

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

74ALVT16646

FEATURES

- 16-bit universal bus interface
- 5V I/O Compatible
- 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
- No bus current loading when output is tied to 5V bus
- Power-up reset
- Power-up 3-State

- 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 74ALVT16646 is a high-performance BiCMOS product designed for V_{CC} operation from 2.5V to 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 (\overline{DIR}) input for direction control.

Data on the A or B bus is clocked into the registers on the Low to High transition of the appropriate clock (\overline{CPAB} or \overline{CPBA}). The select-control (\overline{SAB} and \overline{SBA}) inputs can multiplex stored and real-time (transparent mode data).

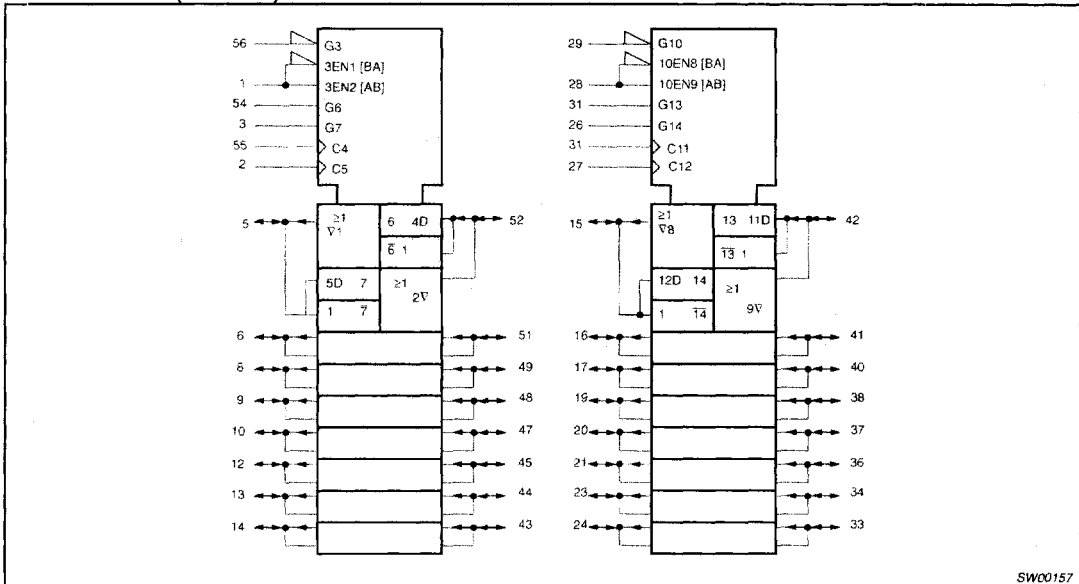
QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS $T_{amb} = 25^{\circ}C$	TYPICAL		UNIT
			2.5V	3.3V	
t_{PLH} t_{PHL}	Propagation delay nAx to nBx or nBx to nAx	$C_L = 50pF$	2.3	1.9	ns
C_{IN}	Input capacitance \overline{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
56-Pin Plastic SSOP Type III	-40°C to +85°C	74ALVT16646 DL	AV16646 DL	SOT371-1
56-Pin Plastic TSSOP Type II	-40°C to +85°C	74ALVT16646 DGG	AV16646 DGG	SOT364-1

LOGIC SYMBOL (IEEE/IEC)

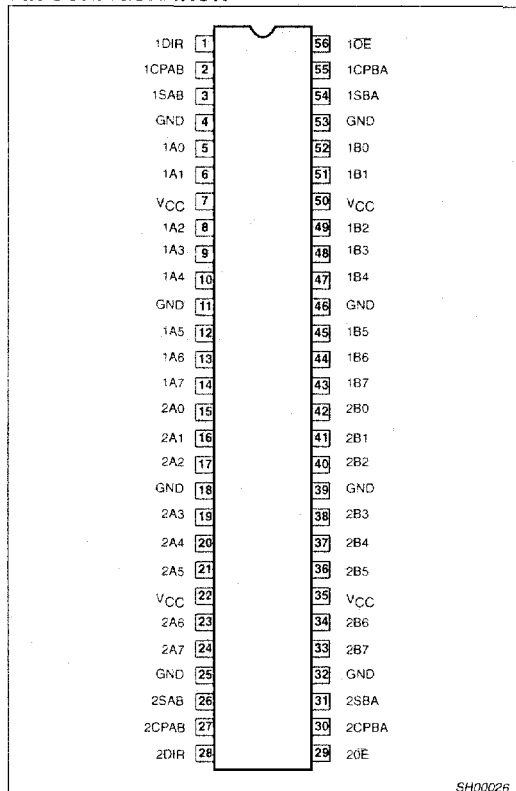


SW00157

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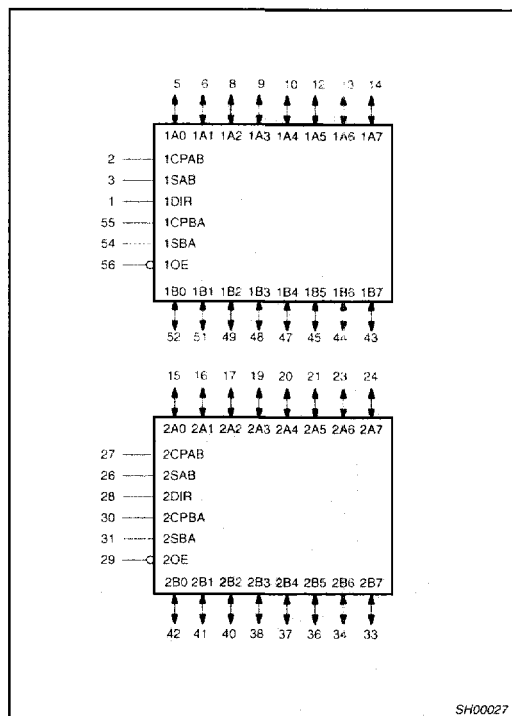
74ALVT16646

PIN CONFIGURATION



SH00026

LOGIC SYMBOL



SH00027

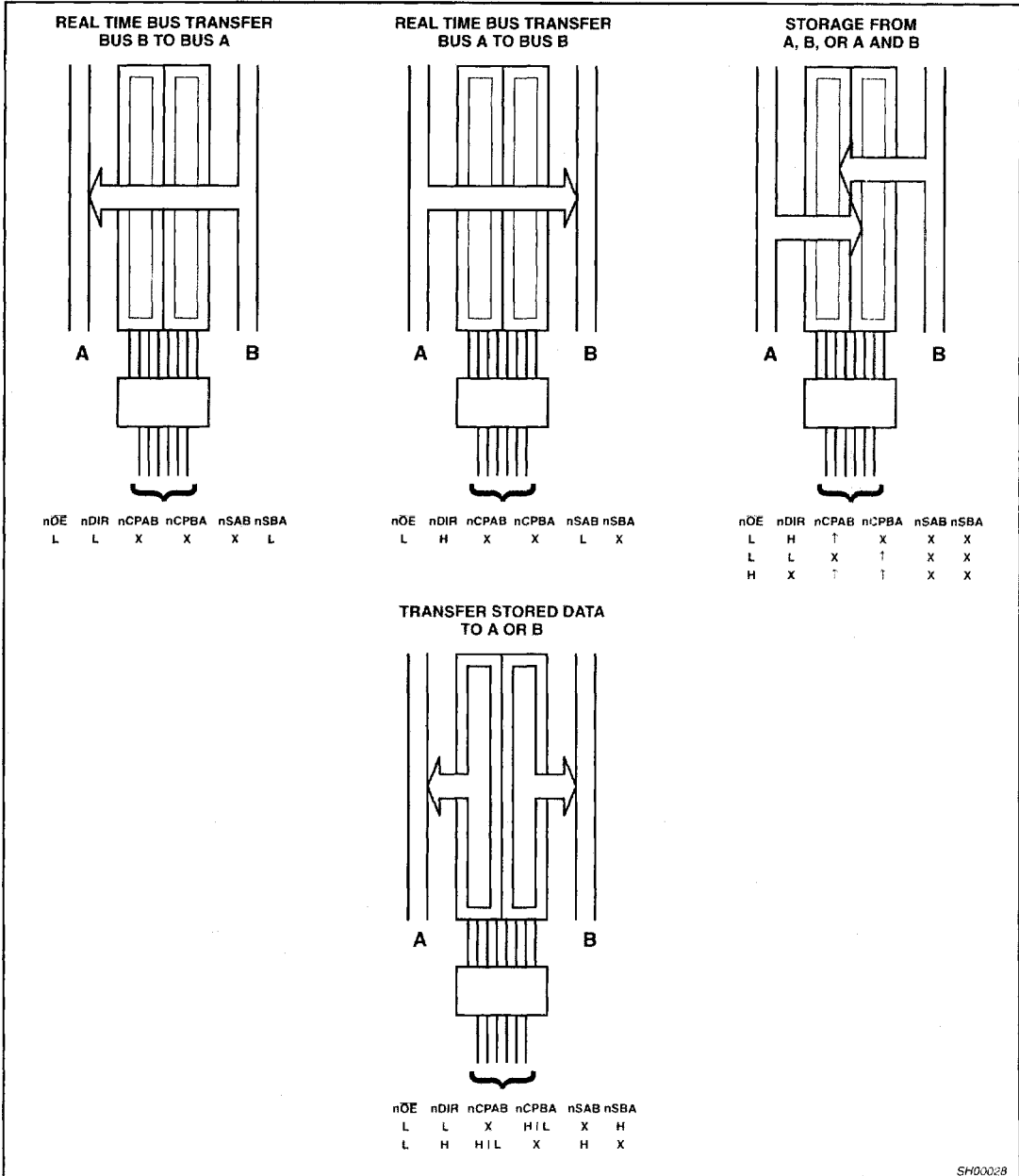
PIN DESCRIPTION

PIN NUMBER	SYMBOL	NAME AND FUNCTION
2, 55, 27, 30	1CPAB, 1CPBA, 2CPAB, 2CPBA	Clock input A to B / Clock input B to A
3, 54, 26, 31	1SAB, 1SBA, 2SAB, 2SBA	Select input A to B / Select input B to A
1, 28	1DIR, 2DIR	Direction control inputs
5, 6, 8, 9, 10, 12, 13, 14 15, 16, 17, 19, 20, 21, 23, 24	1A0 - 1A7, 2A0 - 2A7	Data inputs/outputs (A side)
52, 51, 49, 48, 47, 45, 44, 43 42, 41, 40, 38, 37, 36, 34, 33	1B0 - 1B7, 2B0 - 2B7	Data inputs/outputs (B side)
56, 29	1OE, 2OE	Output enable inputs
4, 11, 18, 25, 32, 39, 46, 53	GND	Ground (0V)
7, 22, 35, 50	V _{CC}	Positive supply voltage

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The following examples demonstrate the four fundamental bus-management functions that can be performed with the 74ALVT16646.

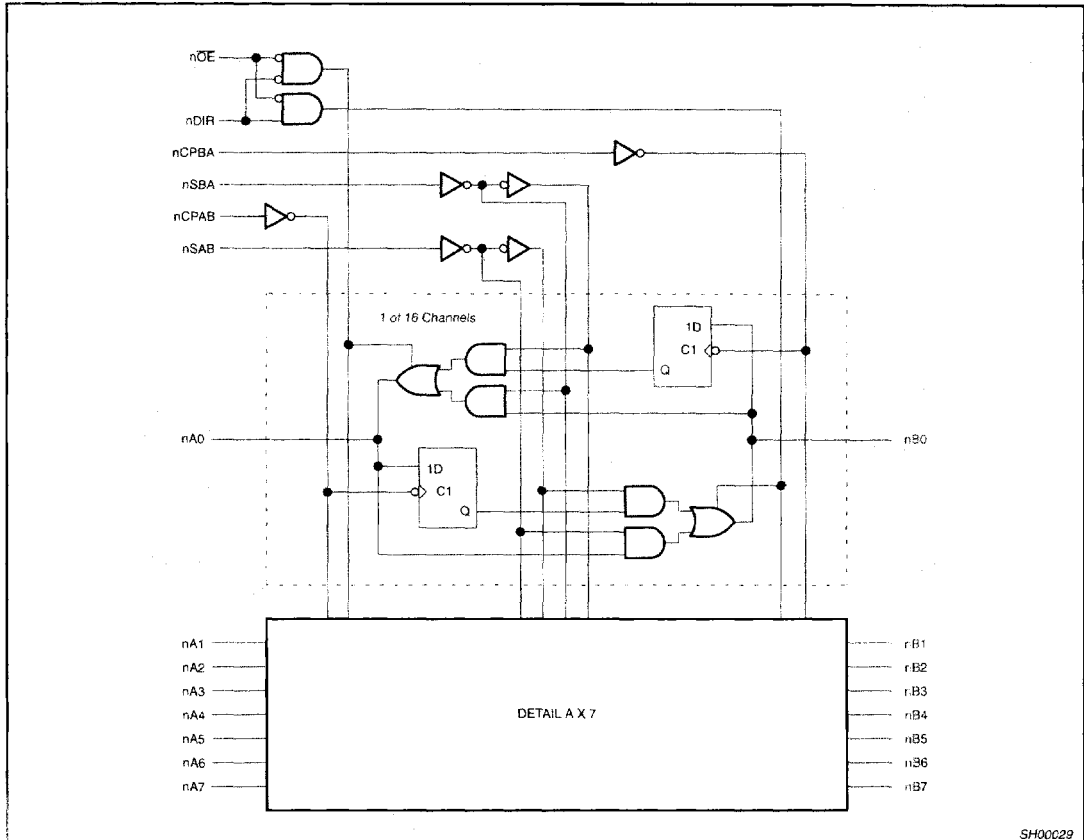


SH00028

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LOGIC DIAGRAM



SH00029

FUNCTION TABLE

INPUTS						DATA I/O		OPERATING MODE
nOE	nDIR	nCPAB	nCPBA	nSAB	nSBA	nAx	nBx	
X	X	↑	X	X	X	Input	Unspecified output*	Store A, B unspecified
X	X	X	↑	X	X	Unspecified output*	Input	Store B, A unspecified
H	X	↑	↑	X	X	Input	Input	Store A and B data Isolation, hold storage
L	L	X	X	X	L	Output	Input	Real time B data to A bus Stored B data to A bus
L	H	X	X	L	X	Input	Output	Real time A data to B bus Stored A data to B bus
L	H	H or L	X	H	X			

H = High voltage level

L = Low voltage level

X = Don't care

↑ = Low-to-High clock transition

* The data output function may be enabled or disabled by various signals at the nOE input. Data input functions are always enabled, i.e., data at the bus pins will be stored on every Low-to-High transition of the clock.

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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.

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	
Δt/Δv	Input transition rise or fall rate; Outputs enabled		10		10	ns/V
T _{amb}	Operating free-air temperature range	-40	+85	-40	+85	°C

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DC ELECTRICAL CHARACTERISTICS (3.3V ± 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 $3.6V; I_{OH} = -100\mu A$	$V_{CC}-0.2$	V_{CC}		V	
		$V_{CC} = 3.0V; I_{OH} = -32mA$	2.0	2.3			
V_{OL}	Low-level output voltage	$V_{CC} = 3.0V; I_{OL} = 100\mu A$		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	
		$V_{CC} = 3.6V; V_I = 5.5V$	I/O 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}	Output off current	$V_{CC} = 0V; V_I$ or $V_O = 0$ to $4.5V$		0.1	±100	μA	
I_{HOLD}	Bus Hold current	$V_{CC} = 3V; V_I = 0.8V$	75	130		μA	
	A or B outputs	$V_{CC} = 3V; V_I = 2.0V$	-75	-140		μA	
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 $V_{CC}; OE/OE = \text{Don't care}$		40	±100	μA	
I_{CCH}	Quiescent supply current	$V_{CC} = 3.6V; \text{Outputs High, } V_I = GND$ or $V_{CC}, I_O = 0$		0.07	0.09	mA	
I_{CCL}		$V_{CC} = 3.6V; \text{Outputs Low, } V_I = GND$ or $V_{CC}, I_O = 0$		3.2	5		
I_{CCZ}		$V_{CC} = 3.6V; \text{Outputs Disabled, } V_I = GND$ or $V_{CC}, I_O = 0^5$		0.07	0.09		
ΔI_{CC}	Additional supply current per input pin ²	$V_{CC} = 3V$ to $3.6V; \text{One input at } V_{CC}-0.6V, \text{Other inputs at } V_{CC}$ or GND		0.04	0.2	mA	

NOTES:

- All typical values are at $V_{CC} = 3.3V$ and $T_{amb} = 25^\circ C$.
- 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 $V_{CC} = 1.2V$ to $V_{CC} = 3.3V \pm 0.3V$ a transition time of 100 μsec is permitted. This parameter is valid for $T_{amb} = 25^\circ C$ only.
- Unused pins at V_{CC} or GND.
- I_{CCZ} is measured with outputs pulled up to V_{CC} or pulled down to ground.

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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
			$V_{CC} = 3.3V \pm 0.3V$			
			MIN	TYP ¹	MAX	
f_{MAX}	Maximum clock frequency	1				MHz
t_{PLH} t_{PHL}	Propagation delay nCPAB to nBx or nCPBA to nAx	1		2.4 2.1	3.4 3.1	ns
t_{PLH} t_{PHL}	Propagation delay nSAB to nBx or nSBA to nAx	2	1.4 1.4	2.4 2.1	4.0 3.6	ns
t_{PLH} t_{PHL}	Propagation delay nAx to nBx or nBx to nAx	2 3	1.0 1.0	1.7 1.8	2.8 2.6	ns
t_{PZH} t_{PZL}	Output enable time to High and Low level	5 6	1.0 1.0	2.3 2.6	4.3 4.4	ns
t_{PHZ} t_{PLZ}	Output disable time from High and Low Level	5 6	1.5 1.5	3.4 2.9	5.4 4.3	ns
t_{PZH} t_{PZL}	Output enable time nDIR to nAx or nBx	5 6	1.0 1.0	2.5 2.6	4.5 4.5	ns
t_{PHZ} t_{PLZ}	Output disable time nDIR to nAx or nBx	5 6	1.5 1.5	3.5 3.1	5.4 4.5	ns

NOTE:1. All typical values are at $V_{CC} = 3.3V$ and $T_{\text{amb}} = 25^\circ\text{C}$.**AC SETUP REQUIREMENTS (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
			$V_{CC} = 3.3V \pm 0.3V$		
			MIN	TYP ¹	
$t_S(\text{H})$ $t_S(\text{L})$	Setup time, High or Low nAx to nCPAB or nBx to nCPBA	4	2.1 2.2	1.0 1.0	ns
$t_H(\text{H})$ $t_H(\text{L})$	Hold time, High or Low nAx to nCPAB or nBx or nCPBA	4	0.0 0.0	-0.5 -0.7	ns
$t_w(\text{H})$ $t_w(\text{L})$	Pulse width, High or Low nCPAB or nCPBA	1	1.5 1.5		ns

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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} = 2.3V; I _{OH} = -8mA	V _{CC} -0.2			V
V _{OL}	Low-level output voltage	V _{CC} = 2.3V; I _{OL} = 100µA V _{CC} = 2.3V; I _{OL} = 24mA		0.07	0.2	V
I _I	Input leakage current	V _{CC} = 2.7V; V _I = GND	Control pins	0.1	±1	µA
		V _{CC} = 0 or 2.7V; V _I = 2.7V		0.1	10	
		V _{CC} = 2.7V; V _I = 2.7V	I/O 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}	Output off current	V _{CC} = 0V; V _I or V _O = 0 to 4.5V		0.1	±100	µA
I _{HOLD} ⁶	Bus Hold current A or B outputs	V _{CC} = 2.5V; V _I = 0.8V		90		µA
		V _{CC} = 2.5V; V _I = 2.0V		75		µA
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} = 2.7V; Outputs High, V _I = GND or V _{CC} , I _O = 0		0.04	0.09	mA
I _{CCL}		V _{CC} = 2.7V; Outputs Low, V _I = GND or V _{CC} , I _O = 0		2.3	4.5	
I _{CCZ}		V _{CC} = 2.7V; Outputs Disabled; V _I = GND or V _{CC} , I _O = 0 ⁵		0.04	0.09	
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		0.01	0.2	mA

NOTES:

- All typical values are at V_{CC} = 2.5V and T_{amb} = 25°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} = 1.2V to V_{CC} = 2.5V ± 0.2V a transition time of 100µsec is permitted. This parameter is valid for T_{amb} = 25°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.

AC CHARACTERISTICS (2.5V ± 0.2V RANGE)

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} = 2.5V ± 0.2V			
			MIN	TYP ¹	MAX	
f _{MAX}	Maximum clock frequency	1	150			MHz
t _{PLH} t _{PHL}	Propagation delay nCPAB to nBx or nCPBA to nAx	1	1.5	3.0	5.5	ns
			1.5	2.8	5.5	
t _{PLH} t _{PHL}	Propagation delay nSAB to nBx or nSBA to nAx	2	1.5	3.4	6.0	ns
			1.5	3.2	6.0	
t _{PLH} t _{PHL}	Propagation delay nAx to nBx or nBx to nAx	2 3	1.2	2.2	4.0	ns
			1.2	2.3	4.1	
t _{PZH} t _{PZL}	Output enable time to High and Low level	5 6	2.0	3.2	6.4	ns
			2.0	3.4	6.4	
t _{PHZ} t _{PLZ}	Output disable time from High and Low Level	5 6	2.0	4.2	7.1	ns
			2.0	3.5	5.8	
t _{PZH} t _{PZL}	Output enable time nDIR to nAx or nBx	5 6	2.0	3.3	6.5	ns
			2.0	3.5	6.5	
t _{PHZ} t _{PLZ}	Output disable time nDIR to nAx or nBx	5 6	2.0	4.3	7.1	ns
			2.0	3.7	6.0	

NOTE:

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

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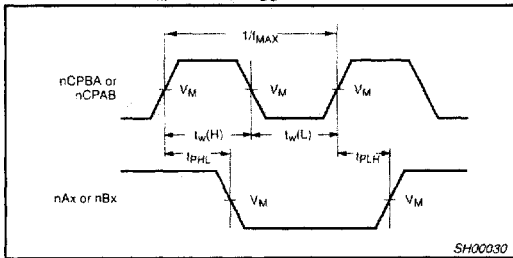
AC SETUP REQUIREMENTS (2.5V ± 0.2V RANGE)

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 $+85^\circ\text{C}$.

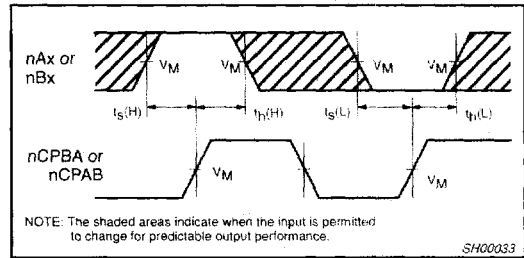
SYMBOL	PARAMETER	WAVEFORM	LIMITS			UNIT
			$V_{CC} = 2.5\text{V} \pm 0.2\text{V}$			
			MIN	TYP ¹	MAX	
$t_s(H)$ $t_s(L)$	Setup time, High or Low nAx to nCPAB or nBx to nCPBA	4	2.5 2.6	1.2 1.2		ns
$t_h(H)$ $t_h(L)$	Hold time, High or Low nAx to nCPAB or nBx or nCPBA	4	0.0 0.0	-1.0 -1.0		ns
$t_w(H)$ $t_w(L)$	Pulse width, High or Low nCPAB or nCPBA	1	1.5 1.5			ns

AC WAVEFORMS

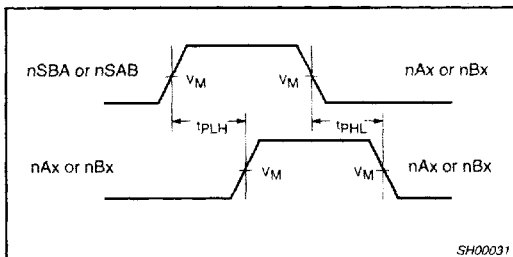
For all waveforms $V_M = 1.5\text{V}$ or $V_{CC} / 2$, whichever is less.



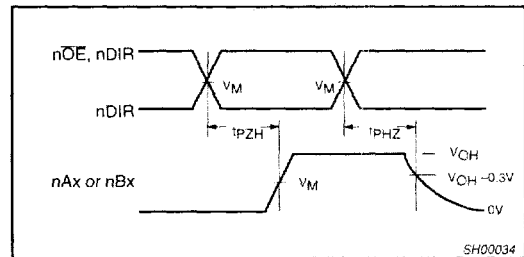
Waveform 1. Propagation Delay, Clock Input to Output, Clock Pulse Width, and Maximum Clock Frequency



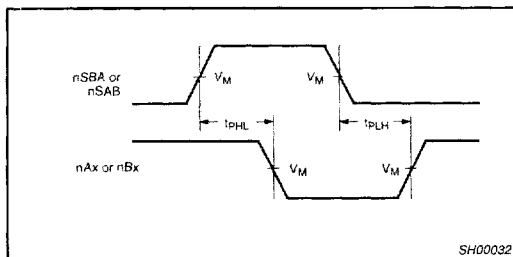
Waveform 4. Data Setup and Hold Times



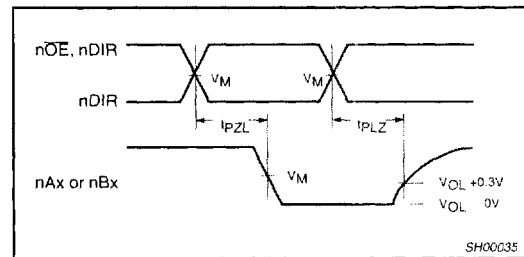
Waveform 2. Propagation Delay, nSAB to nBx or nSAB to nAx, nAx to nBx or nBx to nAx



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



Waveform 3. Propagation Delay, nSBA to nAx or nSAB to nBx



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

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TEST CIRCUIT AND WAVEFORMS

