Integrated Device Technology, Inc.

3.3V CMOS 16-BIT BUS TRANSCEIVER/ REGISTERS

IDT74FCT163646/A/C

FEATURES:

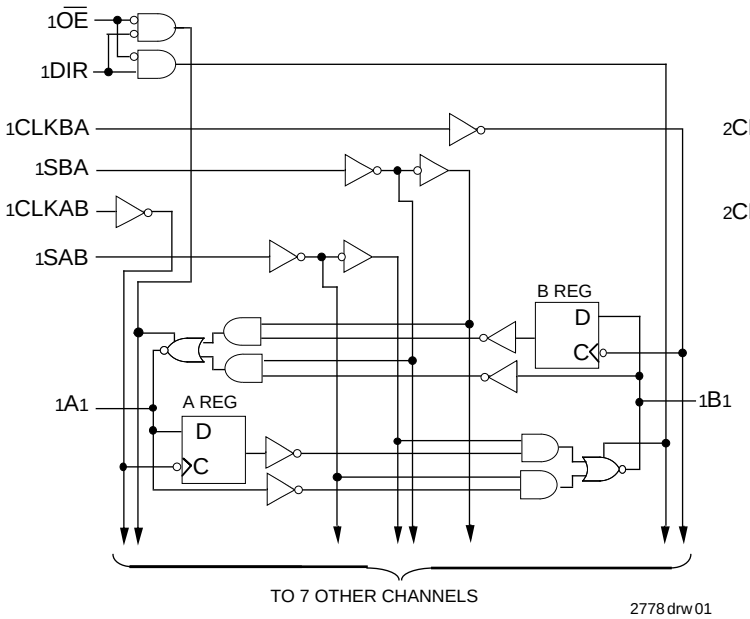
- 0.5 MICRON CMOS Technology
- **Typical $t_{SK(o)}$ (Output Skew) < 250ps**
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- Packages include 25 mil pitch SSOP, 19.6 mil pitch TSSOP and 15.7 mil pitch TVSOP
- Extended commercial range of -40°C to +85°C
- V_{CC} = 3.3V ±0.3V, Normal Range or V_{CC} = 2.7 to 3.6V, Extended Range
- CMOS power levels (0.4µW typ. static)
- Rail-to-Rail output swing for increased noise margin
- Low Ground Bounce (0.3V typ.)
- Inputs (except I/O) can be driven by 3.3V or 5V components

DESCRIPTION:

The FCT163646/A/C 16-bit registered transceivers are built using advanced dual metal CMOS technology. These high-speed, low-power devices are organized as two independant 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 ($x\overline{OE}$) 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 FCT163646/A/C have series current limiting resistors. This offers low ground bounce, minimal undershoot, and controlled output fall times-reducing the need for external series terminating resistors.

FUNCTIONAL BLOCK DIAGRAM



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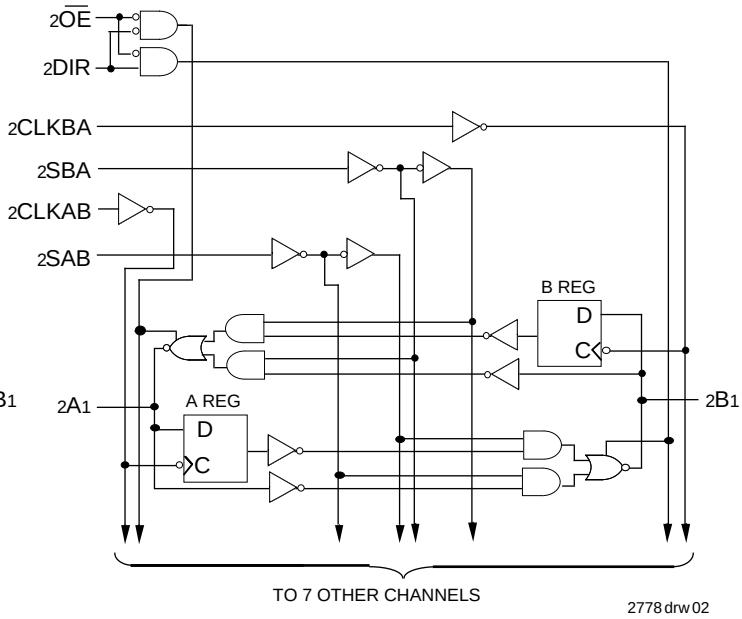

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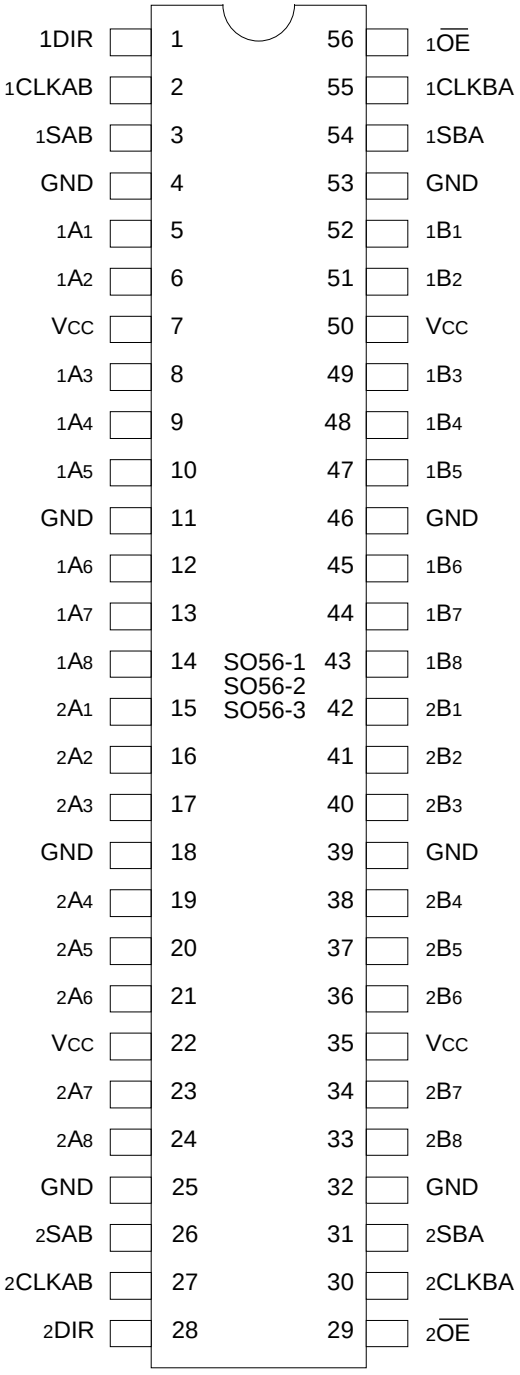
PIN CONFIGURATIONS



SSOP/ TSSOP/TVSOP TOP VIEW

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PIN DESCRIPTION

Pin Names	Description
xAx	Data Register A Inputs Data Register B Outputs
xBx	Data Register B Inputs Data Register A Outputs
xCAB, xCBA	Clock Pulse Inputs
xSAB, xSBA	Output Data Source Select Inputs
xDIR, $x\overline{OE}$	Output Enable Inputs

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ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Description	Max.	Unit
V_{TERM}(2)	Terminal Voltage with Respect to GND	–0.5 to +4.6	V
V_{TERM}(3)	Terminal Voltage with Respect to GND	–0.5 to +7.0	V
V_{TERM}(4)	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 +60	mA

NOTES: 2778 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. Vcc terminals.
3. Input terminals.
4. Output and I/O terminals.

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: 2778 lnk 04

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

FUNCTION TABLE[2]

Inputs						Data I/O[1]		Operation or Function
x$\overline{OE}$	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

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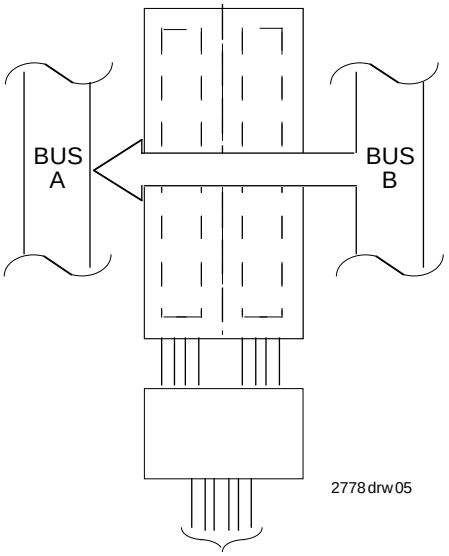
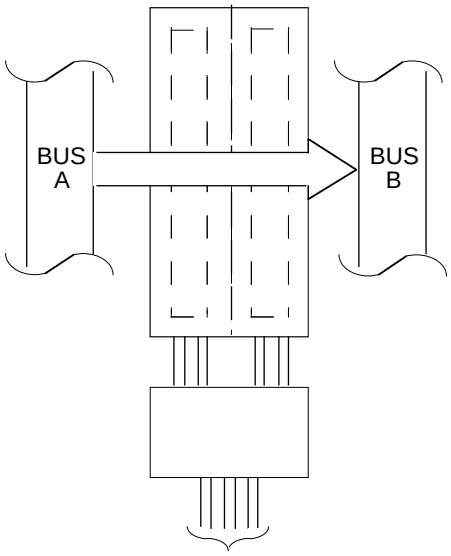
NOTES:
1. The data output functions may be enabled or disabled by various signals at the x$\overline{OE}$ or xDIR inputs. Data input functions are always enabled, i.e. data at the bus pins will be stored on every LOW-to-HIGH transition on the clock inputs.
2. H = HIGH Voltage Level
   L = LOW Voltage Level
   X = Don't Care
   ↑ =LOW-to-HIGH Transition



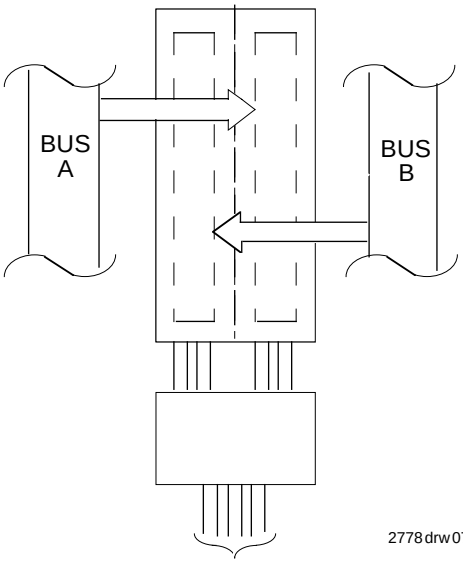
xDIR	xOE	xCLKAB	xCLKBA	xSAB	xSBA
L	L	X	X	X	L

REAL-TIME TRANSFER
BUS B TO A



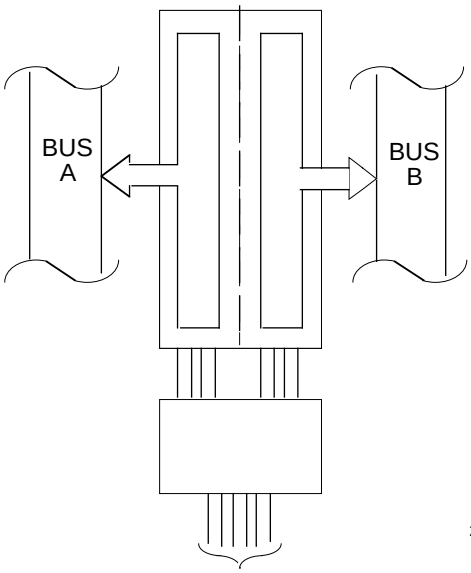
xDIR	xOE	xCLKAB	xCLKBA	xSAB	xSBA
H	L	X	X	L	X

REAL-TIME TRANSFER
BUS A TO B



xDIR	xOE	xCLKAB	xCLKBA	xSAB	xSBA
H	L	↑	X	X	X
L	L	X	↑	X	X
X	H	↑	↑	X	X

STORAGE FROM
A AND/OR B



xDIR (1)	xOE	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°C to +85°C, V_{CC} = 2.7V to 3.6V

Symbol	Parameter	Test Conditions[1]		Min.	Typ.[2]	Max.	Unit
V_{IH}	Input HIGH Level (Input pins)	Guaranteed Logic HIGH Level		2.0	—	5.5	V
	Input HIGH Level (I/O pins)			2.0	—	V_{CC}+0.5	
V_{IL}	Input LOW Level (Input and I/O pins)	Guaranteed Logic LOW Level		–0.5	—	0.8	V
I_{IH}	Input HIGH Current (Input pins)	V_{CC} = Max.	V_I = 5.5V	—	—	±1	µA
	Input HIGH Current (I/O pins)		V_I = V_{CC}	—	—	±1	
I_{IL}	Input LOW Current (Input pins)		V_I = GND	—	—	±1	
	Input LOW Current (I/O pins)		V_I = GND	—	—	±1	
I_{OZH}	High Impedance Output Current	V_{CC} = Max.	V_O = V_{CC}	—	—	±1	µA
I_{OZL}	(3-State Output pins)		V_O = GND	—	—	±1	
V_{IK}	Clamp Diode Voltage	V_{CC} = Min., I_{IN} = –18mA		—	–0.7	–1.2	V
I_{ODH}	Output HIGH Current	V_{CC} = 3.3V, V_{IN} = V_{IH} or V_{IL}, V_O = 1.5V[3]		–36	–60	–110	mA
I_{ODL}	Output LOW Current	V_{CC} = 3.3V, V_{IN} = V_{IH} or V_{IL}, V_O = 1.5V[3]		50	90	200	mA
V_{OH}	Output HIGH Voltage	V_{CC} = Min.	I_{OH} = –0.1mA	V_{CC}–0.2	—	—	V
		V_{IN} = V_{IH} or V_{IL}	I_{OH} = –3mA	2.4	3.0	—	
		V_{CC} = 3.0V, V_{IN} = V_{IH} or V_{IL}	I_{OH} = –8mA	2.4[5]	3.0	—	
V_{OL}	Output LOW Voltage	V_{CC} = Min.	I_{OL} = 0.1mA	—	—	0.2	V
		V_{IN} = V_{IH} or V_{IL}	I_{OL} = 16mA	—	0.2	0.4	
			I_{OL} = 24mA	—	0.3	0.55	
		V_{CC} = 3.0V, V_{IN} = V_{IH} or V_{IL}	I_{OL} = 24mA	—	0.3	0.50	
I_{OS}	Short Circuit Current[4]	V_{CC} = Max., V_O = GND[3]		–60	–135	–240	mA
V_H	Input Hysteresis	—		—	150	—	mV
I_{CCL} I_{CCH} I_{CCZ}	Quiescent Power Supply Current	V_{CC} = Max., V_{IN} = GND or V_{CC}		—	0.1	10	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 = 3.3V, +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. This parameter is guaranteed but not tested.
5. V_{OH} = V_{CC} –0.6V at rated current.

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.	$V_{IN} = V_{CC} - 0.6V$[3]	—	2.0	30	µA
I_{CCD}	Dynamic Power Supply Current[4]	V_{CC} = Max. Outputs Open xDIR = x$\overline{OE}$= GND 50% Duty Cycle One Input Toggling	$V_{IN} = V_{CC}$ V_{IN} = GND	—	60	100	µA/ MHz
I_C	Total Power Supply Current[6]	V_{CC} = Max. Outputs Open f_{CP} = 10MHz (xCLKBA) 50% Duty Cycle xDIR = x$\overline{OE}$ = GND	$V_{IN} = V_{CC}$ V_{IN} = GND	—	0.6	1.0	mA
		fi = 5MHz 50% Duty Cycle One Bit Toggling	$V_{IN} = V_{CC} - 0.6V$ V_{IN} = GND	—	0.6	1.0	
		V_{CC} = Max. Outputs Open f_{CP} = 10MHz (xCLKBA) 50% Duty Cycle xDIR = x$\overline{OE}$ = GND	$V_{IN} = V_{CC}$ V_{IN} = GND	—	3.0	5.0[5]	
		fi = 2.5MHz 50% Duty Cycle Sixteen Bits Toggling	$V_{IN} = V_{CC} - 0.6V$ V_{IN} = GND	—	3.0	5.3[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} = 3.3V, +25°C ambient.
3. Per TTL driven input; 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
   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[4]

Symbol	Parameter	Condition[1]	FCT163646		FCT163646A		FCT163646C		Unit
			Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	
t_{PLH} t_{PHL}	Propagation Delay Bus to Bus	C_L = 50pF R_L = 500Ω	2.0	9.0	2.0	6.3	1.5	5.4	ns
t_{PZH} t_{PZL}	Output Enable Time xDIR or x$\overline{OE}$ to Bus		2.0	14.0	2.0	9.8	1.5	7.8	ns
t_{PHZ} t_{PLZ}	Output Disable Time xDIR or x$\overline{OE}$ to Bus		2.0	9.0	2.0	6.3	1.5	6.3	ns
t_{PLH} t_{PHL}	Propagation Delay Clock to Bus		2.0	9.0	2.0	6.3	1.5	5.7	ns
t_{PLH} t_{PHL}	Propagation Delay xSBA or xSAB to Bus		2.0	11.0	2.0	7.7	1.5	6.2	ns
t_{SU}	Set-up Time HIGH or LOW Bus to Clock		4.0	—	2.0	—	2.0	—	ns
t_H	Hold Time HIGH or LOW Bus to Clock		2.0	—	1.5	—	1.5	—	ns
t_W	Clock Pulse Width HIGH or LOW		6.0	—	5.0	—	5.0	—	ns
$t_{SK}(o)$	Output Skew[3]		—	0.5	—	0.5	—	0.5	ns

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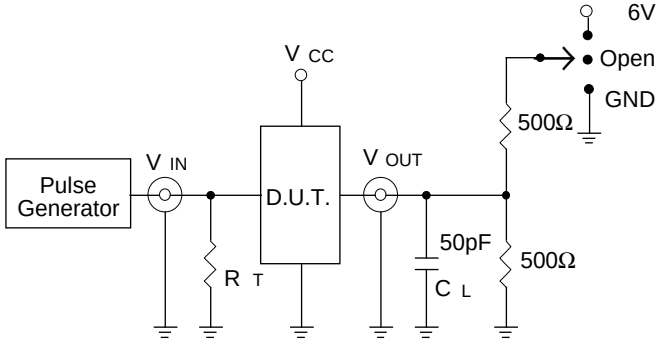
NOTES:
1. See test circuit and waveforms.
2. Minimum limits are guaranteed but not tested on Propagation Delays.
3. Skew between any two outputs, of the same package, switching in the same direction. This parameter is guaranteed by design.
4. Propagation Delays and Enable/Disable times are with V_{CC} = 3.3V ±0.3V, Normal Range. For V_{CC} = 2.7V to 3.6V, Extended Range, all Propagation Delays and Enable/Disable times should be degraded by 20%.

TEST CIRCUITS AND WAVEFORMS

TEST CIRCUITS FOR ALL OUTPUTS



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SWITCH POSITION

Test	Switch
Open Drain Disable Low Enable Low	6V
Disable High Enable High	GND
All Other tests	Open

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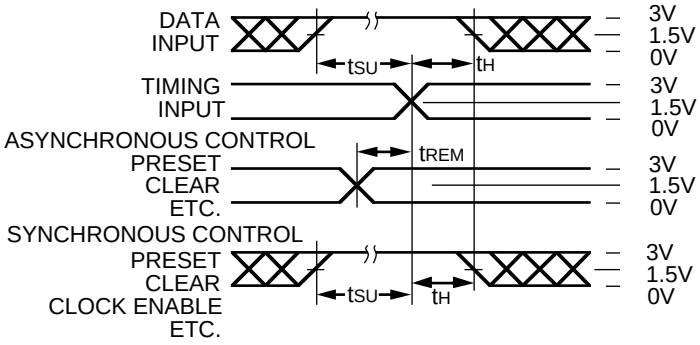
DEFINITIONS:

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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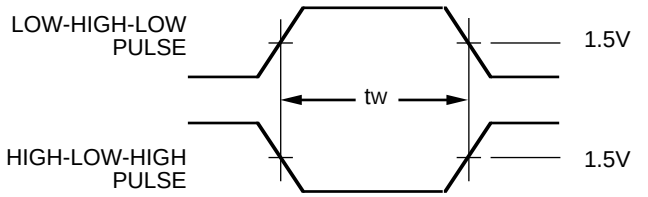
PULSE WIDTH



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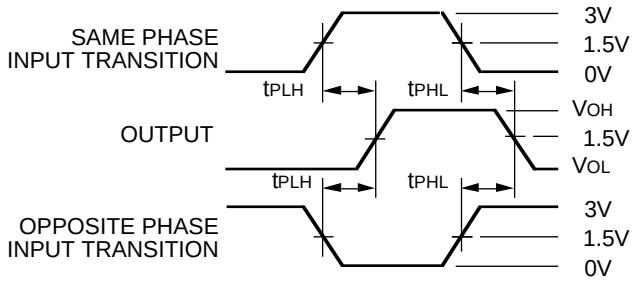
PROPAGATION DELAY



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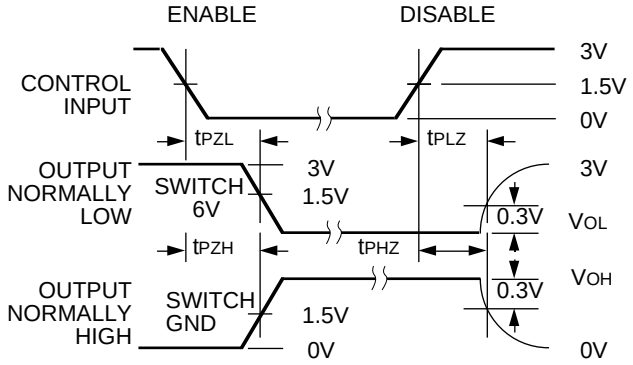
ENABLE AND DISABLE TIMES



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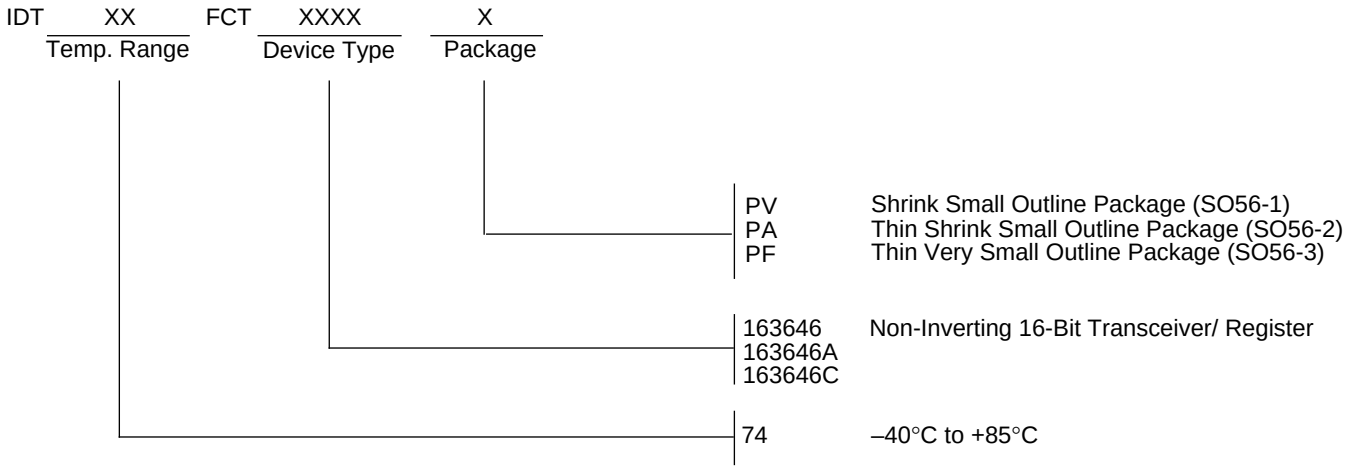
NOTES:

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.
3. If V_{CC} is below 3V, input voltage swings should be adjusted not to exceed V_{CC}.

ORDERING INFORMATION



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