

DATA SHEET

74ALVT16245

**2.5V/3.3V ALVT 16-bit transceiver
(3-State)**

Product specification
Supersedes data of 1995 Nov 01
IC23 Data Handbook

1998 Feb 13

2.5V/3.3V 16-bit transceiver (3-State)

74ALVT16245

FEATURES

- 16-bit bidirectional bus interface
- 5V I/O Compatible
- 3-State buffers
- Output capability: +64mA/–32mA
- TTL input and output switching levels
- Bus-hold data inputs eliminate the need for external pull-up resistors to hold unused inputs
- Live insertion/extraction permitted
- Power-up 3-State
- No bus current loading when output is tied to 5V bus
- Latch-up protection exceeds 500mA per JEDEC Std 17
- ESD protection exceeds 2000V per MIL STD 883 Method 3015 and 400V per Machine Model

DESCRIPTION

The 74ALVT16245 is a high-performance BiCMOS product designed for V_{CC} operation at 2.5V or 3.3V with I/O compatibility up to 5V.

This device is a 16-bit transceiver featuring non-inverting 3-State bus compatible outputs in both send and receive directions. The control function implementation minimizes external timing requirements. The device features an Output Enable ($\overline{OE}$) input for easy cascading and a Direction (DIR) input for direction control.

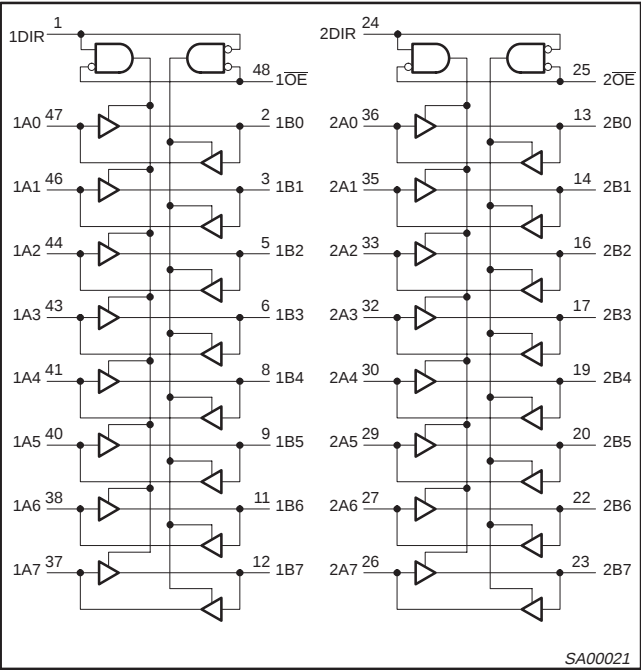
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS $T_{amb} = 25^{\circ}\text{C}$	TYPICAL		UNIT
			2.5V	3.3V	
t_{PLH} t_{PHL}	Propagation delay nAx to nBx or nBx to nAx	$C_L = 50\text{pF}$	1.7 1.9	1.5 1.5	ns
C_{IN}	Input capacitance DIR, $\overline{OE}$	$V_I = 0\text{V}$ or V_{CC}	3	3	pF
$C_{I/O}$	I/O pin capacitance	$V_{I/O} = 0\text{V}$ or V_{CC}	9	9	pF
I_{CCZ}	Total supply current	Outputs disabled	40	70	μA

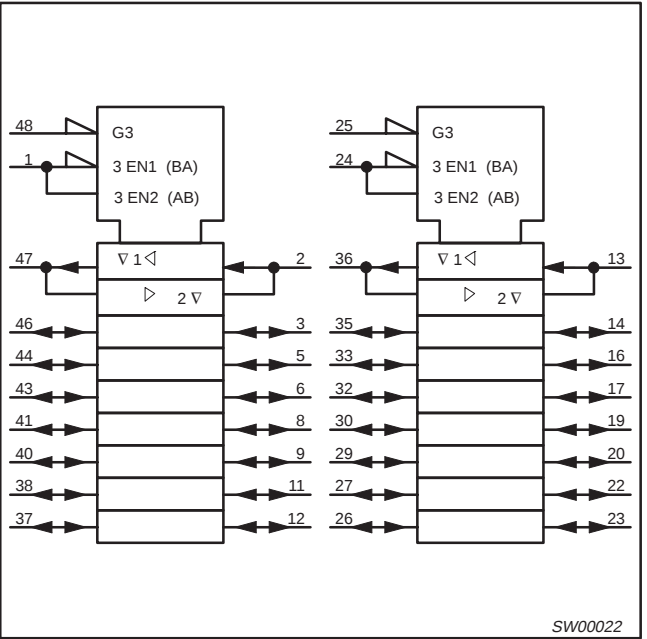
ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	DWG NUMBER
48-Pin Plastic SSOP Type III	–40°C to +85°C	74ALVT16245 DL	AV16245 DL	SOT370-1
48-Pin Plastic TSSOP Type II	–40°C to +85°C	74ALVT16245 DGG	AV16245 DGG	SOT362-1

LOGIC SYMBOL



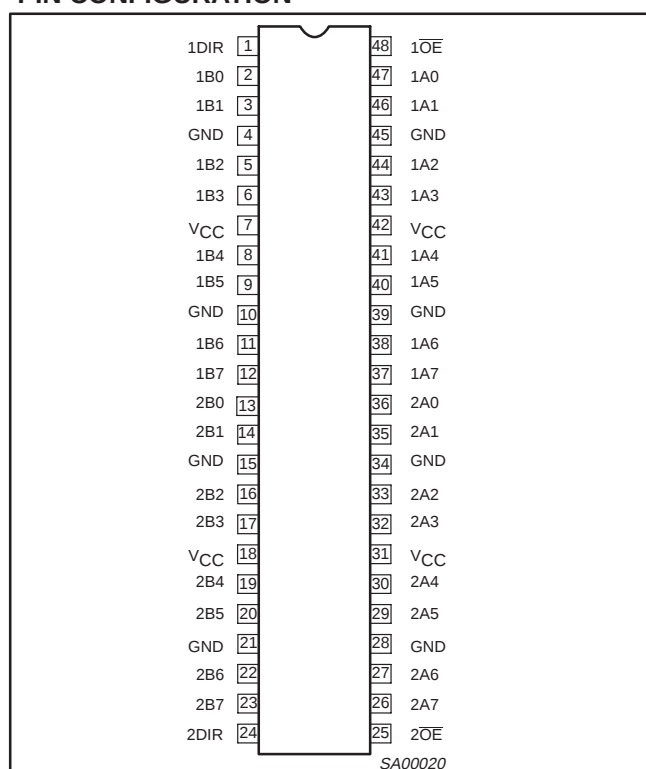
LOGIC SYMBOL (IEEE/IEC)



2.5V/3.3V 16-bit transceiver (3-State)

74ALVT16245

PIN CONFIGURATION



PIN DESCRIPTION

PIN NUMBER	SYMBOL	NAME AND FUNCTION
1, 24	nDIR	Direction control input
47, 46, 44, 43, 41, 40, 38, 37, 36, 35, 33, 32, 30, 29, 27, 26	nA0 – nA7	Data inputs/outputs (A side)
2, 3, 5, 6, 8, 9, 11, 12, 13, 14, 16, 17, 19, 20, 22, 23	nB0 – nB7	Data inputs/outputs (B side)
25, 48	nOE	Output enable input (active-Low)
4, 10, 15, 21, 28, 34, 39, 45	GND	Ground (0V)
7, 18, 31, 42	V _{CC}	Positive supply voltage

FUNCTION TABLE

INPUTS		INPUTS/OUTPUTS	
nOE	nDIR	nAx	nBx
L	L	nAx = nBx	Inputs
L	H	Inputs	nBx = nAx
H	X	Z	Z

H = High voltage level

L = Low voltage level

X = Don't care

Z = High Impedance "off" state

ABSOLUTE MAXIMUM RATINGS^{1, 2}

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
V _{CC}	DC supply voltage		–0.5 to +4.6	V
I _{IK}	DC input diode current	V _I < 0	–50	mA
V _I	DC input voltage ³		–0.5 to +7.0	V
I _{OK}	DC output diode current	V _O < 0	–50	mA
V _{OUT}	DC output voltage ³	Output in Off or High state	–0.5 to +7.0	V
I _{OUT}	DC output current	Output in Low state	128	mA
		Output in High state	–64	
T _{stg}	Storage temperature range		–65 to +150	°C

NOTES:

- Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- The performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability. The maximum junction temperature of this integrated circuit should not exceed 150°C.
- The input and output negative voltage ratings may be exceeded if the input and output clamp current ratings are observed.

2.5V/3.3V 16-bit transceiver (3-State)

74ALVT16245

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	2.5V RANGE LIMITS		3.3V RANGE LIMITS		UNIT
		MIN	MAX	MIN	MAX	
V_{CC}	DC supply voltage	2.3	2.7	3.0	3.6	V
V_I	Input voltage	0	5.5	0	5.5	V
V_{IH}	High-level input voltage	1.7		2.0		V
V_{IL}	Input voltage		0.7		0.8	V
I_{OH}	High-level output current		-8		-32	mA
I_{OL}	Low-level output current		8		32	mA
	Low-level output current; current duty cycle $\leq 50\%$; $f \geq 1$ kHz		24		64	
$\Delta t/\Delta v$	Input transition rise or fall rate; Outputs enabled		10		10	ns/V
T_{amb}	Operating free-air temperature range	-40	+85	-40	+85	°C

DC ELECTRICAL CHARACTERISTICS (3.3V $\pm$ 0.3V RANGE)

SYMBOL	PARAMETER	TEST CONDITIONS		LIMITS			UNIT
				Temp = -40°C to +85°C			
				MIN	TYP ¹	MAX	
V _{IK}	Input clamp voltage	V _{CC} = 3.0V; I _{IK} = −18mA			−0.85	−1.2	V
V _{OH}	High-level output voltage	V _{CC} = 3.0 to 3.6V; I _{OH} = −100μA		V _{CC} −0.2	V _{CC}		V
		V _{CC} = 3.0V; I _{OH} = −32mA		2.0	2.3		
V _{OL}	Low-level output voltage	V _{CC} = 3.0V; I _{OL} = 100μA			0.07	0.2	V
		V _{CC} = 3.0V; I _{OL} = 16mA			0.25	0.4	
		V _{CC} = 3.0V; I _{OL} = 32mA			0.3	0.5	
		V _{CC} = 3.0V; I _{OL} = 64mA			0.4	0.55	
I _I	Input leakage current	V _{CC} = 3.6V; V _I = V _{CC} or GND	Control pins		0.1	±1	μA
		V _{CC} = 0 or 3.6V; V _I = 5.5V			0.1	10	
		V _{CC} = 3.6V; V _I = 5.5V	Data pins ⁴		0.1	20	
		V _{CC} = 3.6V; V _I = V _{CC}			0.5	10	
		V _{CC} = 3.6V; V _I = 0			0.1	−5	
I _{OFF}	Off current	V _{CC} = 0V; V _I or V _O = 0 to 4.5V			0.1	±100	μA
I _{HOLD}	Bus Hold current A or B ports ⁶	V _{CC} = 3V; V _I = 0.8V		75	130		μA
		V _{CC} = 3V; V _I = 2.0V		−75	−140		
		V _{CC} = 0V to 3.6V; V _{CC} = 3.6V		±500			
I _{EX}	Current into an output in the High state when V _O > V _{CC}	V _O = 5.5V; V _{CC} = 3.0V			50	125	μA
I _{PU/PD}	Power up/down 3-State output current ³	V _{CC} ≤ 1.2V; V _O = 0.5V to V _{CC} ; V _I = GND or V _{CC} ; OE/OE = Don't care			40	±100	μA
I _{CCH}	Quiescent supply current	V _{CC} = 3.6V; Outputs High, V _I = GND or V _{CC} , I _O = 0			0.07	0.1	mA
I _{CCL}		V _{CC} = 3.6V; Outputs Low, V _I = GND or V _{CC} , I _O = 0			3.2	5	
I _{CCZ}		V _{CC} = 3.6V; Outputs Disabled; V _I = GND or V _{CC} , I _O = 0 ⁵			0.07	0.1	
ΔI _{CC}	Additional supply current per input pin ²	V _{CC} = 3V to 3.6V; One input at V _{CC} −0.6V, Other inputs at V _{CC} or GND			0.2	0.4	mA

NOTES:

1. All typical values are at $V_{CC} = 3.3V$ and $T_{amb} = 25^\circ C$.
2. This is the increase in supply current for each input at the specified voltage level other than V_{CC} or GND.
3. This parameter is valid for any V_{CC} between 0V and 1.2V with a transition time of up to 10msec. From $V_{CC} = 1.2V$ to $V_{CC} = 3.3V \pm 0.3V$ a transition time of 100 μ sec is permitted. This parameter is valid for $T_{amb} = 25^\circ C$ only.
4. Unused pins at V_{CC} or GND.
5. I_{CCZ} is measured with outputs pulled up to V_{CC} or pulled down to ground.
6. This is the bus hold overdrive current required to force the input to the opposite logic state.

2.5V/3.3V 16-bit transceiver (3-State)

74ALVT16245

AC CHARACTERISTICS (3.3V ± 0.3V RANGE)GND = 0V; $t_R = t_F = 2.5\text{ns}$; $C_L = 50\text{pF}$; $R_L = 500\Omega$; $T_{\text{amb}} = -40^\circ\text{C}$ to $+85^\circ\text{C}$.

SYMBOL	PARAMETER	WAVEFORM	LIMITS			UNIT
			V _{CC} = 3.3V ±0.3V			
			MIN	TYP ¹	MAX	
t _{PLH} t _{PHL}	Propagation delay nAx to nBx or nBx to nAx	1	0.5 0.5	1.5 1.5	2.4 2.4	ns
t _{PZH} t _{PZL}	Output enable time to High and Low level	2	1.0 1.0	2.1 1.7	3.5 2.9	ns
t _{PHZ} t _{PLZ}	Output disable time from High and Low Level	2	1.5 1.5	3.4 2.8	4.5 3.7	ns

NOTE:1. All typical values are at $V_{CC} = 3.3\text{V}$ and $T_{\text{amb}} = 25^\circ\text{C}$.**DC ELECTRICAL CHARACTERISTICS (2.5V ± 0.2V RANGE)**

SYMBOL	PARAMETER	TEST CONDITIONS		LIMITS			UNIT
				Temp = -40°C to +85°C			
				MIN	TYP ¹	MAX	
V _{IK}	Input clamp voltage	V _{CC} = 2.3V; I _{IK} = -18mA			-0.85	-1.2	V
V _{OH}	High-level output voltage	V _{CC} = 2.3 to 3.6V; I _{OH} = -100μA		V _{CC} -0.2			V
		V _{CC} = 2.3V; I _{OH} = -8mA		1.8	2.1		
V _{OL}	Low-level output voltage	V _{CC} = 2.3V; I _{OL} = 100μA			0.07	0.2	V
		V _{CC} = 2.3V; I _{OL} = 24mA			0.3	0.5	
		V _{CC} = 2.3V; I _{OL} = 8mA				0.4	
I _I	Input leakage current	V _{CC} = 2.7V; V _I = V _{CC} or GND	Control pins		0.1	±1	μA
		V _{CC} = 0 or 2.7V; V _I = 5.5V			0.1	10	
		V _{CC} = 2.7V; V _I = 5.5V	Data pins ⁴		0.1	20	
		V _{CC} = 2.7V; V _I = V _{CC}			0.1	10	
		V _{CC} = 2.7V; V _I = 0			0.1	-5	
I _{OFF}	Off current	V _{CC} = 0V; V _I or V _O = 0 to 4.5V			0.1	±100	μA
I _{HOLD}	Bus Hold current	V _{CC} = 2.3V; V _I = 0.7V			90		μA
	Data inputs ⁶	V _{CC} = 2.3V; V _I = 1.7V			-10		
I _{EX}	Current into an output in the High state when V _O > V _{CC}	V _O = 5.5V; V _{CC} = 2.3V			50	125	μA
I _{PU/PD}	Power up/down 3-State output current ³	V _{CC} ≤ 1.2V; V _O = 0.5V to V _{CC} ; V _I = GND or V _{CC} ; OE/OE = Don't care			40	100	μA
I _{CCH}	Quiescent supply current	V _{CC} = 2.7V; Outputs High, V _I = GND or V _{CC} , I _O = 0			0.04	0.1	mA
I _{CCL}		V _{CC} = 2.7V; Outputs Low, V _I = GND or V _{CC} , I _O = 0			2.3	45	
I _{CCZ}		V _{CC} = 2.7V; Outputs Disabled; V _I = GND or V _{CC} , I _O = 0 ⁵			0.04	0.1	
ΔI _{CC}	Additional supply current per input pin ²	V _{CC} = 2.3V to 2.7V; One input at V _{CC} -0.6V, Other inputs at V _{CC} or GND			0.1	0.4	mA

NOTES:

- All typical values are at $V_{CC} = 2.5\text{V}$ and $T_{\text{amb}} = 25^\circ\text{C}$.
- This is the increase in supply current for each input at the specified voltage level other than V_{CC} or GND.
- This parameter is valid for any V_{CC} between 0V and 1.2V with a transition time of up to 10msec. From $V_{CC} = 1.2\text{V}$ to $V_{CC} = 2.5\text{V} \pm 0.3\text{V}$ a transition time of 100μsec is permitted. This parameter is valid for $T_{\text{amb}} = 25^\circ\text{C}$ only.
- Unused pins at V_{CC} or GND.
- I_{CCZ} is measured with outputs pulled up to V_{CC} or pulled down to ground.
- Not guaranteed.

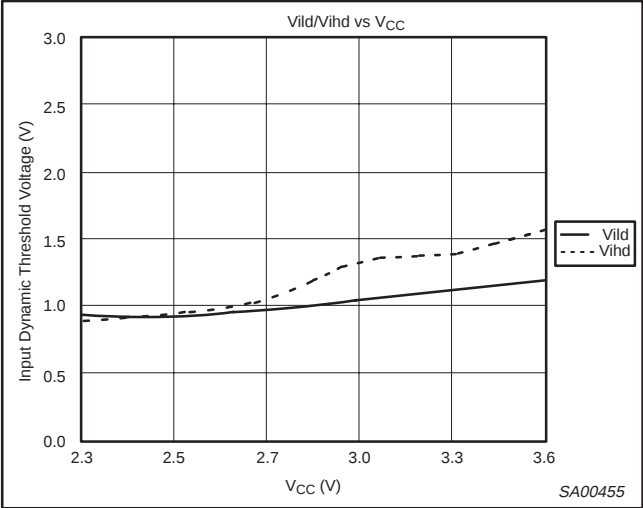
2.5V/3.3V 16-bit transceiver (3-State)

74ALVT16245

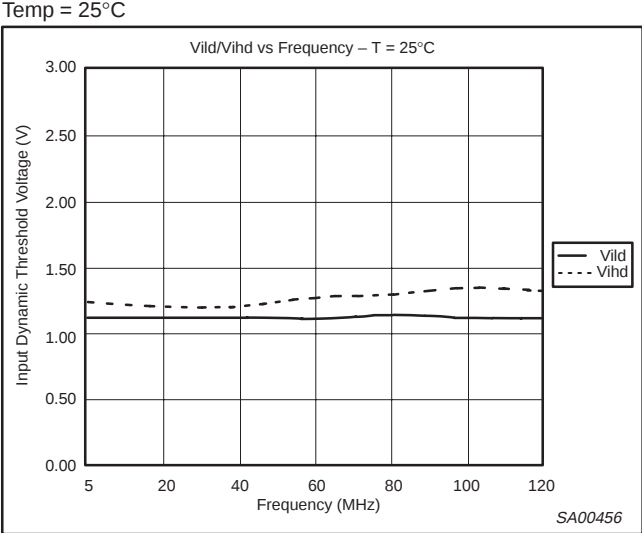
DYNAMIC SWITCHING THRESHOLD

Dynamic switching threshold is the change in V_{IH} and V_{IL} when the device is operated in various switching and output loading conditions. The cause of this variation is due to extra load placed on internal circuit structures. V_{IHD} and V_{ILD} are measures of the dynamic switching threshold. V_{IHD} is the input high switching level when the device is heavily loaded. V_{ILD} is the input low switching level when the device is heavily loaded.

V_{ILD}/V_{IHD} vs V_{CC}

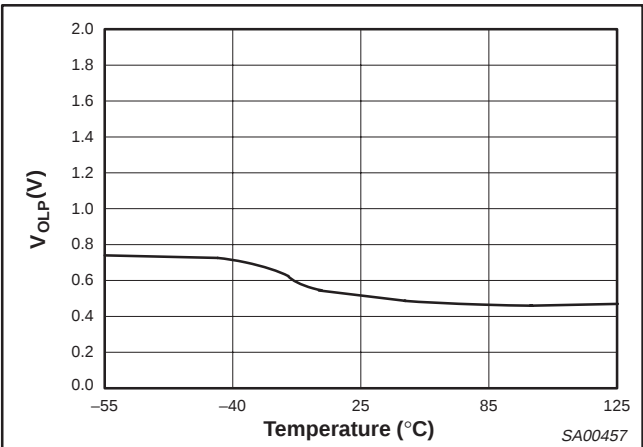


V_{ILD}/V_{IHD} vs Frequency

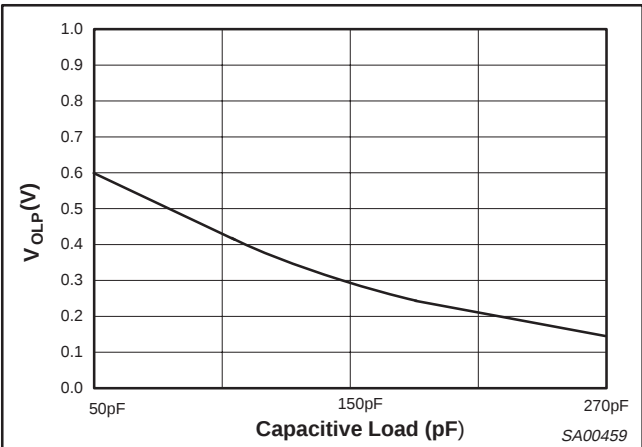


GROUND/ V_{CC} BOUNCE

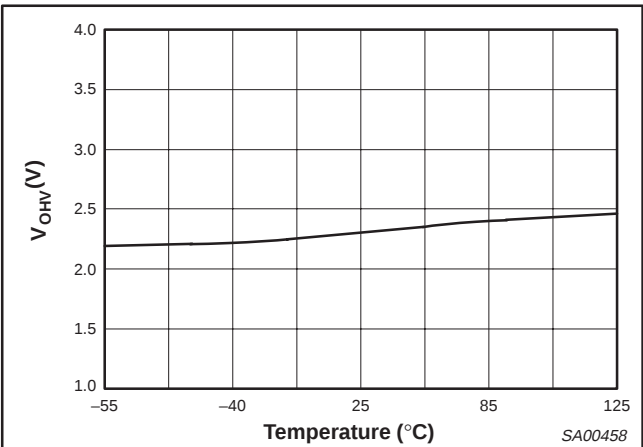
V_{OLP} vs Temperature



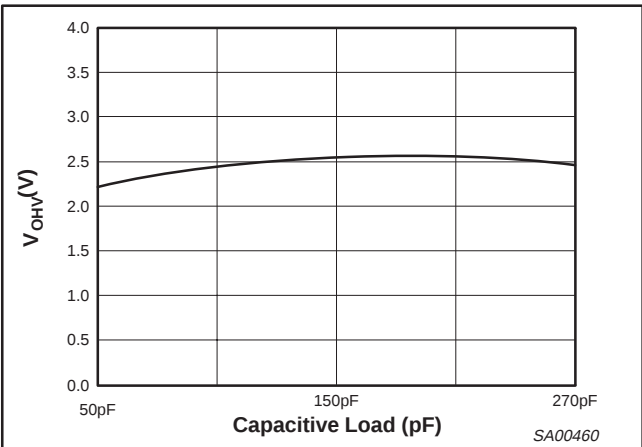
V_{OLP} vs Capacitive Load



V_{OHV} vs Temperature



V_{OHV} vs Capacitive Load



2.5V/3.3V 16-bit transceiver (3-State)

74ALVT16245

AC CHARACTERISTICS (2.5V ± 0.2V RANGE)GND = 0V; $t_R = t_F = 2.5\text{ns}$; $C_L = 50\text{pF}$; $R_L = 500\Omega$; $T_{\text{amb}} = -40^\circ\text{C}$ to $+85^\circ\text{C}$.

SYMBOL	PARAMETER	WAVEFORM	LIMITS			UNIT
			V _{CC} = 2.5V ±0.2V			
			MIN	TYP ¹	MAX	
t _{PLH} t _{PHL}	Propagation delay nAx to nBx or nBx to nAx	1	0.5 0.5	1.7 1.9	2.8 2.8	ns
t _{PZH} t _{PZL}	Output enable time to High and Low level	2	1.5 1.0	3.0 2.3	4.5 3.5	ns
t _{PHZ} t _{PLZ}	Output disable time from High and Low Level	2	1.5 1.0	3.0 2.3	4.6 3.5	ns

NOTE:1. All typical values are at $V_{CC} = 2.5\text{V}$ and $T_{\text{amb}} = 25^\circ\text{C}$.**SKEW DATA** t_{PS} (Pin Skew or Transition Skew)

$$t_{PS} = |t_{PHL} - t_{PLH}|$$

	$V_{CC} = 2.3$	$V_{CC} = 2.5$	$V_{CC} = 2.7$	$V_{CC} = 3.0$	$V_{CC} = 3.3$	$V_{CC} = 3.6$	UNITS
$t_{PS} \text{ Max}$	429	469	430	426	267	336	ps

$$t_{OST} = |t_{P\Phi m} - t_{P\Phi n}|$$

Where Φ is any edge transition (high-to-low or low-to-high)
measured between any two outputs (m or n) within any given
device.

	$V_{CC} = 2.3$	$V_{CC} = 2.5$	$V_{CC} = 2.7$	$V_{CC} = 3.0$	$V_{CC} = 3.3$	$V_{CC} = 3.6$	UNITS
$t_{OST} \text{ nAn-nBn}$	546	625	586	546	427	397	ps
$t_{OST} \text{ nBn-nAn}$	508	547	586	506	427	417	

NOTE:One output switching, Temp = 25°C . t_{OSHL} , t_{OSLH} , (Common Edge Skew)

$$t_{OSHL} = |t_{PHL \text{ max}} - t_{PHL \text{ min}}| \text{ (Output Skew for Low-to-High Transitions)}$$

$$t_{OSLH} = |t_{PLH \text{ max}} - t_{PLH \text{ min}}| \text{ (Output Skew for High-to-Low Transitions)}$$

	$V_{CC} = 2.3$	$V_{CC} = 2.5$	$V_{CC} = 2.7$	$V_{CC} = 3.0$	$V_{CC} = 3.3$	$V_{CC} = 3.6$	UNITS
$t_{OSLH} \text{ nAn-nBn}$	312	312	313	276	267	257	ps
$t_{OSHL} \text{ nAn-nBn}$	312	352	352	297	289	267	
$t_{OSLH} \text{ nBn-nAn}$	235	273	312	274	296	326	
$t_{OSHL} \text{ nBn-nAn}$	234	235	274	248	287	267	

NOTE:One output switching, Temp = 25°C .

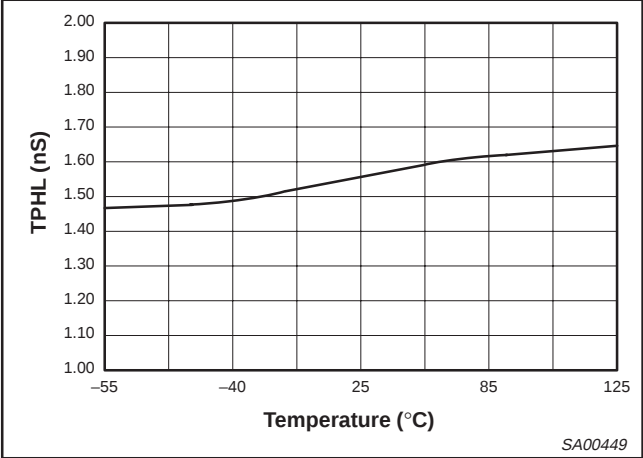
2.5V/3.3V 16-bit transceiver (3-State)

74ALVT16245

EXTENDED DATA

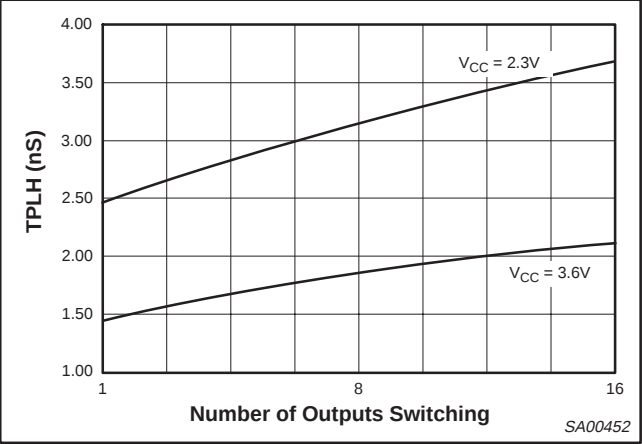
TPHL vs TEMP

V_{CC} = 3.3V, one output switching



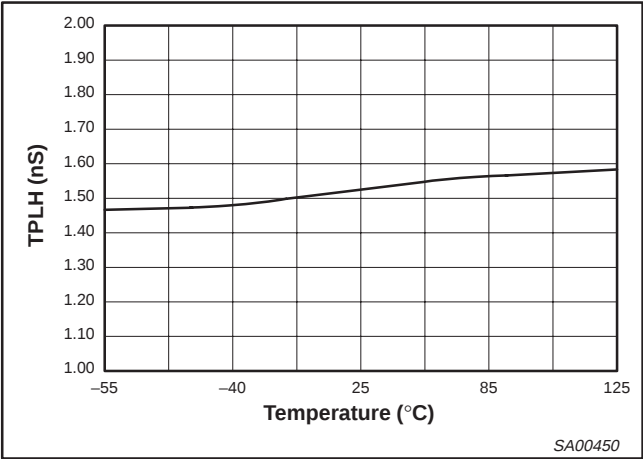
TPLH vs NUMBER of OUTPUTS SWITCHING

T = 25°C, 50pF/500 ohm load



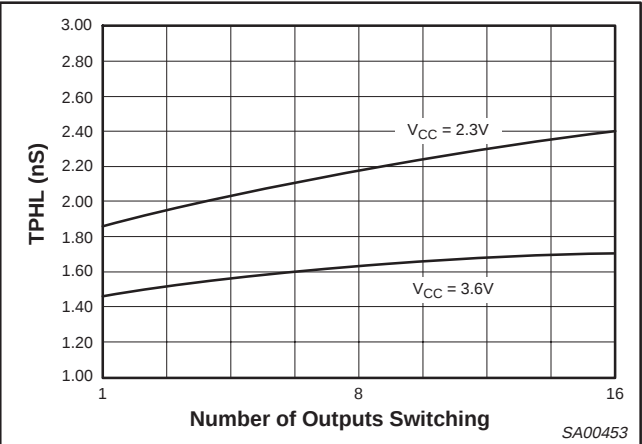
TPLH vs TEMP

V_{CC} = 3.3V, one output switching



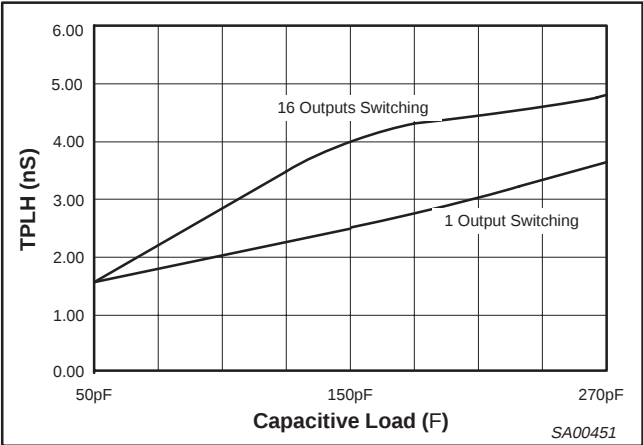
TPLH vs NUMBER of OUTPUTS SWITCHING

T = 25°C, 50pF/500 ohm load



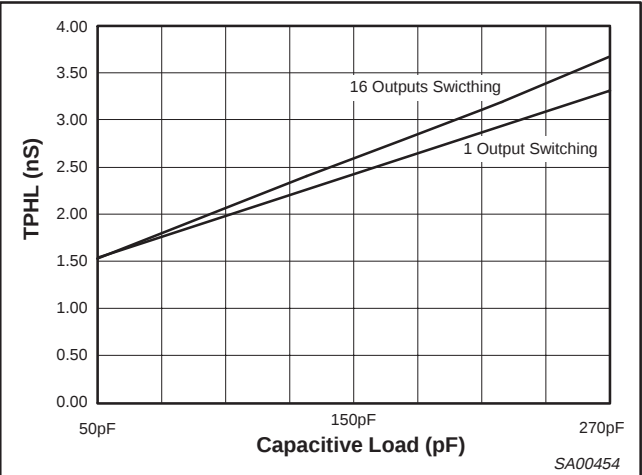
TPLH vs OUTPUT LOAD

Outputs also loaded with 500 ohms to ground, T = 25°C



TPHL vs OUTPUT LOAD

Outputs also loaded with 500 ohms to ground, T = 25°C

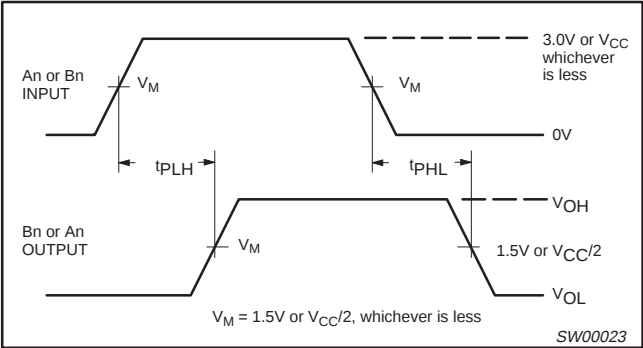


2.5V/3.3V 16-bit transceiver (3-State)

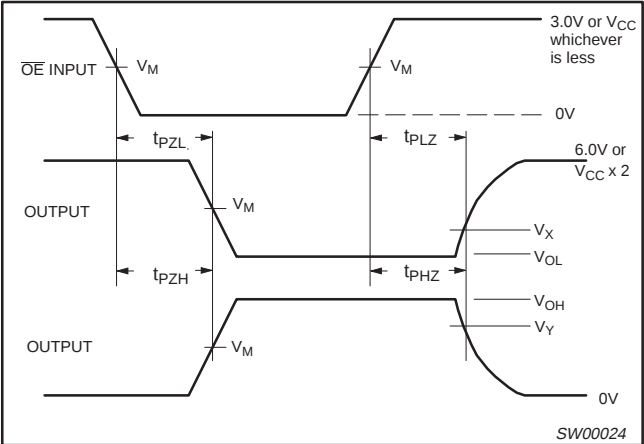
74ALVT16245

AC WAVEFORMS

$V_M = 1.5V$ at $V_{CC} \geq 3.0V$, $V_M = V_{CC}/2$ at $V_{CC} \leq 2.7V$
 $V_X = V_{OL} + 0.3V$ at $V_{CC} \geq 3.0V$, $V_X = V_{OL} + 0.15V$ at $V_{CC} \leq 2.7V$
 $V_Y = V_{OH} - 0.3V$ at $V_{CC} \geq 3.0V$, $V_Y = V_{OH} - 0.15V$ at $V_{CC} \leq 2.7V$



Waveform 1. Input to Output Propagation Delays



Waveform 2. 3-State Output Enable and Disable Times

TEST CIRCUIT AND WAVEFORMS

Test Circuit for 3-State Outputs

SWITCH POSITION

TEST	SWITCH
t_{PLZ}/t_{PZL}	6V or $V_{CC} \times 2$
t_{PLH}/t_{PHL}	Open
t_{PHZ}/t_{PZH}	GND

DEFINITIONS

R_L = Load resistor; see AC CHARACTERISTICS for value.

C_L = Load capacitance includes jig and probe capacitance: See AC CHARACTERISTICS for value.

R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

FAMILY	INPUT PULSE REQUIREMENTS				
	Amplitude	Rep. Rate	t_W	t_R	t_F
74ALVT16	3.0V or V_{CC} whichever is less	$\leq 10MHz$	500ns	$\leq 2.5ns$	$\leq 2.5ns$

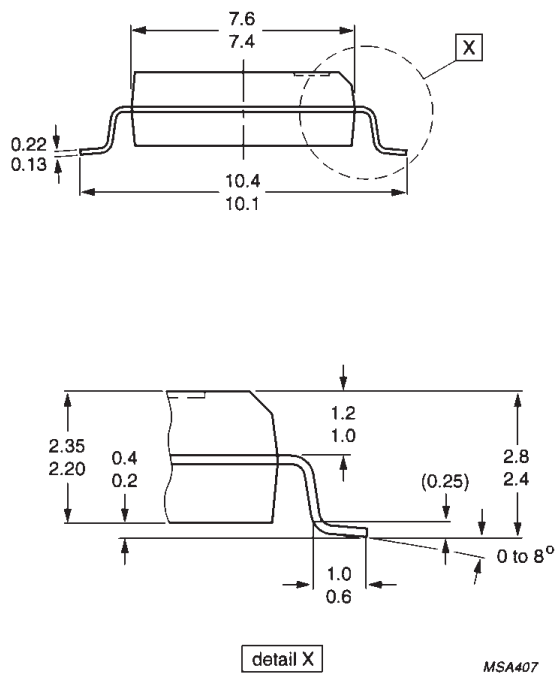
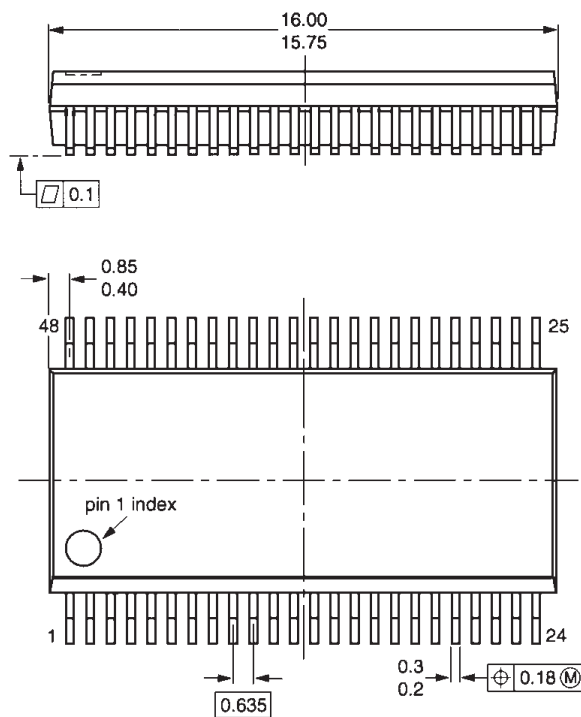
SW00025

2.5V/3.3V ALVT 16-bit transceiver (3-State)

74ALVT16245

SSOP48: plastic shrink small outline package; 48 leads; body width 7.5mm

SOT370-1



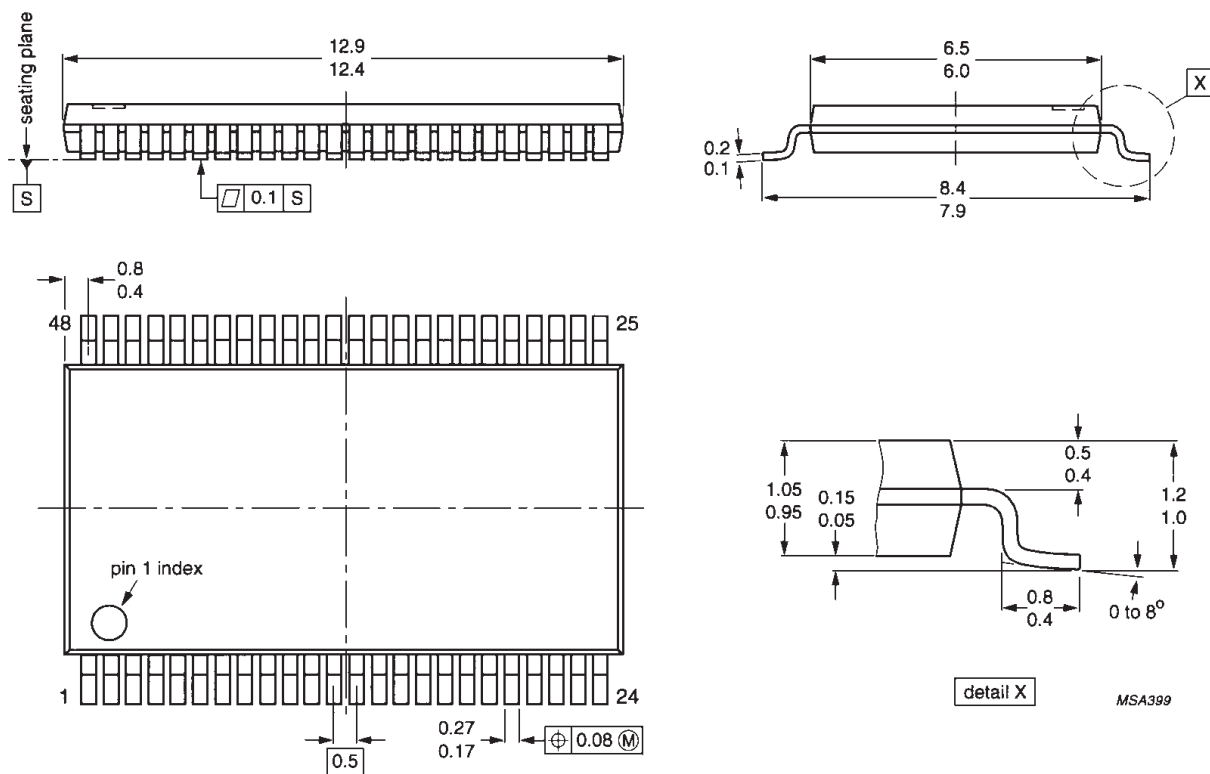
Dimensions in mm.

2.5V/3.3V ALVT 16-bit transceiver (3-State)

74ALVT16245

TSSOP48: plastic thin shrink small outline package; 48 leads; body width 6.1mm

SOT362-1



2.5V/3.3V ALVT 16-bit transceiver (3-State)

74ALVT16245

Data sheet status

Data sheet status	Product status	Definition [1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

[1] Please consult the most recently issued datasheet before initiating or completing a design.

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 134). 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 — 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, without notice, in the products, including circuits, standard cells, and/or software, described or contained herein in order to improve design and/or performance. Philips Semiconductors assumes no responsibility or liability for the use of any of these products, conveys no license 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
811 East Arques Avenue
P.O. Box 3409
Sunnyvale, California 94088-3409
Telephone 800-234-7381

© Copyright Philips Electronics North America Corporation 1998
All rights reserved. Printed in U.S.A.

print code

Date of release: 05-96

Document order number:

9397-750-03647

Let's make things better.