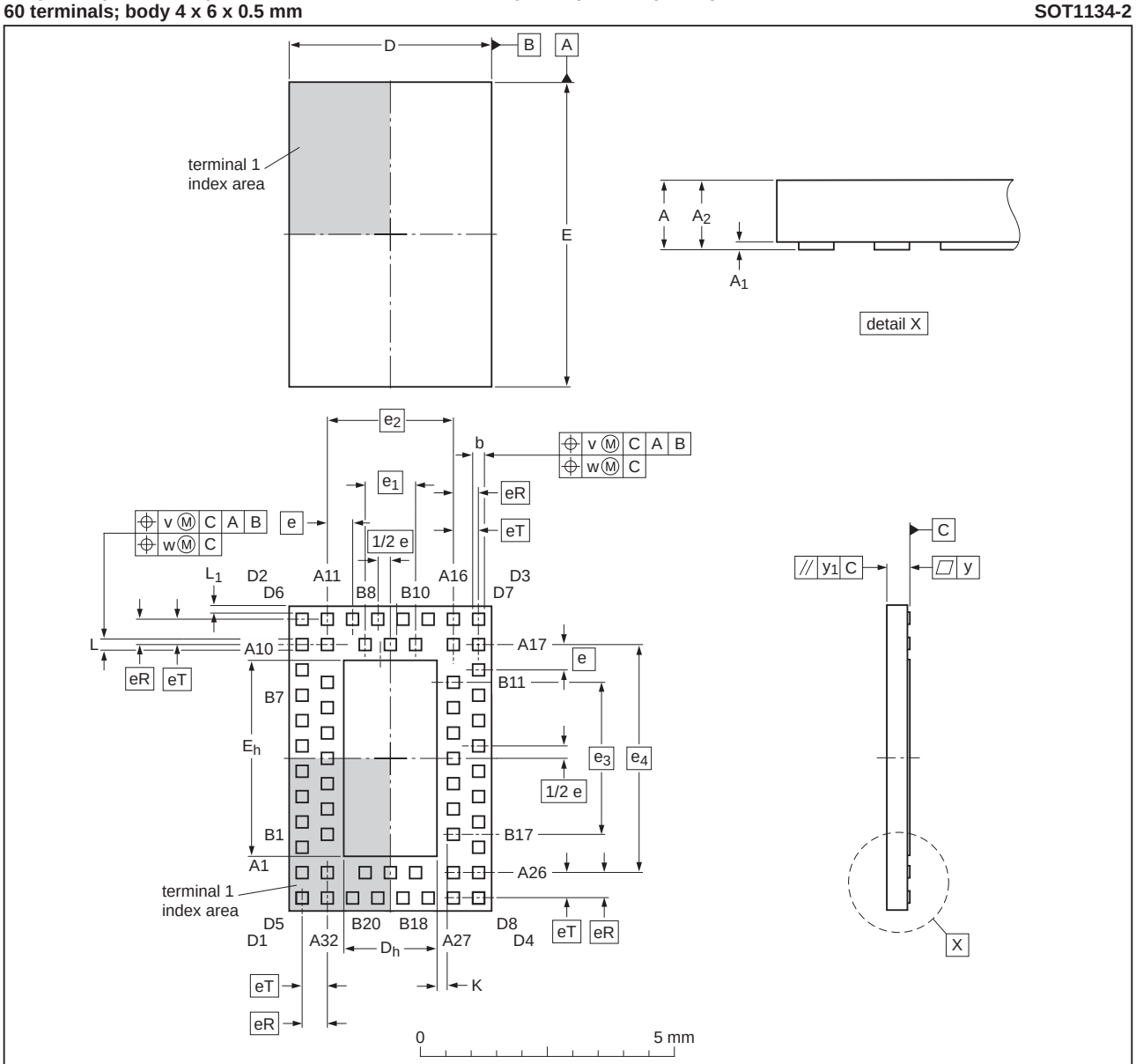
UNIT	A max.	A_1	A_2	b	D	E	e	e_1	e_2	v	w	y	y_1
mm	1	0.3 0.2	0.7 0.6	0.45 0.35	4.6 4.4	7.1 6.9	0.65	3.25	5.85	0.15	0.08	0.08	0.1



OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT702-1		MO-225				~~02-08-08~~ 03-07-01

Fig 13. Package outline SOT702-1 (VFBGA56)

HXQFN60: plastic compatible thermal enhanced extremely thin quad flat package; no leads; 60 terminals; body 4 x 6 x 0.5 mm **SOT1134-2**



Dimensions

Unit		A	A_1	A_2	b	D	D_h	E	E_h	e	e_1	e_2	e_3	e_4	eR	eT	K	L	L_1	v	w	y	y_1
	max	0.50	0.08	0.42	0.28	4.1	1.95	6.1	3.95								0.25	0.28	0.195				
mm	nom		0.05	0.40	0.23	4.0	1.85	6.0	3.85	0.5	1.0	2.5	3.0	4.5	0.5	0.49	0.20	0.23	0.145	0.1	0.05	0.08	0.1
	min		0.02	0.38	0.18	3.9	1.75	5.9	3.75								0.15	0.18	0.095				

sot1134-2_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1134-2	- - -	- - -	- - -			11-08-15

Fig 14. Package outline SOT1134-2 (HXQFN60)

13. Abbreviations

Table 10. Abbreviations

Acronym	Description
BiCMOS	Bipolar Complementary Metal Oxide Semiconductor
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
74LVT_LVTH16374A v.10	20120402	Product data sheet	-	74LVT_LVTH16374A v.9
Modifications:	• For type number 74LVTH16374ABX the sot code has changed to SOT1134-2.			
74LVT_LVTH16374A v.9	20111122	Product data sheet	-	74LVT_LVTH16374A v.8
Modifications:	• Legal pages updated.			
74LVT_LVTH16374A v.8	20110620	Product data sheet	-	74LVT_LVTH16374A v.7
74LVT_LVTH16374A v.7	20100322	Product data sheet	-	74LVT_LVTH16374A v.6
74LVT_LVTH16374A v.6	20100118	product data sheet	-	74LVT16374A v.5
74LVT16374A v.5	20040916	product data sheet	-	74LVT16374A v.4
74LVT16374A v.4	20021101	product specification	-	74LVT16374A v.3
74LVT16374A v.3	19991018	product specification	-	74LVT16374A v.2
74LVT16374A v.2	19980219	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

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