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Team Nexperia

# 74ALVCH16501

18-bit universal bus transceiver; 3-state

Rev. 5 — 10 July 2012

Product data sheet

## 1. General description

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The 74ALVCH16501 is an 18-bit transceiver featuring non-inverting 3-state bus compatible outputs in both send and receive directions. Data flow in each direction is controlled by output enable (OEAB and  $\overline{\text{OEBA}}$ ), latch enable (LEAB and LEBA), and clock (CPAB and CPBA) inputs. For A-to-B data flow, the device operates in the transparent mode when LEAB is HIGH. When LEAB is LOW, the A data is latched if CPAB is held at a HIGH or LOW logic level. If LEAB is LOW, the A-bus data is stored in the latch/flip-flop on the LOW-to HIGH transition of CPAB. When OEAB is HIGH, the outputs are active. When OEAB is LOW, the outputs are in the high-impedance state.

Data flow for B-to-A is similar to that of A-to-B but uses  $\overline{\text{OEBA}}$ , LEBA and CPBA. The output enables are complimentary (OEAB is active HIGH, and  $\overline{\text{OEBA}}$  is active LOW).

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

Active bus hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

## 2. Features and benefits

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- Wide supply voltage range from 1.2 V to 3.6 V
- Complies with JEDEC standard JESD8-B
- CMOS low power consumption
- Direct interface with TTL levels
- Current drive  $\pm 24$  mA at  $V_{CC} = 3.0$  V
- Universal bus transceiver with D-type latches and D-type flip-flops capable of operating in transparent, latched or clocked mode
- All inputs have bus hold circuitry
- Output drive capability 50  $\Omega$  transmission lines at 85 °C
- 3-state non-inverting outputs for bus-oriented applications

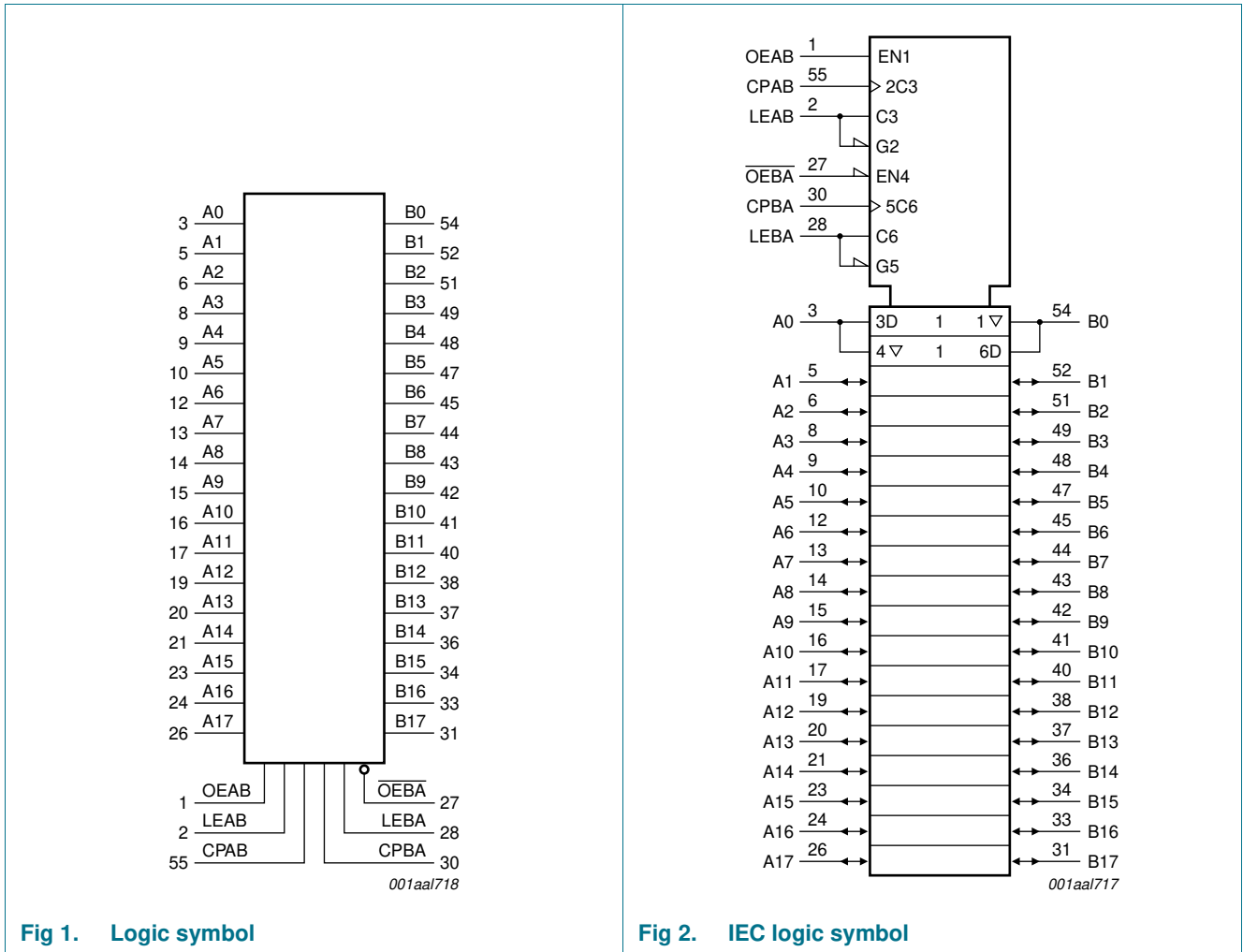


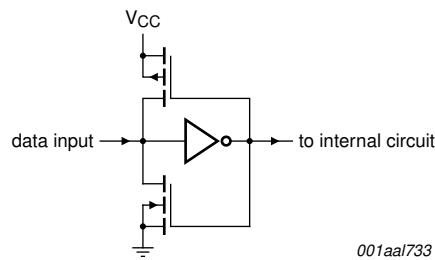
### 3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74ALVCH16501DGG	-40 °C to +85 °C	TSSOP56	plastic thin shrink small outline package; 56 leads; body width 6.1 mm	SOT364-1
74ALVCH16501DL	-40 °C to +85 °C	SSOP56	plastic shrink small outline package; 56 leads; body width 7.5 mm	SOT371-1

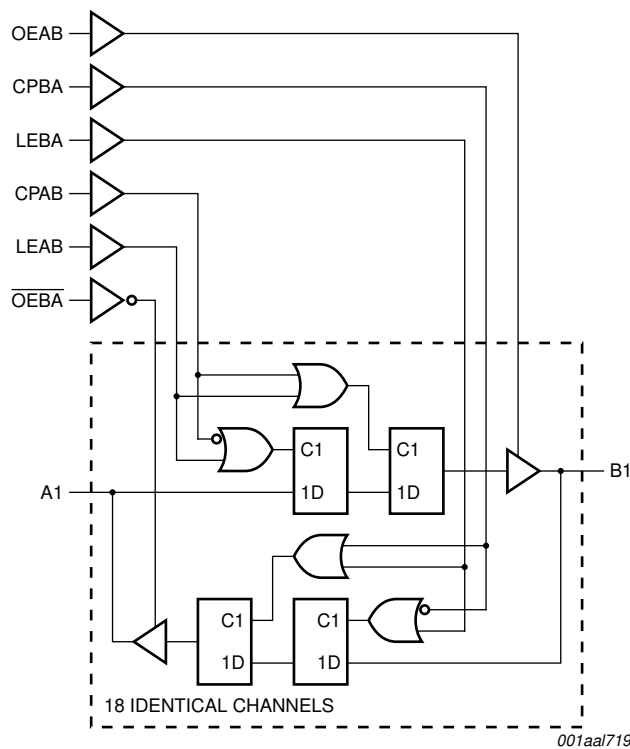
### 4. Functional diagram





001aal733

**Fig 3. Bus hold circuit**



001aal719

**Fig 4. Logic diagram**



## 5. Pinning information

### 5.1 Pinning

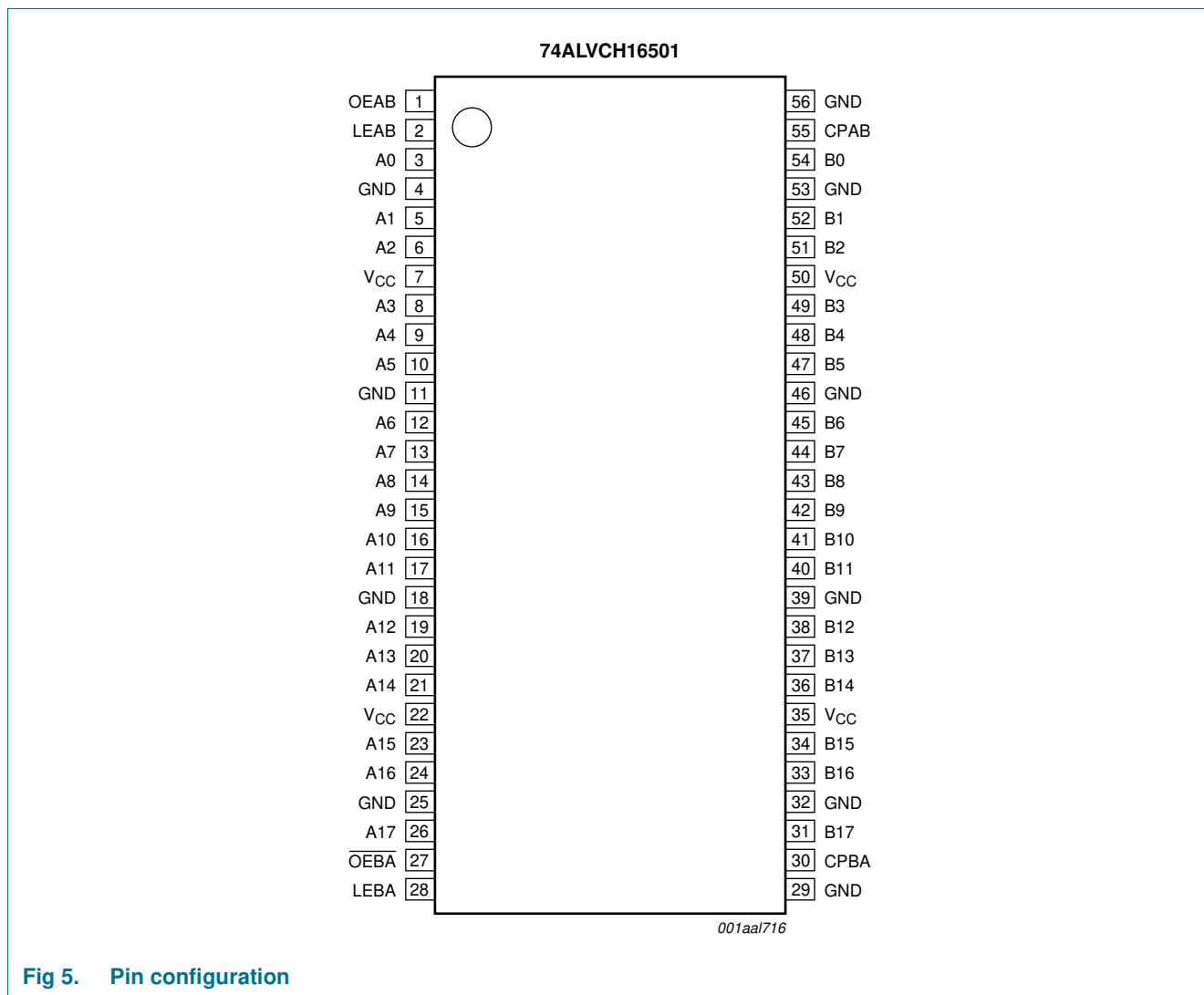


Fig 5. Pin configuration

### 5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
OEAB	1	output enable A-to-B input
LEAB	2	latch enable A-to-B input
A0 to A17	3, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16, 17, 19, 20, 21, 23, 24, 26	data inputs or outputs
GND	4, 11, 18, 25, 29, 32, 39, 46, 53, 56	ground (0 V)
V <sub>CC</sub>	7, 22, 35, 50	positive supply voltage
OEBA	27	output enable B-to-A
LEBA	28	latch enable B-to-A

Table 2. Pin description ...continued

Symbol	Pin	Description
CPBA	30	clock input B-to-A
B0 to B17	54, 52, 51, 49, 48, 47, 45, 44, 43, 42, 41, 40, 38, 37, 36, 34, 33, 31	data inputs or outputs
CPAB	55	clock input A-to-B

## 6. Functional description

### 6.1 Function table

Table 3. Function table<sup>[1]</sup>

Inputs				Output	Operating mode
OEAB	LEAB	CPAB	An	Bn	
L	X	X	X	Z	disabled
H	H	X	H	H	transparent
H	H	X	L	L	latch data and display
H	↓	X	h	H	
H	↓	X	l	L	clock data and display
H	L	↑	h	H	
H	L	↑	l	L	hold data and display
H	L	H or L	X	H	
H	L	H or L	X	L	

[1] A-to-B data flow is shown; B-to-A flow is similar but uses  $\overline{OEBA}$ , LEBA and CPBA.

- H = HIGH voltage level;
- h = HIGH voltage level one set-up time prior to the enable or clock transition;
- L = LOW voltage level;
- l = LOW voltage level one set-up time prior to the enable or clock transition;
- X = don't care;
- Z = high-impedance OFF-state;
- ↓ = HIGH-to-LOW clock transition;
- ↑ = 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
$I_{IK}$	input clamping current	$V_I < 0$ V	-50	-	mA
$V_I$	input voltage	control inputs	[1] -0.5	+4.6	V
		data inputs	[1] -0.5	$V_{CC} + 0.5$	V
$I_{OK}$	output clamping current	$V_O > V_{CC}$ or $V_O < 0$ V	-	±50	mA
$V_O$	output voltage		[1] -0.5	$V_{CC} + 0.5$	V
$I_O$	output current	$V_O = 0$ V to $V_{CC}$	-	±50	mA
$I_{CC}$	supply current		-	100	mA

**Table 4.** Limiting values ...continued

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
$I_{\text{GND}}$	ground current		-100	-	mA
$T_{\text{stg}}$	storage temperature		-65	+150	°C
$P_{\text{tot}}$	total power dissipation	$T_{\text{amb}} = -40\text{ °C to }+125\text{ °C}$			
		SSOP package	[2] -	850	mW
		TSSOP package	[3] -	600	mW

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

[2] Above 55 °C the value of  $P_{\text{tot}}$  derates linearly with 11.3 mW/K.

[3] Above 55 °C the value of  $P_{\text{tot}}$  derates linearly with 8 mW/K.

## 8. Recommended operating conditions

**Table 5.** Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{\text{CC}}$	supply voltage	maximum speed performance				
		$C_{\text{L}} = 30\text{ pF}$	2.3	-	2.7	V
		$C_{\text{L}} = 50\text{ pF}$	3.0	-	3.6	V
		low-voltage applications	1.2	-	3.6	V
$V_{\text{I}}$	input voltage		0	-	$V_{\text{CC}}$	V
$V_{\text{O}}$	output voltage		0	-	$V_{\text{CC}}$	V
$T_{\text{amb}}$	ambient temperature	in free air	-40	-	+85	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{\text{CC}} = 2.3\text{ V to }3.0\text{ V}$	0	-	20	ns/V
		$V_{\text{CC}} = 3.0\text{ V to }3.6\text{ V}$	0	-	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 <sup>[1]</sup>	Max	Unit
<b>T<sub>amb</sub> = -40 °C to +85 °C</b>						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.3 V to 2.7 V	1.7	1.2	-	V
		V <sub>CC</sub> = 2.7 V to 3.6 V	2.0	1.5	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.3 V to 2.7 V	-	1.2	0.7	V
		V <sub>CC</sub> = 2.7 V to 3.6 V	-	1.5	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; V <sub>CC</sub> = 2.3 V to 3.6 V	V <sub>CC</sub> - 0.2	V <sub>CC</sub>	-	V
		I <sub>O</sub> = -6 mA; V <sub>CC</sub> = 2.3 V	V <sub>CC</sub> - 0.3	V <sub>CC</sub> - 0.08	-	V
		I <sub>O</sub> = -12 mA; V <sub>CC</sub> = 2.3 V	V <sub>CC</sub> - 0.6	V <sub>CC</sub> - 0.26	-	V
		I <sub>O</sub> = -12 mA; V <sub>CC</sub> = 2.7 V	V <sub>CC</sub> - 0.5	V <sub>CC</sub> - 0.14	-	V
		I <sub>O</sub> = -12 mA; V <sub>CC</sub> = 3.0 V	V <sub>CC</sub> - 0.6	V <sub>CC</sub> - 0.09	-	V
		I <sub>O</sub> = -24 mA; V <sub>CC</sub> = 3.0 V	V <sub>CC</sub> - 1.0	V <sub>CC</sub> - 0.28	-	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; V <sub>CC</sub> = 2.3 V to 3.6 V	-	GND	0.20	V
		I <sub>O</sub> = 6 mA; V <sub>CC</sub> = 2.3 V	-	0.07	0.40	V
		I <sub>O</sub> = 12 mA; V <sub>CC</sub> = 2.3 V	-	0.15	0.70	V
		I <sub>O</sub> = 12 mA; V <sub>CC</sub> = 2.7 V	-	0.14	0.40	V
		I <sub>O</sub> = 24 mA; V <sub>CC</sub> = 3.0 V	-	0.27	0.55	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 2.3 V to 3.6 V	-	0.1	5	μA
I <sub>OZ</sub>	OFF-state output current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 2.7 V to 3.6 V	-	0.1	10	μA
I <sub>CC</sub>	supply current	V <sub>CC</sub> = 2.3 V to 3.6 V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A	-	0.2	40	μA
ΔI <sub>CC</sub>	additional supply current	per data I/O pin; V <sub>CC</sub> = 2.3 V to 3.6 V; V <sub>I</sub> = V <sub>CC</sub> - 0.6 V; I <sub>O</sub> = 0 A	-	150	750	μA
I <sub>BHL</sub>	bus hold LOW current	V <sub>CC</sub> = 2.3 V; V <sub>I</sub> = 0.7 V	<sup>[2]</sup> 45	-	-	μA
		V <sub>CC</sub> = 3.0 V; V <sub>I</sub> = 0.8 V	<sup>[2]</sup> 75	150	-	μA
I <sub>BHH</sub>	bus hold HIGH current	V <sub>CC</sub> = 2.3 V; V <sub>I</sub> = 1.7 V	<sup>[2]</sup> -45	-	-	μA
		V <sub>CC</sub> = 3.0 V; V <sub>I</sub> = 2.0 V	<sup>[2]</sup> -75	-175	-	μA
I <sub>BHLO</sub>	bus hold LOW overdrive current	V <sub>CC</sub> = 3.6 V	<sup>[2]</sup> 500	-	-	μA
I <sub>BHHO</sub>	bus hold HIGH overdrive current	V <sub>CC</sub> = 3.6 V	<sup>[2]</sup> -500	-	-	μA
C <sub>I</sub>	input capacitance		-	4.0	-	pF
C <sub>I/O</sub>	input/output capacitance		-	8.0	-	pF

[1] All typical values are measured at T<sub>amb</sub> = 25 °C.

[2] Valid for data inputs of bus hold parts only.

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V); test circuit [Figure 10](#).

Symbol	Parameter	Conditions	Min	Typ <sup>[1]</sup>	Max	Unit
<b>T<sub>amb</sub> = -40 °C to +85 °C</b>						
f <sub>max</sub>	maximum frequency	see <a href="#">Figure 8</a>				
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	150	333	- MHz
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	150	340	- MHz
		V <sub>CC</sub> = 2.7 V		150	333	- MHz
t <sub>pd</sub>	propagation delay	An to Bn; Bn to An; see <a href="#">Figure 6</a>	[4]			
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	1.0	2.8	5.1 ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	1.0	3.0	4.2 ns
		V <sub>CC</sub> = 2.7 V		-	3.0	4.6 ns
		LEAB, LEBA to Bn, An; see <a href="#">Figure 8</a>				
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	1.1	3.5	6.1 ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	1.3	3.4	4.8 ns
		V <sub>CC</sub> = 2.7 V		-	3.6	5.3 ns
		CPAB, CPBA to Bn, An; see <a href="#">Figure 8</a>				
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	1.0	3.3	6.1 ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	1.4	3.3	4.9 ns
		V <sub>CC</sub> = 2.7 V		-	3.4	5.6 ns
t <sub>en</sub>	enable time	OEBA to An; see <a href="#">Figure 7</a>	[4]			
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	1.3	2.8	6.3 ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	1.1	2.5	5.0 ns
		V <sub>CC</sub> = 2.7 V		-	3.3	6.0 ns
		OEAB to Bn; see <a href="#">Figure 7</a>				
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	1.0	2.5	5.8 ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	1.0	2.4	4.6 ns
		V <sub>CC</sub> = 2.7 V		-	2.7	5.3 ns
t <sub>dis</sub>	disable time	OEBA to An; see <a href="#">Figure 7</a>	[4]			
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	1.3	2.5	5.3 ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	1.3	3.1	4.2 ns
		V <sub>CC</sub> = 2.7 V		-	3.3	4.6 ns
		OEAB to Bn; see <a href="#">Figure 7</a>				
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	1.5	2.5	6.2 ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	1.4	2.9	5.0 ns
		V <sub>CC</sub> = 2.7 V		-	3.6	5.7 ns

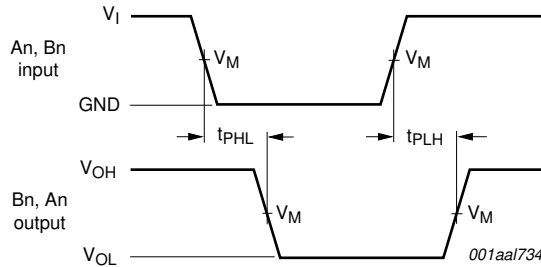
**Table 7. Dynamic characteristics ...continued**

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V); test circuit [Figure 10](#).

Symbol	Parameter	Conditions	Min	Typ <sup>[1]</sup>	Max	Unit	
t <sub>w</sub>	pulse width	LEAB, LEBA HIGH; see <a href="#">Figure 8</a>					
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	3.3	0.8	-	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	3.3	0.9	-	ns
		V <sub>CC</sub> = 2.7 V		3.3	0.7	-	ns
		CPAB, CPBA HIGH or LOW; see <a href="#">Figure 8</a>					
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	3.3	2.0	-	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	3.3	1.1	-	ns
		V <sub>CC</sub> = 2.7 V		3.3	1.4	-	ns
		t <sub>su</sub>	set-up time	An, Bn to CPAB, CPBA; see <a href="#">Figure 9</a>			
V <sub>CC</sub> = 2.3 V to 2.7 V	[2]			1.7	0.1	-	ns
V <sub>CC</sub> = 3.0 V to 3.6 V	[3]			1.3	-0.3	-	ns
V <sub>CC</sub> = 2.7 V				1.4	-0.1	-	ns
An, Bn to LEAB, LEBA; see <a href="#">Figure 9</a>							
V <sub>CC</sub> = 2.3 V to 2.7 V	[2]			1.1	0.1	-	ns
V <sub>CC</sub> = 3.0 V to 3.6 V	[3]			1.0	0.3	-	ns
V <sub>CC</sub> = 2.7 V				1.0	-0.2	-	ns
t <sub>h</sub>	hold time			An, Bn to CPAB, CPBA; see <a href="#">Figure 9</a>			
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	1.7	0.3	-	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	1.3	0.4	-	ns
		V <sub>CC</sub> = 2.7 V		1.6	0.3	-	ns
		An, Bn to LEAB, LEBA; see <a href="#">Figure 9</a>					
		V <sub>CC</sub> = 2.3 V to 2.7 V	[2]	1.6	0.3	-	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	[3]	1.2	0.1	-	ns
		V <sub>CC</sub> = 2.7 V		1.5	0.1	-	ns
		C <sub>PD</sub>	power dissipation capacitance	per buffer; V <sub>I</sub> = GND to V <sub>CC</sub>	[5]		
outputs enabled				-	21	-	pF
outputs disabled				-	3	-	pF

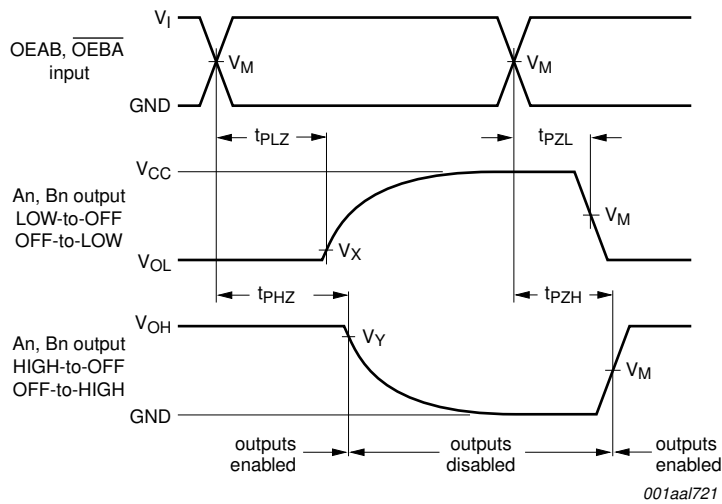
- [1] All typical values are measured at T<sub>amb</sub> = 25 °C.
- [2] Typical values are measured at V<sub>CC</sub> = 2.5 V.
- [3] Typical values are measured at V<sub>CC</sub> = 3.3 V.
- [4] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.  
t<sub>en</sub> is the same as t<sub>PZL</sub> and t<sub>PZH</sub>.  
t<sub>dis</sub> is the same as t<sub>PLZ</sub> and t<sub>PHZ</sub>.
- [5] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).  
P<sub>D</sub> = C<sub>PD</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>i</sub> × N + ∑ (C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) 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;  
∑ (C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of outputs.

11. Waveforms



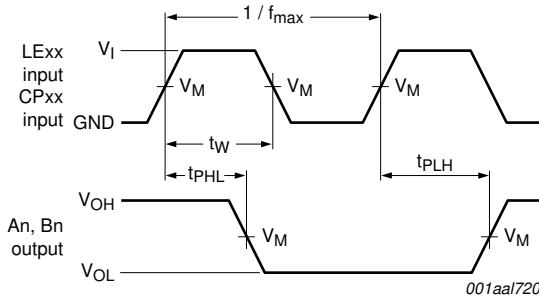
Measurement points are given in [Table 8](#).  
 $V_{OL}$  and  $V_{OH}$  are typical output levels that occur with the output load.

**Fig 6. Propagation delay, data input (An, Bn) to data output (Bn, An)**



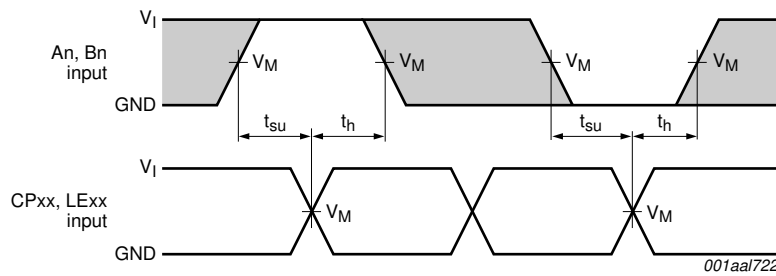
Measurement points are given in [Table 8](#).  
 $V_{OL}$  and  $V_{OH}$  are typical output levels that occur with the output load.

**Fig 7. 3-state output enable and disable times**



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

**Fig 8. Propagation delay, latch enable input (LEAB, LEBA) and clock pulse input (CPAB, CPBA) to data output, and pulse width**



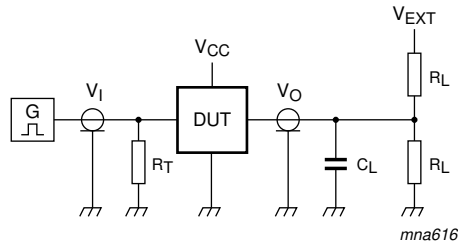
Measurement points are given in [Table 8](#).

**Fig 9. Data set-up and hold times (An, Bn inputs to LEAB, LEBA, CPAB and CPBA inputs)**

**Table 8. Measurement points**

Supply voltage	Input		Output		
	$V_I$	$V_M$	$V_M$	$V_X$	$V_Y$
2.3 V to 2.7 V and < 2.3 V	$V_{CC}$	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	$V_{OL} + 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$
2.7 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	2.7 V	1.5 V	1.5 V	$V_{OL} + 0.3 \text{ V}$	$V_{OH} - 0.3 \text{ V}$

## 12. Test information



Test data is given in [Table 9](#).

Definitions for test circuit:

$R_L$  = Load resistance.

$C_L$  = Load capacitance includes jig and probe capacitance.

$R_T$  = Termination resistance should be equal to  $Z_o$  of pulse generator.

$V_{EXT}$  = External voltage for measuring switching times.

**Fig 10. Load circuit for measuring switching times**

**Table 9. Test data**

Supply voltage	Input		Load		$V_{EXT}$		
$V_{CC}$	$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PLH}, t_{PHL}$	$t_{PLZ}, t_{PZL}$	$t_{PHZ}, t_{PZH}$
2.3 V to 2.7 V	$V_{CC}$	$\leq 2.0$ ns	30 pF	500 $\Omega$	open	$2 \times V_{CC}$	GND
2.7 V	2.7 V	2.5 ns	50 pF	500 $\Omega$	open	$2 \times V_{CC}$	GND
3.0 V to 3.6 V	2.7 V	2.5 ns	50 pF	500 $\Omega$	open	$2 \times V_{CC}$	GND



13. Package outline

TSSOP56: plastic thin shrink small outline package; 56 leads; body width 6.1 mm

SOT364-1

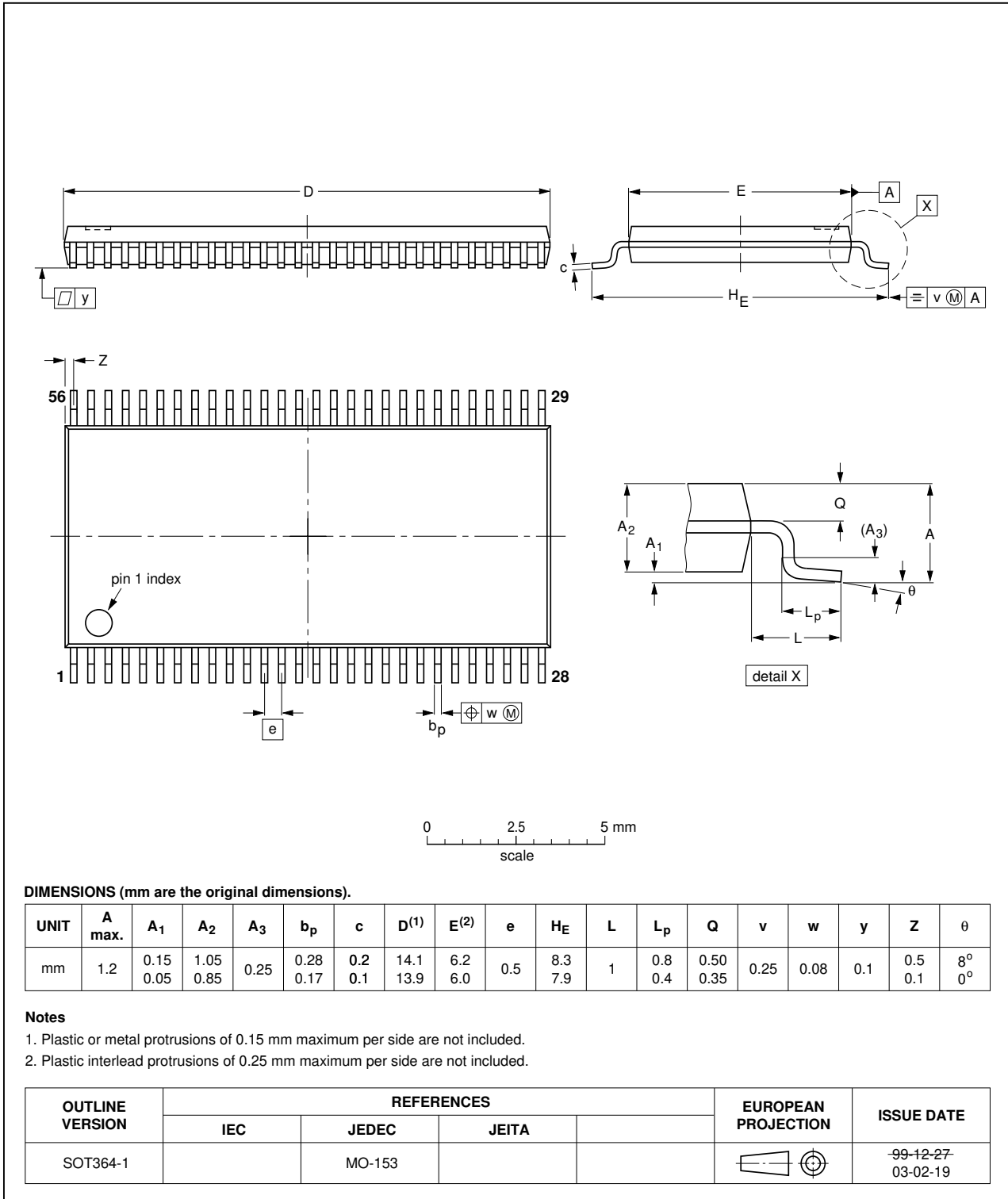


Fig 11. Package outline SOT364-1 (TSSOP56)

SSOP56: plastic shrink small outline package; 56 leads; body width 7.5 mm

SOT371-1

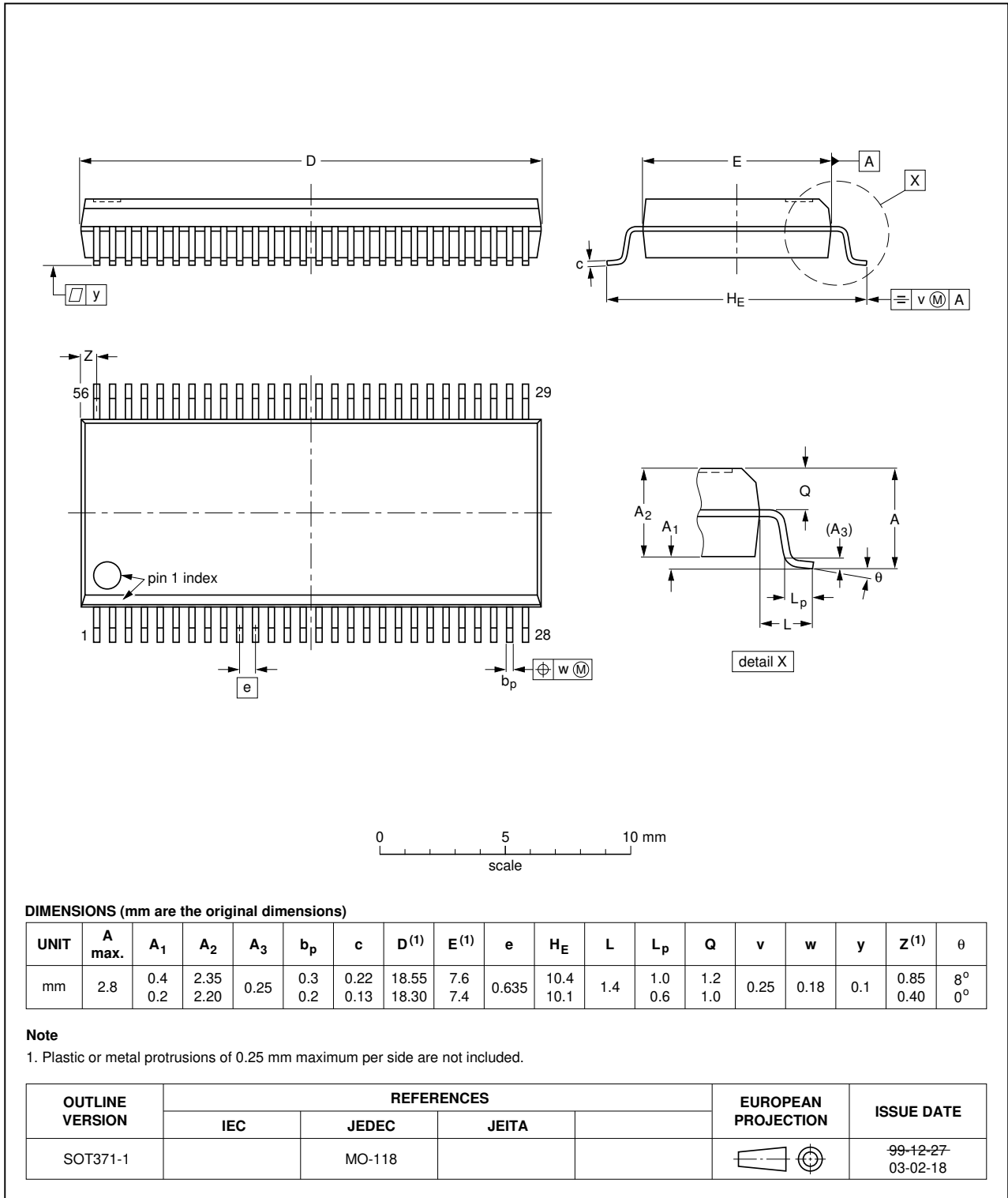


Fig 12. Package outline SOT371-1 (SSOP56)

## 14. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
TTL	Transistor-Transistor Logic

## 15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Order number	Supersedes
74ALVCH16501 v.5	20120710	Product data sheet	-	-	74ALVCH16501 v.4
Modifications:	• Table 8 corrected (errata).				
74ALVCH16501 v.4	20111117	Product data sheet	-	-	74ALVCH16501 v.3
Modifications:	• Legal pages updated.				
74ALVCH16501 v.3	20100402	Product data sheet	-	-	74ALVCH16501 v.2
74ALVCH16501 v.2	19980929	Product specification	-	-	74ALVCH16501 v.1
74ALVCH16501 v.1	19980929	Product specification	-	-	-

## 16. Legal information

### 16.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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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