

## SYNCHRONOUS PRESETTABLE 4-BIT COUNTER

- HIGH SPEED  
 $f_{MAX} = 50 \text{ MHz (TYP.) AT } V_{CC} = 5 \text{ V}$
- LOW POWER DISSIPATION  
 $I_{CC} = 4 \mu\text{A (MAX.) AT } 25 \text{ }^\circ\text{C}$
- OUTPUT DRIVE CAPABILITY  
 10 LSTTL LOADS
- BALANCED PROPAGATION DELAYS  
 $t_{PLH} = t_{PHL}$
- SYMMETRICAL OUTPUT IMPEDANCE  
 $I_{OH} = I_{OL} = 4 \text{ mA (MIN.)}$
- COMPATIBLE WITH TTL OUTPUTS  
 $V_{IH} = 2 \text{ V (MIN.)}; V_{IL} = 0.8 \text{ V (MAX.)}$
- PIN AND FUNCTION COMPATIBLE  
 WITH 54/74LS160 ~ 163

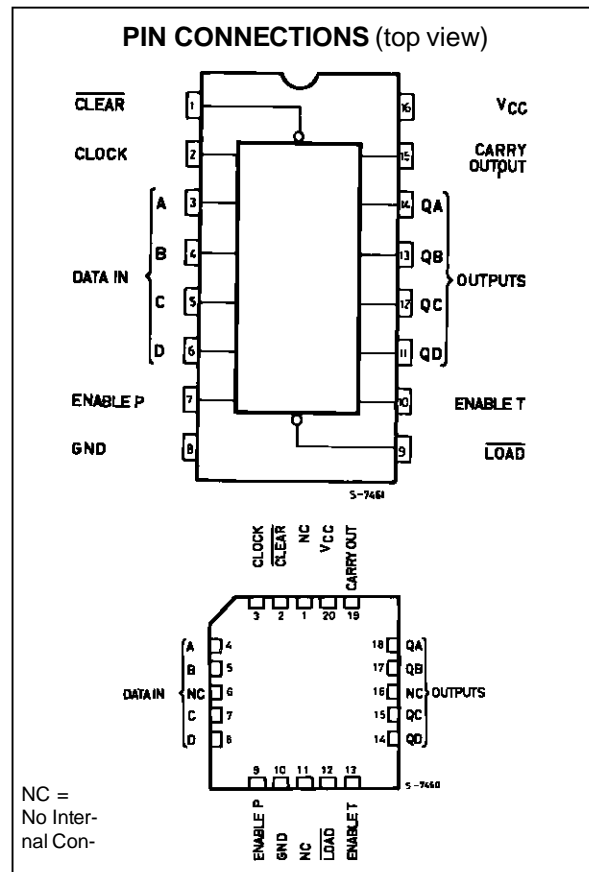
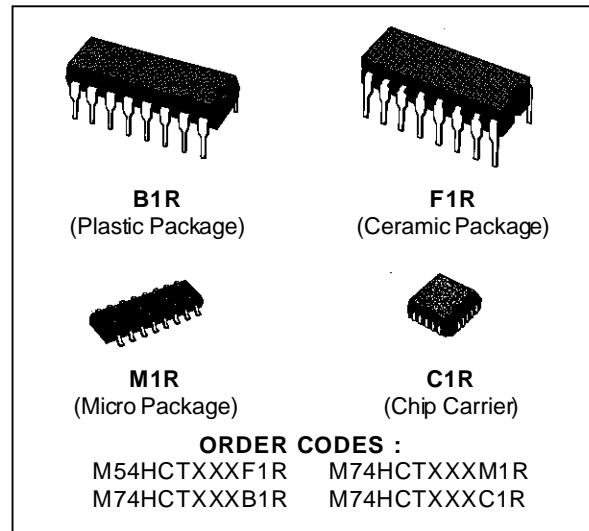
### DESCRIPTION

M54/74HCT160 Decade, Asynchronous Clear  
 M54/74HCT161 Binary, Asynchronous Clear  
 M54/74HCT162 Decade, Synchronous Clear  
 M54/74HCT163 Binary, Synchronous Clear

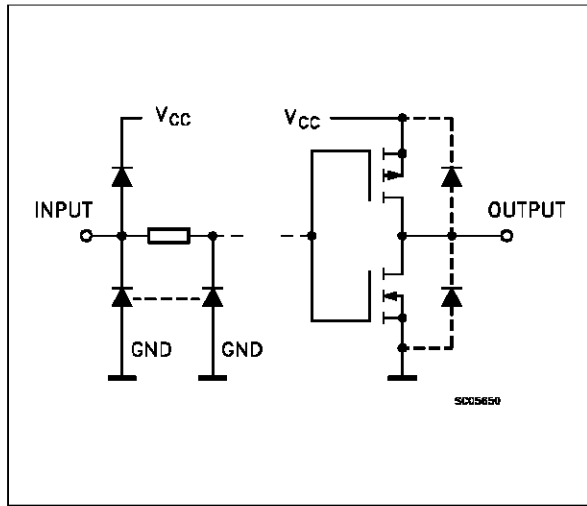
The M54/74HCT160, 161, 162 and 163 are high speed CMOS SYNCHRONOUS PRESETTABLE COUNTERS fabricated with silicon gate C<sup>2</sup>MOS technology. They have the same high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The M54/74HCT160/162 are BCD Decade counters and the M54/74HCT161/163 are 4 bit binary counters. The CLOCK input is active on the rising edge. Both LOAD and CLEAR inputs are active Low.

Presetting of all four IC's is synchronous on the rising edge of the CLOCK. The function on the M54/74HCT162/163 is synchronous to CLOCK, while the M54/74HCT160/161 counters are cleared asynchronously. Two enable inputs (TE and PE) and CARRY output are provided to enable easy cascading of counters, which facilitates easy implementation of N-bit counters without using external gates. This integrated circuit has input and output characteristics that are fully compatible with 54/74 LSTTL logic families. M54/74HCT devices are designed to directly interface HSC<sup>2</sup>MOS systems with TTL and NMOS components. They are also plug in replacements for LSTTL devices giving a reduction of power consumption. All inputs are equipped with



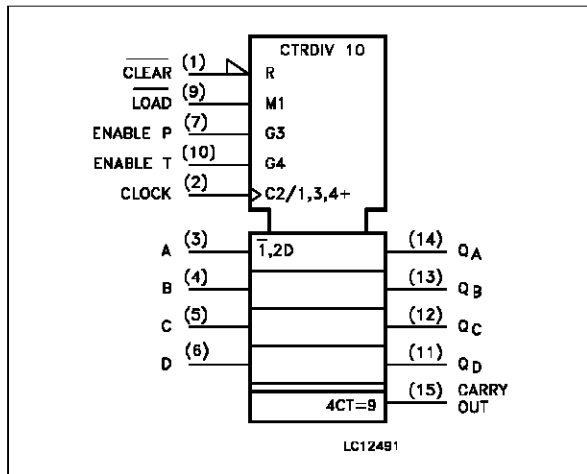
INPUT AND OUTPUT EQUIVALENT CIRCUIT



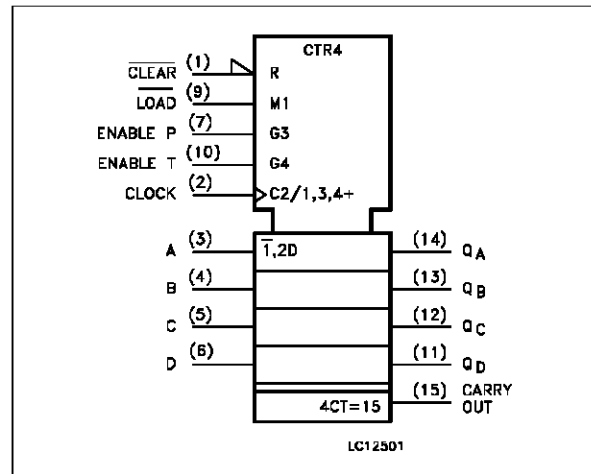
PIN DESCRIPTION

PIN No	SYMBOL	NAME AND FUNCTION
1	CLEAR	Master Reset
2	CLOCK	Clock Input (LOW to HIGH, Edge-triggered)
3, 4, 5, 6	A, B, C, D	Data Inputs
7	ENABLE P	Count Enable Input
10	ENABLE T	Count Enable Carry Input
9	LOAD	Parallel Enable Input
14, 13, 12, 11	QA to QD	Flip Flop Outputs
15	CARRY OUTPUT	Terminal Count Output
8	GND	Ground (0V)
16	Vcc	Positive Supply Voltage

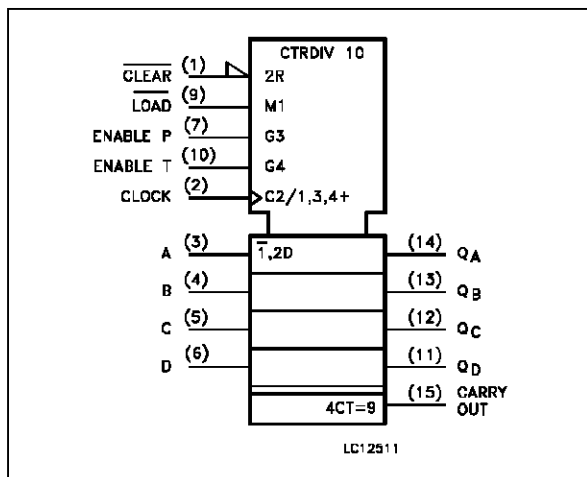
IEC LOGIC SYMBOL (HCT160)



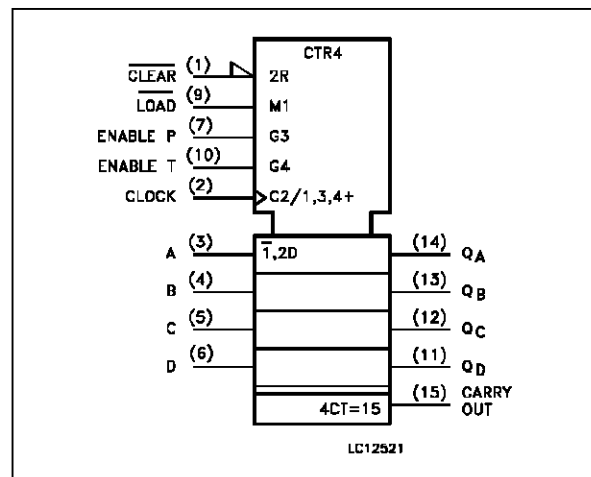
IEC LOGIC SYMBOL (HCT161)



IEC LOGIC SYMBOL (HCT162)



IEC LOGIC SYMBOL (HCT163)

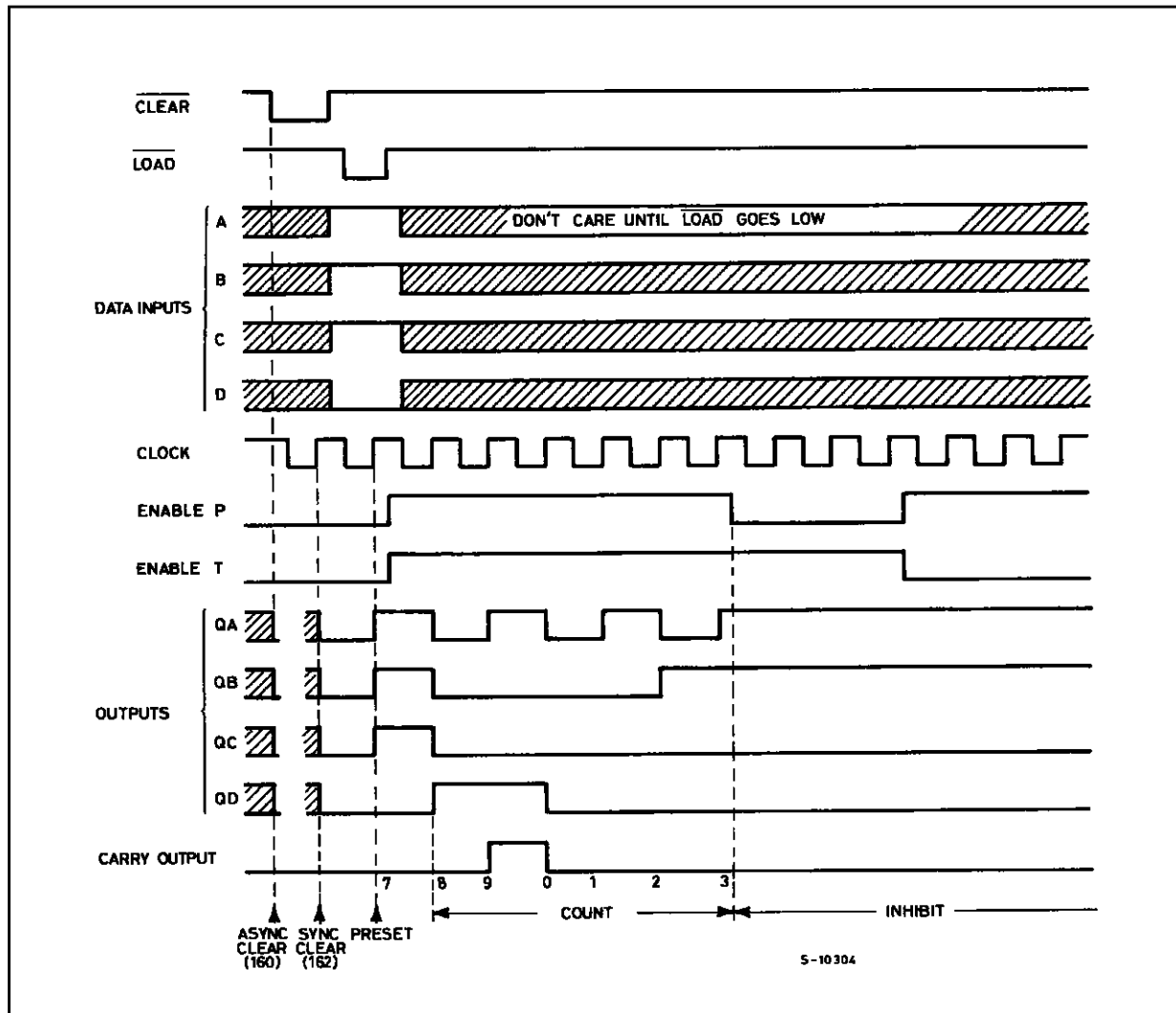


TRUTH TABLE

M54/74HCT160/161					M54/74HCT162/163					OUTPUTS				FUNCTION
INPUTS					INPUTS					QA	QB	QC	QD	
CLR	LD	PE	TE	CK	CLR	LD	PE	TE	CK					
L	X	X	X	X	L	X	X	X	┐	L	L	L	L	RESET TO "0"
H	L	X	X	┐	H	L	X	X	┐	A	B	C	D	PRESET DATA
H	H	X	L	┐	H	H	X	L	┐	NO CHANGE				NO COUNT
H	H	L	X	┐	H	H	L	X	┐	NO CHANGE				NO COUNT
H	H	H	H	┐	H	H	H	H	┐	COUNT UP				COUNT
H	X	X	X	┐	X	X	X	X	┐	NO CHANGE				NO COUNT

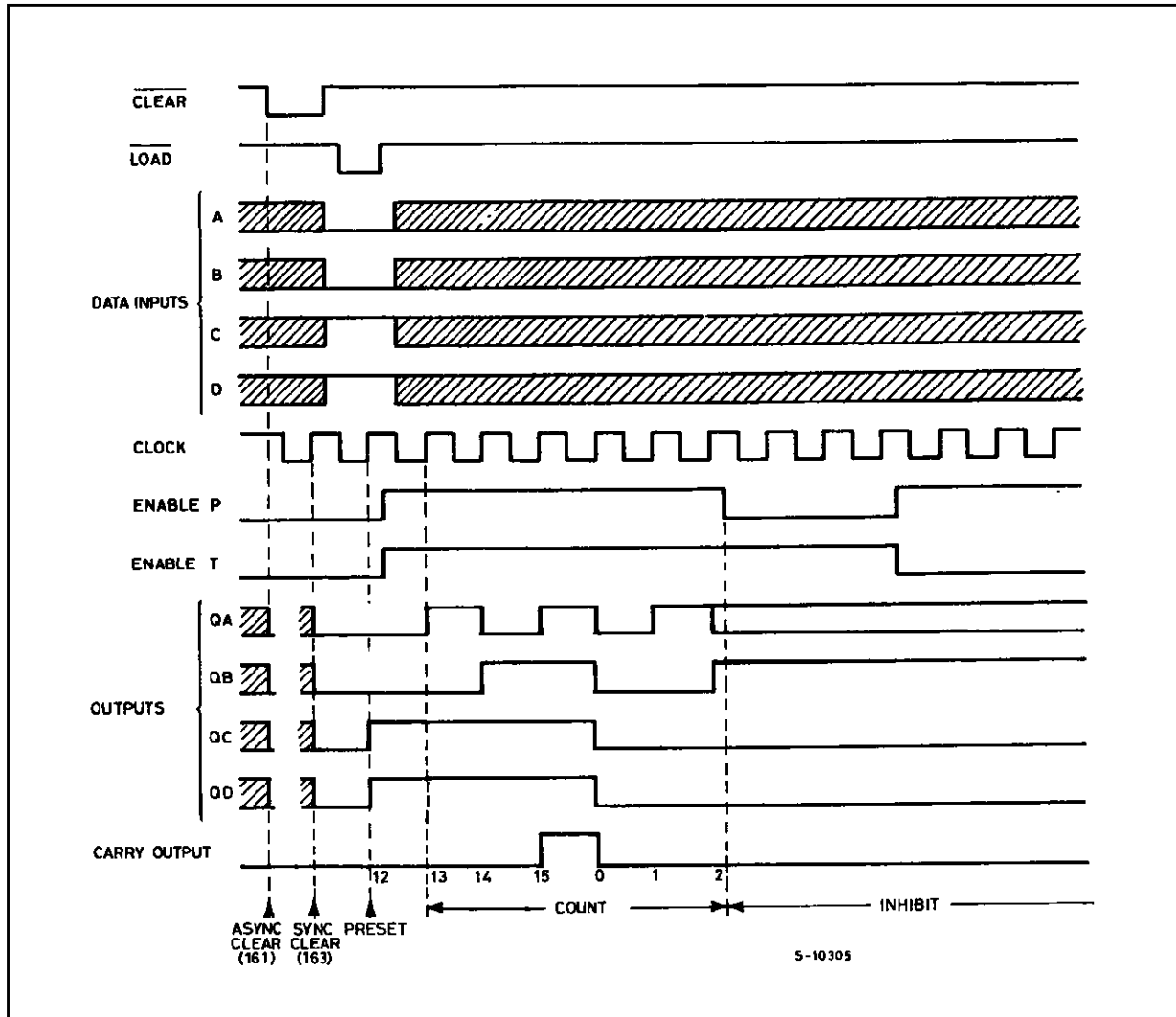
Note: X : Don't Care  
 A, B, C, D : Logi level of data inputs  
 Carry : CARRY = TE • QA • QB • QC • QD ..... (M54/74HCT160/162)  
 : CARRY = TE • QA • QB • QC • QD ..... (M54/74HCT161/163)

TIMING CHART (HCT160/162 : decade counter)

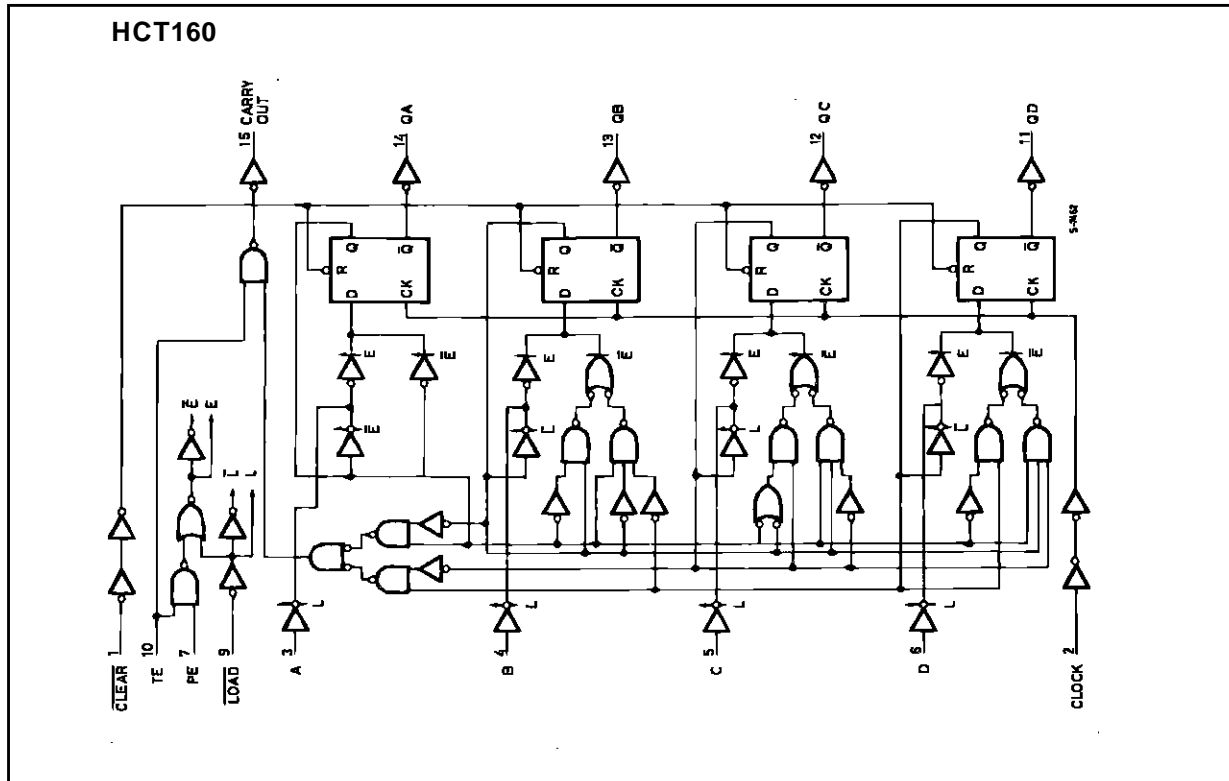


**M54/M74HCT160/161/162/163**

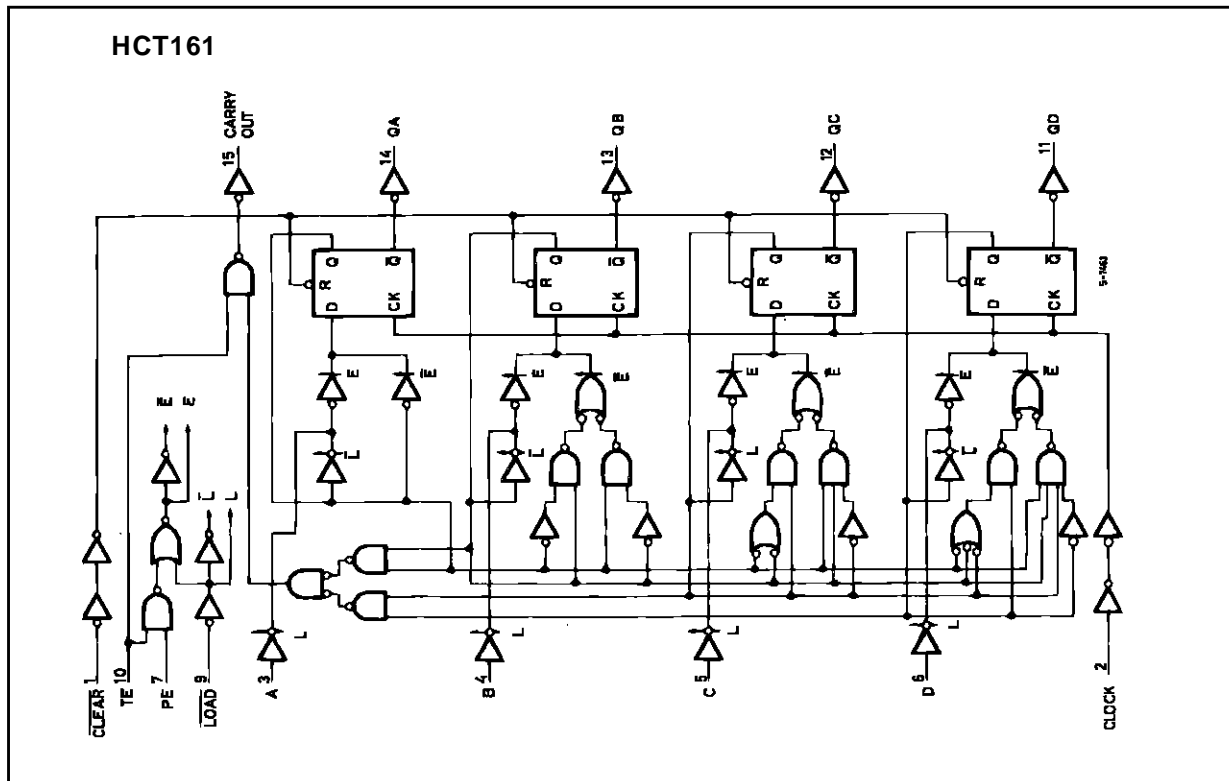
**TIMING CHART (HCT161/163 : binary counter)**



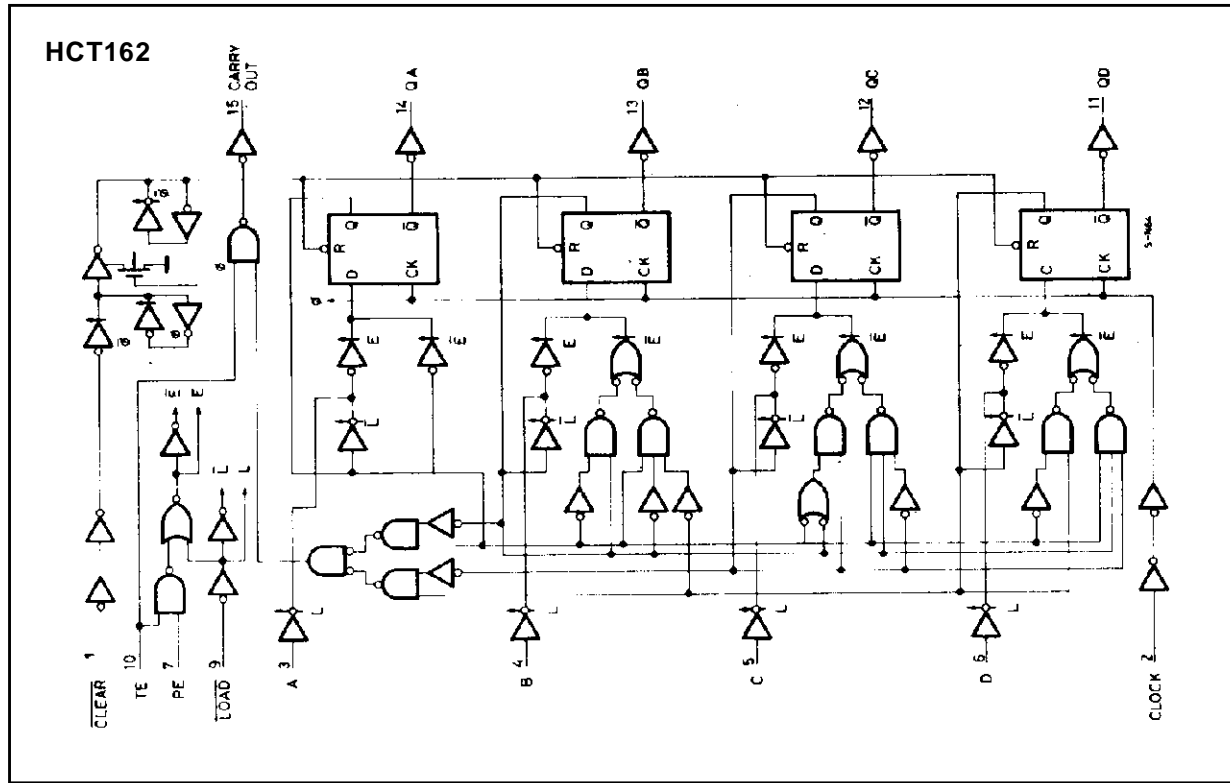
LOGIC DIAGRAM



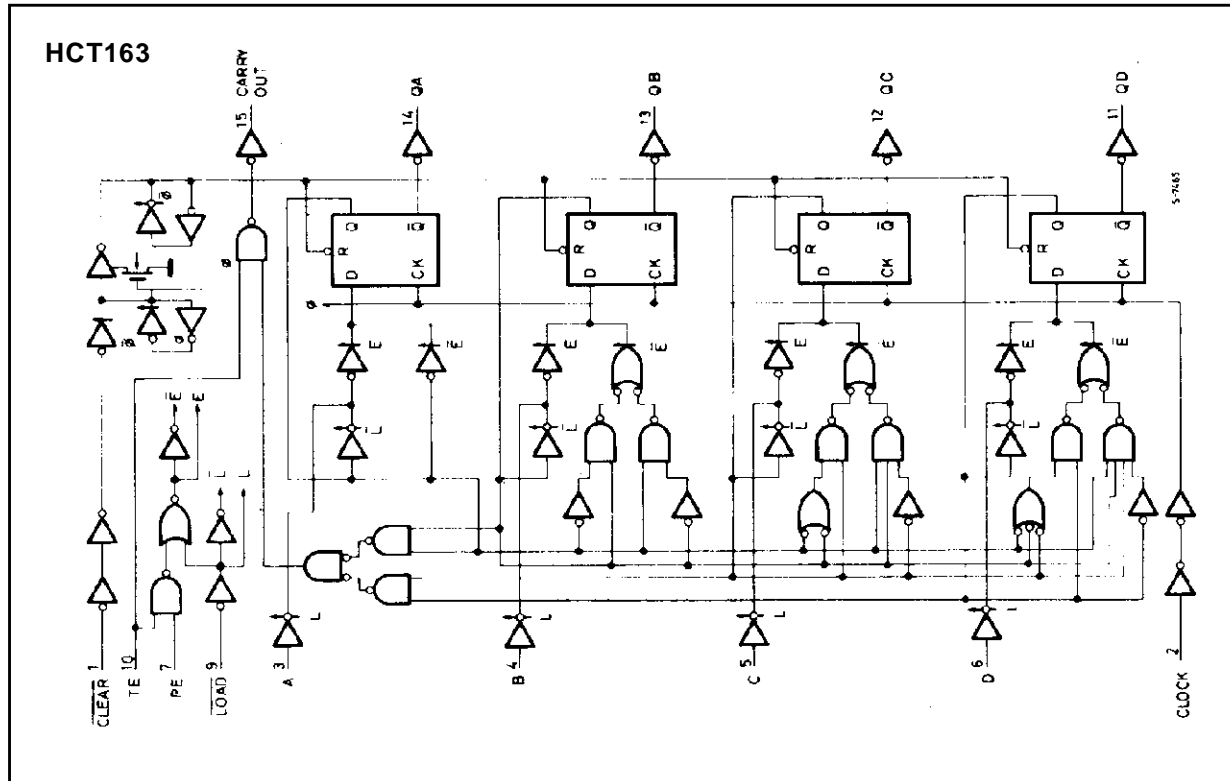
LOGIC DIAGRAM



LOGIC DIAGRAM



LOGIC DIAGRAM



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage	-0.5 to +7	V
V <sub>I</sub>	DC Input Voltage	-0.5 to V <sub>CC</sub> + 0.5	V
V <sub>O</sub>	DC Output Voltage	-0.5 to V <sub>CC</sub> + 0.5	V
I <sub>IK</sub>	DC Input Diode Current	± 20	mA
I <sub>OK</sub>	DC Output Diode Current	± 20	mA
I <sub>O</sub>	DC Output Source Sink Current Per Output Pin	± 25	mA
I <sub>CC</sub> or I <sub>GND</sub>	DC V <sub>CC</sub> or Ground Current	± 50	mA
P <sub>D</sub>	Power Dissipation	500 (*)	mW
T <sub>stg</sub>	Storage Temperature	-65 to +150	°C
T <sub>L</sub>	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.

(\*) 500 mW: ≡ 65 °C derate to 300 mW by 10mW/°C: 65 °C to 85 °C

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage	4.5 to 5.5	V
V <sub>I</sub>	Input Voltage	0 to V <sub>CC</sub>	V
V <sub>O</sub>	Output Voltage	0 to V <sub>CC</sub>	V
T <sub>op</sub>	Operating Temperature: <b>M54HC Series</b> <b>M74HC Series</b>	-55 to +125 -40 to +85	°C °C
t <sub>r</sub> , t <sub>f</sub>	Input Rise and Fall Time (V <sub>CC</sub> = 4.5 to 5.5V)	0 to 500	ns

**DC SPECIFICATIONS**

Symbol	Parameter	Test Conditions		Value						Unit		
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25 °C 54HC and 74HC			-40 to 85 °C 74HC		-55 to 125 °C 54HC			
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.	
V <sub>IH</sub>	High Level Input Voltage	4.5 to 5.5		2.0			2.0		2.0		V	
V <sub>IL</sub>	Low Level Input Voltage	4.5 to 5.5				0.8		0.8		0.8	V	
V <sub>OH</sub>	High Level Output Voltage	4.5	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>O</sub> = -20 μA	4.4	4.5		4.4		4.4	V	
				I <sub>O</sub> = -4.0 mA	4.18	4.31		4.13		4.10		
V <sub>OL</sub>	Low Level Output Voltage	4.5	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>O</sub> = 20 μA		0.0	0.1		0.1		0.1	V
				I <sub>O</sub> = 4.0 mA		0.17	0.26		0.33		0.4	
I <sub>I</sub>	Input Leakage Current	5.5	V <sub>I</sub> = V <sub>CC</sub> or GND				±0.1		±1		±1	μA
I <sub>CC</sub>	Quiescent Supply Current	5.5	V <sub>I</sub> = V <sub>CC</sub> or GND				4		40		80	μA
ΔI <sub>CC</sub>	Additional worst case supply current	5.5	Per Input pin V <sub>I</sub> = 0.5V or V <sub>I</sub> = 2.4V Other Inputs at V <sub>CC</sub> or GND				2.0		2.9		3.0	mA



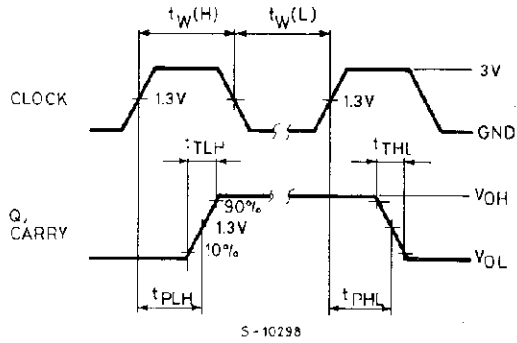
AC ELECTRICAL CHARACTERISTICS ( $C_L = 50$  pF, Input  $t_r = t_f = 6$  ns)

Symbol	Parameter	Test Conditions		Value						Unit	
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25 °C 54HC and 74HC			-40 to 85 °C 74HC		-55 to 125 °C 54HC		
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.
t <sub>TLH</sub> t <sub>THL</sub>	Output Transition Time	4.5			8	15		19		22	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (CK - Q)	4.5			23	36		45		54	ns
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (CK-CO)	4.5			27	42		53		63	ns
t <sub>PLH</sub>	Propagation Delay Time (TE-CO)	4.5			21	33		41		50	ns
t <sub>PLH</sub>	Propagation Delay Time (CLEAR - Q)	4.5	for HCT160/161 only		26	40		50		60	ns
t <sub>PHL</sub>	Propagation Delay Time (CLEAR-CO)	4.5	for HCT160/161 only		28	43		54		65	ns
f <sub>MAX</sub>	Maximum Clock Frequency	4.5		31	49		25		21		MHz
t <sub>W(H)</sub> t <sub>W(L)</sub>	Minimum Pulse Width (CK)	4.5			8	15		19		22	ns
t <sub>W(L)</sub>	Minimum Pulse Width (CLEAR)	4.5	for HCT160/161 only		8	15		19		22	ns
t <sub>s</sub>	Minimum Set-up Time (LOAD, PE, TE)	4.5			11	20		25		30	ns
t <sub>s</sub>	Minimum Set-up Time (A, B, C, D)	4.5			5	15		19		22	ns
t <sub>s</sub>	Minimum Set-up Time (CLEAR)	4.5	for HCT162/163 only		5	15		19		22	ns
t <sub>h</sub>	Minimum Hold Time	4.5				5		5		8	ns
t <sub>REM</sub>	Minimum Removal Time (CLEAR)	4.5	for HCT160/161 only		5	15		19		22	ns
C <sub>IN</sub>	Input Capacitance				5	10		10		10	pF
C <sub>PD</sub> (*)	Power Dissipation Capacitance				33						pF

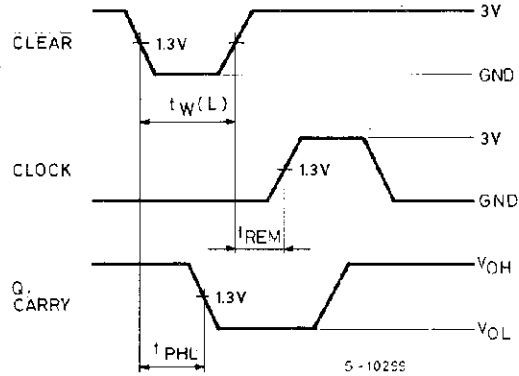
(\*) C<sub>PD</sub> is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN}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

SWITCHING CHARACTERISTICS TEST WAVEFORM

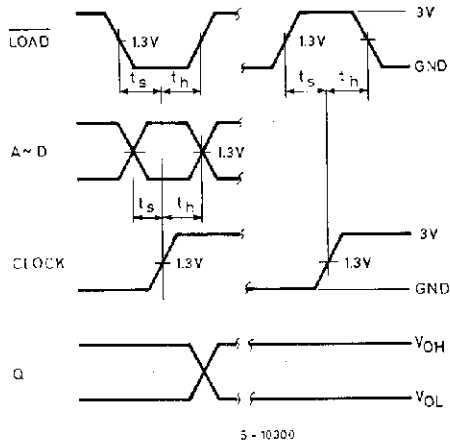
COUNT MODE



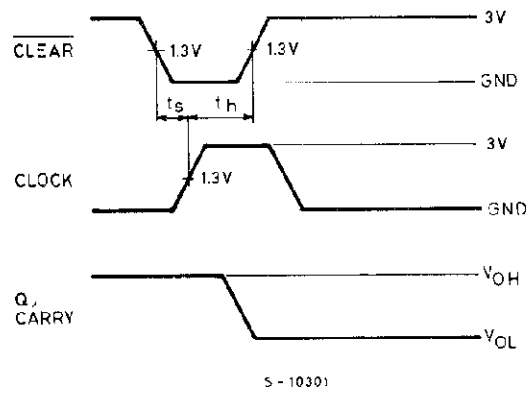
CLEAR MODE (HCT160/161)



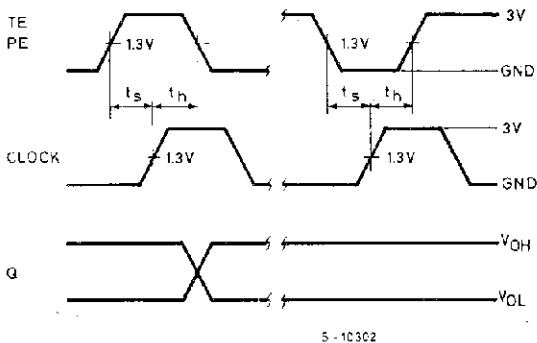
PRESET MODE



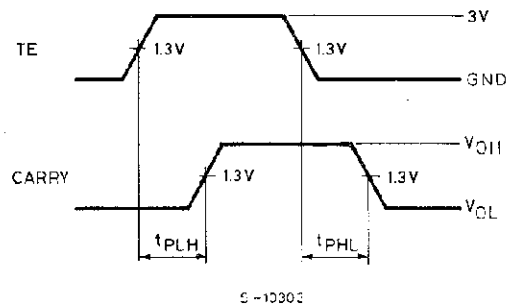
CLEAR MODE (HCT162/163)



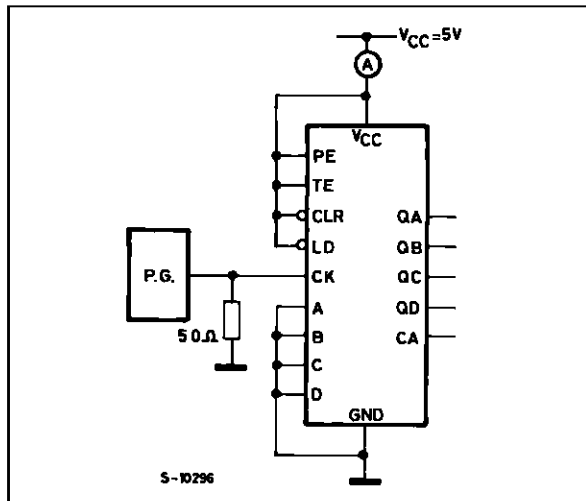
COUNTENABLE MODE



CASCADE MODE  
(fix maximum count)



TEST CIRCUIT I<sub>cc</sub> (Opr.)



TOTAL OPERATING CURRENT WHEN USING A CAPACITIVE LOAD

When the outputs drive a capacitive load, the total current can be calculated as follows :

For M74HCT160/162 :

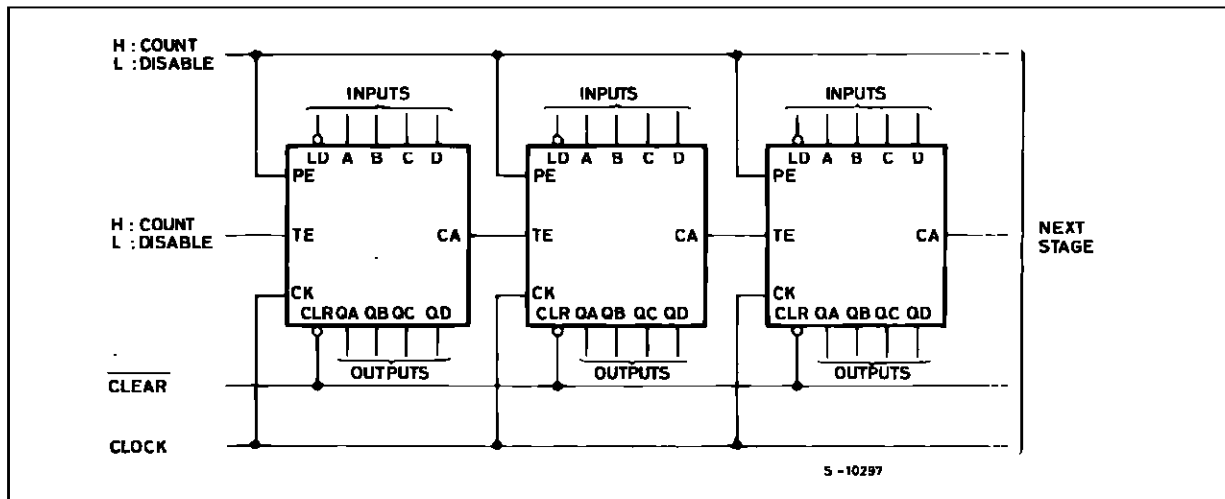
$$\Delta I_{cc} = f_{CK} \cdot V_{CC} \cdot \left( \frac{C_a}{2} + \frac{C_b}{5} + \frac{C_c}{10} + \frac{C_d}{10} + \frac{C_{ca}}{10} \right)$$

For M74HCT161/163 :

$$\Delta I_{cc} = f_{CK} \cdot V_{CC} \cdot \left( \frac{C_a}{2} + \frac{C_b}{4} + \frac{C_c}{8} + \frac{C_d}{16} + \frac{C_{ca}}{16} \right)$$

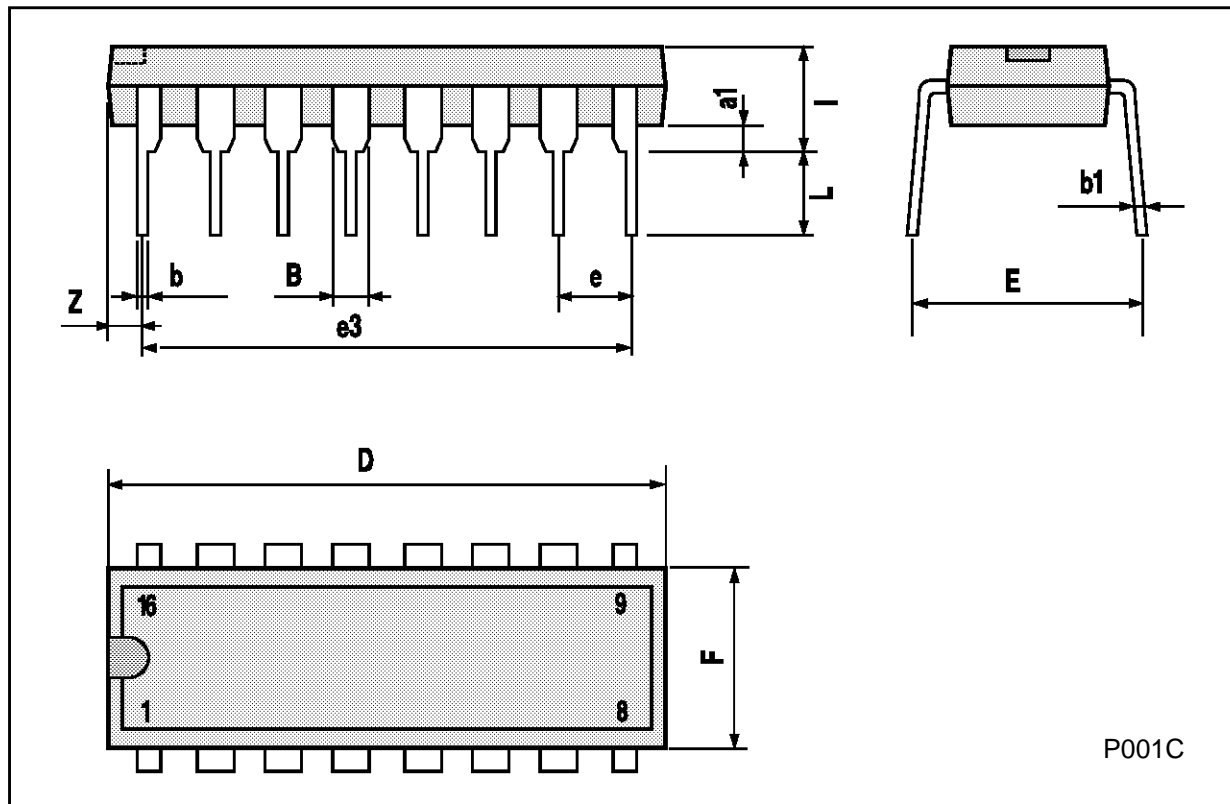
C<sub>a</sub> to C<sub>ca</sub> are the capacitors loading the outputs.

TYPICAL APPLICATION



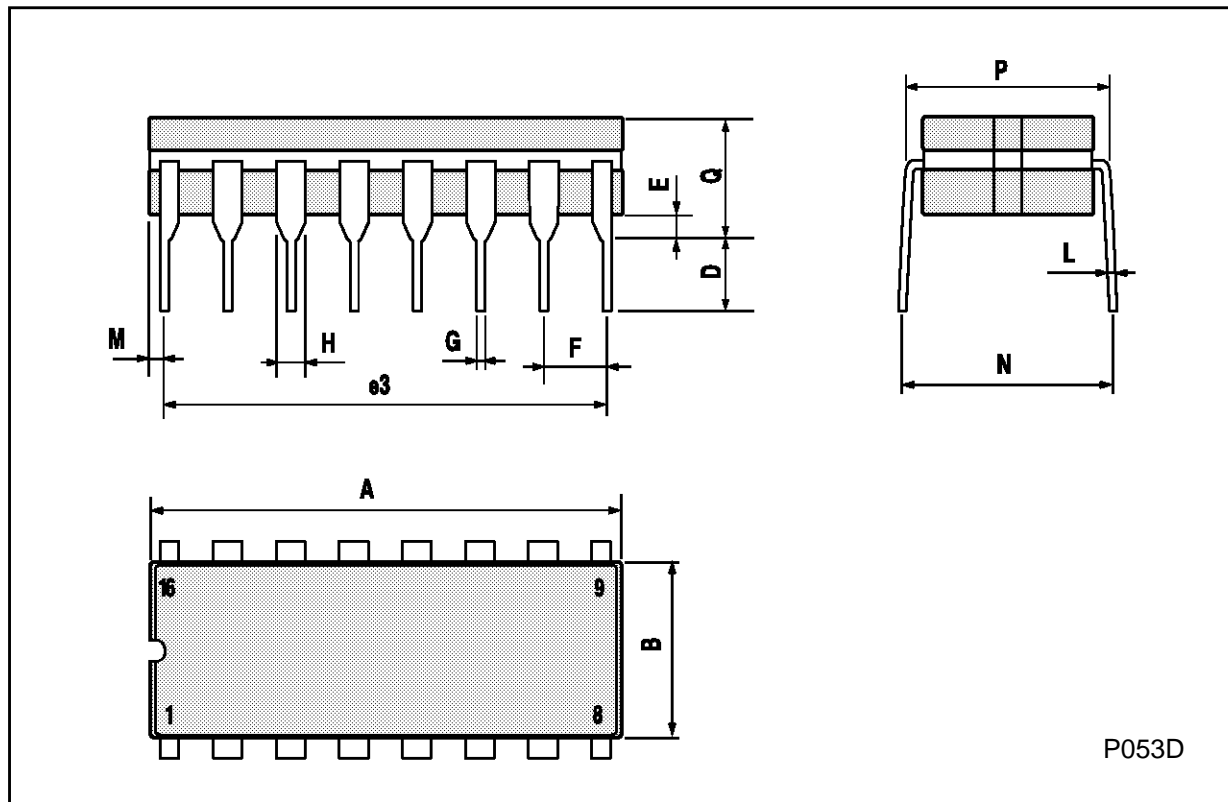
Plastic DIP16 (0.25) MECHANICAL DATA

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



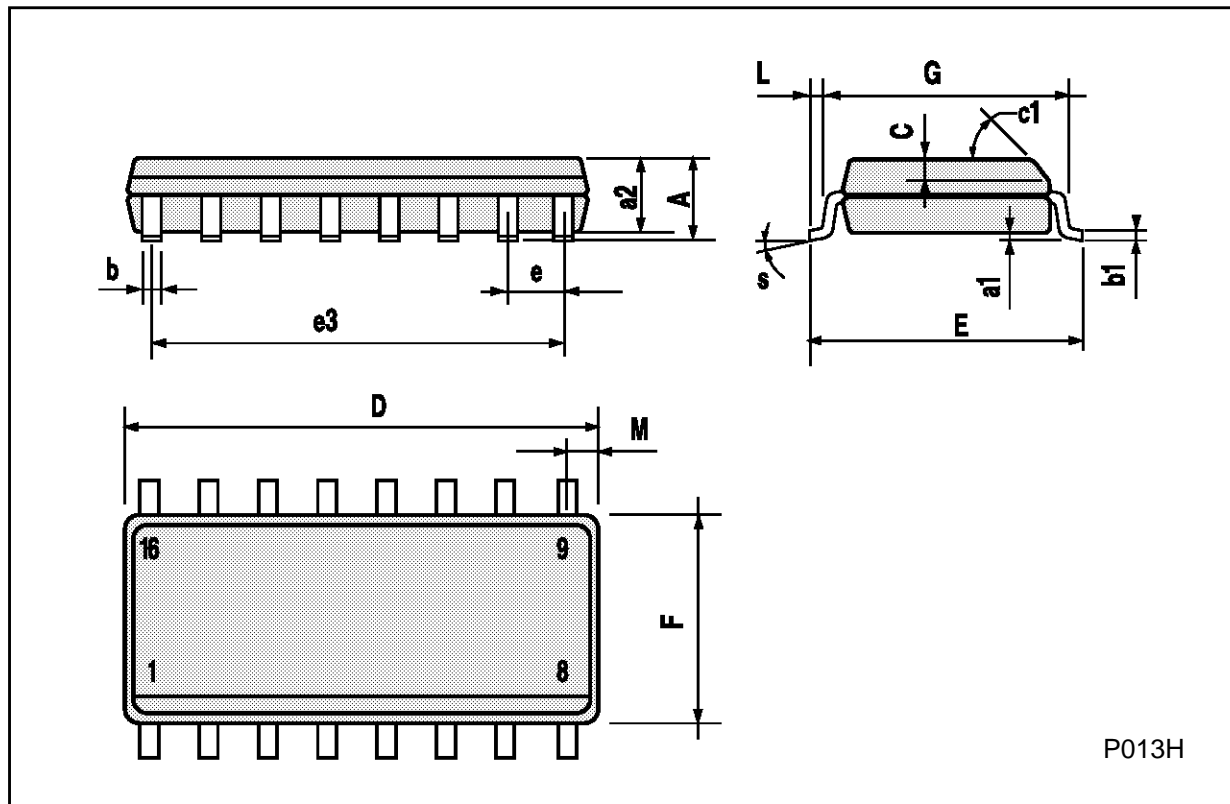
## Ceramic DIP16/1 MECHANICAL DATA

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



SO16 (Narrow) MECHANICAL DATA

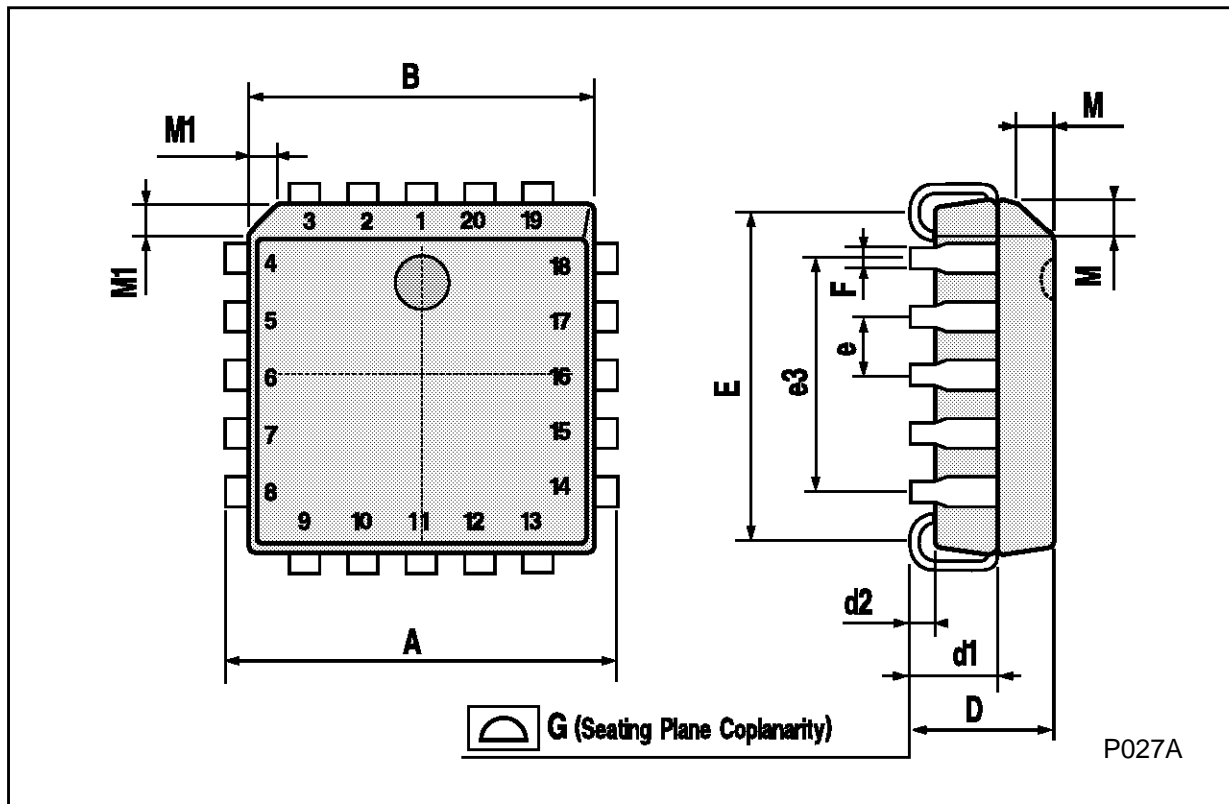
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.004		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157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



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