

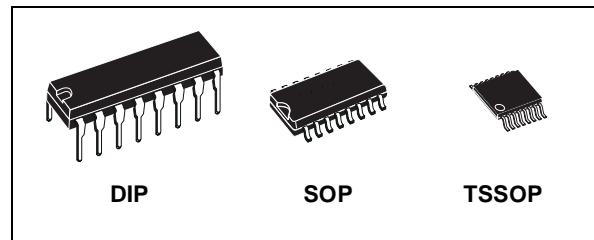
4 BIT SYNCHRONOUS UP/DOWN COUNTERS

- HIGH SPEED :
 $f_{MAX} = 61$ MHz (TYP.) at $V_{CC} = 6V$
- LOW POWER DISSIPATION:
 $I_{CC} = 4\mu A$ (MAX.) at $T_A=25^\circ C$
- HIGH NOISE IMMUNITY:
 $V_{NIH} = V_{NIL} = 28\%$ V_{CC} (MIN.)
- SYMMETRICAL OUTPUT IMPEDANCE:
 $|I_{OHI}| = I_{OL} = 4mA$ (MIN)
- BALANCED PROPAGATION DELAYS:
 $t_{PLH} \approx t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE:
 V_{CC} (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE WITH
74 SERIES 191

DESCRIPTION

The M74HC191 is an high speed CMOS 4-BIT SYNCHRONOUS UP/DOWN COUNTER fabricated with silicon gate C²MOS technology. State changes of the counter are synchronous with the LOW-to-HIGH transition of the Clock Pulse Input.

An asynchronous parallel load input overrides counting and loads the data present on the DATA inputs into the flip-flops, which makes it possible to use the circuits as programmable counters. A count enable input serves as the carry/borrow



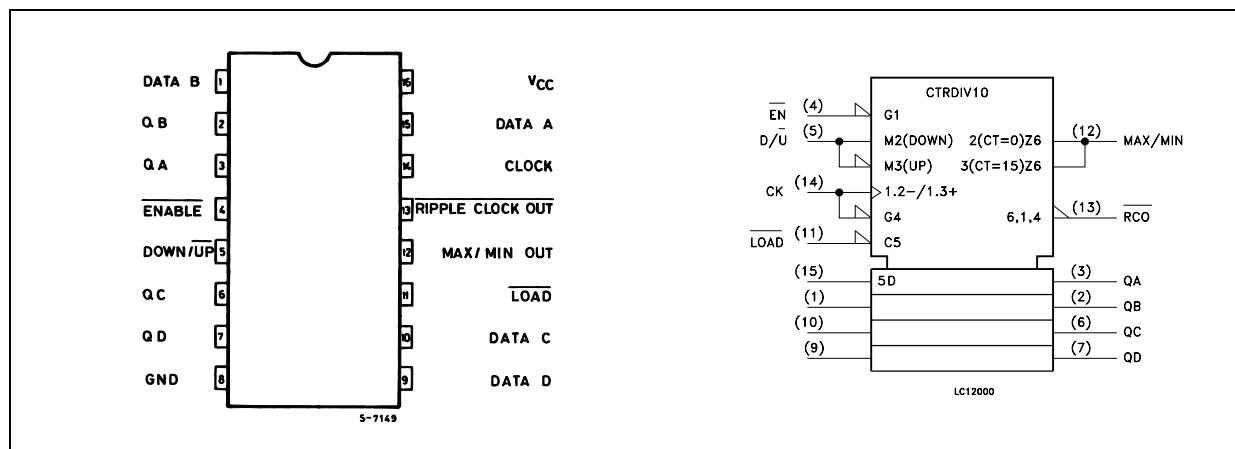
ORDER CODES

PACKAGE	TUBE	T & R
DIP	M74HC191B1R	
SOP	M74HC191M1R	M74HC191RM13TR
TSSOP		M74HC191TTR

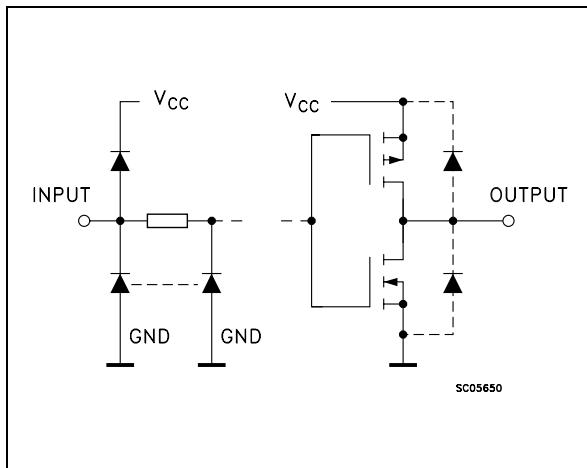
input in multi-stage counters. Control input, Down/Up, determines whether a circuit counts up or down. A MAX/MIN output and a Ripple Clock output provide overflow/underflow indication and make possible a variety of methods for generating carry/borrow signals in multi-stage counter applications.

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

PIN CONNECTION AND IEC LOGIC SYMBOLS



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

PIN No	SYMBOL	NAME AND FUNCTION
3, 2, 6, 7	QA to QD	Flip-Flop Outputs
4	ENABLE	Count Enable Input (Active LOW)
5	U/D	Parallel Data Input
11	LOAD	Load Input (Active LOW)
12	MA/MI OUT	Terminal Count Output
13	RC	Ripple Clock Output (Active LOW)
14	CLOCK	Clock Input (LOW to HIGH, edge triggered)
15, 1, 10, 9	DA to DD	Data Inputs
8	GND	Ground (0V)
16	Vcc	Positive Supply Voltage

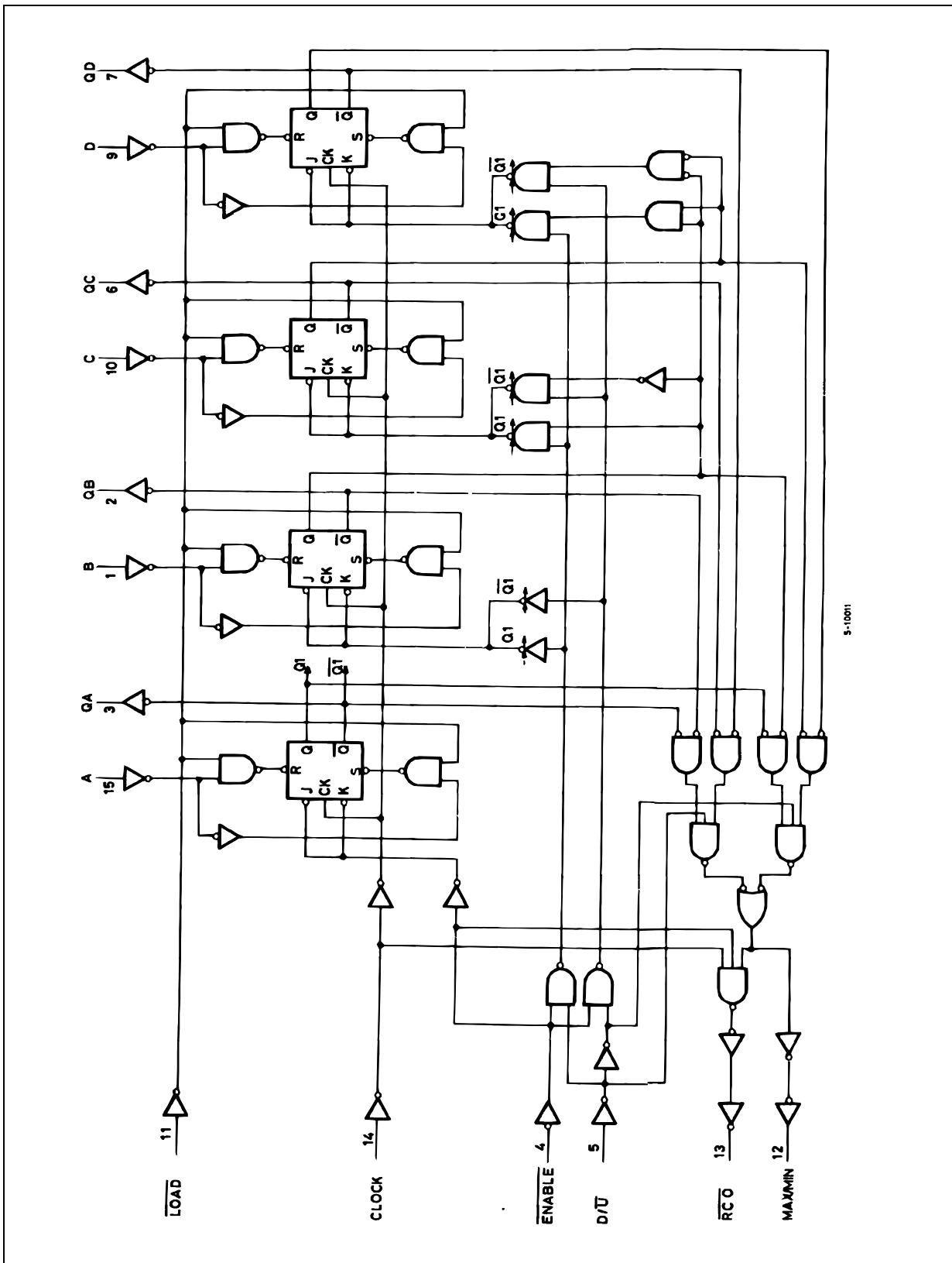
TRUTH TABLE

INPUTS				OUTPUTS				FUNCTION
LOAD	ENABLE	D/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

X : Don't Care

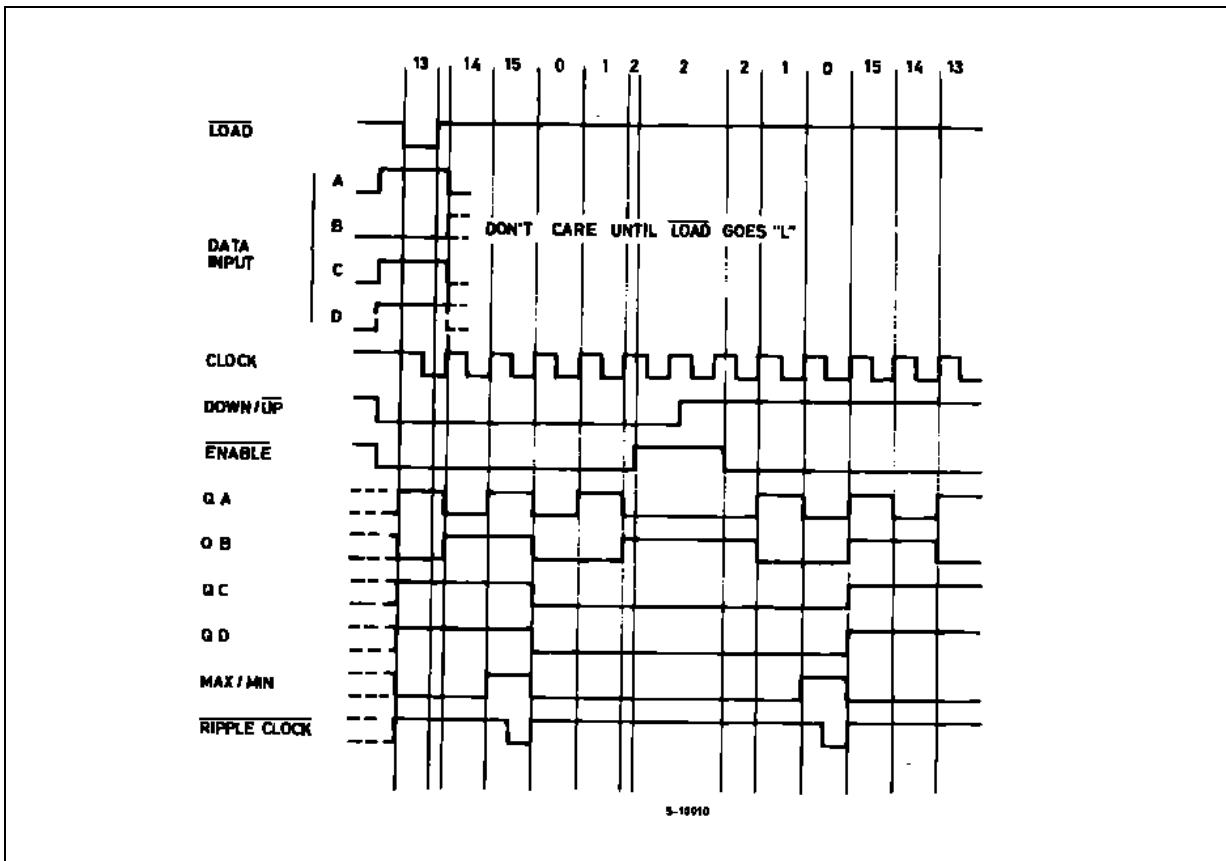
a - d : The level of steady state inputs a through d respectively

LOGIC DIAGRAM



This logic diagram has not been used to estimate propagation delays

TIMING CHART



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	-0.5 to +7	V
V_I	DC Input Voltage	-0.5 to $V_{CC} + 0.5$	V
V_O	DC Output Voltage	-0.5 to $V_{CC} + 0.5$	V
I_{IK}	DC Input Diode Current	± 20	mA
I_{OK}	DC Output Diode Current	± 20	mA
I_O	DC Output Current	± 25	mA
I_{CC} or I_{GND}	DC V_{CC} or Ground Current	± 50	mA
P_D	Power Dissipation	500(*)	mW
T_{stg}	Storage Temperature	-65 to +150	°C
T_L	Lead Temperature (10 sec)	300	°C

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

(*) 500mW at 65 °C; derate to 300mW by 10mW/°C from 65°C to 85°C

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Value			Unit
V_{CC}	Supply Voltage	2 to 6			V
V_I	Input Voltage	0 to V_{CC}			V
V_O	Output Voltage	0 to V_{CC}			V
T_{op}	Operating Temperature	-55 to 125			°C
t_r, t_f	Input Rise and Fall Time	$V_{CC} = 2.0V$	0 to 1000		ns
		$V_{CC} = 4.5V$	0 to 500		ns
		$V_{CC} = 6.0V$	0 to 400		ns

DC SPECIFICATIONS

Symbol	Parameter	Test Condition		Value						Unit	
		V_{CC} (V)		$T_A = 25^\circ C$			$-40 \text{ to } 85^\circ C$		$-55 \text{ to } 125^\circ C$		
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
V_{IH}	High Level Input Voltage	2.0		1.5			1.5		1.5		V
		4.5		3.15			3.15		3.15		
		6.0		4.2			4.2		4.2		
V_{IL}	Low Level Input Voltage	2.0			0.5		0.5		0.5		V
		4.5			1.35		1.35		1.35		
		6.0			1.8		1.8		1.8		
V_{OH}	High Level Output Voltage	2.0	$I_O = -20 \mu A$	1.9	2.0		1.9		1.9		V
		4.5	$I_O = -20 \mu A$	4.4	4.5		4.4		4.4		
		6.0	$I_O = -20 \mu A$	5.9	6.0		5.9		5.9		
		4.5	$I_O = -4.0 mA$	4.18	4.31		4.13		4.10		
		6.0	$I_O = -5.2 mA$	5.68	5.8		5.63		5.60		
V_{OL}	Low Level Output Voltage	2.0	$I_O = 20 \mu A$		0.0	0.1		0.1		0.1	V
		4.5	$I_O = 20 \mu A$		0.0	0.1		0.1		0.1	
		6.0	$I_O = 20 \mu A$		0.0	0.1		0.1		0.1	
		4.5	$I_O = 4.0 mA$		0.17	0.26		0.33		0.40	
		6.0	$I_O = 5.2 mA$		0.18	0.26		0.33		0.40	
I_I	Input Leakage Current	6.0	$V_I = V_{CC} \text{ or GND}$			± 0.1		± 1		± 1	μA
I_{CC}	Quiescent Supply Current	6.0	$V_I = V_{CC} \text{ or GND}$			4		40		80	μA

M74HC191

AC ELECTRICAL CHARACTERISTICS ($C_L = 50 \text{ pF}$, Input $t_r = t_f = 6\text{ns}$)

Symbol	Parameter	Test Condition			Value						Unit	
		V_{CC} (V)	$T_A = 25^\circ\text{C}$			$-40 \text{ to } 85^\circ\text{C}$		$-55 \text{ to } 125^\circ\text{C}$				
			Min.	Typ.	Max.	Min.	Max.	Min.	Max.			
t_{TLH} t_{THL}	Output Transition Time	2.0		30	75		95		110	ns		
		4.5		8	15		19		22			
		6.0		7	13		16		19			
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK - Q)	2.0		92	180		225		270	ns		
		4.5		23	36		45		54			
		6.0		20	31		38		46			
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK - RCO)	2.0		39	120		150		180	ns		
		4.5		13	24		30		36			
		6.0		11	20		26		31			
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK - MAX/MIN)	2.0		120	240		300		360	ns		
		4.5		30	48		60		72			
		6.0		26	41		51		61			
t_{PLH} t_{PHL}	Propagation Delay Time (LOAD - Q)	2.0		108	205		255		310	ns		
		4.5		27	41		51		61			
		6.0		23	35		43		53			
t_{PLH} t_{PHL}	Propagation Delay Time (DATA - Q)	2.0		84	175		220		265	ns		
		4.5		21	35		44		53			
		6.0		18	30		37		45			
t_{PLH} t_{PHL}	Propagation Delay Time (ENABLE - RCO)	2.0		39	105		130		160	ns		
		4.5		13	21		26		32			
		6.0		11	18		22		27			
t_{PLH} t_{PHL}	Propagation Delay Time (D/U - RCO)	2.0		63	180		225		270	ns		
		4.5		21	36		45		54			
		6.0		18	31		38		46			
t_{PLH} t_{PHL}	Propagation Delay Time (D/U - MAX/MIN)	2.0		64	160		200		240	ns		
		4.5		18	32		40		48			
		6.0		15	27		34		41			
f_{MAX}	Maximum Clock Frequency	2.0		6.2	9		4		3.4	MHz		
		4.5		31	37		20		17			
		6.0		37	44		24		20			
$t_{W(H)}$ $t_{W(L)}$	Minimum Pulse Width (CLOCK)	2.0		40	100		125		150	ns		
		4.5		10	20		25		30			
		6.0		9	17		21		26			
$t_{W(L)}$	Minimum Pulse Width (LOAD)	2.0		36	75		95		110	ns		
		4.5		9	15		19		22			
		6.0		8	13		16		19			
t_s	Minimum Set-up Time(SI, PI - CK)	2.0		80	175		220		265	ns		
		4.5		20	35		44		53			
		6.0		17	30		37		45			
t_s	Minimum Set-up Time(S0, S1 - CK)	2.0		16	50		60		75	ns		
		4.5		4	10		12		15			
		6.0		3	9		11		13			
t_h	Minimum Hold Time	2.0			0		0		0	ns		
		4.5			0		0		0			
		6.0			0		0		0			

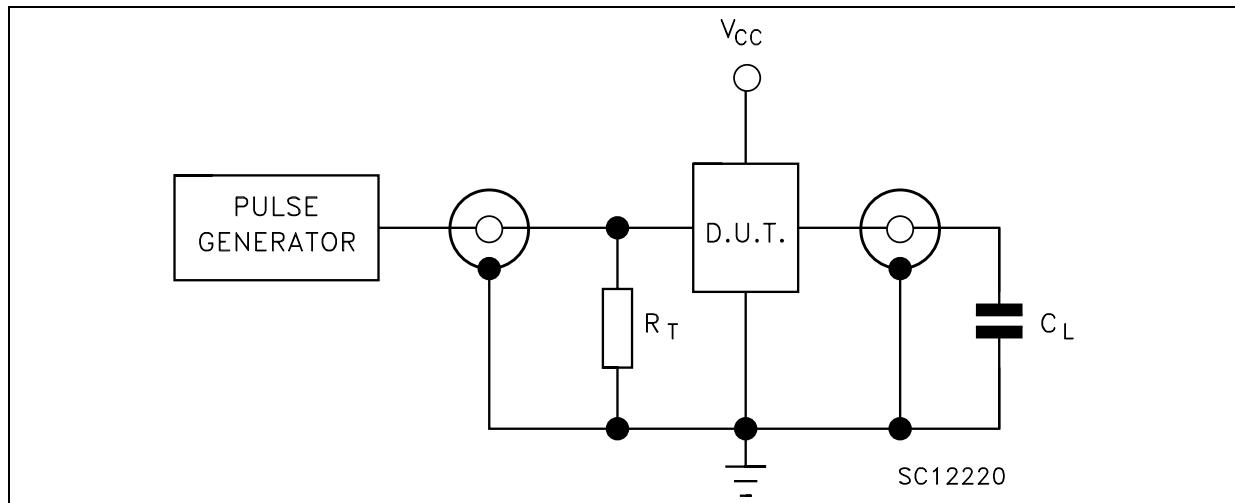
Symbol	Parameter	Test Condition		Value						Unit		
		V _{CC} (V)		T _A = 25°C			-40 to 85°C		-55 to 125°C			
				Min.	Typ.	Max.	Min.	Max.	Min.			
t _{REM}	Minimum Removal Time (CLEAR)	2.0			12	50		60		65	ns	
		4.5			3	10		12		15		
		6.0			3	9		11		13		

CAPACITIVE CHARACTERISTICS

Symbol	Parameter	Test Condition		Value						Unit		
		V _{CC} (V)		T _A = 25°C			-40 to 85°C		-55 to 125°C			
				Min.	Typ.	Max.	Min.	Max.	Min.			
C _{IN}	Input Capacitance	5.0			5	10		10		10	pF	
C _{PD}	Power Dissipation Capacitance (note 1)	5.0			112						pF	

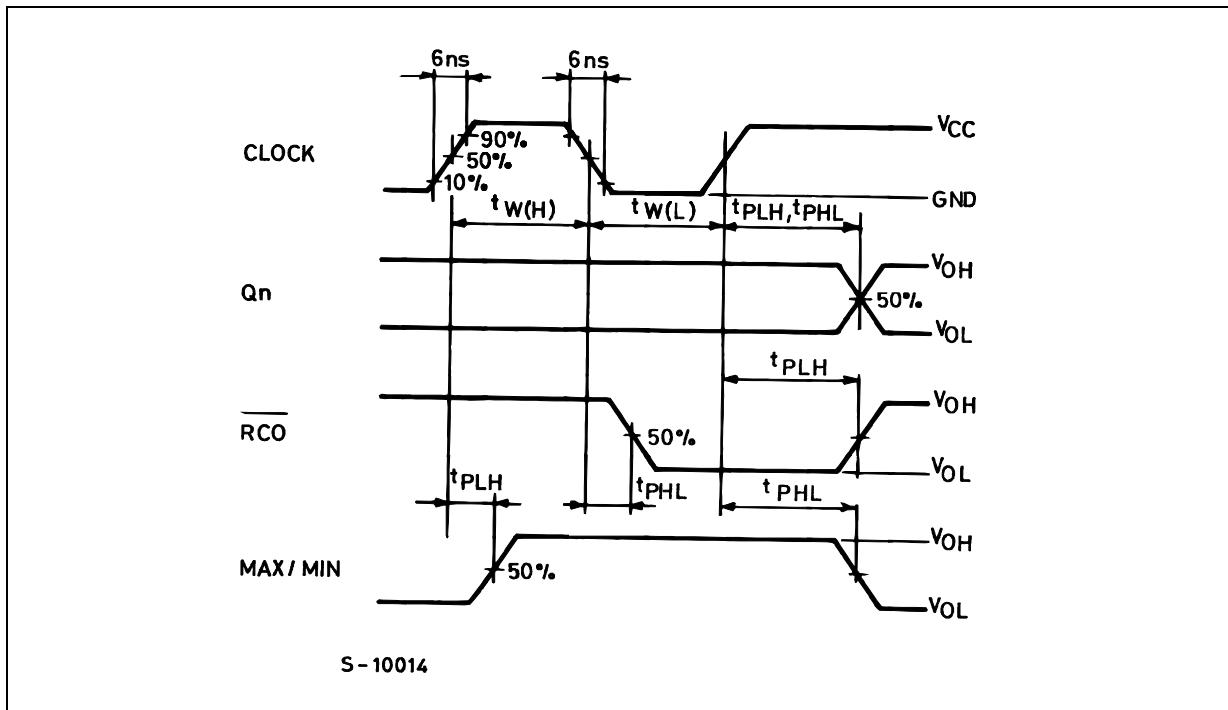
1) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. I_{CC(opr)} = C_{PD} × V_{CC} × f_{IN} + I_{CC}

TEST CIRCUIT

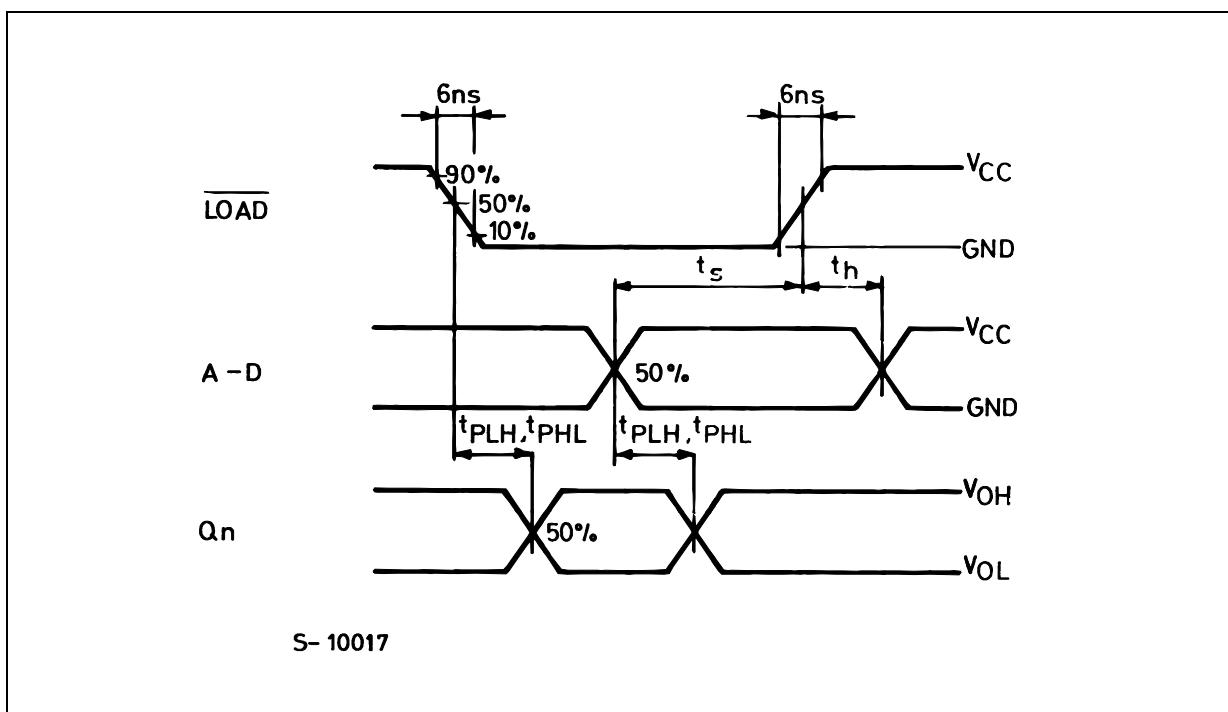


C_L = 50pF or equivalent (includes jig and probe capacitance)
R_T = Z_{OUT} of pulse generator (typically 50Ω)

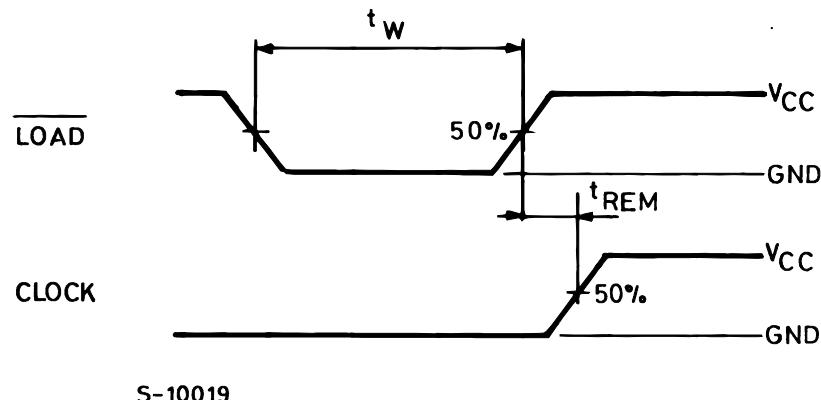
WAVEFORM 1: PROPAGATION DELAY TIME, MINIMUM PULSE WIDTH (CLOCK) (f=1MHz; 50% duty cycle)



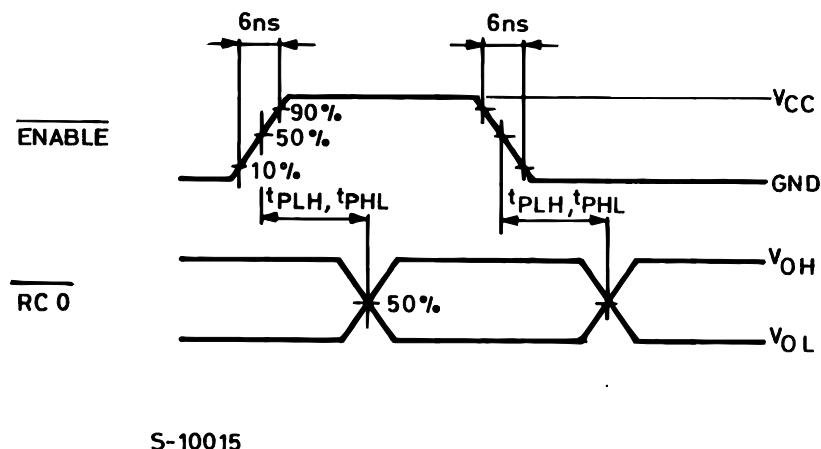
WAVEFORM 2 : PROPAGATION DELAY TIME, SETUP AND HOLD TIME (A-D TO LOAD) (f=1MHz; 50% duty cycle)



WAVEFORM 3 : MINIMUM PULSE WIDTH (LOAD) AND REMOVAL TIME (LOAD TO CLOCK)
(f=1MHz; 50% duty cycle)

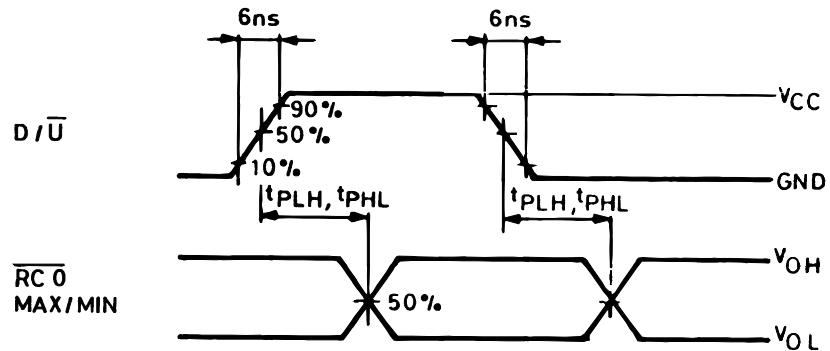


WAVEFORM 4 : PROPAGATION DELAY TIME (f=1MHz; 50% duty cycle)



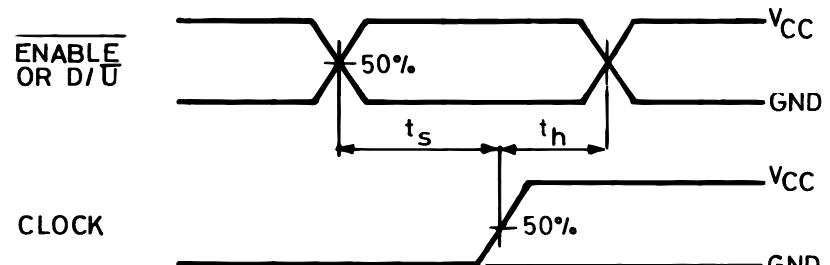
M74HC191

WAVEFORM 5 : PROPAGATION DELAY TIME (f=1MHz; 50% duty cycle)



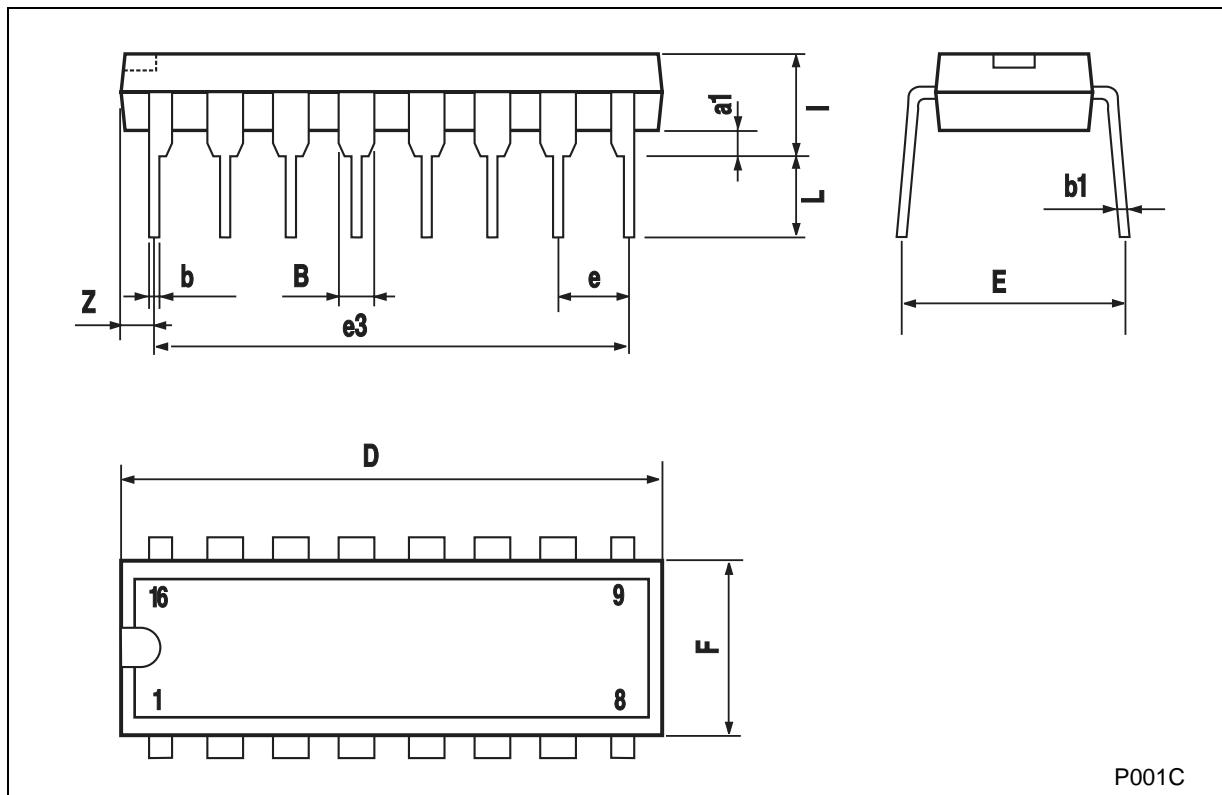
S-10016

WAVEFORM 6 : SETUP AND HOLD TIME (f=1MHz; 50% duty cycle)



S-10018

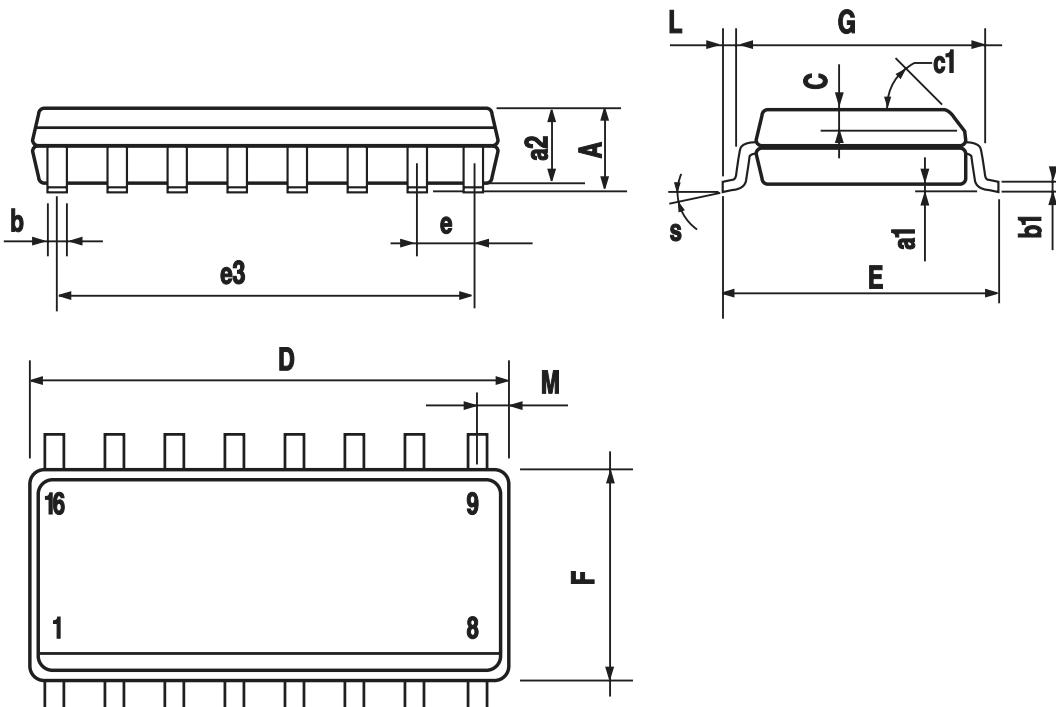
Plastic DIP-16 (0.25) MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050



P001C

SO-16 MECHANICAL DATA

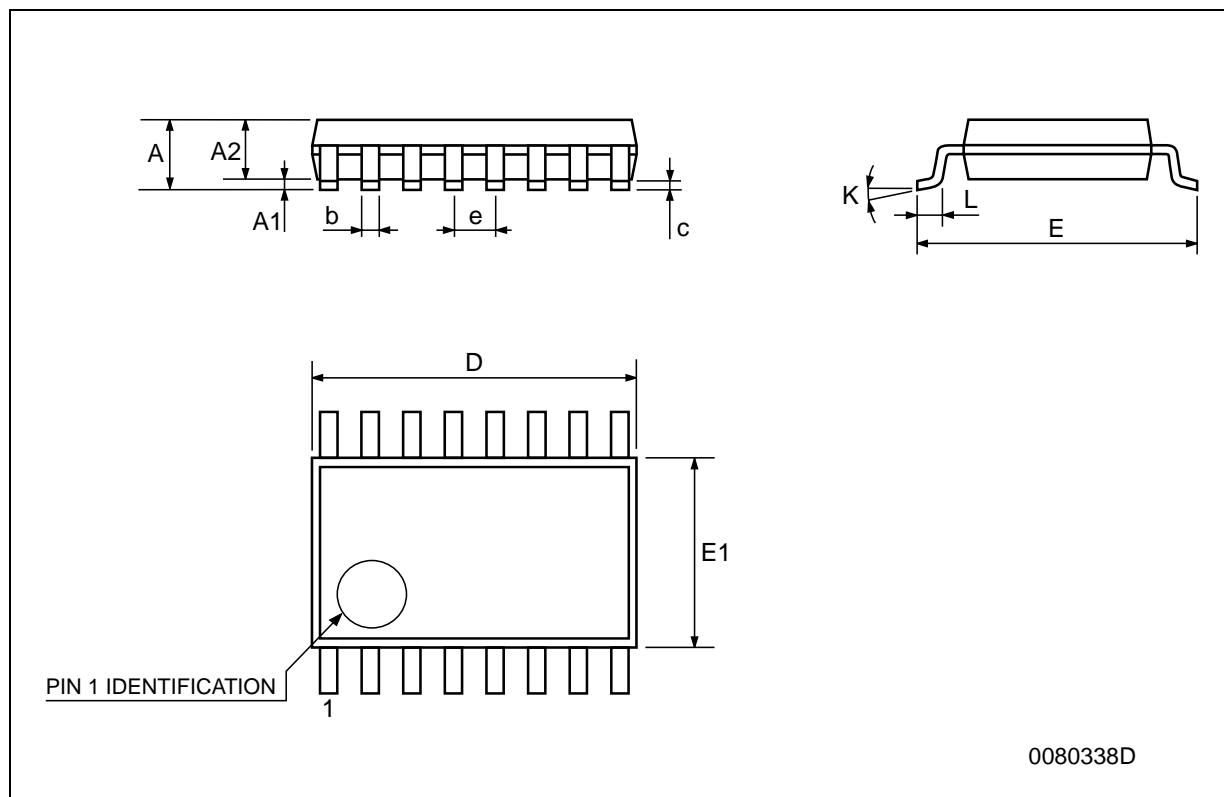
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1		45° (typ.)				
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.62			0.024
S		8° (max.)				



PO13H

TSSOP16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.9	5	5.1	0.193	0.197	0.201
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030



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