



Integrated Device Technology, Inc.

# FAST CMOS 16-BIT TRANSPARENT LATCHES

IDT54/74FCT16373T/AT/CT/ET  
IDT54/74FCT162373T/AT/CT/ET

## FEATURES:

- **Common features:**
  - 0.5 MICRON CMOS Technology
  - **High-speed, low-power CMOS replacement for ABT functions**
  - **Typical  $t_{sk(o)}$  (Output Skew) < 250ps**
  - **Low input and output leakage  $\leq 1\mu A$  (max.)**
  - 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, 15.7 mil pitch TVSOP and 25 mil pitch Cerpack
  - Extended commercial range of -40°C to +85°C
  - $V_{CC} = 5V \pm 10\%$
- **Features for FCT16373T/AT/CT/ET:**
  - High drive outputs (-32mA  $I_{OH}$ , 64mA  $I_{OL}$ )
  - Power off disable outputs permit "live insertion"
  - Typical VOLP (Output Ground Bounce) < 1.0V at  $V_{CC} = 5V, T_A = 25^\circ C$
- **Features for FCT162373T/AT/CT/ET:**
  - Balanced Output Drivers:  $\pm 24mA$  (commercial),  $\pm 16mA$  (military)
  - Reduced system switching noise
  - Typical VOLP (Output Ground Bounce) < 0.6V at  $V_{CC} = 5V, T_A = 25^\circ C$

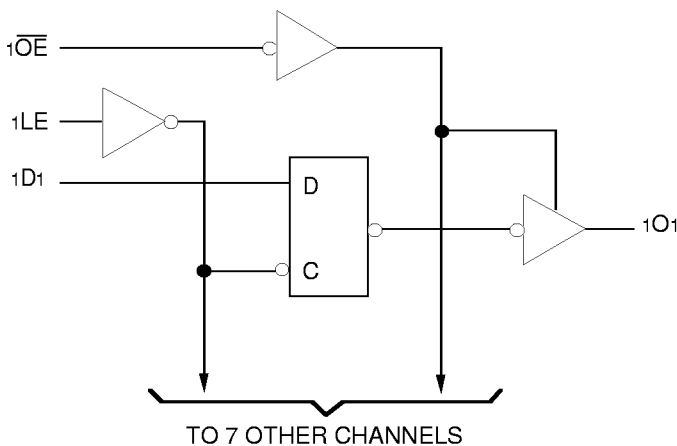
## DESCRIPTION:

The FCT16373T/AT/CT/ET and FCT162373T/AT/CT/ET 16-bit transparent D-type latches are built using advanced dual metal CMOS technology. These high-speed, low-power latches are ideal for temporary storage of data. They can be used for implementing memory address latches, I/O ports, and bus drivers. The Output Enable and Latch Enable controls are organized to operate each device as two 8-bit latches, or one 16-bit latch. Flow-through organization of signal pins simplifies layout. All inputs are designed with hysteresis for improved noise margin.

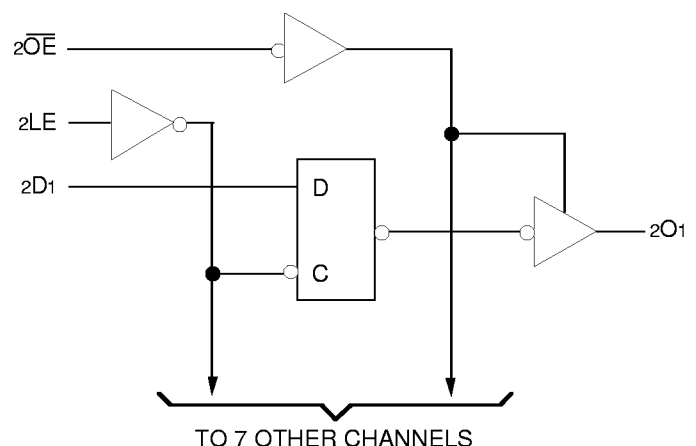
The FCT16373T/AT/CT/ET are ideally suited for driving high-capacitance loads and low-impedance backplanes. The output buffers are designed with power off disable capability to allow "live insertion" of boards when used as backplane drivers.

The FCT162373T/AT/CT/ET have balanced output drive 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 FCT162373T/AT/CT/ET are plug-in replacements for the FCT16373T/AT/CT/ET and ABT16373 for on-board interface applications.

## FUNCTIONAL BLOCK DIAGRAM



2543 drw 01



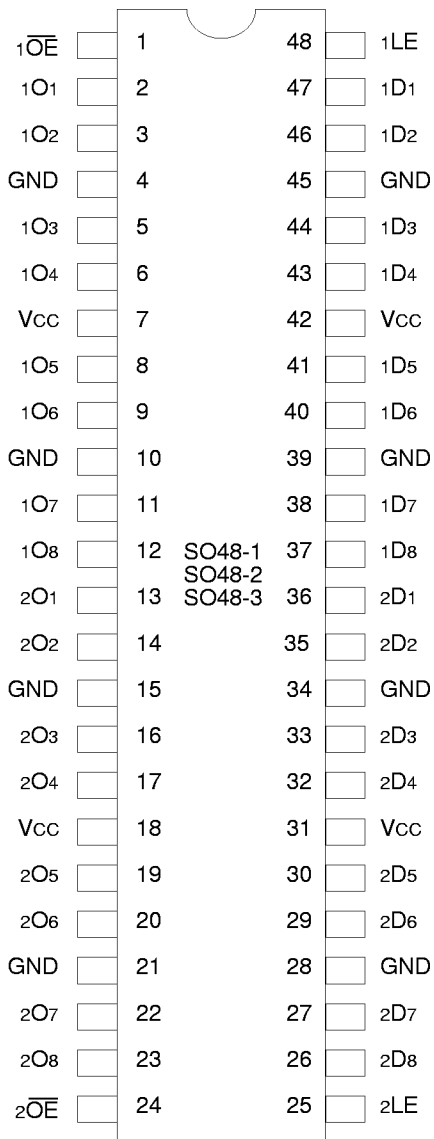
2543 drw 02

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**MILITARY AND INDUSTRIAL TEMPERATURE RANGES**

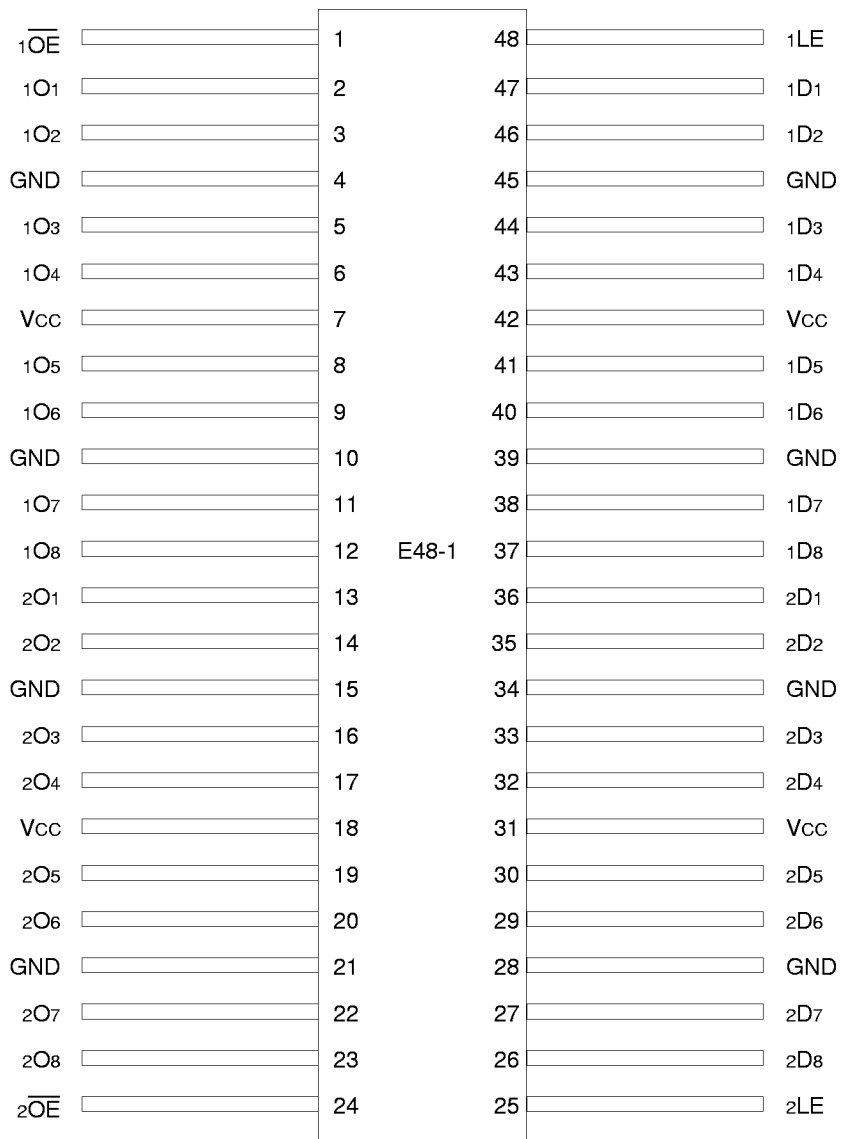
**FEBRUARY 1997**

**PIN CONFIGURATIONS**



**SSOP/  
TSSOP/TVSOP  
TOP VIEW**

2543 drw 03



**CERPACK  
TOP VIEW**

2543 drw 04

## PIN DESCRIPTION

| Pin Names        | Description                      |
|------------------|----------------------------------|
| xDx              | Data Inputs                      |
| xLE              | Latch Enable Input (Active HIGH) |
| $\overline{xOE}$ | Output Enable Input (Active LOW) |
| xOx              | 3-State Outputs                  |

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

| Inputs |     |                  | Outputs |
|--------|-----|------------------|---------|
| xDx    | xLE | $\overline{xOE}$ | xOx     |
| H      | H   | L                | H       |
| L      | H   | L                | L       |
| X      | X   | H                | Z       |

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**NOTE:**

- H = HIGH voltage level  
 L = LOW voltage level  
 X = Don't care  
 Z = High-impedance

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

| Symbol                | Description                          | Max.                         | Unit |
|-----------------------|--------------------------------------|------------------------------|------|
| V <sub>TERM</sub> (2) | Terminal Voltage with Respect to GND | -0.5 to +7.0                 | V    |
| V <sub>TERM</sub> (3) | 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   |

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**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.
- All device terminals except FCT162XXXT Output and I/O terminals.
- Output and I/O terminals for FCT162XXXT.

## CAPACITANCE (T<sub>A</sub> = +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  | 3.5  | 6.0  | pF   |
| C <sub>OUT</sub> | Output Capacitance       | V <sub>OUT</sub> = 0V | 3.5  | 8.0  | pF   |

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**NOTE:**

- 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  $+85^{\circ}\text{C}$ ,  $V_{CC} = 5.0\text{V} \pm 10\%$ ; 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 (Input pins) <sup>(5)</sup>                        | $V_{CC} = \text{Max.}$                                 | $V_I = V_{CC}$      | —    | —                   | $\pm 1$ | $\mu\text{A}$ |
|                                     | Input HIGH Current (I/O pins) <sup>(5)</sup>                          |  |                     | —    | —                   | $\pm 1$ |               |
| $I_{IL}$                            | Input LOW Current (Input pins) <sup>(5)</sup>                         |  | $V_I = \text{GND}$  | —    | —                   | $\pm 1$ |               |
|                                     | Input LOW Current (I/O pins) <sup>(5)</sup>                           |  |                     | —    | —                   | $\pm 1$ |               |
| $I_{OZH}$                           | High Impedance Output Current<br>(3-State Output pins) <sup>(5)</sup> | $V_{CC} = \text{Max.}$                                 | $V_O = 2.7\text{V}$ | —    | —                   | $\pm 1$ | $\mu\text{A}$ |
|                                     |   |  | $V_O = 0.5\text{V}$ | —    | —                   | $\pm 1$ |               |
| $V_{IK}$                            | Clamp Diode Voltage   | $V_{CC} = \text{Min.}, I_{IN} = -18\text{mA}$          |                     | —    | -0.7                | -1.2    | V             |
| $I_{OS}$                            | Short Circuit Current   | $V_{CC} = \text{Max.}, V_O = \text{GND}^{(3)}$         |                     | -80  | -140                | -250    | mA            |
| $V_H$                               | Input Hysteresis  | —  |                     | —    | 100                 | —       | mV            |
| $I_{CCL}$<br>$I_{CCH}$<br>$I_{CCZ}$ | Quiescent Power Supply Current  | $V_{CC} = \text{Max.}, V_{IN} = \text{GND or } V_{CC}$ |                     | —    | 5                   | 500     | $\mu\text{A}$ |

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## OUTPUT DRIVE CHARACTERISTICS FOR FCT16373T

| Symbol    | Parameter                                     | Test Conditions <sup>(1)</sup>                                 |  | Min. | Typ. <sup>(2)</sup> | Max.    | Unit          |
|-----------|---|--|--|------|---------------------|---------|---------------|
| $I_O$     | Output Drive Current                          | $V_{CC} = \text{Max.}, V_O = 2.5\text{V}^{(3)}$                |  | -50  | —                   | -180    | mA            |
| $V_{OH}$  | Output HIGH Voltage                           | $V_{CC} = \text{Min.}$<br>$V_{IN} = V_{IH} \text{ or } V_{IL}$ | $I_{OH} = -3\text{mA}$   | 2.5  | 3.5                 | —       | V             |
|           |   |  | $I_{OH} = -12\text{mA MIL.}$<br>$I_{OH} = -15\text{mA COM'L.}$       | 2.4  | 3.5                 | —       | V             |
|           |   |  | $I_{OH} = -24\text{mA MIL.}$<br>$I_{OH} = -32\text{mA COM'L.}^{(4)}$ | 2.0  | 3.0                 | —       | V             |
|           |   |  | $I_{OL} = 48\text{mA MIL.}$<br>$I_{OL} = 64\text{mA COM'L.}$         | —    | 0.2                 | 0.55    | V             |
| $I_{OFF}$ | Input/Output Power Off Leakage <sup>(5)</sup> | $V_{CC} = 0\text{V}, V_{IN} \text{ or } V_O \leq 4.5\text{V}$  |  | —    | —                   | $\pm 1$ | $\mu\text{A}$ |

2543 Ink 06

## OUTPUT DRIVE CHARACTERISTICS FOR FCT162373T

| Symbol    | Parameter           | Test Conditions <sup>(1)</sup>  |  | Min. | Typ. <sup>(2)</sup> | Max. | Unit |
|-----------|---------------------|---|--|------|---------------------|------|------|
| $I_{ODL}$ | Output LOW Current  | $V_{CC} = 5\text{V}, V_{IN} = V_{IH} \text{ or } V_{IL}, V_{OUT} = 1.5\text{V}^{(3)}$ |  | 60   | 115                 | 200  | mA   |
| $I_{ODH}$ | Output HIGH Current | $V_{CC} = 5\text{V}, V_{IN} = V_{IH} \text{ or } V_{IL}, V_{OUT} = 1.5\text{V}^{(3)}$ |  | -60  | -115                | -200 | mA   |
| $V_{OH}$  | Output HIGH Voltage | $V_{CC} = \text{Min.}$<br>$V_{IN} = V_{IH} \text{ or } V_{IL}$                        | $I_{OH} = -16\text{mA MIL.}$<br>$I_{OH} = -24\text{mA COM'L.}$ | 2.4  | 3.3                 | —    | V    |
| $V_{OL}$  | Output LOW Voltage  | $V_{CC} = \text{Min.}$<br>$V_{IN} = V_{IH} \text{ or } V_{IL}$                        | $I_{OL} = 16\text{mA MIL.}$<br>$I_{OL} = 24\text{mA COM'L.}$   | —    | 0.3                 | 0.55 | V    |

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### 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 tested at one time. Duration of the test should not exceed one second.
- Duration of the condition can 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<br>TTL Inputs HIGH | $V_{CC} = \text{Max.}$<br>$V_{IN} = 3.4V^{(3)}$   |  | —    | 0.5                 | 1.5                 | mA                    |
| $I_{CCD}$       | Dynamic Power Supply<br>Current <sup>(4)</sup>    | $V_{CC} = \text{Max.}$<br>Outputs Open<br>$\overline{xOE} = \text{GND}$<br>One Input Toggling<br>50% Duty Cycle   | $V_{IN} = V_{CC}$<br>$V_{IN} = \text{GND}$ | —    | 60                  | 100                 | $\mu\text{A}/$<br>MHz |
| $I_C$           | Total Power Supply Current <sup>(6)</sup>         | $V_{CC} = \text{Max.}$<br>Outputs Open<br>$f_i = 10\text{MHz}$<br>50% Duty Cycle<br>$\overline{xOE} = \text{GND}$<br>$xLE = V_{CC}$<br>One Bit Toggling       | $V_{IN} = V_{CC}$<br>$V_{IN} = \text{GND}$ | —    | 0.6                 | 1.5                 | mA                    |
|                 |   |   | $V_{IN} = 3.4V$<br>$V_{IN} = \text{GND}$   | —    | 0.9                 | 2.3                 |                       |
|                 |   | $V_{CC} = \text{Max.}$<br>Outputs Open<br>$f_i = 2.5\text{MHz}$<br>50% Duty Cycle<br>$\overline{xOE} = \text{GND}$<br>$xLE = V_{CC}$<br>Sixteen Bits Toggling | $V_{IN} = V_{CC}$<br>$V_{IN} = \text{GND}$ | —    | 2.4                 | 4.5 <sup>(5)</sup>  |                       |
|                 |   |   | $V_{IN} = 3.4V$<br>$V_{IN} = \text{GND}$   | —    | 6.4                 | 16.5 <sup>(5)</sup> |                       |

### NOTES:

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- For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at  $V_{CC} = 5.0V$ ,  $+25^\circ\text{C}$  ambient.
- Per TTL driven input ( $V_{IN} = 3.4V$ ). All other inputs at  $V_{CC}$  or  $\text{GND}$ .
- This parameter is not directly testable, but is derived for use in Total Power Supply Calculations.
- Values for these conditions are examples of the  $I_{CC}$  formula. These limits are guaranteed but not tested.
- $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$   
 $I_C = I_{CC} + \Delta I_{CC} \text{DHNT} + I_{CCD} (f_{CP}N_{CP}/2 + f_i N_i)$   
 $I_{CC} = \text{Quiescent Current } (I_{CC1}, I_{CC2} \text{ and } I_{CCZ})$   
 $\Delta I_{CC} = \text{Power Supply Current for a TTL High Input } (V_{IN} = 3.4V)$   
 $\text{DH} = \text{Duty Cycle for TTL Inputs High}$   
 $N_T = \text{Number of TTL Inputs at DH}$   
 $I_{CCD} = \text{Dynamic Current Caused by an Input Transition Pair (HLH or LHL)}$   
 $f_{CP} = \text{Clock Frequency for Register Devices (Zero for Non-Register Devices)}$   
 $N_{CP} = \text{Number of Clock Inputs at } f_{CP}$   
 $f_i = \text{Input Frequency}$   
 $N_i = \text{Number of Inputs at } f_i$

## SWITCHING CHARACTERISTICS OVER OPERATING RANGE

| Symbol       | Parameter                              | Condition <sup>(1)</sup> | FCT16373T/162373T   |      |                     |      | FCT16373AT/162373AT |      |                     |      | 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<br>tPHL | Propagation Delay<br>xDx to xOx        | CL = 50pF<br>RL = 500Ω   | 1.5                 | 8.0  | 1.5                 | 8.5  | 1.5                 | 5.2  | 1.5                 | 5.6  | ns   |
| tPLH<br>tPHL | Propagation Delay<br>xLE to xOx        |                          | 2.0                 | 13.0 | 2.0                 | 15.0 | 2.0                 | 8.5  | 2.0                 | 9.8  | ns   |
| tPZH<br>tPZL | Output Enable Time                     |                          | 1.5                 | 12.0 | 1.5                 | 13.5 | 1.5                 | 6.5  | 1.5                 | 7.5  | ns   |
| tPHZ<br>tPLZ | Output Disable Time                    |                          | 1.5                 | 7.5  | 1.5                 | 10.0 | 1.5                 | 5.5  | 1.5                 | 6.5  | ns   |
| tSU          | Set-up Time HIGH or LOW,<br>xDx to xLE |                          | 2.0                 | —    | 2.0                 | —    | 2.0                 | —    | 2.0                 | —    | ns   |
| tH           | Hold Time HIGH or LOW,<br>xDx to xLE   |                          | 1.5                 | —    | 1.5                 | —    | 1.5                 | —    | 1.5                 | —    | ns   |
| tw           | xLE Pulse Width HIGH                   |                          | 6.0                 | —    | 6.0                 | —    | 5.0                 | —    | 6.0                 | —    | ns   |
| tSK(o)       | Output Skew <sup>(3)</sup>             |                          | —                   | 0.5  | —                   | 0.5  | —                   | 0.5  | —                   | 0.5  | ns   |

| Symbol       | Parameter                              | Condition <sup>(1)</sup> | FCT16373CT/162373CT |      |                     |      | FCT16373ET/162373ET |      |                     |      | 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<br>tPHL | Propagation Delay<br>xDx to xOx        | CL = 50pF<br>RL = 500Ω   | 1.5                 | 4.2  | 1.5                 | 5.1  | 1.5                 | 3.4  | —                   | —    | ns   |
| tPLH<br>tPHL | Propagation Delay<br>xLE to xOx        |                          | 2.0                 | 5.5  | 2.0                 | 8.0  | 1.5                 | 3.7  | —                   | —    | ns   |
| tPZH<br>tPZL | Output Enable Time                     |                          | 1.5                 | 5.5  | 1.5                 | 6.3  | 1.5                 | 4.4  | —                   | —    | ns   |
| tPHZ<br>tPLZ | Output Disable Time                    |                          | 1.5                 | 5.0  | 1.5                 | 5.9  | 1.5                 | 3.6  | —                   | —    | ns   |
| tSU          | Set-up Time HIGH or LOW,<br>xDx to xLE |                          | 2.0                 | —    | 2.0                 | —    | 1.0                 | —    | —                   | —    | ns   |
| tH           | Hold Time HIGH or LOW,<br>xDx to xLE   |                          | 1.5                 | —    | 1.5                 | —    | 1.0                 | —    | —                   | —    | ns   |
| tw           | xLE Pulse Width HIGH                   |                          | 5.0                 | —    | 6.0                 | —    | 3.0 <sup>(4)</sup>  | —    | —                   | —    | ns   |
| tSK(o)       | Output Skew <sup>(3)</sup>             |                          | —                   | 0.5  | —                   | 0.5  | —                   | 0.5  | —                   | —    | ns   |

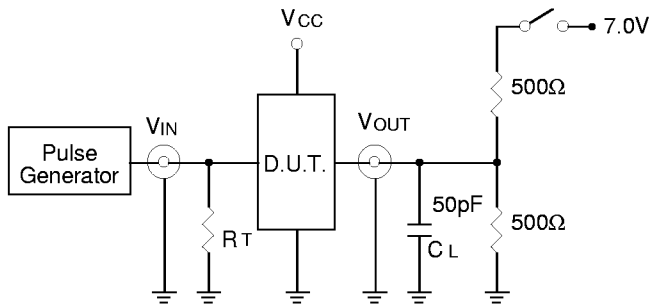
**NOTES:**

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. This limit is guaranteed but not tested.

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## 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 | Closed |
| All Other Tests                         | Open   |

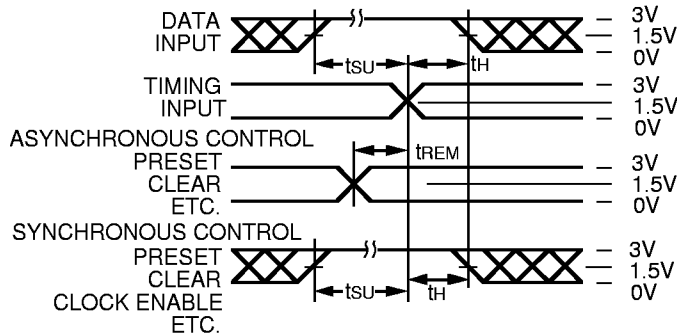
#### DEFINITIONS:

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

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

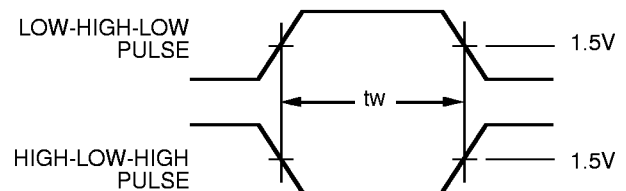
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### SET-UP, HOLD AND RELEASE TIMES



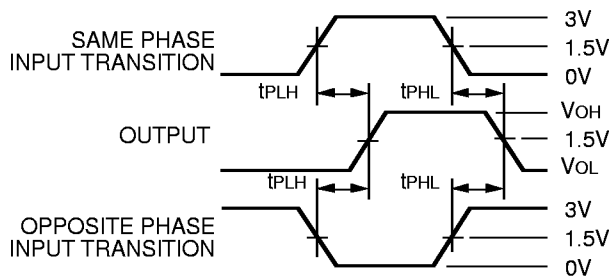
2543 drw 06

### PULSE WIDTH



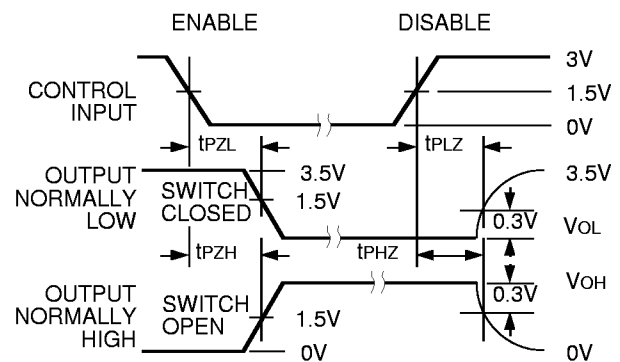
2543 drw 07

### PROPAGATION DELAY



2543 drw 08

### ENABLE AND DISABLE TIMES

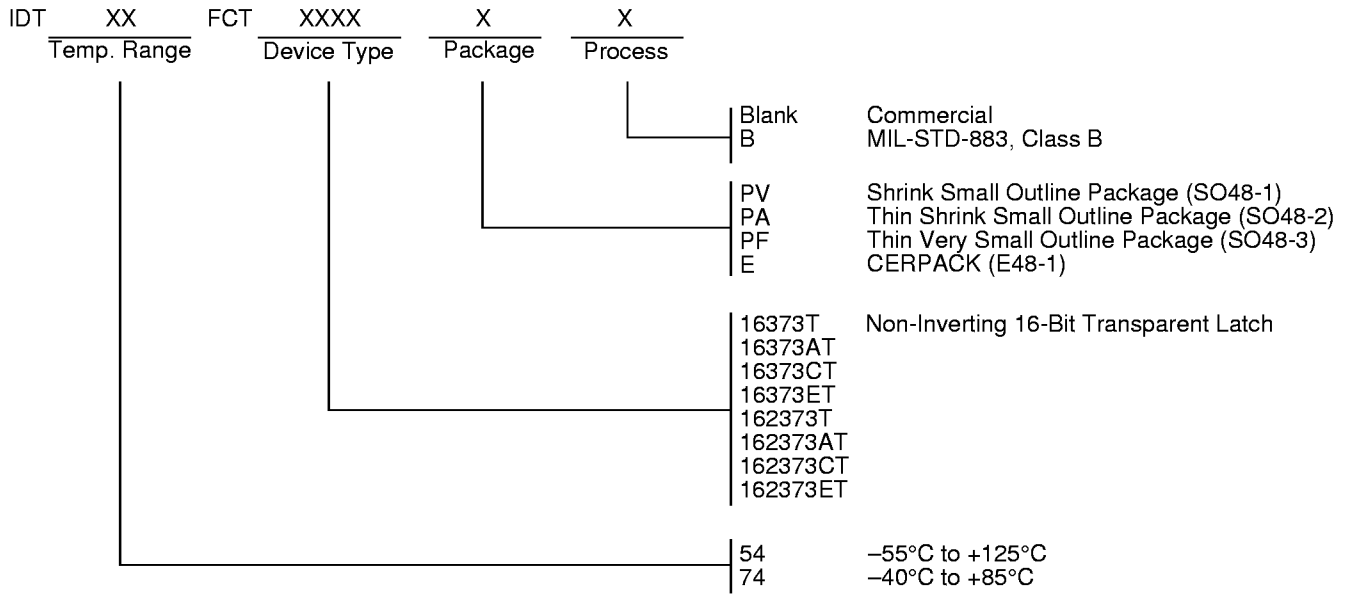


2543 drw 09

#### NOTES:

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

**ORDERING INFORMATION**



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