# 3.3V CMOS 16-BIT BIDIRECTIONAL TRANSCEIVERS

**IDT74FCT163245/A/C**

## FEATURES:

- 0.5 MICRON CMOS Technology
- **Typical tsκ(o) (Output Skew) < 250ps**
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- Packages include 25 mil pitch SSOP, 19.6 mil pitch TSSOP and 15.7 mil pitch TVSOP
- Extended commercial range of -40°C to +85°C
- $V_{CC}$ = 3.3V ±0.3V, Normal Range or $V_{CC}$ = 2.7 to 3.6V, Extended Range
- CMOS power levels (0.4μW typ. static)
- Rail-to-Rail output swing for increased noise margin
- Low Ground Bounce (0.3V typ.)
- Inputs (except I/O) can be driven by 3.3V or 5V components

## DESCRIPTION:

The FCT163245/A/C 16-bit transceivers are built using advanced dual metal CMOS technology. These high-speed, low-power transceivers are ideal for synchronous communication between two busses (A and B). The Direction and Output Enable controls are designed to operate these devices as either two independent 8-bit transceivers or one 16-bit transceiver. The direction control pin (xDIR) controls the direction of data flow. The output enable pin (xOE) overrides the direction control and disables both ports. All inputs are designed with hysteresis for improved noise margin.

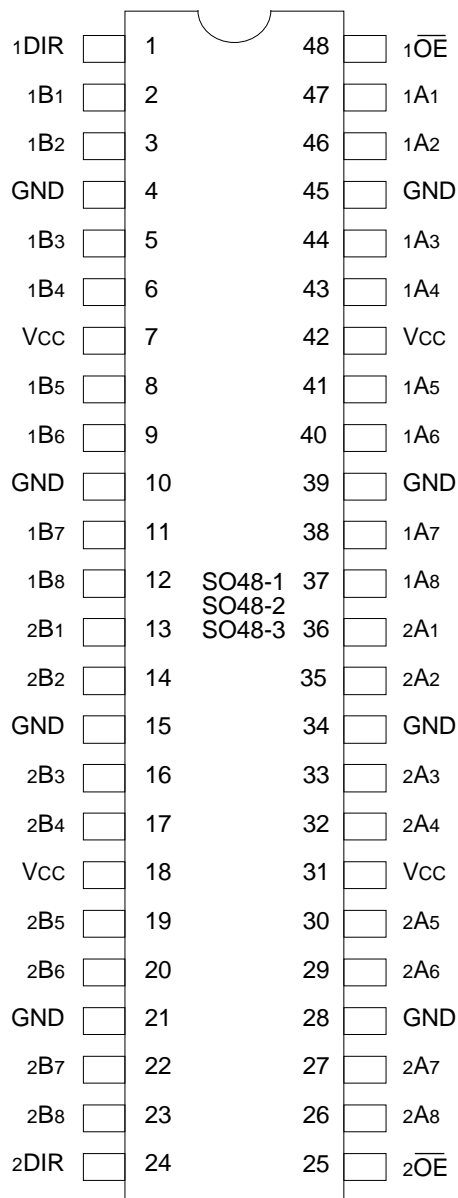## FUNCTIONAL BLOCK DIAGRAM
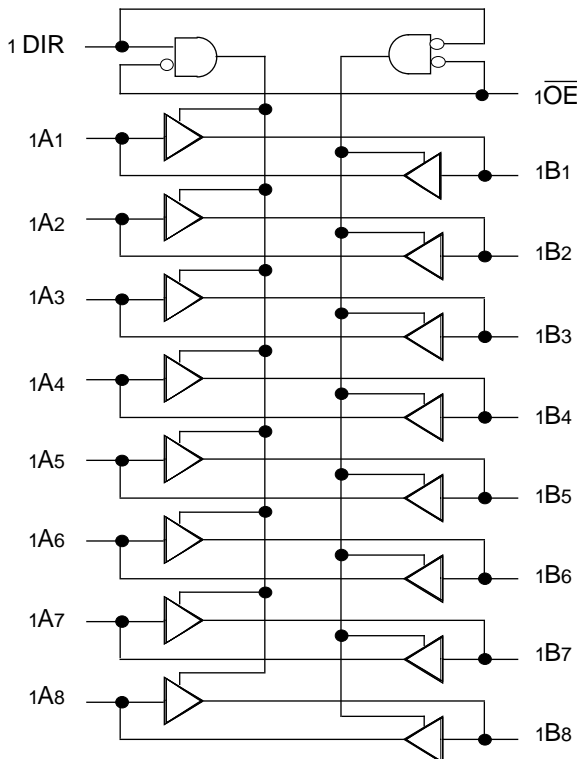


2554 drw 01
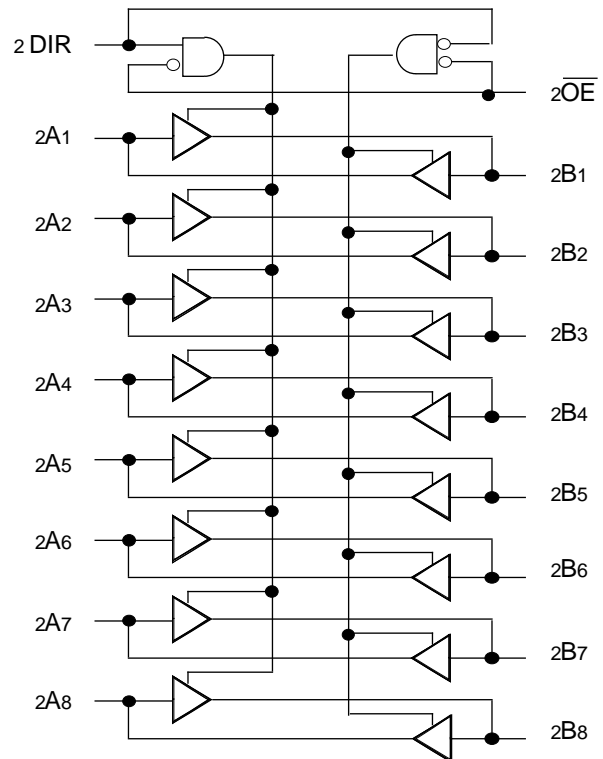
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**COMMERCIAL TEMPERATURE RANGE**

**AUGUST 1996**

**8.2**

**DSC-2554/6**

## PIN CONFIGURATIONS

| | | | | |
|---|---|---|---|---|
| 1DIR | 1 | | 48 | 1$\overline{OE}$ |
| 1B1 | 2 | | 47 | 1A1 |
| 1B2 | 3 | | 46 | 1A2 |
| GND | 4 | | 45 | GND |
| 1B3 | 5 | | 44 | 1A3 |
| 1B4 | 6 | | 43 | 1A4 |
| VCC | 7 | | 42 | VCC |
| 1B5 | 8 | | 41 | 1A5 |
| 1B6 | 9 | | 40 | 1A6 |
| GND | 10 | | 39 | GND |
| 1B7 | 11 | | 38 | 1A7 |
| 1B8 | 12 | SO48-1 | 37 | 1A8 |
| 2B1 | 13 | SO48-2 SO48-3 | 36 | 2A1 |
| 2B2 | 14 | | 35 | 2A2 |
| GND | 15 | | 34 | GND |
| 2B3 | 16 | | 33 | 2A3 |
| 2B4 | 17 | | 32 | 2A4 |
| VCC | 18 | | 31 | VCC |
| 2B5 | 19 | | 30 | 2A5 |
| 2B6 | 20 | | 29 | 2A6 |
| GND | 21 | | 28 | GND |
| 2B7 | 22 | | 27 | 2A7 |
| 2B8 | 23 | | 26 | 2A8 |
| 2DIR | 24 | | 25 | 2$\overline{OE}$ |

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**SSOP/
TSSOP/TVSOP
TOP VIEW**

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

| Symbol | Parameter[1] | Conditions | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $C_{IN}$ | Input Capacitance | $V_{IN}$ = 0V | 3.5 | 6.0 | pF |
| $C_{I/O}$ | I/O Capacitance | $V_{OUT}$ = 0V | 3.5 | 8.0 | pF |

**NOTE:** 2554 lnk 04
1. This parameter is measured at characterization but not tested.

## PIN DESCRIPTION

| Pin Names | Description |
|---|---|
| x$\overline{OE}$ | Output Enable Input (Active LOW) |
| xDIR | Direction Control Input |
| xAx | Side A Inputs or 3-State Outputs |
| xBx | Side B Inputs or 3-State Outputs |

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## ABSOLUTE MAXIMUM RATINGS[1]

| Symbol | Description | Max. | Unit |
|---|---|---|---|
| $V_{TERM}$[2] | Terminal Voltage with Respect to GND | −0.5 to +4.6 | V |
| $V_{TERM}$[3] | Terminal Voltage with Respect to GND | −0.5 to +7.0 | V |
| $V_{TERM}$[4] | Terminal Voltage with Respect to GND | −0.5 to $V_{CC}$ + 0.5 | V |
| $T_{STG}$ | Storage Temperature | −65 to +150 | °C |
| $I_{OUT}$ | DC Output Current | −60 to +60 | mA |

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**NOTES:**
1. Stresses greater than those listed under ABSOLUTE MAXIMUM RAT-INGS 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. Vcc terminals.
3. Input terminals.
4. Output and I/O terminals.

## FUNCTION TABLE[1]

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

2554 tbl 02

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

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Commercial: $T_A$ = –40°C to +85°C, $V_{CC}$ = 2.7V to 3.6V

| Symbol | Parameter | Test Conditions[1] | | Min. | Typ.[2] | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{IH}$ | Input HIGH Level  (Input pins) | Guaranteed Logic HIGH Level | | 2.0 | — | 5.5 | V |
| | Input HIGH Level  (I/O  pins) | | | 2.0 | — | $V_{CC}$+0.5 | |
| $V_{IL}$ | Input LOW Level (Input and I/O pins) | Guaranteed Logic LOW Level | | –0.5 | — | 0.8 | V |
| $I_{IH}$ | Input HIGH Current (Input pins) | $V_{CC}$ = Max. | $V_I$ = 5.5V | — | — | ±1 | µA |
| | Input HIGH Current (I/O pins) | | $V_I$ = $V_{CC}$ | — | — | ±1 | |
| $I_{IL}$ | Input LOW Current (Input pins) | | $V_I$ = GND | — | — | ±1 | |
| | Input LOW Current (I/O pins) | | $V_I$ = GND | — | — | ±1 | |
| $I_{OZH}$ | High Impedance Output Current | $V_{CC}$ = Max. | $V_O$ = $V_{CC}$ | — | — | ±1 | µA |
| $I_{OZL}$ | (3-State Output pins) | | $V_O$ = GND | — | — | ±1 | |
| $V_{IK}$ | Clamp Diode Voltage | $V_{CC}$ = Min., $I_{IN}$ = –18mA | | — | –0.7 | –1.2 | V |
| $I_{ODH}$ | Output HIGH Current | $V_{CC}$ = 3.3V, $V_{IN}$ = $V_{IH}$ or $V_{IL}$,  $V_O$ = 1.5V[3] | | –36 | –60 | –110 | mA |
| $I_{ODL}$ | Output LOW Current | $V_{CC}$ = 3.3V, $V_{IN}$ = $V_{IH}$ or $V_{IL}$,  $V_O$ = 1.5V[3] | | 50 | 90 | 200 | mA |
| $V_{OH}$ | Output HIGH Voltage | $V_{CC}$ = Min. | $I_{OH}$ = –0.1mA | $V_{CC}$–0.2 | — | — | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = –3mA | 2.4 | 3.0 | — | |
| | | $V_{CC}$ = 3.0V $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OH}$ = –8mA | 2.4[5] | 3.0 | — | |
| $V_{OL}$ | Output LOW Voltage | $V_{CC}$ = Min. | $I_{OL}$ = 0.1mA | — | — | 0.2 | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 16mA | — | 0.2 | 0.4 | |
| | | | $I_{OL}$ = 24mA | — | 0.3 | 0.55 | |
| | | $V_{CC}$ = 3.0V $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | $I_{OL}$ = 24mA | — | 0.3 | 0.50 | |
| $I_{OS}$ | Short Circuit Current[4] | $V_{CC}$ = Max.,  $V_O$ = GND[3] | | –60 | –135 | –240 | mA |
| $V_H$ | Input Hysteresis | — | | — | 150 | — | mV |
| $I_{CCL}$ $I_{CCH}$ $I_{CCZ}$ | Quiescent Power Supply Current | $V_{CC}$ = Max., $V_{IN}$ = GND or $V_{CC}$ | | — | 0.1 | 10 | µA |

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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 $V_{CC}$ = 3.3V, +25°C ambient.
3. Not more than one output should be tested at one time.   Duration of the test should not exceed one second.
4. This parameter is guaranteed but not tested.
5. $V_{OH}$ = $V_{CC}$ –0.6V at rated current.

## POWER SUPPLY  CHARACTERISTICS

| Symbol | Parameter | Test Conditions[1] | | Min. | Typ.[2] | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $\Delta I_{CC}$ | Quiescent Power Supply Current TTL Inputs HIGH | $V_{CC}$ = Max. | $V_{IN} = V_{CC} - 0.6V$[3] | — | 2.0 | 30 | µA |
| $I_{CCD}$ | Dynamic Power Supply Current[4] | $V_{CC}$ = Max. Outputs Open $x\overline{OE}$ = xDIR = GND One Input Toggling 50% Duty Cycle | $V_{IN} = V_{CC}$ $V_{IN}$ = GND | — | 50 | 75 | µA/ MHz |
| $I_C$ | Total Power Supply Current[6] | $V_{CC}$ = Max. Outputs Open $f_i$ =10MHz | $V_{IN} = V_{CC}$ $V_{IN}$ = GND | — | 0.5 | 0.8 | mA |
| | | 50% Duty Cycle $x\overline{OE}$ = xDIR = GND One Bit Toggling | $V_{IN} = V_{CC} -0.6V$ $V_{IN}$ = GND | — | 0.5 | 0.8 | |
| | | $V_{CC}$ = Max. Outputs Open $f_i$ = 2.5MHz | $V_{IN} = V_{CC}$ $V_{IN}$ = GND | — | 2.0 | 3.0[5] | |
| | | 50% Duty Cycle $x\overline{OE}$ = xDIR = GND Sixteen Bits Toggling | $V_{IN} = V_{CC} -0.6V$ $V_{IN}$ = GND | — | 2.0 | 3.3[5] | |

2554 tbl 06

**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 $V_{CC}$ = 3.3V, +25°C ambient.
3. Per TTL driven input; 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. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
   $I_C = I_{CC} + \Delta I_{CC} D_H N_T + I_{CCD} (f_{CP}N_{CP}/2 + f_i N_i)$
   $I_{CC}$ = Quiescent Current ($I_{CCL,}$ $I_{CCH}$ and  $I_{CCZ}$)
   $\Delta I_{CC}$ = Power Supply Current for a TTL High Input
   $D_H$ = 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)
   $N_{CP}$ = Number of Clock Inputs at $f_{CP}$
   $f_i$ = Input Frequency
   $N_i$ = Number of Inputs at $f_i$

## SWITCHING CHARACTERISTICS OVER OPERATING RANGE[4]

| Symbol | Parameter | Condition[1] | FCT163245 | | FCT163245A | | FCT163245C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min.[2] | Max. | Min.[2] | Max. | Min.[2] | Max. | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay A to B, B to A | $C_L$ = 50pF $R_L$ = 500Ω | 1.5 | 7.0 | 1.5 | 4.6 | 1.5 | 4.1 | ns |
| $t_{PZH}$ $t_{PZL}$ | Output Enable Time x$\overline{OE}$ to A or B | | 1.5 | 9.5 | 1.5 | 6.2 | 1.5 | 5.8 | ns |
| $t_{PHZ}$ $t_{PLZ}$ | Output Disable Time x$\overline{OE}$ to A or B | | 1.5 | 7.5 | 1.5 | 5.0 | 1.5 | 4.8 | ns |
| $t_{PZH}$ $t_{PZL}$ | Output Enable Time xDIR to A or B[5] | | 1.5 | 9.5 | 1.5 | 6.2 | 1.5 | 5.8 | ns |
| $t_{PHZ}$ $t_{PLZ}$ | Output Disable Time xDIR to A or B[5] | | 1.5 | 7.5 | 1.5 | 5.0 | 1.5 | 4.8 | ns |
| $t_{SK(o)}$ | Output Skew[3] | | — | 0.5 | — | 0.5 | — | 0.5 | ns |

2554 tbl 07

**NOTES:**
1. See test circuit and waveforms.
2. Minimum limits are guaranteed but not tested on Propagation Delays.
3. Skew between any two outputs, of the same package, switching in the same direction. This parameter is guaranteed by design.
4. Propagation Delays and Enable/Disable times are with $V_{CC}$ = 3.3V ±0.3V, Normal Range. For $V_{CC}$ = 2.7V to 3.6V, Extended Range, all Propagation Delays and Enable/Disable times should be degraded by 20%.
5. This parameter is guaranteed but not tested.

# TEST CIRCUITS AND WAVEFORMS

## TEST CIRCUITS FOR ALL OUTPUTS
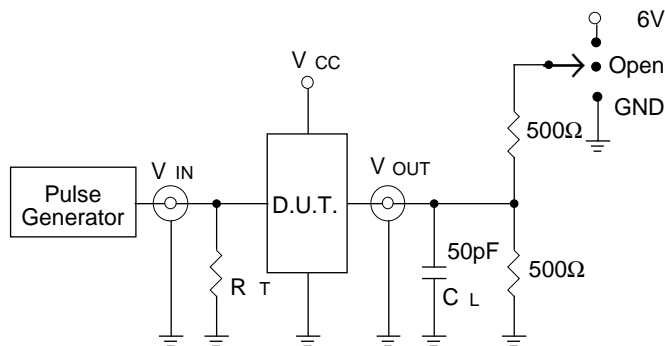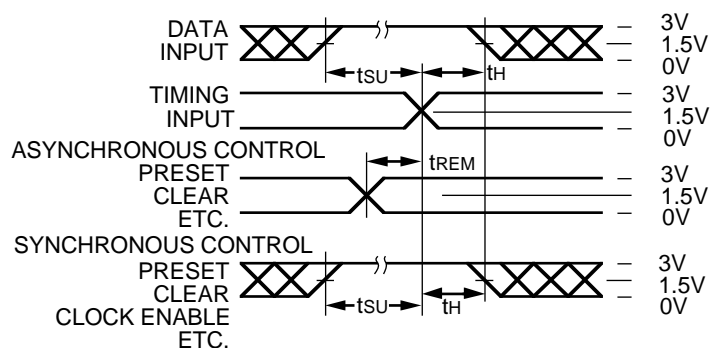


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## SWITCH POSITION

| Test | Switch |
|---|---|
| Open Drain<br>Disable Low<br>Enable Low | 6V |
| Disable High<br>Enable High | GND |
| All Other tests | Open |

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**DEFINITIONS:**
$C_L$ = Load capacitance: includes jig and probe capacitance.
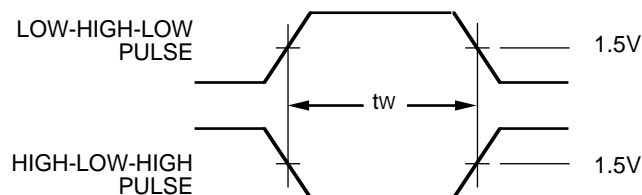$R_T$ = Termination resistance: should be equal to $Z_{OUT}$ of the Pulse Generator.
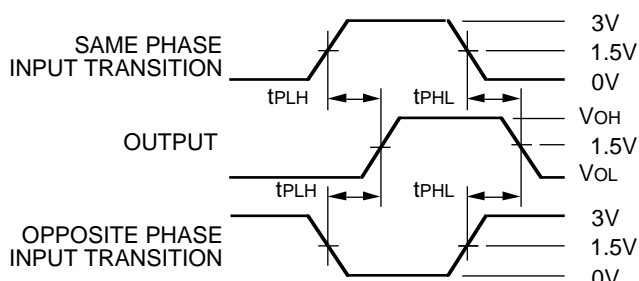
## SET-UP, HOLD AND RELEASE TIMES
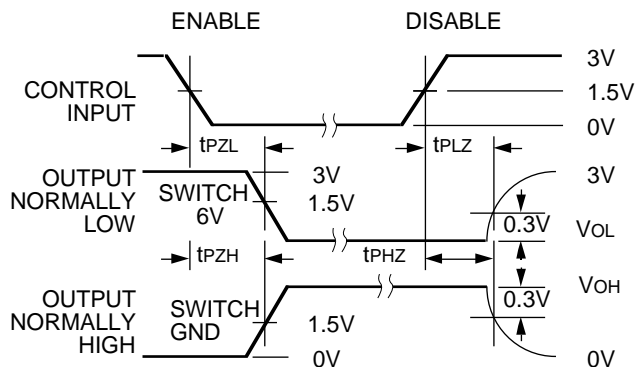


2554 drw 06

## PULSE WIDTH



2554 drw 07

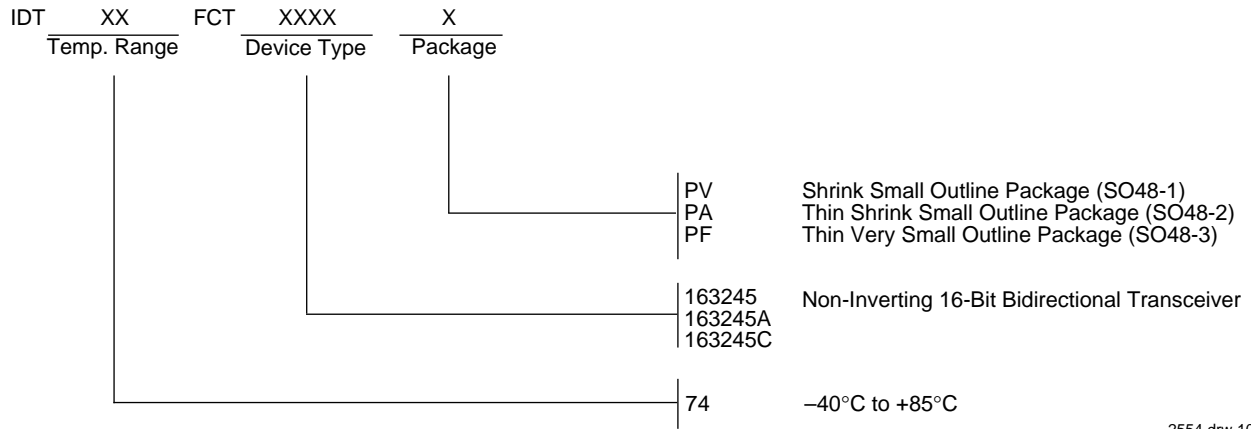## PROPAGATION DELAY



2554 drw 08

## ENABLE AND DISABLE TIMES



2554 drw 09

**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.
3. If $V_{CC}$ is below 3V, input voltage swings should be adjusted not to exceed $V_{CC}$.

## ORDERING INFORMATION

IDT    XX    FCT    XXXX    X
      Temp. Range      Device Type   Package

PV    Shrink Small Outline Package (SO48-1)
PA    Thin Shrink Small Outline Package (SO48-2)
PF    Thin Very Small Outline Package (SO48-3)

163245    Non-Inverting 16-Bit Bidirectional Transceiver
163245A
163245C

74    −40°C to +85°C

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