



Integrated Device Technology, Inc.

# FAST CMOS 16-BIT BUFFER/LINE DRIVER

IDT54/74FCT16244T/AT/CT/ET  
IDT54/74FCT162244T/AT/CT/ET  
IDT54/74FCT166244T/AT/CT  
IDT54/74FCT162H244T/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 ≤ 1μA (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
- **Features for FCT16244T/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 VCC = 5V, TA = 25°C
- **Features for FCT162244T/AT/CT/ET:**
  - Balanced Output Drivers: ±24mA (commercial), ±16mA (military)
  - Reduced system switching noise
  - Typical VOLP (Output Ground Bounce) < 0.6V at VCC = 5V, TA = 25°C
- **Features for FCT166244T/AT/CT:**
  - Light Drive Balanced Output: ±8mA (commercial), ±6mA (military)
  - Minimal system switching noise
  - Typical VOLP (Output Ground Bounce) < 0.25V at VCC = 5V, TA = 25°C
- **Features for FCT162H244T/AT/CT/ET:**
  - Bus-Hold retains last active bus state during 3-state
  - Eliminates the need for external pull up resistors

## DESCRIPTION:

The 16-Bit Buffer/Line Driver is for bus interface or signal buffering applications requiring high speed and low power dissipation. These devices have a flow through pin organization, and shrink packaging to simplify board layout. All inputs are designed with hysteresis for improved noise margin. The three-state controls allow independent 4-bit, 8-bit or combined 16-bit operation. These parts are plug in replacements for 54/74ABT16244 where higher speed, lower noise or lower power dissipation levels are desired.

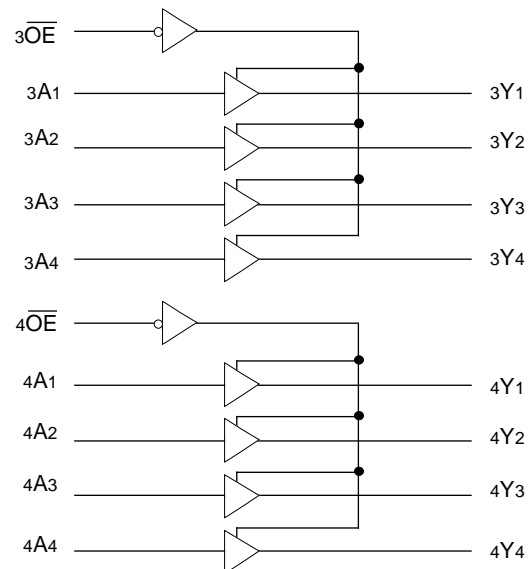
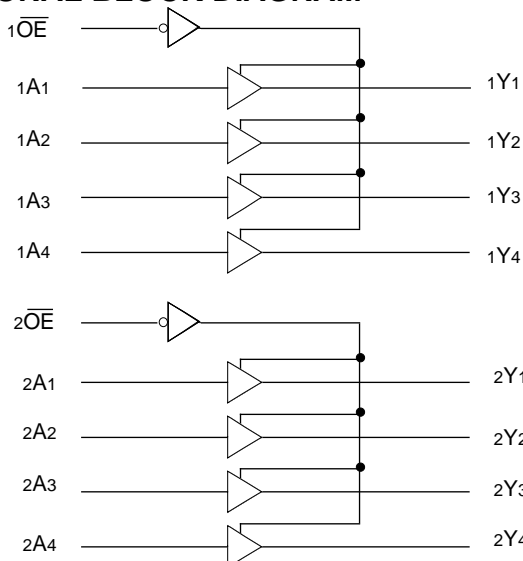
The FCT16244T/AT/CT/ET are ideally suited for driving high capacitance loads (>200pF) and low impedance backplanes. These "high drive" buffers are designed with power off disable capability to allow "live insertion" of boards when used in a backplane interface.

The FCT162244T/AT/CT/ET have balanced output current levels and current limiting resistors. These offer low ground bounce, minimal undershoot, and controlled output fall times, reducing the need for external series terminating resistors while still providing very high speed operation for loads of less than 200pF.

The FCT166244T/AT/CT are suited for very low noise, point-to-point driving where there is a single receiver, or a very light lumped load (<100pF). The buffers are designed to limit the output current to levels which will avoid noise and ringing on the signal lines without using external series terminating resistors.

The FCT162H244T/AT/CT/ET have "Bus-Hold" which retains the input's last state whenever the input goes to high impedance. This prevents "floating" inputs and eliminates the need for pull-up/down resistors.

## FUNCTIONAL BLOCK DIAGRAM



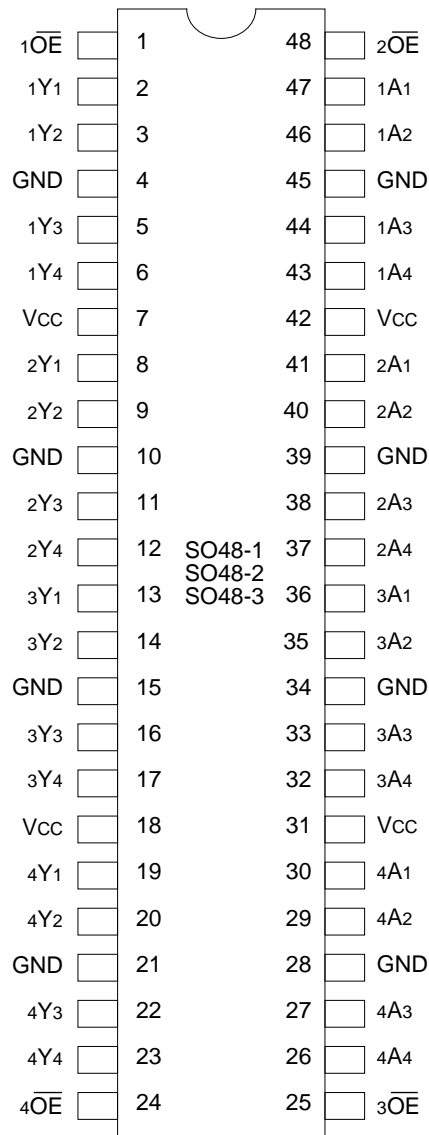
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MILITARY AND COMMERCIAL TEMPERATURE RANGES

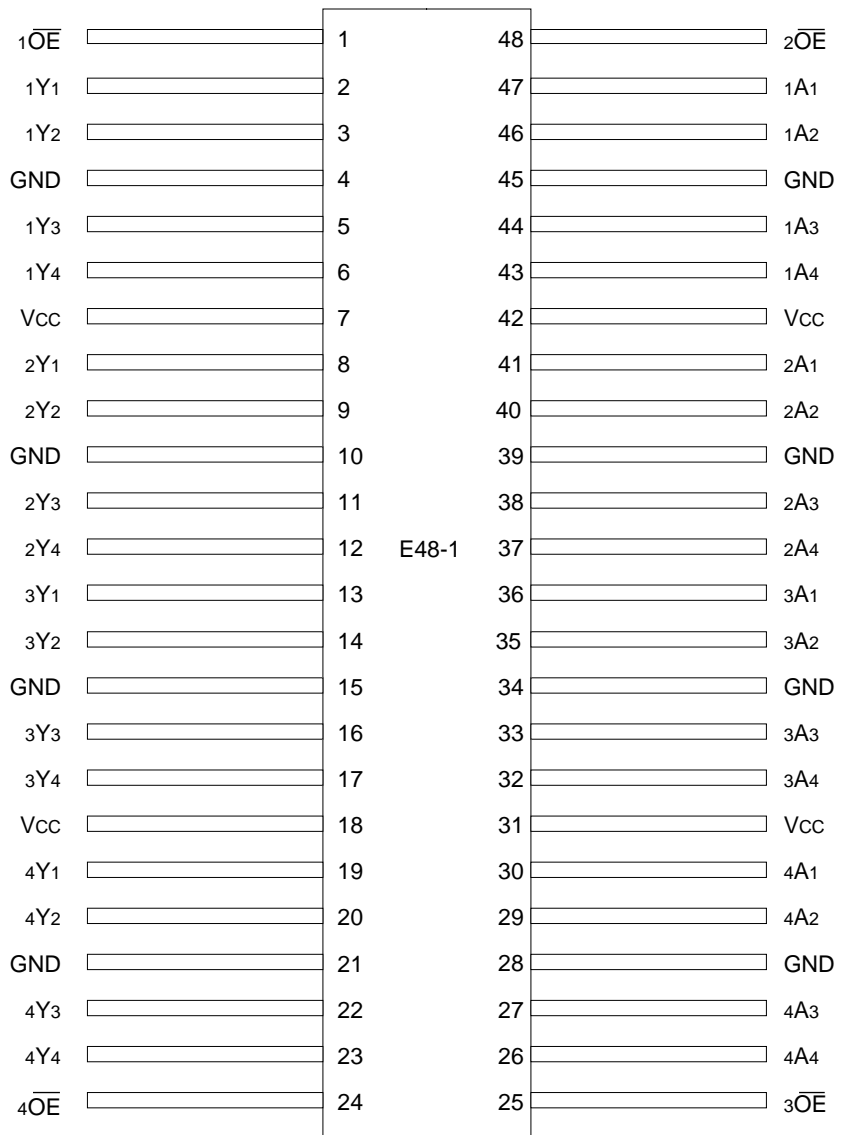
OCTOBER 1996

## PIN CONFIGURATIONS



SSOP/  
TSSOP/TVSOP  
TOP VIEW

2544 drw 03



CERPACK  
TOP VIEW

2544 drw 04

## PIN DESCRIPTION

Pin Names	Description
xOE	3-State Output Enable Inputs (Active LOW)
xAx	Data Inputs <sup>(1)</sup>
xYx	3-State Outputs

**NOTE:**

1. On FCT16xH these pins have "Bus-hold". All other pins are standard inputs, outputs or I/Os.

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## 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

### NOTES:

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- 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 and FCT166XXXT output and I/O terminals.
- Output and I/O terminals for FCT162XXXT and FCT166XXXT.

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

Inputs		Outputs
x $\overline{OE}$	xAx	xYx
L	L	L
L	H	H
H	X	Z

### NOTE:

2544 tbl 02

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

## 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

### NOTE:

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- This parameter is measured at characterization but not tested.

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE (STANDARD PARTS)

Following Conditions Apply Unless Otherwise Specified:

Commercial: T<sub>A</sub> = -40°C to +85°C, V<sub>CC</sub> = 5.0V ± 10%; Military: T<sub>A</sub> = -55°C to +125°C, V<sub>CC</sub> = 5.0V ± 10%

Symbol	Parameter	Test Conditions <sup>(1)</sup>		Min.	Typ. <sup>(2)</sup>	Max.	Unit
V <sub>IH</sub>	Input HIGH Level	Guaranteed Logic HIGH Level		2.0	—	—	V
V <sub>IL</sub>	Input LOW Level	Guaranteed Logic LOW Level		—	—	0.8	V
I <sub>IH</sub>	Input HIGH Current (Input pins) <sup>(5)</sup>	V <sub>CC</sub> = Max.	V <sub>I</sub> = V <sub>CC</sub>	—	—	±1	μA
	Input HIGH Current (I/O pins) <sup>(5)</sup>		V <sub>I</sub> = GND	—	—	±1	
I <sub>IL</sub>	Input LOW Current (Input pins) <sup>(5)</sup>	V <sub>CC</sub> = Max.	V <sub>I</sub> = GND	—	—	±1	μA
	Input LOW Current (I/O pins) <sup>(5)</sup>		V <sub>O</sub> = 2.7V	—	—	±1	
I <sub>OZH</sub>	High Impedance Output Current (3-State Output pins) <sup>(5)</sup>	V <sub>CC</sub> = Max.	V <sub>O</sub> = 2.7V	—	—	±1	μA
I <sub>OZL</sub>			V <sub>O</sub> = 0.5V	—	—	±1	
V <sub>IK</sub>	Clamp Diode Voltage	V <sub>CC</sub> = Min., I <sub>IN</sub> = -18mA		—	-0.7	-1.2	V
I <sub>OS</sub>	Short Circuit Current	V <sub>CC</sub> = Max., V <sub>O</sub> = GND <sup>(3)</sup>		-80	-140	-225	mA
V <sub>H</sub>	Input Hysteresis	—		—	100	—	mV
I <sub>CCL</sub> I <sub>CCH</sub> I <sub>CCZ</sub>	Quiescent Power Supply Current	V <sub>CC</sub> = Max., V <sub>IN</sub> = GND or V <sub>CC</sub>		—	5	500	μA

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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<sub>CC</sub> = 5.0V, +25°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 ± 5μA at T<sub>A</sub> = -55°C.

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE (BUS-HOLD)

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 <sup>(4)</sup>	Standard Input <sup>(5)</sup>	$V_{CC} = \text{Max.}$	$V_I = V_{CC}$	—	—	$\pm 1$	$\mu\text{A}$
		Standard I/O <sup>(5)</sup>			—	—	$\pm 1$	
		Bus-hold Input			—	—	$\pm 100$	
		Bus-hold I/O			—	—	$\pm 100$	
$I_{IL}$	Input LOW Current <sup>(4)</sup>	Standard Input <sup>(5)</sup>	$V_{CC} = \text{Max.}$	$V_I = \text{GND}$	—	—	$\pm 1$	$\mu\text{A}$
		Standard I/O <sup>(5)</sup>			—	—	$\pm 1$	
		Bus-hold Input			—	—	$\pm 100$	
		Bus-hold I/O			—	—	$\pm 100$	
$I_{BH}$ $I_{BHL}$	Bus Hold Sustain Current <sup>(4)</sup>	Bus-hold Input	$V_{CC} = \text{Min.}$	$V_I = 2.0\text{V}$	-50	—	—	$\mu\text{A}$
				$V_I = 0.8\text{V}$	+50	—	—	
$I_{OZH}$	High Impedance Output Current (3-State Output pins) <sup>(5,6)</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	$\mu\text{A}$

### 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  $V_{CC} = 5.0\text{V}$ ,  $+25^{\circ}\text{C}$  ambient.
- Not more than one output should be tested at one time. Duration of the test should not exceed one second.
- Pins with Bus-hold are identified in the pin description.
- The test limit for this parameter is  $\pm 5\mu\text{A}$  at  $T_A = -55^{\circ}\text{C}$ .
- Does not include Bus-hold I/O pins.

### OUTPUT DRIVE CHARACTERISTICS FOR FCT16244T

Symbol	Parameter	Test Conditions <sup>(1)</sup>	Min.	Typ. <sup>(2)</sup>	Max.	Unit	
I <sub>o</sub>	Output Drive Current	V <sub>CC</sub> = Max., V <sub>o</sub> = 2.5V <sup>(3)</sup>	-50	—	-180	mA	
V <sub>OH</sub>	Output HIGH Voltage	V <sub>CC</sub> = Min. V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -3mA	2.5	3.5	—	V
			I <sub>OH</sub> = -12mA MIL. I <sub>OH</sub> = -15mA COM'L.	2.4	3.5	—	V
			I <sub>OH</sub> = -24mA MIL. I <sub>OH</sub> = -32mA COM'L. <sup>(4)</sup>	2.0	3.0	—	V
V <sub>OL</sub>	Output LOW Voltage	V <sub>CC</sub> = Min. V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	—	0.2	0.55	V	
I <sub>OFF</sub>	Input/Output Power Off Leakage <sup>(5)</sup>	V <sub>CC</sub> = 0V, V <sub>IN</sub> or V <sub>o</sub> ≤ 4.5V	—	—	±1	μA	

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### OUTPUT DRIVE CHARACTERISTICS FOR FCT162244T

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

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### OUTPUT DRIVE CHARACTERISTICS FOR FCT166244T

Symbol	Parameter	Test Conditions <sup>(1)</sup>	Min.	Typ. <sup>(2)</sup>	Max.	Unit	
I <sub>ODL</sub>	Output LOW Current	V <sub>CC</sub> = 5V, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , V <sub>OUT</sub> = 1.5V <sup>(3)</sup>	16	48	96	mA	
I <sub>ODH</sub>	Output HIGH Current	V <sub>CC</sub> = 5V, V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , V <sub>OUT</sub> = 1.5V <sup>(3)</sup>	-16	-48	-96	mA	
V <sub>OH</sub>	Output HIGH Voltage	V <sub>CC</sub> = Min. V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -6mA MIL. I <sub>OH</sub> = -8mA COM'L.	2.4	3.3	—	V
			V <sub>CC</sub> = Min. V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	—	0.3	0.55	V
V <sub>OL</sub>	Output LOW Voltage	V <sub>CC</sub> = Min. V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	—	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<sub>CC</sub> = 5.0V, +25°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 ± 5μA at T<sub>A</sub> = -55°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>	$V_{CC} = \text{Max.}$ Outputs Open $\overline{xOE} = \text{GND}$ One Input Toggling 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	60	100	$\mu\text{A}/\text{MHz}$
$I_C$	Total Power Supply Current <sup>(6)</sup>	$V_{CC} = \text{Max.}$ Outputs Open $f_i = 10\text{MHz}$ 50% Duty Cycle $\overline{xOE} = \text{GND}$ One Bit Toggling	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	0.6	1.5	mA
			$V_{IN} = 3.4V$ $V_{IN} = \text{GND}$	—	0.9	2.3	
		$V_{CC} = \text{Max.}$ Outputs Open $f_i = 2.5\text{MHz}$ 50% Duty Cycle $\overline{xOE} = \text{GND}$ Sixteen Bits Toggling	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	2.4	4.5 <sup>(5)</sup>	
			$V_{IN} = 3.4V$ $V_{IN} = \text{GND}$	—	6.4	16.5 <sup>(5)</sup>	

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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  $V_{CC} = 5.0V$ ,  $+25^\circ\text{C}$  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.
- $I_C = I_{\text{QUIESCENT}} + I_{\text{INPUTS}} + I_{\text{DYNAMIC}}$   
 $I_C = I_{CC} + \Delta I_{CC} D_H N_T + I_{CCD} (f_C P_{NCP}/2 + f_i N_i)$   
 $I_{CC} = \text{Quiescent Current (} I_{CCL}, I_{CCH} \text{ and } I_{CCZ})$   
 $\Delta I_{CC} = \text{Power Supply Current for a TTL High Input (} V_{IN} = 3.4V)$   
 $D_H = \text{Duty Cycle for TTL Inputs High}$   
 $N_T = \text{Number of TTL Inputs at } D_H$   
 $I_{CCD} = \text{Dynamic Current Caused by an Input Transition Pair (HLH or LHL)}$   
 $f_C = \text{Clock Frequency for Register Devices (Zero for Non-Register Devices)}$   
 $P_{NCP} = \text{Number of Clock Inputs at } f_C$   
 $f_i = \text{Input Frequency}$   
 $N_i = \text{Number of Inputs at } f_i$

### SWITCHING CHARACTERISTICS OVER OPERATING RANGE FOR FCT16244T/FCT162244T

Symbol	Parameter	Condition <sup>(1)</sup>	FCT16244T/162244T/166244T				FCT16244AT/162244AT/166244AT				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 xAx to xYx	CL = 50pF RL = 500Ω	1.5	6.5	1.5	7.0	1.5	4.8	1.5	5.1	ns
tPZH tPZL	Output Enable Time		1.5	8.0	1.5	8.5	1.5	6.2	1.5	6.5	ns
tPHZ tPLZ	Output Disable Time		1.5	7.0	1.5	7.5	1.5	5.6	1.5	5.9	ns
tSK(o)	Output Skew <sup>(3)</sup>		—	0.5	—	0.5	—	0.5	—	0.5	ns

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Symbol	Parameter	Condition <sup>(1)</sup>	FCT16244CT/162244CT/166244CT				FCT16244ET/162244ET				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 xAx to xYx	CL = 50pF RL = 500Ω	1.5	4.1	1.5	4.6	1.5	3.2	—	—	ns
tPZH tPZL	Output Enable Time		1.5	5.8	1.5	6.5	1.5	4.4	—	—	ns
tPHZ tPLZ	Output Disable Time		1.5	5.2	1.5	5.7	1.5	3.6	—	—	ns
tSK(o)	Output Skew <sup>(3)</sup>		—	0.5	—	0.5	—	0.5	—	—	ns

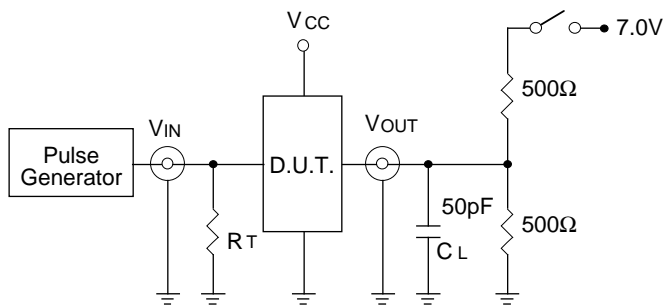
2544 tbl 12

**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



2544 drw 05

### SWITCH POSITION

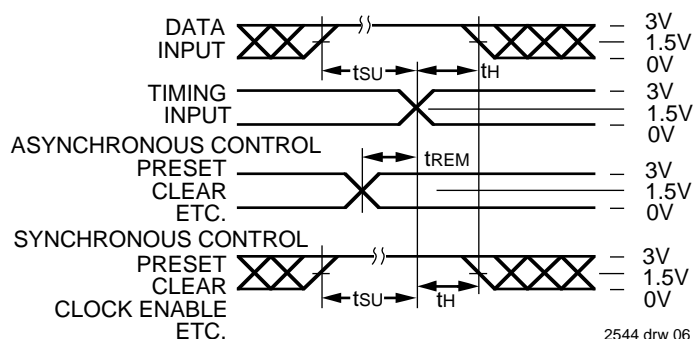
Test	Switch
Open Drain Disable Low Enable Low	Closed
All Other Tests	Open

#### DEFINITIONS:

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

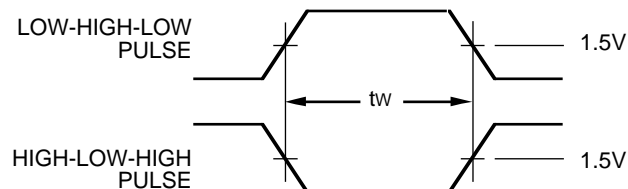
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### SET-UP, HOLD AND RELEASE TIMES



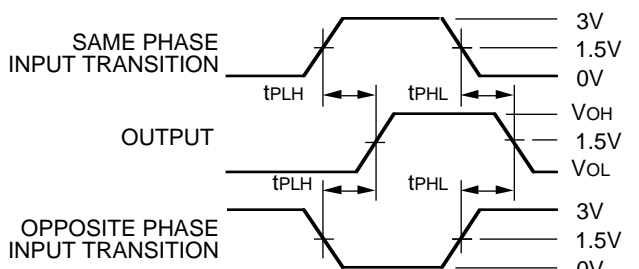
2544 drw 06

### PULSE WIDTH



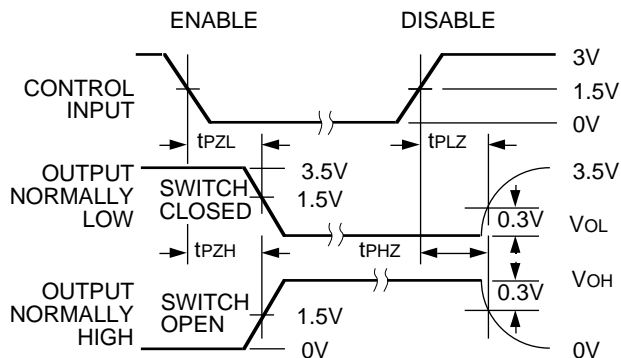
2544 drw 07

### PROPAGATION DELAY



2544 drw 08

### ENABLE AND DISABLE TIMES



#### NOTES:

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

2544 drw 09



## ORDERING INFORMATION

IDT	XX	FCT	X	X	XXXX	X	X		
Temp. Range			Drive	Bus Hold	Device Type	Package	Process		
								Blank B	Commercial MIL-STD-883, Class B
								PV PA PF E	Shrink Small Outline Package (SO48-1) Thin Shrink Small Outline Package (SO48-2) Thin Very Small Outline Package (SO48-3) CERPACK (E48-1)
								244T 244AT 244CT 244ET	Non-Inverting 16-Bit Buffer/Line Driver
								Blank H	Standard Bus-hold
								16 162 166	16-Bit High Drive 16-Bit Balanced Drive 16-Bit Light Drive
								54 74	-55°C to +125°C -40°C to +85°C

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