4-BIT BINARY UP/DOWN COUNTER

The TC74AC191 is an advanced high speed CMOS 4-BIT BINARY COUNTER fabricated with silicon gate and double-layer metal wiring C^2MOS technology.

It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

It has a asynchronous load input ($\overline{LOAD}$) which is active low.

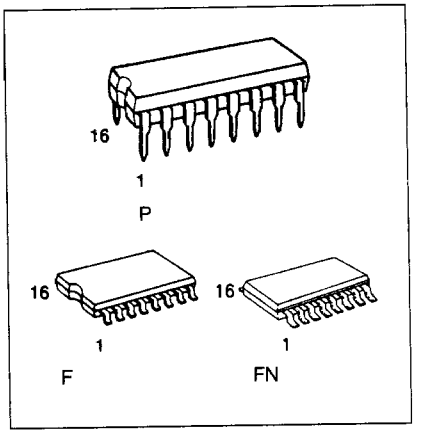
The direction of counting is determined by the level of DOWN/$\overline{UP}$. When D/$\overline{U}$ is low, the counter counts up; when D/$\overline{U}$ is high, it counts down. Counting occurs on the positive going transition of the clock input.

Enable input ($\overline{ENABLE}$) and two carry outputs ($\overline{RIPPLE\ CLOCK\ OUT}$, MAX/MIN) are provided to permit easy cascading of the counters, which facilitates easy implementation of N-bit counters without using external gates.

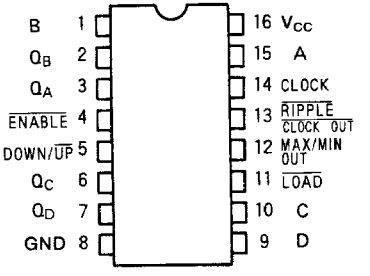
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

FEATURES:

- High Speed ..... f_{MAX}= MHz(typ.) at V_{CC}=5V
- Low Power Dissipation ..... I_{CC}=8 μA(Max.) at Ta=25°C
- High Noise Immunity ..... $V_{NIH}=V_{NIL}$=28% V_{CC}(Min.)
- Symmetrical Output Impedance ··· $|I_{OH}|=I_{OL}$=24mA(Min.) Capability of driving 50Ω transmission lines.
- Balanced Propagation Delays ····· $t_{pLH} \fallingdotseq t_{pHL}$
- Wide Operating Voltage Range ··· V_{CC}(opr.)=2V~5.5V
- Pin and Function Compatible with 74F191

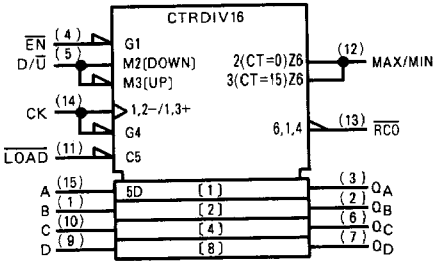


PIN ASSIGNMENT



(TOP VIEW)

IEC LOGIC SYMBOL



ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V_{CC}	−0.5 ~7.0	V
DC Input Voltage	V_{IN}	−0.5 ~V_{CC}+0.5	V
DC Output Voltage	V_{OUT}	−0.5 ~V_{CC}+0.5	V
Input Diode Current	I_{IK}	±20	mA
Output Diode Current	I_{OK}	±50	mA
DC Output Current	I_{OUT}	±50	mA
DC V_{CC}/Ground Current	I_{CC}	±150	mA
Power Dissipation	P_D	500(DIP)*/180(SOP)	mW
Storage Temperature	T_{stg}	−65 ~150	℃
Lead Temperature 10sec	T_L	300	℃

*500mW in the range of Ta= −40℃~ 65℃. From Ta=65℃ to 85℃ a derating factor of −10mW/℃ shall be applied until 300mW.

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	V_{CC}	2.0~5.5	V
Input Voltage	V_{IN}	0 ~ V_{CC}	V
Output Voltage	V_{OUT}	0 ~ V_{CC}	V
Operating Temperature	T_{opr}	−40 ~ 85	℃
Input Rise and Fall Time	dt/dv	0~100(V_{CC}=3.3±0.3V) 0~ 20(V_{CC}= 5 ±0.5V)	ns/v

DC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION		V_{CC}	Ta=25℃ MIN.	Ta=25℃ TYP.	Ta=25℃ MAX.	Ta=−40~85℃ MIN.	Ta=−40~85℃ MAX.	UNIT
High−Level Input Voltage	V_{IH}			2.0 3.0 5.5	1.50 2.10 3.85	− − −	− − −	1.50 2.10 3.85	− − −	V
Low−Level Input Voltage	V_{IL}			2.0 3.0 5.5	− − −	− − −	0.50 0.90 1.65	− − −	0.50 0.90 1.65	V
High−Level Output Voltage	V_{OH}	V_{IN}= V_{IH} or V_{IL}	I_{OH}=−50μA	2.0 3.0 4.5	1.9 2.9 4.4	2.0 3.0 4.5	− − −	1.9 2.9 4.4	− − −	V
			I_{OH}=−4mA I_{OH}=−24mA I_{OH}=−75mA*	3.0 4.5 5.5	2.58 3.94 −	− − −	− − −	2.48 3.80 3.85	− − −	
Low−Level Output Voltage	V_{OL}	V_{IN}= V_{IH} or V_{IL}	I_{OL}=50μA	2.0 3.0 4.5	− − −	0.0 0.0 0.0	0.1 0.1 0.1	− − −	0.1 0.1 0.1	V
			I_{OL}=12mA I_{OL}=24mA I_{OL}=75mA*	3.0 4.5 5.5	− − −	− − −	0.36 0.36 −	− − −	0.44 0.44 1.65	
Input Leakage Current	I_{IN}	V_{IN} =V_{CC} or GND		5.5	−	−	±0.1	−	±1.0	μA
Quiescent Supply Current	I_{CC}	V_{IN} =V_{CC} or GND		5.5	−	−	8.0	−	80.0	

* :This spec indicates the capability of driving 50Ω transmission lines.
One output should be tested at a time for a 10ms maximum duration.

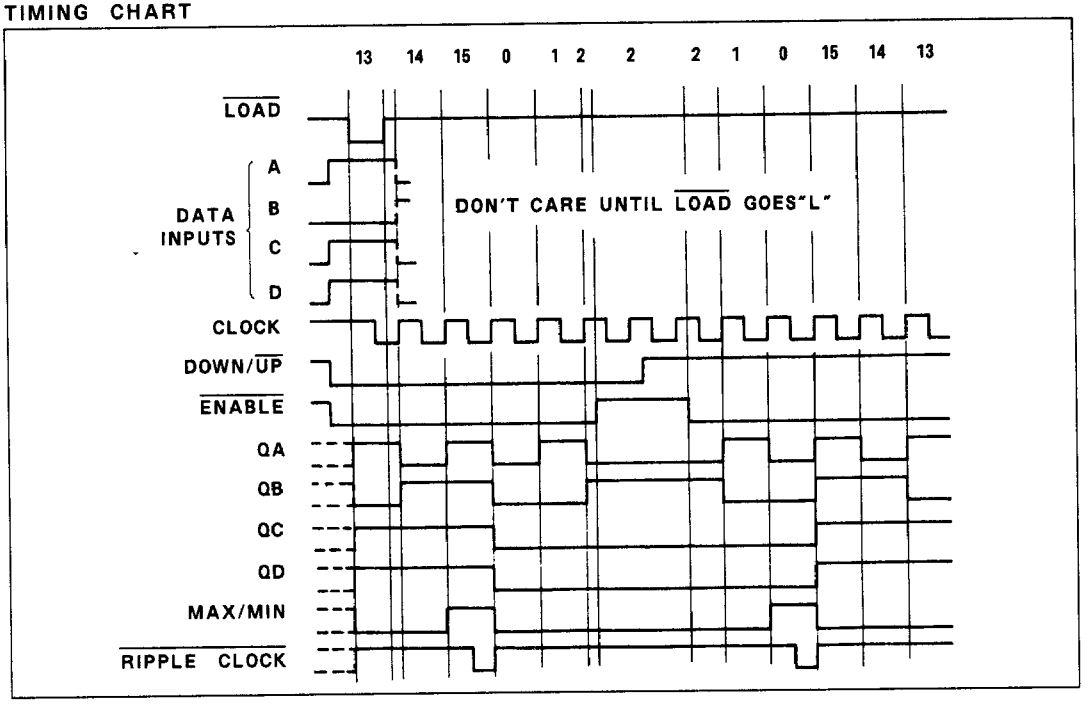
TRUTH TABLE

INPUTS				OUTPUTS				FUNCTION
$\overline{LOAD}$	$\overline{ENABLE}$	D/$\overline{U}$	CLOCK	QA	QB	QC	QD	
L	X	X	X	a	b	c	d	PRESET DATA
H	L	L	↑	UP COUNT				UP COUNT
H	L	H	↑	DOWN COUNT				DOWN COUNT
H	H	X	↑	NO CHANGE				NO COUNT
H	X	X	↓	NO CHANGE				NO COUNT

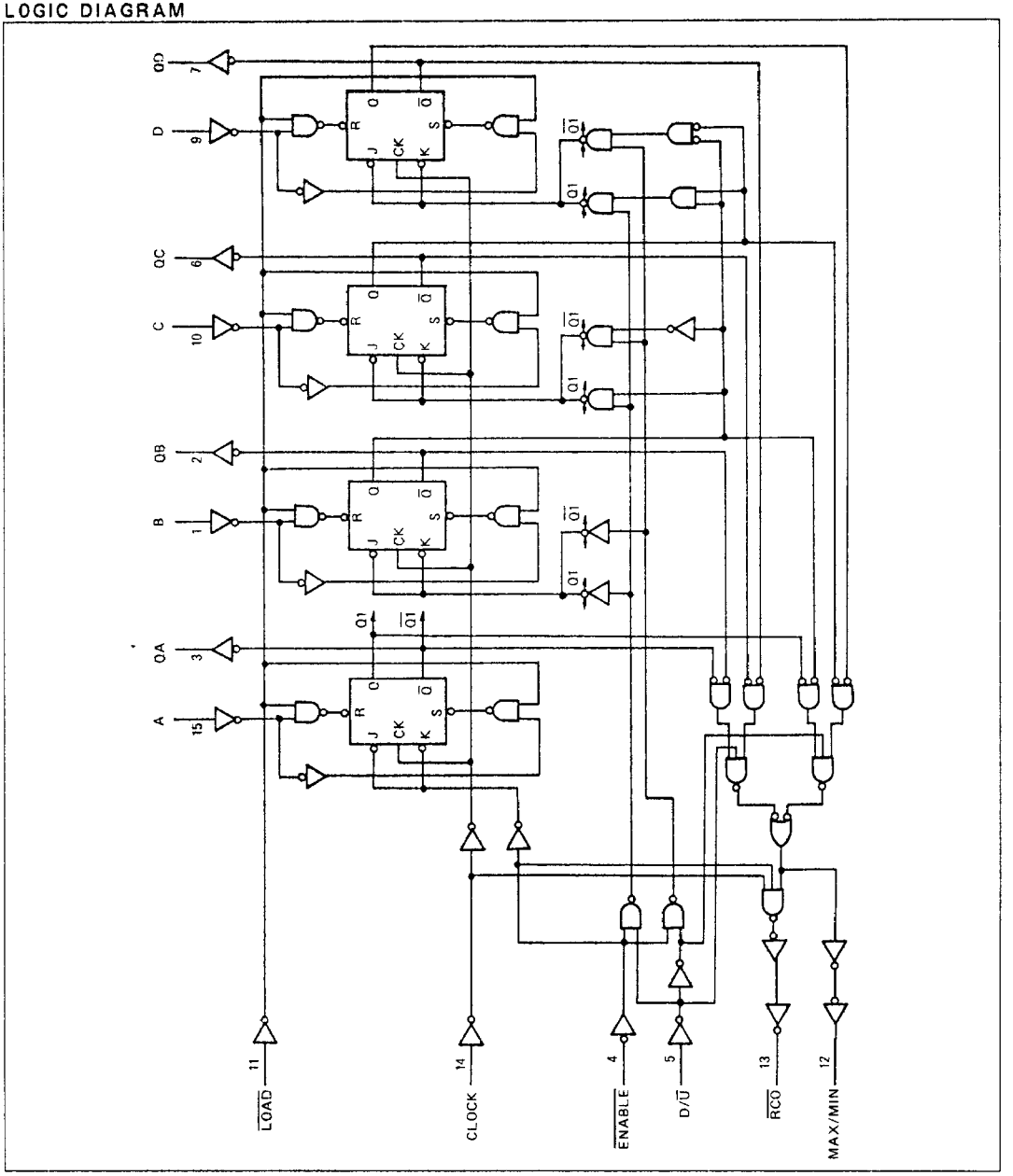
NOTE X:DON'T CARE

a~d:Inputs Level of A~D

TIMING CHART



LOGIC DIAGRAM



TIMING REQUIREMENTS(Input $t_r=t_f=3ns$)

PARAMETER	SYMBOL	TEST CONDITION		Ta=25℃		Ta=−40 ~85℃	UNIT
			V_{CC}	TYP.	LIMIT	LIMIT	
Minimum Pulse Width (CK)	$t_{W(H)}$ $t_{W(L)}$		3.3±0.3 5.0±0.5	− −			ns
Minimum Pulse Width ($\overline{LOAD}$)	$t_{W(L)}$		3.3±0.3 5.0±0.5	− −			
Minimum Set−up Time ($\overline{ENABLE}$, D/$\overline{U}$)	t_s		3.3±0.3 5.0±0.5	− −			
Minimum Set−up Time (DATA−$\overline{LOAD}$)	t_s		3.3±0.3 5.0±0.5	− −			
Minimum Hold Time ($\overline{ENABLE}$, D/$\overline{U}$)	t_h		3.3±0.3 5.0±0.5	− −			
Minimum Hold Time (DATA−$\overline{LOAD}$)	t_h		3.3±0.3 5.0±0.5	− −			
Minimum Removal Time	t_{rem}		3.3±0.3 5.0±0.5	− −			

AC ELECTRICAL CHARACTERISTICS($C_L=50pF$, $R_L=500\Omega$, Input $t_r=t_f=3ns$)

PARAMETER	SYMBOL	TEST CONDITION		Ta=25℃			Ta=−40~85℃		UNIT
			V_{CC}	MIN.	TYP.	MAX.	MIN.	MAX.	
Propagation Delay Time (CK−Q)	t_{pLH} t_{pHL}		3.3±0.3 5.0±0.5	− −			1.0 1.0		ns
Propagation Delay Time (CK−$\overline{RCO}$)	t_{pLH} t_{pHL}		3.3±0.3 5.0±0.5	− −			1.0 1.0		
Propagation Delay Time (CK−MAX/MIN)	t_{pLH} t_{pHL}		3.3±0.3 5.0±0.5	− −			1.0 1.0		
Propagation Delay Time ($\overline{LOAD}$−Q)	t_{pLH} t_{pHL}		3.3±0.3 5.0±0.5	− −			1.0 1.0		
Propagation Delay Time (DATA−Q)	t_{pLH} t_{pHL}		3.3±0.3 5.0±0.5	− −			1.0 1.0		
Propagation Delay Time ($\overline{ENABLE}$−$\overline{RCO}$)	t_{pLH} t_{pHL}		3.3±0.3 5.0±0.5	− −			1.0 1.0		
Propagation Delay Time (D/$\overline{U}$−$\overline{RCO}$)	t_{pLH} t_{pHL}		3.3±0.3 5.0±0.5	− −			1.0 1.0		
Propagation Delay Time (D/$\overline{U}$−MAX/MIN)	t_{pLH} t_{pHL}		3.3±0.3 5.0±0.5	− −			1.0 1.0		

AC ELECTRICAL CHARACTERISTICS(C_L=50pF, R_L=500Ω, Input t_r=t_f=3ns)

PARAMETER	SYMBOL	TEST CONDITION		Ta=25℃			Ta=−40~85℃		UNIT
			V_{CC}	MIN.	TYP.	MAX.	MIN.	MAX.	
Maximum Clock Frequency	f_{MAX}		3.3±0.3 5.0±0.5			– –		– –	MHz
Input Capacitance	C_{IN}			–	5	10	–	10	pF
Power Dissipation Capacitance	C_{PD}(1)			–		–	–	–	

Note (1) C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.
Average operating current can be obtained by the equation:

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$