Integrated Device Technology, Inc.

FAST CMOS UP/DOWN BINARY COUNTERS

IDT54/74FCT193
IDT54/74FCT193A

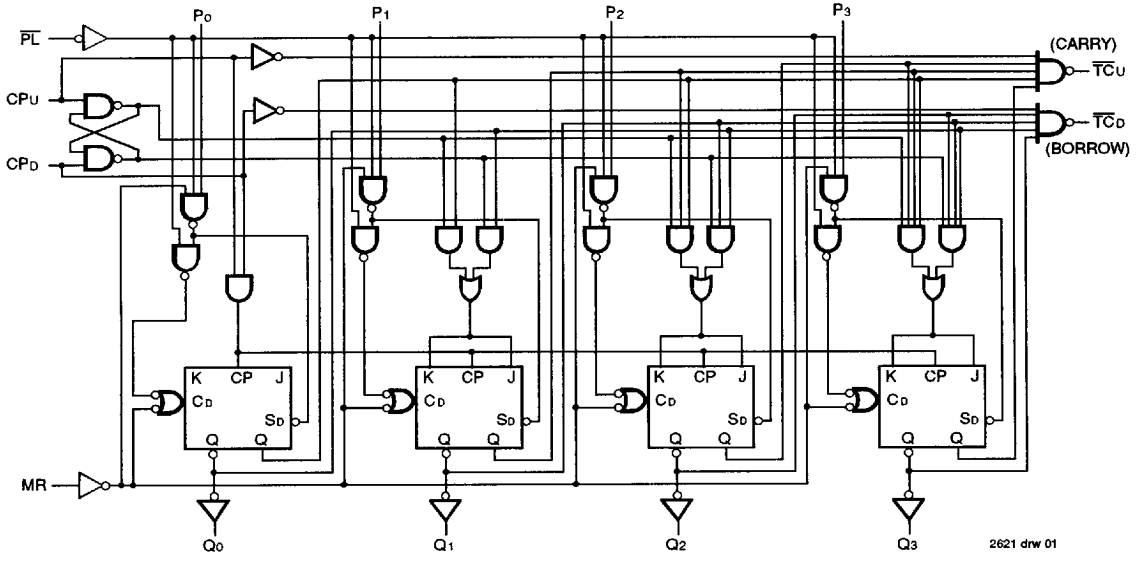
FEATURES:

- IDT54/74FCT193 equivalent to FAST™ speed
- **IDT54/74FCT193A 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 and LCC
- Product available in Radiation Tolerant and Radiation Enhanced versions
- Military product compliant to MIL-STD-883, Class B

DESCRIPTION:

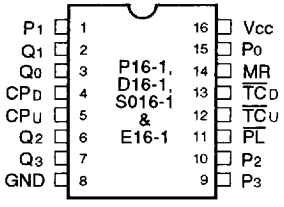
The IDT54/74FCT193 and IDT54/74FCT193A are up/down modulo-16 binary counters built using an advanced dual metal CMOS technology. Separate count-up and count-down clocks are used and, in either counting mode, the circuits operate synchronously. The outputs change state synchronously with the LOW-to-HIGH transitions on the clock inputs. Separate terminal count-up and terminal count-down outputs are provided that are used as the clocks for subsequent stages without extra logic, thus simplifying multiusage counter designs. Individual preset inputs allow the circuit to be used as a programmable counter. Both the Parallel Load ($\overline{PL}$) and the Master Reset (MR) inputs asynchronously override the clocks.

FUNCTIONAL BLOCK DIAGRAM

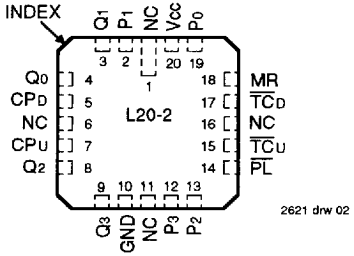


7

PIN CONFIGURATIONS



DIP/SOIC/CERPACK
TOP VIEW



LCC
TOP VIEW

PIN DESCRIPTION

Pin Names	Description
CPU	Count Up Clock Input (Active Rising Edge)
CPD	Count Down Clock Input (Active Rising Edge)
MR	Asynchronous Master Reset (Active HIGH)
$\overline{PL}$	Asynchronous Parallel Load Input (Active LOW)
Pn	Parallel Data Inputs
Qn	Flip-Flop Outputs
$\overline{TC}_D$	Terminal Count Down (Borrow) Output (Active LOW)
$\overline{TC}_U$	Terminal Count Up (Carry) Output (Active LOW)

2621 tbl 05

FUNCTION TABLE[1]

MR	$\overline{PL}$	CPU	CPD	Mode
H	X	X	X	Reset (Asyn.)
L	L	X	X	Preset (Asyn.)
L	H	H	H	No Change
L	H	↑	H	Count Up
L	H	H	↑	Count Down

NOTE: 2621 tbl 06
1. 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 VCC	–0.5 to VCC	V
TA	Operating Temperature	0 to +70	–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	0.5	0.5	W
IOUT	DC Output Current	120	120	mA

NOTES: 2621 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 VCC by +0.5V unless otherwise noted.
2. Input and VCC terminals.
3. Output and I/O terminals.

CAPACITANCE (TA = +25°C, f = 1.0MHz)

Symbol	Parameter[1]	Conditions	Typ.	Max.	Unit
CIN	Input Capacitance	VIN = 0V	6	10	pF
COUT	Output Capacitance	VOUT = 0V	8	12	pF

NOTE: 2621 tbl 02
1. This parameter is guaranteed by characterization data and 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	

2621 tbl 03

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 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.

7

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 $\overline{PL}$ = MR = CP_U = CP_D = 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 $\overline{PL}$ = MR = CP_U = CP_D = GND One Bit Toggling at f_i = 10MHz 50% Duty Cycle	$V_{IN} \geq V_{HC}$ $V_{IN} \leq V_{LC}$ (FCT)	—	1.7	4.0	mA
			V_{IN} = 3.4V V_{IN} = GND	—	2.0	5.0	
		V_{CC} = Max. Outputs Open Preset Mode $\overline{PL}$ = MR = CP_U = CP_D = 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]	

2621 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]	IDT54/74FCT193				IDT54/74FCT193A				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_U or CP_D to $\overline{TC}_U$ or $\overline{TC}_D$	C_L = 50pF R_L = 500Ω	2.0	10.0	2.0	10.5	2.0	6.5	2.0	6.9	ns
t_{PLH} t_{PHL}	Propagation Delay CP_U or CP_D to Q_n		2.0	13.5	2.0	14.0	2.0	8.8	2.0	9.1	ns
t_{PLH} t_{PHL}	Propagation Delay P_n to Q_n		2.0	15.5	2.0	16.5	2.0	10.1	2.0	10.8	ns
t_{PLH} t_{PHL}	Propagation Delay $\overline{PL}$ to Q_n		2.0	14.0	2.0	13.5	2.0	8.8	2.0	9.1	ns
t_{PHL}	Propagation Delay MR to Q_n		3.0	15.5	3.0	16.0	3.0	10.1	3.0	10.4	ns
t_{PLH}	Propagation Delay MR to $\overline{TC}_U$		3.0	14.5	3.0	15.0	3.0	9.4	3.0	9.8	ns
t_{PHL}	Propagation Delay MR to $\overline{TC}_D$		3.0	15.5	3.0	16.0	3.0	10.1	3.0	10.4	ns
t_{PLH} t_{PHL}	Propagation Delay $\overline{PL}$ to $\overline{TC}_U$ or $\overline{TC}_D$		3.0	16.5	3.0	18.5	3.0	10.8	3.0	12.0	ns
t_{PLH} t_{PHL}	Propagation Delay P_n to $\overline{TC}_U$ or $\overline{TC}_D$		3.0	15.5	3.0	16.5	3.0	10.1	3.0	10.8	ns
t_{SU}	Set-up Time, HIGH or LOW P_n to $\overline{PL}$		5.0	—	6.0	—	4.0	—	5.0	—	ns
t_H	Hold Time, HIGH or LOW P_n to $\overline{PL}$		2.0	—	2.0	—	1.5	—	1.5	—	ns
t_W	$\overline{PL}$ Pulse Width, LOW		6.0	—	7.5	—	5.0	—	6.5	—	ns
t_W	CP_U or CP_D Pulse Width HIGH or LOW		5.0	—	7.0	—	4.0[3]	—	6.0	—	ns
t_W	CP_U or CP_D Pulse Width LOW (Change of Direction)		10.0	—	12.0	—	8.0	—	10.0	—	ns
t_W	MR Pulse Width HIGH		6.0	—	6.0	—	5.0	—	5.0	—	ns
t_{REM}	Recovery Time $\overline{PL}$ to CP_U or CP_D		6.0	—	8.0	—	5.0	—	7.0	—	ns
t_{REM}	Recovery Time MR to CP_U or CP_D		4.0	—	4.5	—	3.0	—	3.5	—	ns

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

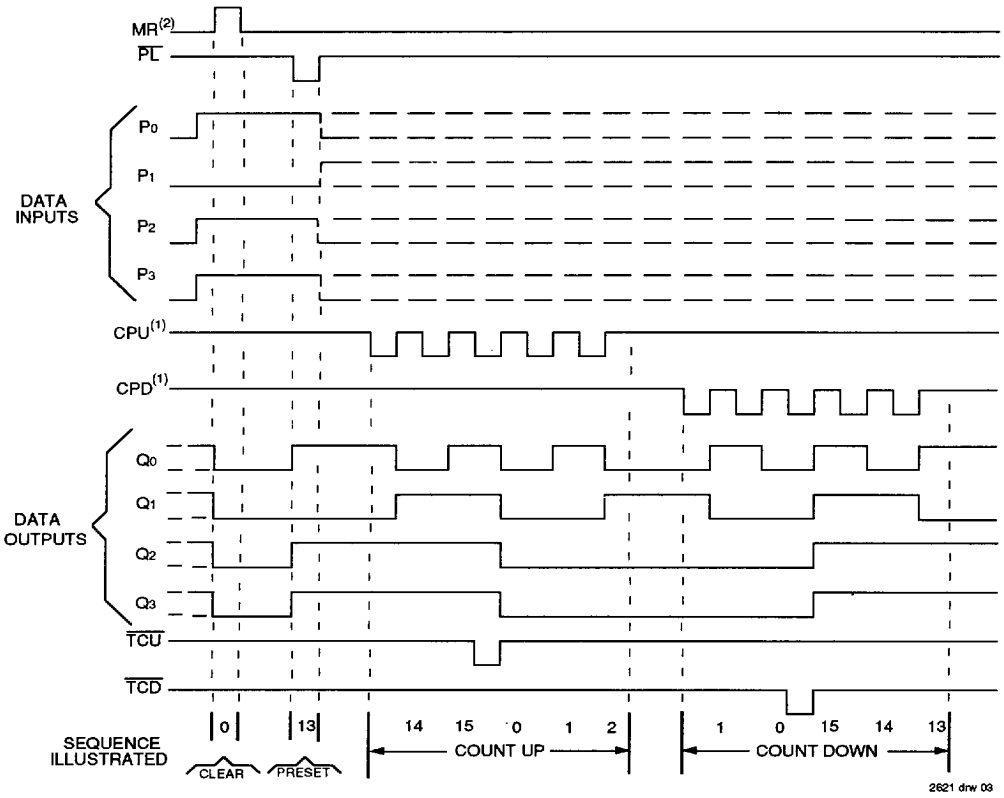
2621 tbl 07

7

TIMING WAVEFORMS

Typical clear, load, and count sequences

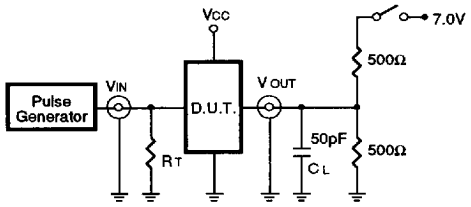
Illustrated below is the following sequence:
- Clear outputs to zero
- Load (preset) to binary thirteen
- Count up to fourteen, fifteen, carry zero, one and two
- Count down to one, zero, borrow, fifteen, fourteen and thirteen



NOTES:
1. MR overrrides load, data, and count inputs
2. When counting up, CPD input must be HIGH; when counting down, CPU input must be HIGH.

TEST CIRCUITS AND WAVEFORMS

TEST CIRCUITS FOR ALL OUTPUTS



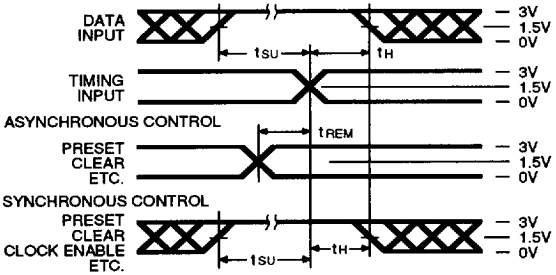
SWITCH POSITION

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

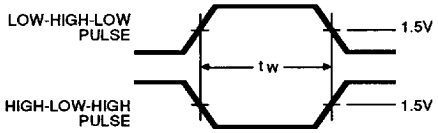
DEFINITIONS: 2621 tbl 09

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

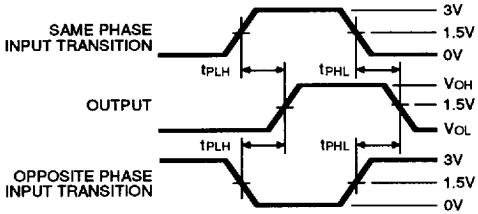
SET-UP, HOLD AND RELEASE TIMES



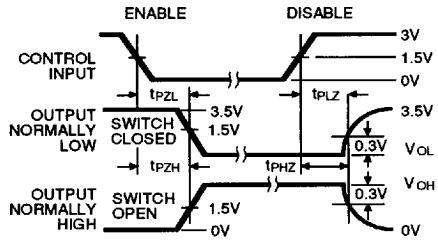
PULSE WIDTH



PROPAGATION DELAY



ENABLE AND DISABLE TIMES

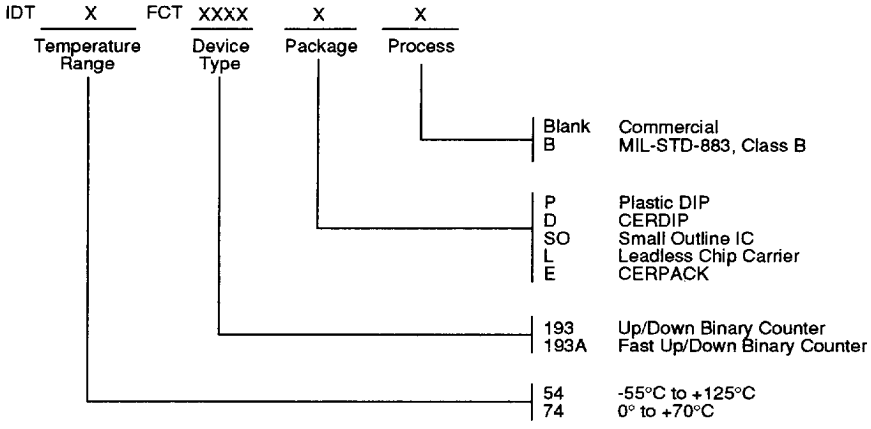


NOTES 2621 drw 04

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

7

ORDERING INFORMATION



2621 drw 03