# 3.3V CMOS 16-BIT BUS TRANSCEIVER WITH 3-STATE OUTPUTS AND 5 VOLT TOLERANT I/O

**IDT74LVC162245A**

## 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 ± 0.3V, Normal Range
- $V_{CC}$ = 2.7V to 3.6V, Extended Range
- CMOS power levels (0.4µ W typ. static)
- All inputs, outputs, and I/O are 5V tolerant
- Available in SSOP and TSSOP packages

## DRIVE FEATURES:

- Balanced Output Drivers: ±12mA (A port)
- High Output Drivers: ±24mA (B port)

## APPLICATIONS:

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

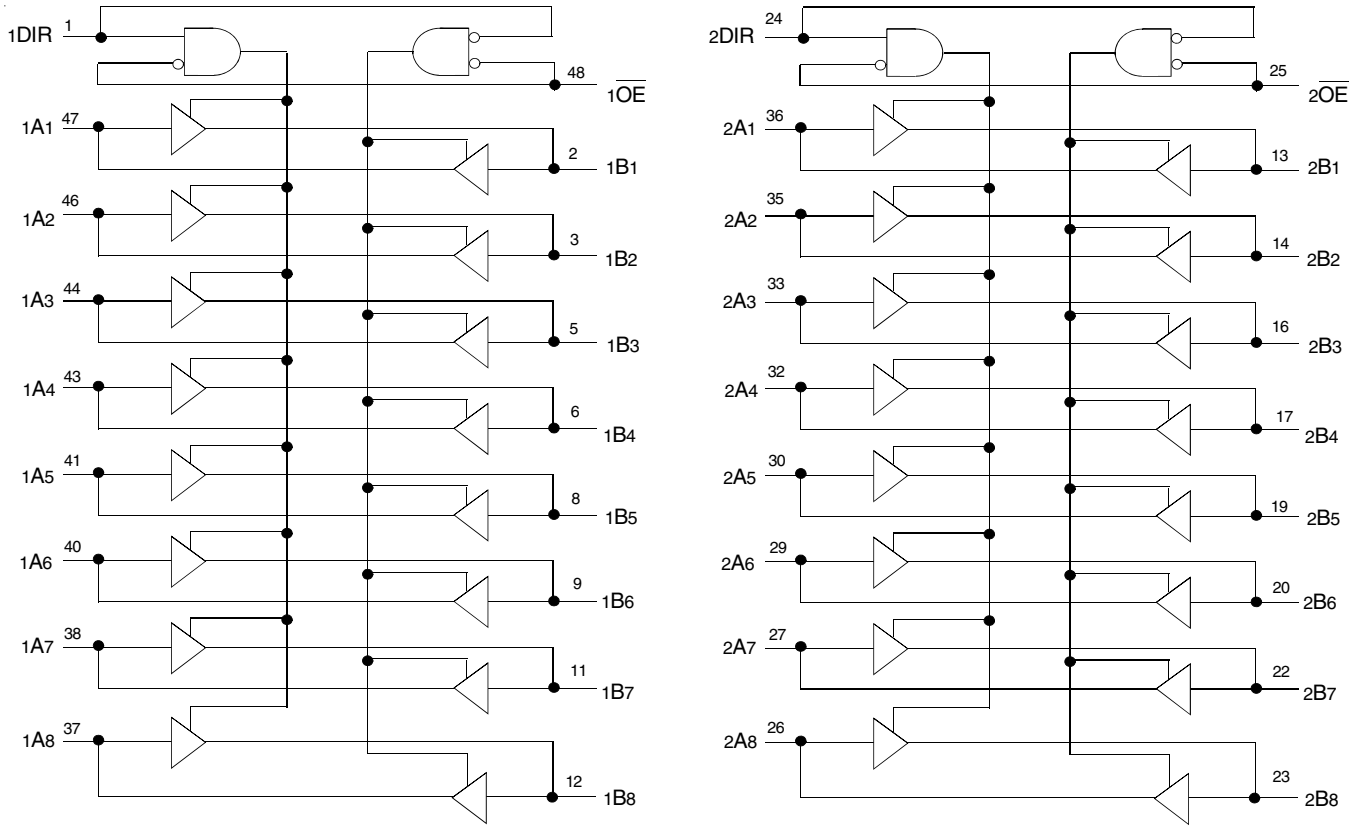
## DESCRIPTION:

This 16-bit transceiver is built using advanced dual metal CMOS technology. The LVC162245A is designed for asynchronous communication between data buses. The control-function implementation minimizes external timing requirements. This device can be used as two 8-bit transceivers or one 16-bit transceiver. It allows data transmission from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable ($\overline{OE}$) input can be used to disable the device so that the buses are effectively isolated. To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to $V_{CC}$ through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

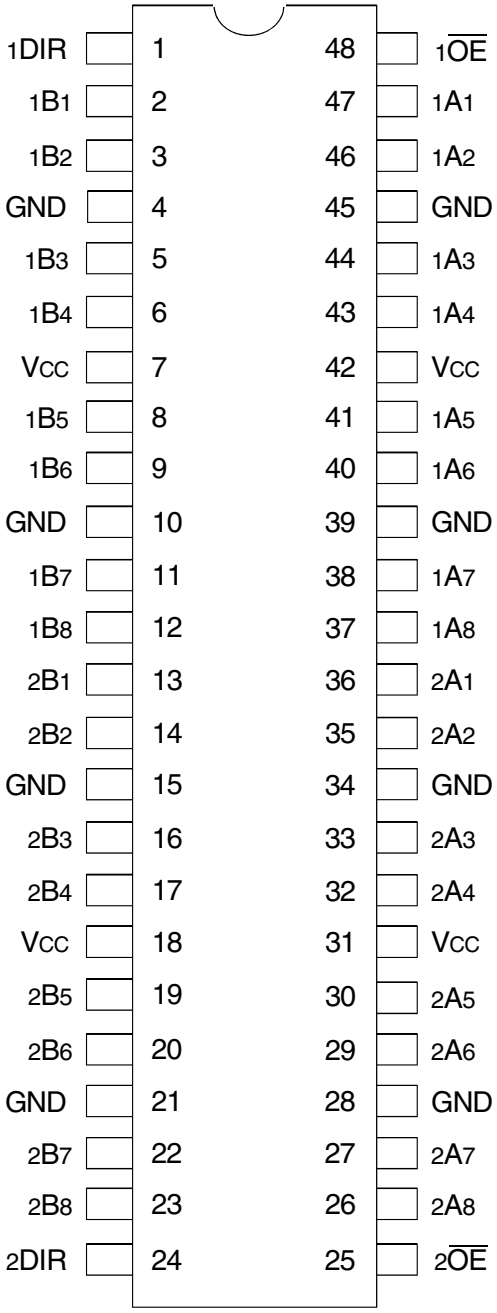
All pins can be driven from either 3.3V or 5V devices. This feature allows the use of this device as a translator in a mixed 3.3V/5V supply system.

The LVC162245A has series resistors in the device output structure of the "A" port which will significantly reduce line noise when used with light loads. The driver has been designed to drive ±12mA at the designated threshold levels. The "B" port has a ±24mA driver.

## FUNCTIONAL BLOCK DIAGRAM



## PIN CONFIGURATION




SSOP / TSSOP
TOP VIEW

## ABSOLUTE MAXIMUM RATINGS(1)

| Symbol | Description | Max | Unit |
|---|---|---|---|
| $V_{TERM}$(2) | Terminal Voltage with Respect to GND | –0.5 to +6.5 | V |
| $V_{TERM}$(3) | Terminal Voltage with Respect to GND | –0.5 to +6.5 | V |
| $T_{STG}$ | Storage Temperature | –65 to +150 | °C |
| $I_{OUT}$ | DC Output Current | –50 to +50 | mA |
| $I_{IK}$<br>$I_{OK}$ | Continuous Clamp Current,<br>$V_I$ < 0 or $V_O$ < 0 | –50 | mA |
| $I_{CC}$<br>$I_{SS}$ | Continuous Current through each<br>$V_{CC}$ or GND | ±100 | mA |

NOTES:
1. 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.
2. $V_{CC}$ terminals.
3. All terminals except $V_{CC}$.

## CAPACITANCE ($T_A$ = +25°C, F = 1.0MHz)

| Symbol | Parameter(1) | Conditions | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{IN}$ = 0V | 4.5 | 6 | pF |
| $C_{OUT}$ | Output Capacitance | $V_{OUT}$ = 0V | 6.5 | 8 | pF |
| $C_{I/O}$ | I/O Port Capacitance | $V_{IN}$ = 0V | 6.5 | 8 | pF |

NOTE:
1. 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 |
| xBx | Side B Inputs or 3-State Outputs |

## FUNCTION TABLE (EACH 8-BIT SECTION)(1)

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

NOTE:
1. H = HIGH Voltage Level
   X = Don't Care
   L = LOW Voltage Level

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:
Operating Condition: $T_A$ = –40°C to +85°C

| Symbol | Parameter | Test Conditions | | Min. | Typ.(1) | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input HIGH Voltage Level | $V_{CC}$ = 2.3V to 2.7V | | 1.7 | — | — | V |
| | | $V_{CC}$ = 2.7V to 3.6V | | 2 | — | — | |
| $V_{IL}$ | Input LOW Voltage Level | $V_{CC}$ = 2.3V to 2.7V | | — | — | 0.7 | V |
| | | $V_{CC}$ = 2.7V to 3.6V | | — | — | 0.8 | |
| $I_{IH}$<br>$I_{IL}$ | Input Leakage Current | $V_{CC}$ = 3.6V | $V_I$ = 0 to 5.5V | — | — | ±5 | µA |
| $I_{OZH}$<br>$I_{OZL}$ | High Impedance Output Current (3-State Output pins) | $V_{CC}$ = 3.6V | $V_O$ = 0 to 5.5V | — | — | ±10 | µA |
| $I_{OFF}$ | Input/Output Power Off Leakage | $V_{CC}$ = 0V, $V_{IN}$ or $V_O \leq$ 5.5V | | — | — | ±50 | µA |
| $V_{IK}$ | Clamp Diode Voltage | $V_{CC}$ = 2.3V, $I_{IN}$ = –18mA | | — | –0.7 | –1.2 | V |
| $V_H$ | Input Hysteresis | $V_{CC}$ = 3.3V | | — | 100 | — | mV |
| $I_{CCL}$<br>$I_{CCH}$ | Quiescent Power Supply Current | $V_{CC}$ = 3.6V | $V_{IN}$ = GND or $V_{CC}$ | — | — | 10 | µA |
| $I_{CCZ}$ | | | $3.6 \leq V_{IN} \leq 5.5V$(2) | — | — | 10 | |
| $\Delta I_{CC}$ | Quiescent Power Supply Current Variation | One input at $V_{CC}$ - 0.6V, other inputs at $V_{CC}$ or GND | | — | — | 500 | µA |

NOTES:
1. Typical values are at $V_{CC}$ = 3.3V, +25°C ambient.
2. This applies in the disabled state only.

## OUTPUT DRIVE CHARACTERISTICS (A PORT)

| Symbol | Parameter | Test Conditions(1) | | Min. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{OH}$ | Output HIGH Voltage | $V_{CC}$ = 2.3V to 3.6V | $I_{OH}$ = – 0.1mA | $V_{CC}$ – 0.2 | — | V |
| | | $V_{CC}$ = 2.3V | $I_{OH}$ = – 4mA | 1.9 | — | |
| | | | $I_{OH}$ = – 6mA | 1.7 | — | |
| | | $V_{CC}$ = 2.7V | $I_{OH}$ = – 4mA | 2.2 | — | |
| | | | $I_{OH}$ = – 8mA | 2 | — | |
| | | $V_{CC}$ = 3V | $I_{OH}$ = – 6mA | 2.4 | — | |
| | | | $I_{OH}$ = – 12mA | 2 | — | |
| $V_{OL}$ | Output LOW Voltage | $V_{CC}$ = 2.3V to 3.6V | $I_{OL}$ = 0.1mA | — | 0.2 | V |
| | | $V_{CC}$ = 2.3V | $I_{OL}$ = 4mA | — | 0.4 | |
| | | | $I_{OL}$ = 6mA | — | 0.55 | |
| | | $V_{CC}$ = 2.7V | $I_{OL}$ = 4mA | — | 0.4 | |
| | | | $I_{OL}$ = 8mA | — | 0.6 | |
| | | $V_{CC}$ = 3V | $I_{OL}$ = 6mA | — | 0.55 | |
| | | | $I_{OL}$ = 12mA | — | 0.8 | |

NOTE:
1. $V_{IH}$ and $V_{IL}$ must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate $V_{CC}$ range. $T_A$ = – 40°C to + 85°C.

## OUTPUT DRIVE CHARACTERISTICS (B PORT)

| Symbol | Parameter | Test Conditions[1] | | Min. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{OH}$ | Output HIGH Voltage | $V_{CC}$ = 2.3V to 3.6V | $I_{OH}$ = – 0.1mA | $V_{CC}$ – 0.2 | — | V |
| | | $V_{CC}$ = 2.3V | $I_{OH}$ = – 6mA | 2 | — | |
| | | $V_{CC}$ = 2.3V | $I_{OH}$ = – 12mA | 1.7 | — | |
| | | $V_{CC}$ = 2.7V | | 2.2 | — | |
| | | $V_{CC}$ = 3V | | 2.4 | — | |
| | | $V_{CC}$ = 3V | $I_{OH}$ = – 24mA | 2 | — | |
| $V_{OL}$ | Output LOW Voltage | $V_{CC}$ = 2.3V to 3.6V | $I_{OL}$ = 0.1mA | — | 0.2 | V |
| | | $V_{CC}$ = 2.3V | $I_{OL}$ = 6mA | — | 0.4 | |
| | | | $I_{OL}$ = 12mA | — | 0.7 | |
| | | $V_{CC}$ = 2.7V | $I_{OL}$ = 12mA | — | 0.4 | |
| | | $V_{CC}$ = 3V | $I_{OL}$ = 24mA | — | 0.55 | |

NOTE:
1. $V_{IH}$ and $V_{IL}$ must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate $V_{CC}$ range. $T_A$ = – 40°C to + 85°C.

## OPERATING CHARACTERISTICS, $V_{CC}$ = 3.3V ± 0.3V, $T_A$ = 25°C

| Symbol | Parameter | Test Conditions | Typical | Unit |
|---|---|---|---|---|
| $C_{PD}$ | Power Dissipation Capacitance per Transceiver Outputs enabled | $C_L$ = 0pF, f = 10Mhz | | pF |
| $C_{PD}$ | Power Dissipation Capacitance per Transceiver Outputs disabled | | | |

## SWITCHING CHARACTERISTICS (A PORT)[1]

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

NOTES:
1. See TEST CIRCUITS AND WAVEFORMS. $T_A$ = – 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)[1]

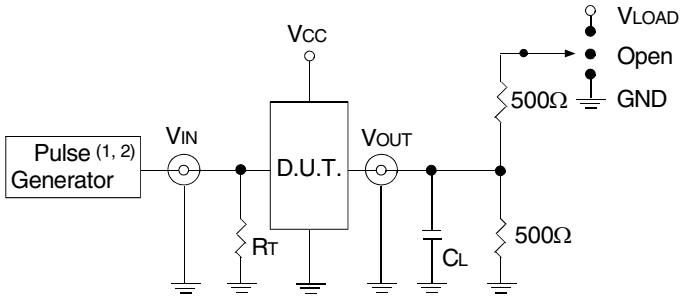
| Symbol | Parameter | $V_{CC}$ = 2.7V | | $V_{CC}$ = 3.3V ± 0.3V | | Unit |
|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>xAx to xBx | 1.5 | 4.7 | 1 | 4 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>x$\overline{OE}$ to xBx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

NOTES:
1. See TEST CIRCUITS AND WAVEFORMS. $T_A$ = – 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 | $V_{CC}^{(1)}$=3.3V±0.3V | $V_{CC}^{(1)}$=2.7V | $V_{CC}^{(2)}$=2.5V±0.2V | Unit |
|---|---|---|---|---|
| $V_{LOAD}$ | 6 | 6 | 2 x Vcc | V |
| $V_{IH}$ | 2.7 | 2.7 | Vcc | V |
| $V_T$ | 1.5 | 1.5 | Vcc / 2 | V |
| $V_{LZ}$ | 300 | 300 | 150 | mV |
| $V_{HZ}$ | 300 | 300 | 150 | mV |
| $C_L$ | 50 | 50 | 30 | pF |



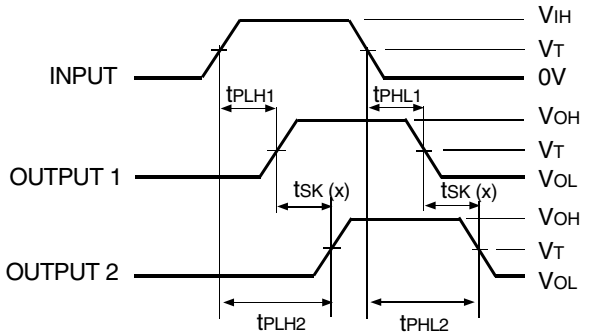

*Test Circuit for All Outputs*

DEFINITIONS:
$C_L$ = Load capacitance: includes jig and probe capacitance.
$R_T$ = Termination resistance: should be equal to $Z_{OUT}$ of the Pulse Generator.

NOTES:
1. Pulse Generator for All Pulses: Rate ≤ 10MHz; $t_F$ ≤ 2.5ns; $t_R$ ≤ 2.5ns.
2. Pulse Generator for All Pulses: Rate ≤ 10MHz; $t_F$ ≤ 2ns; $t_R$ ≤ 2ns.

## SWITCH POSITION

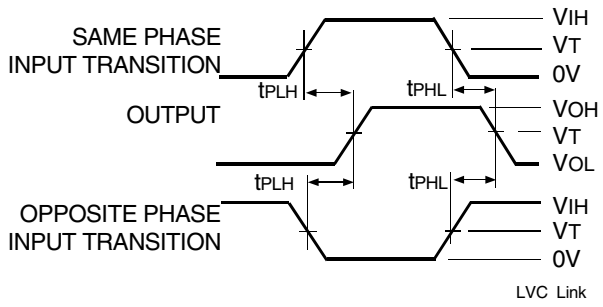
| Test | Switch |
|---|---|
| Open Drain<br>Disable Low<br>Enable Low | $V_{LOAD}$ |
| Disable High<br>Enable High | GND |
| All Other Tests | Open |



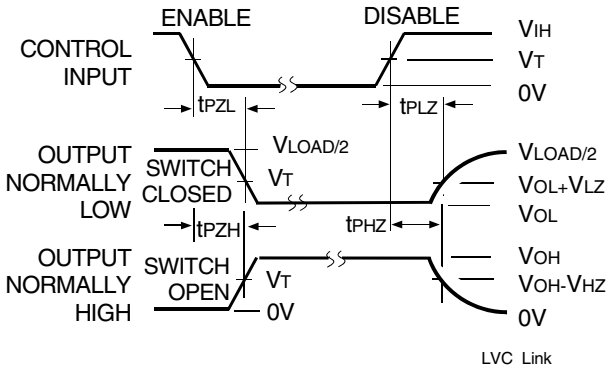

$t_{SK(x)} = |t_{PLH2} - t_{PLH1}|$ or $|t_{PHL2} - t_{PHL1}|$

*Output Skew - $t_{SK(x)}$*

NOTES:
1. For $t_{SK(o)}$ OUTPUT1 and OUTPUT2 are any two outputs.
2. For $t_{SK(b)}$ OUTPUT1 and OUTPUT2 are in the same bank.

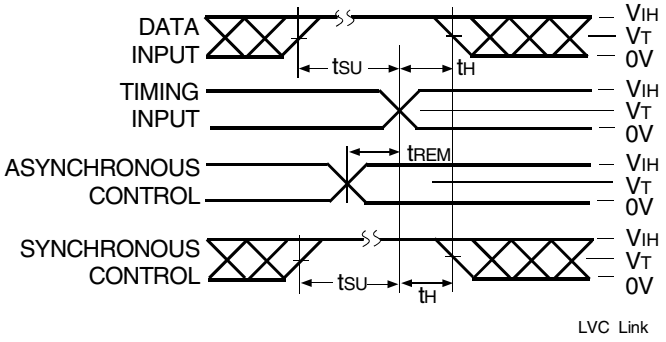



*Propagation Delay*

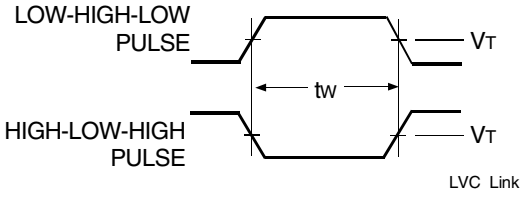



*Enable and Disable Times*

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

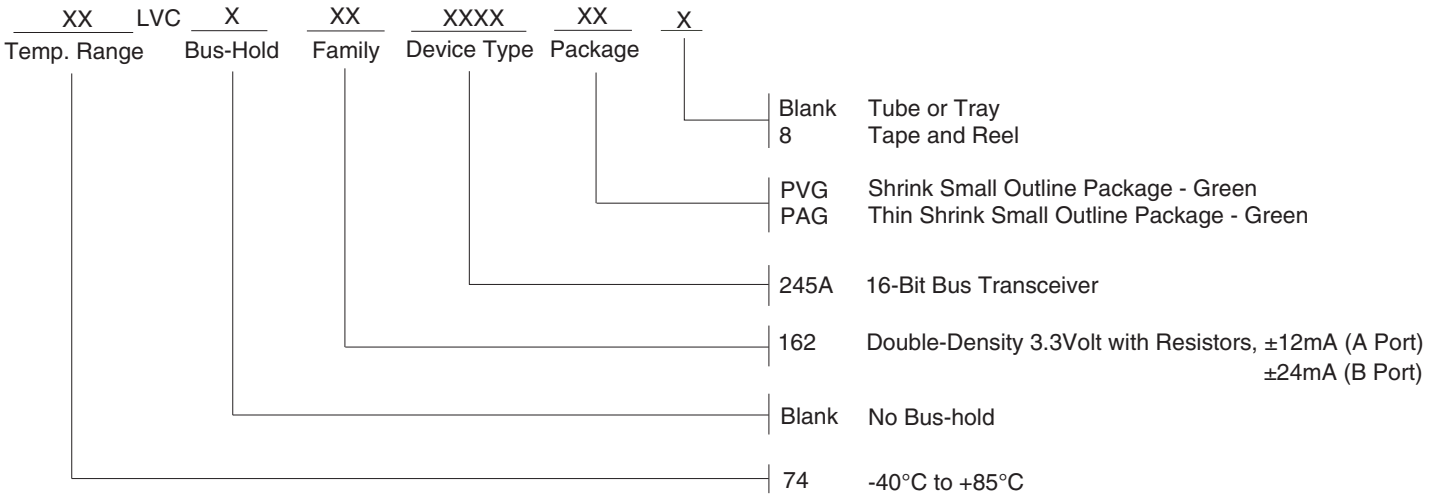



*Set-up, Hold, and Release Times*




*Pulse Width*

# ORDERING INFORMATION



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