



Integrated Device Technology, Inc.

# FAST CMOS 18-BIT R/W BUFFER

IDT54/74FCT162701T/AT

## FEATURES:

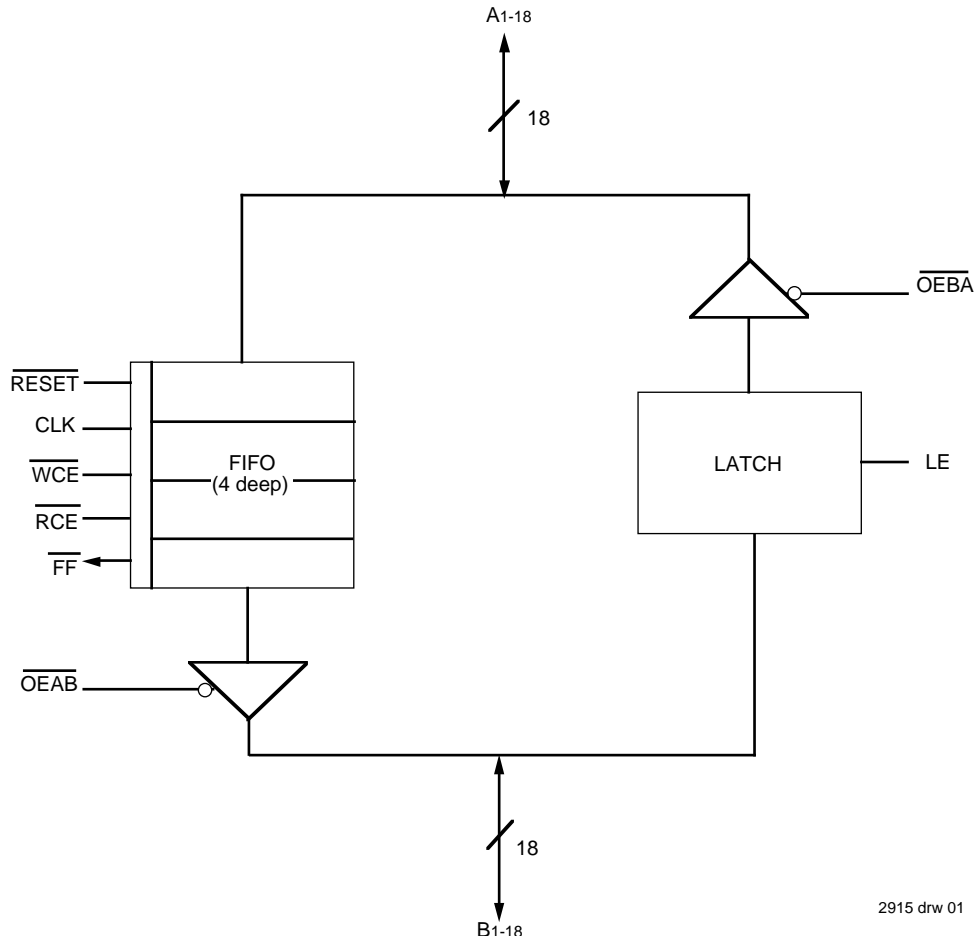
- 0.5 MICRON CMOS Technology
- **Typical tsk(o) (Output Skew) < 250ps**
- **Low input and output leakage  $\leq 1\mu\text{A}$  (max.)**
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- Packages include 25 mil pitch SSOP, 19.6 mil pitch TSSOP, 15.7 mil pitch TVSOP and 25 mil pitch Cerpack
- Extended commercial range of -40°C to +85°C
- Balanced Output Drivers:  $\pm 24\text{mA}$  (commercial),  $\pm 16\text{mA}$  (military)
- Reduced system switching noise
- Typical VOLP (Output Ground Bounce) < 0.6V at VCC = 5V, TA = 25°C
- Ideal for new generation x86 write-back cache solutions
- Suitable for modular x86 architectures
- Four deep write FIFO
- Latch in read path
- Synchronous FIFO reset

## DESCRIPTION:

The FCT162701T/AT is an 18-bit Read/Write buffer with a four deep FIFO and a read-back latch. It can be used as a read/write buffer between a CPU and memory or to interface a high-speed bus and a slow peripheral. The A-to-B (write) path has a four deep FIFO for pipelined operations. The FIFO can be reset and a FIFO full condition is indicated by the full flag ( $\overline{\text{FF}}$ ). The B-to-A (read) path has a latch. A HIGH on LE, allows data to flow transparently from B-to-A. A LOW on LE allows the data to be latched on the falling edge of LE.

The FCT162701T/AT has a balanced output drive with series termination. This provides low ground bounce, minimal undershoot and controlled output edge rates.

## FUNCTIONAL BLOCK DIAGRAM

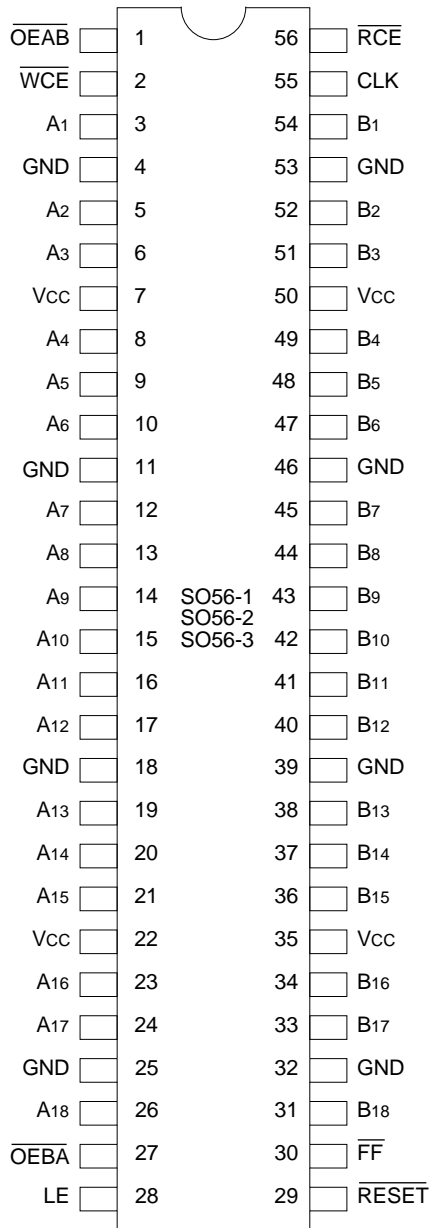


The IDT logo is a registered trademark of Integrated Device Technology, Inc.

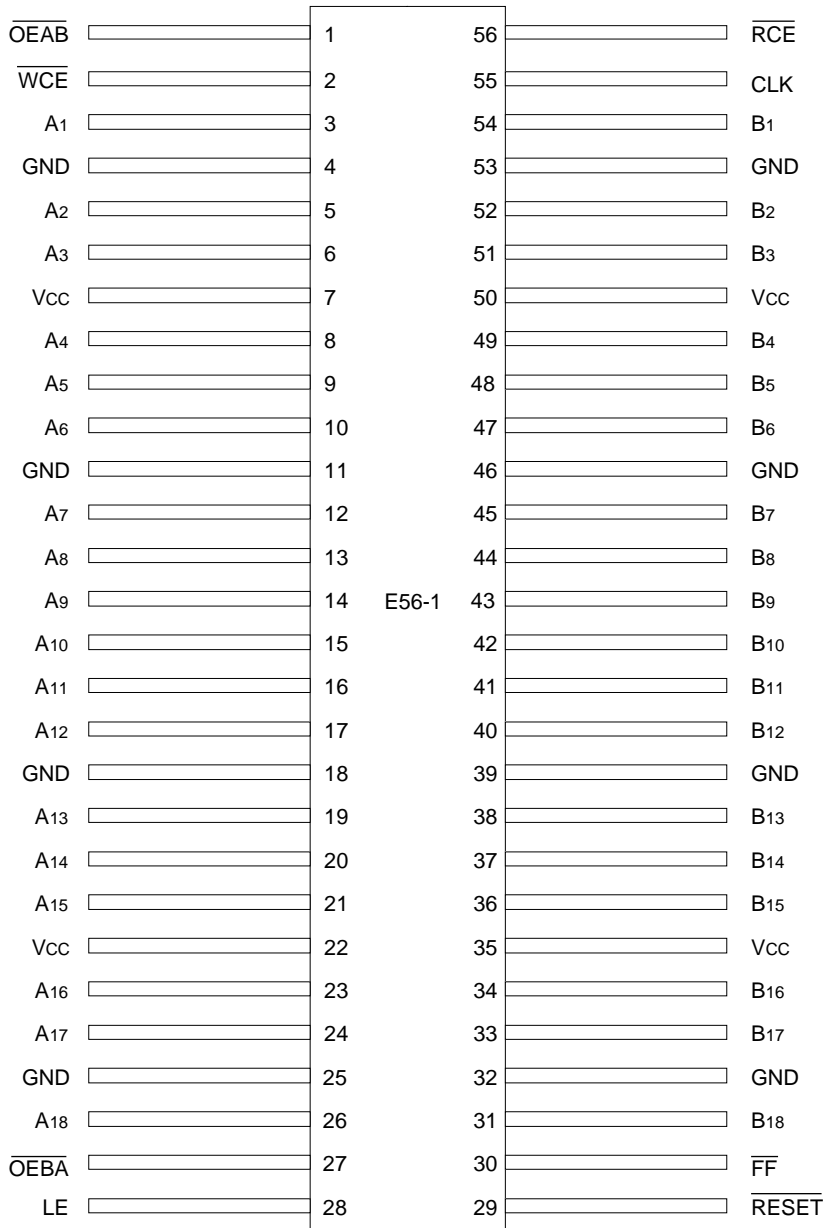
**MILITARY AND COMMERCIAL TEMPERATURE RANGES**

**AUGUST 1996**

**PIN CONFIGURATIONS**



SSOP/  
TSSOP/TVSOP  
TOP VIEW 2915 drw 02



CERPACK  
TOP VIEW 2915 drw 03

## PIN DESCRIPTION

Pin Names	I/O	Description
A1-18	I/O	18 bit I/O port.
B1-18	I/O	18 bit I/O port.
CLK	I	Clock for write path FIFO. Clocks data into FIFO when $\overline{WCE}$ is low, clocks data out of FIFO when $\overline{RCE}$ is low. When FIFO is full all further writes to the FIFO are inhibited. When FIFO is empty all reads from the FIFO are inhibited. CLK also resets the FIFO when $\overline{RESET}$ is low.
$\overline{WCE}$	I	Enable pin for FIFO input clock.
$\overline{RCE}$	I	Enable pin for FIFO output clock.
$\overline{FF}$	O	Write path FIFO full flag. Goes low when FIFO is full.
$\overline{RESET}$	I	Synchronous FIFO reset - when low CLK resets the FIFO. The FIFO pointers are initialized to the "empty" condition and FIFO output is forced high (all ones). The FIFO full flag ( $\overline{FF}$ ) will be high immediately after reset.
$\overline{OEAB}$	I	Output Enable pin for B port.
$\overline{OEBA}$	I	Output Enable pin for A port.
LE	I	Read path latch enable pin. When high, data flows transparently from B port to A port, B data is latched on the falling edge of LE.

2915 tbl 01

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Symbol	Description	Max.	Unit
V <sub>TERM</sub> (2)	Terminal Voltage with Respect to GND	-0.5 to +7.0	V
V <sub>TERM</sub> (3)	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

2915 lmk 02

### 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.
- All device terminals except FCT162XXXXT Output and I/O terminals.
- Output and I/O terminals for FCT162XXXXT.

## 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>I/O</sub>	I/O Capacitance	V <sub>OUT</sub> = 0V	3.5	8.0	pF

2915 lmk 03

### NOTE:

- This parameter is measured at characterization but not tested.

### FUNCTIONAL DESCRIPTION:

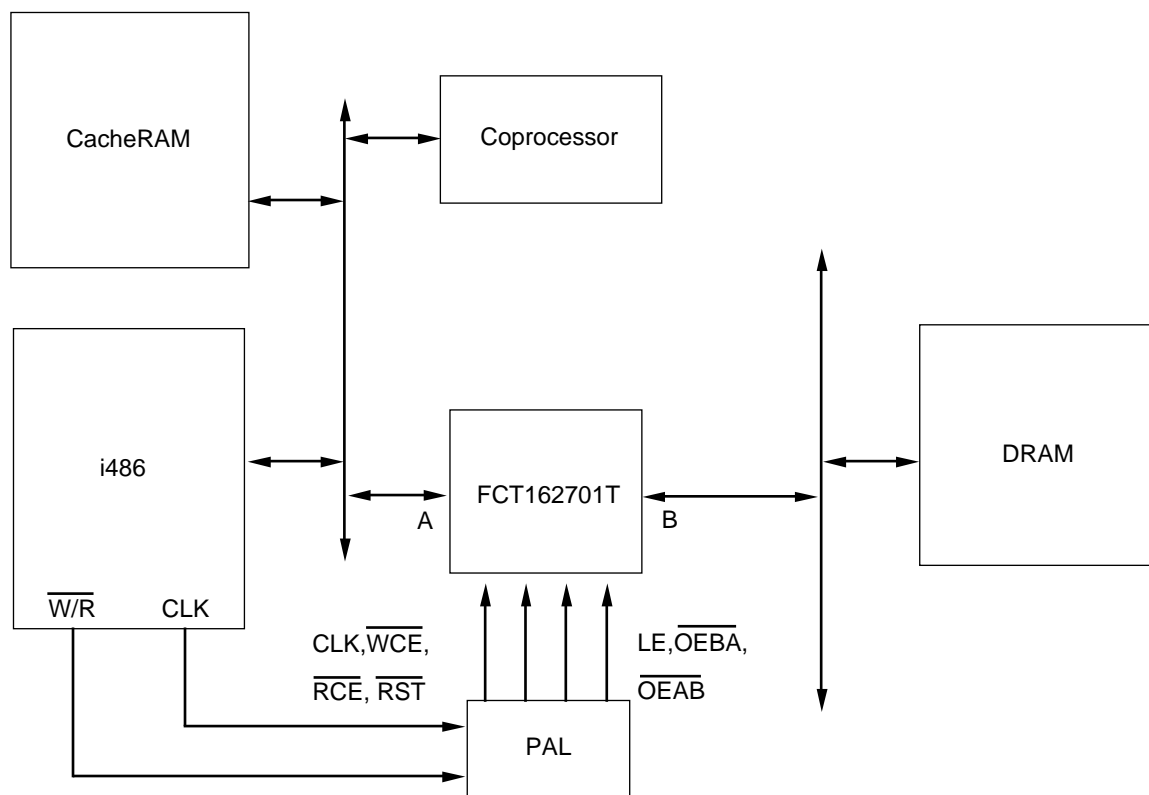
This device is useful as a read/write buffer for modular high end designs. It provides multi-level buffering in the write path and single deep buffering in the read path, and is suited to write back cache implementation. The read path provides a transparent latch.

The four deep FIFO uses one clock with two clock enable pins,  $\overline{WCE}$  and  $\overline{RCE}$  to clock data in and out. The FIFO has an external full flag which goes LOW when the FIFO is full. Internal read and write pointers keep track of the words stored in the FIFO. A write attempt to a full FIFO is ignored. An attempt to read from an empty FIFO will have no effect and the last read data remains at the output of the FIFO. The FIFO may be reset by the synchronous  $\overline{RESET}$  input. This resets

the read and write pointers to the original "empty" condition and also sets all B outputs = 1. Simultaneous read and write attempts (clock data into FIFO as well as clock data out of FIFO) are possible except on FIFO empty and full boundaries. When the FIFO is empty, and a simultaneous read and write is attempted, the read is ignored while the write is executed. If the same is attempted when the FIFO is full, the write is ignored while the read is executed. Normal operation of the four deep FIFO in the write path is independent of the read path operation.

Power, ground and data pin positions on the FCT162701T match those on the FCT16501T/162501T, allowing an easy upgrade.

### APPLICATIONS: 486 INTERFACE



2915 drw 04

Figure 1. FCT162701T Application Example

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified:

Commercial:  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = 5.0\text{V} \pm 10\%$ ; 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 (Input pins) <sup>(5)</sup>	$V_{CC} = \text{Max.}$	$V_I = V_{CC}$	—	—	$\pm 1$	$\mu\text{A}$
	Input HIGH Current (I/O pins) <sup>(5)</sup>			—	—	$\pm 1$	
$I_{IL}$	Input LOW Current (Input pins) <sup>(5)</sup>	$V_{CC} = \text{Max.}$	$V_I = \text{GND}$	—	—	$\pm 1$	
	Input LOW Current (I/O pins) <sup>(5)</sup>			—	—	$\pm 1$	
$I_{OZH}$	High Impedance Output Current (3-State Output pins) <sup>(5)</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	$\mu\text{A}$

2915 Ink 04

## OUTPUT DRIVE CHARACTERISTICS

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

2915 Ink 05

### 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  $V_{CC} = 5.0\text{V}$ ,  $+25^{\circ}\text{C}$  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  $\pm 5\mu\text{A}$  at  $T_A = -55^{\circ}\text{C}$ .

## 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	
$I_{CCD}(\text{CLK})$	Dynamic Power Supply Current due to clock switching <sup>(4)</sup>	$V_{CC} = \text{Max.}$ Outputs Open	CLK Toggling 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	180	240	$\mu\text{A}/$ MHz
$I_{CCD}(\text{O/P})$	Dynamic Power Supply Current due to output switching <sup>(4)</sup>		One Bit Toggling 50% Duty Cycle		—	80	120	
$I_C$	Total Power Supply Current <sup>(6)</sup>	$V_{CC} = \text{Max.}$ Outputs Open $f_{CP} = 10\text{MHz}$ 50% Duty Cycle $\overline{OEAB} = \text{GND}; \overline{OEBA} = V_{CC}$ $LE = \overline{WCE} = \overline{RCE} = \text{GND}$ $\overline{RESET} = V_{CC}$ All Inputs Low	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	1.8	2.9 <sup>(5)</sup>	mA	
			$V_{IN} = 3.4V$ $V_{IN} = \text{GND}$	—	2.1	3.7 <sup>(5)</sup>		
			$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	2.2	3.5		
			$V_{IN} = 3.4V$ $V_{IN} = \text{GND}$	—	2.7	5.0		

### NOTES:

2915 tbl 06

- 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.
- $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$   
 $I_C = I_{CC} + \Delta I_{CC} D_{HNT} + I_{CCD}(\text{CLK}) \times f_{CP} + I_{CCD}(\text{O/P}) \times f_o \times N_o$   
 $I_{CC} = \text{Quiescent Current (} I_{CCL}, I_{CCH} \text{ and } I_{CCZ})$   
 $\Delta I_{CC} = \text{Power Supply Current for a TTL High Input (} V_{IN} = 3.4V)$   
 $D_H = \text{Duty Cycle for TTL Inputs High}$   
 $N_T = \text{Number of TTL Inputs at } D$   
 $I_{CCD} = \text{Dynamic Current Caused by an Input Transition Pair (HLH or LHL)}$   
 $f_{CP} = \text{Clock Frequency for Register Devices (Zero for Non-Register Devices)}$   
 $f_o = \text{Output Frequency}$   
 $N_o = \text{Number of Outputs at } f_o$

## SWITCHING CHARACTERISTICS OVER OPERATING RANGE

Parameter		Test Conditions <sup>(1)</sup>	FCT162701T		FCT162701AT		Unit
			Min. <sup>(2)</sup>	Max. <sup>(2)</sup>	Min. <sup>(2)</sup>	Max. <sup>(2)</sup>	
<b>PROPAGATION DELAYS</b>							
1	B1-18 to A 1-18	Read path/latch	1.5	6.5	1.5	5.5	ns
2	LE (Low to Hi) to A 1-18	Read path/latch	1.5	5.7	1.5	4.7	ns
3	CLK to $\overline{FF}$	Write path	2	7.0	2	6.0	ns
4	CLK to B1-18	Write path	1	6.0	1	5.2	ns
<b>SETUP &amp; HOLD TIMES<sup>(3)</sup></b>							
5	A1-18 to CLK (Low to Hi) Setup	Write path	2.5	—	2.5	—	ns
6	A1-18 to CLK (Low to Hi) Hold	Write path	0	—	0	—	ns
7	B1-18 to LE (Hi to Low) Setup	Read path/latch	3	—	3	—	ns
8	B1-18 to LE (Hi to Low) Hold	Read path/latch	0	—	0	—	ns
9	$\overline{WCE}$ , $\overline{RCE}$ (Low) to CLK Setup	Write path	3	—	3	—	ns
10	$\overline{WCE}$ , $\overline{RCE}$ (Low) to CLK Hold	Write path	0	—	0	—	ns
11	$\overline{RESET}$ (Low) to CLK Setup	Write path	3	—	3	—	ns
12	$\overline{RESET}$ (Low) to CLK Hold	Write path	0	—	0	—	ns
<b>ENABLE &amp; DISABLE TIMES<sup>(3)</sup></b>							
13	$\overline{OEBA}$ Low to A1-18 Enable	Write path	1.5	7.0	1.5	6.0	ns
14	$\overline{OEBA}$ High to A1-18 Disable	Write path	1.5	6.0	1.5	5.0	ns
15	$\overline{OEAB}$ Low to B1-18 Enable	Read path	1.5	7.0	1.5	6.0	ns
16	$\overline{OEAB}$ High to B1-18 Disable	Read path	1.5	6.0	1.5	5.0	ns
<b>MINIMUM PULSE WIDTHS</b>							
17	CLK HIGH or LOW Pulse Width	Write path	3.0	—	3.0	—	ns
18	LE HIGH Pulse Width	Read path/latch	3.0	—	3.0	—	ns

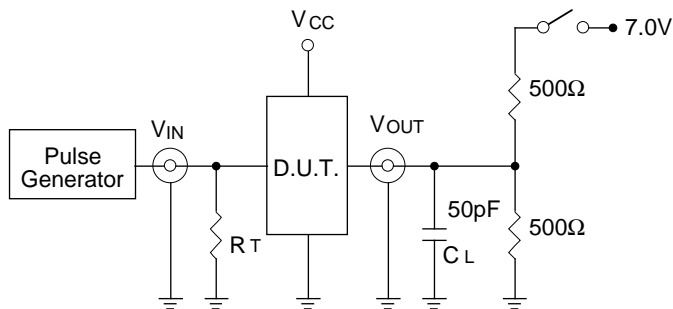
**NOTES:**

1. See test circuit and waveforms.
2. Minimum limits are guaranteed but not tested on Propagation Delays.
3. Guaranteed but not tested.

2915 tbl 07

## TEST CIRCUITS AND WAVEFORMS

### TEST CIRCUITS FOR ALL OUTPUTS



2915 drw 04

### SWITCH POSITION

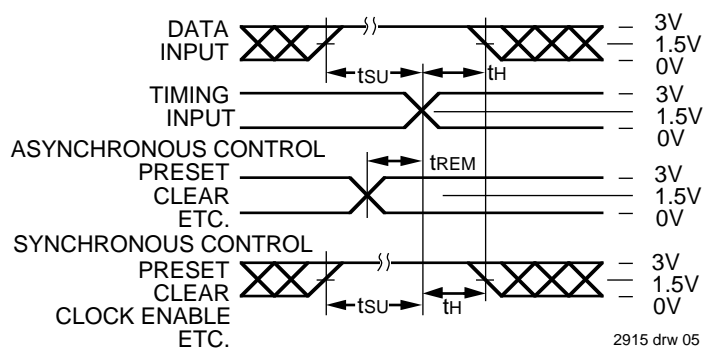
Test	Switch
Open Drain Disable Low Enable Low	Closed
All Other Tests	Open

#### DEFINITIONS:

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

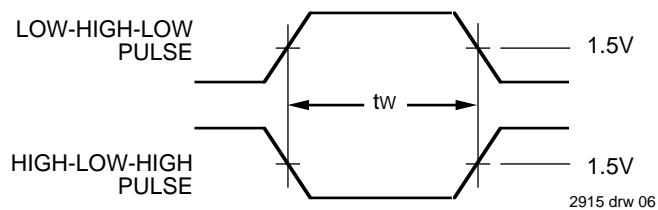
2915 Ink 07

### SET-UP, HOLD AND RELEASE TIMES



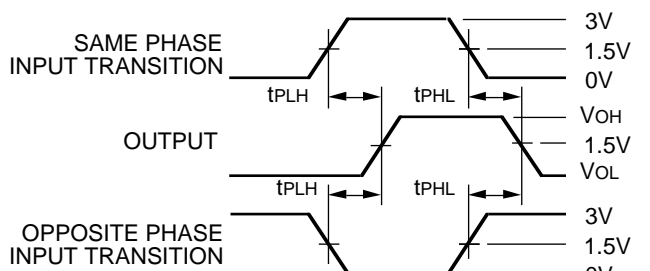
2915 drw 05

### PULSE WIDTH



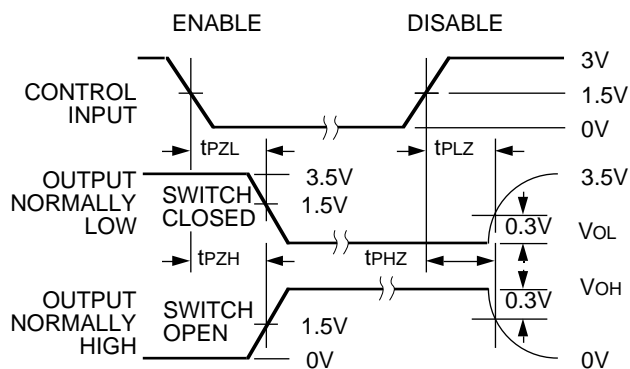
2915 drw 06

### PROPAGATION DELAY



2915 drw 07

### ENABLE AND DISABLE TIMES



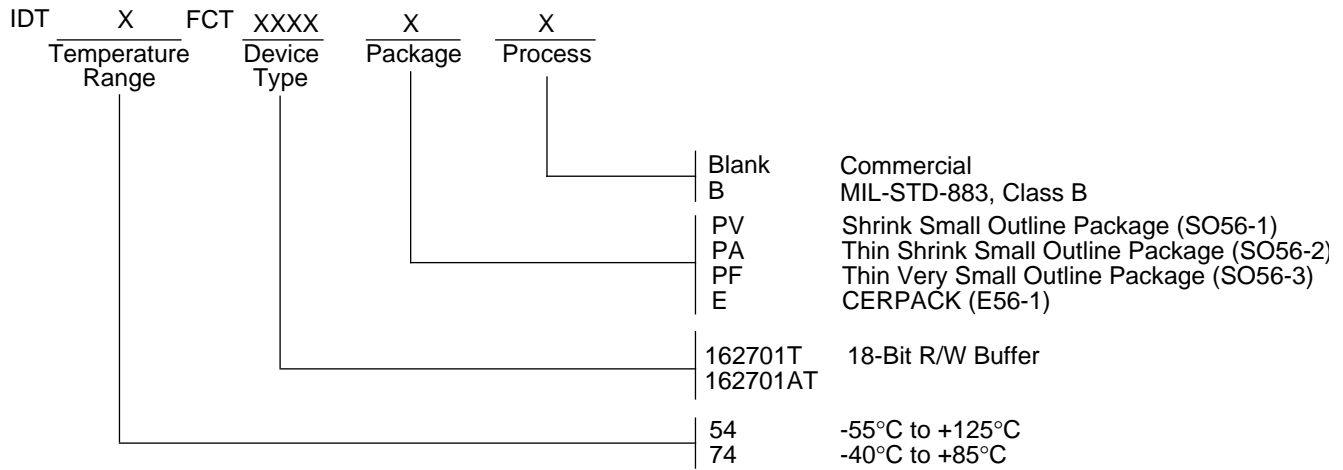
2915 drw 08

#### NOTES:

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



**ORDERING INFORMATION**



2915 drw 09