



3.3V CMOS 18-BIT REGISTERED BUS TRANSCEIVER WITH 5V TOLERANT I/O AND BUS-HOLD

IDT74LVCH16501A

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 μ W typ. static)
- All inputs, outputs, and I/O are 5V tolerant
- Supports hot insertion
- Available in SSOP, TSSOP, and TVSOP 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

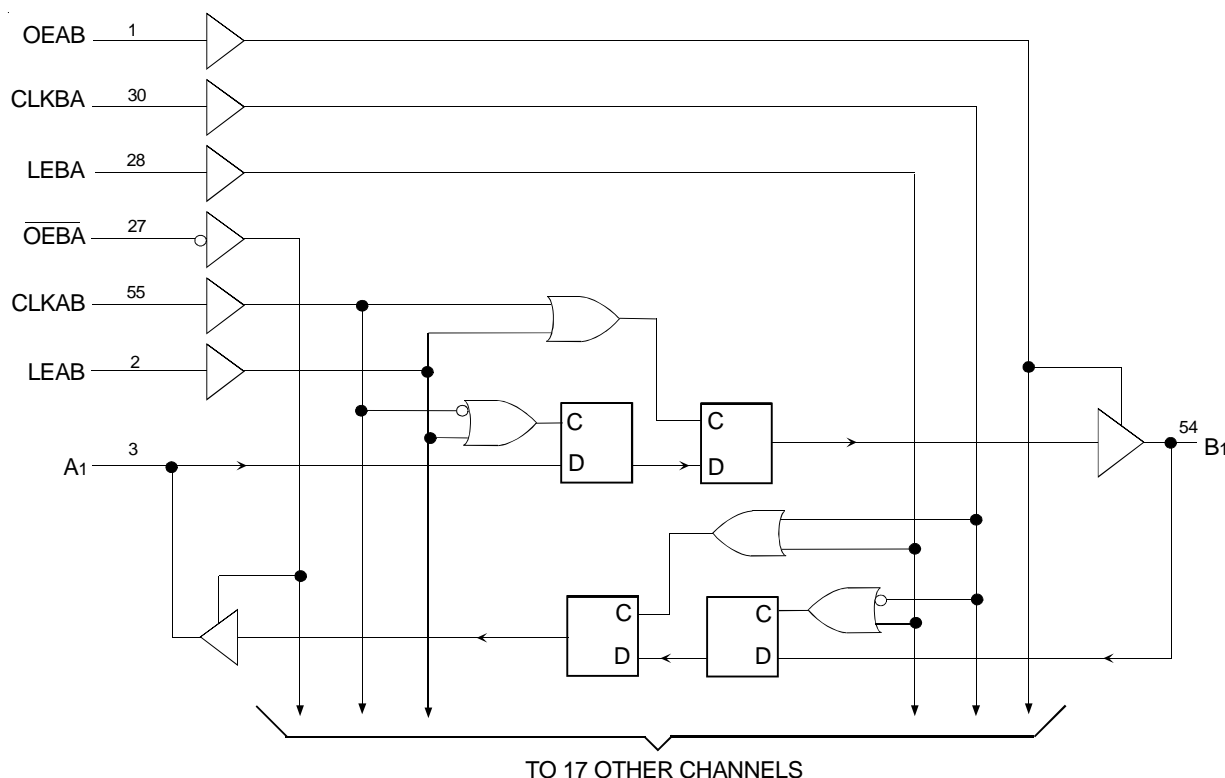
DESCRIPTION:

This 18-bit registered transceiver is built using advanced dual metal CMOS technology. This high-speed, low power 18-bit registered bus transceiver combines D-type latches and D-type flip-flops to allow data flow in transparent latched and clocked modes. Data flow in each direction is controlled by output-enable (OEAB and \overline{OEBA}), latch enable (LEAB and LEBA) and clock (CLKAB and CLKBA) inputs. For A-to-B data flow, the device operates in transparent mode when LEAB is high. When LEAB is low, the A data is latched if CLKAB is held at a high or low logic level. If LEAB is low, the A bus data is stored in the latch/flip-flop on the low-to-high transition of CLKAB. OEAB performs the output enable function on the B port. Data flow from B port to A port is similar but requires using \overline{OEBA} , LEBA and CLKBA. Flow-through organization of signal pins simplifies layout. All inputs are designed with hysteresis for improved noise margin.

The LVCH16501A has been designed with a $\pm 24mA$ output driver. This driver is capable of driving a moderate to heavy load while maintaining speed performance.

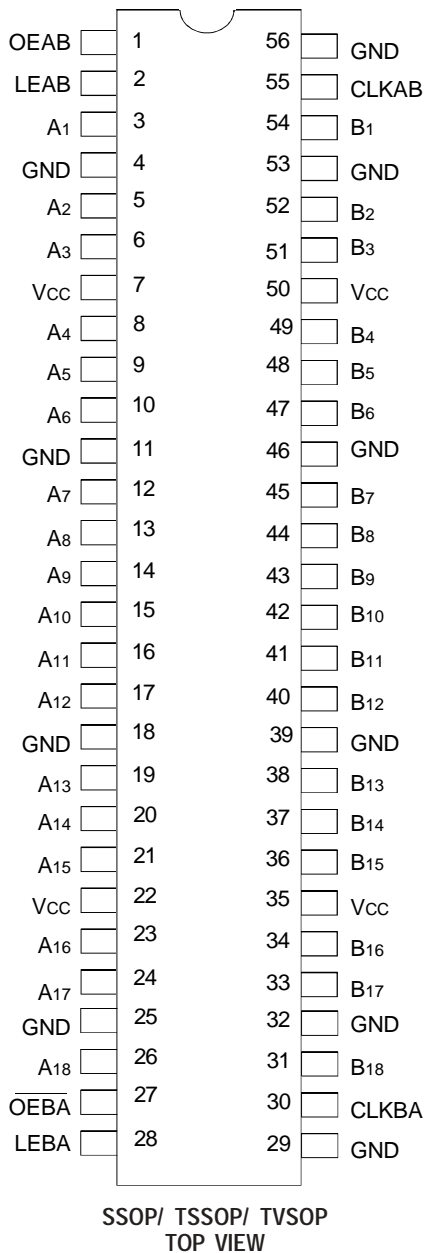
The LVCH16501A has "bus-hold" which retains the inputs' last state whenever the input goes to a high impedance. This prevents floating inputs and eliminates the need for pull-up/down resistors.

FUNCTIONAL BLOCK DIAGRAM



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PIN CONFIGURATION



PIN DESCRIPTION

| Pin Names | Description |
|-------------------|---|
| OEAB | A-to-B Output Enable Input |
| \overline{OEBA} | B-to-A Output Enable Input (Active LOW) |
| LEAB | A-to-B Latch Enable Input |
| LEBA | B-to-A Latch Enable Input |
| CLKAB | A-to-B Clock Input |
| CLKBA | B-to-A Clock Input |
| Ax | A-to-B Data Inputs or B-to-A 3-State Outputs ⁽¹⁾ |
| Bx | B-to-A Data Inputs or A-to-B 3-State Outputs ⁽¹⁾ |

NOTE:

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

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

| 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 _{OUT} | DC Output Current | -50 to +50 | mA |
| I _{IK} I _{OK} | Continuous Clamp Current, V _I < 0 or V _O < 0 | -50 | mA |
| I _{CC} I _{SS} | Continuous Current through each V _{CC} or GND | ±100 | mA |

NOTE:

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.

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.

FUNCTION TABLE^(1,2)

| Inputs | | | | Output |
|--------|------|-------|----|------------------|
| OEAB | LEAB | CLKAB | Ax | Bx |
| L | X | X | X | Z |
| H | H | X | L | L |
| H | H | X | H | H |
| H | L | ↑ | L | L |
| H | L | ↑ | H | H |
| H | L | L | X | B ⁽³⁾ |
| H | L | H | X | B ⁽⁴⁾ |

NOTES:

- A-to-B data flow is shown. B-to-A data flow is similar, but uses \overline{OEBA} , LEBA, and CLKBA.
- 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.
- Output level before the indicated steady-state input conditions were established, provided that CLKAB was HIGH before LEAB went LOW.

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. ⁽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} I _{IL} | Input Leakage Current | V _{CC} = 3.6V | V _I = 0 to 5.5V | — | — | ±5 | μA |
| I _{OZH} 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 ≤ 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 _{CC1} I _{CC2} I _{CC3} | Quiescent Power Supply Current | V _{CC} = 3.6V | V _{IN} = GND or V _{CC} | — | — | 10 | μA |
| | | | 3.6 ≤ V _{IN} ≤ 5.5V ⁽²⁾ | — | — | 10 | |
| ΔI _{CC} | Quiescent Power Supply Current Variation | One input at V _{CC} - 0.6V, other inputs at V _{CC} or GND | | — | — | 500 | μA |

NOTES:

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

BUS-HOLD CHARACTERISTICS

| Symbol | Parameter ⁽¹⁾ | Test Conditions | | Min. | Typ. ⁽²⁾ | Max. | Unit |
|--|----------------------------------|------------------------|----------------------------|------|---------------------|------|------|
| I _{BHH} I _{BHL} | Bus-Hold Input Sustain Current | V _{CC} = 3V | V _I = 2V | -75 | — | — | μA |
| | | | V _I = 0.8V | 75 | — | — | |
| I _{BHH} I _{BHL} | Bus-Hold Input Sustain Current | V _{CC} = 2.3V | V _I = 1.7V | — | — | — | μA |
| | | | V _I = 0.7V | — | — | — | |
| I _{BHHO} I _{BHLO} | Bus-Hold Input Overdrive Current | V _{CC} = 3.6V | V _I = 0 to 3.6V | — | — | ±500 | μA |

NOTES:

- Pins with Bus-Hold are identified in the pin description.
- Typical values are at V_{CC} = 3.3V, +25°C ambient.

OUTPUT DRIVE CHARACTERISTICS

| Symbol | Parameter | Test Conditions ⁽¹⁾ | | Min. | Max. | Unit |
|--------|---------------------|--------------------------------|---------------|-----------|------|------|
| VOH | Output HIGH Voltage | VCC = 2.3V to 3.6V | IOH = - 0.1mA | VCC - 0.2 | — | V |
| | | VCC = 2.3V | IOH = - 6mA | 2 | — | |
| | | VCC = 2.3V | IOH = - 12mA | 1.7 | — | |
| | | VCC = 2.7V | | 2.2 | — | |
| | | VCC = 3V | | 2.4 | — | |
| | | VCC = 3V | IOH = - 24mA | 2 | — | |
| VOL | Output LOW Voltage | VCC = 2.3V to 3.6V | IOL = 0.1mA | — | 0.2 | V |
| | | VCC = 2.3V | IOL = 6mA | — | 0.4 | |
| | | | IOL = 12mA | — | 0.7 | |
| | | VCC = 2.7V | IOL = 12mA | — | 0.4 | |
| | | VCC = 3V | IOL = 24mA | — | 0.55 | |

- NOTE:**
1. VIH and VIL must be within the min. or max. range shown in the DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE table for the appropriate VCC range. TA = - 40°C to + 85°C.

OPERATING CHARACTERISTICS, VCC = 3.3V ± 0.3V, TA = 25°C

| Symbol | Parameter | Test Conditions | Typical | Unit |
|--------|--|---------------------|---------|------|
| CPD | Power Dissipation Capacitance per Transceiver Outputs enabled | CL = 0pF, f = 10Mhz | | pF |
| CPD | Power Dissipation Capacitance per Transceiver Outputs disabled | | | |

SWITCHING CHARACTERISTICS⁽¹⁾

| Symbol | Parameter | V _{CC} = 2.7V | | V _{CC} = 3.3V ± 0.3V | | Unit |
|--------------------------------------|--|------------------------|------|-------------------------------|------|------|
| | | Min. | Max. | Min. | Max. | |
| t _{PLH} t _{PHL} | Propagation Delay Ax to Bx or Bx to Ax | 1.5 | 5.2 | 1.5 | 4.6 | ns |
| t _{PLH} t _{PHL} | Propagation Delay LEBA to Ax, LEAB to Bx | 1.5 | 6 | 1.5 | 5.3 | ns |
| t _{PLH} t _{PHL} | Propagation Delay CLKBA to Ax, CLKAB to Bx | 1.5 | 6 | 1.5 | 5.3 | ns |
| t _{PZH} t _{PZL} | Output Enable Time \overline{OEBA} to Ax, OEAB to Bx | 1.5 | 6 | 1.5 | 5.6 | ns |
| t _{PHZ} t _{PLZ} | Output Disable Time $\overline{OEB\bar{A}}$ to Ax, OEAB to Bx | 1.5 | 6.5 | 1.5 | 5.8 | ns |
| t _{SU} | Set-up Time, HIGH or LOW Ax to CLKAB, Bx to CLKBA | 3 | — | 3 | — | ns |
| t _H | Hold Time, HIGH or LOW Ax to CLKAB, Bx to CLKBA | 0 | — | 0 | — | ns |
| t _{SU} | Set-up Time, HIGH or LOW Ax to LEAB, Bx to LEBA | CLK LOW | 3 | — | 3 | ns |
| | | CLK HIGH | 2 | — | 2 | |
| t _H | Hold Time, HIGH or LOW Ax to LEAB, Bx to LEBA | 1.5 | — | 1.5 | — | ns |
| t _w | Pulse Width HIGH, LEAB or LEBA | 3 | — | 3 | — | ns |
| t _w | Pulse Width HIGH or LOW, CLKAB or CLKBA | 3 | — | 3 | — | ns |
| t _{sk(0)} | Output Skew ⁽²⁾ | — | — | — | 500 | ps |

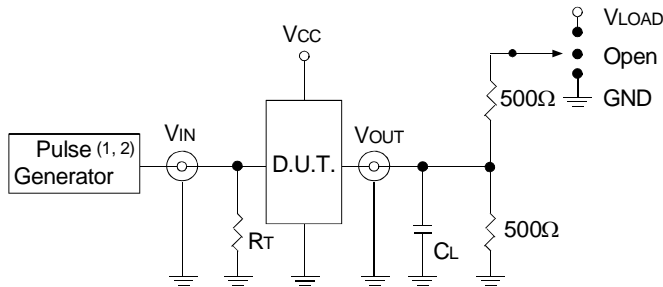
NOTES:

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 V _{CC} | V |
| V _{IH} | 2.7 | 2.7 | V _{CC} | V |
| V _T | 1.5 | 1.5 | V _{CC} / 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:

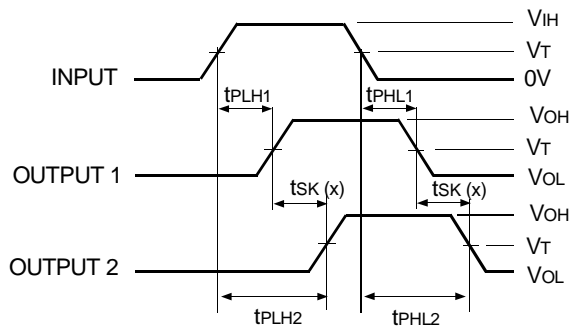
C_L = Load capacitance: includes jig and probe capacitance.
R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator.

NOTES:

1. Pulse Generator for All Pulses: Rate ≤ 10MHz; t_r ≤ 2.5ns; t_r ≤ 2.5ns.
2. Pulse Generator for All Pulses: Rate ≤ 10MHz; t_r ≤ 2ns; t_r ≤ 2ns.

SWITCH POSITION

| Test | Switch |
|---|-------------------|
| Open Drain Disable Low Enable Low | V _{LOAD} |
| Disable High Enable High | GND |
| All Other Tests | Open |

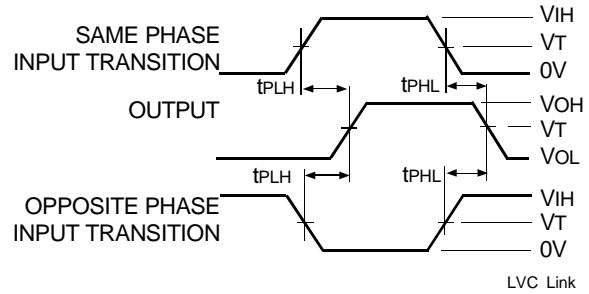


$$tsk(x) = |t_{PLH2} - t_{PLH1}| \text{ or } |t_{PHL2} - t_{PHL1}|$$

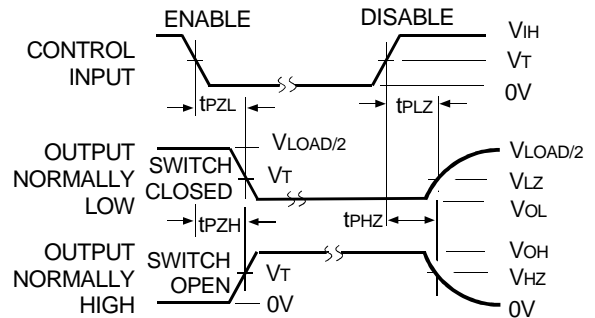
Output Skew - tsk(x)

NOTES:

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



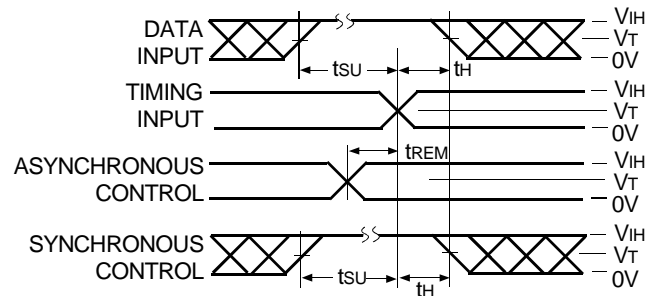
Propagation Delay



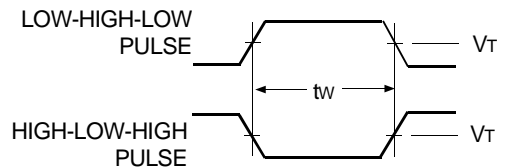
Enable and Disable Times

NOTE:

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

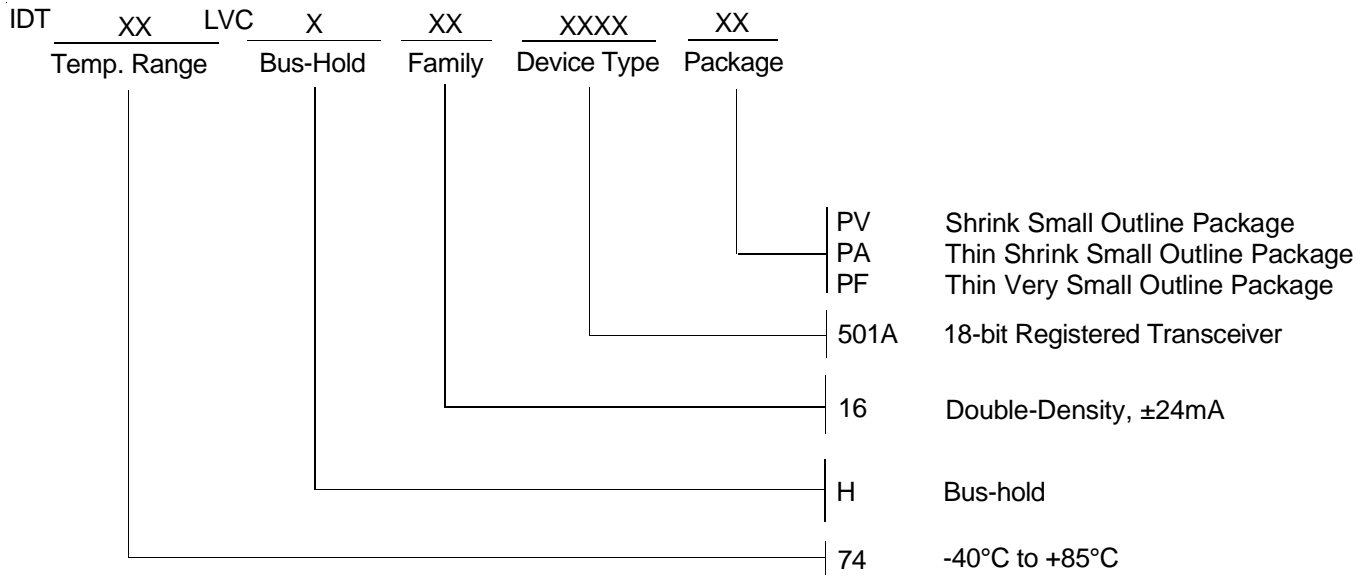


Set-up, Hold, and Release Times



Pulse Width

ORDERING INFORMATION



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