TEXAS INSTRUMENTS

CY74FCT191T

SCCS016 - May 1994 - Revised February 2000

4-Bit Up/Down Binary Counter

Features

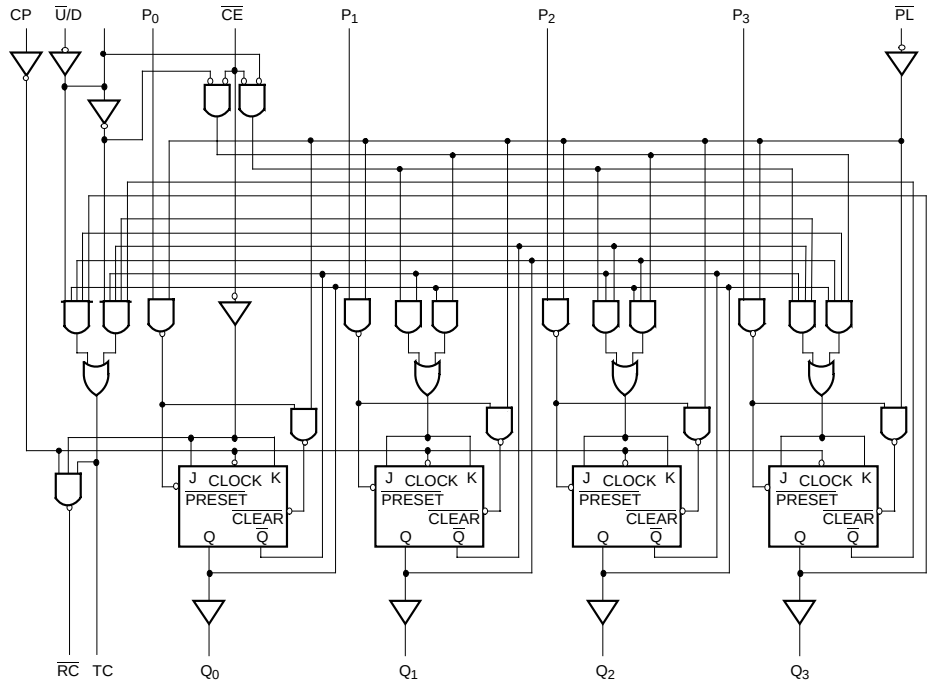
- **Function, pinout, and drive compatible with FCT and F logic**
- **FCT-C speed at 6.2 ns max, FCT-A speed at 7.8 ns max.**
- **Reduced V_{OH} (typically = 3.3V) versions of equivalent FCT functions**
- **Edge-rate control circuitry for significantly improved noise characteristics**
- **Power-off disable permits live insertion**
- **ESD > 2000V**
- **Matched rise and fall times**
- **Sink current 64 mA**
  Source current 32 mA

Functional Description

The FCT191T is a reversible modulo-16 binary counter, featuring synchronous counting and asynchronous presetting. The preset allows the FCT191T 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.

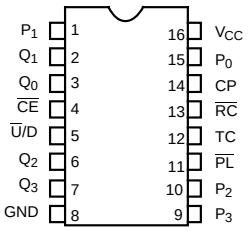
The outputs are designed with a power-off disable feature to allow for live insertion of boards.

Logic Block Diagram



Pin Configurations

SOIC/QSOP
Top View



Pin Description

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

$\overline{RC}$ Function Table[1]

Inputs		Outputs	
$\overline{CE}$	CP	T[2]	$\overline{RC}$
L	⌐⌐	H	⌐⌐
H	X	X	H
X	X	L	H

$\overline{RC}$ Function Table[1]

Inputs		Outputs	
$\overline{CE}$	CP	T[2]	$\overline{RC}$

Notes:
1. H = HIGH Voltage Level, L = LOW Voltage Level, X = Don't Care, ⌐¬ = LOW-to-HIGH clock transition. ¬⌐ =Low Pulse.
2. TC is generated internally.

Mode Select[1]

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)

Maximum Ratings[3, 4]

(Above which the useful life may be impaired. For user guidelines, not tested.)

Storage Temperature .....–65°C to +150°C

Ambient Temperature with Power Applied.....–65°C to +135°C

Supply Voltage to Ground Potential..... –0.5V to +7.0V

DC Input Voltage ..... –0.5V to +7.0V

DC Output Voltage..... –0.5V to +7.0V

DC Output Current (Maximum Sink Current/Pin) .....120 mA

Power Dissipation 0.5W

Static Discharge Voltage.....>2001V (per MIL-STD-883, Method 3015)

Operating Range

Range	Ambient Temperature	V_{CC}
Commercial	–40°C to +85°C	5V ± 5%

Electrical Characteristics Over the Operating Range

Parameter	Description	Test Conditions	Min.	Typ.[5]	Max.	Unit
V_{OH}	Output HIGH Voltage	V_{CC}=Min., I_{OH}=–32 mA	2.0			V
		V_{CC}=Min., I_{OH}=–15 mA	2.4	3.3		V
V_{OL}	Output LOW Voltage	V_{CC}=Min., I_{OL}=64 mA		0.3	0.55	V
V_{IH}	Input HIGH Voltage		2.0			V
V_{IL}	Input LOW Voltage				0.8	V
V_H	Hysteresis[6]	All inputs		0.2		V
V_{IK}	Input Clamp Diode Voltage	V_{CC}=Min., I_{IN}=–18 mA		–0.7	–1.2	V
I_I	Input HIGH Current	V_{CC}=Max., V_{IN}=V_{CC}			5	µA
I_{IH}	Input HIGH Current	V_{CC}=Max., V_{IN}=2.7V			±1	µA
I_{IL}	Input LOW Current	V_{CC}=Max., V_{IN}=0.5V			±1	µA
I_{OS}	Output Short Circuit Current[7]	V_{CC}=Max., V_{OUT}=0.0V	–60	–120	–225	mA
I_{OFF}	Power-Off Disable	V_{CC}=0V, V_{OUT}=4.5V			±1	µA

Capacitance[6]

Parameter	Description	Typ.[5]	Max.	Unit
C_{IN}	Input Capacitance	5	10	pF
C_{OUT}	Output Capacitance	9	12	pF

Notes:
3. Unless otherwise noted, these limits are over the operating free-air temperature range.
4. Unused inputs must always be connected to an appropriate logic voltage level, preferably either V_{CC} or ground.
5. Typical values are at V_{CC}=5.0V, T_A=+25°C ambient.
6. This parameter is specified but not tested.
7. Not more than one output should be shorted at a time. Duration of short should not exceed one second. The use of high-speed test apparatus and/or sample and hold techniques are preferable in order to minimize internal chip heating and more accurately reflect operational values. Otherwise prolonged shorting of a high output may raise the chip temperature well above normal and thereby cause invalid readings in other parametric tests. In any sequence of parameter tests, I_{OS} tests should be performed last.

Power Supply Characteristics

Parameter	Description	Test Conditions	Typ.[5]	Max.	Unit
I_{CC}	Quiescent Power Supply Current	V_{CC}=Max., $V_{IN} \le 0.2V$, $V_{IN} \ge V_{CC}-0.2V$	0.1	0.2	mA
ΔI_{CC}	Quiescent Power Supply Current (TTL inputs HIGH)	V_{CC}=Max., V_{IN}=3.4V,[8] f_1=0, Outputs Open	0.5	2.0	mA
I_{CCD}	Dynamic Power Supply Current[9]	V_{CC}=Max., One Bit Toggling, Preset Mode, 50% Duty Cycle, Outputs Open, $\overline{MR}$=V_{CC}=$\overline{SR}$, $\overline{PL}$=$\overline{CE}$=$\overline{U}$/D=CP=GND, $V_{IN} \le 0.2V$ or $V_{IN} \ge V_{CC}-0.2V$	0.06	0.12	mA/MHz
I_C	Total Power Supply Current[10]	V_{CC}=Max., Preset Mode, 50% Duty Cycle, Outputs Open, One Bit Toggling at f_1=5 MHz, $\overline{PL}$=$\overline{CE}$=$\overline{U}$/D=CP=GND, V_{IN}=V_{CC}, V_{IN}=GND	0.4	0.8	mA
		V_{CC}=Max., Preset Mode, 50% Duty Cycle, Outputs Open, One Bit Toggling at f_1=5 MHz, V_{IN}=3.4V or V_{IN}=GND	0.7	1.8	mA
		V_{CC}=Max., Preset Mode, 50% Duty Cycle, Outputs Open, Four Bits Toggling at f_1=5 MHz, $\overline{PL}$=$\overline{CE}$=$\overline{U}$/D=CP=GND, V_{IN}=V_{CC}, V_{IN}=GND	1.3	2.6[11]	mA
		V_{CC}=Max., Preset Mode, 50% Duty Cycle, Outputs Open, Four Bits Toggling at f_1=5 MHz, $\overline{PL}$=$\overline{CE}$=$\overline{U}$/D=CP=GND, V_{IN}=3.4V or V_{IN}=GND	2.3	6.6[11]	mA

Notes:

8. Per TTL driven input (V_{IN}=3.4V); all other inputs at V_{CC} or GND.
9. This parameter is not directly testable, but is derived for use in Total Power Supply calculations.
10. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$
    $I_C = I_{CC}+\Delta I_{CC}D_H N_T+I_{CCD}(f_0/2 + f_1N_1)$
    I_{CC} = Quiescent Current with CMOS input levels
    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_0 = Clock frequency for registered devices, otherwise zero
    f_1 = Input signal frequency
    N_1 = Number of inputs changing at f_1
    All currents are in milliamps and all frequencies are in megahertz.
11. Values for these conditions are examples of the I_{CC} formula. These limits are specified but not tested.

Switching Characteristics Over the Operating Range

Parameter	Description	CY74FCT191AT		CY74FCT191CT		Unit	Fig. No.[13]
		Min.[12]	Max.	Min.[12]	Max.		
t_{PLH} t_{PHL}	Propagation Delay CP to Q_n	1.5	7.8	1.5	6.2	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay CP to TC	1.5	11.8	1.5	9.4	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay CP to $\overline{RC}$	1.5	8.5	1.5	6.8	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay $\overline{CE}$ to $\overline{RC}$	1.5	7.2	1.5	6.0	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay $\overline{U}$/D to $\overline{RC}$	1.5	13.0	1.5	11.0	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay $\overline{U}$/D to TC	1.5	7.2	1.5	6.1	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay P_n to Q_n	1.5	9.1	1.5	7.7	ns	1, 5
t_{PLH} t_{PHL}	Propagation Delay $\overline{PL}$ to Q_n	2.0	8.5	2.0	7.2	ns	1, 5
t_{SU}	Set-Up Time HIGH or LOW P_n to $\overline{PL}$	4.0		3.5		ns	4
t_H	Hold Time HIGH or LOW P_n to $\overline{PL}$	1.5		1.0		ns	4
t_{SU}	Set-Up Time LOW $\overline{CE}$ to CP	9.0		7.2		ns	4
t_H	Hold Time LOW $\overline{CE}$ to CP	0		0		ns	4
t_{SU}	Set-Up Time HIGH or LOW $\overline{U}$/D to CP	10.0		8.0		ns	4
t_H	Hold Time HIGH or LOW $\overline{U}$/D to CP	0		0		ns	4
t_W	$\overline{PL}$ Pulse Width LOW	5.5		5.0		ns	5
t_W	Clock Pulse Width[6] HIGH or LOW	4.0		4.0		ns	5
t_{REM}	Recovery Time $\overline{PL}$ to CP	5.0		4.5		ns	6

Notes:
12. Minimum limits are specified but not tested on Propagation Delays.
13. See “Parameter Measurement Information” in the General Information section.

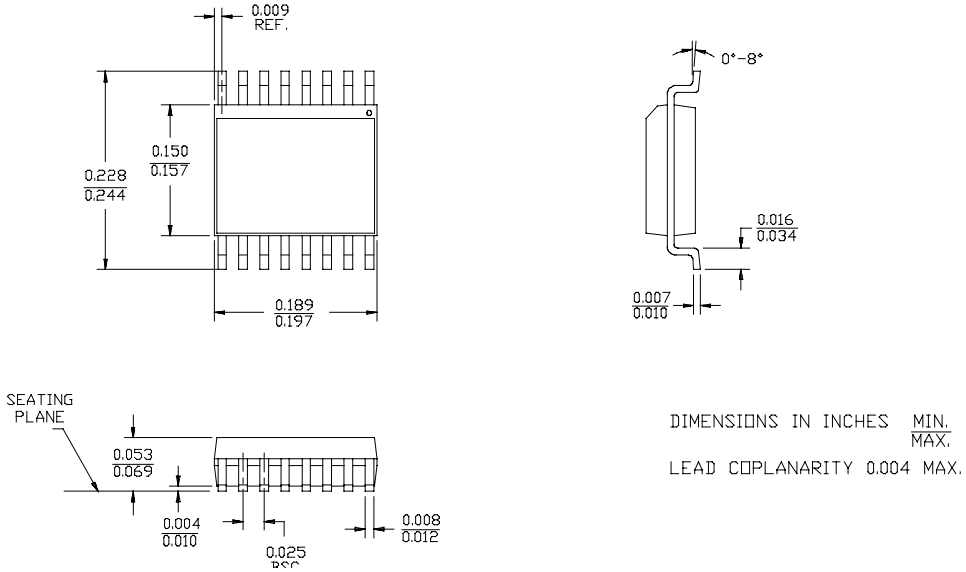
Ordering Information

Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
6.2	CY74FCT191CTQCT	Q1	16-Lead (150-Mil) QSOP	Commercial
	CY74FCT191CTSOC/SOCT	S1	16-Lead (300-Mil) Molded SOIC	
7.8	CY74FCT191ATSOC/SOCT	S1	16-Lead (300-Mil) Molded SOIC	Commercial

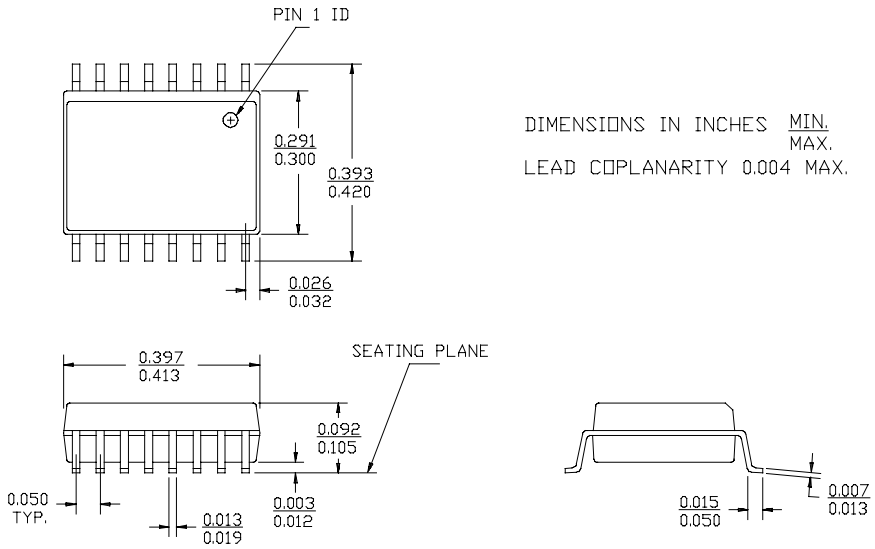
Document #: 38-00286-B

Package Diagrams

16-Lead Quarter Size Outline Q1



16-Lead Molded SOIC S1



IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.