



Integrated Device Technology, Inc.

3.3V CMOS OCTAL TRANSCIVER/ REGISTERS (3-STATE)

IDT54/74FCT3646/A
IDT54/74FCT3648/A
IDT54/74FCT3651/A
IDT54/74FCT3652/A
PRODUCT PREVIEW

FEATURES:

- 0.5 MICRON CMOS Technology
- ESD > 2000V per MIL-STD-883, Method 3015;
> 200V using machine model (C = 200pF, R = 0)
- 25 mil Center SSOP Packages
- Extended commercial range of -40°C to +85°C
- Vcc = 3.3V ±0.3V, Normal Range or
Vcc = 2.7V to 3.6V, Extended Range
- CMOS power levels (10μW typ. static)
- Rail-to-Rail output swing for increased noise margin
- Military product compliant to MIL-STD-883, Class B

DESCRIPTION:

The IDT54/74FCT3646/A, IDT54/74FCT3648/A, IDT54/74FCT3651/A and IDT54/74FCT3652/A consist of a bus transceiver with 3-state D-type flip-flops and control circuitry arranged for multiplexed transmission of data directly from the

data bus or from the internal storage registers.

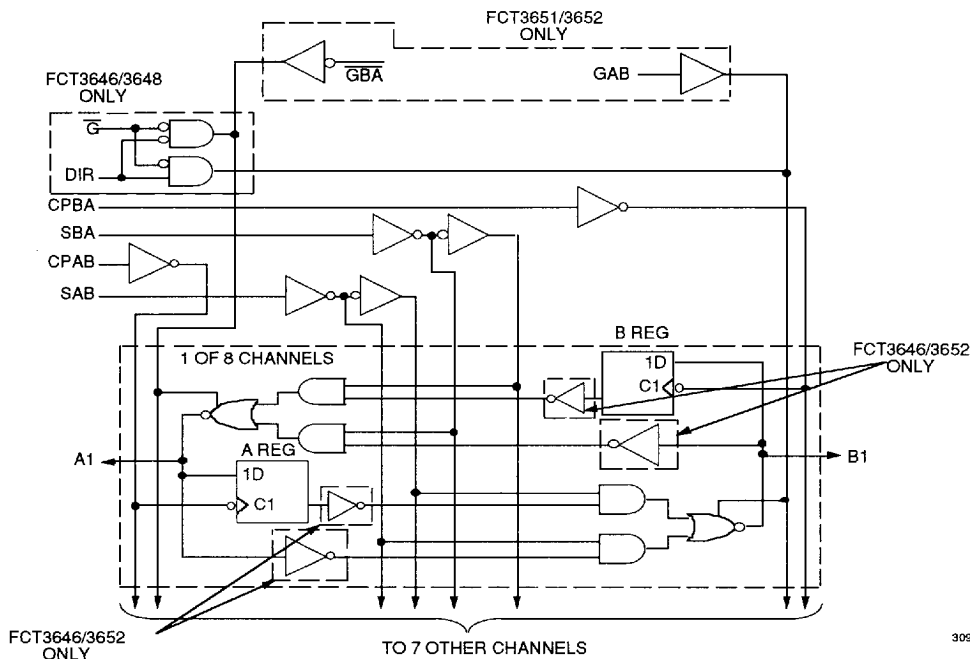
The FCT3651/3652 utilize GAB and GBA signals to control the transceiver functions. The FCT3646/3648 utilize the enable control ($\bar{G}$) and direction (DIR) pins to control the transceiver functions.

SAB and SBA control pins are provided to select either real-time or stored data transfer. The circuitry used for select control will eliminate the typical decoding glitch that occurs in a multiplexer during the transition between stored and real-time data. A LOW input level selects real-time data and a HIGH selects stored data.

Data on the A or B data bus, or both, can be stored in the internal D flip-flops by LOW-to-HIGH transitions at the appropriate clock pins (CPAB or CPBA), regardless of the select or enable control pins.

The IDT54/74FCT3xxx/A have series current limiting resistors. These offer 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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MILITARY AND COMMERCIAL TEMPERATURE RANGES

APRIL 1994

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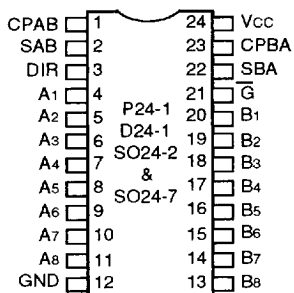
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PIN CONFIGURATIONS

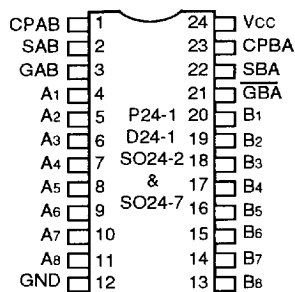
FCT3646/3648



DIP/SOIC/SSOP
TOP VIEW

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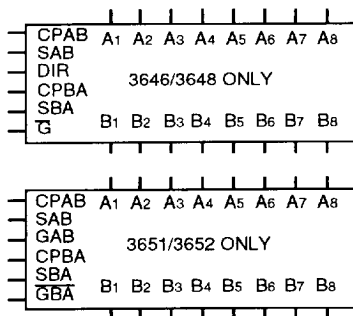
FCT3651/3652



DIP/SOIC/SSOP
TOP VIEW

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LOGIC SYMBOLS



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PIN DESCRIPTION

Pin Names	Description
A1 - A8	Data Register A Inputs Data Register B Outputs
B1 - B8	Data Register B Inputs Data Register A Outputs
CPAB, CPBA	Clock Pulse Inputs
SAB, SBA	Output Data Source Select Inputs
DIR, G	Output Enable Inputs (3646/3648)
GAB, GBA	Output Enable Inputs (3651/3652)

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FUNCTION TABLE (3646/3648)

Inputs						Data I/O ⁽¹⁾		Operation or Function	
$\bar{G}$	DIR	CPAB	CPBA	SAB	SBA	A ₁ - A ₈	B ₁ - B ₈	FCT3646	FCT3648
H	X	H or L	H or L	X	X	Input	Input	Isolation	Isolation
H	X	↑	↑	X	X			Store A and B Data	Store A and B Data
L	L	X	X	X	L	Output	Input	Real-Time B Data to A Bus	Real-Time $\bar{B}$ Data to A Bus
L	L	X	H or L	X	H			Stored B Data to A Bus	Stored $\bar{B}$ Data to A Bus
L	H	X	X	L	X	Input	Output	Real-Time A Data to B Bus	Real-Time $\bar{A}$ Data to B Bus
L	H	H or L	X	H	X			Stored A Data to B Bus	Stored $\bar{A}$ Data to B Bus

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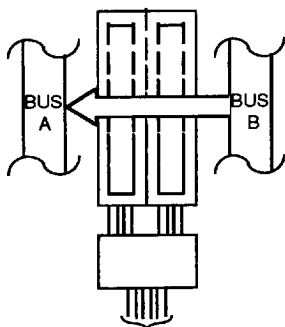
FUNCTION TABLE (3651/3652)

Inputs						Data I/O		Operation or Function	
GAB	$\bar{G}\bar{B}\bar{A}$	CPAB	CPBA	SAB	SBA	A ₁ - A ₈	B ₁ - B ₈	FCT3651	FCT3652
L	H	H or L	H or L	X	X	Input	Input	Isolation	Isolation
L	H	↑	↑	X	X			Store A and B Data	Store A and B Data
X	H	↑	H or L	X	X	Input	Unspecified ⁽¹⁾	Store A, Hold B	Store A, Hold B
H	H	↑	↑	X ⁽²⁾	X	Input	Output	Store A in Both Registers ⁽³⁾	Store A in Both Registers
L	X	H or L	↑	X	X	Unspecified ⁽¹⁾	Input	Hold A, Store B	Hold A, Store B
L	L	↑	↑	X	X ⁽²⁾	Output	Input	Store B in Both Registers ⁽⁴⁾	Store B in Both Registers
L	L	X	X	X	L	Output	Input	Real-Time $\bar{B}$ Data to A Bus	Real-Time B Data to A Bus
L	L	X	H or L	X	H			Stored $\bar{B}$ Data to A Bus	Stored B Data to A Bus
H	H	X	X	L	X	Input	Output	Real-Time $\bar{A}$ Data to B Bus	Real-Time A Data to B Bus
H	H	H or L	X	H	X			Stored $\bar{A}$ Data to B Bus	Stored A Data to B Bus
H	L	H or L	H or L	H	H	Output	Output	Stored $\bar{A}$ Data to B Bus and Stored $\bar{B}$ Data to A Bus	Stored A Data to B Bus and Stored B Data to A Bus

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NOTES:

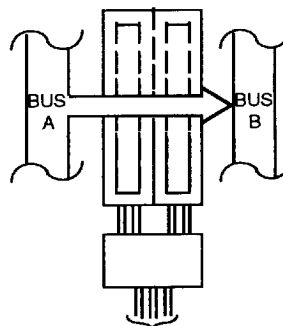
1. The data output functions may be enabled or disabled by various signals at the GAB or $\bar{G}\bar{B}\bar{A}$ inputs. Data input functions are always enabled, i.e. data at the bus pins will be stored on every LOW-to-HIGH transition on the clock inputs.
2. Select control = L: clocks can occur simultaneously.
Select control = H: clocks must be staggered in order to load both registers.
H = HIGH, L = LOW, X = Don't Care, ≠ = LOW-to-HIGH transition.
3. $\bar{A}$ in B Register.
4. $\bar{B}$ in A Register.



3651/3652	GAB	$\overline{GBA}$	CPAB	CPBA	SAB	SBA
	L	L	X	X	X	L
3646/3648	DIR	$\overline{G}$	CPAB	CPBA	SAB	SBA
	L	L	X	X	X	L

REAL-TIME TRANSFER
 BUS B TO A

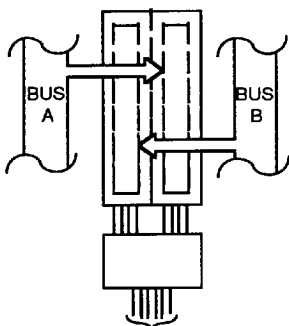
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3651/3652	GAB	$\overline{GBA}$	CPAB	CPBA	SAB	SBA
	H	H	X	X	L	X
3646/3648	DIR	$\overline{G}$	CPAB	CPBA	SAB	SBA
	H	L	X	X	L	X

REAL-TIME TRANSFER
 BUS A TO B

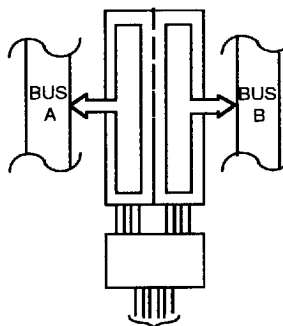
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3651/3652	GAB	$\overline{GBA}$	CPAB	CPBA	SAB	SBA
	X	H	↑	X	X	X
	L	X	X	↑	X	X
	L	H	↑	↑	X	X
3646/3648	DIR	$\overline{G}$	CPAB	CPBA	SAB	SBA
	H	L	↑	X	X	X
	L	L	X	↑	X	X
	X	H	↑	↑	X	X

STORAGE FROM
 A AND/OR B

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3651/3652	GAB	$\overline{GBA}$	CPAB	CPBA	SAB	SBA
	H	L	H or	H or	H	H
3646/3648 ⁽¹⁾	DIR	$\overline{G}$	CPAB	CPBA	SAB	SBA
	L	L	X	H or	X	H
	H	L	H or	X	H	X

TRANSFER STORES
 DATA TO A AND/OR B

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NOTE:

1. FCT3646/3648 cannot transfer data to A bus and B bus simultaneously.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

Symbol	Rating	Commercial	Military	Unit
VTERM ⁽²⁾	Terminal Voltage with Respect to GND	−0.5 to +4.6	−0.5 to +4.6	V
VTERM ⁽³⁾	Terminal Voltage with Respect to GND	−0.5 to +7.0	−0.5 to +7.0	V
VTERM ⁽⁴⁾	Terminal Voltage with Respect to GND	−0.5 to Vcc + 0.5	−0.5 to Vcc + 0.5	V
TA	Operating Temperature	−40 to +85	−55 to +125	°C
TBIAS	Temperature Under Bias	−55 to +125	−65 to +135	°C
TSTG	Storage Temperature	−55 to +125	−65 to +150	°C
PT	Power Dissipation	1.0	1.0	W
IOUT	DC Output Current	−60 to +60	−60 to +60	mA

- NOTES:
- 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.
 - Vcc terminals.
 - Input terminals.
 - Output and I/O terminals.

CAPACITANCE (TA = +25°C, f = 1.0MHz)

Symbol	Parameter ⁽¹⁾	Conditions	Typ.	Max.	Unit
CIN	Input Capacitance	VIN = 0V	3.5	6.0	pF
COUT	Output Capacitance	VOUT = 0V	4.0	8.0	pF

- NOTE:
- This parameter is measured at characterization but not tested.

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Commercial: $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, $V_{CC} = 2.7\text{V}$ to 3.6V ; Military: $T_A = -55^{\circ}\text{C}$ to $+125^{\circ}\text{C}$, $V_{CC} = 2.7\text{V}$ 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) ⁽⁶⁾	$V_{CC} = \text{Max.}$	$V_I = 5.5\text{V}$	—	—	± 1	μA
	Input HIGH Current (I/O pins) ⁽⁶⁾		$V_I = V_{CC}$	—	—	± 1	
I_{IL}	Input LOW Current (Input pins) ⁽⁶⁾		$V_I = \text{GND}$	—	—	± 1	
	Input LOW Current (I/O pins) ⁽⁶⁾		$V_I = \text{GND}$	—	—	± 1	
I_{OZH}	High Impedance Output Current	$V_{CC} = \text{Max.}$	$V_O = V_{CC}$	—	—	± 1	μA
I_{OZL}	(3-State Output pins) ⁽⁶⁾		$V_O = \text{GND}$	—	—	± 1	
V_{IK}	Clamp Diode Voltage	$V_{CC} = \text{Min.}, I_{IN} = -18\text{mA}$		—	-0.7	-1.2	V
I_{ODH}	Output HIGH Current	$V_{CC} = 3.3\text{V}, V_{IN} = V_{IH} \text{ or } V_{IL}, V_O = 1.5\text{V}^{(3)}$		-36	-60	-110	mA
I_{ODL}	Output LOW Current	$V_{CC} = 3.3\text{V}, V_{IN} = V_{IH} \text{ or } V_{IL}, V_O = 1.5\text{V}^{(3)}$		50	90	200	mA
V_{OH}	Output HIGH Voltage	$V_{CC} = \text{Min.}$	$I_{OH} = -0.1\text{mA}$	$V_{CC}-0.2$	—	—	V
		$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -3\text{mA}$	2.4	3.0	—	
		$V_{CC} = 3.0\text{V}$	$I_{OH} = -6\text{mA MIL.}$	2.4 ⁽⁵⁾	3.0	—	
		$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -8\text{mA COM'L.}$				
V_{OL}	Output LOW Voltage	$V_{CC} = \text{Min.}$	$I_{OL} = 0.1\text{mA}$	—	—	0.2	V
		$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 16\text{mA}$	—	0.2	0.4	
			$I_{OL} = 24\text{mA}$	—	0.3	0.5	
I_{OS}	Short Circuit Current ⁽⁴⁾	$V_{CC} = \text{Max.}, V_O = \text{GND}^{(3)}$		-60	-135	-240	mA
V_H	Input Hysteresis	—		—	150	—	mV
I_{CCL}	Quiescent Power Supply Current	$V_{CC} = \text{Max.}, V_{IN} = \text{GND or } V_{CC}$	COM'L.	—	0.1	10	μA
I_{CCH}							
I_{CCZ}			MIL.	—	0.1	100	

NOTES:

- For conditions shown as Max. or Min., use appropriate value specified under Electrical Characteristics for the applicable device type.
- Typical values are at $V_{CC} = 3.3\text{V}$, $+25^{\circ}\text{C}$ ambient.
- Not more than one output should be tested at one time. Duration of the test should not exceed one second.
- This parameter is guaranteed but not tested.
- $V_{OH} = V_{CC} - 0.6\text{V}$ at rated current.
- The test limits for this parameter is $\pm 5\mu\text{A}$ at $T_A = -55^{\circ}\text{C}$.

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POWER SUPPLY CHARACTERISTICS

Symbol	Parameter	Test Conditions ⁽¹⁾		Min.	Typ. ⁽²⁾	Max.	Unit
ΔI_{CC}	Quiescent Power Supply Current	$V_{CC} = \text{Max.}$	$V_{IN} = V_{CC} - 0.6V^{(3)}$				μA
I_{CCD}	Dynamic Power Supply Current ⁽⁴⁾	$V_{CC} = \text{Max.}$ Outputs Open $GAB = \overline{GBA} = GND$ or $\overline{G} = \overline{DIR} = GND$ One Input Toggling 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = GND$				$\mu A / MHz$
I_C	Total Power Supply Current ⁽⁶⁾	$V_{CC} = \text{Max.}$ Outputs Open $f_{CP} = 10MHz$ 50% Duty Cycle $GAB = \overline{GBA} = GND$ or $\overline{G} = \overline{DIR} = GND$ One Bit Toggling at $f_i = 5MHz$ 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = GND$				mA
			$V_{IN} = V_{CC} - 0.6V$ $V_{IN} = GND$				
		$V_{CC} = \text{Max.}$ Outputs Open $f_{CP} = 10MHz$ 50% Duty Cycle $GAB = \overline{GBA} = GND$ or $\overline{G} = \overline{DIR} = GND$ Eight Bits Toggling at $f_i = 5MHz$ 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = GND$				
			$V_{IN} = V_{CC} - 0.6V$ $V_{IN} = GND$				

- NOTES:**
- For conditions shown as max. or min., use appropriate value specified under Electrical Characteristics for the applicable device type.
 - Typical values are at $V_{CC} = 3.3V$, $+25^{\circ}C$ ambient.
 - Per TTL driven input; all other inputs at V_{CC} or 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.
 - $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
 $I_C = I_{CC} + \Delta I_{CC} D_{HNT} + I_{CCD} (f_{CP} N_{CP} / 2 + f_i N_i)$
 $I_{CC} = \text{Quiescent Current (} I_{CC1}, I_{CC2} \text{ and } I_{CC3} \text{)}$
 $\Delta I_{CC} = \text{Power Supply Current for a TTL High Input}$
 $D_H = \text{Duty Cycle for TTL Inputs High}$
 $N_T = \text{Number of TTL Inputs at } D_H$
 $I_{CCD} = \text{Dynamic Current Caused by an Input Transition Pair (HLH or LHL)}$
 $f_{CP} = \text{Clock Frequency for Register Devices (Zero for Non-Register Devices)}$
 $N_{CP} = \text{Number of Clock Inputs at } f_{CP}$
 $f_i = \text{Input Frequency}$
 $N_i = \text{Number of Inputs at } f_i$

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SWITCHING CHARACTERISTICS OVER OPERATING RANGE⁽³⁾

Timing Characteristics Over Operating Range											
Symbol	Parameter	Condition ⁽¹⁾	FCT3646/3648/ 3651/3652				FCT3646A/3648A/ 3651A/3652A				Unit
			Com'l.		Mil.		Com'l.		Mil.		
			Min. ⁽²⁾	Max.	Min. ⁽²⁾	Max.	Min. ⁽²⁾	Max.	Min. ⁽²⁾	Max.	
tPLH	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
tPHL	Output Enable Time, $\bar{G}$, DIR to Bus (646, 648 only)		2.0	14.0	2.0	15.0	2.0	9.8	2.0	10.5	ns
tPZH	Output Enable Time, GAB, GBA to Bus (651, 652 only)		2.0	14.0	2.0	15.0	2.0	9.8	2.0	10.5	ns
tPZL	Output Disable Time, $\bar{G}$, DIR to Bus (646, 648 only)		2.0	9.0	2.0	11.0	2.0	6.3	2.0	7.7	ns
tPHZ	Output Disable Time, GAB, GBA to Bus (651, 652 only)		2.0	9.0	2.0	11.0	2.0	6.3	2.0	7.7	ns
tPLH	Propagation Delay Clock to Bus		2.0	9.0	2.0	10.0	2.0	6.3	2.0	7.0	ns
tPHL	Propagation Delay SBA or SAB 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

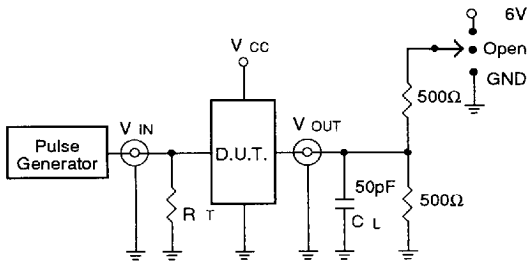
NOTES:

- See test circuit and waveforms.
- Minimum limits are guaranteed but not tested on Propagation Delays.
- Propagation Delays and Enable/Disable times are with $V_{CC} = 3.3V \pm 0.3V$, Normal Range. For $V_{CC} = 2.7V$ to $3.6V$, Extended Range, all Propagation Delays and Enable/Disable times should be degraded by 20%.

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TEST CIRCUITS AND WAVEFORMS

TEST CIRCUITS FOR ALL OUTPUTS



3094 drw 09

SWITCH POSITION

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

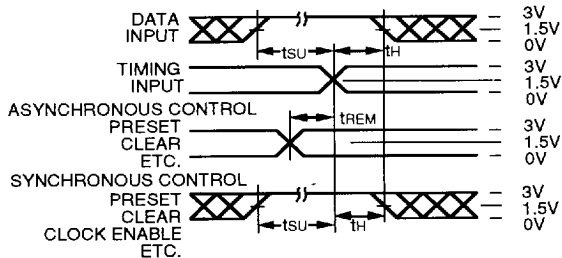
DEFINITIONS:

CL = Load capacitance; includes jig and probe capacitance.

RT = Termination resistance; should be equal to ZOUT of the Pulse Generator.

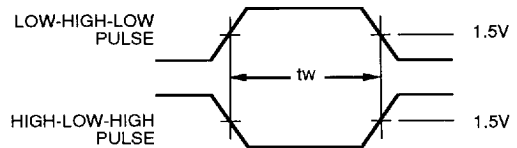
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SET-UP, HOLD AND RELEASE TIMES



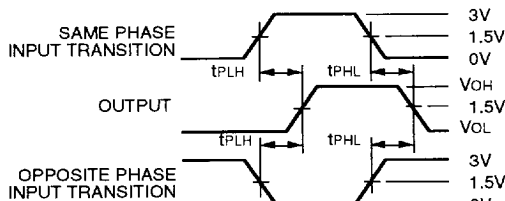
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PULSE WIDTH



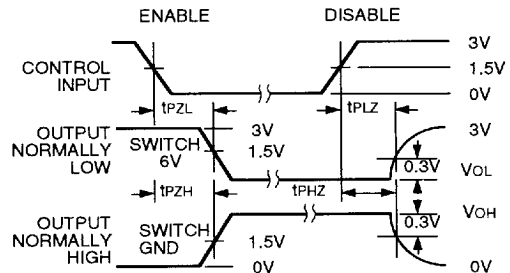
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PROPAGATION DELAY



3094 drw 12

ENABLE AND DISABLE TIMES



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NOTES:

- Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.
- Pulse Generator for All Pulses: Rate $\leq 1.0\text{MHz}$; $t_r \leq 2.5\text{ns}$; $t_f \leq 2.5\text{ns}$.
- If V_{CC} is below 3V, input voltage swings should be adjusted not to exceed V_{CC} .

ORDERING INFORMATION

IDT	XX	FCT	X	XX	X	X	
Temp. Range			Family	Device Type	Package	Process	
							Blank
							B
							P
							D
							SO
							PY
							646
							648
							651
							652
							646A
							648A
							651A
							652A
							3
							54
							74

Commercial
 MIL-STD-883, Class B

Plastic DIP (P20-1)
 CERDIP (D20-1)
 Small Outline IC (SO20-2)
 Shrink Small Outline Package (SO20-7)

Non-Inverting Octal Transceiver/Register
 Inverting Octal Transceiver/Register
 Inverting Octal Transceiver/Register
 Non-Inverting Octal Transceiver/Register

3.3 Volt

-55°C to +125°C
 -40°C to +85°C

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