Integrated Device Technology, Inc.

FAST CMOS 12-BIT SYNCHRONOUS BUS EXCHANGER

IDT54/74FCT162H272AT/CT/ET

FEATURES:

- 0.5 MICRON CMOS Technology
- **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
- Balanced Output Drivers: ±24mA (commercial)
  ±16mA (military)
- Reduced system switching noise
- Typical VOLP (Output Ground Bounce) < 0.6V at VCC = 5V, TA = 25°C
- Bus Hold retains last active bus state during 3-state
- Eliminates the need for external pull up resistors

DESCRIPTION:

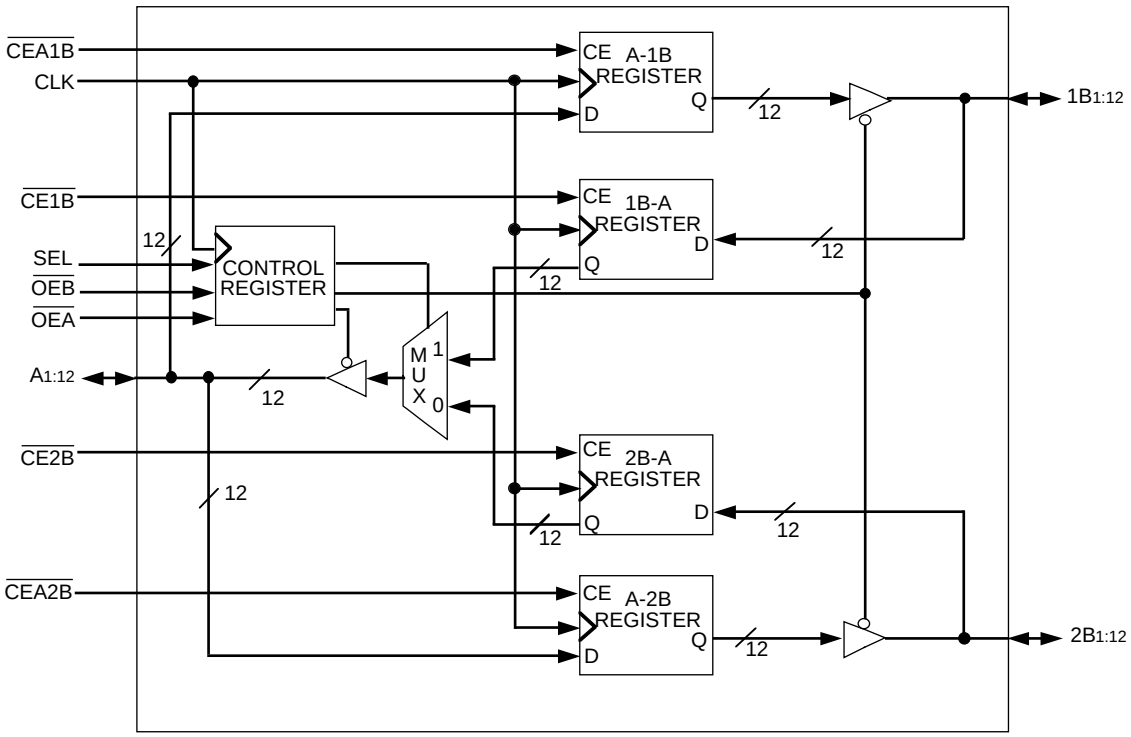
The FCT162H272AT/CT/ET synchronous tri-port bus exchangers are high-speed, bidirectional,12-bit, registered, bus multiplexers for use in synchronous memory interleaving applications. All registers have a common clock and use a clock enable ($\overline{CE}$xxx) on each data register to control data sequencing. The output enables and mux select ($\overline{OEA}$, $\overline{OEB}$ and SEL) are also under synchronous control allowing direction changes to be edge triggered events.

The tri-port bus exchanger has three 12-bit ports. Data may be transferred between the A port and either/both of the B ports. The clock enable ($\overline{CE1B}$, $\overline{CE2B}$, $\overline{CEA1B}$ and $\overline{CEA2B}$) inputs control the data storage. Both B ports have a common output enable ($\overline{OEB}$) to aid in synchronously loading the B registers from the B port.

The FCT162H272AT/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 FCT162H272AT/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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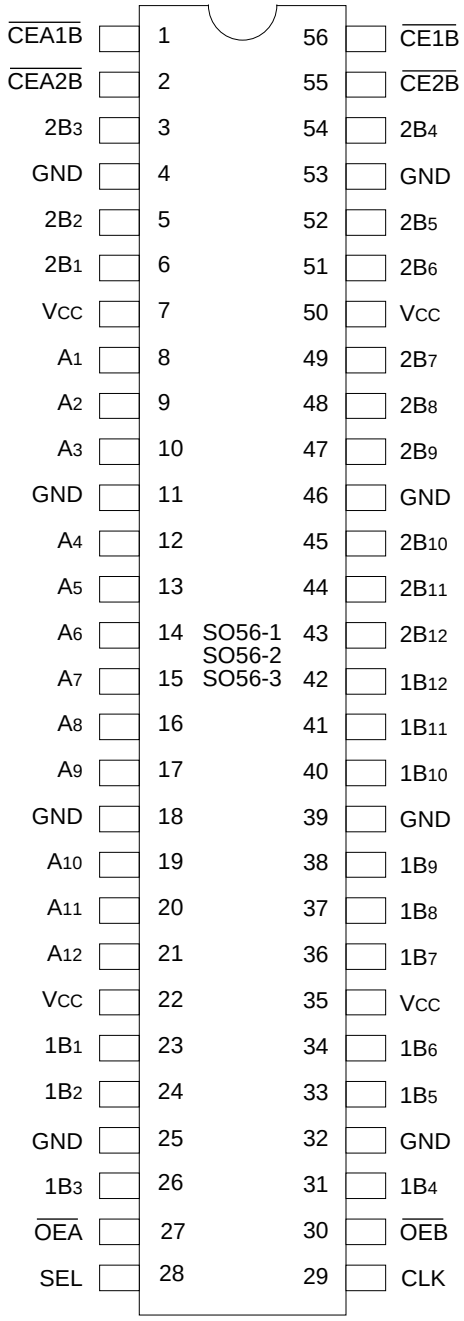
PIN CONFIGURATIONS



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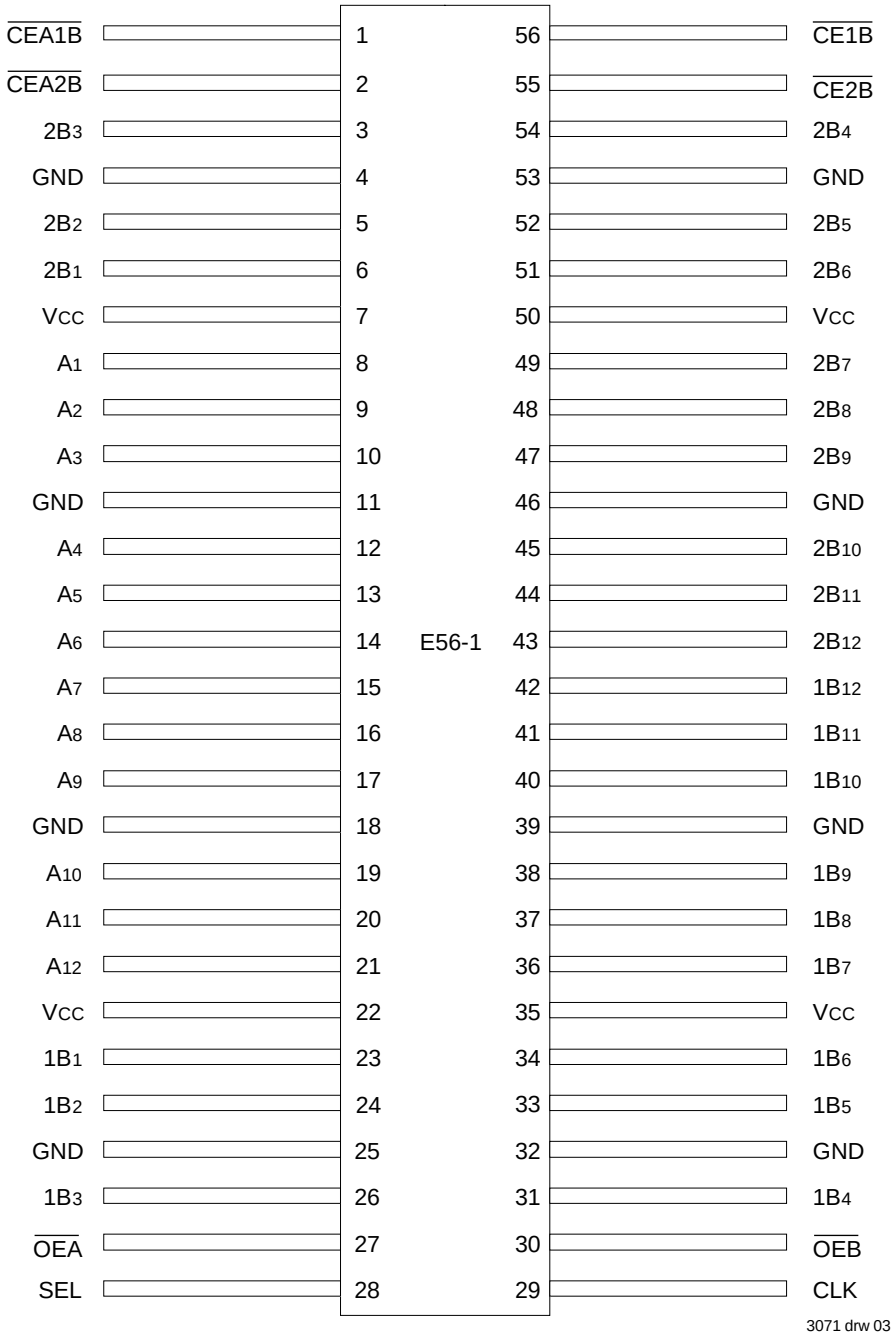
SSOP/ TSSOP/TVSOP TOP VIEW



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CERPACK TOP VIEW

PIN DESCRIPTION

Signal	I/O	Description
A(1:12)	I/O	Bidirectional Data Port A. Usually connected to the CPU's Address/Data bus.(1)
1B(1:12)	I/O	Bidirectional Data Port 1B. Usually connected to the even path or even bank of memory.(1)
2B(1:12)	I/O	Bidirectional Data Port 2B. Usually connected to the odd path or odd bank of memory.(1)
CLK	I	Clock Input.
$\overline{CEA1B}$	I	Clock Enable Input for the A-1B Register. If $\overline{CEA1B}$ is LOW during the rising edge of CLK, data will be clocked into register A-1B (Active LOW).
$\overline{CEA2B}$	I	Clock Enable Input for the A-2B Register. If $\overline{CEA2B}$ is LOW during the rising edge of CLK, data will be clocked into register A-2B (Active LOW).
$\overline{CE1B}$	I	Clock Enable Input for the 1B-A Register. If $\overline{CE1B}$ is LOW during the rising edge of CLK, data will be clocked into register 1B-A (Active LOW).
$\overline{CE2B}$	I	Clock Enable Input for the 2B-A Register. If $\overline{CE2B}$ is LOW during the rising edge of CLK, data will be clocked into register 2B-A (Active LOW).
SEL	I	1B or 2B Path Selection. When HIGH during the rising edge of CLK, SEL enables data transfer from 1B Port to A Port. When LOW during the rising edge of CLK, SEL enables data transfer from 2B Port to A Port.
$\overline{OEA}$	I	Synchronous Output Enable for A Port (Active LOW).
$\overline{OEB}$	I	Synchronous Output Enable for 1B Port and 2B Port (Active LOW).

NOTES: 3071 tbl 01
1. On FCT162H272T these pins have "Bus Hold". All other pins are standard inputs, outputs or I/Os.

ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Description	Max.	Unit
V_{TERM}(2)	Terminal Voltage with Respect to GND	–0.5 to +7.0	V
V_{TERM}(3)	Terminal Voltage with Respect to GND	–0.5 to V_{CC} +0.5	V
T_{STG}	Storage Temperature	–65 to +150	°C
I_{OUT}	DC Output Current	–60 to +120	mA

NOTES: 3071 tbl 02
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.

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: 3071 tbl 03
1. This parameter is measured at characterization but not tested.

FUNCTION TABLES(2)

Inputs							Output
1B	2B	SEL	$\overline{CE1B}$	$\overline{CE2B}$	$\overline{OEA}$	CLK	A
H	X	H	L	X	L	↑	H
L	X	H	L	X	L	↑	L
X	X	H	H	X	L	↑	A(1)
X	H	L	X	L	L	↑	H
X	L	L	X	L	L	↑	L
X	X	L	X	H	L	↑	A(1)
X	X	X	X	X	H	↑	Z

3071 tbl 04

Inputs					Outputs	
A	$\overline{CEA1B}$	$\overline{CEA2B}$	$\overline{OEB}$	CLK	1B	2B
H	L	L	L	↑	H	H
L	L	L	L	↑	L	L
H	L	H	L	↑	H	B(1)
L	L	H	L	↑	L	B(1)
H	H	L	L	↑	B(1)	H
L	H	L	L	↑	B(1)	L
X	H	H	L	↑	B(1)	B(1)
X	X	X	H	↑	Z	Z
X	X	X	L	↑	Active	Active

NOTES: 3071 tbl 05
1. Output level before the indicated steady-state input conditions were established.
2. H = HIGH Voltage Level
   L = LOW Voltage Level
   X = Don't Care
   Z = High Impedance
   ↑ = LOW-to-HIGH Transition

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	Bus-Hold Input	V_{CC} = Min.	V_I = 2.0V	–50	—	—	µA
I_{BHL}	Sustain Current[4]			V_I = 0.8V	+50	—	—	
I_{OZH}	High Impedance Output Current		V_{CC} = Max.	V_O = 2.7V	—	—	±1	µA
I_{OZL}	(3-State Output pins)[5,6]			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

3071 tbl 06

OUTPUT DRIVE CHARACTERISTICS FOR FCT162H272T

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

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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 One Output Port Enabled $\overline{CExx}$ = GND One Input Bit Toggling One Output Bit Toggling 50% Duty Cycle	V_{IN} = V_{CC} V_{IN} = GND	—	60	100	µA/ MHz
I_C	Total Power Supply Current[6]	V_{CC} = Max. Outputs Open fi = 10MHz	V_{IN} = V_{CC} V_{IN} = GND	—	0.6	1.5	mA
		50% Duty Cycle One Output Port Enabled $\overline{CExx}$ = GND One Input Bit Toggling One Output Bit Toggling	V_{IN} = 3.4V V_{IN} = GND	—	0.9	2.3	
		V_{CC} = Max. Outputs Open fi = 2.5MHz	V_{IN} = V_{CC} V_{IN} = GND	—	1.8	3.5[5]	
		50% Duty Cycle One Output Port Enabled $\overline{CExx}$ = GND Twelve Input Bits Toggling Twelve Output Bits Toggling	V_{IN} = 3.4V V_{IN} = GND	—	4.8	12.5[5]	

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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 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

SWITCHING CHARACTERISTICS OVER OPERATING RANGE

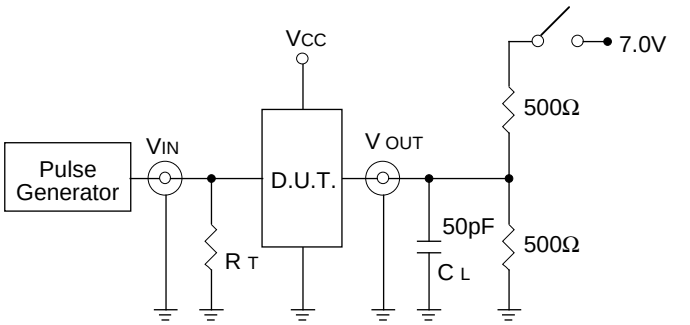
Symbol	Parameter		Condition[1]	FCT162H272AT				FCT162H272CT				FCT162H272ET				Unit
				Com'l.		Mil.		Com'l.		Mil.		Com'l.		Mil.		
				Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	
t_{PLH} t_{PHL}	Propagation Delay CLK to 1Bx or CLK to 2Bx		C_L = 50pF R_L = 500Ω	1.5	5.8	1.5	6.2	1.5	5.2	1.5	5.6	1.5	4.8	—	—	ns
t_{PLH} t_{PHL}	Propagation Delay CLK to Ax	$\overline{SEL}$ Stable $\overline{CE}$xB Enabled		1.5	6.0	1.5	6.4	1.5	5.4	1.5	5.8	1.5	5.0	—	—	ns
		$\overline{SEL}$ Changing $\overline{CE}$xB Disabled		1.5	6.0	1.5	6.4	1.5	5.4	1.5	5.8	1.5	5.4	—	—	ns
		$\overline{SEL}$ Changing $\overline{CE}$xB Enabled		1.5	7.6	1.5	7.9	1.5	6.6	1.5	7.0	1.5	5.6	—	—	ns
t_{PZH} t_{PZL}	Output Enable Time CLK to Ax, CLK to 1Bx, or CLK to 2Bx			1.5	7.7	1.5	8.1	1.5	6.8	1.5	7.2	1.5	6.0	—	—	ns
t_{PHZ} t_{PLZ}	Output Disable Time CLK to Ax, CLK to 1Bx, or CLK to 2Bx			1.5	6.4	1.5	6.8	1.5	6.0	1.5	6.4	1.5	5.6	—	—	ns
t_{SU}	Set-Up Time, HIGH or LOW Data to CLK			2.0	—	2.0	—	2.0	—	2.0	—	2.0	—	—	—	ns
t_{SU}	Set-Up Time, $\overline{OEA}$ to CLK, $\overline{OEB}$ to CLK			2.0	—	2.0	—	2.0	—	2.0	—	2.0	—	—	—	ns
t_{SU}	Set-Up Time, SEL to CLK			2.0	—	2.0	—	2.0	—	2.0	—	2.0	—	—	—	ns
t_{SU}	Set-Up Time, $\overline{CEA1B}$ to CLK, $\overline{CE1B}$ to CLK, $\overline{CE2B}$ to CLK, or $\overline{CEA2B}$ to CLK			2.0	—	2.0	—	2.0	—	2.0	—	2.0	—	—	—	ns
t_H	Hold Time, CLK to Data			0	—	0	—	0	—	0	—	0	—	—	—	ns
t_H	Hold Time, CLK to $\overline{OEA}$, CLK to $\overline{OEB}$, CLK to SEL			0.5	—	0.5	—	0.5	—	0.5	—	0.5	—	—	—	ns
t_H	Hold Time, CLK to $\overline{CEA1B}$, CLK to $\overline{CE1B}$, CLK to $\overline{CE2B}$, CLK to $\overline{CEA2B}$			0	—	0	—	0	—	0	—	0	—	—	—	ns
t_W	Pulse Width, CLK HIGH[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

3071 tbl 10

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



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SWITCH POSITION

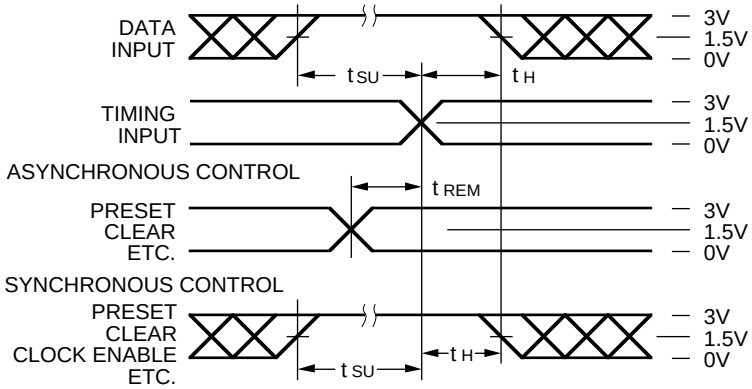
Test	Switch
Open Drain Disable Low Enable Low	Closed
All Other Tests	Open

3032 tbl 11

DEFINITIONS:

C_L = Load capacitance: includes jig and probe capacitance.
R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator.

SET-UP, HOLD AND RELEASE TIMES



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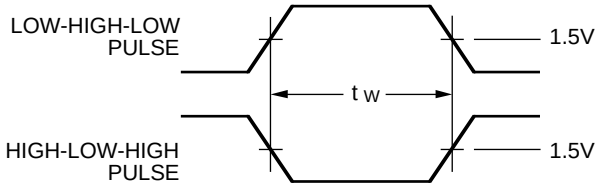
PULSE WIDTH



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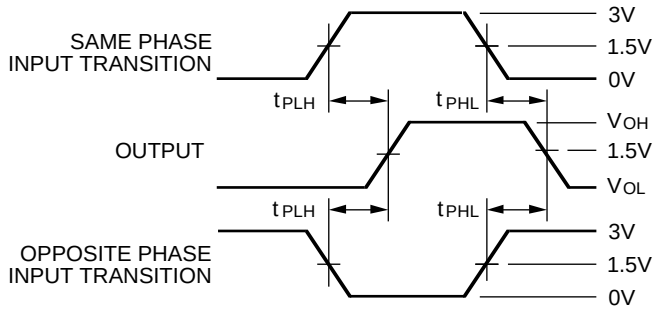
PROPAGATION DELAY



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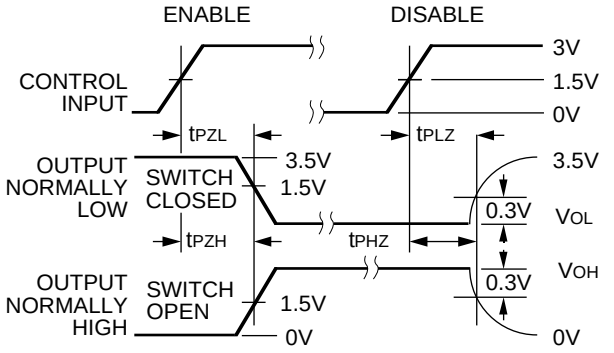
ENABLE AND DISABLE TIMES



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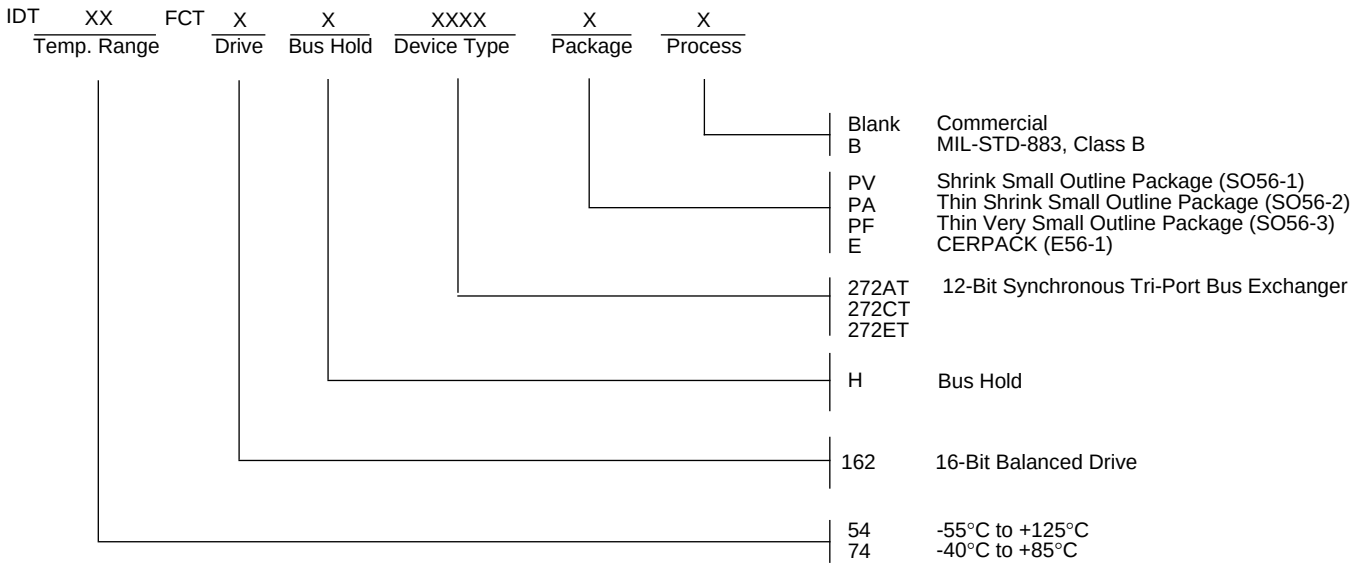
NOTES:

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

ORDERING INFORMATION



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