Integrated Device Technology, Inc.

# FAST CMOS OCTAL BIDIRECTIONAL TRANSCEIVERS

**IDT54/74FCT245T/AT/CT/DT - 2245T/AT/CT**
**IDT54/74FCT640T/AT/CT**
**IDT54/74FCT645T/AT/CT/DT**

## FEATURES:

- **Common features:**
  - Low input and output leakage ≤1µA (max.)
  - CMOS power levels
  - True TTL input and output compatibility
    - $V_{OH}$ = 3.3V (typ.)
    - $V_{OL}$ = 0.3V (typ.)
  - Meets or exceeds JEDEC standard 18 specifications
  - Product available in Radiation Tolerant and Radiation Enhanced versions
  - Military product compliant to MIL-STD-883, Class B and DESC listed (dual marked)
  - Available in DIP, SOIC, SSOP, QSOP, CERPACK and LCC packages
- **Features for FCT245T/FCT640T/FCT645T:**
  - Std., A, C and D speed grades
  - High drive outputs (-15mA $I_{OH}$, 64mA $I_{OL}$)
- **Features for FCT2245T:**
  - Std., A and C speed grades
  - Resistor outputs (-15mA $I_{OH}$, 12mA $I_{OL}$ Com.)
    (-12mA $I_{OH}$, 12mA $I_{OL}$ Mil.)
  - Reduced system switching noise

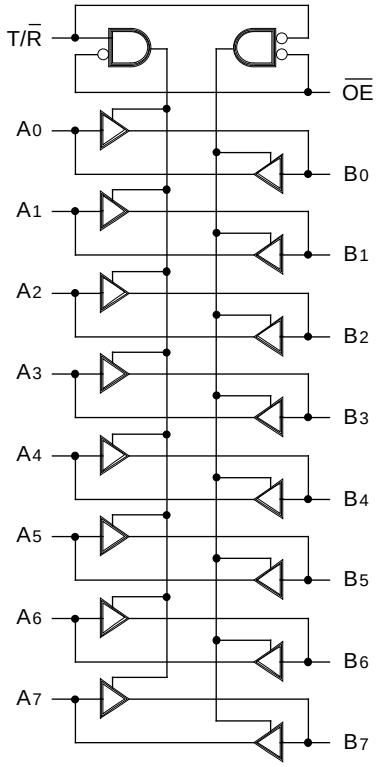
## DESCRIPTION:

The IDT octal bidirectional transceivers are built using an advanced dual metal CMOS technology. The FCT245T/FCT2245T, FCT640T and FCT645T are designed for asynchronous two-way communication between data buses. The transmit/receive (T/$\overline{R}$) input determines the direction of data flow through the bidirectional transceiver. Transmit (active HIGH) enables data from A ports to B ports, and receive (active LOW) from B ports to A ports. The output enable ($\overline{OE}$) input, when HIGH, disables both A and B ports by placing them in HIGH Z condition.

The FCT245T/FCT2245T and FCT645T transceivers have non-inverting outputs. The FCT640T has inverting outputs.

The FCT2245T has balanced drive outputs with current limiting resistors. This offers low ground bounce, minimal undershoot and controlled output fall times- reducing the need for external series terminating resistors. The FCT2xxxT parts are plug-in replacements for FCTxxxT parts.

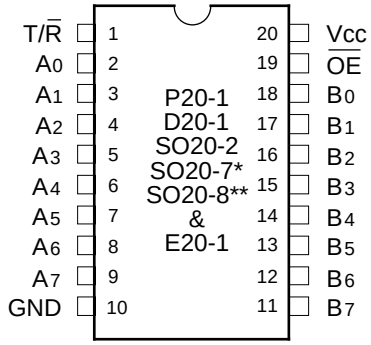
## FUNCTIONAL BLOCK DIAGRAM




FCT245T/2245T, FCT645T are non-inverting options.
FCT640T is the inverting options.

2539 drw 01

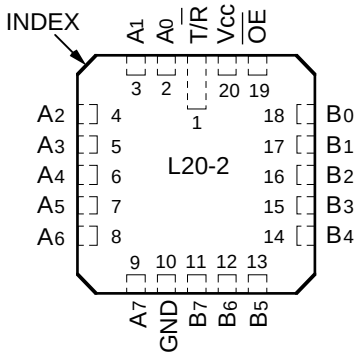
## PIN CONFIGURATIONS




**DIP/SOIC/SSOP/QSOP/CERPACK**
**TOP VIEW**

*FCT245T/2245T, FCT645T only.
**FCT245T/2245T, FCT640T

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**LCC**
**TOP VIEW**

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## PIN DESCRIPTION

| Pin Names | Description |
|---|---|
| $\overline{OE}$ | Output Enable Input (Active LOW) |
| T/$\overline{R}$ | Transmit/Receive Input |
| $A_0$-$A_7$ | Side A Inputs or 3-State Outputs |
| $B_0$-$B_7$ | Side B Inputs or 3-State Outputs |

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## FUNCTION TABLE(2)

| Inputs | | Outputs |
|---|---|---|
| $\overline{OE}$ | T/$\overline{R}$ | |
| L | L | Bus B Data to Bus A(1) |
| L | H | Bus B Data to Bus B(1) |
| H | X | High Z State |

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**NOTES:**
1. 640 is inverting from input to output.
2. H = HIGH Voltage Level
   L = LOW Voltage Level
   X = Don't Care

## ABSOLUTE MAXIMUM RATINGS(1)

| Symbol | Rating | Commercial | Military | Unit |
|---|---|---|---|---|
| $V_{TERM}$(2) | Terminal Voltage with Respect to GND | –0.5 to +7.0 | –0.5 to +7.0 | V |
| $V_{TERM}$(3) | Terminal Voltage with Respect to GND | –0.5 to $V_{CC}$ +0.5 | –0.5 to $V_{CC}$ +0.5 | V |
| $T_A$ | Operating Temperature | 0 to +70 | –55 to +125 | °C |
| $T_{BIAS}$ | Temperature Under Bias | –55 to +125 | –65 to +135 | °C |
| $T_{STG}$ | Storage Temperature | –55 to +125 | –65 to +150 | °C |
| $P_T$ | Power Dissipation | 0.5 | 0.5 | W |
| $I_{OUT}$ | DC Output Current | –60 to +120 | –60 to +120 | mA |

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**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. No terminal voltage may exceed $V_{CC}$ by +0.5V unless otherwise noted.
2. Input and $V_{CC}$ terminals only.
3. Outputs and I/O terminals only.

## CAPACITANCE (TA = +25°C, F = 1.0MHZ)

| Symbol | Parameter(1) | Conditions | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{IN}$ = 0V | 6 | 10 | pF |
| $C_{OUT}$ | Output Capacitance | $V_{OUT}$ = 0V | 8 | 12 | pF |

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**NOTE:**
1. This parameter is measured at characterization but not tested.

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:
Commercial: $T_A$ = 0°C to +70°C, $V_{CC}$ = 5.0V ± 5%; Military: $T_A$ = –55°C to +125°C, $V_{CC}$ = 5.0V ± 10%

| Symbol | Parameter | Test Conditions[1] | | Min. | Typ.[2] | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input HIGH Level | Guaranteed Logic HIGH Level | | 2.0 | — | — | V |
| $V_{IL}$ | Input LOW Level | Guaranteed Logic LOW Level | | — | — | 0.8 | V |
| $I_{IH}$ | Input HIGH Current[4] | $V_{CC}$ = Max. | $V_I$ = 2.7V | — | — | ±1 | µA |
| $I_{IL}$ | Input LOW Current[4] | | $V_I$ = 0.5V | — | — | ±1 | |
| $I_{OZH}$ | High Impedance Output Current | $V_{CC}$ = Max. | $V_O$ = 2.7V | — | — | ±1 | µA |
| $I_{OZL}$ | (3-State Output pins)[4] | | $V_O$ = 0.5V | — | — | ±1 | |
| $I_I$ | Input HIGH Current[4] | $V_{CC}$ = Max., $V_I$ = $V_{CC}$ (Max.) | | — | — | ±1 | µA |
| $V_{IK}$ | Clamp Diode Voltage | $V_{CC}$ = Min., $I_{IN}$ = –18mA | | — | –0.7 | –1.2 | V |
| $V_H$ | Input Hysteresis | — | | — | 200 | — | mV |
| $I_{CC}$ | Quiescent Power Supply Current | $V_{CC}$ = Max., $V_{IN}$ = GND or $V_{CC}$ | | — | 0.01 | 1 | mA |

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## OUTPUT DRIVE CHARACTERISTICS FOR FCT245T/640T/645T

| Symbol | Parameter | Test Conditions[1] | | Min. | Typ.[2] | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{OH}$ | Output HIGH Voltage | $V_{CC}$ = Min.<br>$V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = –6mA MIL.<br>$I_{OH}$ = –8mA COM'L. | 2.4 | 3.3 | — | V |
| | | | $I_{OH}$ = –12mA MIL.<br>$I_{OH}$ = –15mA COM'L. | 2.0 | 3.0 | — | V |
| $V_{OL}$ | Output LOW Voltage | $V_{CC}$ = Min.<br>$V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 48mA MIL.<br>$I_{OL}$ = 64mA COM'L. | — | 0.3 | 0.55 | V |
| $I_{OS}$ | Short Circuit Current | $V_{CC}$ = Max., $V_O$ = GND[3] | | –60 | –120 | –225 | mA |

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## OUTPUT DRIVE CHARACTERISTICS FOR FCT2245T

| Symbol | Parameter | Test Conditions[1] | | Min. | Typ.[2] | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $I_{ODL}$ | Output LOW Current | $V_{CC}$ = 5V, $V_{IN}$ = $V_{IH}$ or $V_{IL}$, $V_{OUT}$ = 1.5V[3] | | 16 | 48 | — | mA |
| $I_{ODH}$ | Output HIGH Current | $V_{CC}$ = 5V, $V_{IN}$ = $V_{IH}$ or $V_{IL}$, $V_{OUT}$ = 1.5V[3] | | –16 | –48 | — | mA |
| $V_{OH}$ | Output HIGH Voltage | $V_{CC}$ = Min.<br>$V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = –12mA MIL.<br>$I_{OH}$ = –15mA COM'L. | 2.4 | 3.3 | — | V |
| $V_{OL}$ | Output LOW Voltage | $V_{CC}$ = Min.<br>$V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 12mA | — | 0.3 | 0.50 | V |

2539 lnk 07

**NOTES:**

1. For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at Vcc = 5.0V, +25°C ambient.
3. Not more than one output should be shorted at one time. Duration of the short circuit test should not exceed one second.
4. The test limit for this parameter is ±5µA at $T_A$ = –55°C.

## POWER SUPPLY CHARACTERISTICS

| Symbol | Parameter | Test Conditions[1] | | | Min. | Typ.[2] | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| $\Delta I_{CC}$ | Quiescent Power Supply Current<br>TTL Inputs HIGH | $V_{CC}$ = Max.<br>$V_{IN}$ = 3.4V[3] | | | — | 0.5 | 2.0 | mA |
| $I_{CCD}$ | Dynamic Power Supply Current[4] | $V_{CC}$ = Max.<br>Outputs Open<br>$\overline{OE}$ = T/$\overline{R}$ = GND<br>One Input Toggling<br>50% Duty Cycle | $V_{IN}$ = $V_{CC}$<br>$V_{IN}$ = GND | FCTxxxT | — | 0.15 | 0.25 | mA/<br>MHz |
| | | | | FCT2xxxT | — | 0.06 | 0.12 | |
| $I_C$ | Total Power Supply Current[6] | $V_{CC}$ = Max.<br>Outputs Open<br>fi = 10MHz<br>50% Duty Cycle<br>$\overline{OE}$ = T/$\overline{R}$ = GND<br>One Bit Toggling | $V_{IN}$ = $V_{CC}$ | FCTxxxT | — | 1.5 | 3.5 | mA |
| | | | $V_{IN}$ = GND | FCT2xxxT | — | 0.6 | 2.2 | |
| | | | $V_{IN}$ = 3.4 | FCTxxxT | — | 1.8 | 4.5 | |
| | | | $V_{IN}$ = GND | FCT2xxxT | | 0.9 | 3.2 | |
| | | $V_{CC}$ = Max.<br>Outputs Open<br>fi = 2.5MHz<br>50% Duty Cycle<br>$\overline{OE}$ = T/$\overline{R}$ = GND<br>Eight Bits Toggling | $V_{IN}$ = $V_{CC}$ | FCTxxxT | — | 3.0 | 6.0[5] | |
| | | | $V_{IN}$ = GND | FCT2xxxT | — | 1.2 | 3.4[5] | |
| | | | $V_{IN}$ = 3.4 | FCTxxxT | — | 5.0 | 14.0[5] | |
| | | | $V_{IN}$ = GND | FCT2xxxT | — | 3.2 | 11.4[5] | |

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**NOTES:**

1. For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at $V_{CC}$ = 5.0V, +25°C ambient.
3. Per TTL driven input ($V_{IN}$ = 3.4V). All other inputs at $V_{CC}$ or GND.
4. This parameter is not directly testable, but is derived for use in Total Power Supply Calculations.
5. Values for these conditions are examples of the $I_{CC}$ formula. These limits are guaranteed but not tested.
6. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
   $I_C = I_{CC} + \Delta I_{CC} D_H N_T + I_{CCD} (f_{CP}/2 + f_i N_i)$
   $I_{CC}$ = Quiescent Current
   $\Delta I_{CC}$ = Power Supply Current for a TTL High Input ($V_{IN}$ = 3.4V)
   $D_H$ = Duty Cycle for TTL Inputs High
   $N_T$ = Number of TTL Inputs at $D_H$
   $I_{CCD}$ = Dynamic Current Caused by an Input Transition Pair (HLH or LHL)
   $f_{CP}$ = Clock Frequency for Register Devices (Zero for Non-Register Devices)
   $f_i$ = Input Frequency
   $N_i$ = Number of Inputs at $f_i$
   All currents are in milliamps and all frequencies are in megahertz.

## SWITCHING CHARACTERISTICS OVER OPERATING RANGE

| Symbol | Parameter | Conditions[1] | FCT245T FCT2245T | | | | FCT245AT FCT2245AT | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Com'l. | | Mil. | | Com'l. | | Mil. | | |
| | | | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>A to B, B to A | $C_L$ = 50 pF<br>$R_L$ = 500Ω | 1.5 | 7.0 | 1.5 | 7.5 | 1.5 | 4.6 | 1.5 | 4.9 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>$\overline{OE}$ to A or B | | 1.5 | 9.5 | 1.5 | 10.0 | 1.5 | 6.2 | 1.5 | 6.5 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>$\overline{OE}$ to A or B | | 1.5 | 7.5 | 1.5 | 10.0 | 1.5 | 5.0 | 1.5 | 6.0 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>T/$\overline{R}$ to A or B[3] | | 1.5 | 9.5 | 1.5 | 10.0 | 1.5 | 6.2 | 1.5 | 6.5 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>T/$\overline{R}$ to A or B[3] | | 1.5 | 7.5 | 1.5 | 10.0 | 1.5 | 5.0 | 1.5 | 6.0 | ns |

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| Symbol | Parameter | Conditions[1] | FCT245CT FCT2245CT | | | | FCT245DT | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Com'l. | | Mil. | | Com'l. | | Mil. | | |
| | | | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>A to B, B to A | $C_L$ = 50 pF<br>$R_L$ = 500Ω | 1.5 | 4.1 | 1.5 | 4.5 | 1.5 | 3.8 | — | — | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>$\overline{OE}$ to A or B | | 1.5 | 5.8 | 1.5 | 6.2 | 1.5 | 5.0 | — | — | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>$\overline{OE}$ to A or B | | 1.5 | 4.8 | 1.5 | 5.2 | 1.5 | 4.3 | — | — | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>T/$\overline{R}$ to A or B[3] | | 1.5 | 5.8 | 1.5 | 6.2 | 1.5 | 5.0 | — | — | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>T/$\overline{R}$ to A or B[3] | | 1.5 | 4.8 | 1.5 | 5.2 | 1.5 | 4.3 | — | — | ns |

2534 tbl 10

## SWITCHING CHARACTERISTICS OVER OPERATING RANGE

| Symbol | Parameter | Conditions[1] | FCT640T | | | | FCT640AT | | | | FCT640CT | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Com'l. | | Mil. | | Com'l. | | Mil. | | Com'l. | | Mil. | | |
| | | | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>A to B, B to A | $C_L$ = 50 pF<br>$R_L$ = 500Ω | 2.0 | 7.0 | 2.0 | 8.0 | 1.5 | 5.0 | 1.5 | 5.3 | 1.5 | 4.4 | 1.5 | 4.7 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>$\overline{OE}$ to A or B | | 2.0 | 13.0 | 2.0 | 16.0 | 1.5 | 6.2 | 1.5 | 6.5 | 1.5 | 5.8 | 1.5 | 6.2 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>$\overline{OE}$ to A or B | | 2.0 | 10.0 | 2.0 | 12.0 | 1.5 | 5.0 | 1.5 | 6.0 | 1.5 | 4.8 | 1.5 | 5.2 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>T/$\overline{R}$ to A or B[3] | | 2.0 | 13.0 | 2.0 | 16.0 | 1.5 | 6.2 | 1.5 | 6.5 | 1.5 | 5.8 | 1.5 | 6.2 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>T/$\overline{R}$ to A or B[3] | | 2.0 | 10.0 | 2.0 | 12.0 | 1.5 | 5.0 | 1.5 | 6.0 | 1.5 | 4.8 | 1.5 | 5.2 | ns |

**NOTES:**

2534 tbl 11

1. See test circuit and waveforms.
2. Minimum limits are guaranteed but not tested on Propagation Delays.
3. This parameter is guaranteed but not tested.

## SWITCHING CHARACTERISTICS OVER OPERATING RANGE

| | | | FCT645T | | | | FCT645AT | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Com'l. | | Mil. | | Com'l. | | Mil. | | |
| Symbol | Parameter | Conditions[1] | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | Unit |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>A to B, B to A | $C_L$ = 50 pF<br>$R_L$ = 500Ω | 1.5 | 9.5 | 1.5 | 11.0 | 1.5 | 4.6 | 1.5 | 4.9 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>$\overline{OE}$ to A or B | | 1.5 | 11.0 | 1.5 | 12.0 | 1.5 | 6.2 | 1.5 | 6.5 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>$\overline{OE}$ to A or B | | 1.5 | 12.0 | 1.5 | 13.0 | 1.5 | 5.0 | 1.5 | 6.0 | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>T/$\overline{R}$ to A or B[3] | | 1.5 | 11.0 | 1.5 | 12.0 | 1.5 | 6.2 | 1.5 | 6.5 | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>T/$\overline{R}$ to A or B[3] | | 1.5 | 12.0 | 1.5 | 13.0 | 1.5 | 5.0 | 1.5 | 6.0 | ns |

2534 tbl 12

| | | | FCT645CT | | | | FCT645DT | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Com'l. | | Mil. | | Com'l. | | Mil. | | |
| Symbol | Parameter | Conditions[1] | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | Unit |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>A to B, B to A | $C_L$ = 50 pF<br>$R_L$ = 500Ω | 1.5 | 4.1 | 1.5 | 4.5 | 1.5 | 3.8 | — | — | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>$\overline{OE}$ to A or B | | 1.5 | 5.8 | 1.5 | 6.2 | 1.5 | 5.0 | — | — | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>$\overline{OE}$ to A or B | | 1.5 | 4.8 | 1.5 | 5.2 | 1.5 | 4.3 | — | — | ns |
| $t_{PZH}$<br>$t_{PZL}$ | Output Enable Time<br>T/$\overline{R}$ to A or B[3] | | 1.5 | 5.8 | 1.5 | 6.2 | 1.5 | 5.0 | — | — | ns |
| $t_{PHZ}$<br>$t_{PLZ}$ | Output Disable Time<br>T/$\overline{R}$ to A or B[3] | | 1.5 | 4.8 | 1.5 | 5.2 | 1.5 | 4.3 | — | — | ns |

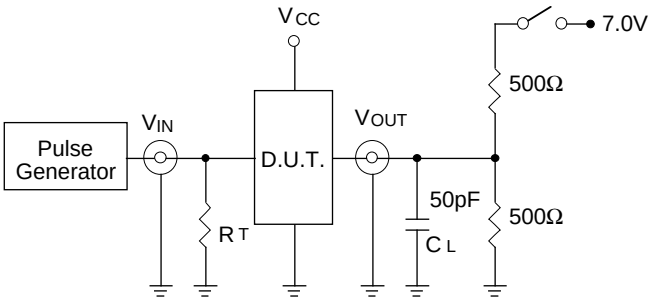
**NOTES:**

2534 tbl 13

1. See test circuit and waveforms.
2. Minimum limits are guaranteed but not tested on Propagation Delays.
3. This parameter is guaranteed but not tested.

# TEST CIRCUITS AND WAVEFORMS

## TEST CIRCUITS FOR ALL OUTPUTS




2534 drw 04

## SWITCH POSITION

| Test | Switch |
|---|---|
| Open Drain<br>Disable Low<br>Enable Low | Closed |
| All Other Tests | Open |

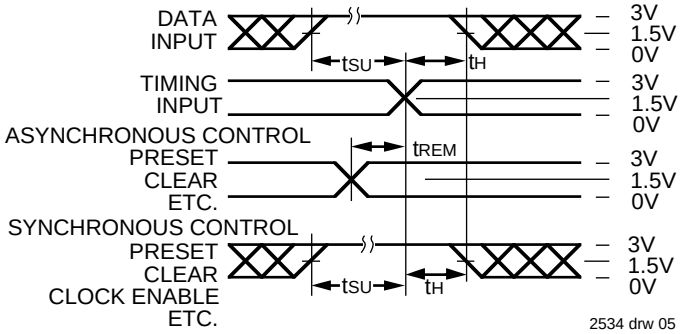
2534 lnk 14

**DEFINITIONS:**

$C_L$= Load capacitance: includes jig and probe capacitance.

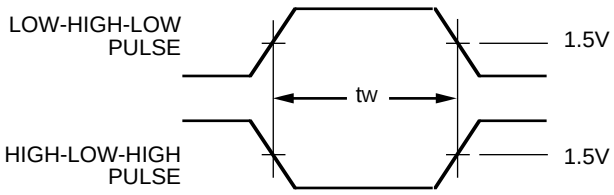
$R_T$ = Termination resistance: should be equal to $Z_{OUT}$ of the Pulse Generator.

## SET-UP, HOLD AND RELEASE TIMES



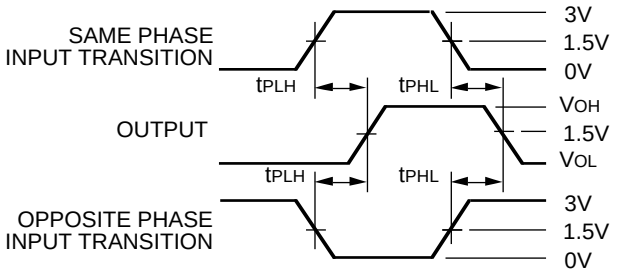

2534 drw 05

## PULSE WIDTH



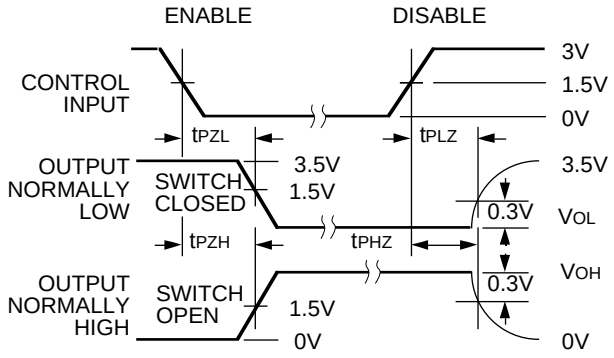

2534 drw 06

## PROPAGATION DELAY




2534 drw 07

## ENABLE AND DISABLE TIMES

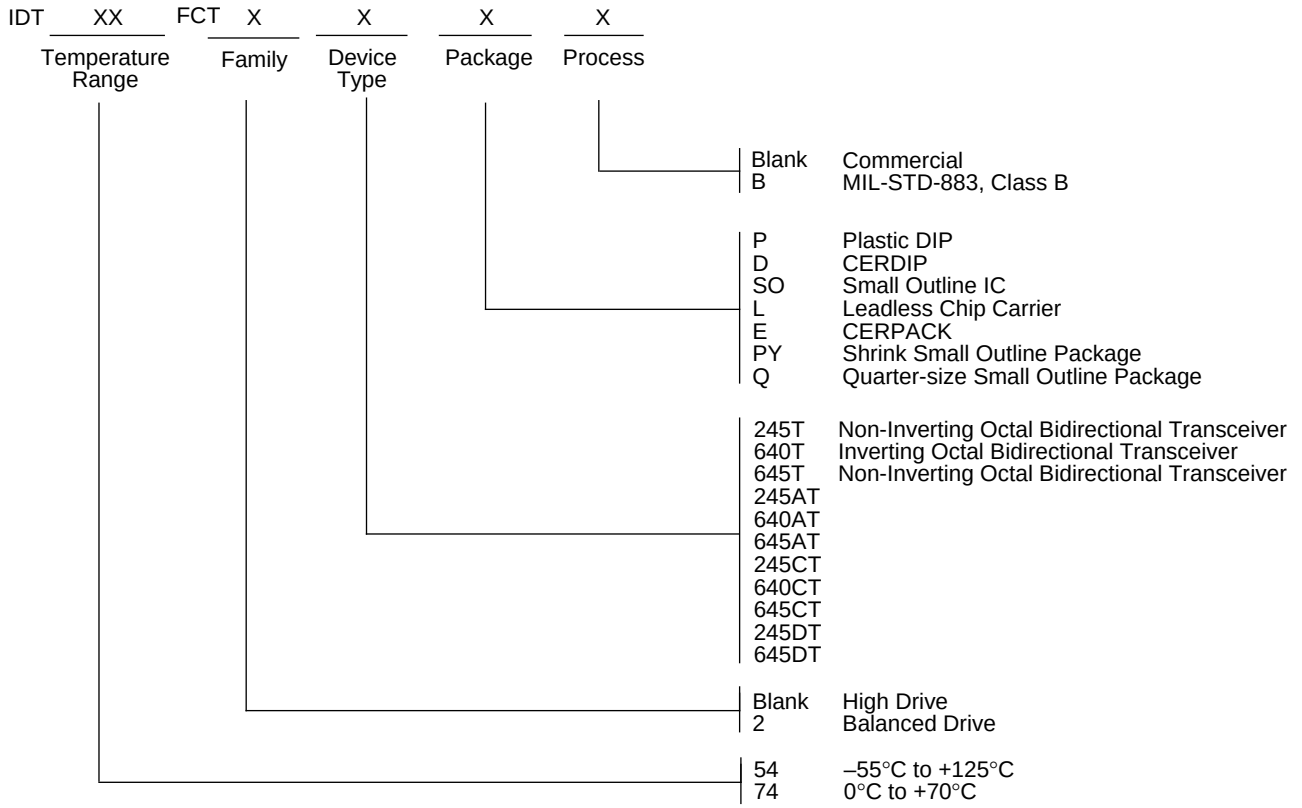



2534 drw 08

**NOTES:**

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH
2. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; $t_F$ ≤ 2.5ns; $t_R$ ≤ 2.5ns

## ORDERING INFORMATION




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