



# 3.3V CMOS 16-BIT BUS TRANSCIVER/REGISTER WITH 3-STATE OUTPUTS, 5 VOLT TOLERANT I/O

**IDT74LVC16646A**

## FEATURES:

- 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
- CMOS power levels (0.4 $\mu$ W typ. static)
- All inputs, outputs, and I/O are 5V tolerant
- Supports hot insertion
- Available in SSOP and TSSOP packages

## DRIVE FEATURES:

- High Output Drivers:  $\pm 24mA$
- Reduced system switching noise

## APPLICATIONS:

- 5V and 3.3V mixed voltage systems
- Data communication and telecommunication systems

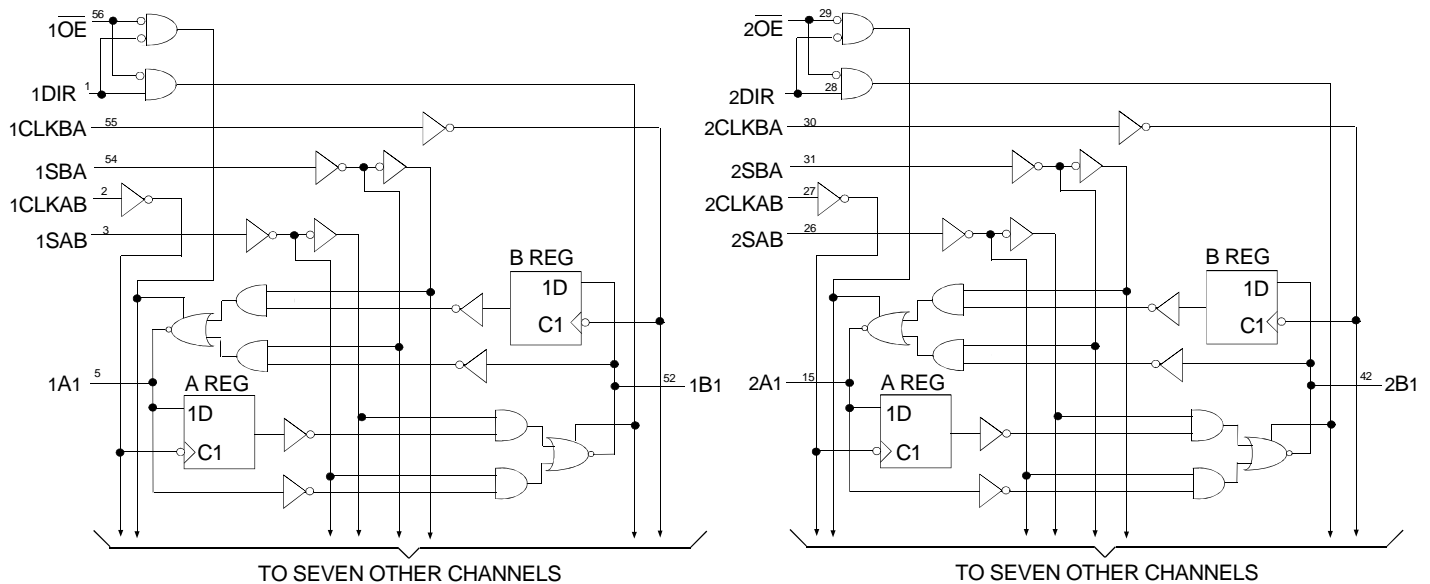
## DESCRIPTION:

The LVC16646A 16-bit bus transceiver/register is built using advanced dual metal CMOS technology. This high-speed, low power device is organized as two independent 8-bit D-type transceivers with 3-state D-type registers. The control circuitry is organized for multiplexed transmission of data between the A bus and B bus either directly or from the internal storage registers. Each 8-bit transceiver/register features direction control (DIR), over-riding Output Enable control ( $\overline{OE}$ ) and Select lines (SAB and SBA) to select either real-time data or stored data. Separate clock inputs are provided for A and B port registers. Data on the A or B data bus, or both, can be stored in the internal registers by the low-to-high transitions at the appropriate clock pins. Flow-through organization of signal pins simplifies layout. All inputs are designed with hysteresis for improved noise margin.

All pins can be driven from either 3.3V or 5V devices. This feature allows the use of this device as a translator in a mixed 3.3V/5V supply system.

The LVC16646A has been designed with a  $\pm 24mA$  output driver. The driver is capable of driving a moderate to heavy load while maintaining speed performance.

## FUNCTIONAL BLOCK DIAGRAM

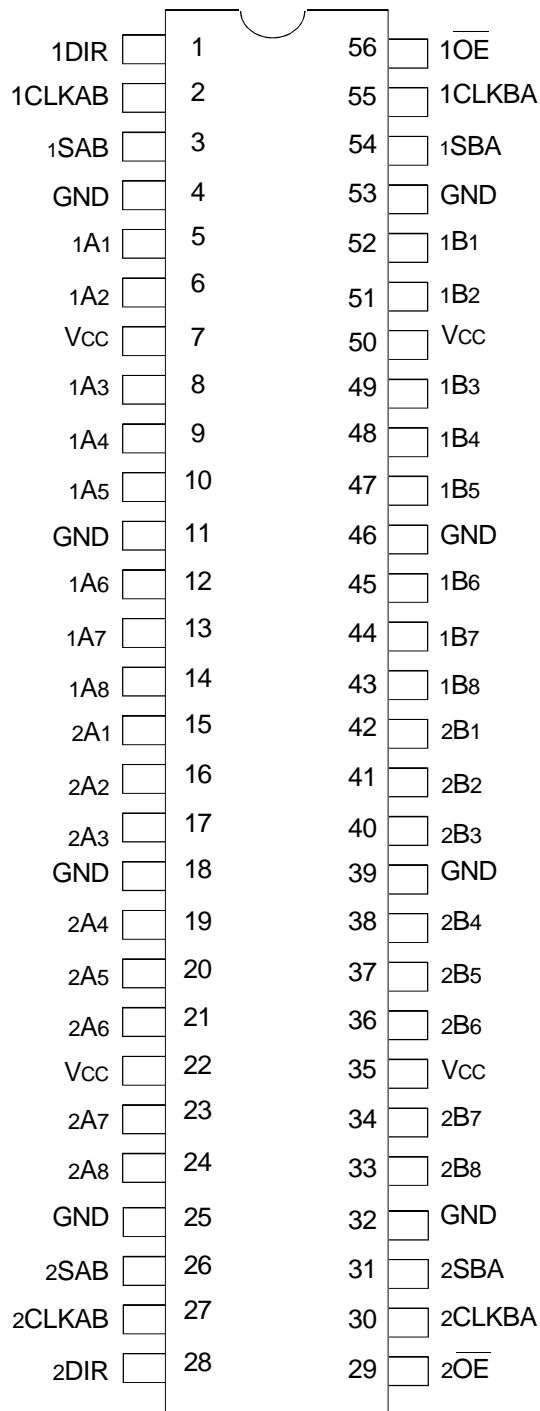


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INDUSTRIAL TEMPERATURE RANGE

JANUARY 2004

## PIN CONFIGURATION



SSOP/ TSSOP  
TOP VIEW

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

Symbol	Description	Max	Unit
VTERM	Terminal Voltage with Respect to GND	-0.5 to +6.5	V
TSTG	Storage Temperature	-65 to +150	°C
I <sub>OUT</sub>	DC Output Current	-50 to +50	mA
I <sub>IK</sub> I <sub>OK</sub>	Continuous Clamp Current, V <sub>I</sub> < 0 or 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

### NOTE:

- 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.

## 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	4.5	6	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>OUT</sub> = 0V	6.5	8	pF
C <sub>I/O</sub>	I/O Port Capacitance	V <sub>IN</sub> = 0V	6.5	8	pF

### NOTE:

- As applicable to the device type.

## PIN DESCRIPTION

Pin Names	Description
xAx	Data Register A Inputs Data Register B 3-State Outputs
xBx	Data Register B Inputs Data Register A 3-State Outputs
xCLKAB, xCLKBA	Clock Pulse Inputs
xSAB, xSBA	Output Data Source Select Inputs
x $\overline{OE}$	Output Enable Inputs
xDIR	Direction Control Inputs

FUNCTION TABLE<sup>(1)</sup>

Inputs						Data I/O <sup>(2)</sup>		Operation or Function
x $\overline{OE}$	xDIR	xCLKAB	xCLKBA	xSAB	xSBA	xAx	xBx	
X	X	↑	X	X	X	Input	Unspecified <sup>(2)</sup>	Store A, B unspecified <sup>(2)</sup>
X	X	X	↑	X	X	Unspecified <sup>(2)</sup>	Input	Store B, A unspecified <sup>(2)</sup>
H	X	↑	↑	X	X	Input	Input	Store A and B data
H	X	H or L	H or L	X	X	Input	Input	Isolation, hold storage
L	L	X	X	X	L	Output	Input	Real time B data to A bus
L	L	X	H or L	X	H	Output	Input	Stored B data to A bus
L	H	X	X	L	X	Input	Output	Real time A data to B bus
L	H	H or L	X	H	X	Input	Output	Stored A data to B bus

NOTES:

- H = HIGH Voltage Level  
X = Don't Care  
L = LOW Voltage Level  
↑ = LOW-to-HIGH transition
- The data output functions may be enabled or disabled by various signals at the x $\overline{OE}$  or xDIR inputs. 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 inputs.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

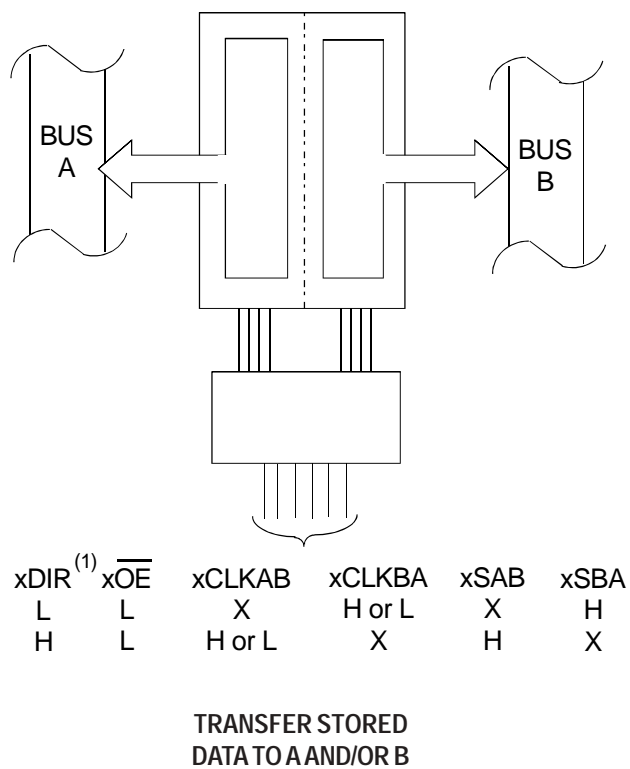
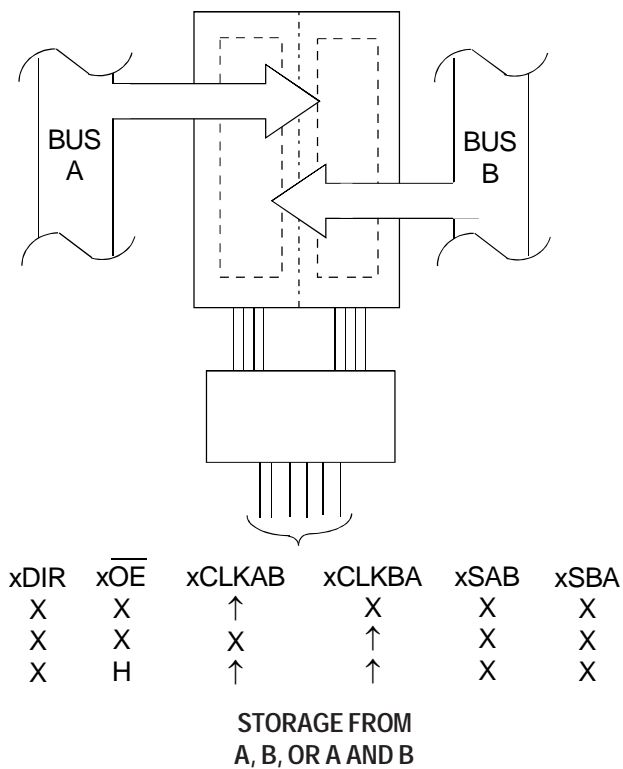
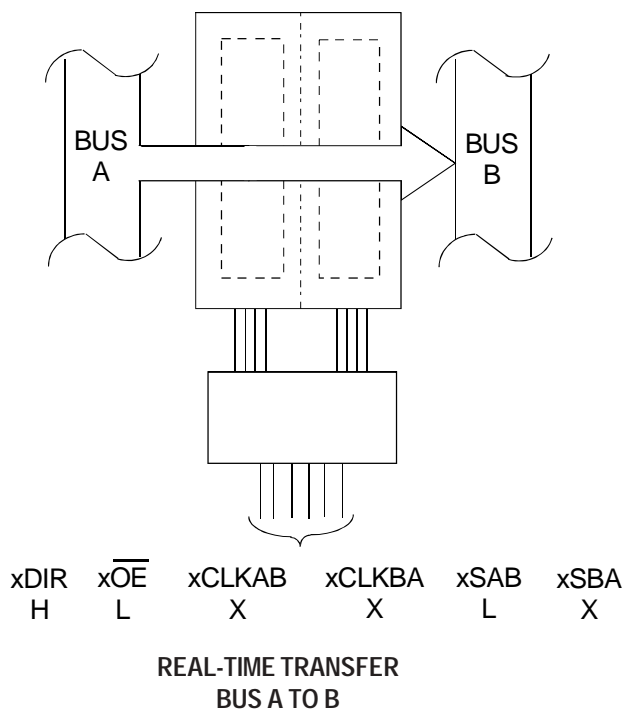
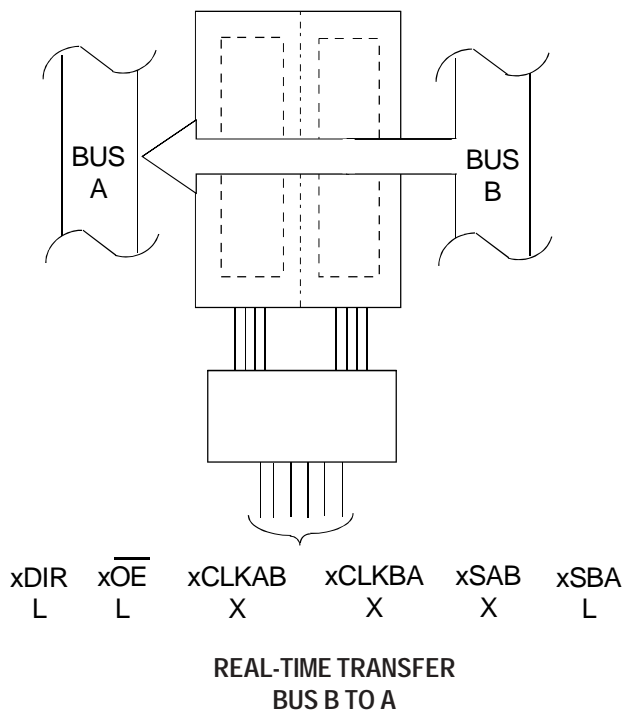
Following Conditions Apply Unless Otherwise Specified:

Operating Condition: TA = -40°C to +85°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> I <sub>IL</sub>	Input Leakage Current	V <sub>CC</sub> = 3.6V	V <sub>I</sub> = 0 to 5.5V	—	—	±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> = 0 to 5.5V	—	—	±10	μA
I <sub>OFF</sub>	Input/Output Power Off Leakage	V <sub>CC</sub> = 0V, V <sub>IN</sub> or V <sub>O</sub> ≤ 5.5V		—	—	±50	μA
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>CCH</sub> I <sub>CCZ</sub>	Quiescent Power Supply Current	V <sub>CC</sub> = 3.6V	V <sub>IN</sub> = GND or V <sub>CC</sub>	—	—	10	μA
			3.6 ≤ V <sub>IN</sub> ≤ 5.5V <sup>(2)</sup>	—	—	10	
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		—	—	500	μA

NOTES:

- Typical values are at V<sub>CC</sub> = 3.3V, +25°C ambient.
- This applies in the disabled state only.



**NOTE:**  
1. Cannot transfer data to A Bus and B Bus simultaneously.

## OUTPUT DRIVE CHARACTERISTICS

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	2.2	—	
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.

## OPERATING CHARACTERISTICS, V<sub>CC</sub> = 3.3V ± 0.3V, T<sub>A</sub> = 25°C

Symbol	Parameter	Test Conditions	Typical	Unit
CPD	Power Dissipation Capacitance per Transceiver Outputs enabled	C <sub>L</sub> = 0pF, f = 10Mhz	60	pF
CPD	Power Dissipation Capacitance per Transceiver Outputs disabled		12	

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

Symbol	Parameter	V <sub>CC</sub> = 2.7V		V <sub>CC</sub> = 3.3V ± 0.3V		Unit
		Min.	Max.	Min.	Max.	
f <sub>MAX</sub>		150	—	150	—	MHz
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay xAx to xBx or xBx to xAx	—	6.8	1.3	5.7	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay CLKBA to xAx, CLKAB to xBx	—	7.9	1.8	6.7	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay xSBA or xSAB to xAx or xBx	—	9.2	1.7	7.7	ns
t <sub>PZH</sub> t <sub>PZL</sub>	Output Enable Time x $\overline{OE}$ to xAx or Bx	—	8.5	1.3	6.9	ns
t <sub>PZH</sub> t <sub>PZL</sub>	Output Enable Time xDIR to xAx or Bx	—	8.5	1.4	7.2	ns
t <sub>PHZ</sub> t <sub>PLZ</sub>	Output Disable Time x $\overline{OE}$ to xAx or Bx	—	7.7	2.1	6.9	ns
t <sub>PHZ</sub> t <sub>PLZ</sub>	Output Disable Time xDIR to xAx or Bx	—	7.8	2	7	ns
t <sub>SU</sub>	Set-up Time HIGH or LOW xAx or xBx before CLKAB $\uparrow$ or CLKBA $\uparrow$	3.2	—	2.9	—	ns
t <sub>H</sub>	Hold Time HIGH or LOW xAx or xBx after CLKAB $\uparrow$ or CLKBA $\uparrow$	—	—	0.3	—	ns
t <sub>w</sub>	Clock Pulse Width HIGH or LOW	3.3	—	3.3	—	ns
t <sub>SK(O)</sub>	Output Skew <sup>(2)</sup>	—	—	—	500	ps

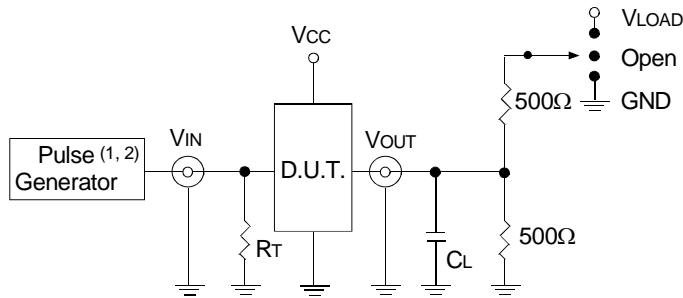
NOTES:

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.

## 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:

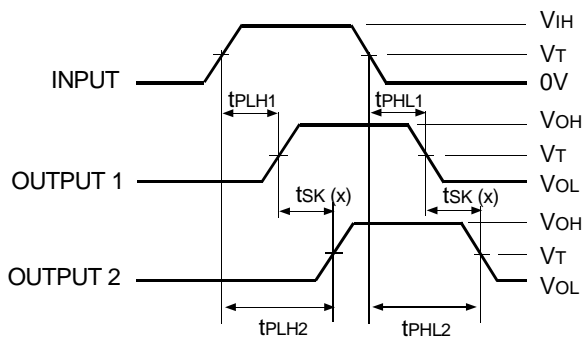
C<sub>L</sub> = Load capacitance: includes jig and probe capacitance.  
R<sub>T</sub> = Termination resistance: should be equal to Z<sub>OUT</sub> of the Pulse Generator.

#### NOTES:

1. Pulse Generator for All Pulses: Rate ≤ 10MHz; t<sub>F</sub> ≤ 2.5ns; t<sub>R</sub> ≤ 2.5ns.
2. Pulse Generator for All Pulses: Rate ≤ 10MHz; t<sub>F</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

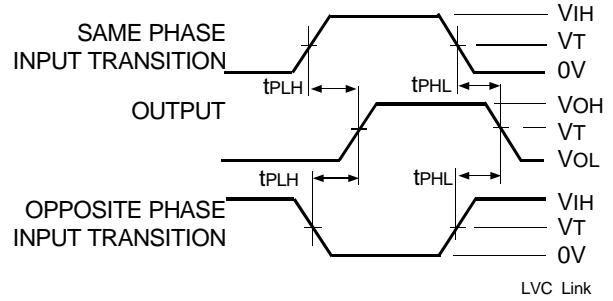


$$tsk(x) = |t_{PLH2} - t_{PLH1}| \text{ or } |t_{PHL2} - t_{PHL1}|$$

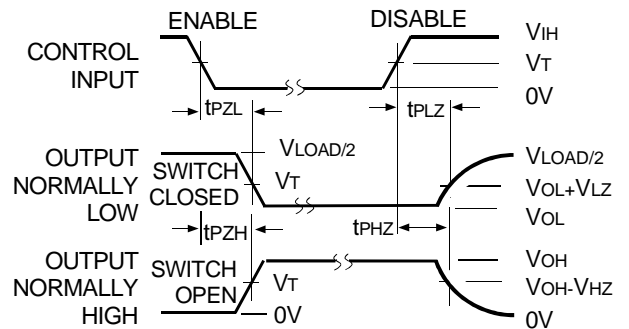
Output Skew - tsk(x)

#### NOTES:

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



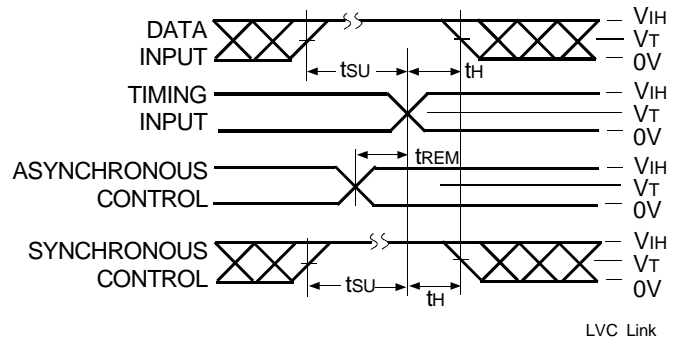
Propagation Delay



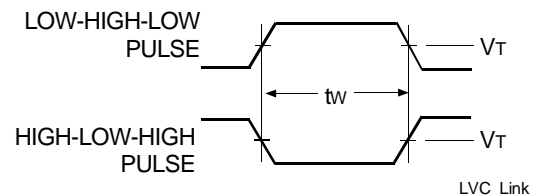
Enable and Disable Times

#### NOTE:

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

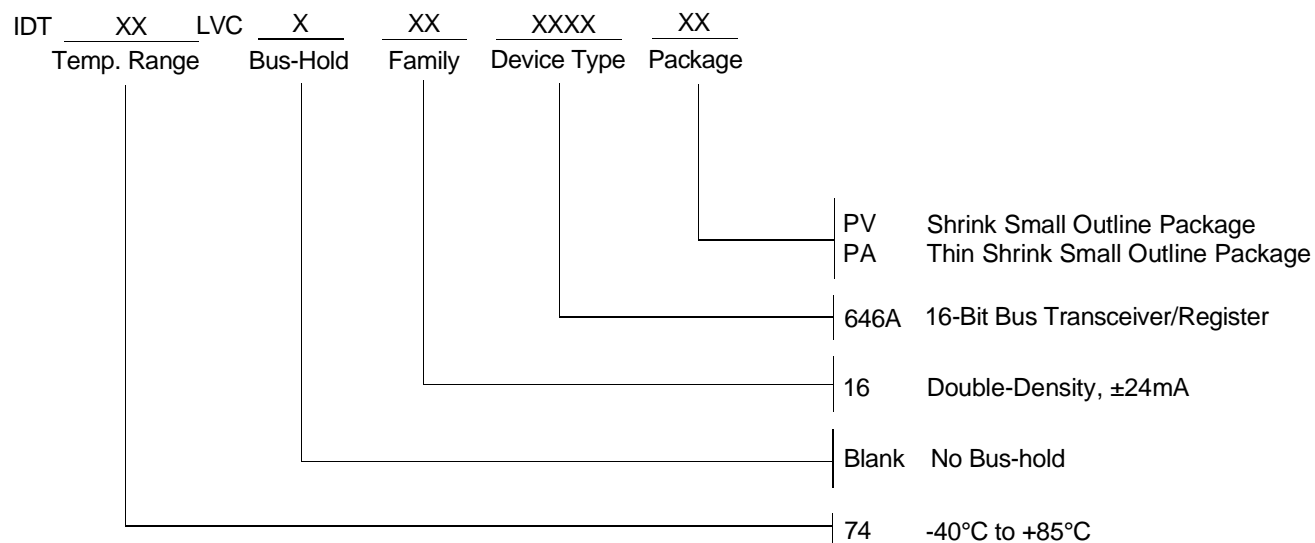


Set-up, Hold, and Release Times



Pulse Width

## ORDERING INFORMATION



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