



# 3.3V CMOS 16-BIT BUS TRANSCEIVER WITH 5 VOLT TOLERANT I/O AND BUS-HOLD

**IDT74LVCH162245A**

## 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
- Available in SSOP, TSSOP, and TVSOP packages

## DRIVE FEATURES:

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

## APPLICATIONS:

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

## DESCRIPTION:

This 16-bit bus transceiver is built using advanced dual metal CMOS technology. This high-speed, low power transceiver is ideal for asynchronous communication between two busses (A and B). The Direction and Output Enable controls are designed to operate this device as either two independent 8-bit transceivers or one 16-bit transceiver. The direction control pin (DIR) controls the direction of data flow. The output enable pin ( $\overline{OE}$ ) overrides the direction control and disables both ports. All inputs are designed with hysteresis for improved noise margin.

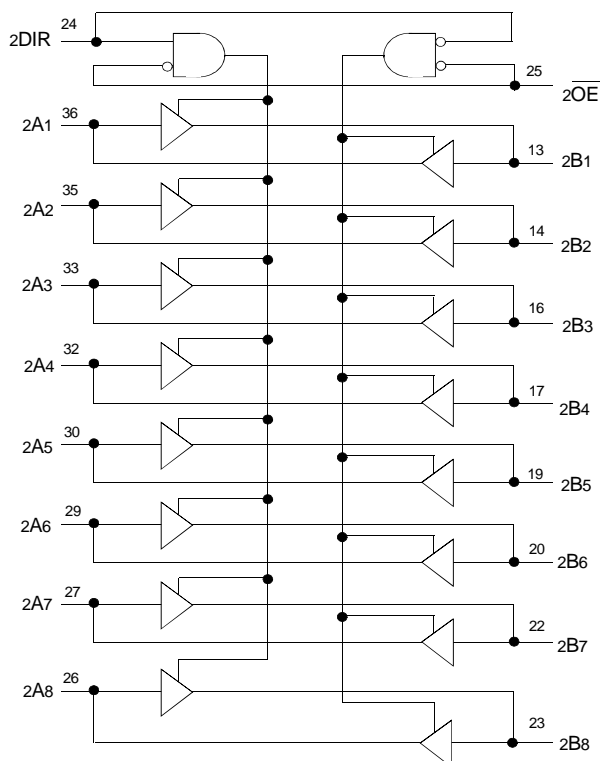
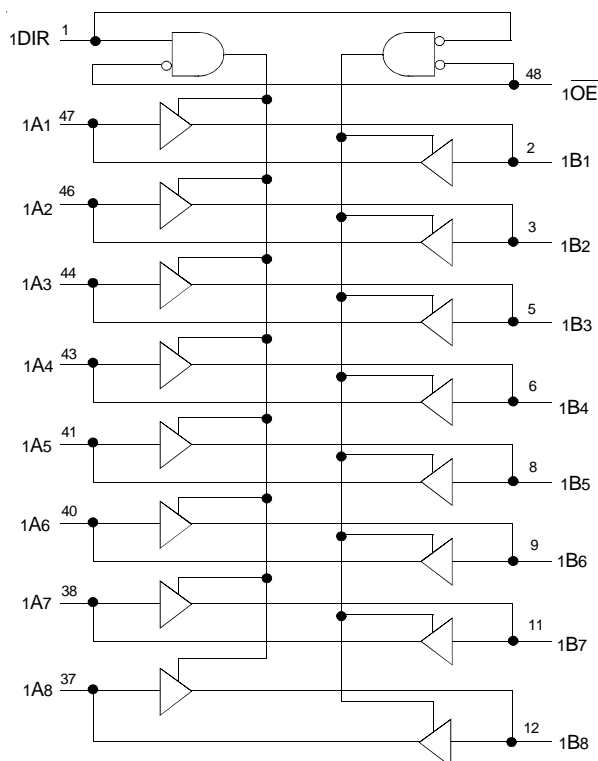
All pins can be driven from either 3.3V or 5V devices. This feature allows the use of this device as a translator in a mixed 3.3V/5V supply system.

The LVCH162245A (B port) has been designed with a  $\pm 24mA$  output driver. This driver is capable of driving a moderate to heavy load while maintaining speed performance.

The LVCH162245 (A port) has series resistors in the device output structure which will significantly reduce line noise when used with light loads. The driver has been designed to drive  $\pm 12mA$  at the designated threshold levels.

The LVCH162245A has "bus-hold" which retains the inputs' last state whenever the input goes to a high impedance. This prevents floating inputs and eliminates the need for pull-up/down resistors.

## FUNCTIONAL BLOCK DIAGRAM

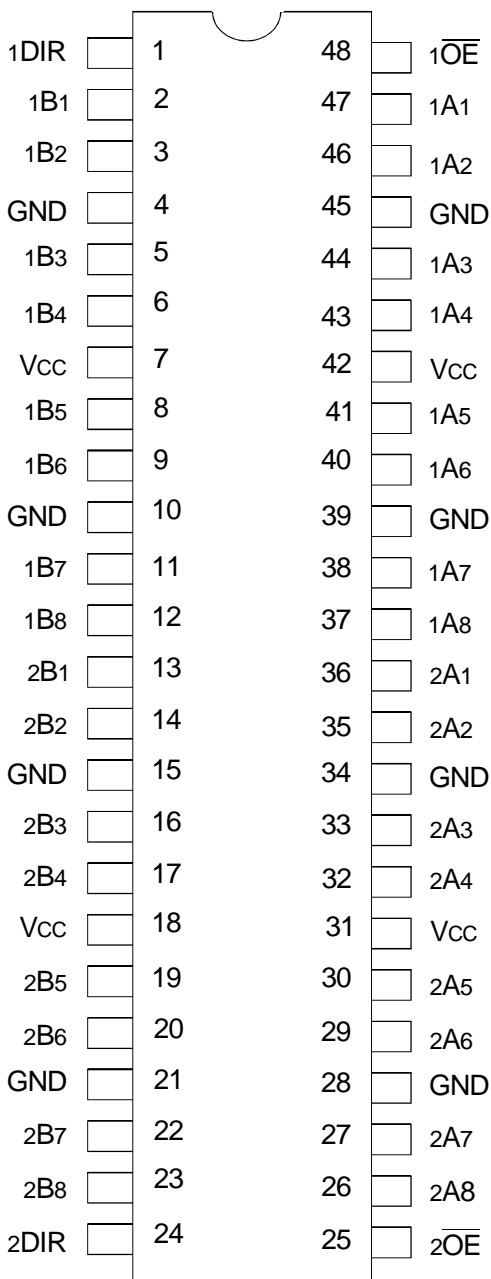


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INDUSTRIAL TEMPERATURE RANGE

MARCH 1999

## PIN CONFIGURATION



SSOP/ TSSOP/ TVSOP  
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><br>I <sub>OK</sub> | Continuous Clamp Current,<br>V <sub>I</sub> < 0 or V <sub>O</sub> < 0 | -50          | mA   |
| I <sub>CC</sub><br>I <sub>SS</sub> | Continuous Current through each<br>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                                     |
|-------------------|---|
| x $\overline{OE}$ | Output Enable Input (Active LOW)                |
| xDIR              | Direction Control Output                        |
| xAx               | Side A Inputs or 3-State Outputs <sup>(1)</sup> |
| xBx               | Side B Inputs or 3-State Outputs <sup>(1)</sup> |

### NOTE:

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

## FUNCTION TABLE (EACH 8-BIT SECTION)<sup>(1)</sup>

| Inputs            |      | Outputs         |
|-------------------|------|-----------------|
| x $\overline{OE}$ | xDIR |                 |
| L                 | L    | B Data to A Bus |
| L                 | H    | A Data to B Bus |
| H                 | X    | High Z State    |

### NOTE:

- H = HIGH Voltage Level  
X = Don't Care  
L = LOW Voltage Level  
Z = High-Impedance

## 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><br>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><br>I <sub>OZL</sub>                     | High Impedance Output Current<br>(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><br>I <sub>CC2</sub><br>I <sub>CC3</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:

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

## BUS-HOLD CHARACTERISTICS

| Symbol                                 | Parameter <sup>(1)</sup>         | Test Conditions        |                            | Min. | Typ. <sup>(2)</sup> | Max. | Unit |
|--|----------------------------------|------------------------|----------------------------|------|---------------------|------|------|
| I <sub>BH1</sub><br>I <sub>BH2</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>BH3</sub><br>I <sub>BH4</sub>   | Bus-Hold Input Sustain Current   | V <sub>CC</sub> = 2.3V | V <sub>I</sub> = 1.7V      | —    | —                   | —    | μA   |
|  |                                  |                        | V <sub>I</sub> = 0.7V      | —    | —                   | —    |      |
| I <sub>BHO1</sub><br>I <sub>BHO2</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> = - 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                   | —    |      |
| I <sub>OH</sub> = - 12mA | 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> = 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:**  
1. 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> = - 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:**  
1. 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,  $V_{CC} = 3.3V \pm 0.3V$ ,  $T_A = 25^\circ C$

| Symbol | Parameter  | Test Conditions           | Typical | Unit |
|--------|--|---------------------------|---------|------|
| CPD    | Power Dissipation Capacitance per Transceiver Outputs enabled  | $C_L = 0pF$ , $f = 10MHz$ | 39      | pF   |
| CPD    | Power Dissipation Capacitance per Transceiver Outputs disabled |                           | 4       |      |

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

| Symbol                               | Parameter                                       | $V_{CC} = 2.7V$ |      | $V_{CC} = 3.3V \pm 0.3V$ |      | Unit |
|--------------------------------------|---|-----------------|------|--------------------------|------|------|
|                                      |   | Min.            | Max. | Min.                     | Max. |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>xBx to xAx                 | 1.5             | 5.7  | 1.5                      | 4.8  | ns   |
| t <sub>PZH</sub><br>t <sub>PZL</sub> | Output Enable Time<br>x $\overline{OE}$ to xAx  | 1.5             | 7.9  | 1.5                      | 6.3  | ns   |
| t <sub>PHZ</sub><br>t <sub>PLZ</sub> | Output Disable Time<br>x $\overline{OE}$ to xAx | 1.5             | 8.3  | 2.2                      | 7.4  | ns   |
| t <sub>SK(O)</sub>                   | Output Skew <sup>(2)</sup>                      | —               | —    | —                        | 500  | ps   |

NOTES:

1. See TEST CIRCUITS AND WAVEFORMS.  $T_A = -40^\circ C$  to  $+85^\circ C$ .
2. Skew between any two outputs of the same package and switching in the same direction.

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

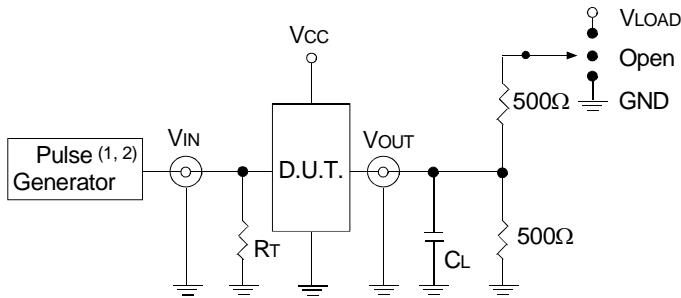
| Symbol                               | Parameter                                       | $V_{CC} = 2.7V$ |      | $V_{CC} = 3.3V \pm 0.3V$ |      | Unit |
|--------------------------------------|---|-----------------|------|--------------------------|------|------|
|                                      |   | Min.            | Max. | Min.                     | Max. |      |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | Propagation Delay<br>xAx to xBx                 | 1.5             | 4.7  | 1                        | 4    | ns   |
| t <sub>PZH</sub><br>t <sub>PZL</sub> | Output Enable Time<br>x $\overline{OE}$ to xBx  | 1.5             | 6.7  | 1.5                      | 5.5  | ns   |
| t <sub>PHZ</sub><br>t <sub>PLZ</sub> | Output Disable Time<br>x $\overline{OE}$ to xBx | 1.5             | 7.1  | 1.5                      | 6.6  | ns   |
| t <sub>SK(O)</sub>                   | Output Skew <sup>(2)</sup>                      | —               | —    | —                        | 500  | ps   |

NOTES:

1. See TEST CIRCUITS AND WAVEFORMS.  $T_A = -40^\circ C$  to  $+85^\circ C$ .
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:

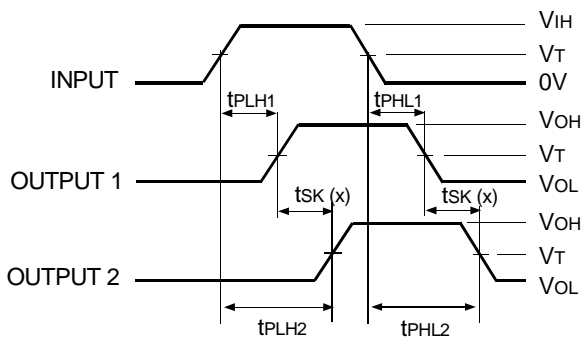
C<sub>L</sub> = Load capacitance: includes jig and probe capacitance.  
R<sub>T</sub> = Termination resistance: should be equal to Z<sub>OUT</sub> of the Pulse Generator.

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<br>Disable Low<br>Enable Low | V <sub>LOAD</sub> |
| Disable High<br>Enable High             | GND               |
| All Other Tests                         | Open              |

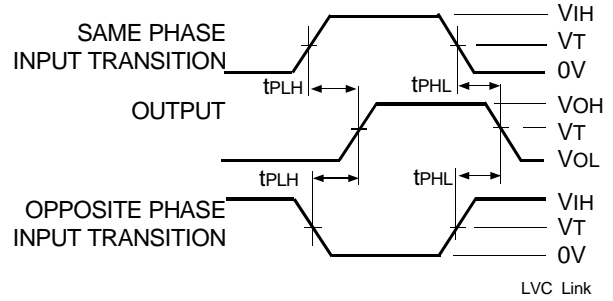


$$tsK(x) = |t_{PLH2} - t_{PLH1}| \text{ or } |t_{PHL2} - t_{PHL1}|$$

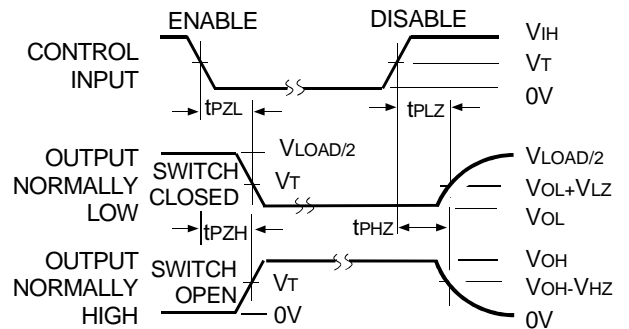
Output Skew - tsK(x)

NOTES:

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



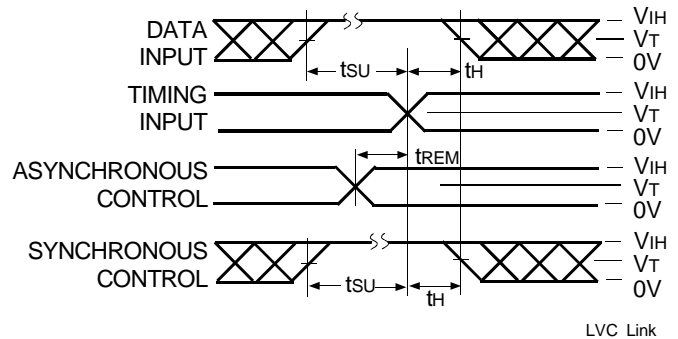
Propagation Delay



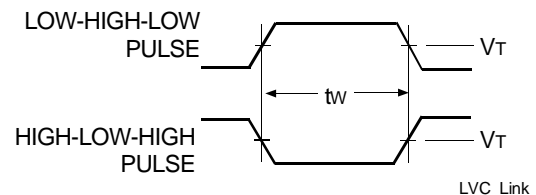
Enable and Disable Times

NOTE:

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

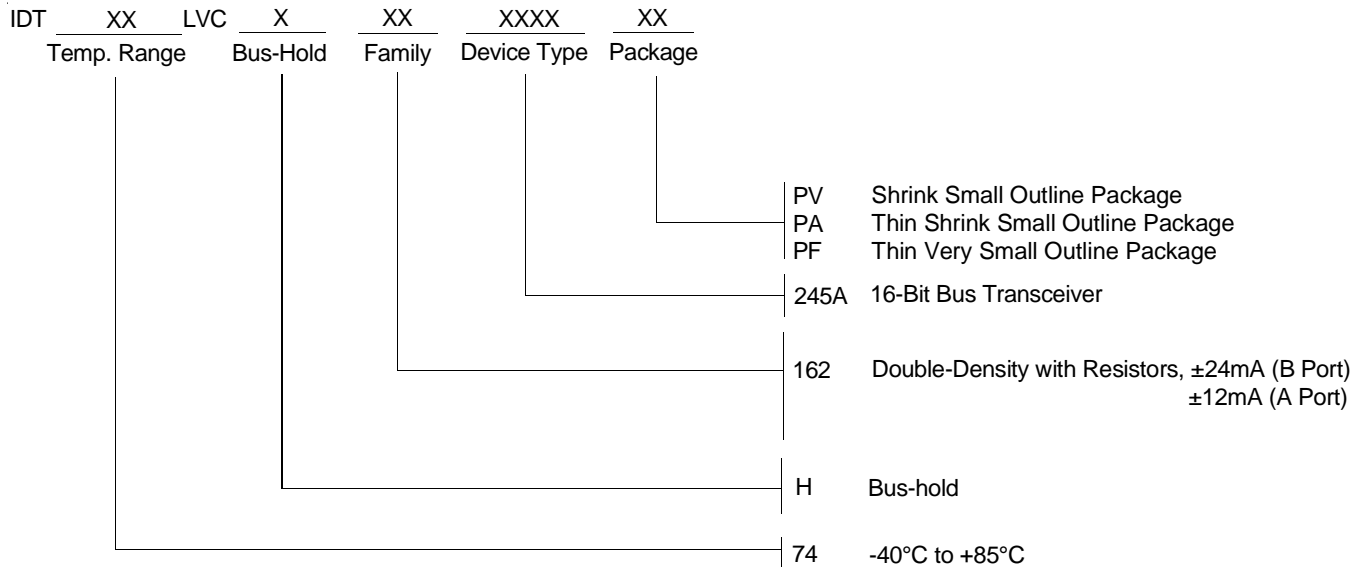


Set-up, Hold, and Release Times



Pulse Width

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