



# FAST CMOS 18-BIT REGISTERED TRANSCEIVER

## IDT54/74FCT16500AT/CT

### FEATURES:

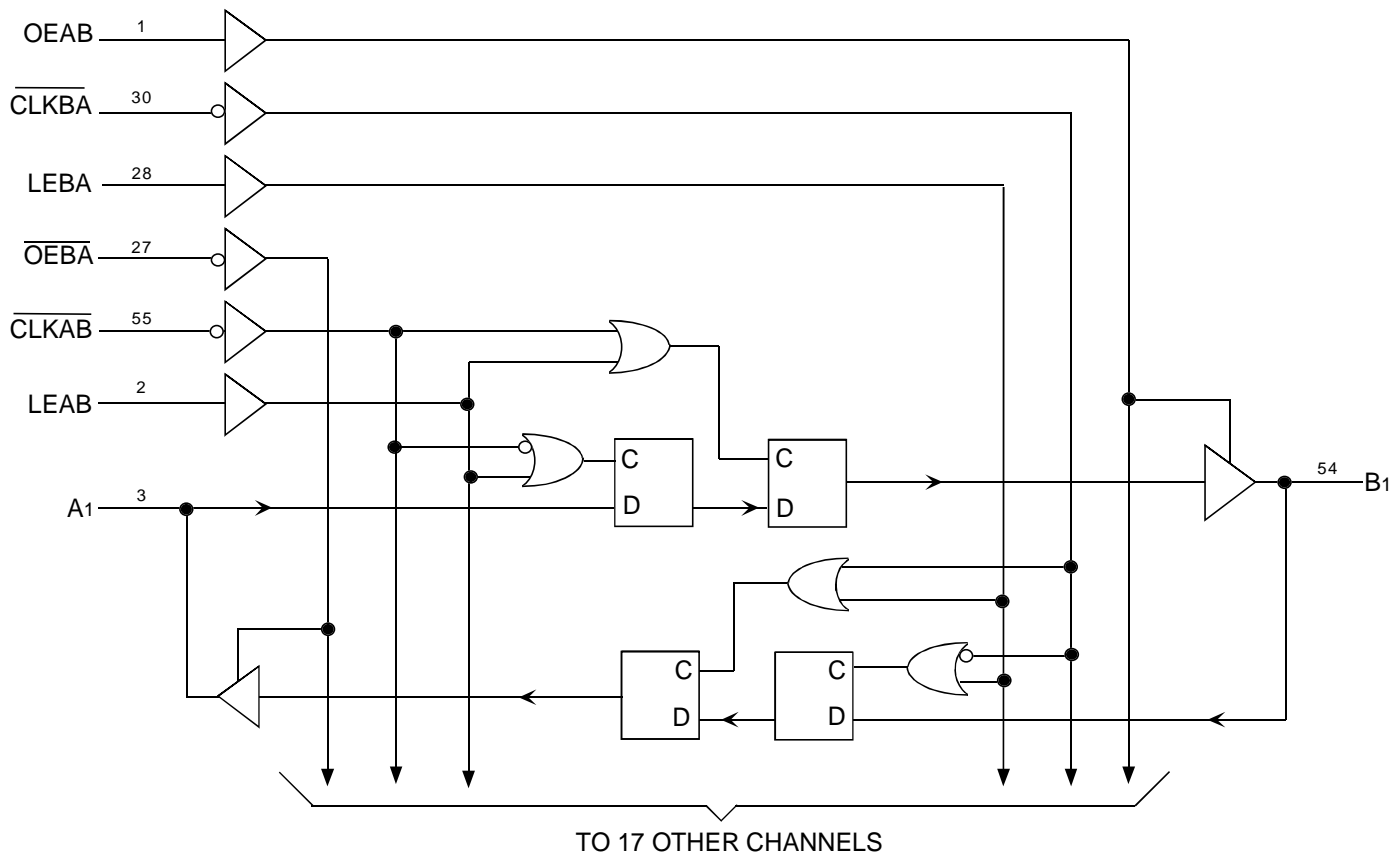
- 0.5 MICRON CMOS Technology
- High-speed, low-power CMOS replacement for ABT functions
- Typical tsk(o) (Output Skew) < 250ps
- Low input and output leakage  $\leq 1\mu A$  (max.)
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- $V_{CC} = 5V \pm 10\%$
- High drive outputs (-32mA IOH, 64mA IOL)
- Power off disable outputs permit "live insertion"
- Typical VOLP (Output Ground Bounce) < 1.0V at  $V_{CC} = 5V$ ,  $T_A = 25^\circ C$
- Available in the following packages:
  - Industrial: SSOP, TSSOP
  - Military: CERPACK

### DESCRIPTION:

The FCT16500T 18-bit registered transceivers are built using advanced dual metal CMOS technology. These high-speed, low-power 18-bit registered bus transceivers combine 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 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 high-to-low transition of CLKAB. OEAB performs the output enable function on the B port. Data flow from B port to A port is similar but uses OEBA, LEBA and CLKBA. Flow-through organization of signal pins simplifies layout. All inputs are designed with hysteresis for improved noise margin.

The FCT16500T 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.

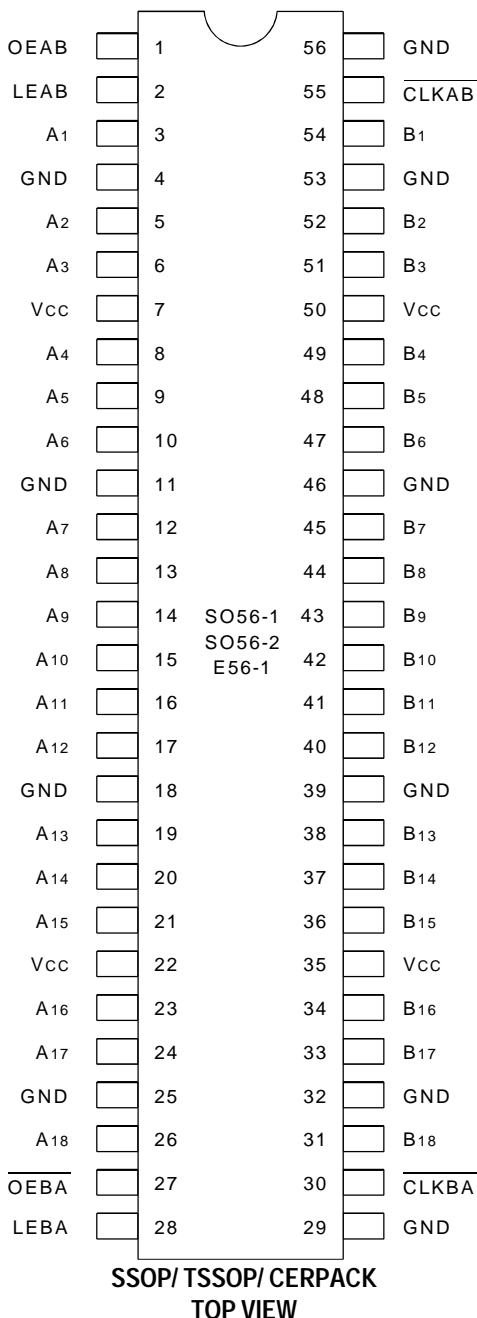
### FUNCTIONAL BLOCK DIAGRAM



MILITARY AND INDUSTRIAL TEMPERATURE RANGES

MAY 2001

## 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
$\overline{CLKAB}$	A-to-B Clock Input (Active LOW)
$\overline{CLKBA}$	B-to-A Clock Input (Active LOW)
Ax	A-to-B Data Inputs or B-to-A 3-State Outputs
Bx	B-to-A Data Inputs or A-to-B 3-State Outputs

## ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Description	Max	Unit
$V_{TERM}^{(2)}$	Terminal Voltage with Respect to GND	-0.5 to +7	V
$V_{TERM}^{(3)}$	Terminal Voltage with Respect to GND	-0.5 to $V_{CC}+0.5$	V
TSTG	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 FCT162XXX Output and I/O terminals.
- Output and I/O terminals for FCT162XXX.

## 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	3.5	6	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>OUT</sub> = 0V	3.5	8	pF

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### NOTE:

- This parameter is measured at characterization but not tested.

## FUNCTION TABLE<sup>(1,4)</sup>

Inputs				Outputs	
OEAB	LEAB	$\overline{CLKAB}$	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	H	X	B <sup>(2)</sup>	
H	L	L	X	B <sup>(3)</sup>	

### NOTES:

- A-to-B data flow is shown. B-to-A data flow is similar but uses  $\overline{OEBA}$ , LEBA, and  $\overline{CLKBA}$ .
- Output level before the indicated steady-state input conditions were established.
- Output level before the indicated steady-state input conditions were established, provided that  $\overline{CLKAB}$  was LOW before LEAB went LOW.
- H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Don't Care  
Z = High-impedance  
↓ = HIGH-to-LOW Transition

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Industrial:  $T_A = -40^{\circ}\text{C}$  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	—	—	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	$V_{CC} = \text{Max.}$	$V_O = 2.7\text{V}$	—	—	$\pm 1$	$\mu\text{A}$
$I_{OZL}$	(3-State Output pins) <sup>(5)</sup>		$V_O = 0.5\text{V}$	—	—	$\pm 1$	
$V_{IK}$	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
$I_{CCL}$ $I_{CCH}$ $I_{CCZ}$	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

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	$V_{CC} = \text{Min.}$ $V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -3\text{mA}$	2.5	3.5	—	V
			$I_{OH} = -12\text{mA MIL}$	2.4	3.5	—	V
			$I_{OH} = -15\text{mA IND}$	—	—	—	—
			$I_{OH} = -24\text{mA MIL}$ $I_{OH} = -32\text{mA IND}^{(4)}$	2	3	—	V
$V_{OL}$	Output LOW Voltage	$V_{CC} = \text{Min.}$ $V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 48\text{mA MIL}$ $I_{OL} = 64\text{mA IND}$	—	0.2	0.55	V
$I_{OFF}$	Input/Output Power Off Leakage <sup>(5)</sup>	$V_{CC} = 0\text{V}, V_{IN} \text{ or } V_O \leq 4.5\text{V}$		—	—	$\pm 1$	$\mu\text{A}$

### 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 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 TTL Inputs HIGH	$V_{CC} = \text{Max.}$ $V_{IN} = 3.4V^{(3)}$		—	0.5	1.5	mA
$I_{CCD}$	Dynamic Power Supply Current <sup>(4)</sup>	$V_{CC} = \text{Max.}, \text{Outputs Open}$ $OEAB = \overline{OEBA} = V_{CC} \text{ or GND}$ One Input Toggling 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	75	120	$\mu A /$ MHz
$I_C$	Total Power Supply Current <sup>(6)</sup>	$V_{CC} = \text{Max.}, \text{Outputs Open}$ $f_{CP} = 10\text{MHz} (\overline{CLKAB})$ 50% Duty Cycle $OEAB = \overline{OEBA} = V_{CC}$ $LEAB = \text{GND}$ One Bit Toggling $f_i = 5\text{MHz}$ 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	0.8	1.7	mA
			$V_{IN} = 3.4V$ $V_{IN} = \text{GND}$	—	1.3	3.2	
		$V_{CC} = \text{Max.}, \text{Outputs Open}$ $f_{CP} = 10\text{MHz} (\overline{CLKAB})$ 50% Duty Cycle $OEAB = \overline{OEBA} = V_{CC}$ $LEAB = \text{GND}$ Eighteen Bits Toggling $f_i = 2.5\text{MHz}$ 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	3.8	6.5 <sup>(5)</sup>	
			$V_{IN} = 3.4V$ $V_{IN} = \text{GND}$	—	8.5	20.8 <sup>(5)</sup>	

### NOTES:

- For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at  $V_{CC} = 5.0V$ ,  $+25^\circ C$  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.
- $I_C = I_{\text{QUIESCENT}} + I_{\text{INPUTS}} + I_{\text{DYNAMIC}}$   
 $I_C = I_{CC} + \Delta I_{CC} D_{HNT} + I_{CCD} (f_{CP} N_{CP} / 2 + f_i N_i)$   
 $I_{CC} = \text{Quiescent Current} (I_{CCL}, I_{CCH} \text{ and } I_{CCZ})$   
 $\Delta I_{CC} = \text{Power Supply Current for a TTL High Input} (V_{IN} = 3.4V)$   
 $D_H = \text{Duty Cycle for TTL Inputs High}$   
 $N_T = \text{Number of TTL Inputs at } D_H$   
 $I_{CCD} = \text{Dynamic Current Caused by an Input Transition Pair (HLH or LHL)}$   
 $f_{CP} = \text{Clock Frequency for Register Devices (Zero for Non-Register Devices)}$   
 $N_{CP} = \text{Number of Clock Inputs at } f_{CP}$   
 $f_i = \text{Input Frequency}$   
 $N_i = \text{Number of Inputs at } f_i$

## SWITCHING CHARACTERISTICS OVER OPERATING RANGE

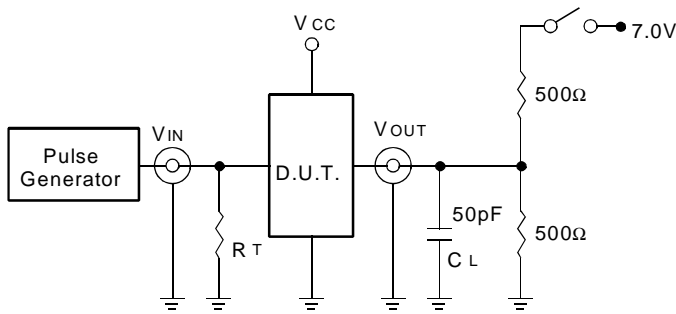
Symbol	Parameter	Condition <sup>(1)</sup>	FCT16500AT				FCT16500CT				Unit
			Ind.		Mil.		Ind.		Mil.		
			Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	
f <sub>MAX</sub>	CLKAB or CLKBA frequency <sup>(4)</sup>	C <sub>L</sub> = 50pF R <sub>L</sub> = 500Ω	—	150	—	150	—	150	—	150	MHz
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Ax to Bx or Bx to Ax		1.5	5.1	1.5	5.6	1.5	3.8	1.5	4.6	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay LEBA to Ax, LEAB to Bx		1.5	5.6	1.5	6	1.5	4.2	1.5	5.6	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay CLKBA to Ax, CLKAB to Bx		1.5	5.6	1.5	6	1.5	4.4	1.5	5.4	ns
t <sub>PZH</sub> t <sub>PZL</sub>	Output Enable Time OEBA to Ax, OEAB to Bx		1.5	6	1.5	6.4	1.5	4.8	1.5	6	ns
t <sub>PHZ</sub> t <sub>PLZ</sub>	Output Disable Time OEBA to Ax, OEAB to Bx		1.5	5.6	1.5	6	1.5	4.4	1.5	5.6	ns
t <sub>SU</sub>	Set-up Time, HIGH or LOW Ax to $\overline{\text{CLKAB}}$ , Bx to $\overline{\text{CLKBA}}$		3	—	3	—	2.4	—	3	—	ns
t <sub>H</sub>	Hold Time, HIGH or LOW Ax to $\overline{\text{CLKAB}}$ , Bx to $\overline{\text{CLKBA}}$		0	—	0	—	0	—	0	—	ns
t <sub>SU</sub>	Set-up Time HIGH or LOW Ax to LEAB, Bx to LEBA	Clock HIGH	3	—	3	—	2	—	3	—	ns
		Clock LOW	1.5	—	1.5	—	1.5	—	1.5	—	ns
t <sub>H</sub>	Hold Time, HIGH or LOW Ax to LEAB, Bx to LEBA		1.5	—	1.5	—	0.5	—	1.5	—	ns
t <sub>w</sub>	LEAB or LEBA Pulse Width HIGH <sup>(4)</sup>		3	—	3	—	3	—	3	—	ns
t <sub>w</sub>	CLKAB or CLKBA Pulse Width HIGH or LOW <sup>(4)</sup>		3	—	3	—	3	—	3	—	ns
t <sub>SK(0)</sub>	Output Skew <sup>(3)</sup>		—	0.5	—	0.5	—	0.5	—	0.5	ns

### NOTES:

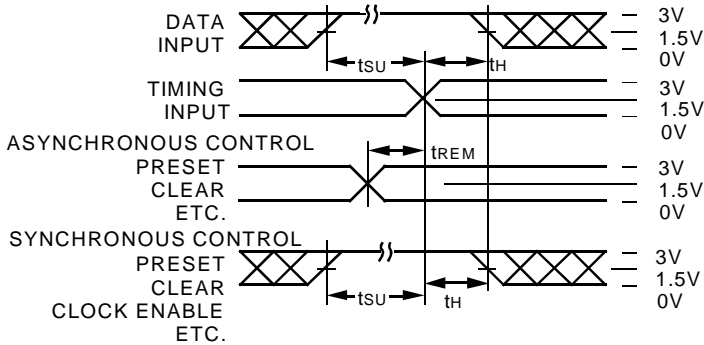
1. See test circuits and waveforms.
2. Minimum limits are guaranteed but not tested on Propagation Delays.
3. Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.
4. This parameter is guaranteed but not tested.

## TEST CIRCUITS AND WAVEFORMS

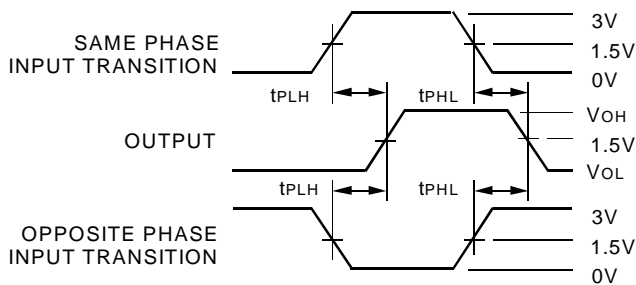
### TEST CIRCUITS FOR ALL OUTPUTS



### SET-UP, HOLD, AND RELEASE TIMES



### PROPAGATION DELAY



### SWITCH POSITION

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

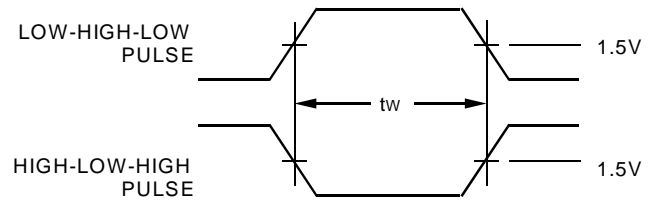
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### DEFINITIONS:

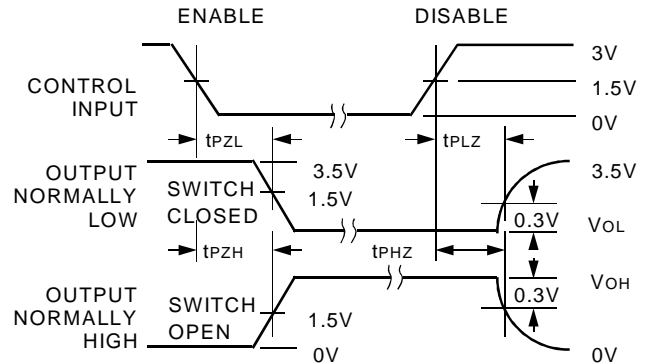
CL = Load capacitance: includes jig and probe capacitance.

RT = Termination resistance: should be equal to ZOUT of the Pulse Generator.

### PULSE WIDTH



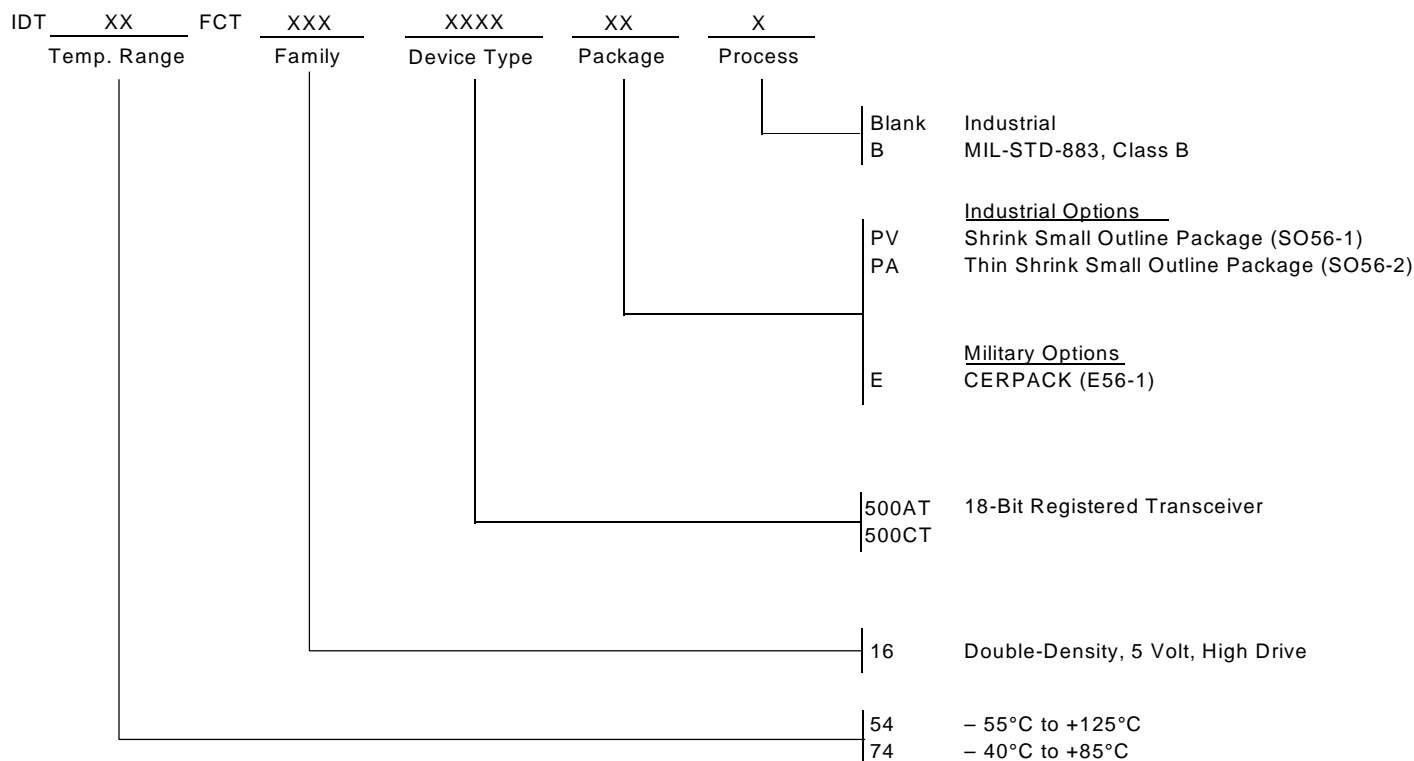
### ENABLE AND DISABLE TIMES



### NOTES:

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.
2. 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**



**NOTE:**

New, tighter specs listed in the table below were changed effective with date code "0101" (parts shipped after January 1, 2001).

Device	Parameter	Description	Condition	Old (ns)	New (ns)
<b>74FCT16500C</b>	t <sub>PLH</sub> , t <sub>PHL</sub>	Prop Delay Ax to Bx, or Bx to Ax	50pF/500 Ω	4.6	3.8
	t <sub>PLH</sub> , t <sub>PHL</sub>	Prop Delay LEBA to Ax, LEAB to Bx	50pF/500 Ω	5.3	4.2
	t <sub>PLH</sub> , t <sub>PHL</sub>	Prop Delay CLKBA to Ax, CLKAB to Bx	50pF/500 Ω	5.3	4.4
	t <sub>PZH</sub> , t <sub>PZL</sub>	Output Enable OEBA to Ax, OEAB to Bx	50pF/500 Ω	5.6	4.8
	t <sub>PHZ</sub> , t <sub>PLZ</sub>	Output Disable OEBA to Ax, OEAB to Bx	50pF/500 Ω	5.2	4.4



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