



Integrated Device Technology, Inc.

# FAST CMOS OCTAL BIDIRECTIONAL TRANSCEIVERS

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

## FEATURES:

### • Common features:

- Low input and output leakage  $\leq 1\mu\text{A}$  (max.)
- Extended commercial range of  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$
- CMOS power levels
- True TTL input and output compatibility
  - $V_{OH} = 3.3\text{V}$  (typ.)
  - $V_{OL} = 0.3\text{V}$  (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, TSSOP CERPACK and LCC packages

### • Features for FCT245T/FCT645T:

- Std., A, C and D speed grades
- High drive outputs (-15mA IOH, 64mA IOL)

### • Features for FCT2245T:

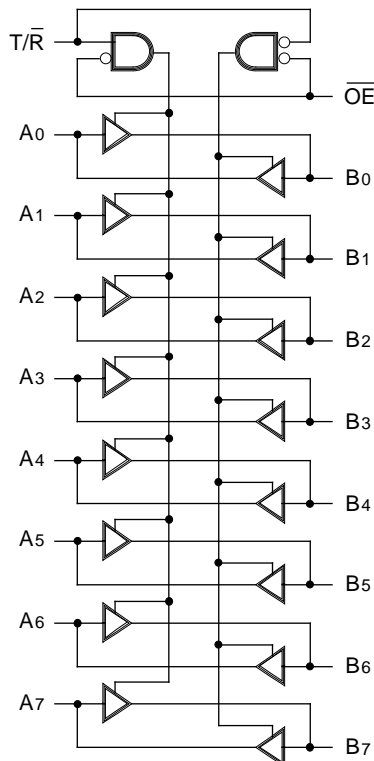
- Std., A and C speed grades
- Resistor outputs (-15mA IOH, 12mA IOL Com.)  
(-12mA IOH, 12mA IOL Mil.)
- Reduced system switching noise

## DESCRIPTION:

The IDT octal bidirectional transceivers are built using an advanced dual metal CMOS technology. The FCT245T/FCT2245T and FCT645T are designed for asynchronous two-way communication between data buses. The transmit/receive ( $T/\bar{R}$ ) 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 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



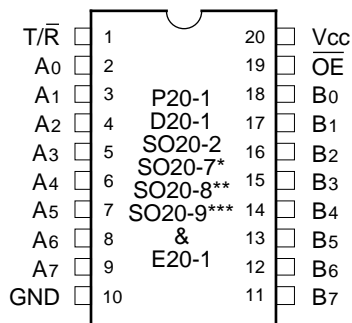
2539 drw 01

The IDT logo is a registered trademark of Integrated Device Technology, Inc.

**MILITARY AND INDUSTRIAL TEMPERATURE RANGES**

**FEBRUARY 1997**

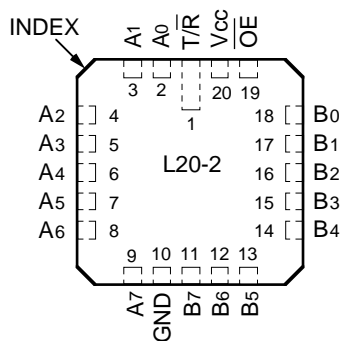
## PIN CONFIGURATIONS



2539 drw 02

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

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



2539 drw 03

LCC  
TOP VIEW

## PIN DESCRIPTION

Pin Names	Description
$\overline{OE}$	Output Enable Input (Active LOW)
T/ $\overline{R}$	Transmit/Receive Input
A0-A7	Side A Inputs or 3-State Outputs
B0-B7	Side B Inputs or 3-State Outputs

2539 tbl 01

## FUNCTION TABLE<sup>(1)</sup>

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

2539 tbl 02

**NOTE:**

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

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Symbol	Description	Max.	Unit
V <sub>TERM</sub> <sup>(2)</sup>	Terminal Voltage with Respect to GND	-0.5 to +7.0	V
V <sub>TERM</sub> <sup>(3)</sup>	Terminal Voltage with Respect to GND	-0.5 to V <sub>CC</sub> +0.5	V
T <sub>STG</sub>	Storage Temperature	-65 to +150	°C
I <sub>OUT</sub>	DC Output Current	-60 to +120	mA

2539 Ink 03

**NOTES:**

- 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<sub>CC</sub> by +0.5V unless otherwise noted.
- Input and V<sub>CC</sub> terminals only.
- Outputs and I/O terminals only.

## CAPACITANCE (TA = +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	6	10	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>OUT</sub> = 0V	8	12	pF

**NOTE:**

2539 Ink 04

- This parameter is measured at characterization but not tested.

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Commercial:  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = 5.0\text{V} \pm 5\%$ ; Military:  $T_A = -55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ,  $V_{CC} = 5.0\text{V} \pm 10\%$

Symbol	Parameter	Test Conditions <sup>(1)</sup>		Min.	Typ. <sup>(2)</sup>	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 <sup>(4)</sup>	$V_{CC} = \text{Max.}$	$V_I = 2.7\text{V}$	—	—	$\pm 1$	$\mu\text{A}$
$I_{IL}$	Input LOW Current <sup>(4)</sup>		$V_I = 0.5\text{V}$	—	—	$\pm 1$	
$I_{OZH}$	High Impedance Output Current (3-State Output pins) <sup>(4)</sup>	$V_{CC} = \text{Max.}$	$V_O = 2.7\text{V}$	—	—	$\pm 1$	$\mu\text{A}$
$I_{OZL}$			$V_O = 0.5\text{V}$	—	—	$\pm 1$	
$I_I$	Input HIGH Current <sup>(4)</sup>	$V_{CC} = \text{Max.}, V_I = V_{CC} (\text{Max.})$		—	—	$\pm 1$	$\mu\text{A}$
$V_{IK}$	Clamp Diode Voltage	$V_{CC} = \text{Min.}, I_{IN} = -18\text{mA}$		—	-0.7	-1.2	V
$V_H$	Input Hysteresis	—		—	200	—	mV
$I_{CC}$	Quiescent Power Supply Current	$V_{CC} = \text{Max.}, V_{IN} = \text{GND or } V_{CC}$		—	0.01	1	mA

2539 Ink 05

## OUTPUT DRIVE CHARACTERISTICS FOR FCT245T/645T

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

2539 Ink 06

## OUTPUT DRIVE CHARACTERISTICS FOR FCT2245T

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

2539 Ink 07

### NOTES:

- For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at  $V_{CC} = 5.0\text{V}$ ,  $+25^{\circ}\text{C}$  ambient.
- Not more than one output should be shorted at one time. Duration of the short circuit test should not exceed one second.
- The test limit for this parameter is  $\pm 5\mu\text{A}$  at  $T_A = -55^{\circ}\text{C}$ .

## POWER SUPPLY CHARACTERISTICS

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

2539 tbl 08

### NOTES:

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

**SWITCHING CHARACTERISTICS OVER OPERATING RANGE**

Symbol	Parameter	Conditions <sup>(1)</sup>	FCT245T FCT2245T				FCT245AT FCT2245AT				Unit
			Com'l.		Mil.		Com'l.		Mil.		
			Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	
tPLH tPHL	Propagation Delay A to B, B to A	CL = 50 pF RL = 500Ω	1.5	7.0	1.5	7.5	1.5	4.6	1.5	4.9	ns
tPZH tPZL	Output Enable Time $\overline{OE}$ to A or B		1.5	9.5	1.5	10.0	1.5	6.2	1.5	6.5	ns
tPHZ tPLZ	Output Disable Time $\overline{OE}$ to A or B		1.5	7.5	1.5	10.0	1.5	5.0	1.5	6.0	ns
tPZH tPZL	Output Enable Time T/R to A or B <sup>(3)</sup>		1.5	9.5	1.5	10.0	1.5	6.2	1.5	6.5	ns
tPHZ tPLZ	Output Disable Time T/R to A or B <sup>(3)</sup>		1.5	7.5	1.5	10.0	1.5	5.0	1.5	6.0	ns
tPZH tPZL	Output Enable Time T/R to A or B <sup>(3)</sup>		1.5	9.5	1.5	10.0	1.5	6.2	1.5	6.5	ns

2534 tbl 09

Symbol	Parameter	Conditions <sup>(1)</sup>	FCT245CT FCT2245CT				FCT245DT				Unit
			Com'l.		Mil.		Com'l.		Mil.		
			Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	
tPLH tPHL	Propagation Delay A to B, B to A	CL = 50 pF RL = 500Ω	1.5	4.1	1.5	4.5	1.5	3.8	—	—	ns
tPZH tPZL	Output Enable Time $\overline{OE}$ to A or B		1.5	5.8	1.5	6.2	1.5	5.0	—	—	ns
tPHZ tPLZ	Output Disable Time $\overline{OE}$ to A or B		1.5	4.8	1.5	5.2	1.5	4.3	—	—	ns
tPZH tPZL	Output Enable Time T/R to A or B <sup>(3)</sup>		1.5	5.8	1.5	6.2	1.5	5.0	—	—	ns
tPHZ tPLZ	Output Disable Time T/R to A or B <sup>(3)</sup>		1.5	4.8	1.5	5.2	1.5	4.3	—	—	ns
tPZH tPZL	Output Enable Time T/R to A or B <sup>(3)</sup>		1.5	5.8	1.5	6.2	1.5	5.0	—	—	ns

2534 tbl 10  
2534 tbl 11

**NOTES:**

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**

Symbol	Parameter	Conditions <sup>(1)</sup>	FCT645T				FCT645AT				Unit
			Com'l.		Mil.		Com'l.		Mil.		
			Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	
tPLH tPHL	Propagation Delay A to B, B to A	CL = 50 pF RL = 500Ω	1.5	9.5	1.5	11.0	1.5	4.6	1.5	4.9	ns
tPZH tPZL	Output Enable Time OE to A or B		1.5	11.0	1.5	12.0	1.5	6.2	1.5	6.5	ns
tPHZ tPLZ	Output Disable Time OE to A or B		1.5	12.0	1.5	13.0	1.5	5.0	1.5	6.0	ns
tPZH tPZL	Output Enable Time T/R to A or B <sup>(3)</sup>		1.5	11.0	1.5	12.0	1.5	6.2	1.5	6.5	ns
tPHZ tPLZ	Output Disable Time T/R to A or B <sup>(3)</sup>		1.5	12.0	1.5	13.0	1.5	5.0	1.5	6.0	ns
tPHZ tPLZ	Output Disable Time T/R to A or B <sup>(3)</sup>		1.5	12.0	1.5	13.0	1.5	5.0	1.5	6.0	ns

2534 tbl 12

Symbol	Parameter	Conditions <sup>(1)</sup>	FCT645CT				FCT645DT				Unit
			Com'l.		Mil.		Com'l.		Mil.		
			Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	
tPLH tPHL	Propagation Delay A to B, B to A	CL = 50 pF RL = 500Ω	1.5	4.1	1.5	4.5	1.5	3.8	—	—	ns
tPZH tPZL	Output Enable Time OE to A or B		1.5	5.8	1.5	6.2	1.5	5.0	—	—	ns
tPHZ tPLZ	Output Disable Time OE to A or B		1.5	4.8	1.5	5.2	1.5	4.3	—	—	ns
tPZH tPZL	Output Enable Time T/R to A or B <sup>(3)</sup>		1.5	5.8	1.5	6.2	1.5	5.0	—	—	ns
tPHZ tPLZ	Output Disable Time T/R to A or B <sup>(3)</sup>		1.5	4.8	1.5	5.2	1.5	4.3	—	—	ns
tPHZ tPLZ	Output Disable Time T/R to A or B <sup>(3)</sup>		1.5	4.8	1.5	5.2	1.5	4.3	—	—	ns

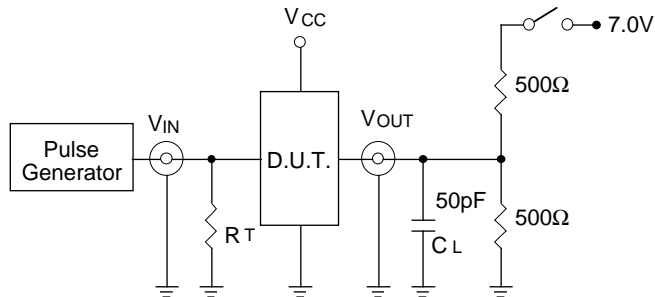
2534 tbl 13

**NOTES:**

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

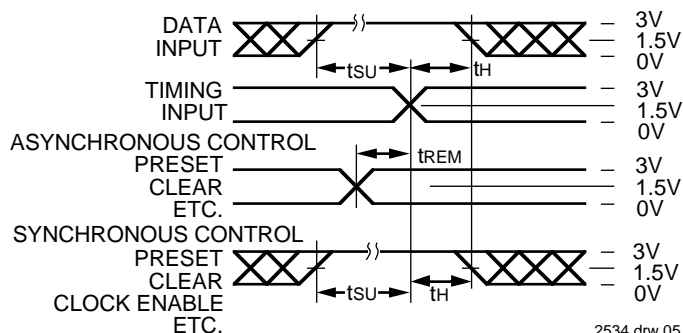
Test	Switch
Open Drain Disable Low Enable Low	Closed
All Other Tests	Open

#### DEFINITIONS:

CL = Load capacitance: includes jig and probe capacitance.  
RT = Termination resistance: should be equal to ZOUT of the Pulse Generator.

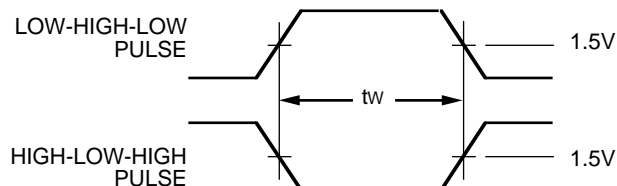
2534 Ink 14

### SET-UP, HOLD AND RELEASE TIMES



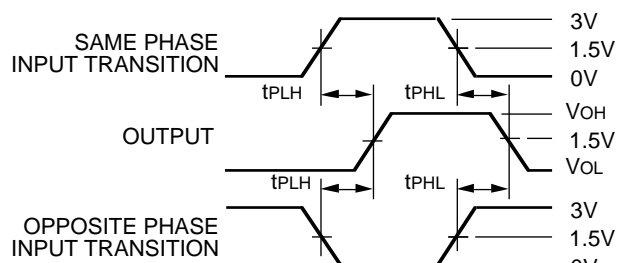
2534 drw 05

### PULSE WIDTH



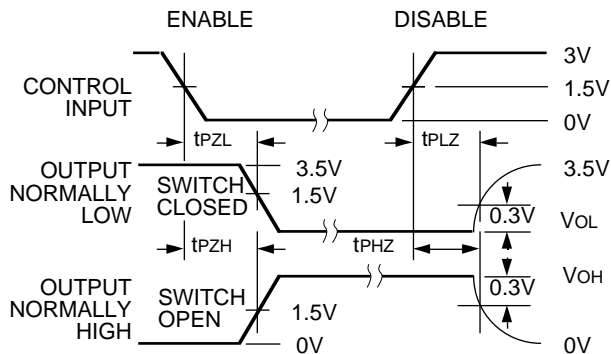
2534 drw 06

### PROPAGATION DELAY



2534 drw 07

### ENABLE AND DISABLE TIMES

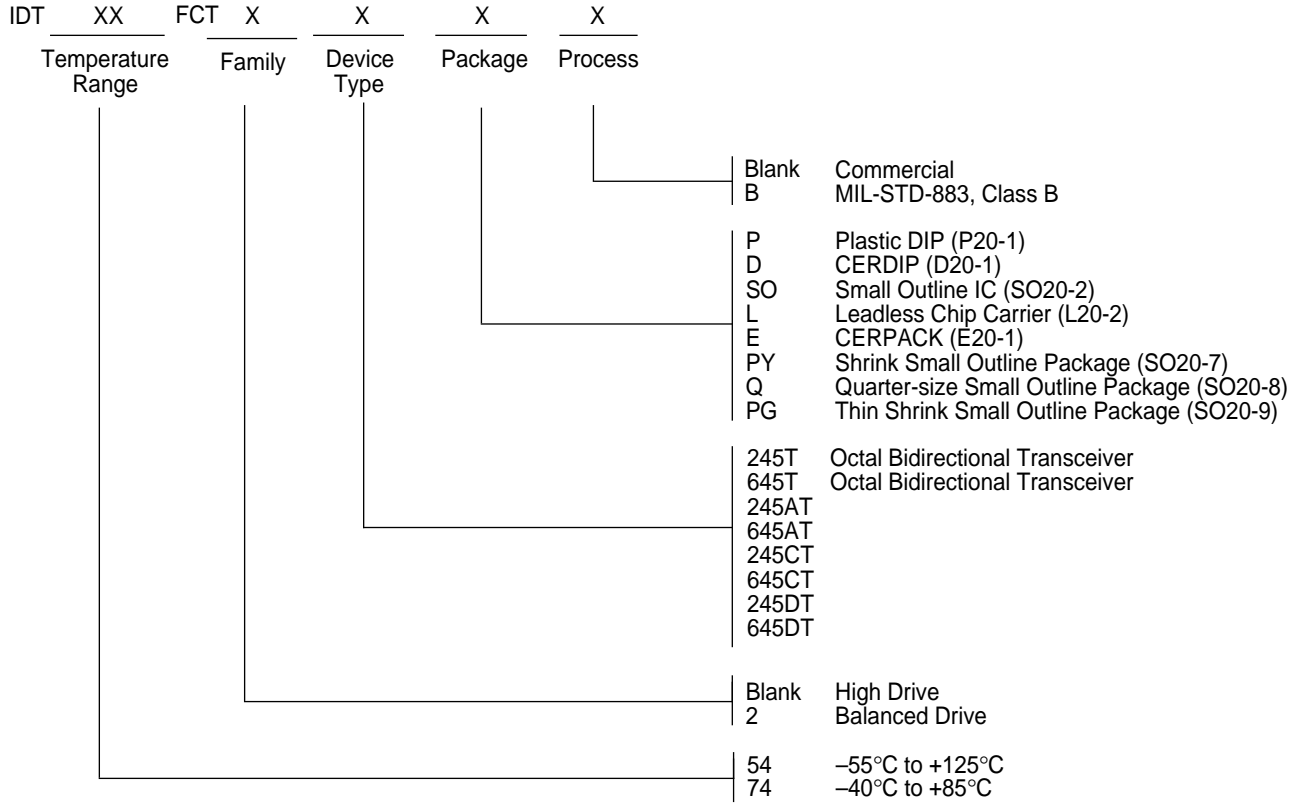


2534 drw 08

#### NOTES:

- Diagram shown for input Control Enable-LOW and input Control Disable-HIGH
- Pulse Generator for All Pulses: Rate  $\leq 1.0\text{MHz}$ ;  $t_f \leq 2.5\text{ns}$ ;  $t_r \leq 2.5\text{ns}$

**ORDERING INFORMATION**



2539 drw 09