Integrated Device Technology, Inc.

FAST CMOS 18-BIT REGISTERED TRANSCEIVER

IDT54/74FCT16501AT/CT/ET
IDT54/74FCT162501AT/CT/ET
IDT54/74FCT162H501AT/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 ≤ 1μA (max.)**
  - ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
  - 25 mil pitch SSOP and Cerpack Packages and 19.6 mil pitch TSSOP Package
  - Extended commercial range of -40°C to +85°C
- **Features for FCT16501AT/CT/ET:**
  - High drive outputs (-32mA I_{OH}, 64mA I_{OL})
  - Power off disable outputs permit "live insertion"
  - Typical V_{OLP} (Output Ground Bounce) < 1.0V at V_{CC} = 5V, T_A = 25°C
- **Features for FCT162501AT/CT/ET:**
  - Balanced Output Drivers: ±24mA (commercial), ±16mA (military)
  - Reduced system switching noise
  - Typical V_{OLP} (Output Ground Bounce) < 0.6V at V_{CC} = 5V, T_A = 25°C
- **Features for FCT162H501AT/CT/ET:**
  - Bus Hold retains last active bus state during 3-state
  - Eliminates the need for external pull up resistors

DESCRIPTION:

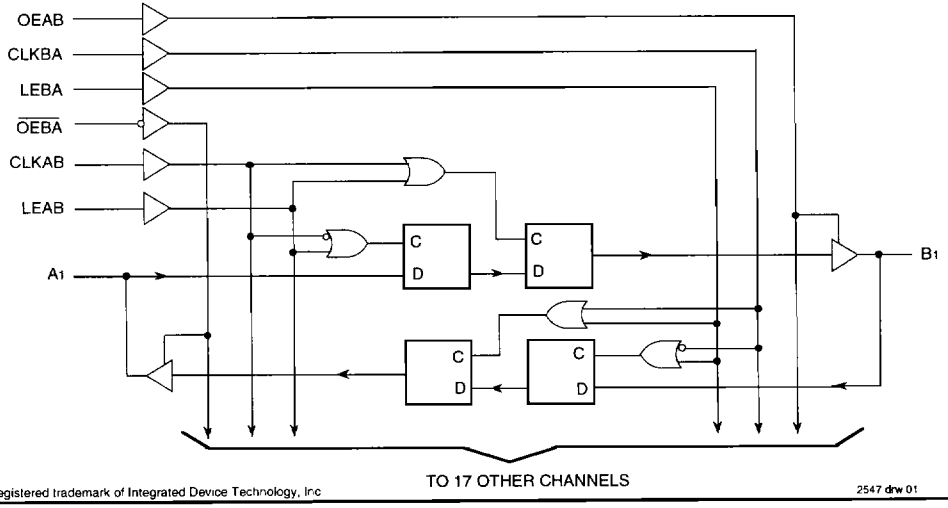
The FCT16501AT/CT/ET and FCT162501AT/CT/ET 18-bit registered transceivers are built using advanced dual metal CMOS technology. These high-speed, low-power 18-bit registered bus transceivers combine D-type latches and D-type flip-flops to allow data flow in transparent, latched and clocked modes. Data flow in each direction is controlled by output-enable (OEAB and $\overline{OEBA}$), 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 LOW-to-HIGH transition of CLKAB. OEAB is the output enable for the B port. Data flow from the B port to the A port is similar but requires using $\overline{OEBA}$, LEBA and CLKBA. Flow-through organization of signal pins simplifies layout. All inputs are designed with hysteresis for improved noise margin.

The FCT16501AT/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 FCT162501AT/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 FCT162501AT/CT/ET are plug-in replacements for the FCT16501AT/CT/ET and ABT16501 for on-board bus interface applications.

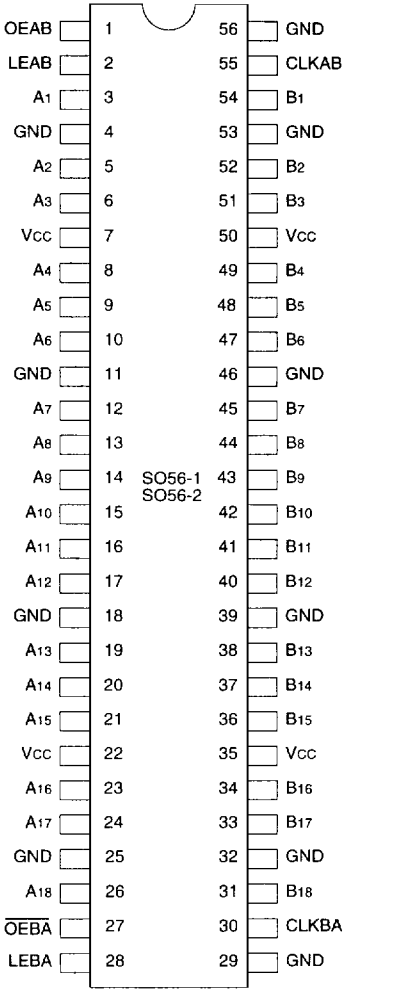
The FCT162H501AT/CT/ET have "Bus Hold" which retains the input's last state whenever the input goes to high impedance. This prevents "floating" inputs and eliminates the need for pull-up/down resistors.

FUNCTIONAL BLOCK DIAGRAM

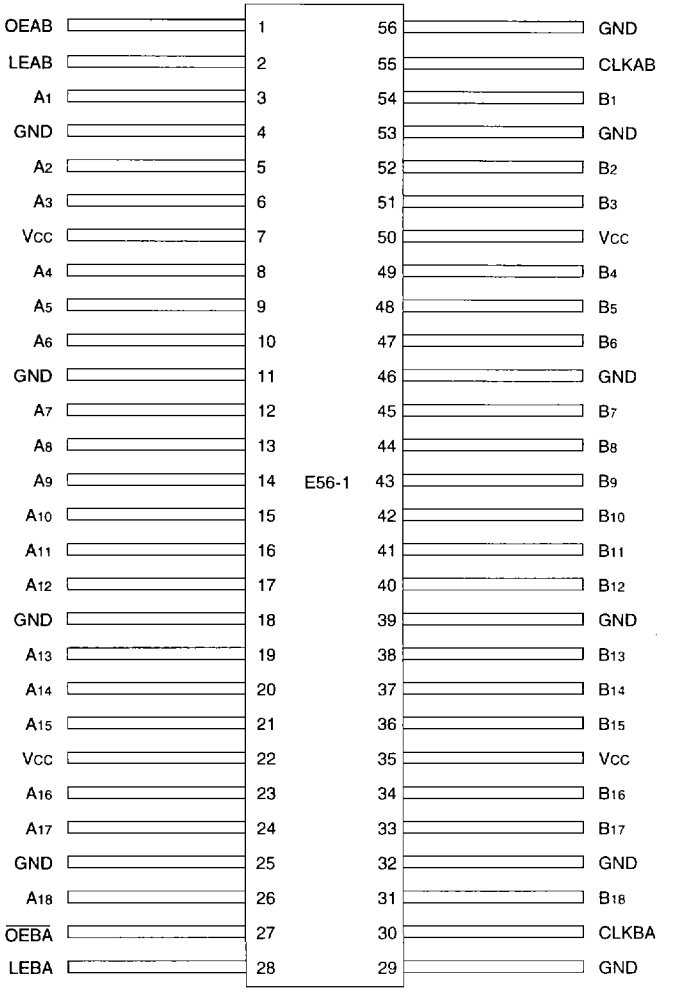


2547 drw 01

PIN CONFIGURATIONS



SSOP
TSSOP
TOP VIEW



CERPACK
TOP VIEW

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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
CLKAB	A-to-B Clock Input
CLKBA	B-to-A Clock Input
Ax	A-to-B Data Inputs or B-to-A 3-State Outputs(1)
Bx	B-to-A Data Inputs or A-to-B 3-State Outputs(1)

NOTE: 2547 tbl 01
1. On FCT16xH501T these pins have "Bus Hold". All other pins are standard inputs, outputs or I/Os.

ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Rating	Commercial	Military	Unit
V_{TERM}(2)	Terminal Voltage with Respect to GND	–0.5 to +7.0	–0.5 to +7.0	V
V_{TERM}(3)	Terminal Voltage with Respect to GND	–0.5 to V_{CC} +0.5	–0.5 to V_{CC} +0.5	V
T_A	Operating Temperature	–40 to +85	–55 to +125	°C
T_{BIAS}	Temperature Under Bias	–55 to +125	–65 to +135	°C
T_{STG}	Storage Temperature	–55 to +125	–65 to +150	°C
P_T	Power Dissipation	1.0	1.0	W
I_{OUT}	DC Output Current	–60 to +120	–60 to +120	mA

NOTES: 2547 lnk 03
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.

FUNCTION TABLE(1,4)

Inputs				Outputs
OEAB	LEAB	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	L	X	B(2)
H	L	H	X	B(3)

NOTES: 2547 tbl 02
1. A-to-B data flow is shown. B-to-A data flow is similar but uses $\overline{OEBA}$, LEBA, and CLKBA.
2. Output level before the indicated steady-state input conditions were established.
3. Output level before the indicated steady-state input conditions were established, provided that CLKAB was HIGH before LEAB went LOW.
4. H = HIGH Voltage Level
   L = LOW Voltage Level
   X = Don't Care
   Z = High-impedance
   ↑ = LOW-to-HIGH Transition

CAPACITANCE (T_A = +25°C, f = 1.0MHz)

Symbol	Parameter(1)	Conditions	Typ.	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V	3.5	6.0	pF
$C_{I/O}$	I/O Capacitance	V_{OUT} = 0V	3.5	8.0	pF

NOTE: 2547 lnk 04
1. 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_A = −40°C to +85°C, V_{CC} = 5.0V ± 10%; Military: T_A = −55°C to +125°C, V_{CC} = 5.0V ± 10%

Symbol	Parameter	Test Conditions[1]		Min.	Typ.[2]	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)[5]	V_{CC} = Max.	V_I = V_{CC}	—	—	±1	µA
	Input HIGH Current (I/O pins)[5]			—	—	±1	
I_{IL}	Input LOW Current (Input pins)[5]		V_I = GND	—	—	±1	
	Input LOW Current (I/O pins)[5]			—	—	±1	
I_{OZH}	High Impedance Output Current	V_{CC} = Max.	V_O = 2.7V	—	—	±1	µA
I_{OZL}	(3-State Output pins)[5]		V_O = 0.5V	—	—	±1	
V_{IK}	Clamp Diode Voltage	V_{CC} = Min., I_{IN} = −18mA		—	−0.7	−1.2	V
I_{OS}	Short Circuit Current	V_{CC} = Max., V_O = GND[3]		−80	−140	−225	mA
V_H	Input Hysteresis	—		—	100	—	mV
I_{CCL} I_{CCH} I_{CCZ}	Quiescent Power Supply Current	V_{CC} = Max., V_{IN} = GND or V_{CC}		—	5	500	µA

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OUTPUT DRIVE CHARACTERISTICS FOR FCT16501T

Symbol	Parameter	Test Conditions[1]		Min.	Typ.[2]	Max.	Unit
I_O	Output Drive Current	V_{CC} = Max., V_O = 2.5V[3]		−50	—	−180	mA
V_{OH}	Output HIGH Voltage	V_{CC} = Min.	I_{OH} = −3mA	2.5	3.5	—	V
		V_{IN} = V_{IH} or V_{IL}	I_{OH} = −12mA MIL. I_{OH} = −15mA COM'L.	2.4	3.5	—	V
			I_{OH} = −24mA MIL. I_{OH} = −32mA COM'L.[4]	2.0	3.0	—	V
V_{OL}	Output LOW Voltage	V_{CC} = Min. V_{IN} = V_{IH} or V_{IL}	I_{OL} = 48mA MIL. I_{OL} = 64mA COM'L.	—	0.2	0.55	V
I_{OFF}	Input/Output Power Off Leakage[5]	V_{CC} = 0V, V_{IN} or V_O ≤ 4.5V		—	—	±1	µA

2547 lnk 06

OUTPUT DRIVE CHARACTERISTICS FOR FCT162501T

Symbol	Parameter	Test Conditions[1]		Min.	Typ.[2]	Max.	Unit
I_{ODL}	Output LOW Current	V_{CC} = 5V, V_{IN} = V_{IH} or V_{IL}, V_{OUT} = 1.5V[3]		60	115	200	mA
I_{ODH}	Output HIGH Current	V_{CC} = 5V, V_{IN} = V_{IH} or V_{IL}, V_{OUT} = 1.5V[3]		−60	−115	−200	mA
V_{OH}	Output HIGH Voltage	V_{CC} = Min. V_{IN} = V_{IH} or V_{IL}	I_{OH} = −16mA MIL. I_{OH} = −24mA COM'L.	2.4	3.3	—	V
V_{OL}	Output LOW Voltage	V_{CC} = Min. V_{IN} = V_{IH} or V_{IL}	I_{OL} = 16mA MIL. I_{OL} = 24mA COM'L.	—	0.3	0.55	V

2547 lnk 07

NOTES:

1. For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at Vcc = 5.0V, +25°C ambient.
3. Not more than one output should be tested at one time. Duration of the test should not exceed one second.
4. Duration of the condition can not exceed one second.
5. The test limit for this parameter is ± 5µA at T_A = −55°C.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE (BUS HOLD)

Following Conditions Apply Unless Otherwise Specified:
Commercial: T_A = −40°C to +85°C, V_{CC} = 5.0V ± 10%; Military: T_A = −55°C to +125°C, V_{CC} = 5.0V ± 10%

Symbol	Parameter		Test Conditions[1]		Min.	Typ.[2]	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[4]	Standard Input[5]	V_{CC} = Max.	V_I = V_{CC}	—	—	±1	µA
		Standard I/O[5]			—	—	±1	
		Bus Hold Input			—	—	±100	
		Bus Hold I/O			—	—	±100	
I_{IL}	Input LOW Current[4]	Standard Input[5]		V_I = GND	—	—	±1	
		Standard I/O[5]			—	—	±1	
		Bus Hold Input			—	—	±100	
		Bus Hold I/O			—	—	±100	
I_{BHH}	Bus Hold Sustain Current[4]	Bus Hold Input	V_{CC} = Min.	V_I = 2.0V	−50	—	—	µA
I_{BHL}				V_I = 0.8V	+50	—	—	
I_{OZH}	High Impedance Output Current (3-State Output pins)[5,6]		V_{CC} = Max.	V_O = 2.7V	—	—	±1	µA
I_{OZL}				V_O = 0.5V	—	—	±1	
V_{IK}	Clamp Diode Voltage		V_{CC} = Min., I_{IN} = −18mA		—	-0.7	-1.2	V
I_{OS}	Short Circuit Current		V_{CC} = Max., V_O = GND[3]		−80	-140	-225	mA
V_H	Input Hysteresis		—		—	100	—	mV
I_{CCL} I_{CCH} I_{CCZ}	Quiescent Power Supply Current		V_{CC} = Max., V_{IN} = GND or V_{CC}		—	5	500	µA

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NOTES:

1. For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
2. Typical values are at Vcc = 5.0V, +25°C ambient.
3. Not more than one output should be tested at one time. Duration of the test should not exceed one second.
4. Pins with Bus Hold are identified in the pin description.
5. The test limit for this parameter is ± 5µA at T_A = −55°C.
6. Does not include Bus Hold I/O pins.

POWER SUPPLY CHARACTERISTICS

Symbol	Parameter	Test Conditions[1]		Min.	Typ.[2]	Max.	Unit
ΔI_{CC}	Quiescent Power Supply Current TTL Inputs HIGH	V_{CC} = Max. V_{IN} = 3.4V[3]		—	0.5	1.5	mA
I_{CCD}	Dynamic Power Supply Current[4]	V_{CC} = Max., Outputs Open OEAB = $\overline{OEBA}$ = V_{CC} or GND One Input Toggling 50% Duty Cycle	V_{IN} = V_{CC} V_{IN} = GND	—	75	120	µA/ MHz
I_C	Total Power Supply Current[6]	V_{CC} = Max., Outputs Open f_{CP} = 10MHz (CLKAB) 50% Duty Cycle OEAB = $\overline{OEBA}$ = V_{CC} LEAB = GND One Bit Toggling f_i = 5MHz 50% Duty Cycle	V_{IN} = V_{CC} V_{IN} = GND	—	0.8	1.7	mA
			V_{IN} = 3.4V V_{IN} = GND	—	1.3	3.2	
		V_{CC} = Max., Outputs Open f_{CP} = 10MHz (CLKAB) 50% Duty Cycle OEAB = $\overline{OEBA}$ = V_{CC} LEAB = GND Eighteen Bits Toggling f_i = 2.5MHz 50% Duty Cycle	V_{IN} = V_{CC} V_{IN} = GND	—	3.8	6.5[5]	
			V_{IN} = 3.4V V_{IN} = GND	—	8.5	20.8[5]	

2547 tbl 09

NOTES:

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

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SWITCHING CHARACTERISTICS OVER OPERATING RANGE

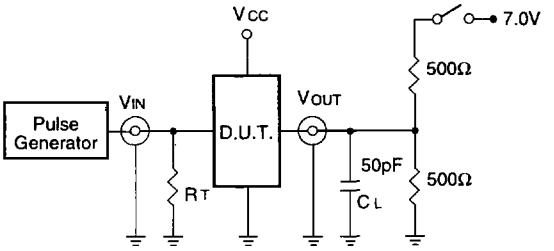
Symbol	Parameter		Condition[1]	FCT16501AT/162501AT				FCT16501CT/162501CT				FCT16501ET/162501ET				Unit
				Com'l.		Mil.		Com'l.		Mil.		Com'l.		Mil.		
				Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	
f_{MAX}	CLKAB or CLKBA frequency[4]		C_L = 50pF	—	150	—	150	—	150	—	150	—	150	—	—	MHz
t_{PLH} t_{PHL}	Propagation Delay Ax to Bx or Bx to Ax		R_L = 500Ω	1.5	5.1	1.5	5.6	1.5	4.6	1.5	4.6	1.5	3.8	—	—	ns
t_{PLH} t_{PHL}	Propagation Delay LEBA to Ax, LEAB to Bx			1.5	5.6	1.5	6.0	1.5	5.3	1.5	5.6	1.5	4.2	—	—	ns
t_{PLH} t_{PHL}	Propagation Delay CLKBA to Ax, CLKAB to Bx			1.5	5.6	1.5	6.0	1.5	5.3	1.5	5.4	1.5	4.2	—	—	ns
t_{PZH} t_{PZL}	Output Enable Time $\overline{OEBA}$ to Ax, OEAB to Bx			1.5	6.0	1.5	6.4	1.5	5.6	1.5	6.0	1.5	4.8	—	—	ns
t_{PHZ} t_{PLZ}	Output Disable Time $\overline{OEBA}$ to Ax, OEAB to Bx			1.5	5.6	1.5	6.0	1.5	5.2	1.5	5.6	1.5	5.2	—	—	ns
t_{SU}	Set-up Time, HIGH or LOW Ax to CLKAB, Bx to CLKBA			3.0	—	3.0	—	3.0	—	3.0	—	2.4	—	—	—	ns
t_H	Hold Time HIGH or LOW Ax to CLKAB, Bx to CLKBA			0	—	0	—	0	—	0	—	0	—	—	—	ns
t_{SU}	Set-up Time HIGH or LOW	Clock LOW		3.0	—	3.0	—	3.0	—	3.0	—	2.0	—	—	—	ns
	Ax to LEAB, Bx to LEBA	Clock HIGH		1.5	—	1.5	—	1.5	—	1.5	—	1.5	—	—	—	ns
t_H	Hold Time, HIGH or LOW Ax to LEAB, Bx to LEBA			1.5	—	1.5	—	1.5	—	1.5	—	0.5	—	—	—	ns
t_W	LEAB or LEBA Pulse Width HIGH[4]			3.0	—	3.0	—	3.0	—	3.0	—	3.0	—	—	—	ns
t_W	CLKAB or CLKBA Pulse Width HIGH or LOW[4]			3.0	—	3.0	—	3.0	—	3.0	—	3.0	—	—	—	ns
$t_{SK(o)}$	Output Skew[3]			—	0.5	—	0.5	—	0.5	—	0.5	—	0.5	—	—	ns

NOTES:
2547 tbl 10

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



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SWITCH POSITION

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

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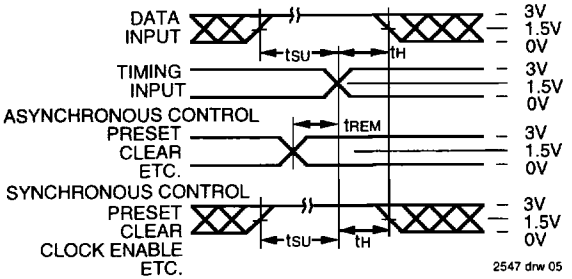
DEFINITIONS:

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

SET-UP, HOLD AND RELEASE TIMES



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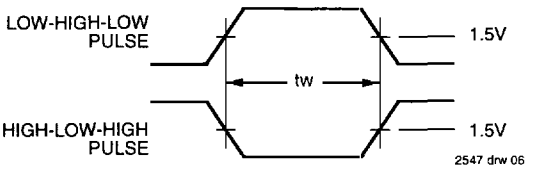
PULSE WIDTH



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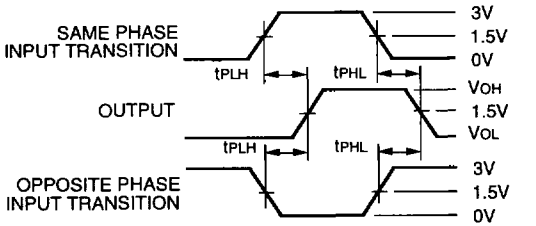
PROPAGATION DELAY



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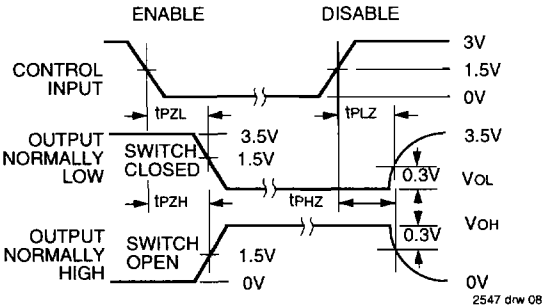
ENABLE AND DISABLE TIMES



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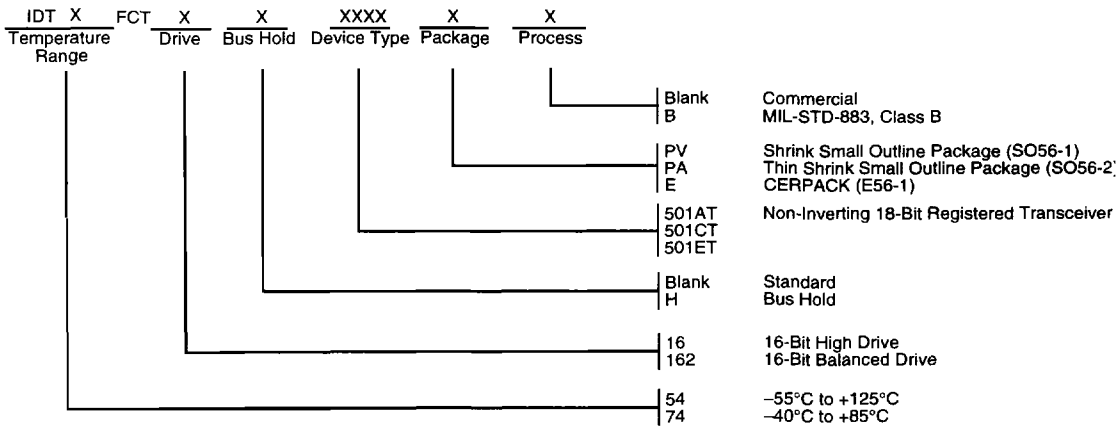
NOTES:

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH
2. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; tF ≤ 2.5ns; tR ≤ 2.5ns

ORDERING INFORMATION



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