



# 3.3V CMOS 12-BIT TO 24-BIT REGISTERED BUS EXCHANGER WITH 3-STATE OUTPUTS AND BUS-HOLD

IDT74ALVCH162268

## FEATURES:

- 0.5 MICRON CMOS Technology
- Typical  $t_{SK(O)}$  (Output Skew) < 250ps
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- $V_{CC} = 3.3V \pm 0.3V$ , Normal Range
- $V_{CC} = 2.7V$  to  $3.6V$ , Extended Range
- $V_{CC} = 2.5V \pm 0.2V$
- CMOS power levels ( $0.4\mu W$  typ. static)
- Rail-to-Rail output swing for increased noise margin
- Available in TSSOP and TVSOP packages

## DRIVE FEATURES:

- High Output Drivers:  $\pm 24mA$  (A port)
- Balanced Output Drivers:  $\pm 12mA$  (B port)

## APPLICATIONS:

- 3.3V high speed systems
- 3.3V and lower voltage computing systems

## DESCRIPTION:

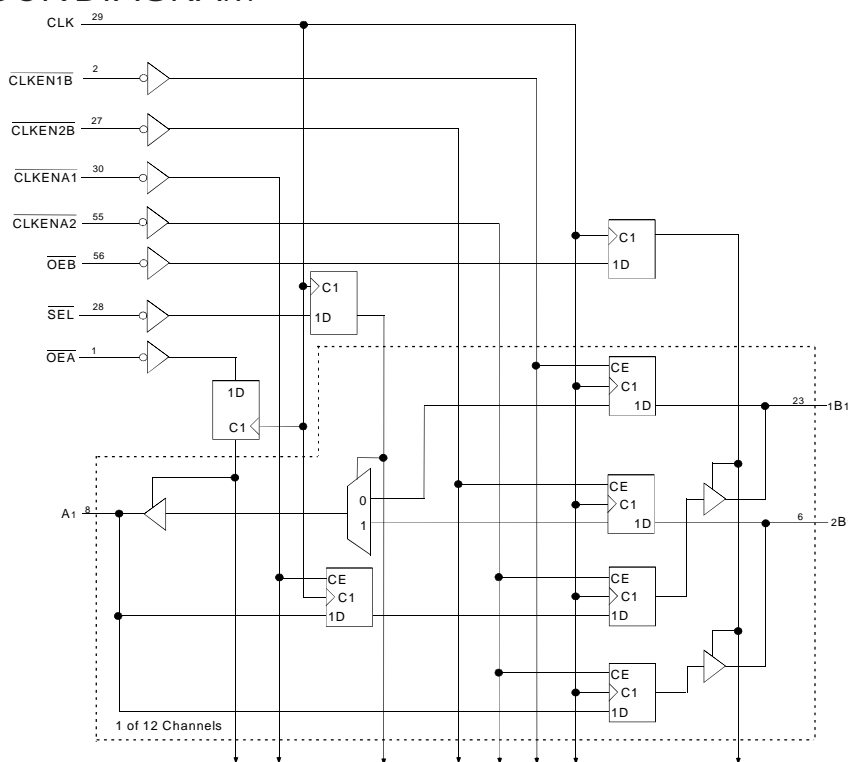
This 12-bit to 24-bit registered bus exchanger is built using advanced dual metal CMOS technology. This device is used for applications in which data must be transferred from a narrow high-speed bus to a wide, lower-frequency bus.

The ALVCH162268 device provides synchronous data exchange between the two ports. Data is stored in the internal registers on the low-to-high transition of the clock (CLK) input when the appropriate clock-enable ( $\overline{CLKEN}$ ) inputs are low. The select ( $\overline{SEL}$ ) line is synchronous with CLK and selects 1B or 2B input data for the A outputs. For data transfer in the A-to-B direction, a two-stage pipeline is provided in the A-to-1B path, with a single storage register in the A-to-2B path. Proper control of these inputs allows two sequential 12-bit words to be presented as a 24-bit word on the B-port. Data flow is controlled by the active-low output enables ( $\overline{OEA}$  and  $\overline{OEB}$ ). These control terminals are registered to synchronize the bus-direction changes with CLK.

The ALVCH162268 has series resistors in the device output structure of the "B" port which will significantly reduce line noise when used with light loads. This driver has been designed to drive  $\pm 12mA$  at the designated threshold levels. The "A" port has a  $\pm 24mA$  driver.

The ALVCH162268 has "bus-hold" which retains the inputs' last state whenever the input bus goes to a high impedance. This prevents floating inputs and eliminates the need for pull-up/down resistors.

## FUNCTIONAL BLOCK DIAGRAM

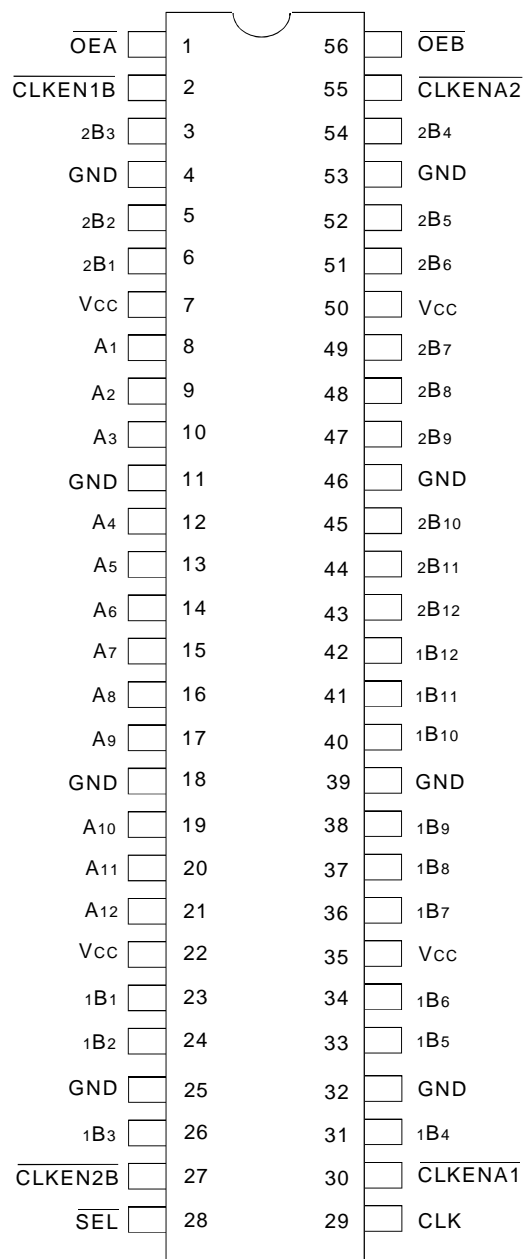


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INDUSTRIAL TEMPERATURE RANGE

JANUARY 2004

## PIN CONFIGURATION



TSSOP/ TVSOP  
TOP VIEW

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Symbol	Description	Max	Unit
VTERM <sup>(2)</sup>	Terminal Voltage with Respect to GND	-0.5 to +4.6	V
VTERM <sup>(3)</sup>	Terminal Voltage with Respect to GND	-0.5 to VCC+0.5	V
TSTG	Storage Temperature	-65 to +150	°C
IOUT	DC Output Current	-50 to +50	mA
I <sub>IK</sub>	Continuous Clamp Current, V <sub>I</sub> < 0 or V <sub>I</sub> > V <sub>CC</sub>	±50	mA
I <sub>OK</sub>	Continuous Clamp Current, V <sub>O</sub> < 0	-50	mA
I <sub>CC</sub> I <sub>SS</sub>	Continuous Current through each V <sub>CC</sub> or GND	±100	mA

### NOTES:

- Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
- V<sub>CC</sub> terminals.
- All terminals except V<sub>CC</sub>.

## CAPACITANCE (T<sub>A</sub> = +25°C, F = 1.0MHz)

Symbol	Parameter <sup>(1)</sup>	Conditions	Typ.	Max.	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 0V	5	7	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>OUT</sub> = 0V	7	9	pF
C <sub>I/O</sub>	I/O Port Capacitance	V <sub>IN</sub> = 0V	7	9	pF

### NOTE:

- As applicable to the device type.

## FUNCTION TABLES<sup>(1)</sup>

### OUTPUT ENABLE

Inputs			Outputs	
CLK	$\overline{OE}A$	$\overline{OE}B$	A <sub>x</sub>	1B <sub>x</sub> , 2B <sub>x</sub>
↑	H	H	Z	Z
↑	H	L	Z	Active
↑	L	H	Active	Z
↑	L	L	Active	Active

### A-TO-B STORAGE ( $\overline{OE}B = L$ AND $\overline{OE}A = H$ )

Inputs				Outputs	
$\overline{CLK}ENA1$	$\overline{CLK}ENA2$	CLK	A <sub>x</sub>	1B <sub>x</sub>	2B <sub>x</sub>
H	H	X	X	1B <sub>0</sub> <sup>(2)</sup>	2B <sub>0</sub> <sup>(2)</sup>
L	L	↑	L	L <sup>(3)</sup>	L
L	L	↑	H	H <sup>(3)</sup>	H
X	L	↑	L	X	L
X	L	↑	H	X	H

FUNCTION TABLES (CONTINUED)<sup>(1)</sup>

B-TO-A STORAGE ( $\overline{OE}A = L$  AND  $\overline{OE}B = H$ )

Inputs						Output
$\overline{CLKEN1B}$	$\overline{CLKEN2B}$	CLK	$\overline{SEL}$	1Bx	2Bx	Ax
H	X	X	H	X	X	$A_0^{(2)}$
X	H	X	L	X	X	$A_0^{(2)}$
L	X	↑	H	L	X	L
L	X	↑	H	H	X	H
X	L	↑	L	X	L	L
X	L	↑	L	X	H	H

NOTE:

- H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Don't Care  
Z = High Impedance  
↑ = LOW-to-HIGH transition
- Output level before the indicated steady-state input conditions were established.
- Two CLK edges are needed to propagate data.

PIN DESCRIPTION

Pin Names	I/O	Description
Ax (1:12)	I/O	Bidirectional Data Port A. Usually connected to the CPU's address/data bus. <sup>(1)</sup>
1Bx (1:12)	I/O	Bidirectional Data Port 1B. Usually connected to the even path or even bank of memory. <sup>(1)</sup>
2Bx (1:12)	I/O	Bidirectional Data Port 2B. Usually connected to the odd path or odd bank of memory. <sup>(1)</sup>
CLK	I	Clock Input
$\overline{CLKENA1}$	I	Clock Enable Input for the A-1B Register. If $\overline{CLKENA1}$ is LOW during the rising edge of CLK, data will be clocked into register A-1B (Active LOW).
$\overline{CLKENA2}$	I	Clock Enable Input for the A-1B Register. If $\overline{CLKENA2}$ is LOW during the rising edge of CLK, data will be clocked into register A-2B (Active LOW).
$\overline{CLKEN1B}$	I	Clock Enable Input for the A-1B Register. If $\overline{CLKEN1B}$ is LOW during the rising edge of CLK, data will be clocked into register 1B-A (Active LOW).
$\overline{CLKEN2B}$	I	Clock Enable Input for the A-1B Register. If $\overline{CLKEN2B}$ is LOW during the rising edge of CLK, data will be clocked into register 2B-A (Active LOW).
$\overline{SEL}$	I	1B or 2B Port Selection. When HIGH during the rising edge of CLK, $\overline{SEL}$ enables data transfer from 1B Port to A Port. When LOW during the rising edge of CLK, $\overline{SEL}$ enables data transfer from 2B Port to A Port (Active LOW).
$\overline{OE}A$	I	Synchronous Output Enable for A Port (Active LOW)
$\overline{OE}B$	I	Synchronous Output Enable for A Port (Active LOW)

NOTE:

- These pins have "Bus-Hold". All other pins are standard inputs, outputs, or I/Os.

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Operating Condition:  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

Symbol	Parameter	Test Conditions		Min.	Typ. <sup>(1)</sup>	Max.	Unit
V <sub>IH</sub>	Input HIGH Voltage Level	V <sub>CC</sub> = 2.3V to 2.7V		1.7	—	—	V
		V <sub>CC</sub> = 2.7V to 3.6V		2	—	—	
V <sub>IL</sub>	Input LOW Voltage Level	V <sub>CC</sub> = 2.3V to 2.7V		—	—	0.7	V
		V <sub>CC</sub> = 2.7V to 3.6V		—	—	0.8	
I <sub>IH</sub>	Input HIGH Current	V <sub>CC</sub> = 3.6V	V <sub>I</sub> = V <sub>CC</sub>	—	—	±5	μA
I <sub>IL</sub>	Input LOW Current	V <sub>CC</sub> = 3.6V	V <sub>I</sub> = GND	—	—	±5	μA
I <sub>OZH</sub> I <sub>OZL</sub>	High Impedance Output Current (3-State Output pins)	V <sub>CC</sub> = 3.6V	V <sub>O</sub> = V <sub>CC</sub>	—	—	±10	μA
			V <sub>O</sub> = GND	—	—	±10	
V <sub>IK</sub>	Clamp Diode Voltage	V <sub>CC</sub> = 2.3V, I <sub>IN</sub> = -18mA		—	-0.7	-1.2	V
V <sub>H</sub>	Input Hysteresis	V <sub>CC</sub> = 3.3V		—	100	—	mV
I <sub>CC1</sub> I <sub>CC2</sub> I <sub>CC3</sub>	Quiescent Power Supply Current	V <sub>CC</sub> = 3.6V V <sub>IN</sub> = GND or V <sub>CC</sub>		—	0.1	40	μA
ΔI <sub>CC</sub>	Quiescent Power Supply Current Variation	One input at V <sub>CC</sub> - 0.6V, other inputs at V <sub>CC</sub> or GND		—	—	750	μA

**NOTE:**

1. Typical values are at V<sub>CC</sub> = 3.3V, +25°C ambient.

## BUS-HOLD CHARACTERISTICS

Symbol	Parameter <sup>(1)</sup>	Test Conditions		Min.	Typ. <sup>(2)</sup>	Max.	Unit
I <sub>BHH</sub> I <sub>BHL</sub>	Bus-Hold Input Sustain Current	V <sub>CC</sub> = 3V	V <sub>I</sub> = 2V	-75	—	—	μA
			V <sub>I</sub> = 0.8V	75	—	—	
I <sub>BHH</sub> I <sub>BHL</sub>	Bus-Hold Input Sustain Current	V <sub>CC</sub> = 2.3V	V <sub>I</sub> = 1.7V	-45	—	—	μA
			V <sub>I</sub> = 0.7V	45	—	—	
I <sub>BHHO</sub> I <sub>BHLO</sub>	Bus-Hold Input Overdrive Current	V <sub>CC</sub> = 3.6V	V <sub>I</sub> = 0 to 3.6V	—	—	±500	μA

**NOTES:**

1. Pins with Bus-Hold are identified in the pin description.
2. Typical values are at V<sub>CC</sub> = 3.3V, +25°C ambient.

## OUTPUT DRIVE CHARACTERISTICS (A PORT)

Symbol	Parameter	Test Conditions <sup>(1)</sup>		Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	V <sub>CC</sub> = 2.3V to 3.6V	I <sub>OH</sub> = - 0.1mA	V <sub>CC</sub> - 0.2	—	V
		V <sub>CC</sub> = 2.3V	I <sub>OH</sub> = - 6mA	2	—	
		V <sub>CC</sub> = 2.3V	I <sub>OH</sub> = - 12mA	1.7	—	
		V <sub>CC</sub> = 2.7V		2.2	—	
		V <sub>CC</sub> = 3V		2.4	—	
		V <sub>CC</sub> = 3V		I <sub>OH</sub> = - 24mA	2	
V <sub>OL</sub>	Output LOW Voltage	V <sub>CC</sub> = 2.3V to 3.6V	I <sub>OL</sub> = 0.1mA	—	0.2	V
		V <sub>CC</sub> = 2.3V	I <sub>OL</sub> = 6mA	—	0.4	
			I <sub>OL</sub> = 12mA	—	0.7	
		V <sub>CC</sub> = 2.7V	I <sub>OL</sub> = 12mA	—	0.4	
		V <sub>CC</sub> = 3V	I <sub>OL</sub> = 24mA	—	0.55	

**NOTE:**

- V<sub>IH</sub> and V<sub>IL</sub> must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate V<sub>CC</sub> range.  
T<sub>A</sub> = - 40°C to + 85°C.

## OUTPUT DRIVE CHARACTERISTICS (B PORT)

Symbol	Parameter	Test Conditions <sup>(1)</sup>		Min.	Max.	Unit
V <sub>OH</sub>	Output HIGH Voltage	V <sub>CC</sub> = 2.3V to 3.6V	I <sub>OH</sub> = - 0.1mA	V <sub>CC</sub> - 0.2	—	V
		V <sub>CC</sub> = 2.3V	I <sub>OH</sub> = - 4mA	1.9	—	
			I <sub>OH</sub> = - 6mA	1.7	—	
		V <sub>CC</sub> = 2.7V	I <sub>OH</sub> = - 4mA	2.2	—	
			I <sub>OH</sub> = - 8mA	2	—	
		V <sub>CC</sub> = 3V	I <sub>OH</sub> = - 6mA	2.4	—	
V <sub>OL</sub>	Output LOW Voltage	V <sub>CC</sub> = 2.3V to 3.6V	I <sub>OL</sub> = 0.1mA	—	0.2	V
		V <sub>CC</sub> = 2.3V	I <sub>OL</sub> = 4mA	—	0.4	
			I <sub>OL</sub> = 6mA	—	0.55	
		V <sub>CC</sub> = 2.7V	I <sub>OL</sub> = 4mA	—	0.4	
			I <sub>OL</sub> = 8mA	—	0.6	
		V <sub>CC</sub> = 3V	I <sub>OL</sub> = 6mA	—	0.55	
	I <sub>OL</sub> = 12mA	—	0.8			

**NOTE:**

- V<sub>IH</sub> and V<sub>IL</sub> must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate V<sub>CC</sub> range.  
T<sub>A</sub> = - 40°C to + 85°C.

## OPERATING CHARACTERISTICS, T<sub>A</sub> = 25°C

Symbol	Parameter	Test Conditions	V <sub>CC</sub> = 2.5V ± 0.2V	V <sub>CC</sub> = 3.3V ± 0.3V	Unit
			Typical	Typical	
CPD	Power Dissipation Capacitance Outputs enabled	C <sub>L</sub> = 0pF, f = 10Mhz	87	120	pF
CPD	Power Dissipation Capacitance Outputs disabled		80	118	

SWITCHING CHARACTERISTICS (A PORT)<sup>(1)</sup>

Symbol	Parameter	V <sub>CC</sub> = 2.5V ± 0.2V		V <sub>CC</sub> = 2.7V		V <sub>CC</sub> = 3.3V ± 0.3V		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
f <sub>MAX</sub>		120	—	125	—	150	—	MHz
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay CLK to Ax (1B)	1.6	5.8	—	5.4	1.7	4.8	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay CLK to Ax (2B)	1.6	5.8	—	5.3	1.8	4.8	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay CLK to Ax ( $\overline{\text{SEL}}$ )	2.5	7.3	—	6.5	2.4	5.8	ns
t <sub>PZH</sub> t <sub>PZL</sub>	Output Enable Time CLK to Ax	2	6.2	—	5.6	1.8	5.1	ns
t <sub>PHZ</sub> t <sub>PLZ</sub>	Output Disable Time CLK to Ax	2	6.5	—	5.4	2.1	5	ns
t <sub>SU</sub>	Set-up Time, Ax data before CLK ↑	4.5	—	4	—	3.4	—	ns
t <sub>SU</sub>	Set-up Time, $\overline{\text{SEL}}$ before CLK ↑	1.4	—	1.6	—	1.3	—	ns
t <sub>SU</sub>	Set-up Time, $\overline{\text{CLKENA1}}$ or $\overline{\text{CLKENA2}}$ before CLK ↑	3.6	—	3.4	—	2.8	—	ns
t <sub>SU</sub>	Set-up Time, $\overline{\text{OE A}}$ before CLK ↑	4.2	—	3.9	—	3.2	—	ns
t <sub>H</sub>	Hold Time, Ax data after CLK ↑	0	—	0	—	0.2	—	ns
t <sub>H</sub>	Hold Time, $\overline{\text{SEL}}$ after CLK ↑	1	—	1	—	1	—	ns
t <sub>H</sub>	Hold Time, $\overline{\text{CLKENA1}}$ or $\overline{\text{CLKENA2}}$ after CLK ↑	0.1	—	0.1	—	0.4	—	ns
t <sub>H</sub>	Hold Time, $\overline{\text{OE A}}$ after CLK ↑	0	—	0	—	0.2	—	ns
t <sub>w</sub>	Pulse Width, CLK HIGH or LOW	3.3	—	3.3	—	3.3	—	ns
t <sub>SK(O)</sub>	Output Skew <sup>(2)</sup>	—	—	—	—	—	500	ps

NOTES:

1. See TEST CIRCUITS AND WAVEFORMS. T<sub>A</sub> = - 40°C to + 85°C.
2. Skew between any two outputs of the same package and switching in the same direction.

SWITCHING CHARACTERISTICS (B PORT)<sup>(1)</sup>

Symbol	Parameter	V <sub>CC</sub> = 2.5V ± 0.2V		V <sub>CC</sub> = 2.7V		V <sub>CC</sub> = 3.3V ± 0.3V		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
f <sub>MAX</sub>		120	—	125	—	150	—	MHz
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay CLK to 1Bx or 2Bx	1.6	6.1	—	5.9	1.8	5.4	ns
t <sub>PZH</sub> t <sub>PZL</sub>	Output Enable Time CLK to 1Bx or 2Bx	2.7	7.2	—	6.8	2.6	6.1	ns
t <sub>PHZ</sub> t <sub>PLZ</sub>	Output Disable Time CLK to 1Bx or 2Bx	2.8	7.2	—	6.1	2.5	5.9	ns
t <sub>SU</sub>	Set-up Time, Bx data before CLK ↑	0.8	—	1.2	—	1	—	ns
t <sub>SU</sub>	Set-up Time, $\overline{\text{CLKEN1B}}$ or $\overline{\text{CLKEN2B}}$ before CLK ↑	3.2	—	3	—	2.5	—	ns
t <sub>SU</sub>	Set-up Time, $\overline{\text{OE B}}$ before CLK ↑	4.2	—	3.9	—	3.2	—	ns
t <sub>H</sub>	Hold Time, Bx data after CLK ↑	1.3	—	1.2	—	1.3	—	ns
t <sub>H</sub>	Hold Time, $\overline{\text{CLKEN1B}}$ or $\overline{\text{CLKEN2B}}$ after CLK ↑	0.1	—	0	—	0.5	—	ns
t <sub>H</sub>	Hold Time, $\overline{\text{OE B}}$ after CLK ↑	0	—	0	—	0.2	—	ns
t <sub>SK(O)</sub>	Output Skew <sup>(2)</sup>	—	—	—	—	—	500	ps

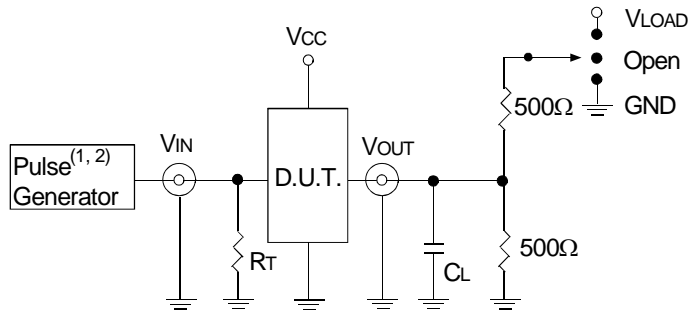
NOTES:

1. See TEST CIRCUITS AND WAVEFORMS. T<sub>A</sub> = - 40°C to + 85°C.
2. Skew between any two outputs of the same package and switching in the same direction.

## TEST CIRCUITS AND WAVEFORMS

### TEST CONDITIONS

Symbol	V <sub>CC</sub> <sup>(1)</sup> =3.3V±0.3V	V <sub>CC</sub> <sup>(1)</sup> =2.7V	V <sub>CC</sub> <sup>(2)</sup> =2.5V±0.2V	Unit
V <sub>LOAD</sub>	6	6	2 x V <sub>CC</sub>	V
V <sub>IH</sub>	2.7	2.7	V <sub>CC</sub>	V
V <sub>T</sub>	1.5	1.5	V <sub>CC</sub> / 2	V
V <sub>LZ</sub>	300	300	150	mV
V <sub>HZ</sub>	300	300	150	mV
C <sub>L</sub>	50	50	30	pF



Test Circuit for All Outputs

#### DEFINITIONS:

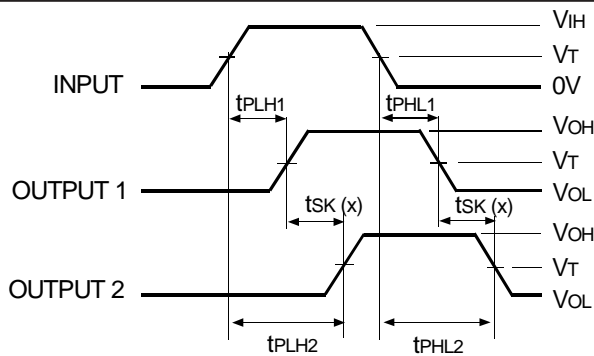
C<sub>L</sub> = Load capacitance: includes jig and probe capacitance.  
R<sub>T</sub> = Termination resistance: should be equal to Z<sub>OUT</sub> of the Pulse Generator.

#### NOTES:

1. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; t<sub>r</sub> ≤ 2.5ns; t<sub>r</sub> ≤ 2.5ns.
2. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; t<sub>r</sub> ≤ 2ns; t<sub>r</sub> ≤ 2ns.

### SWITCH POSITION

Test	Switch
Open Drain Disable Low Enable Low	V <sub>LOAD</sub>
Disable High Enable High	GND
All Other Tests	Open

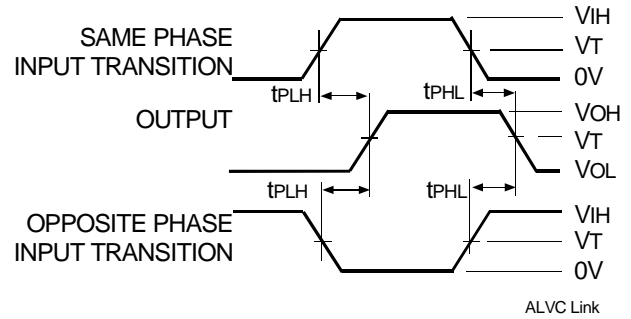


$$tsk(x) = |t_{PLH2} - t_{PLH1}| \text{ or } |t_{PHL2} - t_{PHL1}|$$

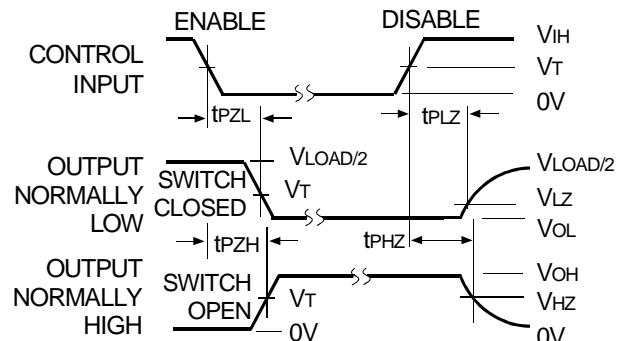
Output Skew - *tsk(x)*

#### NOTES:

1. For tsk(o) OUTPUT1 and OUTPUT2 are any two outputs.
2. For tsk(b) OUTPUT1 and OUTPUT2 are in the same bank.



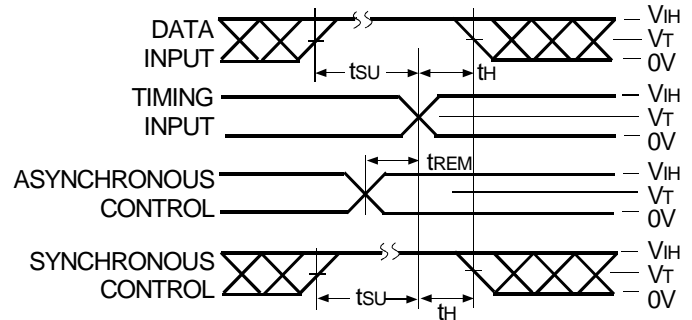
Propagation Delay



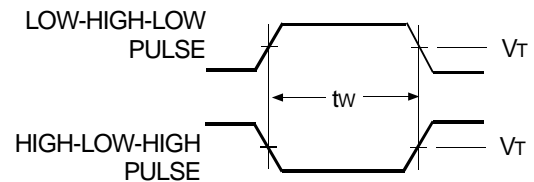
Enable and Disable Times

#### NOTE:

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.



Set-up, Hold, and Release Times



Pulse Width

## ORDERING INFORMATION

IDT	XX	ALVC	X	XX	XXX	XX	
Temp. Range	Bus-Hold	Family	Device Type	Package			
						PA	Thin Shrink Small Outline Package
						PF	Thin Very Small Outline Package
					268		12-Bit To 24-Bit Registered Bus Exchanger with 3-State Outputs
				162			Double-Density with Resistors, $\pm 24\text{mA}$ (A port) $\pm 12\text{mA}$ (B port)
			H				Bus-Hold
					74		$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$



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