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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

Philips Semiconductors

PHILIPS

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.

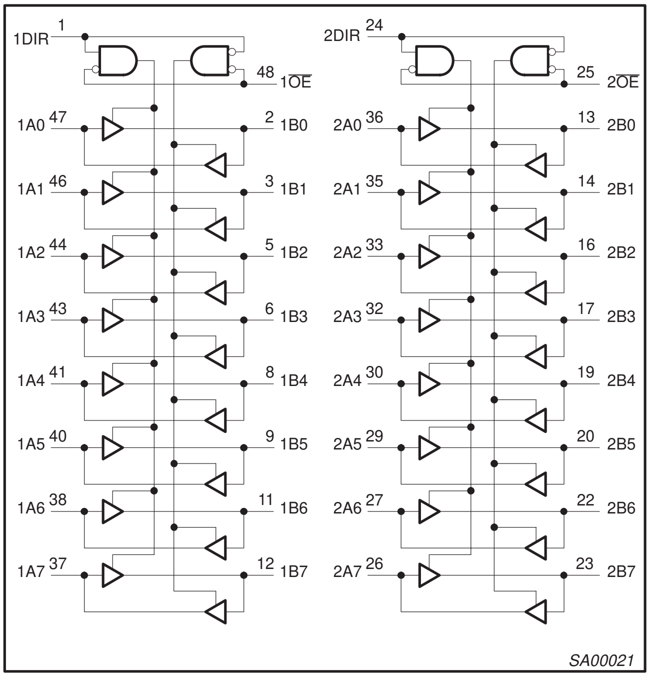
QUICK REFERENCE DATA

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

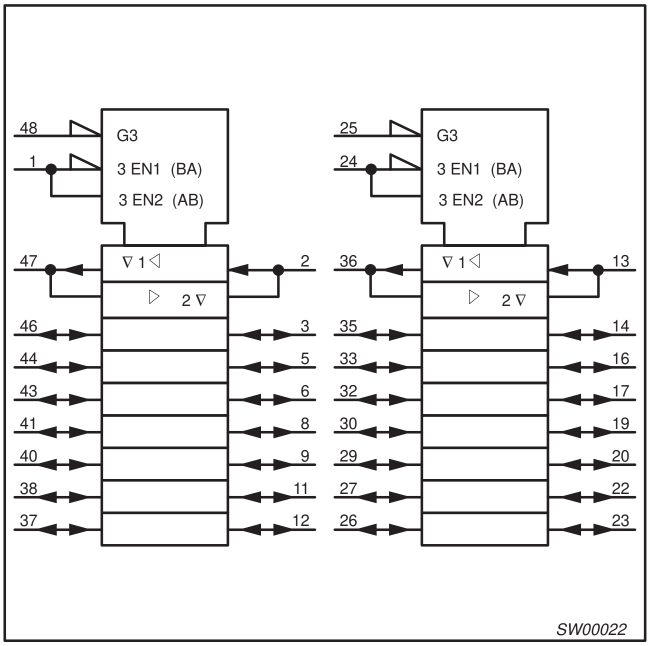
ORDERING INFORMATION

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

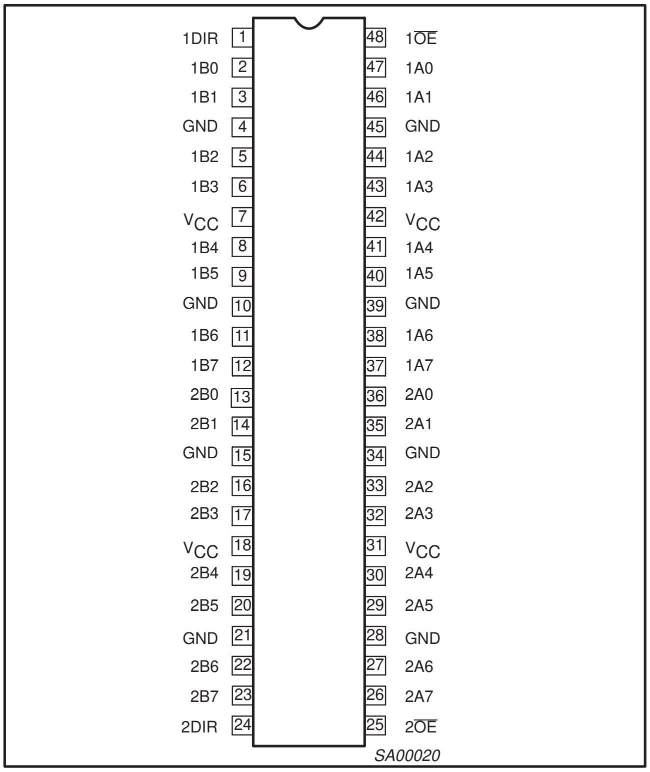
LOGIC SYMBOL



LOGIC SYMBOL (IEEE/IEC)



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	n$\overline{OE}$	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	
n$\overline{OE}$	**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:
1. 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.
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. The maximum junction temperature of this integrated circuit should not exceed 150°C.
3. The input and output negative voltage ratings may be exceeded if the input and output clamp current ratings are observed.

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 ≤ 50%; f ≥ 1kHz		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 ± 0.3V RANGE)

SYMBOL	PARAMETER	TEST CONDITIONS		LIMITS Temp = -40°C to +85°C			UNIT
				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]	$V_{CC} \leq$ 1.2V; V_O = 0.5V to V_{CC}; V_I = GND or V_{CC}; OE/$\overline{OE}$ = 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°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 ± 0.3V a transition time of 100µsec is permitted. This parameter is valid for T_{amb} = 25°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.

AC CHARACTERISTICS (3.3V ± 0.3V RANGE)

GND = 0V; $t_R = t_F = 2.5ns$; $C_L = 50pF$; $R_L = 500\Omega$; $T_{amb} = -40°C$ to +85°C.

SYMBOL	PARAMETER	WAVEFORM	LIMITS V_{CC} = 3.3V ± 0.3V MIN	TYP[1]	MAX	UNIT
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} = 3.3V and T_{amb} = 25°C.

DC ELECTRICAL CHARACTERISTICS (2.5V ± 0.2V RANGE)

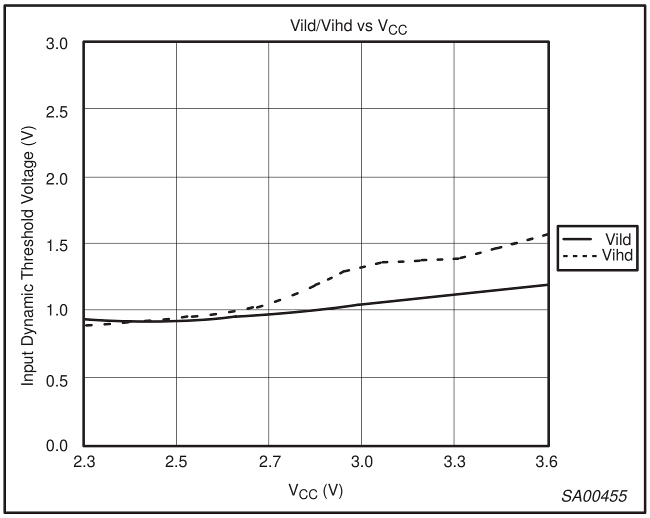
SYMBOL	PARAMETER	TEST CONDITIONS		LIMITS Temp = -40°C to +85°C MIN	TYP[1]	MAX	UNIT
V_{IK}	Input clamp voltage	V_{CC} = 2.3V; I_{IK} = –18mA			–0.85	–1.2	V
V_{OH}	High-level output voltage	V_{CC} = 2.3 to 3.6V; I_{OH} = –100µA		V_{CC}–0.2			V
		V_{CC} = 2.3V; I_{OH} = –8mA		1.8	2.1		
V_{OL}	Low-level 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 Data inputs[6]	V_{CC} = 2.3V; V_I = 0.7V			90		µA
		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]	$V_{CC} \leq 1.2V$; V_O = 0.5V to V_{CC}; V_I = GND or V_{CC}; OE/$\overline{OE}$ = 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:
1. All typical values are at V_{CC} = 2.5V and T_{amb} = 25°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} = 2.5V ± 0.3V a transition time of 100µsec is permitted. This parameter is valid for T_{amb} = 25°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. Not guaranteed.

DYNAMIC SWITCHING THRESHOLD

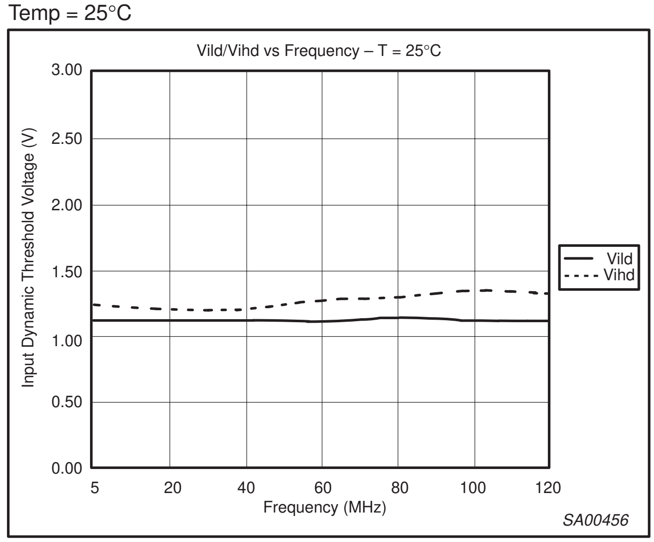
Dynamic switching threshold is the change in V_{IH} and V_{IL} when the device is operated in various switching and output loading conditions. The cause of this variation is due to extra load placed on internal circuit structures. V_{IHD} and V_{ILD} are measures of the dynamic switching threshold. V_{IHD}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



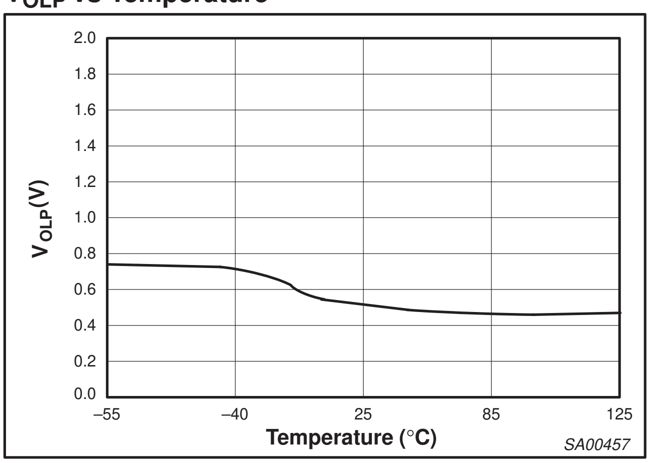
V_{ILD}/V_{IHD} vs Frequency

Temp = 25°C

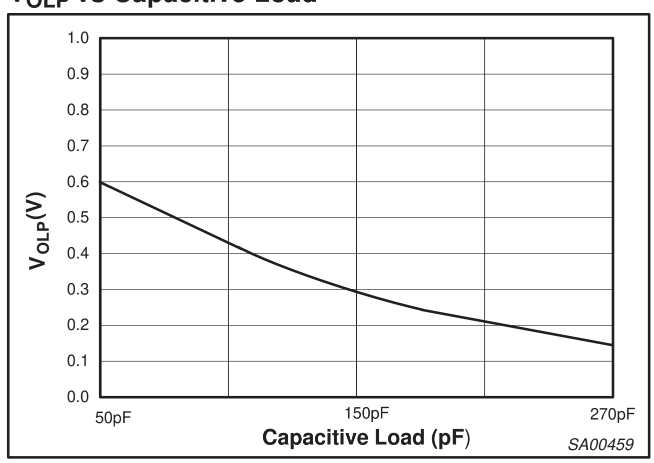


GROUND/V_{CC} BOUNCE

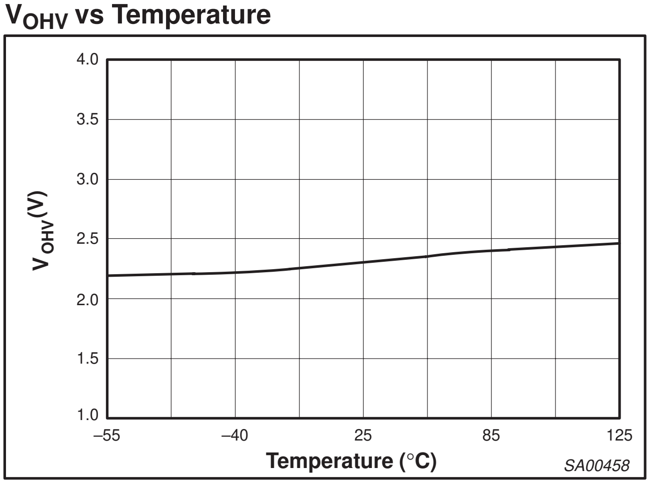
V_{OLP} vs Temperature



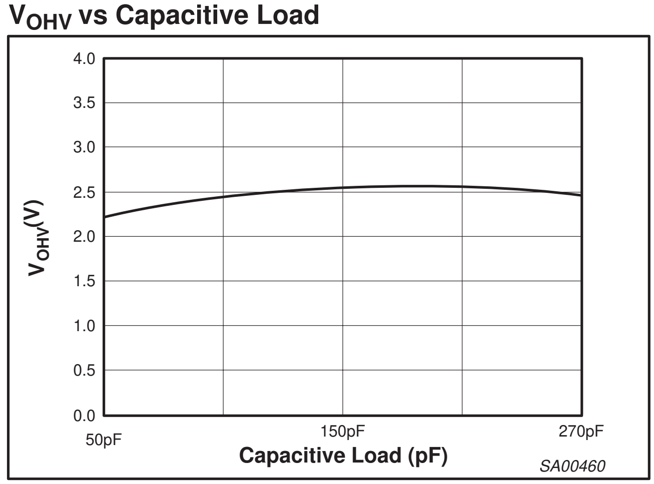
V_{OLP} vs Capacitive Load



V_{OHV} vs Temperature



V_{OHV} vs Capacitive Load



AC CHARACTERISTICS (2.5V ± 0.2V RANGE)

GND = 0V; $t_R = t_F = 2.5ns$; $C_L = 50pF$; $R_L = 500\Omega$; $T_{amb} = -40°C$ to $+85°C$.

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} = 2.5V and T_{amb} = 25°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} 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} nAn-nBn	546	625	586	546	427	397	ps
nBn-nAn	508	547	586	506	427	417	

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

t_{OSHL}, t_{OSLH}, (Common Edge Skew)

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

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

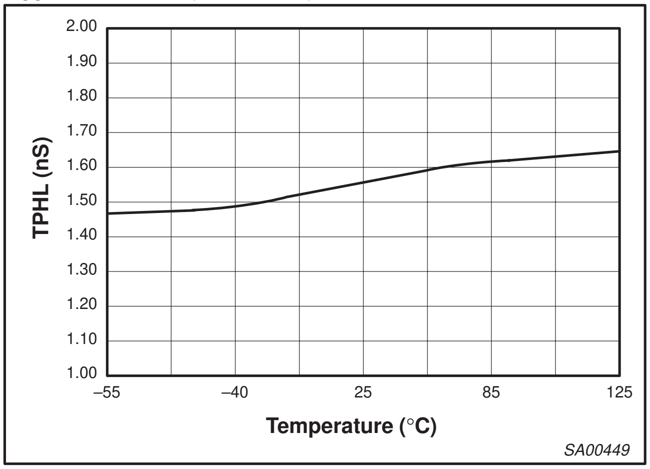
	V_{CC} = 2.3	V_{CC} = 2.5	V_{CC} = 2.7	V_{CC} = 3.0	V_{CC} = 3.3	V_{CC} = 3.6	UNITS
t_{OSLH} nAn-nBn	312	312	313	276	267	257	ps
t_{OSHL} nAn-nBn	312	352	352	297	289	267	
t_{OSLH} nBn-nAn	235	273	312	274	296	326	
t_{OSHL} nBn-nAn	234	235	274	248	287	267	

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

EXTENDED DATA

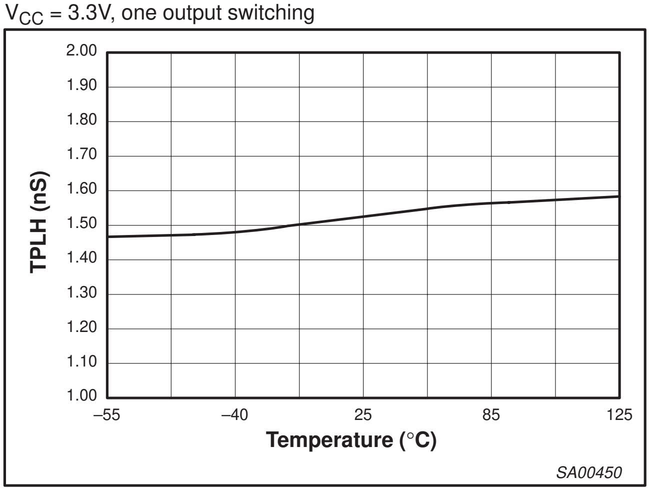
TPHL vs TEMP

V_{CC} = 3.3V, one output switching



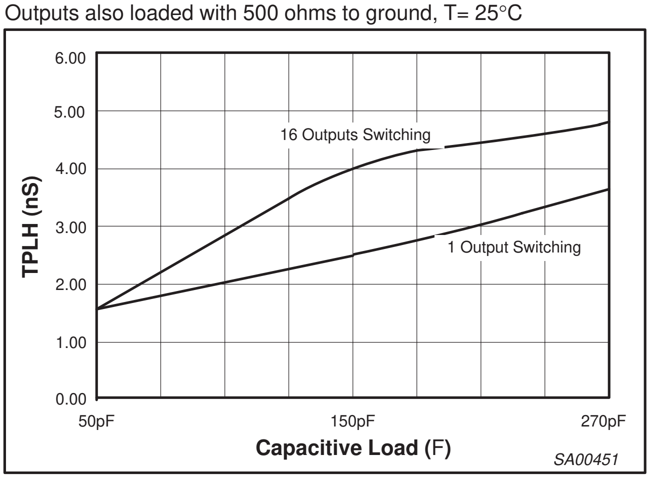
TPLH vs TEMP

V_{CC} = 3.3V, one output switching



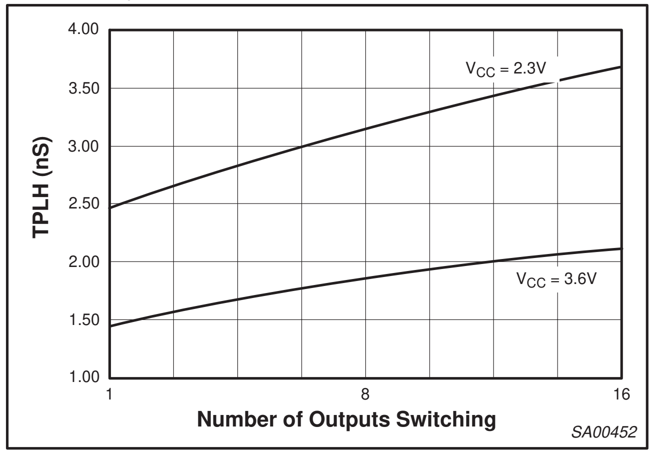
TPLH vs OUTPUT LOAD

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



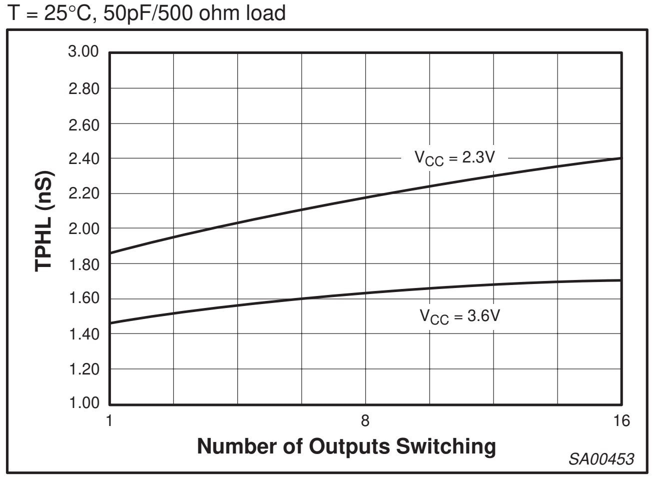
TPLH vs NUMBER of OUTPUTS SWITCHING

T = 25°C, 50pF/500 ohm load



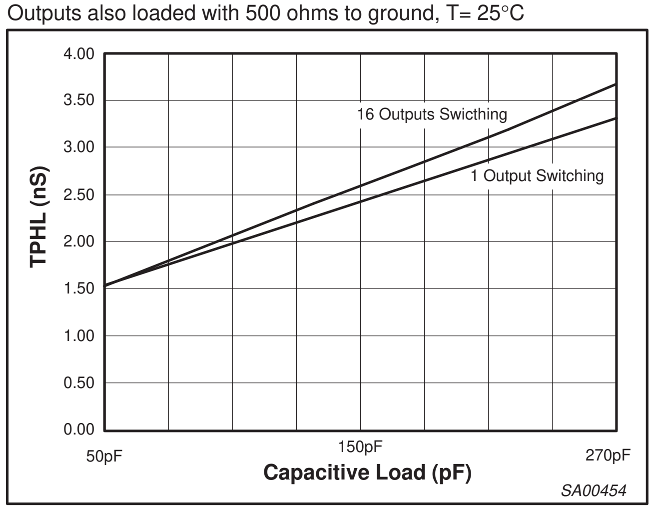
TPHL vs NUMBER of OUTPUTS SWITCHING

T = 25°C, 50pF/500 ohm load



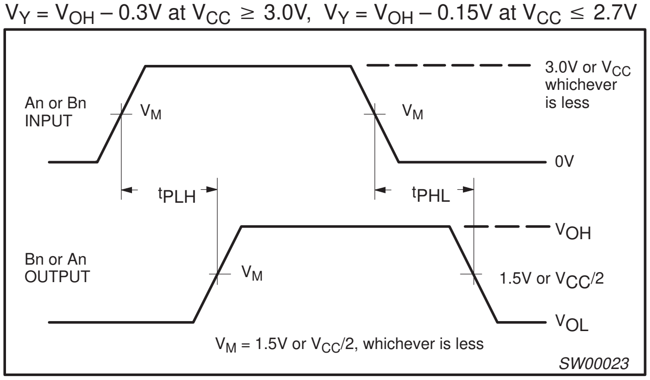
TPHL vs OUTPUT LOAD

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

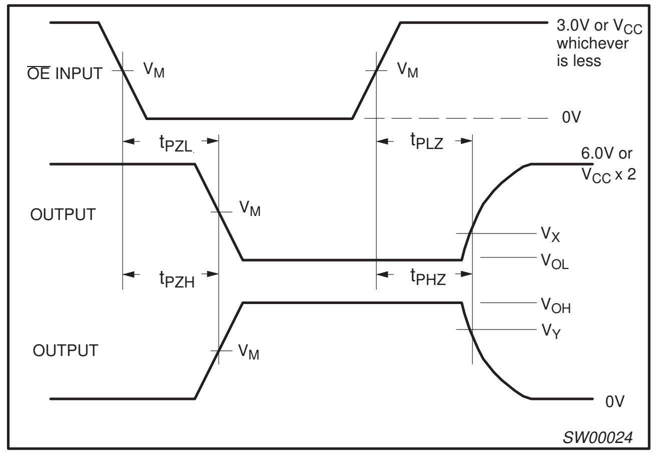


AC WAVEFORMS

$V_M = 1.5V$ 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 $V_{CC} \leq 2.7V$

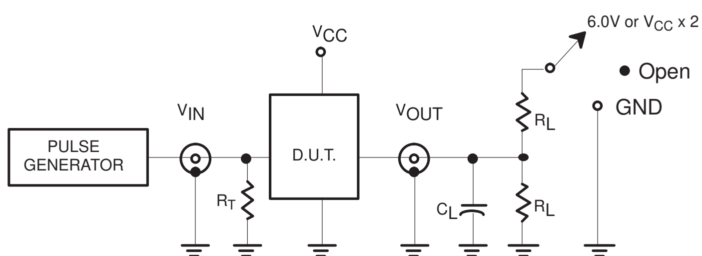


Waveform 1. Input to Output Propagation Delays

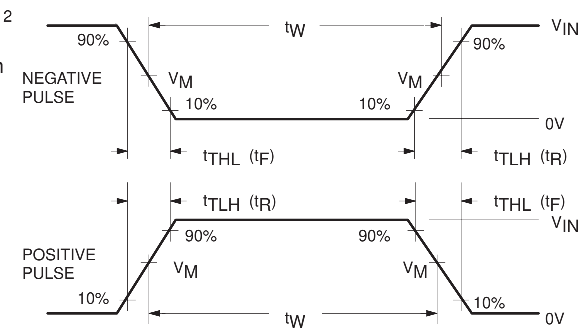


Waveform 2. 3-State Output Enable and Disable Times

TEST CIRCUIT AND WAVEFORMS



Test Circuit for 3-State Outputs



SWITCH POSITION

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

DEFINITIONS

R_L = Load resistor; see AC CHARACTERISTICS for value.

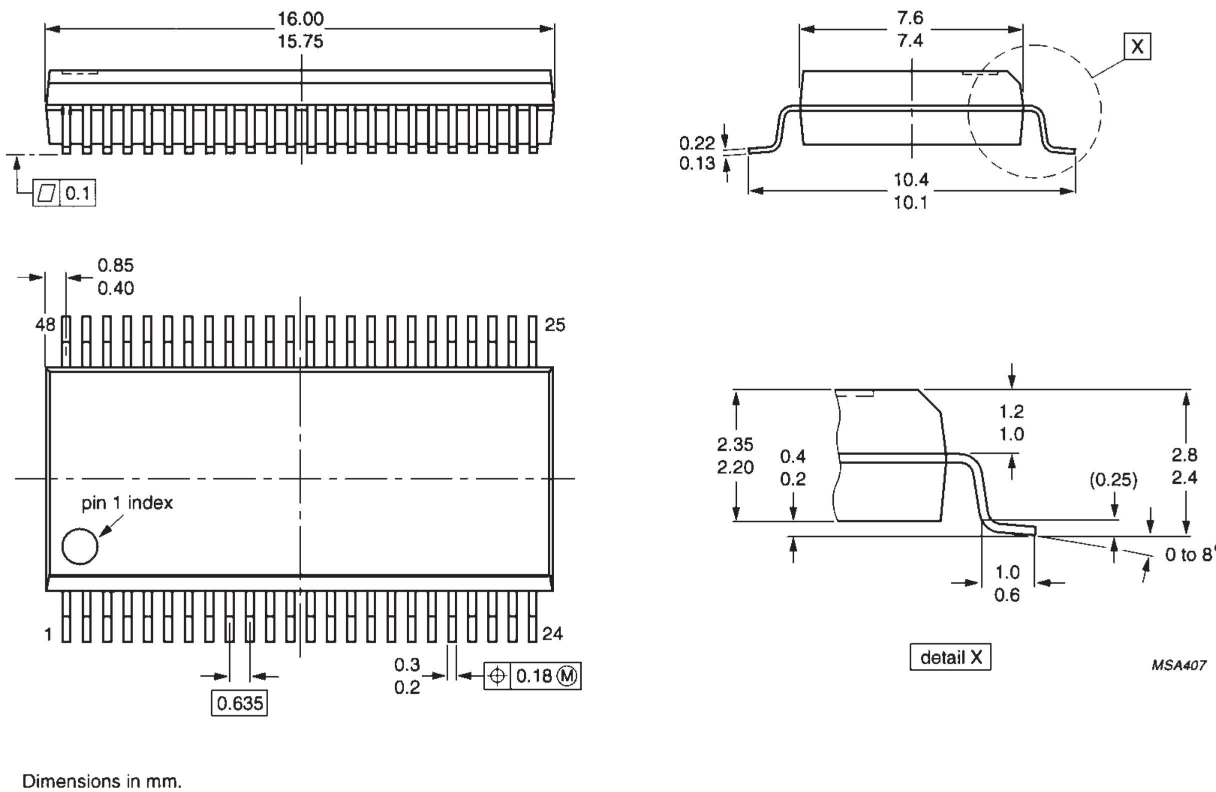
C_L = Load capacitance includes jig and probe capacitance: See AC CHARACTERISTICS for value.

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

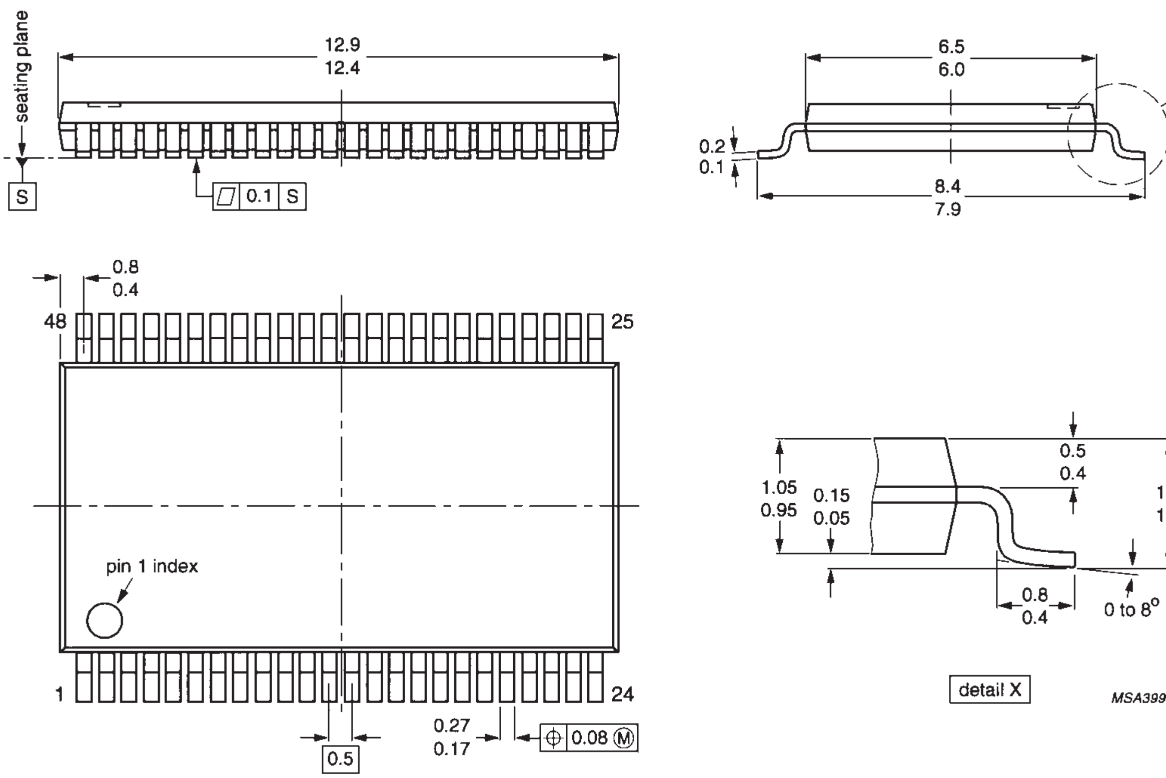
FAMILY	INPUT PULSE REQUIREMENTS				
	Amplitude	Rep. Rate	t_W	t_R	t_F
74ALVT16	3.0V or V_{CC} whichever is less	≤10MHz	500ns	≤2.5ns	≤2.5ns

SW00025

SSOP48: plastic shrink small outline package; 48 leads; body width 7.5mm **SOT370-1**



TSSOP48: plastic thin shrink small outline package; 48 leads; body width 6.1mm **SOT362-1**



Dimensions in mm.

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 chages 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.

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