



# FAST CMOS 16-BIT BUS TRANSCEIVER/REGISTER *IDT54/74FCT16652T/AT/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  $\leq 1\mu\text{A}$  (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  $V_{CC} = 5V$ ,  $T_A = 25^\circ\text{C}$
- Available in the following packages:
  - Industrial: SSOP, TSSOP, TVSOP
  - Military: CERPACK

## DESCRIPTION:

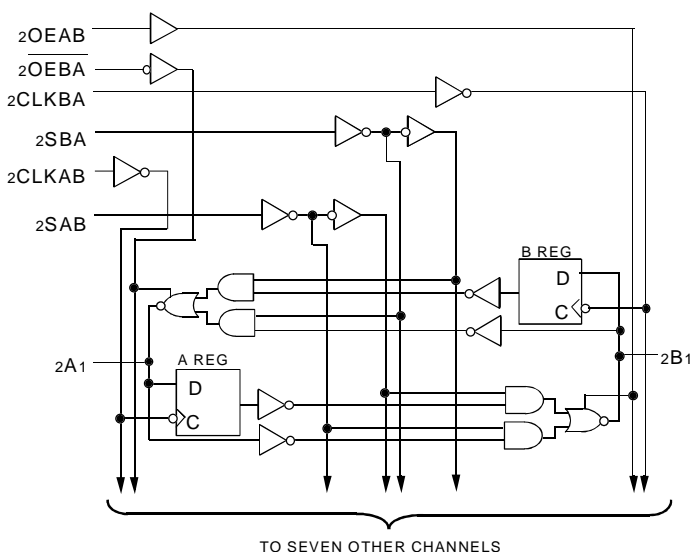
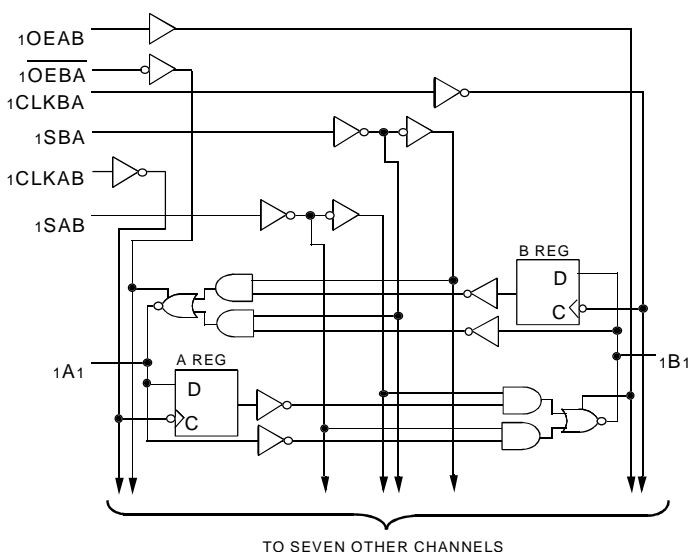
The FCT16652T 16-bit registered transceivers are built using advanced dual metal CMOS technology. These high-speed, low-power devices are organized as two independent 8-bit bus transceivers with 3-state D-type registers. For example, the xOEAB and xOEBA signals control the transceiver functions.

The xSAB and xSBA control pins are provided to select either real time or stored data transfer. The circuitry used for select control will eliminate the typical decoding glitch that occurs in a multiplexer during the transition between stored and real time data. A low input level selects real-time data and a high level selects stored data.

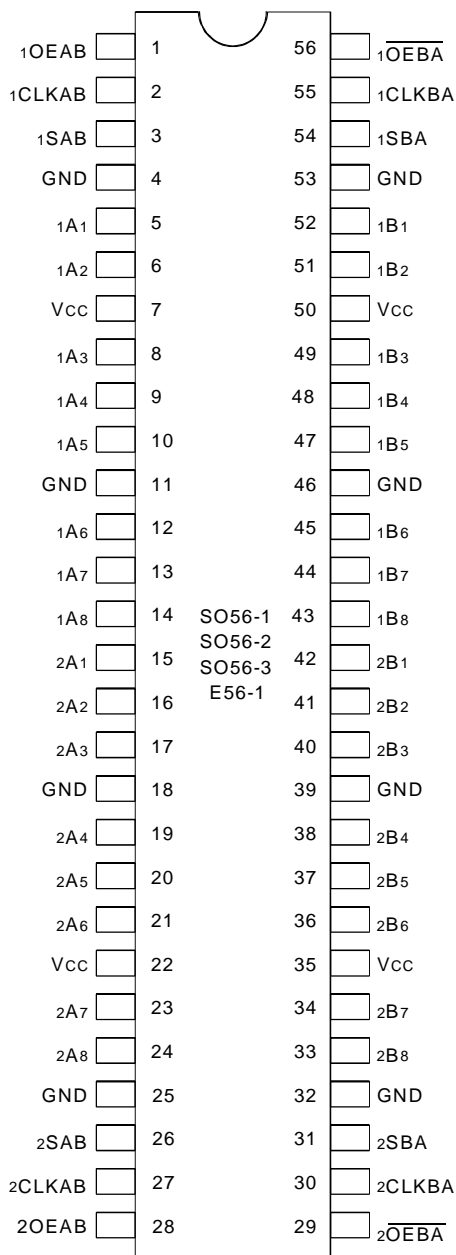
Data on the A or B data bus, or both, can be stored in the internal D-flip-flops by low-to-high transitions at the appropriate clock pins (xCLKAB or xCLKBA), regardless of the select or enable control pins. Flow-through organization of signal pins simplifies layout. All inputs are designed with hysteresis for improved noise margin.

The FCT16652T is 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



## PIN CONFIGURATION



SSOP/TSSOP/TVSOP/CERPACK  
TOP VIEW

## ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Description	Max	Unit
V <sub>TERM</sub> (2)	Terminal Voltage with Respect to GND	-0.5 to +7	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

5v16-link

### 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 (T<sub>A</sub> = +25°C, f = 1MHz)

Symbol	Parameter(1)	Conditions	Typ.	Max.	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 0V	4.5	6	pF
C <sub>OUT</sub>	Output Capacitance	V <sub>OUT</sub> = 0V	5.5	8	pF

### NOTE:

- This parameter is measured at characterization but not tested.

## PIN DESCRIPTION

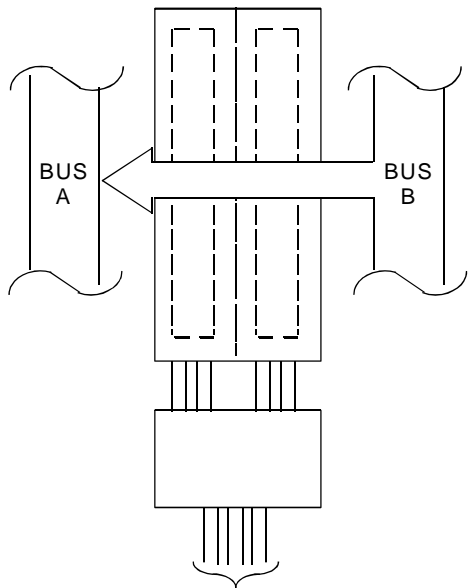
Pin Names	Description
xAx	Data Register A Inputs Data Register B Outputs
xBx	Data Register B Inputs Data Register A Outputs
xCLKAB, xCLKBA	Clock Pulse Inputs
xSAB, xSBA	Output Data Source Select Inputs
xOEAB, xOEBA	Output Enable Inputs

## FUNCTION TABLE

Inputs						Data I/O <sup>(1)</sup>		Operation or Function
xOEAB	$\overline{\text{xOEBA}}$	xCLKAB	xCLKBA	xSAB	xSBA	xAx	xBx	
L	H	H or L	H or L	X	X	Input	Input	Isolation
L	H	↑	↑	X	X			Store A and B Data
X	H	↑	H or L	X	X	Input	Unspecified <sup>(1)</sup>	Store A, Hold B
H	H	↑	↑	X <sup>(2)</sup>	X	Input	Output	Store A in Both Registers
L	X	H or L	↑	X	X	Unspecified <sup>(1)</sup>	Input	Hold A, Store B
L	L	↑	↑	X	X <sup>(2)</sup>	Output	Input	Store B in both Registers
L	L	X	X	X	L	Output	Input	Real Time B Data to A Bus
L	L	X	H or L	X	H			Stored B Data to A Bus
H	H	X	X	L	X	Input	Output	Real Time A Data to B Bus
H	H	H or L	X	H	X			Stored A Data to B Bus
H	L	H or L	H or L	H	H	Output	Output	Stored A Data to B Bus and Stored B Data to A Bus

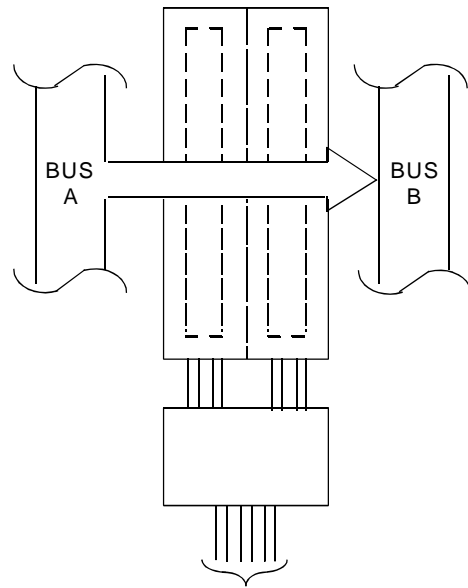
### NOTES:

- The data output functions may be enabled or disabled by various signals at the xOEAB or  $\overline{\text{xOEBA}}$  inputs. Data input functions are always enabled, i.e. data at the bus pins will be stored on every LOW-to-HIGH transition on the clocks inputs.
- Select control = L: clocks can occur simultaneously.  
Select control = H: clocks must be staggered to load both registers.
- H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Don't care  
↑ = LOW-to-HIGH Transition



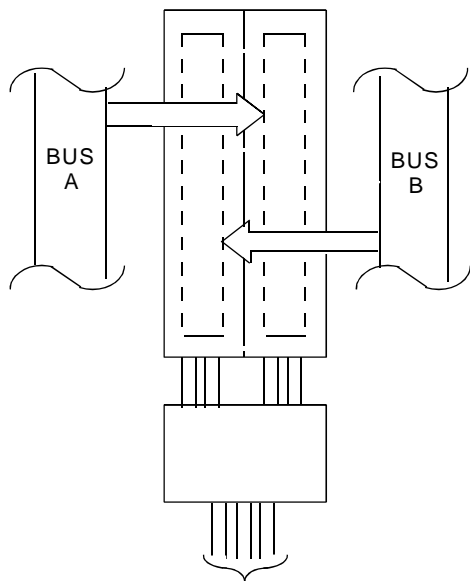
xOEAB	$\overline{xOEBA}$	xCLKAB	xCLKBA	xSAB	xSBA
L	L	X	X	X	L

**REAL-TIME TRANSFER  
BUS B TO A**



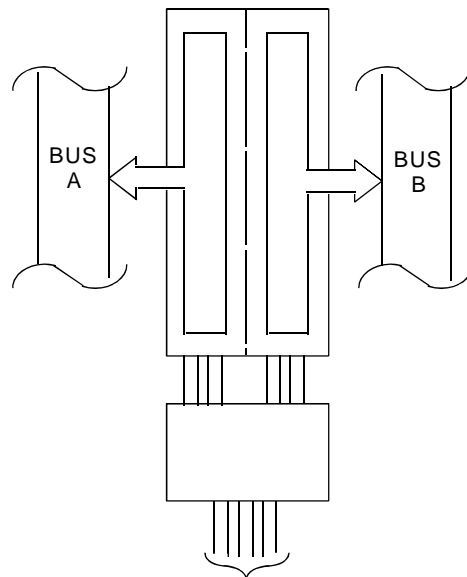
xOEAB	$\overline{xOEBA}$	xCLKAB	xCLKBA	xSAB	xSBA
H	H	X	X	L	X

**REAL-TIME TRANSFER  
BUS A TO B**



xOEAB	$\overline{xOEBA}$	xCLKAB	xCLKBA	xSAB	xSBA
X	H	↑	X	X	X
L	X	X	↑	X	X
L	H	↑	↑	X	X

**STORAGE FROM  
A AND/OR B**



xOEAB	$\overline{xOEBA}$	xCLKAB	xCLKBA	xSAB	xSBA
H	L	H or L	H or L	H	H

**TRANSFER STORED  
DATA TO A AND/OR B**

## 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 (3-State Output pins) <sup>(5)</sup>	$V_{CC} = \text{Max.}$	$V_O = 2.7\text{V}$	—	—	$\pm 1$	$\mu\text{A}$
$I_{OZL}$			$V_O = 0.5\text{V}$	—	—	$\pm 1$	
$V_{IK}$	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
$I_{CCL}$	Quiescent Power Supply Current	$V_{CC} = \text{Max.}$		—	5	500	$\mu\text{A}$
$I_{CCH}$		$V_{IN} = \text{GND or } V_{CC}$					
$I_{CCZ}$							

5v16-link

## 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

	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>	$V_{CC} = \text{Max.}$ Outputs Open $\overline{xOEAB} = \overline{xOEBA} = \text{GND}$ One Input Toggling 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	75	120	$\mu\text{A}/\text{MHz}$
$I_C$	Total Power Supply Current <sup>(6)</sup>	$V_{CC} = \text{Max.}$ Outputs Open $f_{CP} = 10\text{MHz}$ (xCLKBA) 50% Duty Cycle $\overline{xOEAB} = \overline{xOEBA} = \text{GND}$ 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	
		$V_{CC} = \text{Max.}$ Outputs Open $f_{CP} = 10\text{MHz}$ (xCLKBA) 50% Duty Cycle $\overline{xOEAB} = \overline{xOEBA} = \text{GND}$ Sixteen 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>	
			$V_{IN} = 3.4V$ $V_{IN} = \text{GND}$	—	8.3	20 <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  $V_{CC} = 5.0V$ ,  $+25^\circ\text{C}$  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.
- $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$   
 $I_C = I_{CC} + \Delta I_{CC} D_{HNT} + I_{CCD} (f_{CP} N_{CP} / 2 + f_i N_i)$   
 $I_{CC} = \text{Quiescent Current (} I_{CCL}, I_{CCH} \text{ and } I_{CCZ})$   
 $\Delta I_{CC} = \text{Power Supply Current for a TTL High Input (} V_{IN} = 3.4V)$   
 $D_H = \text{Duty Cycle for TTL Inputs High}$   
 $N_T = \text{Number of TTL Inputs at } D_H$   
 $I_{CCD} = \text{Dynamic Current Caused by an Input Transition Pair (HLH or LHL)}$   
 $f_{CP} = \text{Clock Frequency for Register Devices (Zero for Non-Register Devices)}$   
 $N_{CP} = \text{Number of Clock Inputs at } f_{CP}$   
 $f_i = \text{Input Frequency}$   
 $N_i = \text{Number of Inputs at } f_i$

## SWITCHING CHARACTERISTICS OVER OPERATING RANGE

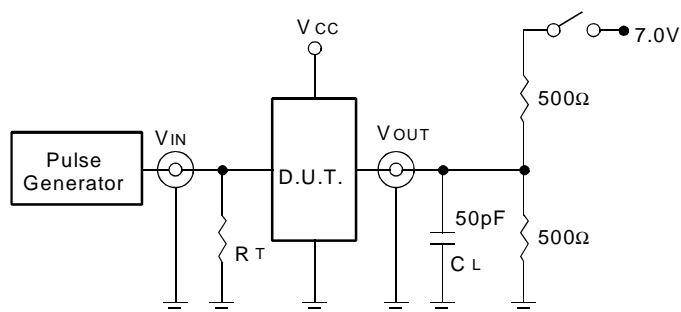
Symbol	Parameter	Condition <sup>(1)</sup>	FCT16652T				FCT16652AT				FCT16652CT				Unit
			Ind.		Mil.		Ind.		Mil.		Ind.		Mil.		
			Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Bus to Bus	CL = 50pF RL = 500Ω	2	9	2	11	2	6.3	2	7.7	1.5	3.9	1.5	6	ns
t <sub>PZH</sub> t <sub>PZL</sub>	Output Enable Time xOEAB or xOEBA to Bus		2	14	2	15	2	9.8	2	10.5	1.5	4.8	1.5	8.9	ns
t <sub>PHZ</sub> t <sub>PLZ</sub>	Output Disable Time xOEAB or xOEBA to Bus		2	9	2	11	2	6.3	2	7.7	1.5	4.4	1.5	7.7	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Clock to Bus		2	9	2	10	2	6.3	2	7	1.5	4.1	1.5	6.3	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay xSBA or xSAB to Bus		2	11	2	12	2	7.7	2	8.4	1.5	4.2	1.5	7	ns
t <sub>SU</sub>	Set-up Time HIGH or LOW Bus to Clock		4	—	4.5	—	2	—	2	—	2	—	2	—	ns
t <sub>H</sub>	Hold Time HIGH or LOW Bus to Clock		2	—	2	—	1.5	—	1.5	—	0	—	1.5	—	ns
t <sub>w</sub>	Clock Pulse Width HIGH or LOW		6	—	6	—	5	—	5	—	3	—	5	—	ns
t <sub>sk(o)</sub>	Output Skew <sup>(3)</sup>		—	0.5	—	0.5	—	0.5	—	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.

## TEST CIRCUITS AND WAVEFORMS

### TEST CIRCUITS FOR ALL OUTPUTS



### SWITCH POSITION

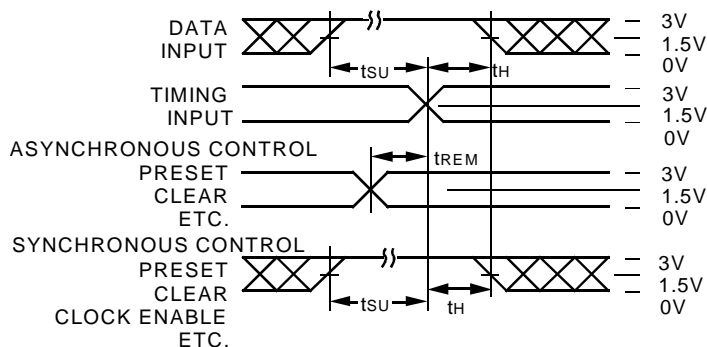
Test	Switch
Open Drain	Closed
Disable Low	
Enable Low	
All Other Tests	Open

5v16-link

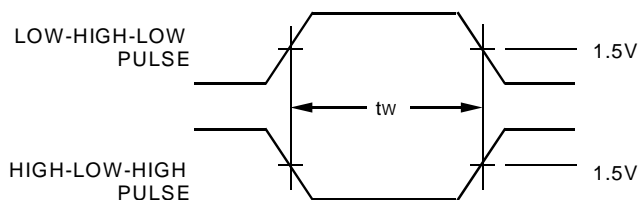
### DEFINITIONS:

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

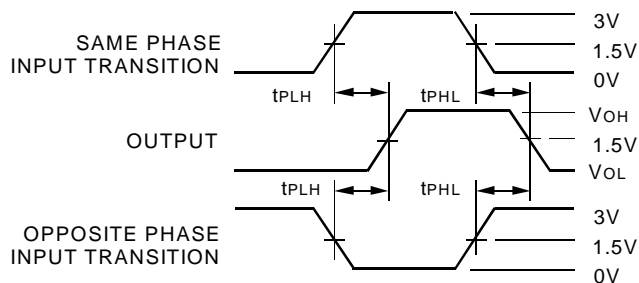
### SET-UP, HOLD, AND RELEASE TIMES



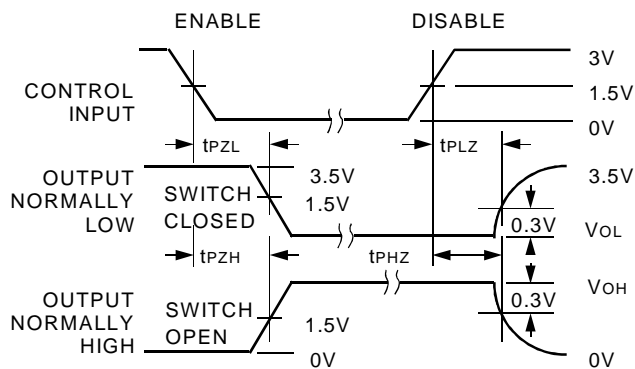
### PULSE WIDTH



### PROPAGATION DELAY



### ENABLE AND DISABLE TIMES

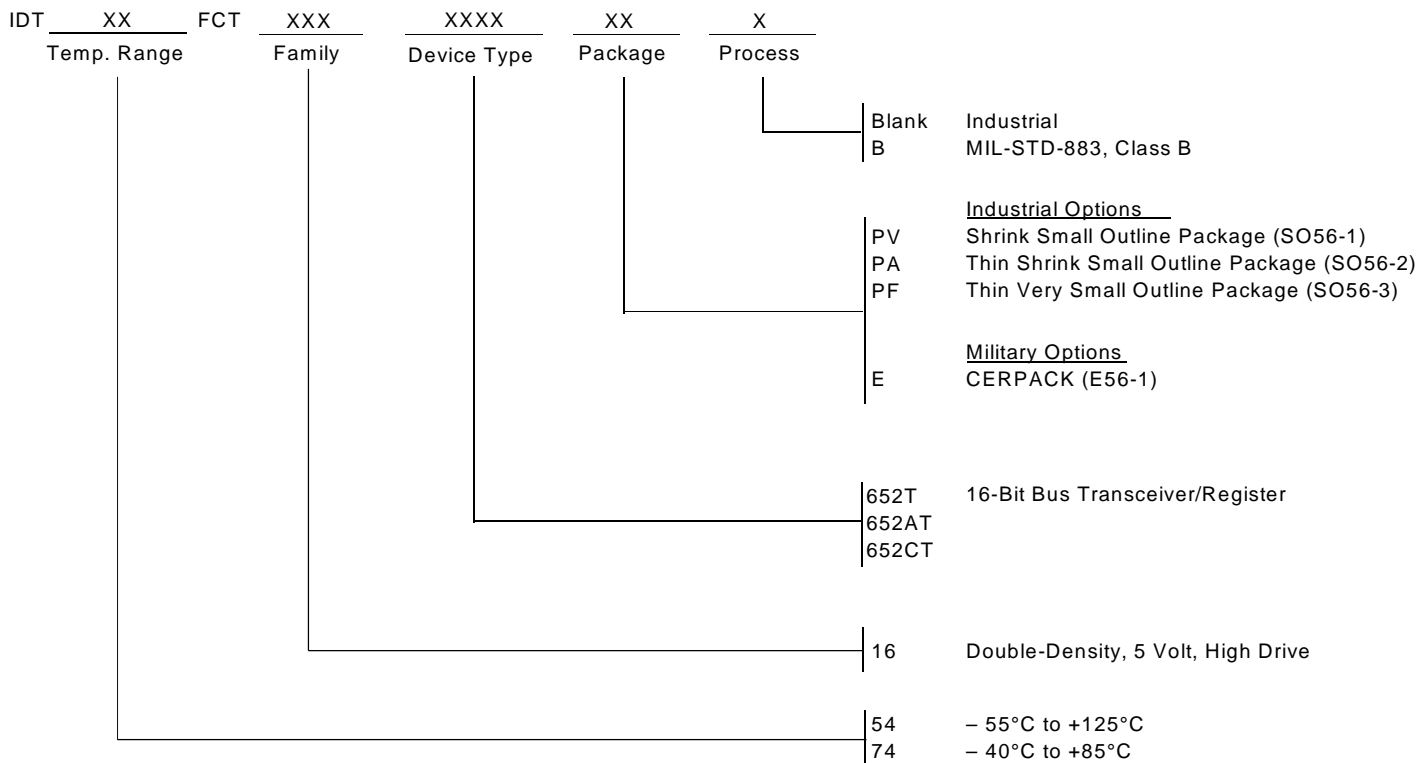


### NOTES:

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)
74FCT16652C	t <sub>PLH</sub> , t <sub>PHL</sub>	Prop Delay Bus to Bus	50pF/500 Ω	5.4	3.9
	t <sub>PLH</sub> , t <sub>PHL</sub>	Prop Delay Clock to Bus	50pF/500 Ω	5.7	4.1
	t <sub>PLH</sub> , t <sub>PHL</sub>	Prop Delay xSBA or xSAB to bus	50pF/500 Ω	6.2	4.2
	t <sub>PZH</sub> , t <sub>PZL</sub>	Output Enable xOEBA or xOEBA to Bus	50pF/500 Ω	7.8	4.8
	t <sub>PHZ</sub> , t <sub>PLZ</sub>	Output Disable xOEBA or xOEBA to Bus	50pF/500 Ω	6.3	4.4



**CORPORATE HEADQUARTERS**  
2975 Stender Way  
Santa Clara, CA 95054

**for SALES:**  
800-345-7015 or 408-727-6116  
fax: 408-492-8674  
www.idt.com\*

\*To search for sales office near you, please click the sales button found on our home page or dial the 800# above and press 2.  
The IDT logo is a registered trademark of Integrated Device Technology, Inc.