



Integrated Device Technology, Inc.

# FAST CMOS 16-BIT BUS TRANSCEIVER/ REGISTERS (3-STATE)

IDT54/74FCT16646T/AT/CT/ET  
IDT54/74FCT162646T/AT/CT/ET

## FEATURES:

- **Common 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)
  - 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 FCT16646T/AT/CT/ET:**
  - High drive outputs (-32mA IOH, 64mA IOL)
  - Power off disable outputs permit "live insertion"
  - Typical VOLP (Output Ground Bounce) < 1.0V at  $V_{CC} = 5V, T_A = 25^\circ\text{C}$
- **Features for FCT162646T/AT/CT/ET:**
  - Balanced Output Drivers:  $\pm 24\text{mA}$  (commercial),  $\pm 16\text{mA}$  (military)
  - Reduced system switching noise
  - Typical VOLP (Output Ground Bounce) < 0.6V at  $V_{CC} = 5V, T_A = 25^\circ\text{C}$

74FCT162646T/AT/CT/ET 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. The control circuitry is organized for multiplexed transmission of data between A bus and B bus either directly or from the internal storage registers. Each 8-bit transceiver/register features direction control (xDIR), over-riding Output Enable control (xOE) and Select lines (xSAB and xSBA) to select either real-time data or stored data. Separate clock inputs are provided for A and B port registers. Data on the A or B data bus, or both, can be stored in the internal registers by the LOW-to-HIGH transitions at the appropriate clock pins. Flow-through organization of signal pins simplifies layout. All inputs are designed with hysteresis for improved noise margin.

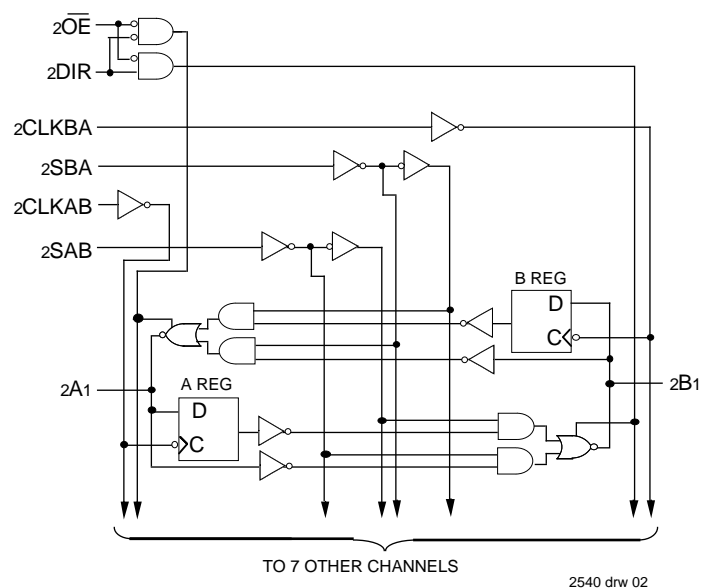
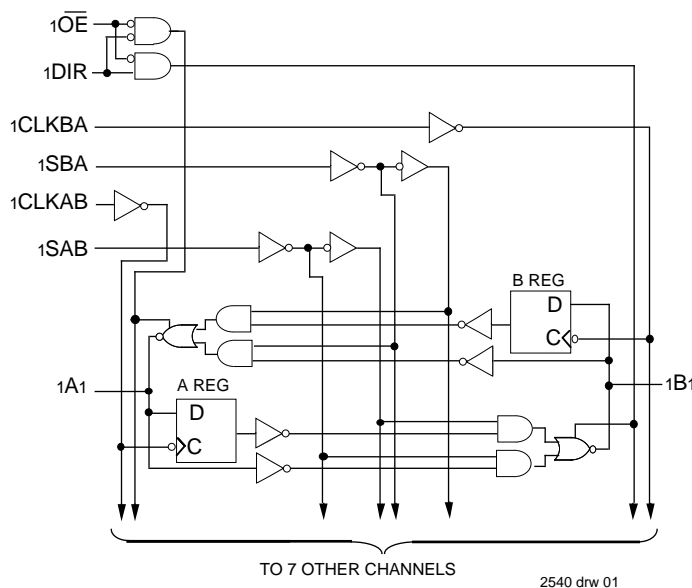
The IDT54/74FCT16646T/AT/CT/ET are ideally suited for driving high-capacitance loads and low-impedance backplanes. The output buffers are designed with power off disable capability to allow "live insertion" of boards when used as backplane drivers.

The IDT54/74FCT162646T/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 IDT54/74FCT162646T/AT/CT/ET are plug-in replacements for the IDT54/74FCT16646T/AT/CT/ET and 54/74ABT16646 for on-board bus interface applications.

## DESCRIPTION:

The IDT54/74FCT16646T/AT/CT/ET and IDT54/

## FUNCTIONAL BLOCK DIAGRAM

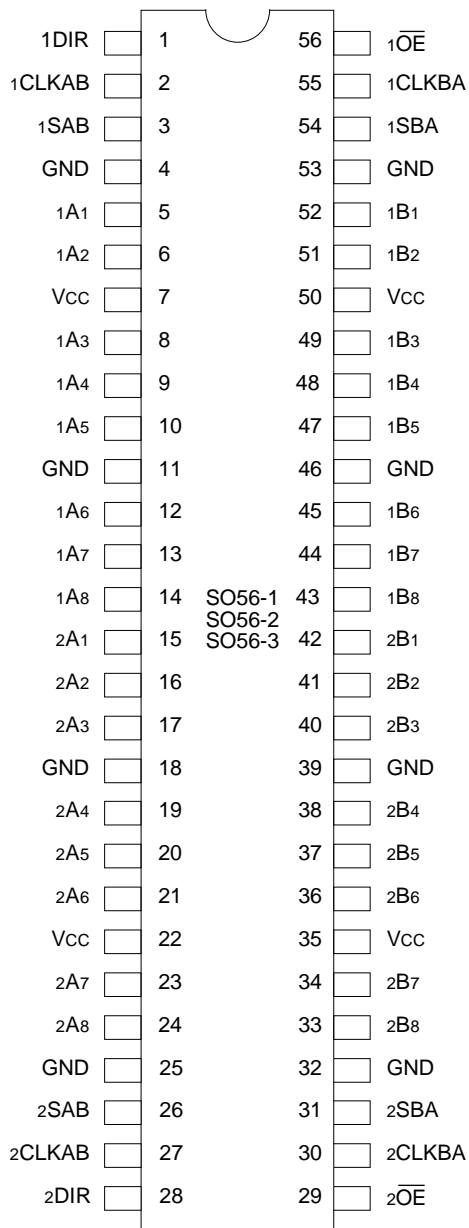


The IDT logo is a registered trademark of Integrated Device Technology, Inc.

**MILITARY AND COMMERCIAL TEMPERATURE RANGES**

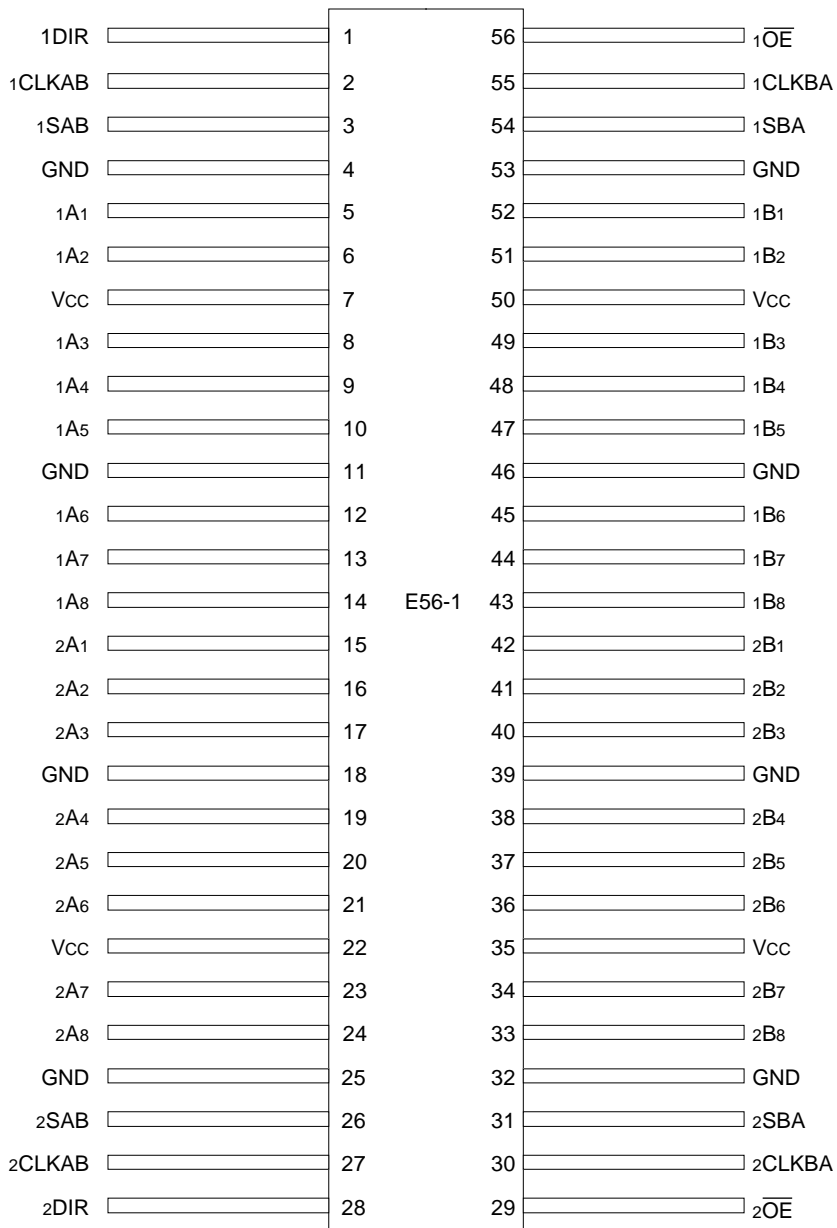
**AUGUST 1996**

## PIN CONFIGURATIONS



SSOP/  
TSSOP/TVSOP  
TOP VIEW

2540 drw 03



CERPACK  
TOP VIEW

2540 drw 04

## 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
xDIR, xOE	Output Enable Inputs

2540 tbl 01

## 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>I/O</sub>	I/O Capacitance	V <sub>OUT</sub> = 0V	3.5	8.0	pF

### NOTE:

2540 tbl 02

1. This parameter is measured at characterization but not tested.

## FUNCTION TABLE<sup>(2)</sup>

Inputs						Data I/O <sup>(1)</sup>		Operation or Function
xOE	xDIR	xCLKAB	xCLKBA	xSAB	xSBA	xAx	xBx	
H	X	H or L	H or L	X	X	Input	Input	Isolation
H	X	↑	↑	X	X			Store A and B Data
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
L	H	X	X	L	X	Input	Output	Real Time A Data to B Bus
L	H	H or L	X	H	X			Stored A Data to B Bus

### NOTES:

2540 tbl 03

1. The data output functions may be enabled or disabled by various signals at the xOE or xDIR 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 clock inputs.
2. H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Don't Care  
↑ = LOW-to-HIGH Transition

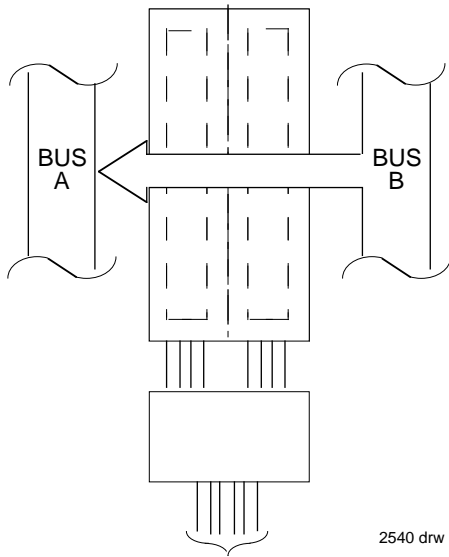
## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

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

2540 tbl 04

### NOTES:

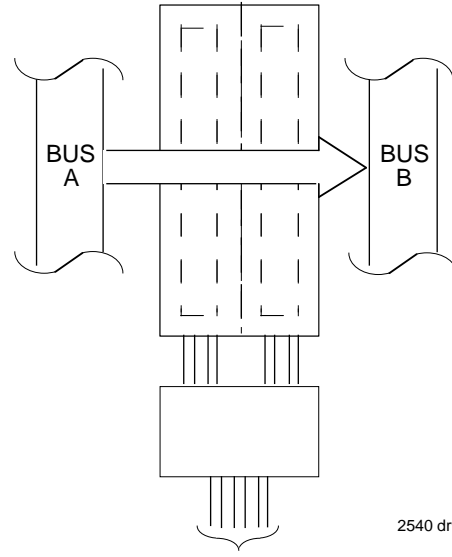
1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. All device terminals except FCT162XXXT Output and I/O terminals.
3. Output and I/O terminals for FCT162XXXT.



2540 drw 05

xDIR	x $\overline{\text{OE}}$	xCLKAB	xCLKBA	xSAB	xSBA
L	L	X	X	X	L

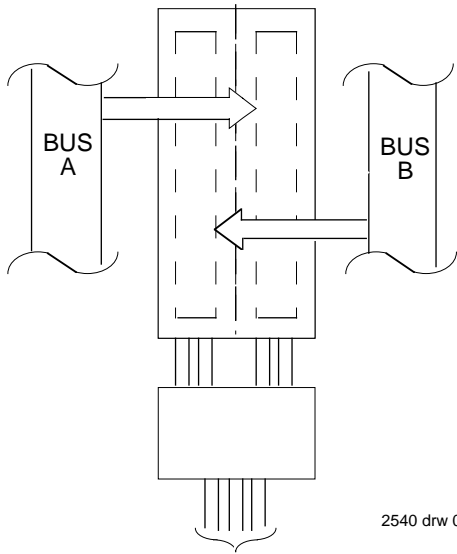
**REAL-TIME TRANSFER  
 BUS B TO A**



2540 drw 06

xDIR	x $\overline{\text{OE}}$	xCLKAB	xCLKBA	xSAB	xSBA
H	L	X	X	L	X

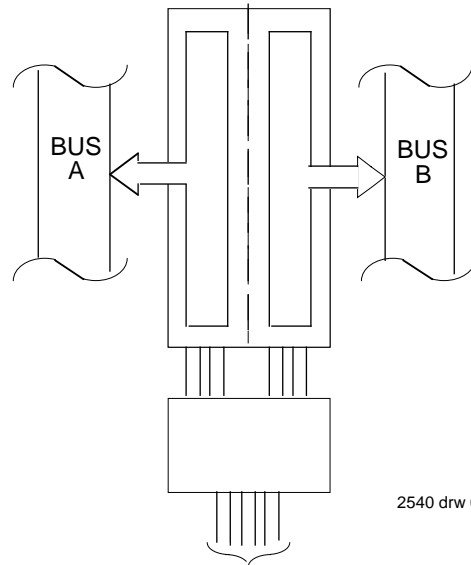
**REAL-TIME TRANSFER  
 BUS A TO B**



2540 drw 07

xDIR	x $\overline{\text{OE}}$	xCLKAB	xCLKBA	xSAB	xSBA
H	L	↑	X	X	X
L	L	X	↑	X	X
X	H	↑	↑	X	X

**STORAGE FROM  
 A AND/OR B**



2540 drw 08

xDIR <sup>(1)</sup>	x $\overline{\text{OE}}$	xCLKAB	xCLKBA	xSAB	xSBA
L	L	X	H or L	X	H
H	L	H or L	X	H	X

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

**NOTE:**

1. Cannot transfer data to A bus and B bus simultaneously.

## 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>	$V_{CC} = \text{Max.}$	$V_i = \text{GND}$	—	—	$\pm 1$	$\mu\text{A}$
	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	-225	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	$\mu\text{A}$

2540 Ink 05

## OUTPUT DRIVE CHARACTERISTICS FOR FCT16646T

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	$V_{CC} = \text{Min.}$ $V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -3\text{mA}$	2.5	3.5	—	V
			$I_{OH} = -12\text{mA MIL.}$ $I_{OH} = -15\text{mA COM'L.}$	2.4	3.5	—	V
			$I_{OH} = -24\text{mA MIL.}$ $I_{OH} = -32\text{mA COM'L.}^{(4)}$	2.0	3.0	—	V
$V_{OL}$	Output LOW Voltage	$V_{CC} = \text{Min.}$ $V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 48\text{mA MIL.}$ $I_{OL} = 64\text{mA COM'L.}$	—	0.2	0.55	V
$I_{OFF}$	Input/Output Power Off Leakage <sup>(5)</sup>	$V_{CC} = 0\text{V}, V_{IN}$ or $V_o \leq 4.5\text{V}$		—	—	$\pm 1$	$\mu\text{A}$

2540 Ink 06

## OUTPUT DRIVE CHARACTERISTICS FOR FCT162646T

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

2540 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 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(1)		Min.	Typ.(2)	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(4)	$V_{CC} = \text{Max.}$ Outputs Open $xDIR = x\overline{OE} = \text{GND}$ 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(6)	$V_{CC} = \text{Max.}$ Outputs Open $f_{CP} = 10\text{MHz}$ (xCLKBA) 50% Duty Cycle $xDIR = x\overline{OE} = \text{GND}$ 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 $xDIR = x\overline{OE} = \text{GND}$ Sixteen Bits Toggling $f_i = 2.5\text{MHz}$ 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	3.8	6.5(5)	
			$V_{IN} = 3.4V$ $V_{IN} = \text{GND}$	—	8.3	20.0(5)	

### NOTES:

2540 tbl 08

- 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  $I_C$  formula. These limits are guaranteed but not tested.
- $I_C = I_{\text{QUIESCENT}} + I_{\text{INPUTS}} + I_{\text{DYNAMIC}}$   
 $I_C = I_{CC} + \Delta I_{CC} \text{DHNT} + I_{CCD} (f_{CP}N_{CP}/2 + f_iN_i)$   
 $I_{CC} = \text{Quiescent Current (IcCL, IcCH and IcCZ)}$   
 $\Delta I_{CC} = \text{Power Supply Current for a TTL High Input (VIN = 3.4V)}$   
 $\text{DH} = \text{Duty Cycle for TTL Inputs High}$   
 $\text{NT} = \text{Number of TTL Inputs at DH}$   
 $I_{CCD} = \text{Dynamic Current Caused by an Input Transition Pair (HLH or LHL)}$   
 $f_{CP} = \text{Clock Frequency for Register Devices (Zero for Non-Register Devices)}$   
 $N_{CP} = \text{Number of Clock Inputs at } f_{CP}$   
 $f_i = \text{Input Frequency}$   
 $N_i = \text{Number of Inputs at } f_i$

### SWITCHING CHARACTERISTICS OVER OPERATING RANGE

Symbol	Parameter	Condition <sup>(1)</sup>	FCT16646T/162646T				FCT16646AT/162646AT				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 Bus to Bus	CL = 50pF RL = 500Ω	2.0	9.0	2.0	11.0	2.0	6.3	2.0	7.7	ns
tPZH tPZL	Output Enable Time xDIR or xOE to Bus		2.0	14.0	2.0	15.0	2.0	9.8	2.0	10.5	ns
tPHZ tPLZ	Output Disable Time xDIR or xOE to Bus		2.0	9.0	2.0	11.0	2.0	6.3	2.0	7.7	ns
tPLH tPHL	Propagation Delay Clock to Bus		2.0	9.0	2.0	10.0	2.0	6.3	2.0	7.0	ns
tPLH tPHL	Propagation Delay xSBA or xSAB to Bus		2.0	11.0	2.0	12.0	2.0	7.7	2.0	8.4	ns
tsu	Set-up Time HIGH or LOW Bus to Clock		4.0	—	4.5	—	2.0	—	2.0	—	ns
th	Hold Time HIGH or LOW Bus to Clock		2.0	—	2.0	—	1.5	—	1.5	—	ns
tw	Clock Pulse Width HIGH or LOW		6.0	—	6.0	—	5.0	—	5.0	—	ns
tsk(o)	Output Skew <sup>(3)</sup>		—	0.5	—	0.5	—	0.5	—	0.5	ns

2540 tbl 09

Symbol	Parameter	Condition <sup>(1)</sup>	FCT16646CT/162646CT				FCT16646ET/162646ET				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 Bus to Bus	CL = 50pF RL = 500Ω	1.5	5.4	1.5	6.0	1.5	3.8	—	—	ns
tPZH tPZL	Output Enable Time xDIR or xOE to Bus		1.5	7.8	1.5	8.9	1.5	4.8	—	—	ns
tPHZ tPLZ	Output Disable Time xDIR or xOE to Bus		1.5	6.3	1.5	7.7	1.5	4.0	—	—	ns
tPLH tPHL	Propagation Delay Clock to Bus		1.5	5.7	1.5	6.3	1.5	3.8	—	—	ns
tPLH tPHL	Propagation Delay xSBA or xSAB to Bus		1.5	6.2	1.5	7.0	1.5	4.2	—	—	ns
tsu	Set-up Time HIGH or LOW Bus to Clock		2.0	—	2.0	—	2.0	—	—	—	ns
th	Hold Time HIGH or LOW Bus to Clock		1.5	—	1.5	—	0.0	—	—	—	ns
tw	Clock Pulse Width HIGH or LOW		5.0	—	5.0	—	3.0 <sup>(4)</sup>	—	—	—	ns
tsk(o)	Output Skew <sup>(3)</sup>		—	0.5	—	0.5	—	0.5	—	—	ns

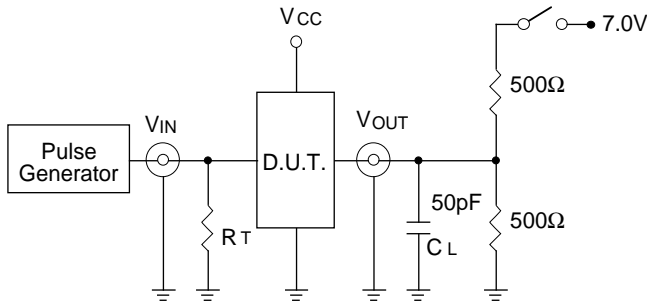
**NOTES:**

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.

2540 tbl10

## TEST CIRCUITS AND WAVEFORMS

### TEST CIRCUITS FOR ALL OUTPUTS



2556 drw 05

### SWITCH POSITION

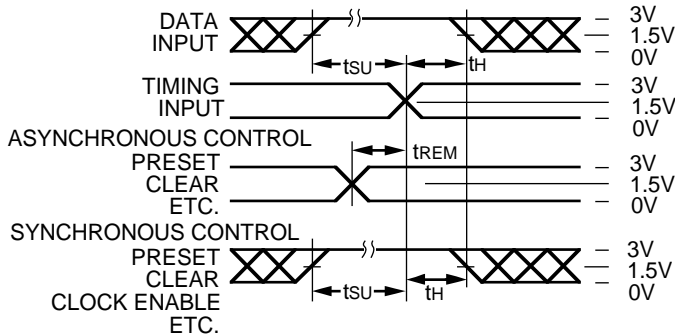
Test	Switch
Open Drain Disable Low Enable Low	Closed
All Other Tests	Open

#### DEFINITIONS:

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

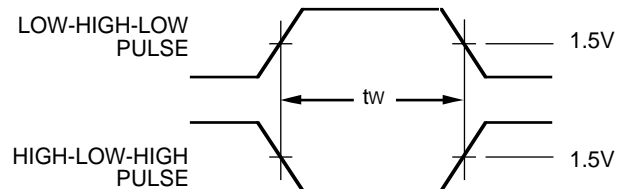
2556 Ink 10

### SET-UP, HOLD AND RELEASE TIMES



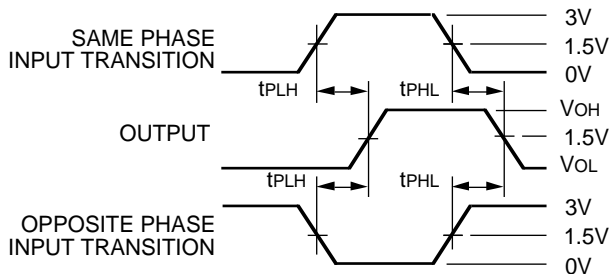
2556 drw 06

### PULSE WIDTH



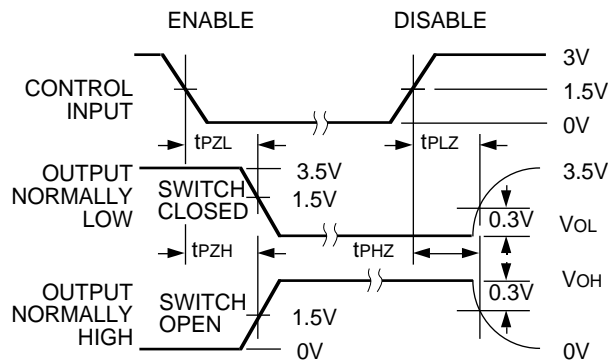
2556 drw 07

### PROPAGATION DELAY



2556 drw 08

### ENABLE AND DISABLE TIMES



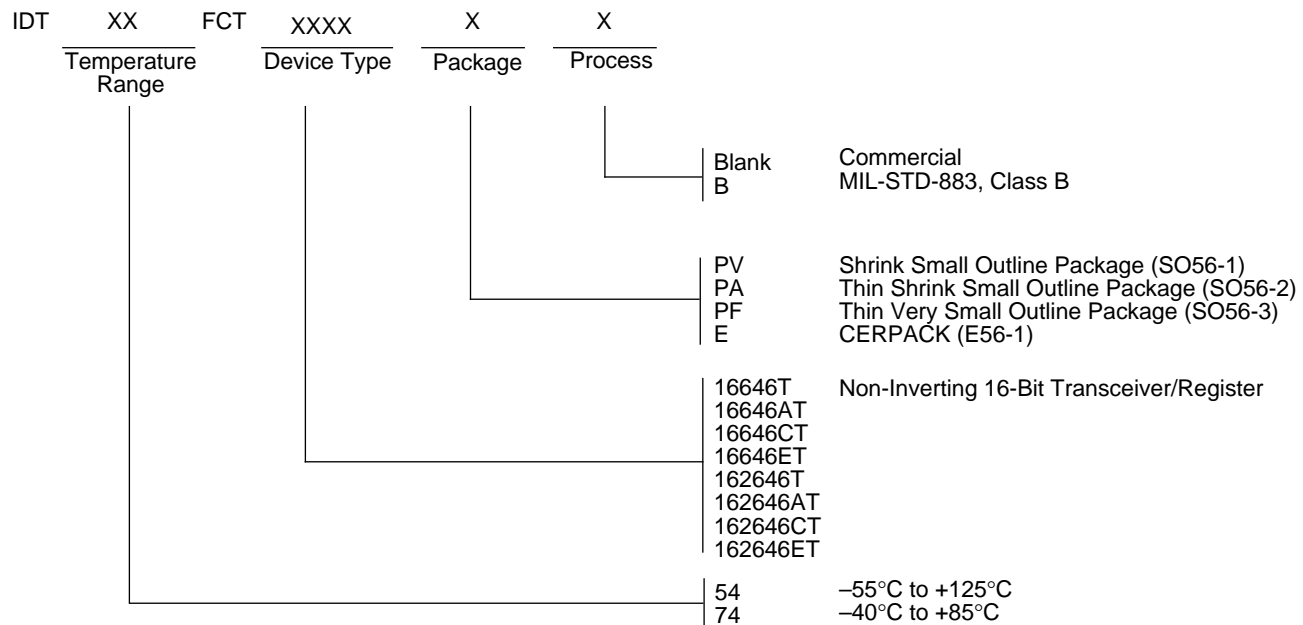
2556 drw 09

#### NOTES:

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



**ORDERING INFORMATION**



2540 drw 14