

74ALVT16821

20-bit bus interface D-type flip-flop; positive-edge trigger;
3-state

Rev. 4 — 22 January 2018

Product data sheet

1 General description

The 74ALVT16821 high-performance BiCMOS device combines low static and dynamic power dissipation with high speed and high output drive. It is designed for V_{CC} operation at 2.5 V or 3.3 V with I/O compatibility to 5 V.

The 74ALVT16821 has two 10-bit, edge triggered registers, with each register coupled to a 3-state output buffer. The two sections of each register are controlled independently by the clock (nCP) and output enable ($n\overline{OE}$) control gates.

Each register is fully edge triggered. The state of each D input, one set-up time before the LOW-to-HIGH clock transition, is transferred to the corresponding flip-flops Q output.

The 3-state output buffers are designed to drive heavily loaded 3-state buses, MOS memories, or MOS microprocessors.

The active low output enable ($n\overline{OE}$) controls all ten 3-state buffers independent of the register operation. When $n\overline{OE}$ is LOW, the data in the register appears at the outputs. When $n\overline{OE}$ is HIGH, the outputs are in high-impedance OFF-state, which means they will neither drive nor load the bus.

2 Features and benefits

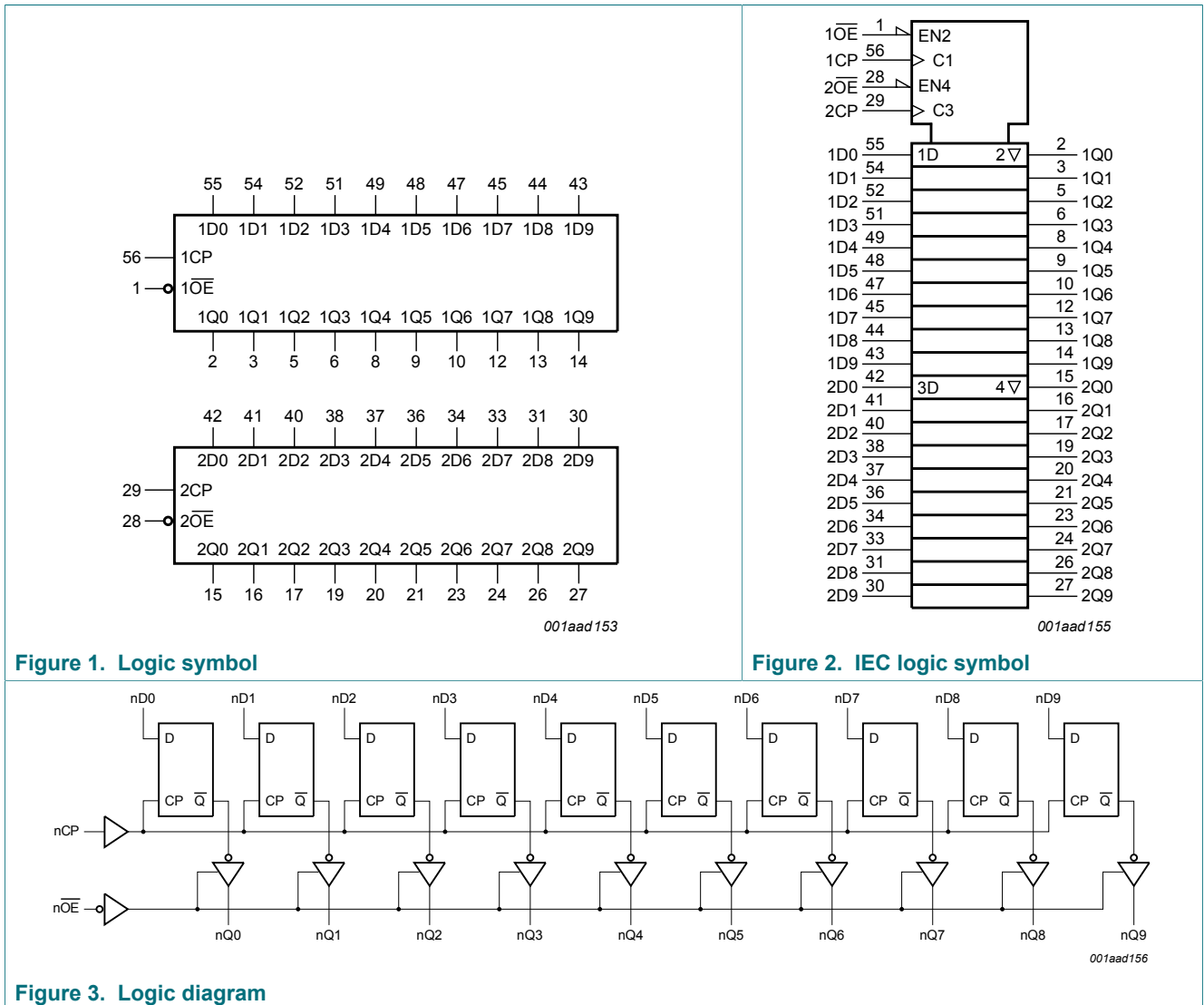
- 20-bit positive-edge triggered register
- 5 V I/O compatible
- Multiple V_{CC} and GND pins minimize switching noise
- Bus hold data inputs eliminate the need for external pull-up resistors to hold unused inputs
- Live insertion and extraction permitted
- Power-up reset
- Power-up 3-state
- Output capability: +64 mA and -32 mA
- Latch-up protection:
 - JESD78: exceeds 500 mA
- ESD protection:
 - MIL STD 883, method 3015: exceeds 2000 V
 - MM: exceeds 200 V

3 Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74ALVT16821DGG	-40 °C to +85 °C	TSSOP56	plastic thin shrink small outline package; 56 leads; body width 6.1 mm	SOT364-1

4 Functional diagram



5 Pinning information

5.1 Pinning

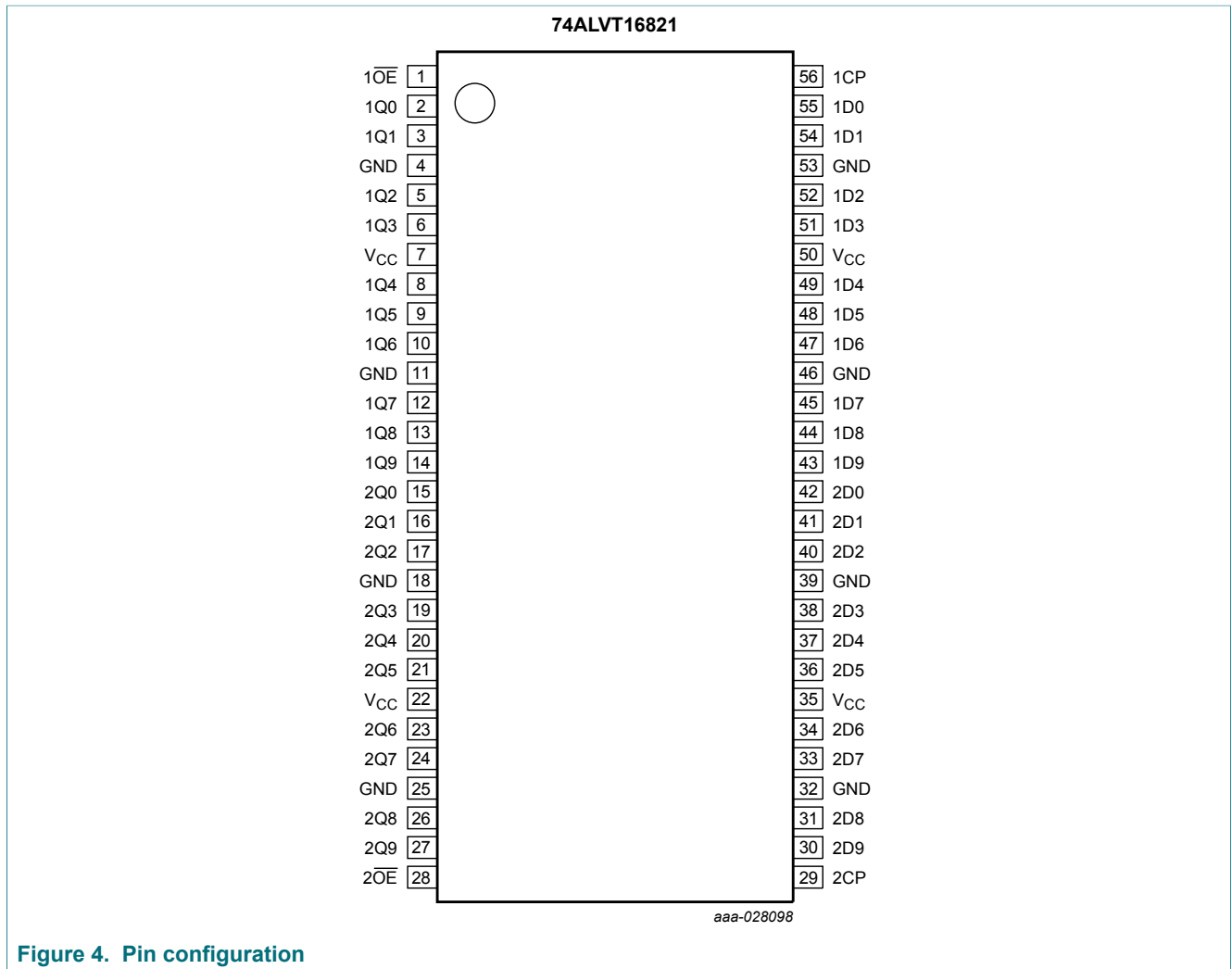


Figure 4. Pin configuration

5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1D0, 1D1, 1D2, 1D3, 1D4, 1D5, 1D6, 1D7, 1D8, 1D9	55, 54, 52, 51, 49, 48, 47, 45, 44, 43	data inputs
1Q0, 1Q1, 1Q2, 1Q3, 1Q4, 1Q5, 1Q6, 1Q7, 1Q8, 1Q9	2, 3, 5, 6, 8, 9, 10, 12, 13, 14	data outputs
2D0, 2D1, 2D2, 2D3, 2D4, 2D5, 2D6, 2D7, 2D8, 2D9	42, 41, 40, 38, 37, 36, 34, 33, 31, 30	data inputs
2Q0, 2Q1, 2Q2, 2Q3, 2Q4, 2Q5, 2Q6, 2Q7, 2Q8, 2Q9	15, 16, 17, 19, 20, 21, 23, 24, 26, 27	data outputs
1 \overline{OE} , 2 \overline{OE}	1, 28	output enable inputs (active LOW)
1CP, 2CP	56, 29	clock pulse inputs (active rising edge)
GND	4, 11, 18, 25, 32, 39, 46, 53	ground (0 V)
V _{CC}	7, 22, 35, 50	supply voltage

6 Functional description

Table 3. Function table ^[1]

Operating mode	Input			Internal register	Output
	nOE	nCP	nDn		
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 LOW-to-HIGH clock transition;
 L = LOW voltage level;
 l = LOW voltage level one set-up time prior to the LOW-to-HIGH 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).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		-0.5	+4.6	V
V_I	input voltage		[1] -1.2	+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

[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.

8 Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		Unit
			Min	Max	Min	Max	
V_{CC}	supply voltage		2.3	2.7	3.0	3.6	V
V_I	input voltage		0	5.5	0	5.5	V
I_{OH}	HIGH-level output current		-	-8	-	-32	mA
I_{OL}	LOW-level output current	none	-	8	-	32	mA
		current duty cycle $\leq 50\%$; $f \geq 1$ kHz	-	24	-	64	mA
$\Delta t/\Delta V$	input transition rise and fall rate	outputs enabled	-	10	-	10	ns/V
T_{amb}	ambient temperature	free-air	-40	+85	-40	+85	°C

9 Static characteristics

Table 6. Static characteristics

At recommended operating conditions; $T_{amb} = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Typ ^[1]	Max	Unit
$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$						
V_{IK}	input clamping voltage	$V_{CC} = 2.3\text{ V}$; $I_{IK} = -18\text{ mA}$	-	-0.85	-1.2	V
V_{IH}	HIGH-level input voltage		1.7	-	-	V
V_{IL}	LOW-level input voltage		-	-	0.7	V
V_{OH}	HIGH-level output voltage	$V_{CC} = 2.3\text{ V}$ to 3.6 V ; $I_O = -100\text{ }\mu\text{A}$	$V_{CC} - 0.2$	V_{CC}	-	V
		$V_{CC} = 2.3\text{ V}$; $I_O = -8\text{ mA}$	1.8	2.1	-	V
V_{OL}	LOW-level output voltage	$V_{CC} = 2.3\text{ V}$; $I_O = 100\text{ }\mu\text{A}$	-	0.07	0.2	V
		$V_{CC} = 2.3\text{ V}$; $I_O = 24\text{ mA}$	-	0.3	0.5	V
		$V_{CC} = 2.3\text{ V}$; $I_O = 8\text{ mA}$	-	-	0.4	V
$V_{OL(pu)}$	power-up LOW-level output voltage	$V_{CC} = 2.7\text{ V}$; $I_O = 1\text{ mA}$; $V_I = V_{CC}$ or GND ^[2]	-	-	0.55	V
I_I	input leakage current	all input pins				
		$V_{CC} = 0\text{ V}$ or 2.7 V ; $V_I = 5.5\text{ V}$ ^[3]	-	0.1	10	μA
		control pins				
		$V_{CC} = 2.7\text{ V}$; $V_I = V_{CC}$ or GND	-	0.1	± 1	μA
		data pins; ^[3]				
		$V_{CC} = 2.7\text{ V}$; $V_I = V_{CC}$	-	0.1	1	μA
	$V_{CC} = 2.7\text{ V}$; $V_I = 0\text{ V}$	-	0.1	-5	μA	
I_{OFF}	power-off leakage current	$V_{CC} = 0\text{ V}$; V_I or $V_O = 0\text{ V}$ to 4.5 V	-	0.1	± 100	μA
I_{BHL}	bus hold LOW current	data inputs; $V_{CC} = 2.3\text{ V}$; $V_I = 0.7\text{ V}$	-	90	-	μA
I_{BHH}	bus hold HIGH current	data inputs; $V_{CC} = 2.3\text{ V}$; $V_I = 1.7\text{ V}$	-	-10	-	μA
I_{EX}	external current	output in HIGH-state; $V_O = 5.5\text{ V}$; $V_{CC} = 2.3\text{ V}$	-	10	125	μA
$I_{O(pu/pd)}$	power-up/power-down output current	$V_{CC} \leq 1.2\text{ V}$; $V_O = 0.5\text{ V}$ to V_{CC} ; $V_I = \text{GND}$ or V_{CC} ; $nOE = \text{don't care}$ ^[4]	-	1	± 100	μA
I_{OZ}	OFF-state output current	$V_{CC} = 2.7\text{ V}$; $V_I = V_{IL}$ or V_{IH}				
		output HIGH-state; $V_O = 2.3\text{ V}$	-	0.5	5	μA
		output LOW-state; $V_O = 0.5\text{ V}$	-	0.5	-5	μA
I_{CC}	supply current	$V_{CC} = 2.7\text{ V}$; $V_I = \text{GND}$ or V_{CC} ; $I_O = 0\text{ A}$				
		outputs HIGH-state	-	0.04	0.1	mA
		outputs LOW-state	-	2.3	4.5	mA
		outputs disabled ^[5]		0.04	0.1	mA
ΔI_{CC}	additional supply current	per input pin; $V_{CC} = 2.3\text{ V}$ to 2.7 V ; one input at $V_{CC} - 0.6\text{ V}$; other inputs at V_{CC} or GND ^[6]	-	0.04	0.4	mA
C_I	input capacitance	$V_I = 0\text{ V}$ or V_{CC}	-	3	-	pF
C_O	output capacitance	$V_O = 0\text{ V}$ or V_{CC}	-	9	-	pF

20-bit bus interface D-type flip-flop; positive-edge trigger; 3-state

Symbol	Parameter	Conditions	Min	Typ ^[1]	Max	Unit	
V_{CC} = 3.3 V ± 0.3 V							
V _{IK}	input clamping voltage	V _{CC} = 3.0 V; I _{IK} = -18 mA	-	-0.85	-1.2	V	
V _{IH}	HIGH-level input voltage		2.0	-	-	V	
V _{IL}	LOW-level input voltage		-	-	0.8	V	
V _{OH}	HIGH-level output voltage	V _{CC} = 3.0 V to 3.6 V; I _O = -100 μA	V _{CC} - 0.2	V _{CC}	-	V	
		V _{CC} = 3.0 V; I _O = -32 mA	2.0	2.3	-	V	
V _{OL}	LOW-level output voltage	V _{CC} = 3.0 V					
		I _O = 100 μA	-	0.07	0.2	V	
		I _O = 16 mA	-	0.25	0.4	V	
		I _O = 32 mA	-	0.3	0.5	V	
V _{OL(pu)}	power-up LOW-level output voltage	I _O = 64 mA	-	0.4	0.55	V	
		V _{CC} = 3.6 V; I _O = 1 mA; V _I = V _{CC} or GND	[2]	-	-	0.55	V
I _I	input leakage current	all input pins;	[3]				
		V _{CC} = 0 V or 3.6 V; V _I = 5.5 V	-	0.1	10	μA	
		control pins					
		V _{CC} = 3.6 V; V _I = V _{CC} or GND	-	0.1	±1	μA	
		data pins;	[3]				
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	
		V _{CC} = 3.6 V; V _I = V _{CC}	-	0.5	1	μA	
I _{BHL}	bus hold LOW current	data inputs; V _{CC} = 3 V; V _I = 0.8 V	75	130	-	μA	
I _{BHH}	bus hold HIGH current	data inputs; V _{CC} = 3 V; V _I = 2.0 V	-75	-140	-	μA	
I _{BHLO}	bus hold LOW overdrive current	data inputs; V _{CC} = 3.6 V; V _I = 0 V to 3.6 V	[7]	500	-	μA	
I _{BHHO}	bus hold HIGH overdrive current	data inputs; V _{CC} = 3.6 V; V _I = 0 V to 3.6 V	[7]	-500	-	μA	
I _{EX}	external current	output in HIGH-state when V _O > V _{CC} ; V _O = 5.5 V; V _{CC} = 3.0 V	-	10	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} ; n \overline{OE} = don't care	[8]	-	1	±100	μA
I _{OZ}	OFF-state output current	V _{CC} = 3.6 V; V _I = V _{IL} or V _{IH}					
		output HIGH-state; V _O = 3.0 V	-	0.5	5	μA	
		output LOW-state; V _O = 0.5 V	-	0.5	-5	μA	
I _{CC}	supply current	V _{CC} = 3.6 V; V _I = GND or V _{CC} ; I _O = 0 A					
		outputs HIGH-state	-	0.07	0.1	mA	
		outputs LOW-state	-	5.1	7	mA	
		outputs disabled	[5]	-	0.07	0.1	mA

Symbol	Parameter	Conditions	Min	Typ ^[1]	Max	Unit
ΔI_{CC}	additional supply current	per input pin; $V_{CC} = 3\text{ V to }3.6\text{ V}$; one input at $V_{CC} - 0.6\text{ V}$; other inputs at V_{CC} or GND ^[6]	-	0.04	0.4	mA
C_I	input capacitance	$V_I = 0\text{ V or }V_{CC}$	-	3	-	pF
C_O	output capacitance	$V_O = 0\text{ V or }V_{CC}$	-	9	-	pF

- [1] All typical values for $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ are measured at $V_{CC} = 2.5\text{ V}$ and $T_{amb} = 25\text{ }^\circ\text{C}$.
All typical values for $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ are measured at $V_{CC} = 3.3\text{ V}$ and $T_{amb} = 25\text{ }^\circ\text{C}$.
- [2] For valid test results, data must not be loaded into the flip-flops (or latches) after applying power.
- [3] Unused pins at V_{CC} or GND.
- [4] 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 $V_{CC} = 1.2\text{ V}$ to $(2.5 \pm 0.2)\text{ V}$ a transition time of 100 μs is permitted. This parameter is valid for $T_{amb} = 25\text{ }^\circ\text{C}$ only.
- [5] I_{CC} with outputs disabled is measured with outputs pulled to V_{CC} or GND.
- [6] This is the increase in supply current for each input at the specified voltage level other than V_{CC} or GND.
- [7] This is the bus hold overdrive current required to force the input to the opposite logic state.
- [8] 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 $V_{CC} = 1.2\text{ V}$ to $(3.3 \pm 0.3)\text{ V}$ a transition time of 100 μs is permitted. This parameter is valid for $T_{amb} = 25\text{ }^\circ\text{C}$ only.

10 Dynamic characteristics

Table 7. Dynamic characteristics

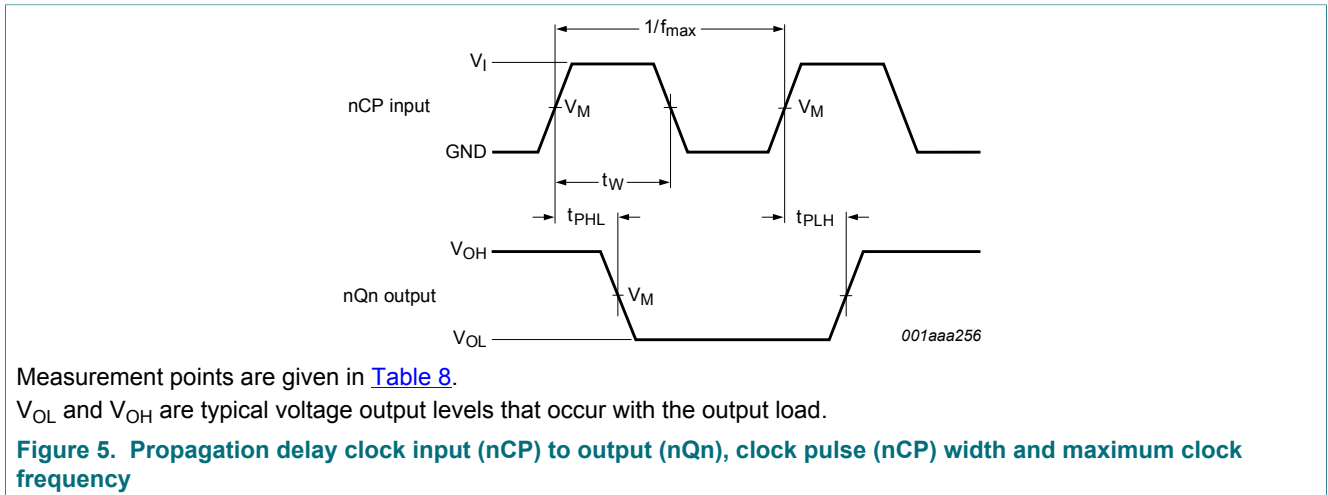
Voltages are referenced to GND (ground = 0 V); $T_{amb} = -40\text{ }^\circ\text{C to }+85\text{ }^\circ\text{C}$; for test circuit see [Figure 8](#).

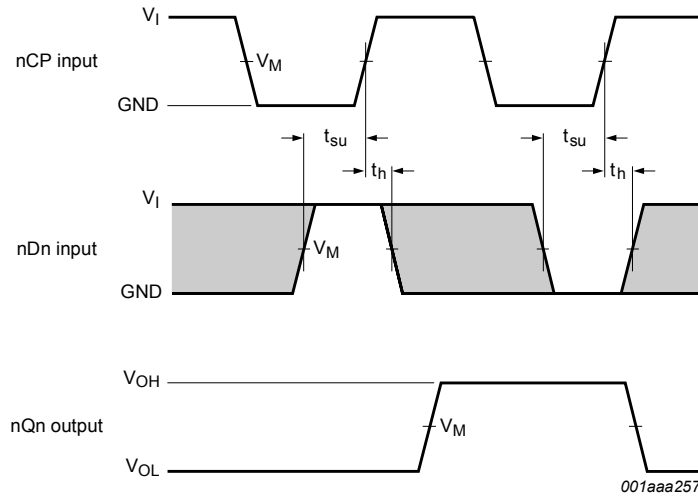
Symbol	Parameter	Conditions	Min	Typ ^[1]	Max	Unit
$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$						
t_{PLH}	LOW to HIGH propagation delay	nCP to nQn; see Figure 5	1.0	2.6	4.0	ns
t_{PHL}	HIGH to LOW propagation delay	nCP to nQn; see Figure 5	1.0	2.7	4.4	ns
t_{PZH}	OFF-state to HIGH propagation delay	$n\overline{OE}$ to nQn; see Figure 7	1.5	2.8	4.6	ns
t_{PZL}	OFF-state to LOW propagation delay	$n\overline{OE}$ to nQn; see Figure 7	1.0	1.8	4.1	ns
t_{PHZ}	HIGH to OFF-state propagation delay	$n\overline{OE}$ to nQn; see Figure 7	1.5	2.7	4.4	ns
t_{PLZ}	LOW to OFF-state propagation delay	$n\overline{OE}$ to nQn; see Figure 7	1.0	2.1	3.3	ns
t_{su}	set-up time	nDn to nCP; HIGH; see Figure 6	1.5	0.1	-	ns
		nDn to nCP; LOW; see Figure 6	2.0	0.5	-	ns
t_h	hold time	nDn to nCP; HIGH; see Figure 6	0.3	-0.5	-	ns
		nDn to nCP; LOW; see Figure 6	0.5	-0.1	-	ns
t_W	pulse width	nCP HIGH; see Figure 5	1.5	-	-	ns
		nCP LOW	1.5	-	-	ns
f_{max}	maximum frequency	nCP; see Figure 5	150	-	-	MHz

Symbol	Parameter	Conditions	Min	Typ ^[1]	Max	Unit
V_{CC} = 3.3 V ± 0.3 V						
t _{PLH}	LOW to HIGH propagation delay	nCP to nQn; see Figure 5	0.5	1.7	3.0	ns
t _{PHL}	HIGH to LOW propagation delay	nCP to nQn; see Figure 5	0.5	1.8	3.2	ns
t _{PZH}	OFF-state to HIGH propagation delay	n \overline{OE} to nQn; see Figure 7	1.0	2.1	3.5	ns
t _{PZL}	OFF-state to LOW propagation delay	n \overline{OE} to nQn; see Figure 7	0.5	1.4	3.0	ns
t _{PHZ}	HIGH to OFF-state propagation delay	n \overline{OE} to nQn; see Figure 7	1.5	2.9	4.2	ns
t _{PLZ}	LOW to OFF-state propagation delay	n \overline{OE} to nQn; see Figure 7	1.5	2.4	3.4	ns
t _{su}	set-up time	nDn to nCP; HIGH; see Figure 6	1.5	0.1	-	ns
		nDn to nCP; LOW; see Figure 6	1.5	0.1	-	ns
t _h	hold time	nDn to nCP; HIGH; see Figure 6	0.5	0.1	-	ns
		nDn to nCP; LOW; see Figure 6	0.5	0.1	-	ns
t _w	pulse width	nCP HIGH; see Figure 5	1.5	-	-	ns
		nCP LOW	1.5	-	-	ns
f _{max}	maximum frequency	nCP; see Figure 5	150	-	-	MHz

[1] All typical values for V_{CC} = 2.5 V ± 0.2 V are measured at V_{CC} = 2.5 V and T_{amb} = 25 °C.
 All typical values for V_{CC} = 3.3 V ± 0.3 V are measured at V_{CC} = 3.3 V and T_{amb} = 25 °C.

10.1 Waveforms and test circuit



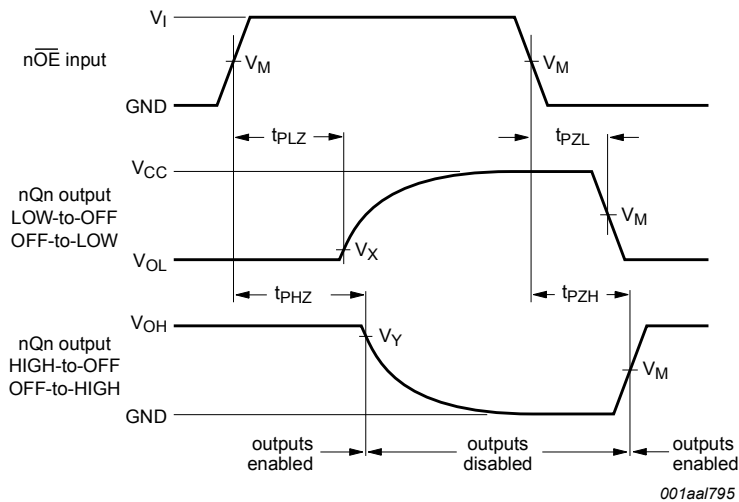


Measurement points are given in [Table 8](#).

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

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

Figure 6. Set-up times and hold times data input (nDn) to clock input (nCP)



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

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

Figure 7. OFF-state to HIGH and LOW propagation delays and LOW and HIGH to OFF-state propagation delays

Table 8. Measurement points

V_{CC}	Input	Output		
	V_M	V_M	V_X	V_Y
$V_{CC} \leq 2.7 \text{ V}$	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	$V_{OL} + 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$
$V_{CC} \geq 3.0 \text{ V}$	1.5 V	1.5 V	$V_{OL} + 0.3 \text{ V}$	$V_{OH} - 0.3 \text{ V}$

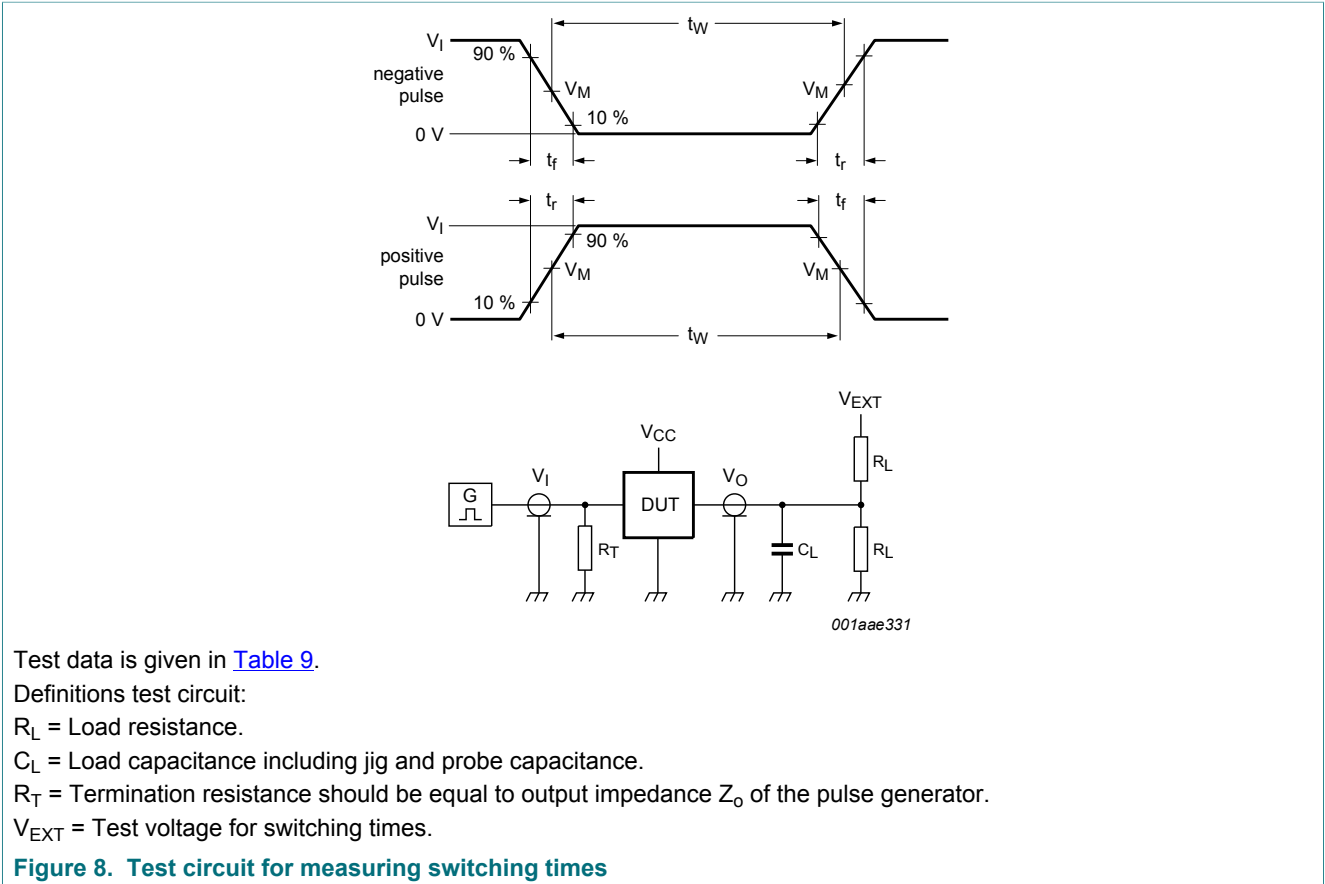


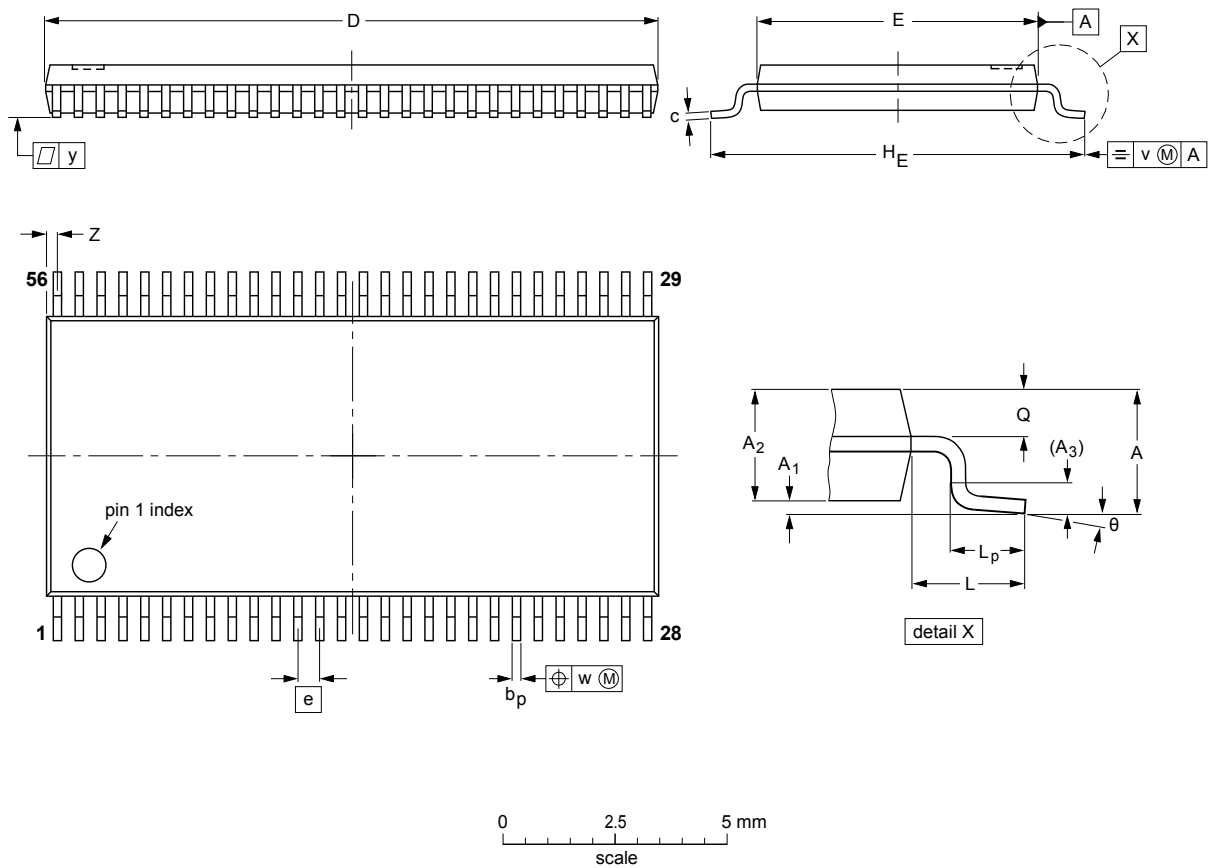
Table 9. Test data

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}
3.0 V or V_{CC} whichever is less	≤ 10 MHz	500 ns	≤ 2.5 ns	50 pF	500 Ω	GND	6 V or $V_{CC} \times 2$	open

11 Package outline

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

SOT364-1



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	14.1 13.9	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	0.5 0.1	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			
SOT364-1		MO-153				99-12-27 03-02-19

Figure 9. Package outline SOT364-1 (TSSOP56)

12 Abbreviations

Table 10. Abbreviations

Acronym	Description
BICMOS	Bipolar Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
MIL	Military
MM	Machine Model
MOS	Metal Oxide Semiconductor

13 Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74ALVT16821 v.4	20180122	Product data sheet	-	74ALVT16821 v.3
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. Type number 74ALVT16821DL (SOT371-1 / SSOP56) removed. 			
74ALVT16821 v.3	20050613	Product data sheet	-	74ALVT16821 v.2
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors. Section 2: modified 'JEDEC Std 17' into 'JESD78'. Section 9: changed maximum values of propagation delay, output enable time and output disable time. 			
74ALVT16821 v.2	19980213	Product specification	-	74ALVT16821 v.1
74ALVT16821 v.1	19970501	Product specification	-	-

14 Legal information

14.1 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.nexperia.com>.

14.2 Definitions

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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	4
6	Functional description	4
7	Limiting values	5
8	Recommended operating conditions	5
9	Static characteristics	6
10	Dynamic characteristics	8
10.1	Waveforms and test circuit	9
11	Package outline	12
12	Abbreviations	13
13	Revision history	13
14	Legal information	14

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