DATA SHEET

74LVT16500A
3.3V 18-bit universal bus transceiver (3-State)

Product specification
Supersedes data of 1997 Jun 12
IC23 Data Handbook

1998 Feb 19

Philips
Semiconductors

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3.3V 18-bit universal bus transceiver (3-State) 74LVT16500A

FEATURES

- 18-bit bidirectional bus interface
- 3-State buffers
- Output capability: +64mA/-32mA
- TTL input and output switching levels
- Input and output interface capability to systems at 5V supply
- Bus-hold data inputs eliminate the need for external pull-up resistors to hold unused inputs
- Live insertion/extraction permitted
- Power-up reset
- Power-up 3-State
- No bus current loading when output is tied to 5V bus
- Negative edge-triggered clock inputs
- Latch-up protection exceeds 500mA per JEDEC JC40.2 Std 17
- ESD protection exceeds 2000V per MIL STD 883 Method 3015 and 200V per Machine Model

DESCRIPTION

The 74LVT16500A is a high-performance BiCMOS product designed for V_{CC} operation at 3.3V.

This device is an 18-bit universal 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 ($\overline{\text{CPAB}}$ and $\overline{\text{CPBA}}$) 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 $\overline{\text{CPAB}}$ 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 High-to-Low transition of $\overline{\text{CPAB}}$. 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 $\overline{\text{CPBA}}$. The output enables are complimentary (OEAB is active High, and $\overline{\text{OEBA}}$ is active Low).

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

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS T_{amb} = 25°C	TYPICAL	UNIT
t_{PLH} t_{PHL}	Propagation delay An to Bn or Bn to An	C_L = 50pF; V_{CC} = 3.3V	1.9	ns
C_{IN}	Input capacitance (Control pins)	V_I = 0V or 3.0V	3	pF
$C_{I/O}$	I/O pin capacitance	Outputs disabled; $V_{I/O}$ = 0V or 3.0V	9	pF
I_{CCZ}	Total supply current	Outputs disabled; V_{CC} = 3.6V	70	µA

ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	DWG NUMBER
56-Pin Plastic SSOP Type III	–40°C to +85°C	74LVT16500A DL	VT16500A DL	SOT371-1
56-Pin Plastic TSSOP Type II	–40°C to +85°C	74LVT16500A DGG	VT16500A DGG	SOT364-1

PIN DESCRIPTION

PIN NUMBER	SYMBOL	NAME AND FUNCTION
1	OEAB	A-to-B Output enable input
27	$\overline{\text{OEBA}}$	B-to-A Output enable input (active low)
2, 28	LEAB/LEBA	A-to-B/B-to-A Latch enable input
55,30	$\overline{\text{CPAB}}$/$\overline{\text{CPBA}}$	A-to-B/B-to-A Clock input (active falling edge)
3, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16, 17, 19, 20, 21, 23, 24, 26	A0-A17	Data inputs/outputs (A side)
54, 52, 51, 49, 48, 47, 45, 44, 43, 42, 41, 40, 38, 37, 36, 34, 33, 31	B0-B17	Data inputs/outputs (B side)
4, 11, 18, 25, 32, 39, 46, 53	GND	Ground (0V)
7, 22, 35, 50	V_{CC}	Positive supply voltage

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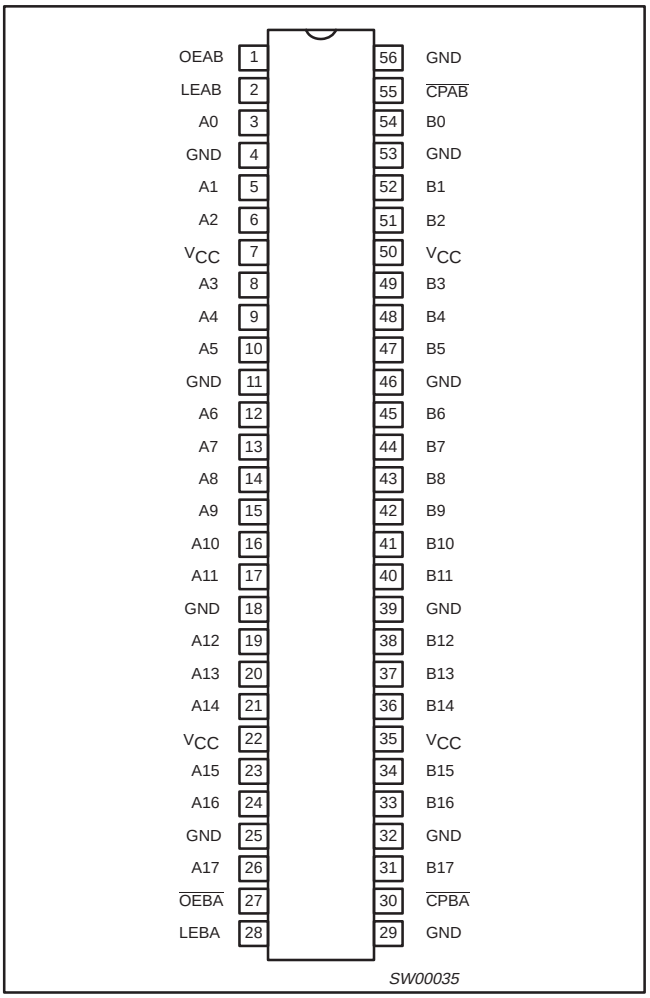
PIN CONFIGURATION



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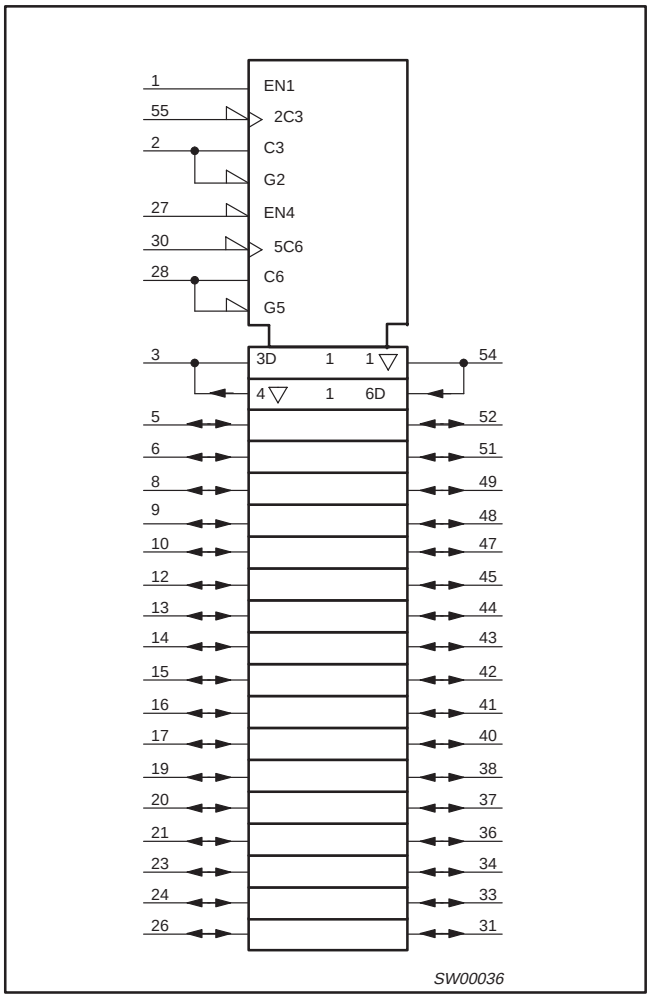
LOGIC SYMBOL (IEEE/IEC)



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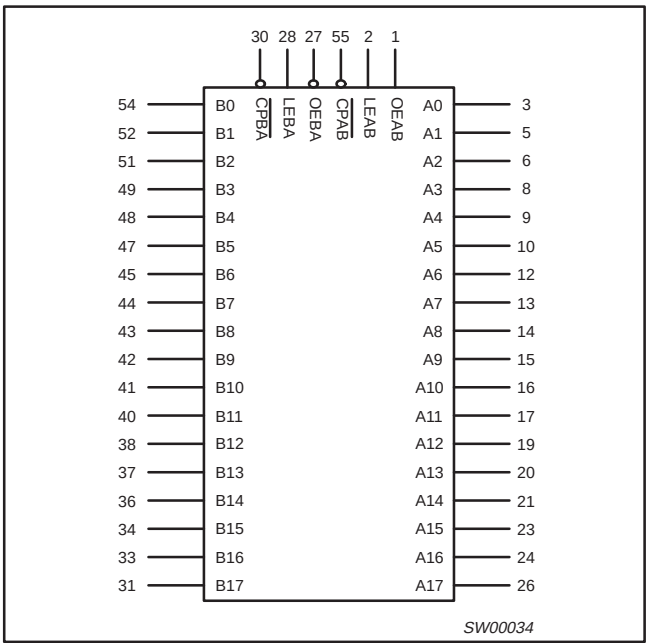
LOGIC SYMBOL



SW00034

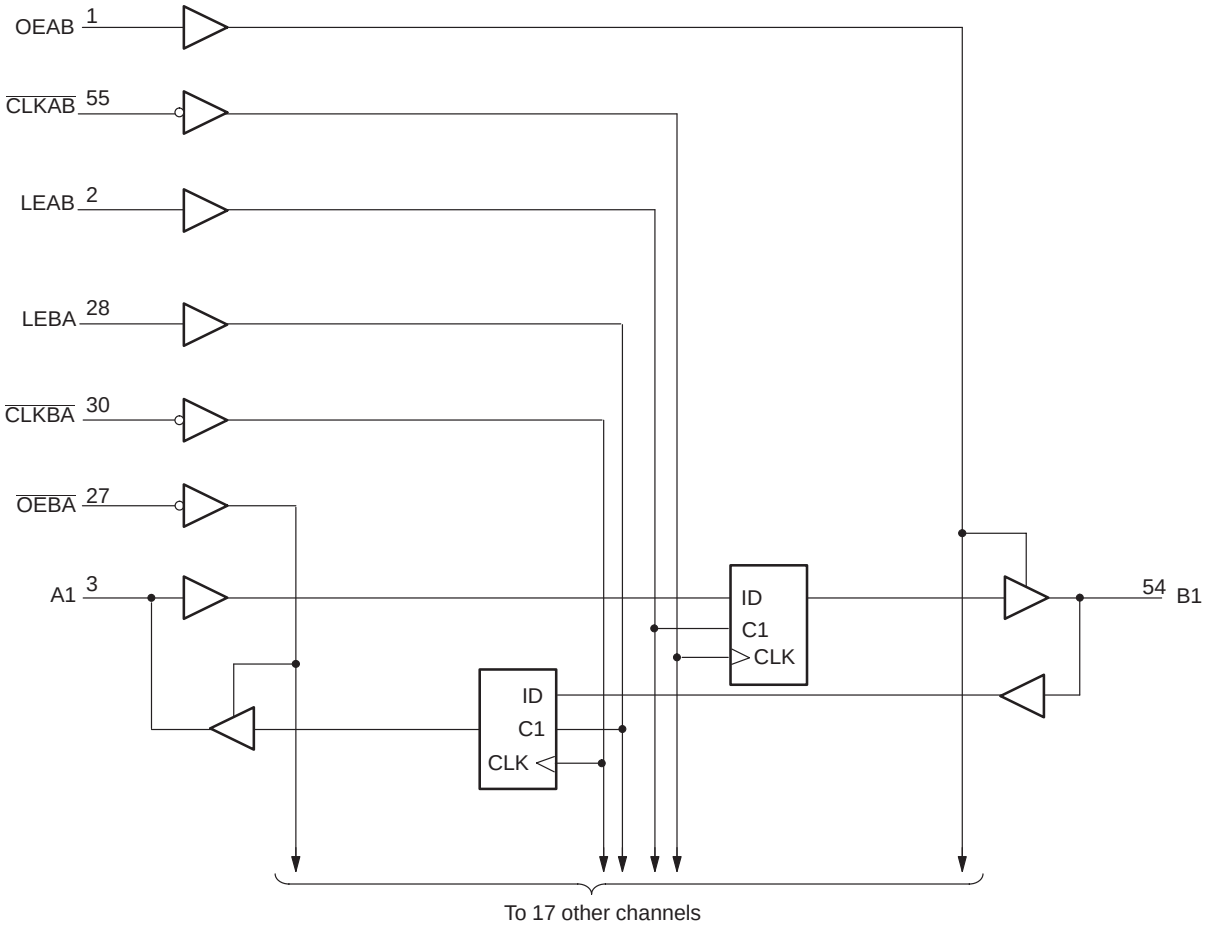
FUNCTION TABLE

INPUTS				Internal Registers	OUTPUTS	OPERATING MODE
OEAB	LEAB	$\overline{CPAB}$	An		Bn	
L	H	X	X	X	Z	Disabled
L	↓	X	h	H	Z	Disabled, Latch data
L	↓	X	I	L	Z	
L	L	H or L	X	NC	Z	Disabled, Hold data
L	L	↓	h	H	Z	Disabled, Clock data
L	L	↓	I	L	Z	
H	H	X	H	H	H	Transparent
H	H	X	L	L	L	
H	↓	X	h	H	H	Latch data & display
H	↓	X	I	L	L	
H	L	↓	h	H	H	Clock data & display
H	L	↓	I	L	L	
H	L	H or L	X	H	H	Hold data & display
H	L	H or L	X	L	L	

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

H = High voltage level
h = High voltage level one set-up time prior to the Enable or Clock transition
L = Low voltage level
I = Low voltage level one set-up time prior to the Enable or Clock transition
NC= No Change
X = Don't care
Z = High Impedance "off" state
↓ = High-to-Low Enable or Clock transition

LOGIC DIAGRAM



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	LIMITS		UNIT
		MIN	MAX	
V_{CC}	DC 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}	Input voltage		0.8	V
I_{OH}	High-level output current		–32	mA
I_{OL}	Low-level output current		32	mA
	Low-level output current; current duty cycle ≤ 50%; f ≥ 1kHz		64	
$\Delta t/\Delta v$	Input transition rise or fall rate; Outputs enabled		10	ns/V
T_{amb}	Operating free-air temperature range	–40	+85	°C

DC ELECTRICAL CHARACTERISTICS

SYMBOL	PARAMETER	TEST CONDITIONS		LIMITS			UNIT
				Temp = -40°C to +85°C			
				MIN	TYP[1]	MAX	
V_{IK}	Input clamp voltage	V_{CC} = 2.7V; I_{IK} = –18mA			–.85	–1.2	V
V_{OH}	High-level output voltage	V_{CC} = 2.7 to 3.6V; I_{OH} = –100µA		V_{CC}-0.2	V_{CC}		V
		V_{CC} = 2.7V; I_{OH} = –8mA		2.4	2.55		
		V_{CC} = 3.0V; I_{OH} = –32mA		2.0	2.30		
V_{OL}	Low-level output voltage	V_{CC} = 2.7V; I_{OL} = 100µA			0.07	0.2	V
		V_{CC} = 2.7V; I_{OL} = 24mA			0.3	0.5	
		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			0.36	0.55	
V_{RST}	Power-up output low voltage[5]	V_{CC} = 3.6V; I_O = 1mA; V_I = GND or V_{CC}			0.1	0.55	V
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	I/O Data pins[4]		1.0	20	
		V_{CC} = 3.6V; V_I = V_{CC}			0.1	10	
		V_{CC} = 3.6V; V_I = 0			0.1	-5	
I_{OFF}	Output off current	V_{CC} = 0V; V_I or V_O = 0 to 4.5V			1.0	±100	µA
I_{HOLD}	Bus Hold current A or B outputs7	V_{CC} = 3V; V_I = 0.8V		75	130		µA
		V_{CC} = 3V; V_I = 2.0V		-75	–130		
		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}; $\overline{OE}$/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	0.12	mA
I_{CCL}		V_{CC} = 3.6V; Outputs Low, V_I = GND or V_{CC}, I_O = 0			4	6	
I_{CCZ}		V_{CC} = 3.6V; Outputs Disabled; V_I = GND or V_{CC}, I_O = 0[6]			0.07	0.12	
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			0.1	0.2	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. For valid test results, data must not be loaded into the flip-flops (or latches) after applying power.
6. I_{CCZ} is measured with outputs pulled to V_{CC} or GND.
7. This is the bus hold overdrive current required to force the input to the opposite logic state.

AC CHARACTERISTICS

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

SYMBOL	PARAMETER	WAVEFORM	LIMITS				UNIT
			V_{CC} = 3.3V ±0.3V			V_{CC} = 2.7V	
			MIN	TYP[1]	MAX	MAX	
f_{MAX}	Maximum clock frequency	1	150	350			MHz
t_{PLH} t_{PHL}	Propagation delay An to Bn or Bn to An	2	0.5 0.5	1.9 1.9	4.2 4.2	5.4 5.4	ns
t_{PLH} t_{PHL}	Propagation delay $\overline{CPAB}$ to Bn or $\overline{CPBA}$ to An	1	1.0 1.0	3.2 3.2	5.4 5.4	6.4 6.4	ns
t_{PLH} t_{PHL}	Propagation delay LEAB to Bn or LEBA to An	3	1.0 1.0	2.4 2.9	5.4 5.4	6.4 6.4	ns
t_{PZH} t_{PZL}	Output enable time to High and Low level	5 6	1.0 1.0	2.4 2.2	3.9 3.9	4.6 5.2	ns
t_{PHZ} t_{PLZ}	Output disable time from High and Low Level	5 6	1.0 1.0	2.8 3.2	5.2 5.2	5.6 5.6	ns

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

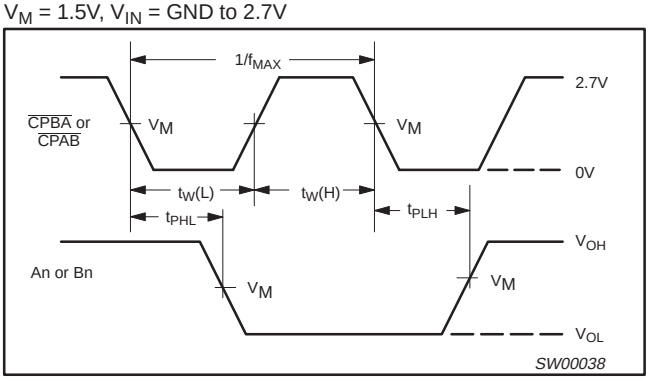
AC SETUP REQUIREMENTS

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

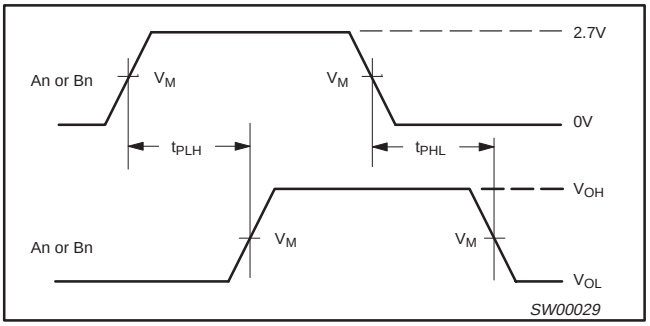
SYMBOL	PARAMETER	WAVEFORM	LIMITS			UNIT
			V_{CC} = 3.3V ±0.3V		V_{CC} = 2.7V	
			MIN	TYP	MIN	
ts(H) ts(L)	Setup time, High or Low An to $\overline{CPAB}$ or Bn to $\overline{CPBA}$	4	1.8 1.8	1.0 0.7	1.5 1.5	ns
th(H) th(L)	Hold time, High or Low An to $\overline{CPAB}$ or Bn to $\overline{CPBA}$	4	0 0	0 0	0 0	ns
ts(H) ts(L)	Setup time, High or Low An to LEAB or Bn to $\overline{CPBA}$	4	1.8 1.8	1.1 0.8	1.5 1.5	ns
th(H) th(L)	Hold time, High or Low An to LEAB or Bn to LEBA	4	0 0	0 0	0 0	ns
tw(H) tw(L)	Pulse width, High or Low $\overline{CPAB}$ or $\overline{CPBA}$	1	1.2 1.2	0.8 0.8	1.5 1.5	ns
tw(H)	LEAB or LEBA pulse width, High	3	1.2	0.8	1.5	ns

AC WAVEFORMS

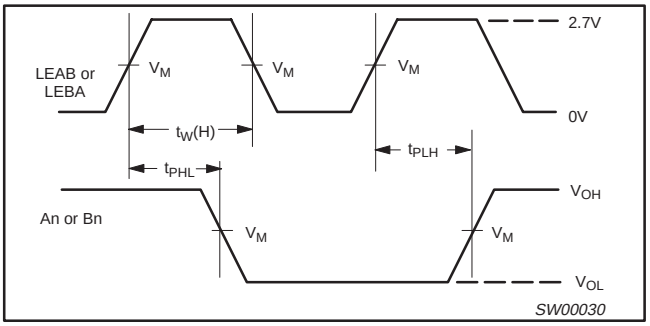
V_M = 1.5V, V_{IN} = GND to 2.7V



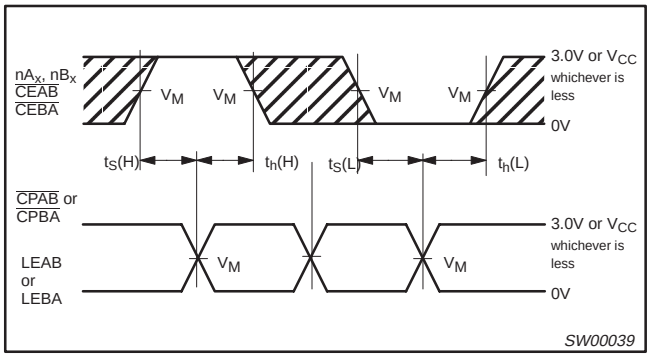
Waveform 1. Propagation Delay, Clock Input to Output, Clock Pulse Width, and Maximum Clock Frequency



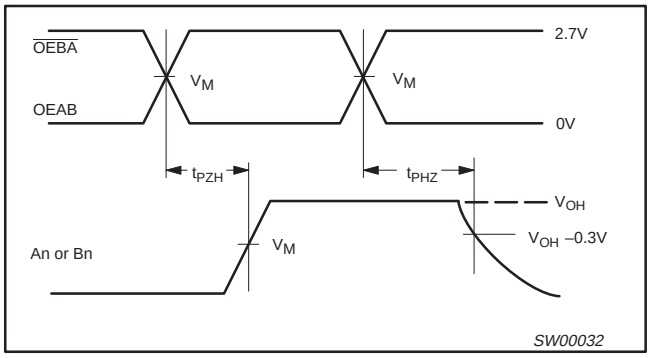
Waveform 2. Propagation Delay, Transparent Mode



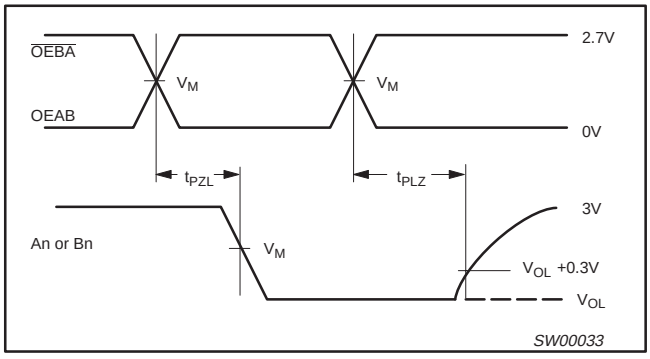
Waveform 3. Propagation Delay, Enable to Output, and Enable Pulse Width



Waveform 4. Data Setup and Hold Times

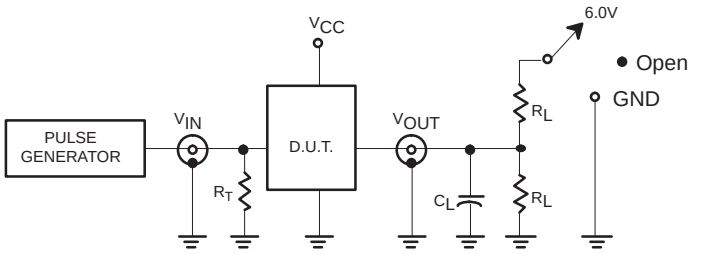


Waveform 5. 3-State Output Enable Time to High Level and Output Disable Time from High Level

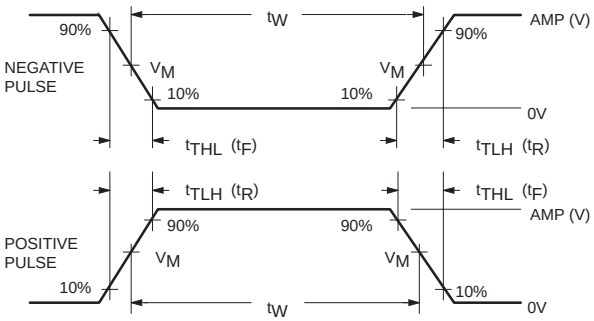


Waveform 6. 3-State Output Enable Time to Low Level and Output Disable Time from Low Level

TEST CIRCUIT AND WAVEFORMS



Test Circuit for 3-State Outputs



V_M = 1.5V
Input Pulse Definition

SWITCH POSITION

TEST	SWITCH
t_{PLZ}/t_{PZL}	6V
t_{PLH}/t_{PHL}	Open
t_{PHZ}/t_{PZH}	GND

DEFINITIONS

R_L = Load resistor; see AC CHARACTERISTICS for value.

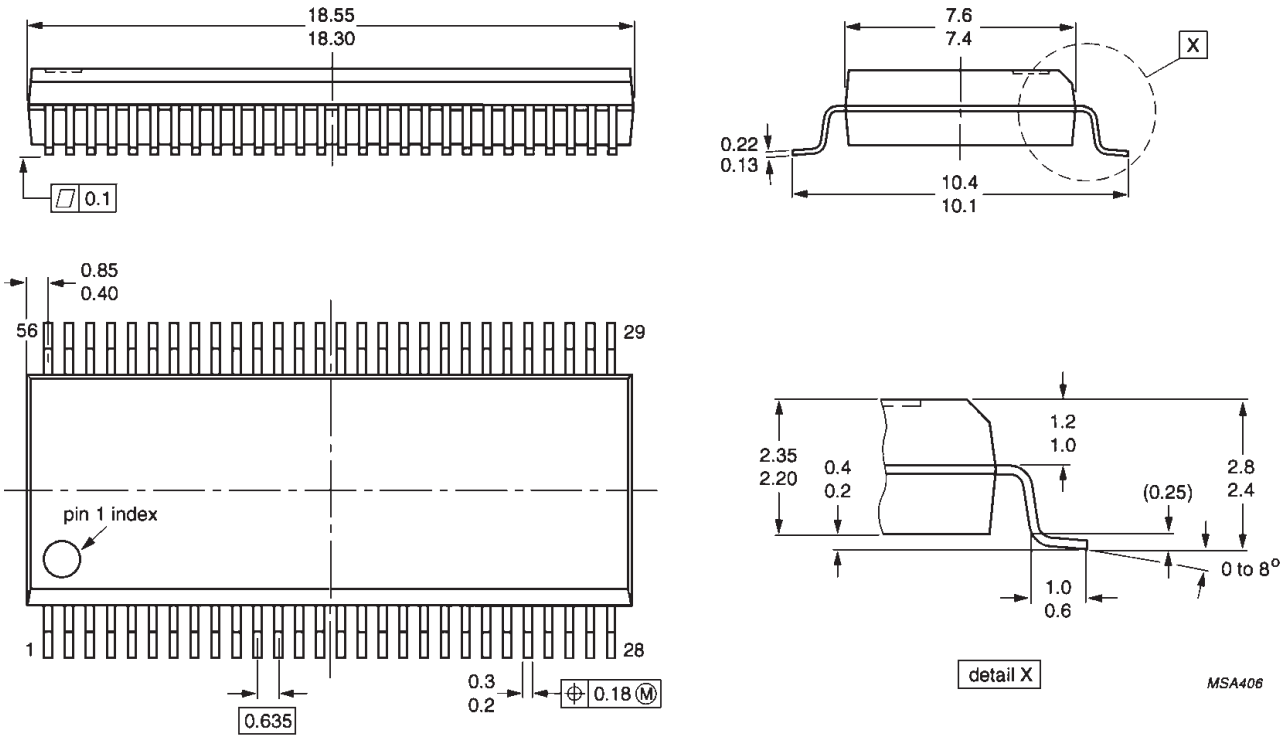
C_L = Load capacitance includes jig and probe capacitance: See AC CHARACTERISTICS for value.

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
74LVT16	2.7V	≤10MHz	500ns	≤2.5ns	≤2.5ns

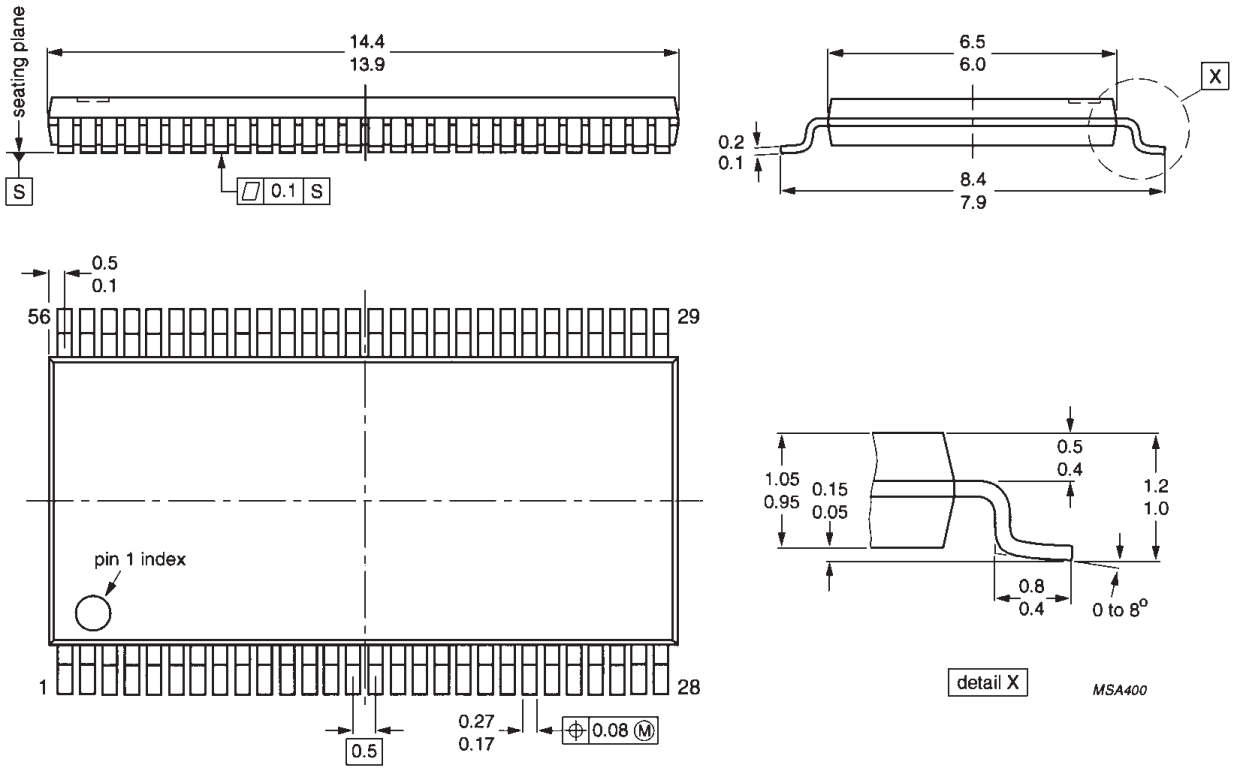
SW00040

SSOP56: plastic shrink small outline package; 56 leads; body width 7.5mm **SOT371-1**



Dimensions in mm.

TSSOP56: plastic thin shrink small outline package; 56 leads; body width 6.1mm **SOT364-1**



Dimensions in mm.

NOTES

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.

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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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