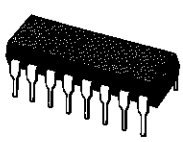
SGS-THOMSON MICROELECTRONICS

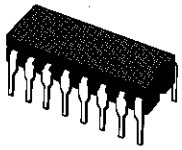
M54/M74HC190
M54/M74HC191

4 BIT SYNCHRONOUS UP/DOWN COUNTERS

- HIGH SPEED
  f_{MAX} = 48 MHz (TYP.) AT V_{CC} = 5 V
- LOW POWER DISSIPATION
  I_{CC} = 4 µA (MAX.) AT T_A = 25 °C
- HIGH NOISE IMMUNITY
  $V_{NIH} = V_{NIL}$ = 28 % V_{CC} (MIN.)
- OUTPUT DRIVE CAPABILITY
  10 LSTTL LOADS
- SYMMETRICAL OUTPUT IMPEDANCE
  $|I_{OH}| = I_{OL}$ = 4 mA (MIN.)
- BALANCED PROPAGATION DELAYS
  $t_{PLH} = t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE
  V_{CC} (OPR) = 2 V TO 6 V
- PIN AND FUNCTION COMPATIBLE
  WITH 54/74LS190/191



B1R
(Plastic Package)



F1R
(Ceramic Package)

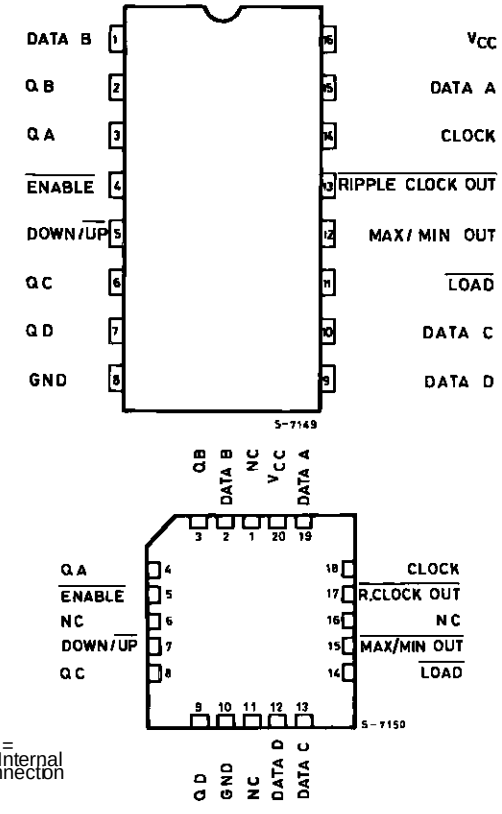
M1R
(Micro Package)

C1R
(Chip Carrier)

ORDER CODES :

M54HCXXXF1R M74HCXXXM1R
M74HCXXXB1R M74HCXXXC1R

PIN CONNECTIONS (top view)



NC = No Internal Connection

DESCRIPTION

The M54/74HC190/191 are high speed CMOS 4-BIT SYNCHRONOUS UP/DOWN COUNTERS fabricated in silicon gate C^2MOS technology.

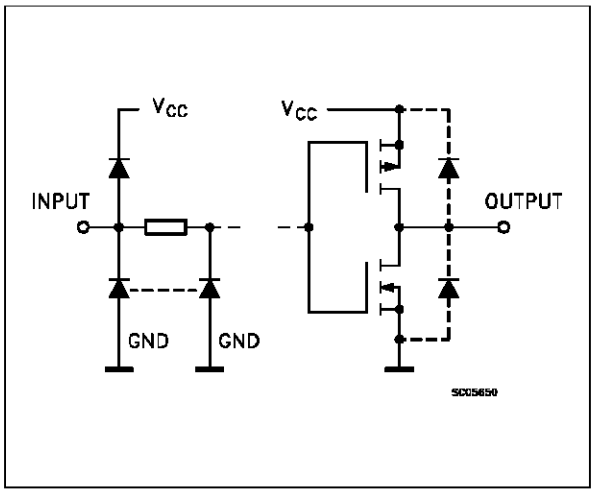
They have the same high speed performance of LSTTL combined with true CMOS low power consumption.

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 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.

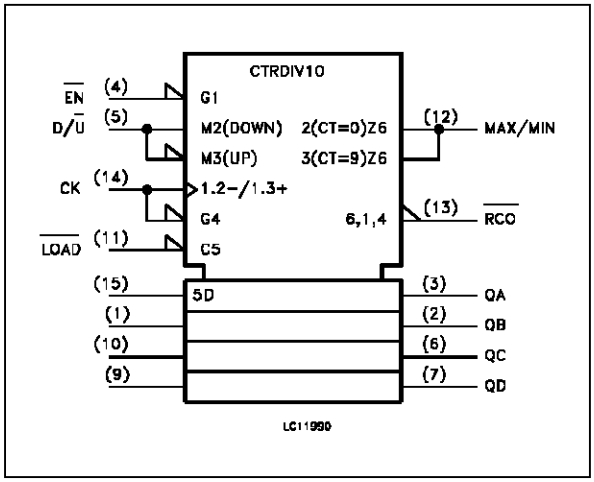
INPUT AND OUTPUT EQUIVALENT CIRCUIT



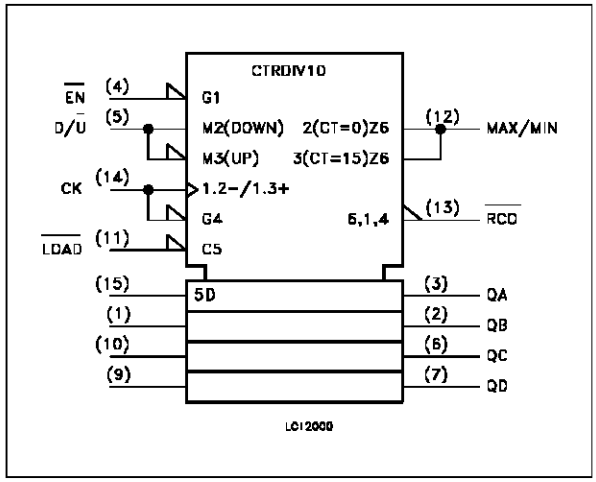
PIN DESCRIPTION

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

IEC LOGIC SYMBOL (HC190)



IEC LOGIC SYMBOL (HC191)

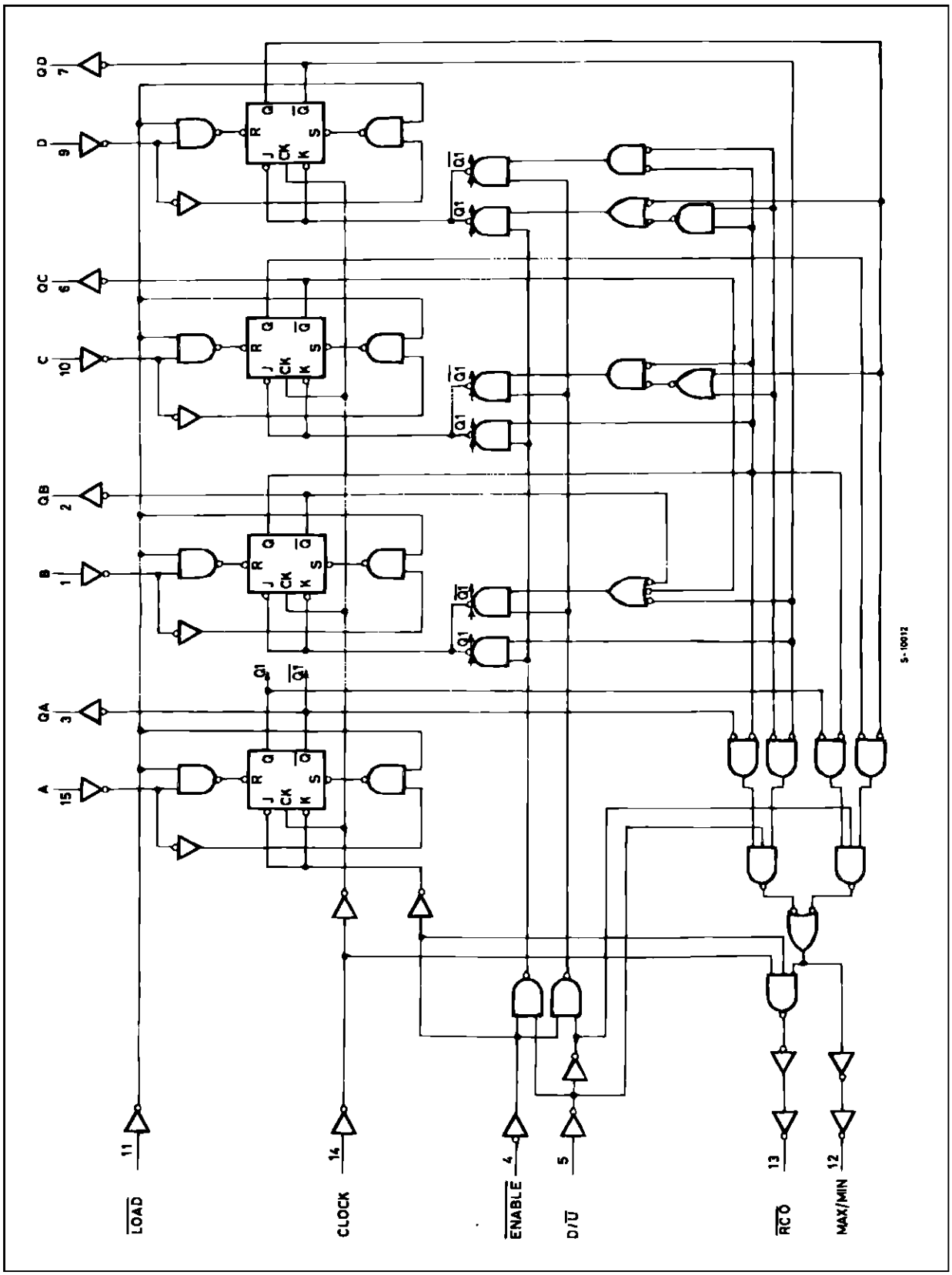


TRUTH TABLE

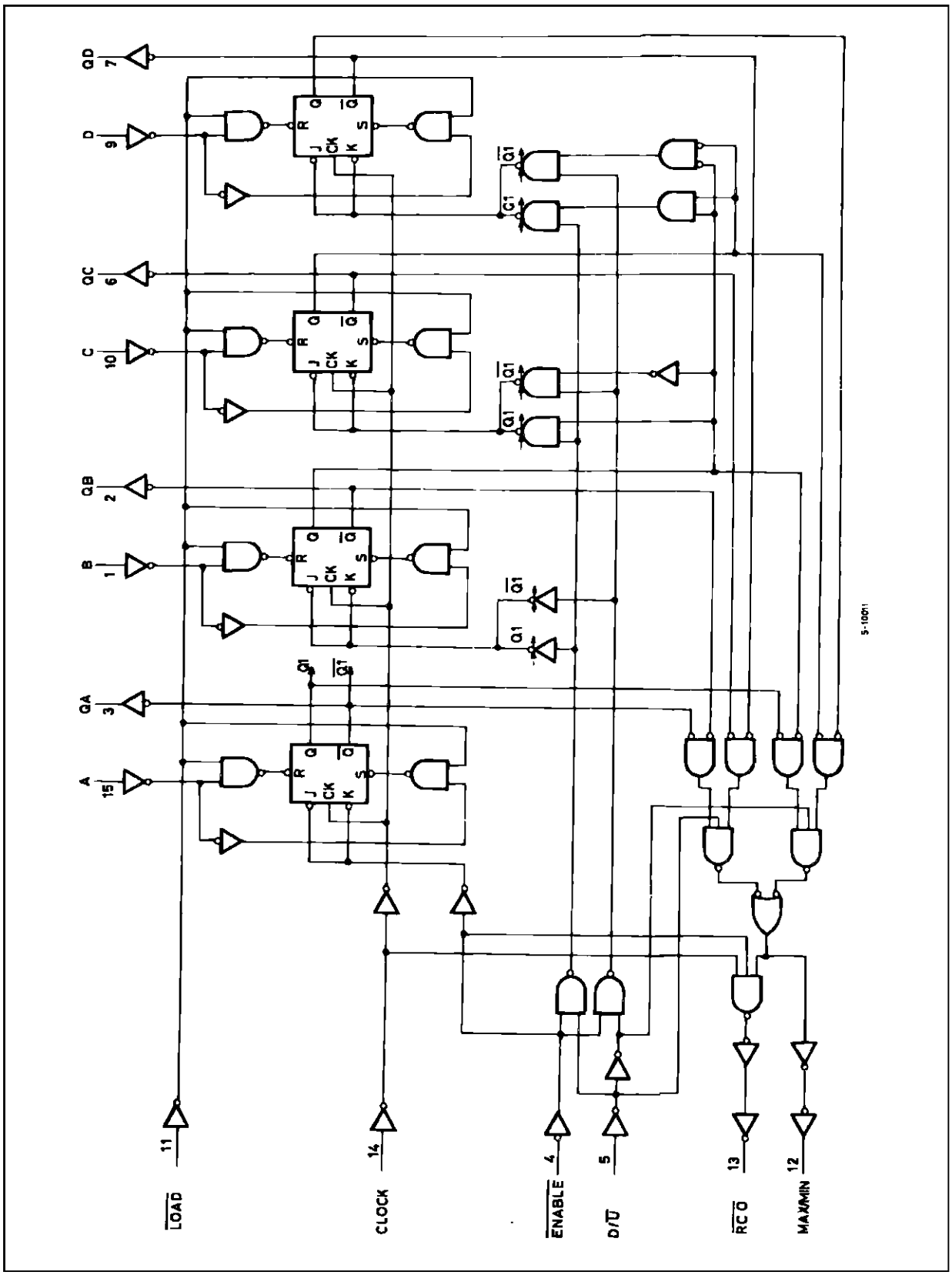
INPUTS				OUTPUS				FUNCTION
$\overline{LOAD}$	$\overline{ENABLE}$	D/$\overline{U}$	CLOCK	QA	QB	QC	QD	
L	X	X	X	a	b	c	d	PRESET DATA
H	L	L	⎍	UP COUNT				UP COUNT
H	L	H	⎍	DOWN COUNT				DOWN COUNT
H	H	X	⎍	NO CHANGE				NO COUNT
H	X	X	⎎	NO CHANGE				NO COUNT

X: Don't Care
a - d: The level of steady state inputs at inputs a through D respectively

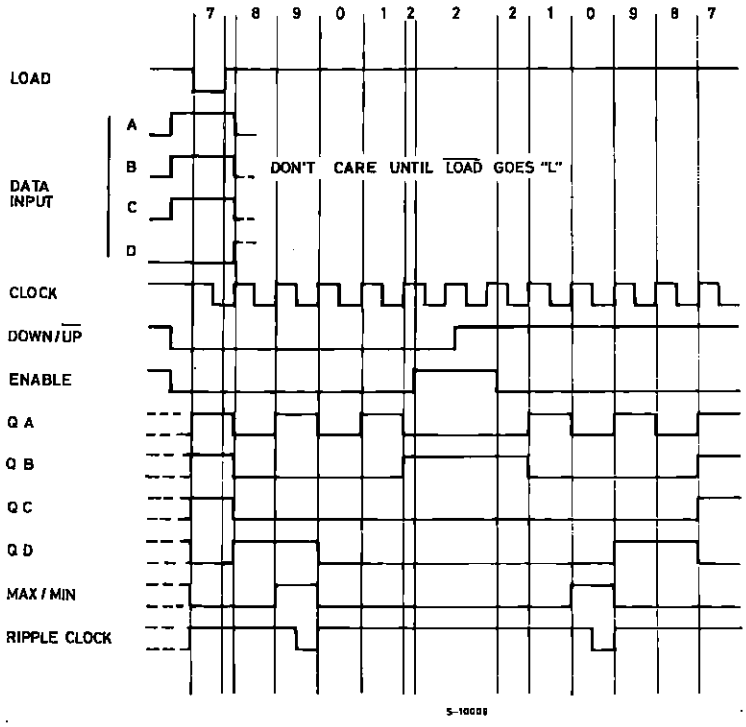
LOGIC DIAGRAM (HC190)



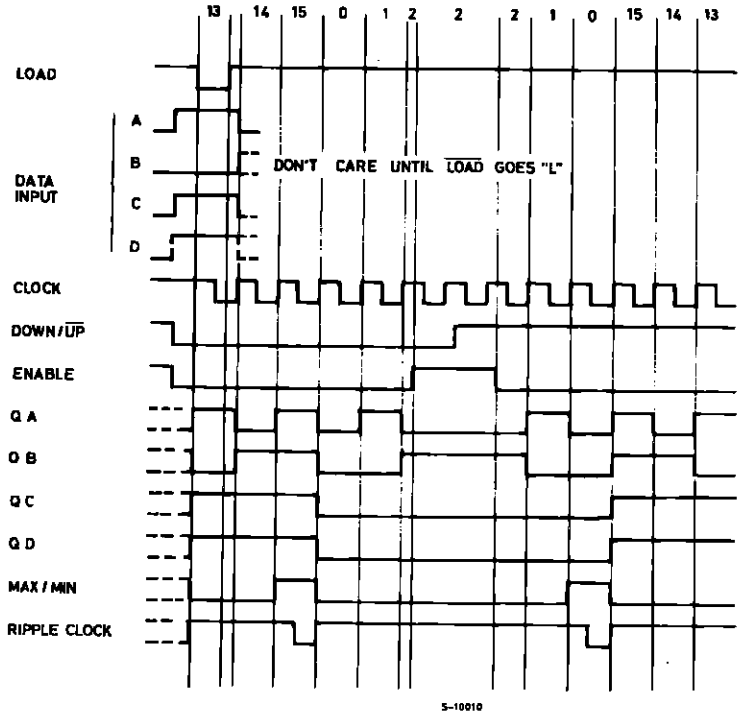
LOGIC DIAGRAM (HC191)



TIMING CHART (HC190)



TIMING CHART (HC191)



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 Source Sink Current Per Output Pin	± 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 condition is not implied.
(*) 500 mW: ≅ 65 °C derate to 300 mW by 10mW/°C: 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: **M54HC** Series **M74HC** Series		-55 to +125 -40 to +85	°C °C
t_r, t_f	Input Rise and Fall Time	V_{CC} = 2 V	0 to 1000	ns
		V_{CC} = 4.5 V	0 to 500	
		V_{CC} = 6 V	0 to 400	

DC SPECIFICATIONS

Symbol	Parameter	Test Conditions			Value							Unit
		V_{CC} (V)			T_A = 25 °C 54HC and 74HC			-40 to 85 °C 74HC		-55 to 125 °C 54HC		
					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	V_I = V_{IH} or V_{IL}	I_O=-20 µA	1.9	2.0		1.9		1.9		V
		4.5			4.4	4.5		4.4		4.4		
		6.0			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	V_I = V_{IH} or V_{IL}	I_O= 20 µA		0.0	0.1		0.1		0.1	V
		4.5				0.0	0.1		0.1		0.1	
		6.0				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} or GND				±0.1		±1		±1	µA
I_{CC}	Quiescent Supply Current	6.0	V_I = V_{CC} or GND				4		40		80	µA

AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, Input t_r = t_f = 6 ns)

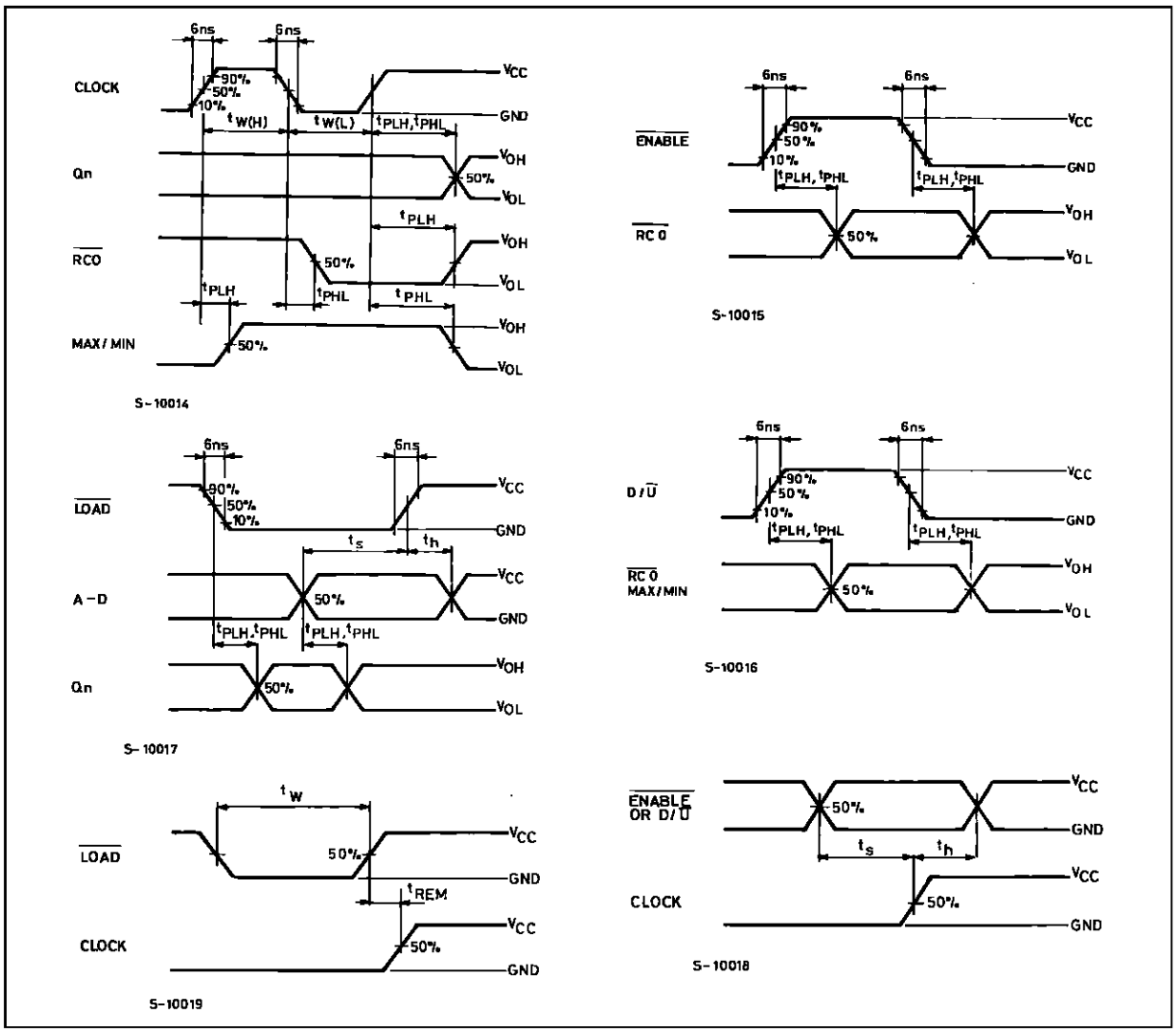
Symbol	Parameter	Test Conditions		Value						Unit
		V_{CC} (V)		T_A = 25 °C 54HC and 74HC			-40 to 85 °C 74HC		-55 to 125 °C 54HC	
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t_{TLH} t_{THL}	Output Transition Time	2.0			30	75		95		110	ns
		4.5			8	15		19		22	
		6.0			7	13		16		19	
t_{PLH} t_{PHL}	Propagation 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 - $\overline{RCO}$)	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 $\overline{Delay}$ Time (LOAD - Q)	2.0			108	205		255		310	ns
		4.5			27	41		51		62	
		6.0			23	35		43		53	

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

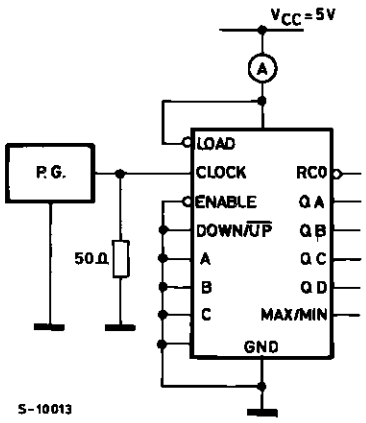
Symbol	Parameter	Test Conditions		Value							Unit
		V_{CC} (V)		T_A = 25 °C 54HC and 74HC			-40 to 85 °C 74HC		-55 to 125 °C 54HC		
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t_{PLH} t_{PHL}	Propagation Delay Time (DATA - Q)	2.0			84	175		220		265	ns
		4.5			21	35		44		53	
		6.0			18	30		37		45	
t_{PLH} 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		5	9		4		3.4		MHz
		4.5		25	37		20		17		
		6.0		30	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	
t_{REM}	Minimum Removal Time	2.0			12	50		60		5	ns
		4.5			3	10		12		15	
		6.0			3	9		11		13	
C_{IN}	Input Capacitance				5	10		10		10	pF
C_{PD} (*)	Power Dissipation Capacitance		for HC190 for HC191		111 112						pF

(*) 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 operting current can be obtained by the following equation. $I_{CC}(opr) = C_{PD} \bullet V_{CC} \bullet f_{IN} + I_{CC}$

SWITCHING CHARACTERISTICS TEST WAVEFORM



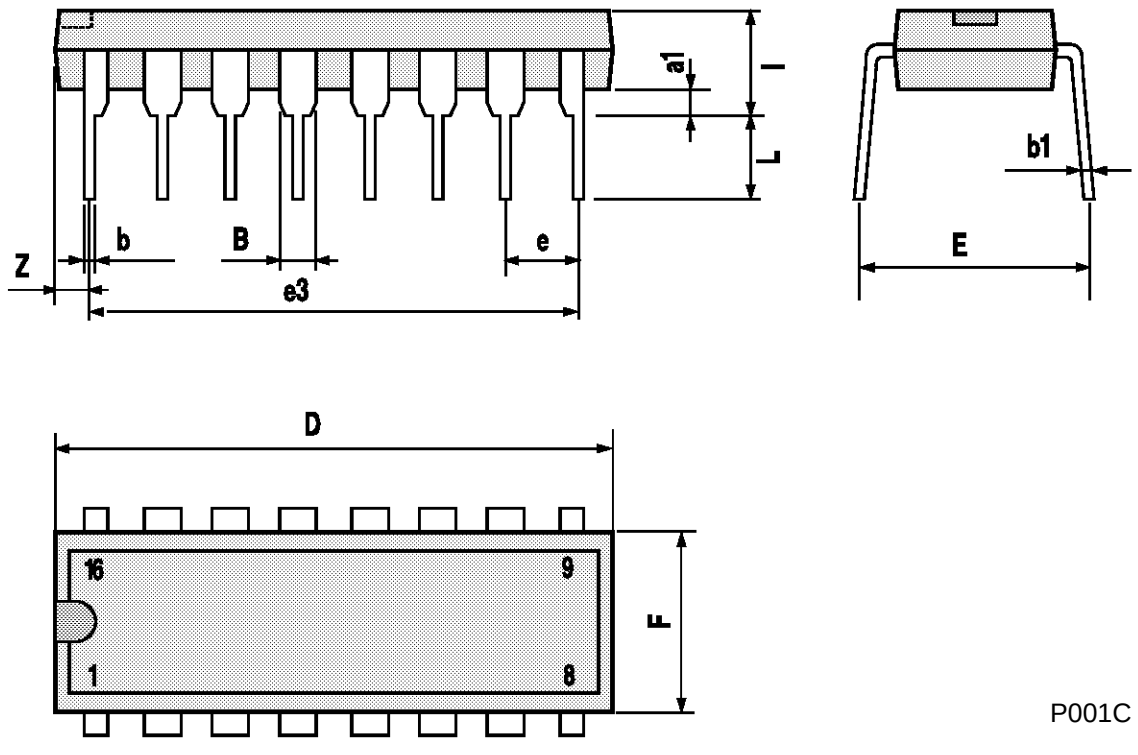
TEST CIRCUIT I_{CC} (Opr.)



INPUT TRANSITION TIME IS THE SAME AS THAT IN CASE OF SWITCHING CHARACTERISTICS TEST.

Plastic DIP16 (0.25) MECHANICAL DATA

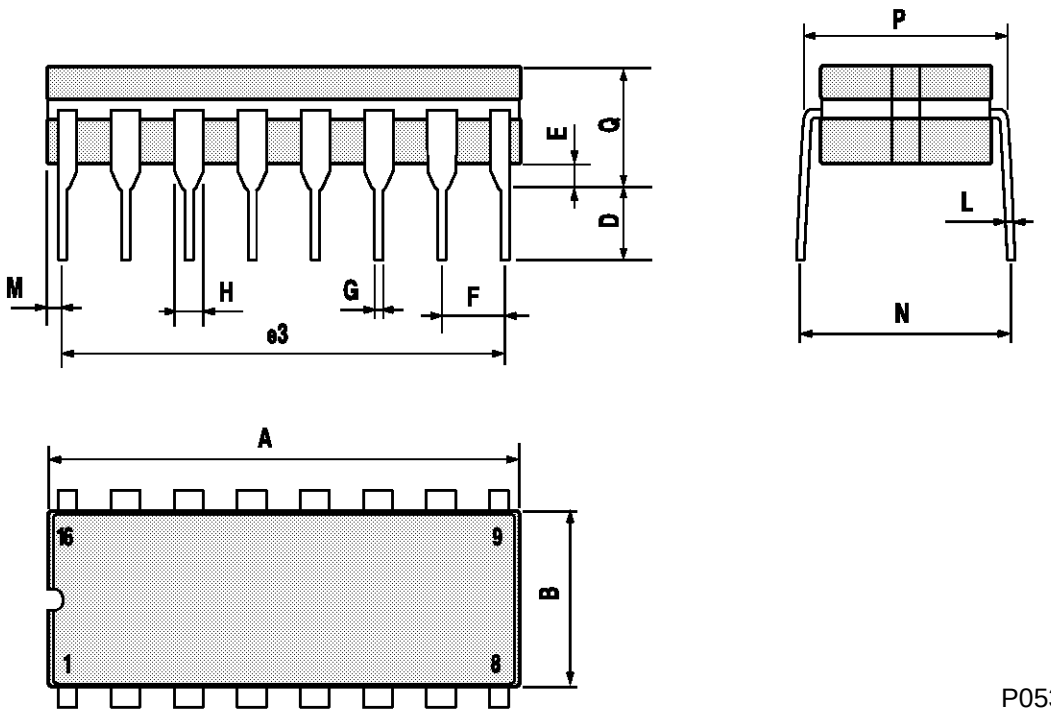
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050



P001C

Ceramic DIP16/1 MECHANICAL DATA

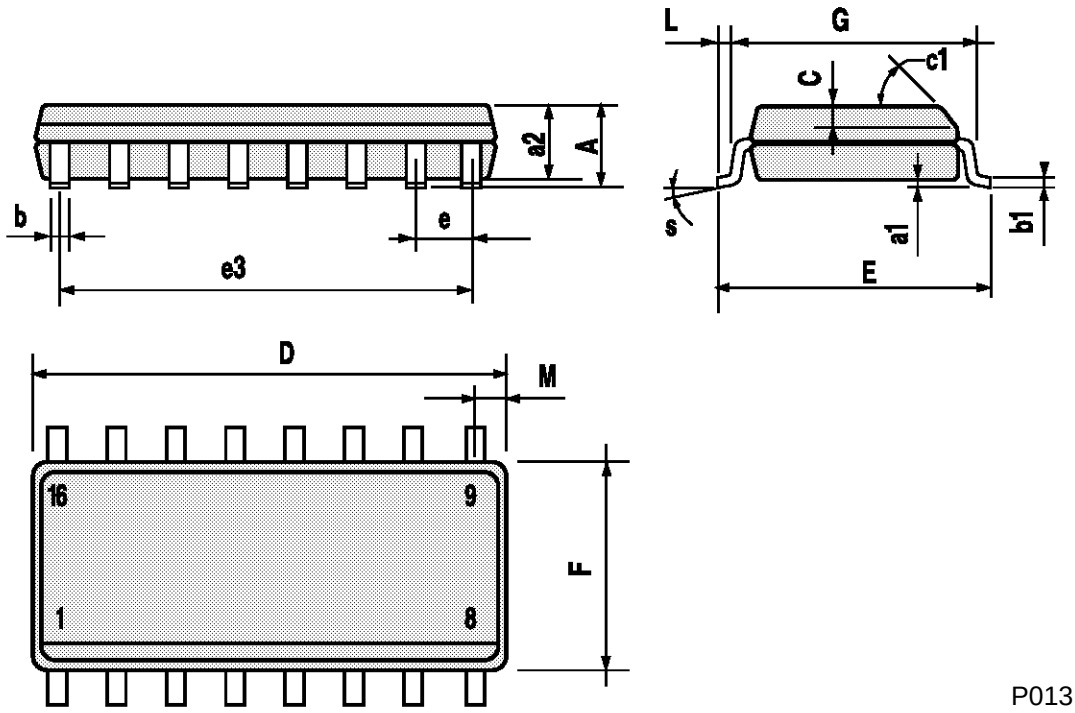
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			20			0.787
B			7			0.276
D		3.3			0.130	
E	0.38			0.015		
e3		17.78			0.700	
F	2.29		2.79	0.090		0.110
G	0.4		0.55	0.016		0.022
H	1.17		1.52	0.046		0.060
L	0.22		0.31	0.009		0.012
M	0.51		1.27	0.020		0.050
N			10.3			0.406
P	7.8		8.05	0.307		0.317
Q			5.08			0.200



P053D

SO16 (Narrow) MECHANICAL DATA

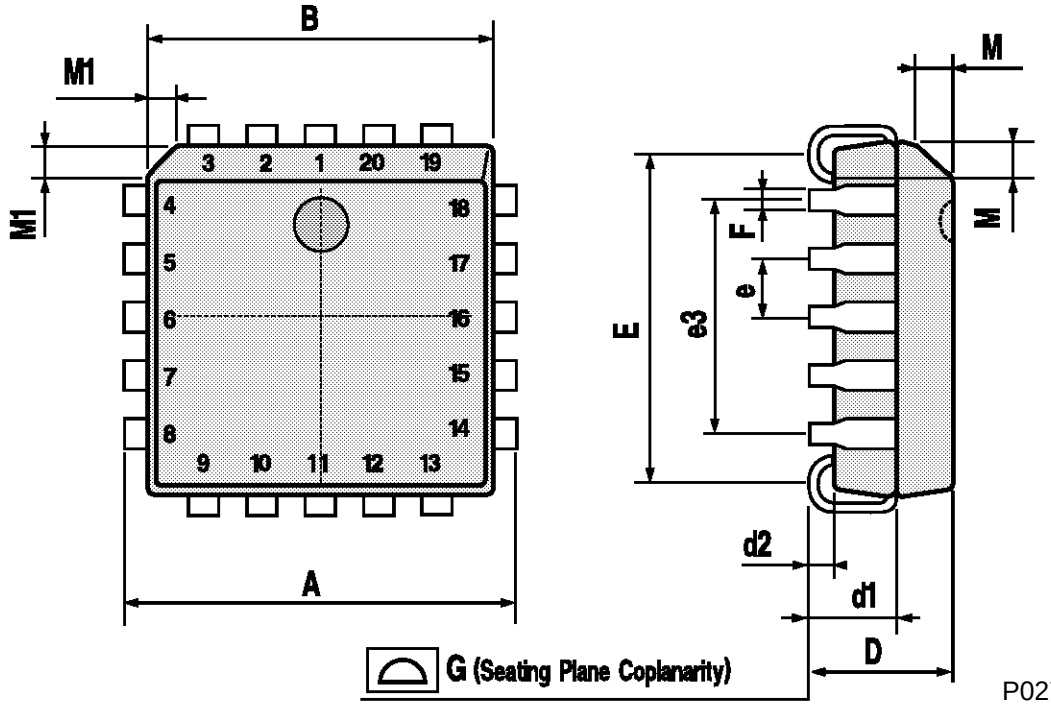
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.004		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157
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.)					



P013H

PLCC20 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	9.78		10.03	0.385		0.395
B	8.89		9.04	0.350		0.356
D	4.2		4.57	0.165		0.180
d1		2.54			0.100	
d2		0.56			0.022	
E	7.37		8.38	0.290		0.330
e		1.27			0.050	
e3		5.08			0.200	
F		0.38			0.015	
G			0.101			0.004
M		1.27			0.050	
M1		1.14			0.045	



P027A