



Integrated Device Technology, Inc.

### 3.3V CMOS 16-BIT REGISTERED TRANSCEIVER

IDT74FCT163952A/B/C

#### FEATURES:

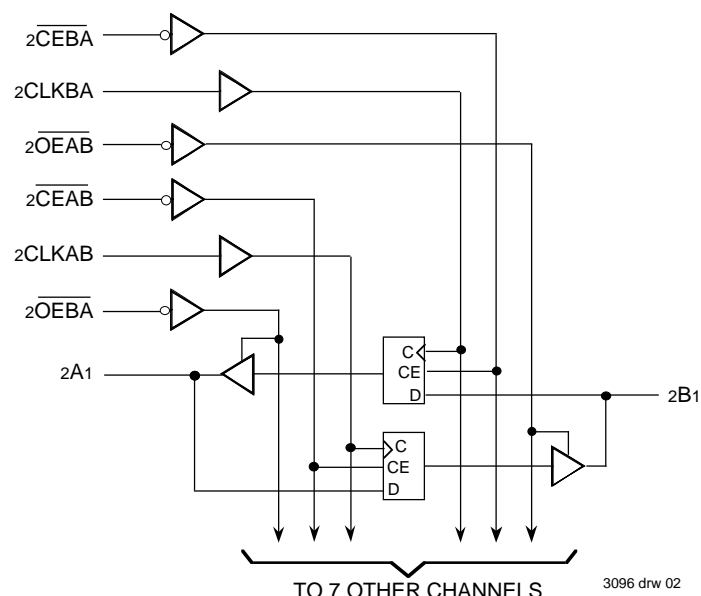
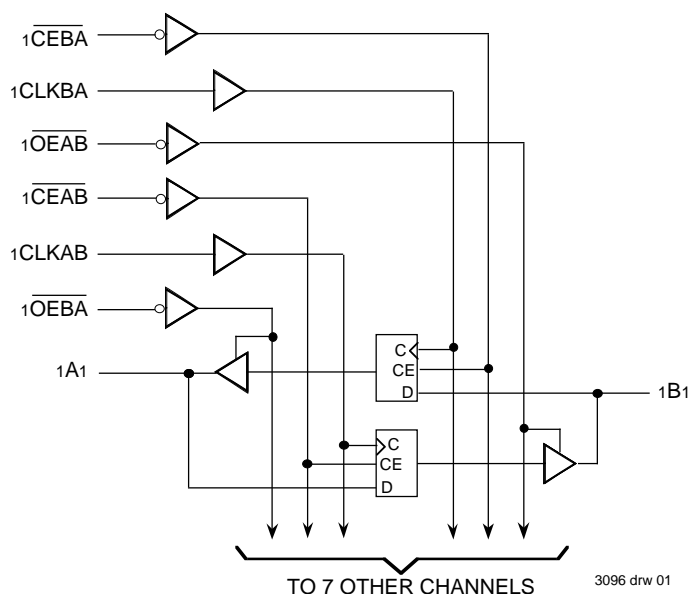
- 0.5 MICRON CMOS Technology
- **Typical  $t_{sk(o)}$  (Output Skew) < 250ps**
- ESD > 2000V per MIL-STD-883, Method 3015; > 200V using machine model (C = 200pF, R = 0)
- Packages include 25 mil pitch SSOP, 19.6 mil pitch TSSOP and 15.7 mil pitch TVSOP
- Extended commercial range of -40°C to +85°C
- VCC = 3.3V ±0.3V, Normal Range or VCC = 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 FCT163952A/B/C 16-bit registered transceivers are built using advanced dual metal CMOS technology. These high-speed, low-power devices are organized as two independent 8-bit D-type registered transceivers with separate input and output control for independent control of data flow in either direction. For example, the A-to-B Enable ( $\overline{xCEAB}$ ) must be LOW to enter data from the A port.  $\overline{xCLKAB}$  controls the clocking function. When  $\overline{xCLKAB}$  toggles from LOW-to-HIGH, the data present on the A port will be clocked into the register.  $\overline{xOEAB}$  performs the output enable function on the B port. Data flow from the B port to A port is similar but requires using  $\overline{xCEBA}$ ,  $\overline{xCLKBA}$ , and  $\overline{xOEBA}$  inputs. Full 16-bit operation is achieved by tying the control pins of the independent transceivers together.

The FCT163952A/B/C 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

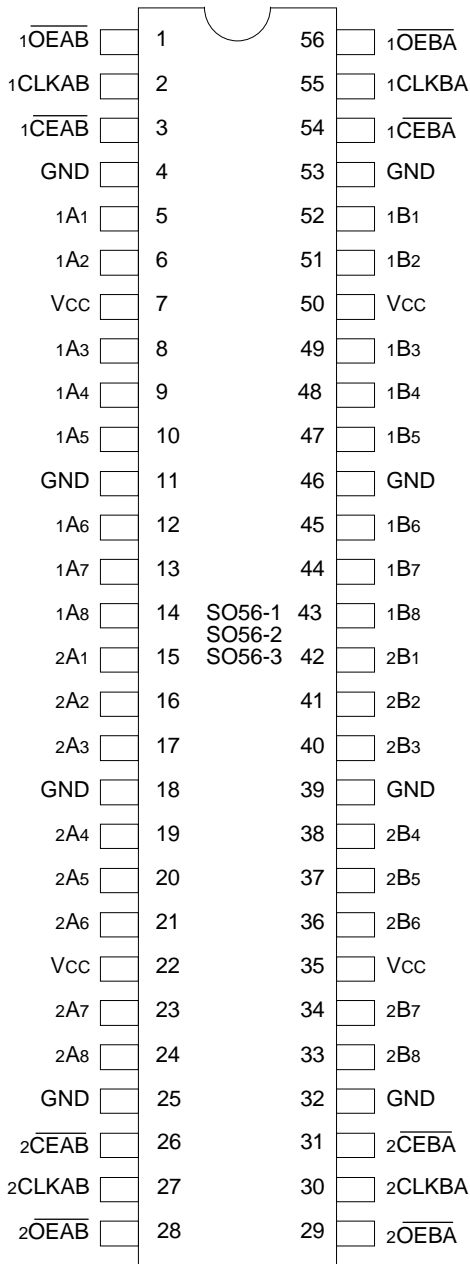


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COMMERCIAL TEMPERATURE RANGE

AUGUST 1996

### PIN CONFIGURATIONS



SSOP/  
TSSOP/TVSOP  
TOP VIEW 3096 drw 03

### CAPACITANCE (TA = +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

NOTE: 1. This parameter is measured at characterization but not tested. 3096 lnk 04

### PIN DESCRIPTION

Pin Names	Description
x $\overline{OEAB}$	A-to-B Output Enable Input (Active LOW)
x $\overline{OEBA}$	B-to-A Output Enable Input (Active LOW)
x $\overline{CEAB}$	A-to-B Clock Enable Input (Active LOW)
x $\overline{CEBA}$	B-to-A Clock Enable Input (Active LOW)
xCLKAB	A-to-B Clock Input
xCLKBA	B-to-A Clock Input
xAx	A-to-B Data Inputs or B-to-A 3-State Outputs
xBx	B-to-A Data Inputs or A-to-B 3-State Outputs

3096 tbl 01

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

Symbol	Description	Max.	Unit
V <sub>TERM</sub> <sup>(2)</sup>	Terminal Voltage with Respect to GND	-0.5 to +4.6	V
V <sub>TERM</sub> <sup>(3)</sup>	Terminal Voltage with Respect to GND	-0.5 to +7.0	V
V <sub>TERM</sub> <sup>(4)</sup>	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 +60	mA

NOTES: 3096 lnk 03

- 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.
- V<sub>CC</sub> terminals.
- Input terminals.
- Output and I/O terminals.

### FUNCTION TABLE<sup>(1,3)</sup>

Inputs				Outputs
x $\overline{CEAB}$	xCLKAB	x $\overline{OEAB}$	xAx	xBx
H	X	L	X	B <sup>(2)</sup>
X	L	L	X	B <sup>(2)</sup>
L	↑	L	L	L
L	↑	L	H	H
X	X	H	X	Z

NOTES: 3096 tbl 02

- A-to-B data flow is shown: B-to-A data flow is similar but uses, x $\overline{CEBA}$ , xCLKBA, and x $\overline{OEBA}$ .
- Level of B before the indicated steady-state input conditions were established.
- H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Don't Care  
↑ = LOW-to-HIGH Transition  
Z = High-impedance

## 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  $3.6\text{V}$

Symbol	Parameter	Test Conditions <sup>(1)</sup>		Min.	Typ. <sup>(2)</sup>	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)	$V_{CC} = \text{Max.}$	$V_I = 5.5\text{V}$	—	—	$\pm 1$	$\mu\text{A}$
	Input HIGH Current (I/O pins)		$V_I = V_{CC}$	—	—	$\pm 1$	
$I_{IL}$	Input LOW Current (Input pins)		$V_I = \text{GND}$	—	—	$\pm 1$	
	Input LOW Current (I/O pins)		$V_I = \text{GND}$	—	—	$\pm 1$	
$I_{OZH}$	High Impedance Output Current (3-State Output pins)	$V_{CC} = \text{Max.}$	$V_O = V_{CC}$	—	—	$\pm 1$	$\mu\text{A}$
$I_{OZL}$			$V_O = \text{GND}$	—	—	$\pm 1$	
$V_{IK}$	Clamp Diode Voltage	$V_{CC} = \text{Min.}, I_{IN} = -18\text{mA}$		—	-0.7	-1.2	V
$I_{ODH}$	Output HIGH Current	$V_{CC} = 3.3\text{V}, V_{IN} = V_{IH}$ or $V_{IL}, V_O = 1.5\text{V}^{(3)}$		-36	-60	-110	mA
$I_{ODL}$	Output LOW Current	$V_{CC} = 3.3\text{V}, V_{IN} = V_{IH}$ or $V_{IL}, V_O = 1.5\text{V}^{(3)}$		50	90	200	mA
$V_{OH}$	Output HIGH Voltage	$V_{CC} = \text{Min.}$ $V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -0.1\text{mA}$	$V_{CC}-0.2$	—	—	V
			$I_{OH} = -3\text{mA}$	2.4	3.0	—	
			$I_{OH} = -8\text{mA}$	$2.4^{(5)}$	3.0	—	
$V_{OL}$	Output LOW Voltage	$V_{CC} = \text{Min.}$ $V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 0.1\text{mA}$	—	—	0.2	V
			$I_{OL} = 16\text{mA}$	—	0.2	0.4	
			$I_{OL} = 24\text{mA}$	—	0.3	0.55	
		$V_{CC} = 3.0\text{V}$ $V_{IN} = V_{IH}$ or $V_{IL}$	—	0.3	0.50		
$I_{OS}$	Short Circuit Current <sup>(4)</sup>	$V_{CC} = \text{Max.}, V_O = \text{GND}^{(3)}$		-60	-135	-240	mA
$V_H$	Input Hysteresis	—		—	150	—	mV
$I_{CCL}$ $I_{CCH}$ $I_{CCZ}$	Quiescent Power Supply Current	$V_{CC} = \text{Max.},$ $V_{IN} = \text{GND}$ or $V_{CC}$		—	0.1	10	$\mu\text{A}$

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### 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.

## POWER SUPPLY CHARACTERISTICS

Symbol	Parameter	Test Conditions <sup>(1)</sup>		Min.	Typ. <sup>(2)</sup>	Max.	Unit
$\Delta I_{CC}$	Quiescent Power Supply	$V_{CC} = \text{Max.}$	$V_{IN} = V_{CC} - 0.6V^{(3)}$	—	2.0	100	$\mu A$
$I_{CCD}$	Dynamic Power Supply Current <sup>(4)</sup>	$V_{CC} = \text{Max.}$ , Outputs Open $\overline{xOEAB}$ or $\overline{xOEBA} = \text{GND}$ One Input Toggling 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	60	100	$\mu A / \text{MHz}$
$I_C$	Total Power Supply Current <sup>(6)</sup>	$V_{CC} = \text{Max.}$ , Outputs Open $f_{CP} = 10\text{MHz}$ (xCLKAB) 50% Duty Cycle $\overline{xOEAB} = \overline{xCEAB} = \text{GND}$ $\overline{xOEBA} = V_{CC}$ One Bit Toggling $f_i = 5\text{MHz}$ 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	0.6	1.0	mA
			$V_{IN} = V_{CC} - 0.6V$ $V_{IN} = \text{GND}$	—	0.6	1.1	
		$V_{CC} = \text{Max.}$ , Outputs Open $f_{CP} = 10\text{MHz}$ (xCLKAB) 50% Duty Cycle $\overline{xOEAB} = \overline{xCEAB} = \text{GND}$ $\overline{xOEBA} = V_{CC}$ Sixteen Bits Toggling $f_i = 2.5\text{MHz}$ 50% Duty Cycle	$V_{IN} = V_{CC}$ $V_{IN} = \text{GND}$	—	3.0	5.0 <sup>(5)</sup>	
			$V_{IN} = V_{CC} - 0.6V$ $V_{IN} = \text{GND}$	—	3.0	5.9 <sup>(5)</sup>	

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### 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  $\text{GND}$ .
- 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.
- $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$   
 $I_C = I_{CC} + \Delta I_{CC} D_{HNT} + I_{CCD} (f_{CP} N_{CP} / 2 + f_i N_i)$   
 $I_{CC} = \text{Quiescent Current (} I_{CCL}, I_{CCH} \text{ and } I_{CCZ})$   
 $\Delta I_{CC} = \text{Power Supply Current for a TTL High Input}$   
 $D_H = \text{Duty Cycle for TTL Inputs High}$   
 $N_T = \text{Number of TTL Inputs at } D_H$   
 $I_{CCD} = \text{Dynamic Current Caused by an Input Transition Pair (HLH or LHL)}$   
 $f_{CP} = \text{Clock Frequency for Register Devices (Zero for Non-Register Devices)}$   
 $N_{CP} = \text{Number of Clock Inputs at } f_{CP}$   
 $f_i = \text{Input Frequency}$   
 $N_i = \text{Number of Inputs at } f_i$

### SWITCHING CHARACTERISTICS OVER OPERATING RANGE<sup>(5)</sup>

Symbol	Parameter	Condition <sup>(1)</sup>	FCT163952A		FCT163952B		FCT163952C		Unit
			Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	Min. <sup>(2)</sup>	Max.	
tPLH	Propagation Delay	CL = 50pF RL = 500Ω	2.0	10.0	2.0	7.5	2.0	6.3	ns
tPHL	xCLKAB, xCLKBA to xBx, xAx								
tPZH	Output Enable Time		1.5	10.5	1.5	8.0	1.5	7.0	ns
tPZL	xOEBA, xOEAB to xAx, xBx								
tPHZ	Output Disable Time		1.5	10.0	1.5	7.5	1.5	6.5	ns
tPLZ	xOEBA, xOEAB to xAx, xBx								
tSU	Set-up Time HIGH or LOW xAx, xBx to xCLKAB, xCLKBA		2.5	—	2.5	—	2.5	—	ns
tH	Hold Time HIGH or LOW xAx, xBx to xCLKAB, xCLKBA		2.0	—	1.5	—	1.5	—	ns
tSU	Set-up Time HIGH or LOW xCEAB, xCEBA to xCLKAB, xCLKBA		3.0	—	3.0	—	3.0	—	ns
tH	Hold Time HIGH or LOW xCEAB, xCEBA to xCLKAB, xCLKBA		2.0	—	2.0	—	2.0	—	ns
tw	Pulse Width HIGH or LOW xCLKAB or xCLKBA <sup>(4)</sup>	3.0	—	3.0	—	3.0	—	ns	
tsk(o)	Output Skew <sup>(3)</sup>	—	0.5	—	0.5	—	0.5	ns	

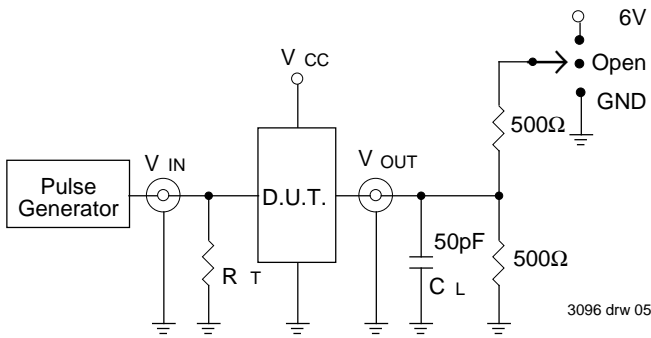
**NOTES:**

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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.
5. Propagation Delays and Enable/Disable times are with Vcc = 3.3V ±0.3V, Normal Range. For Vcc = 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



3096 drw 05

### SWITCH POSITION

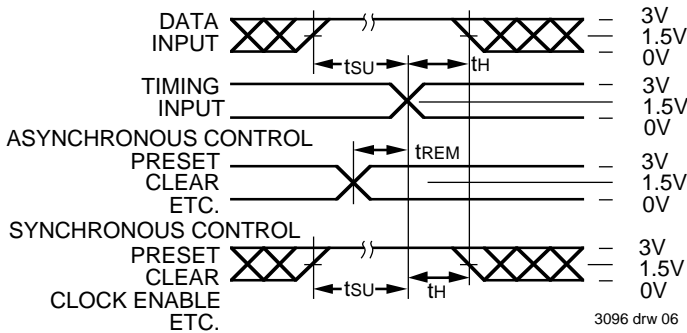
Test	Switch
Open Drain Disable Low Enable Low	6V
Disable High Enable High	GND
All Other tests	Open

#### DEFINITIONS:

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

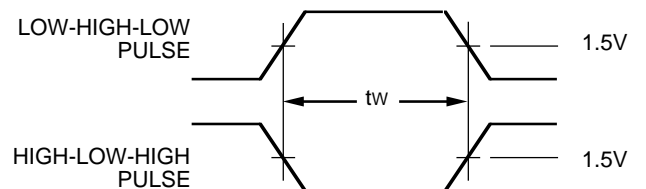
3096 Ink 09

### SET-UP, HOLD AND RELEASE TIMES



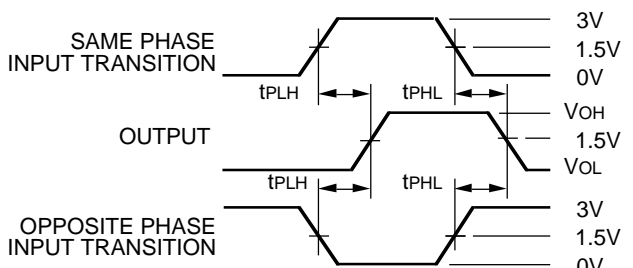
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### PULSE WIDTH



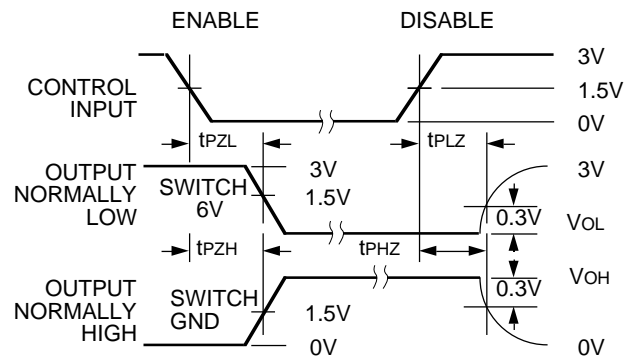
3096 drw 07

### PROPAGATION DELAY



3096 drw 08

### ENABLE AND DISABLE TIMES

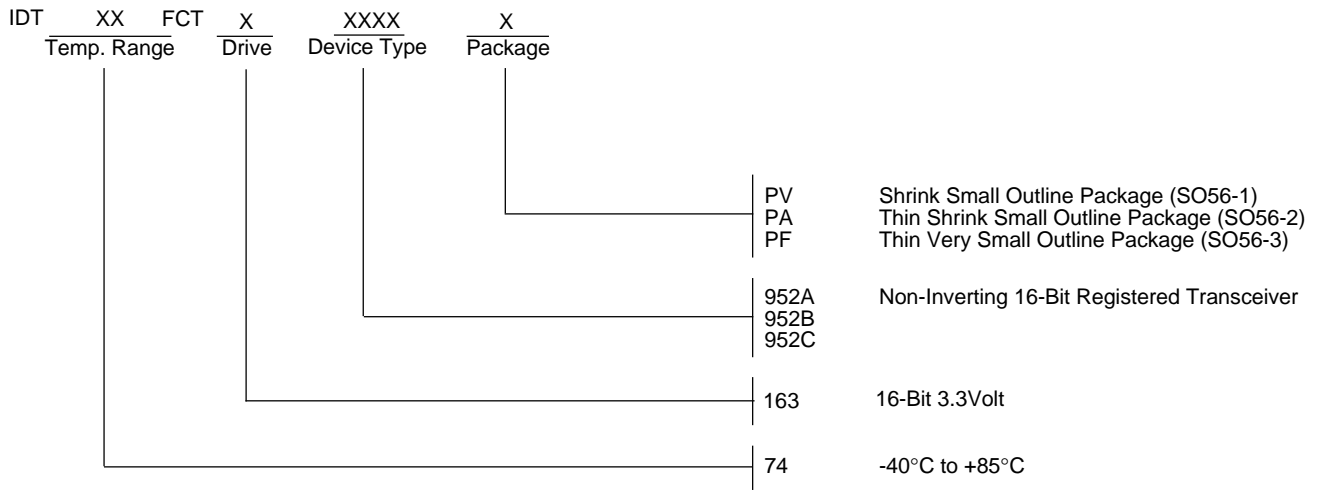


3096 drw 09

#### NOTES:

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

**ORDERING INFORMATION**



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