Integrated Device Technology, Inc.

FAST CMOS UP/DOWN BINARY COUNTER

IDT54/74FCT191
IDT54/74FCT191A

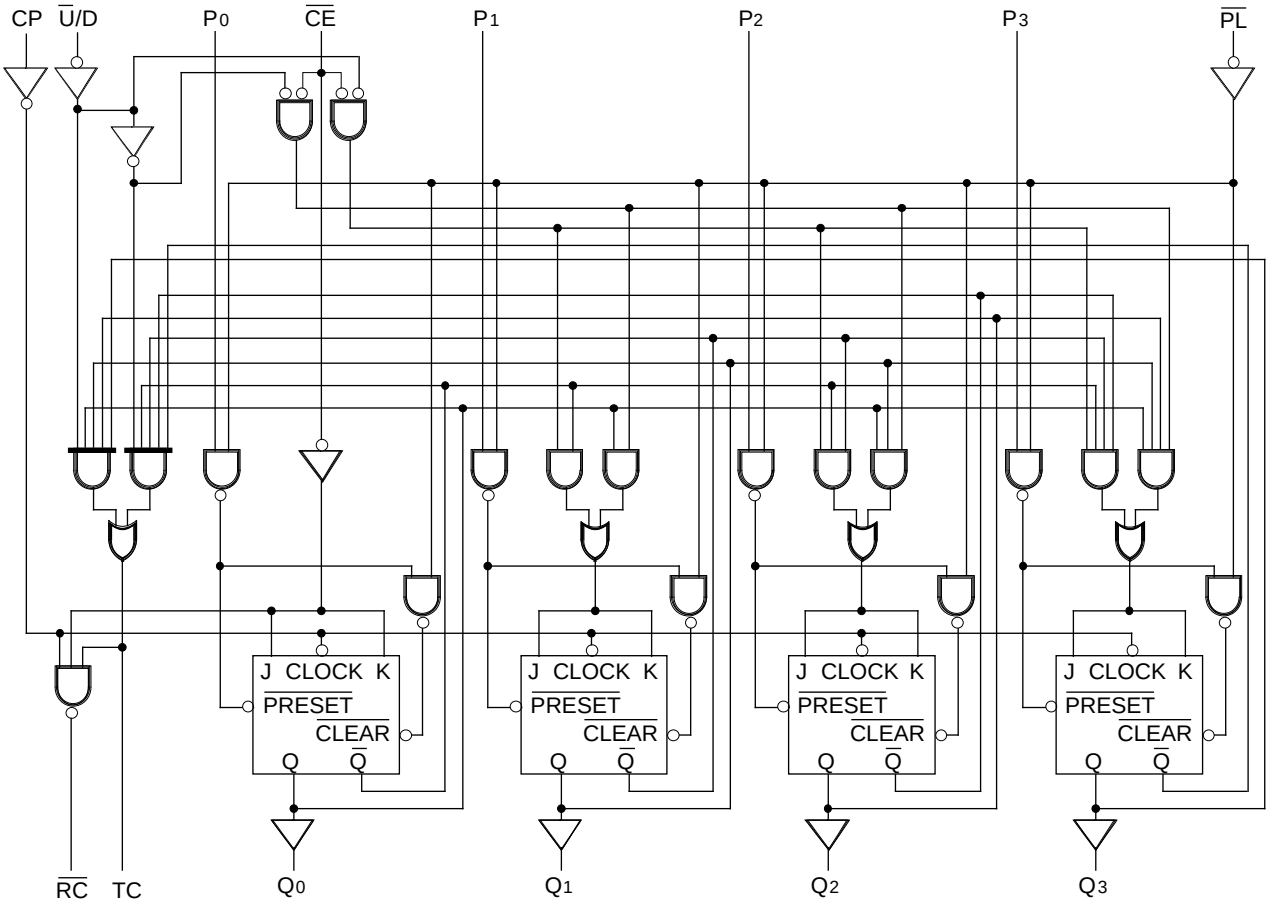
FEATURES:

- IDT54/74FCT191 equivalent to FAST™ speed
- **IDT54/74FCT191A 35% faster than FAST**
- Equivalent to FAST output drive over full temperature and voltage supply extremes
- I_{OL} = 48mA (commercial), 32mA (military)
- CMOS power levels (1mW typ. static)
- CMOS output level compatible
- Substantially lower input current levels than FAST (5µA max.)
- JEDEC standard pinout for DIP, LCC and SOIC
- Product available in Radiation Tolerant and Radiation Enhanced versions
- Military product compliant to MIL-STD-883, Class B

DESCRIPTION:

The IDT54/74FCT191 and IDT54/74FCT191A are reversible modulo-16 binary counters, featuring synchronous counting and asynchronous presetting and are built using an advanced dual metal CMOS technology. The preset feature allows the IDT54/74FCT191 and IDT54/74FCT191A to be used in programmable dividers. The count enable input, terminal count output and ripple clock output make possible a variety of methods of implementing multiusage counters. In the counting modes, state changes are initiated by the rising edge of the clock.

FUNCTIONAL BLOCK DIAGRAMS



2616 drw 01

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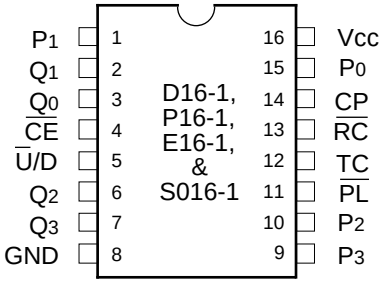
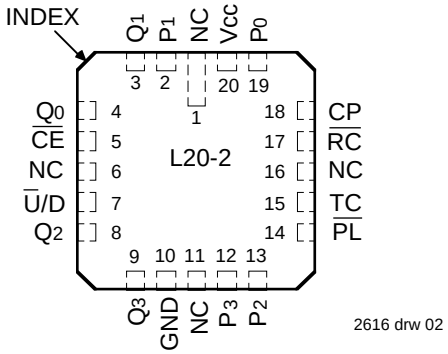
FAST is a trademark of National Semiconductor Co.

PIN CONFIGURATIONS



DIP/SOIC/CERPACK
TOP VIEW
***MR FOR '161**



2616 drw 02

LCC
TOP VIEW
***SR FOR '163**

PIN DESCRIPTION

Pin Names	Description
$\overline{CE}$	Count Enable Input (Active LOW)
CP	Clock Pulse Input (Active Rising Edge)
P_{0-3}	Parallel Data Inputs
$\overline{PL}$	Asynchronous Parallel Load Input (Active LOW)
$\overline{U}/D$	Up/Down Count Control Input
Q_{0-3}	Flip-Flop Outputs
$\overline{RC}$	Ripple Clock Output (Active LOW)
TC	Terminal Count Output (Active HIGH)

2616 tbl 05

$\overline{RC}$ FUNCTION TABLE[2]

Inputs		Outputs	
$\overline{CE}$	CP	TC[1]	$\overline{RC}$
L	⊓	H	⊓
H	X	X	H
X	X	L	H

2616 tbl 06

MODE SELECT FUNCTION TABLE[2]

Inputs				Mode
$\overline{PL}$	$\overline{CE}$	$\overline{U}/D$	CP	
H	L	L	↑	Count Up
H	L	H	↑	Count Down
L	X	X	X	Preset (Asynchronous)
H	H	X	X	No Change (Hold)

2616 tbl 07

NOTES:
1. TC is generated internally.
2. H = HIGH Voltage Level, L = LOW Voltage Level, X = Don't Care, ↑= LOW-to-HIGH clock transition.

ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Rating	Commercial	Military	Unit
V_{TERM}(2)	Terminal Voltage with Respect to GND	–0.5 to +7.0	–0.5 to +7.0	V
V_{TERM}(3)	Terminal Voltage with Respect to GND	–0.5 to V_{CC}	–0.5 to V_{CC}	V
T_A	Operating Temperature	0 to +70	–55 to +125	°C
T_{BIAS}	Temperature Under Bias	–55 to +125	–65 to +135	°C
T_{STG}	Storage Temperature	–55 to +125	–65 to +150	°C
P_T	Power Dissipation	0.5	0.5	W
I_{OUT}	DC Output Current	120	120	mA

NOTES: 2616 tbl 01

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. No terminal voltage may exceed V_{CC} by +0.5V unless otherwise noted.
2. Inputs and V_{CC} terminals.
3. Outputs 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	6	10	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V	8	12	pF

NOTE: 2616 tbl 02

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

DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

Following Conditions Apply Unless Otherwise Specified: V_{LC} = 0.2V; V_{HC} = V_{CC} – 0.2V
Commercial: T_A = 0°C to +70°C, V_{CC} = 5.0V ± 5%; 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	COM'L(5)	2.0V	—	—	V
			MIL	3.0V	—	—	V
V_{IL}	Input LOW Level	Guaranteed Logic LOW Level		—	—	0.8	V
I_{IH}	Input HIGH Current	V_{CC} = Max.	V_I = V_{CC}	—	—	5	µA
			V_I = 2.7V	—	—	5(4)	
I_{IL}	Input LOW Current		V_I = 0.5V	—	—	–5(4)	
			V_I = GND	—	—	–5	
V_{IK}	Clamp Diode Voltage	V_{CC} = Min., I_N = –18mA		—	–0.7	–1.2	V
I_{OS}	Short Circuit Current	V_{CC} = Max.(3), V_O = GND		–60	–120	—	mA
V_{OH}	Output HIGH Voltage	V_{CC} = 3V, V_{IN} = V_{LC} or V_{HC}, I_{OH} = –32µA		V_{HC}	V_{CC}	—	V
		V_{CC} = Min.	I_{OH} = –300µA	V_{HC}	V_{CC}	—	
		V_{IN} = V_{IH} or V_{IL}	I_{OH} = –12mA MIL.	2.4	4.3	—	
			I_{OH} = –15mA COM'L.	2.4	4.3	—	
V_{OL}	Output LOW Voltage	V_{CC} = 3V, V_{IN} = V_{LC} or V_{HC}, I_{OL} = 300µA		—	GND	V_{LC}	V
		V_{CC} = Min.	I_{OL} = 300µA	—	GND	V_{LC}(4)	
		V_{IN} = V_{IH} or V_{IL}	I_{OL} = 32mA MIL.	—	0.3	0.5	
			I_{OL} = 48mA COM'L.	—	0.3	0.5	

NOTES: 2616 tbl 03

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 and maximum loading.
3. Not more than one output should be shorted at one time. Duration of the short circuit test should not exceed one second.
4. This parameter is guaranteed but not tested.
5. Clock pin requires a minimum V_{IH} of 2.7V.

POWER SUPPLY CHARACTERISTICS V_{LC} = 0.2V, V_{HC} = V_{CC} – 0.2V

Symbol	Parameter	Test Conditions[1]		Min.	Typ.[2]	Max.	Unit
I_{CC}	Quiescent Power Supply Current	V_{CC} = Max. $V_{IN} \geq V_{HC}$; $V_{IN} \leq V_{LC}$		—	0.2	1.5	mA
ΔI_{CC}	Quiescent Power Supply Current TTL Inputs HIGH	V_{CC} = Max., V_{IN} = 3.4V[3]		—	0.5	2.0	mA
I_{CCD}	Dynamic Power Supply Current[4]	V_{CC} = Max., Outputs Open Preset Mode $\overline{PL}$ = $\overline{CE}$ = $\overline{U}$/D = CP = GND One Input Toggling 50% Duty Cycle	$V_{IN} \geq V_{HC}$ $V_{IN} \leq V_{LC}$	—	0.15	0.25	mA/ MHz
I_C	Total Power Supply Current[6]	V_{CC} = Max., Outputs Open Preset Mode $\overline{PL}$ = $\overline{CE}$ = $\overline{U}$/D = CP = GND One Bit Toggling at f_i = 5MHz 50% Duty Cycle	$V_{IN} \geq V_{HC}$ $V_{IN} \leq V_{LC}$ (FCT)	—	1.0	2.8	mA
			V_{IN} = 3.4V V_{IN} = GND	—	1.2	3.8	
		V_{CC} = Max., Outputs Open Preset Mode $\overline{PL}$ = $\overline{CE}$ = $\overline{U}$/D = CP = GND Four Bits Toggling at f_i = 5MHz 50% Duty Cycle	$V_{IN} \geq V_{HC}$ $V_{IN} \leq V_{LC}$ (FCT)	—	3.2	6.5[5]	
			V_{IN} = 3.4V V_{IN} = GND	—	4.2	10.5[5]	

2616 tbl 04

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. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
   $I_C = I_{CC} + \Delta I_{CC} D_H N_T + I_{CCD}(f_{CP}/2 + f_i N_i)$
   I_{CC} = Quiescent Current
   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)
   f_i = Input Frequency
   N_i = Number of Inputs at f_i
   All currents are in milliamps and all frequencies are in megahertz.

SWITCHING CHARACTERISTICS OVER OPERATING RANGE

Symbol	Parameter	Condition[1]	IDT54/74FCT191				IDT54/74FCT191A				Unit
			Com'l.		Mil.		Com'l.		Mil.		
			Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	Min.[2]	Max.	
t_{PLH} t_{PHL}	Propagation Delay CP to Q_n	C_L = 50pF R_L = 500Ω	2.5	12.0	1.5	16.0	2.5	7.8	1.5	10.5	ns
t_{PLH} t_{PHL}	Propagation Delay CP to TC		3.0	14.0	2.0	16.0	3.0	11.8	2.0	12.2	ns
t_{PLH} t_{PHL}	Propagation Delay CP to $\overline{RC}$		2.5	8.5	1.5	12.5	2.5	8.5	1.5	10.0	ns
t_{PLH} t_{PHL}	Propagation Delay $\overline{CE}$ to $\overline{RC}$		2.0	8.0	2.0	8.5	2.0	7.2	2.0	8.0	ns
t_{PLH} t_{PHL}	Propagation Delay $\overline{U}$/D to $\overline{RC}$		4.0	20.0	4.0	22.5	4.0	13.0	4.0	14.7	ns
t_{PLH} t_{PHL}	Propagation Delay $\overline{U}$/D to TC		3.0	11.0	3.0	13.0	3.0	7.2	3.0	8.5	ns
t_{PLH} t_{PHL}	Propagation Delay P_n to Q_n		2.0	14.0	1.5	16.0	2.0	9.1	1.5	10.4	ns
t_{PLH} t_{PHL}	Propagation Delay $\overline{PL}$ to Q_n		3.0	13.0	3.0	14.0	3.0	8.5	3.0	9.1	ns
t_{SU}	Set-up Time, HIGH or LOW Pn to $\overline{PL}$		5.0	—	6.0	—	4.0	—	5.0	—	ns
t_H	Hold Time, HIGH or LOW Pn to $\overline{PL}$		1.5	—	1.5	—	1.5	—	1.5	—	ns
t_{SU}	Set-up Time LOW $\overline{CE}$ to CP		10.0	—	10.5	—	9.0	—	9.5	—	ns
t_H	Hold Time LOW $\overline{CE}$ to CP		0	—	0	—	0	—	0	—	ns
t_{SU}	Set-up Time, HIGH or LOW $\overline{U}$/D to CP		12.0	—	12.0	—	10.0	—	10.0	—	ns
t_H	Hold Time, HIGH or LOW $\overline{U}$/D to CP		0	—	0	—	0	—	0	—	ns
t_W	$\overline{PL}$ Pulse Width LOW		6.0	—	8.5	—	5.5	—	8.0	—	ns
t_W	CP Pulse Width HIGH or LOW		5.0	—	7.0	—	4.0[3]	—	6.0	—	ns
t_{REM}	Recovery Time $\overline{PL}$ to CP		6.0	—	7.5	—	5.0	—	6.5	—	ns

NOTES:
1. See test circuit and waveform.
2. Minimum limits are guaranteed but not tested on Propagation Delays.
3. This parameter is guaranteed but not tested.

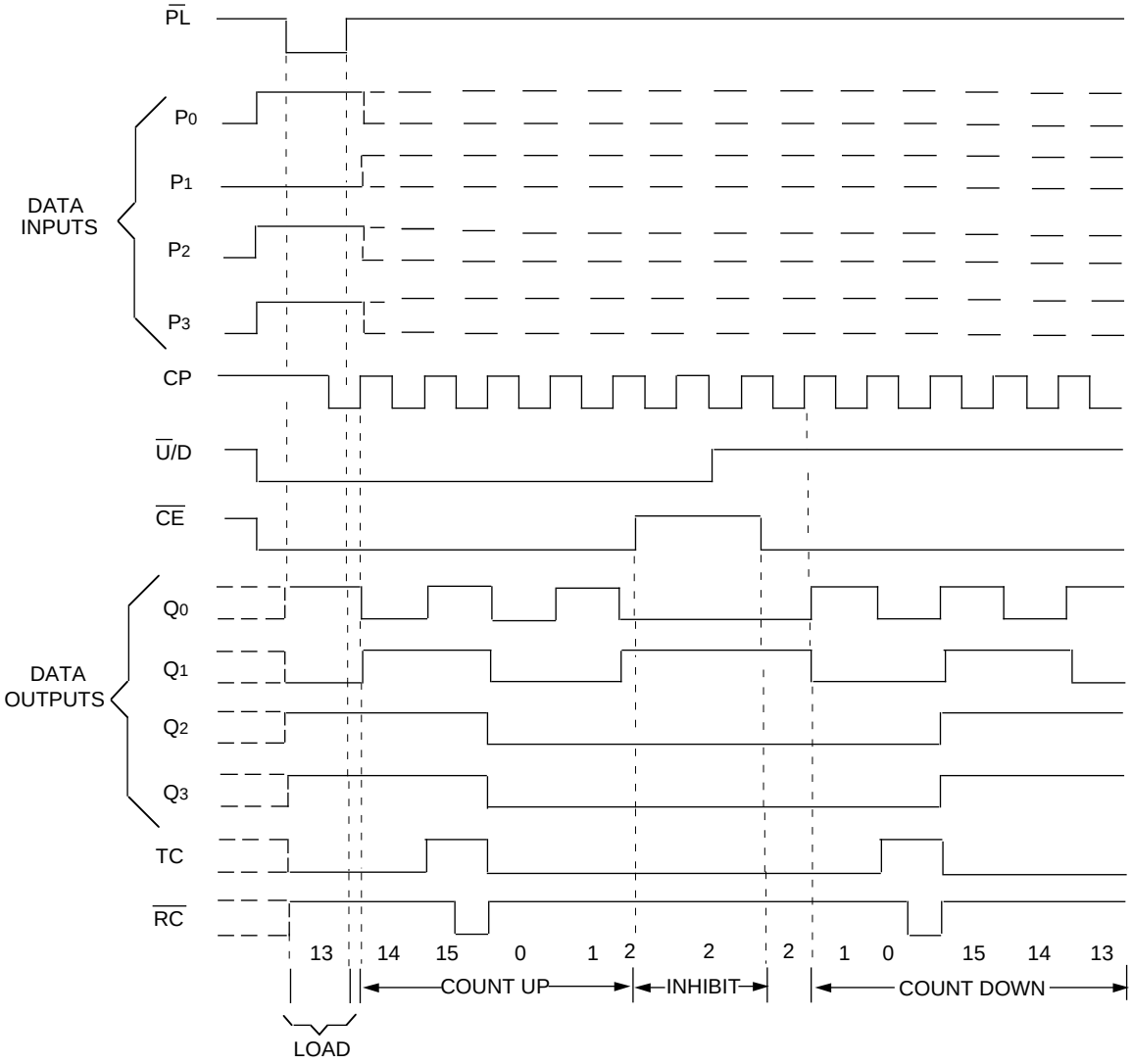
2616 tbl 08

TIMING WAVEFORMS

Typical load, count, and inhibit sequences

Illustrated below is the following sequence:

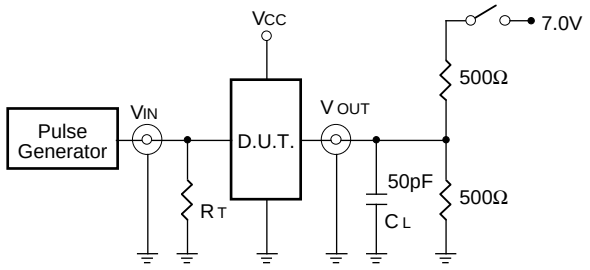
- Load (preset) to binary thirteen
- Count up to fourteen, fifteen (maximum), zero, one and two
- Inhibit
- Count down to one, zero (minimum), fifteen, fourteen and thirteen



2616 drw 05

TEST CIRCUITS AND WAVEFORMS

TEST CIRCUITS FOR ALL OUTPUTS



SWITCH POSITION

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

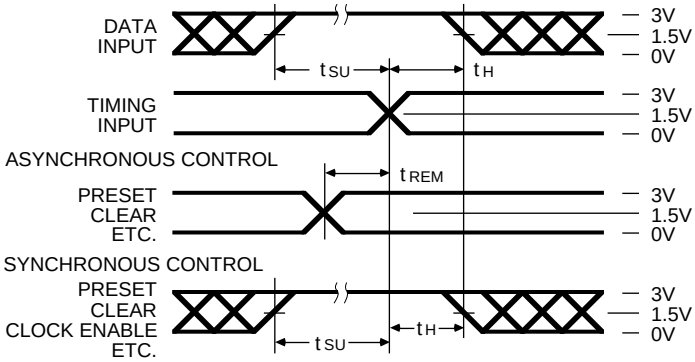
2616 tbl 09

DEFINITIONS:

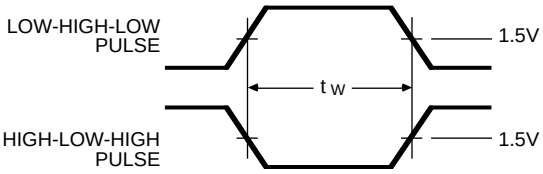
C_L = Load capacitance: includes jig and probe capacitance.

R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator.

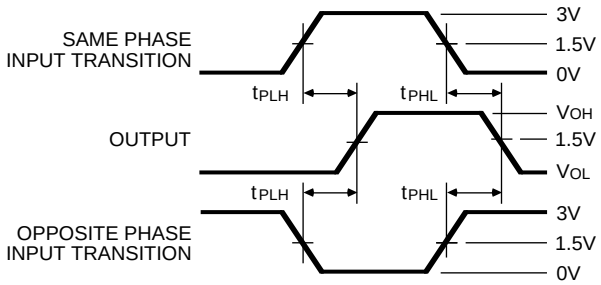
SET-UP, HOLD AND RELEASE TIMES



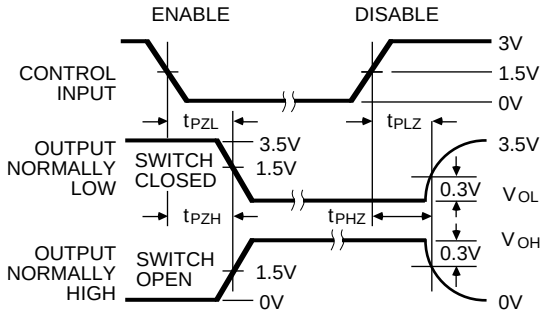
PULSE WIDTH



PROPAGATION DELAY



ENABLE AND DISABLE TIMES

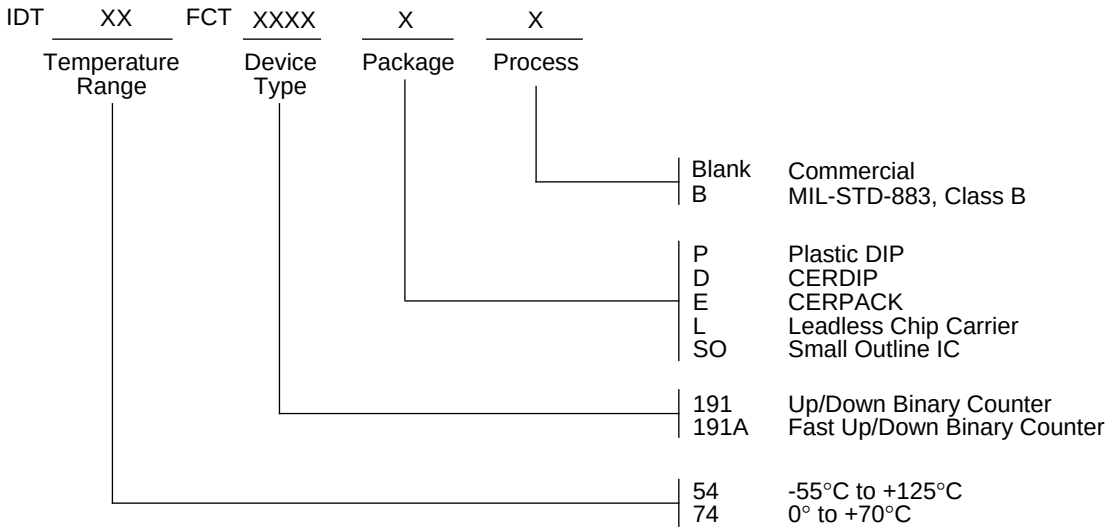


2616 drw 04

NOTES:

1. Diagram shown for input Control Enable-LOW and input Control Disable-HIGH.
2. Pulse Generator for All Pulses: Rate ≤ 1.0 MHz; Z_O ≤ 50Ω; t_F ≤ 2.5ns; t_R ≤ 2.5ns.

ORDERING INFORMATION



2616 drw 03