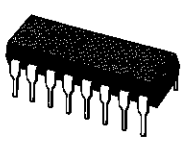
SGS-THOMSON MICROELECTRONICS

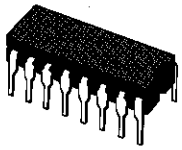
M54/74HC160/161
M54/74HC162/163

SYNCHRONOUS PRESETTABLE 4-BIT COUNTER

- HIGH SPEED
  f_{MAX} = 63 MHz (TYP.) AT V_{CC} = 5 V
- LOW POWER DISSIPATION
  I_{CC} = 4 μA (MAX.) AT 25 °C
- OUTPUT DRIVE CAPABILITY
  10 LSTTL LOADS
- BALANCED PROPAGATION DELAYS
  $t_{PLH} = t_{PHL}$
- HIGH NOISE IMMUNITY
  $V_{NIH} = V_{NIL}$ = 28 % V_{CC} (MIN.)
- WIDE OPERATING VOLTAGE RANGE
  V_{CC} (OPR) = 2 V TO 6 V
- PIN AND FUNCTION COMPATIBLE
  WITH 54/74LS160 ~ 163



B1R
(Plastic Package)



F1R
(Ceramic Package)

M1R
(Micro Package)

C1R
(Chip Carrier)

ORDER CODES :

M54HCXXXF1R M74HCXXXM1R
M74HCXXXB1R M74HCXXXC1R

DESCRIPTION

M54/74HC160 Decade, Asynchronous Clear
M54/74HC161 Binary, Asynchronous Clear
M54/74HC162 Decade, Synchronous Clear
M54/74HC163 Binary, Synchronous Clear

The M54/74HC160, 161, 162 and 163 are high speed CMOS SYNCHRONOUS PRESETTABLE COUNTERS fabricated with silicon gate C^2MOS technology.

They have the same the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The M54/74HC160/162 are BCD Decade counters and the M54/74HC161/163 are 4 bit binary counters.

The CLOCK input is active on the rising edge. Both $\overline{LOAD}$ and $\overline{CLEAR}$ inputs are active Low.

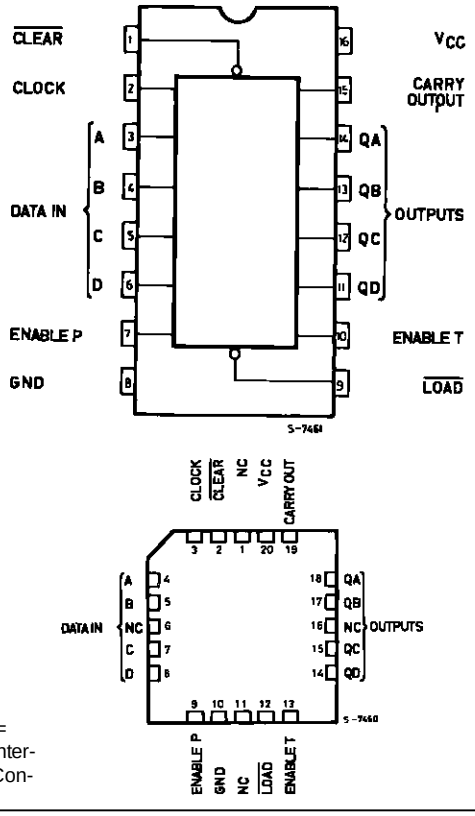
Presetting of all four IC's is synchronous on the rising edge of the CLOCK.

The function on the M54/74HC162/163 is synchronous to CLOCK, while the M54/74HC160/161 counters are cleared asynchronously.

Two enable inputs (TE and PE) and CARRY output are provided to enable easy cascading of counters, which facilities easy implementation of N-bit counters without using external gates.

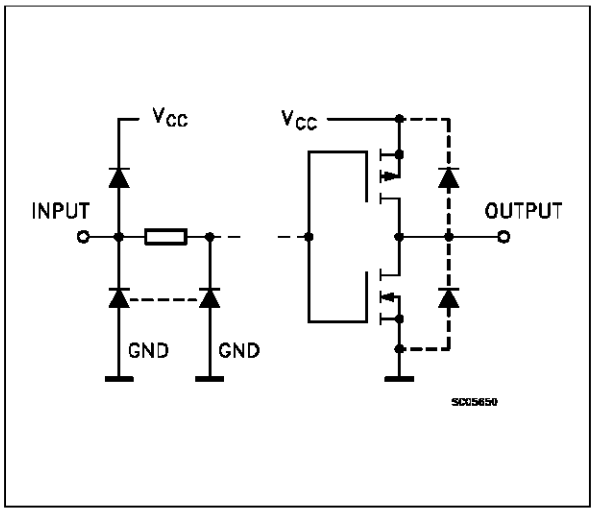
All inputs are equipped with protection circuits against static discharge and transient excess voltage.

PIN CONNECTIONS (top view)



NC = No Internal Con-

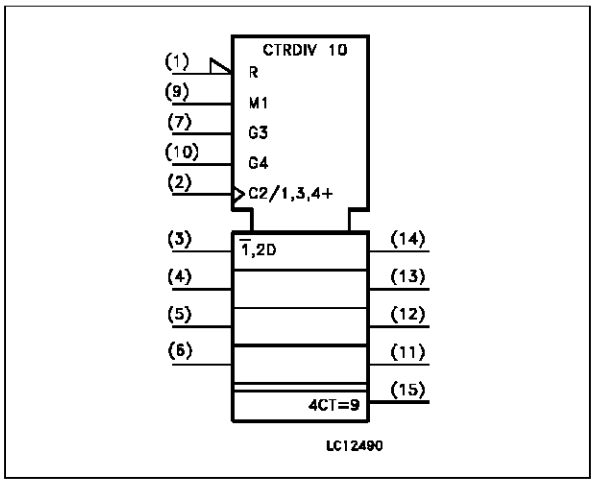
INPUT AND OUTPUT EQUIVALENT CIRCUIT



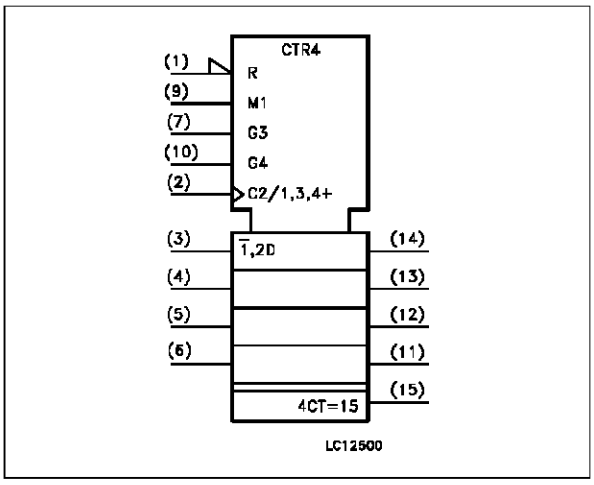
PIN DESCRIPTION

PIN No	SYMBOL	NAME AND FUNCTION
1	CLEAR	Asynchronous 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	ENABLET	Count Enable Carry Input
9	$\overline{\text{LOAD}}$	Parallel Enable Input
14, 13, 12, 11	QA to QD	Flip Flop Outputs
15	CARRY OUTPUT	Terminal Count Output
8	GND	Ground (0V)
16	V_{CC}	Positive Supply Voltage

IEC LOGIC SYMBOL (HC160)



IEC LOGIC SYMBOL (HC161)



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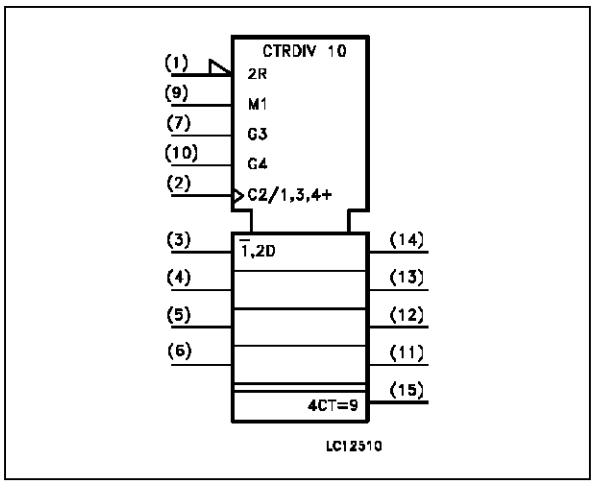
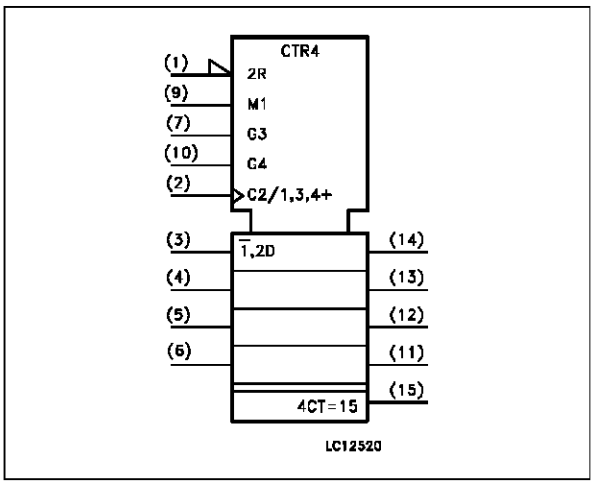


IEC LOGIC SYMBOL (HC163)

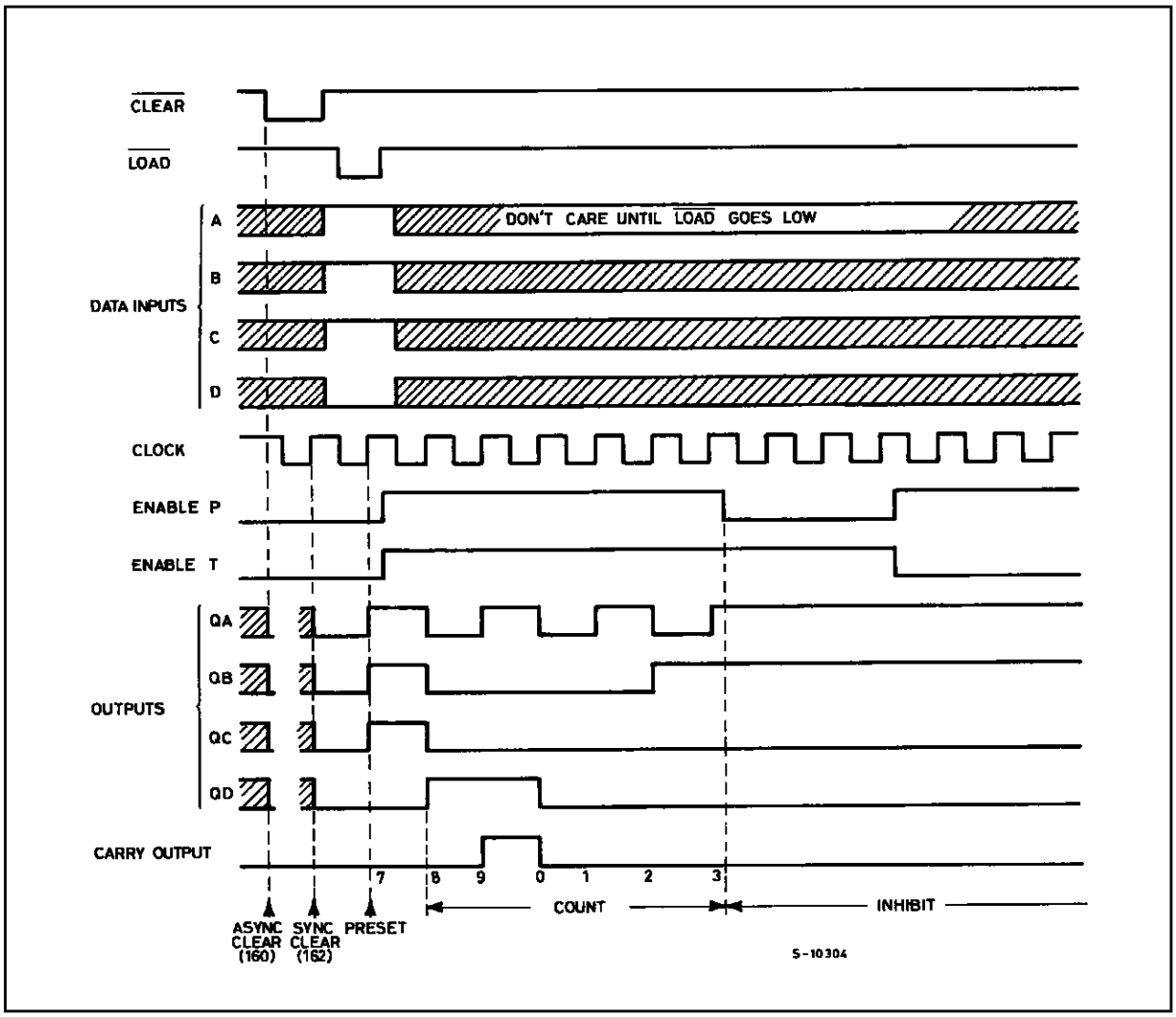


TRUTH TABLE

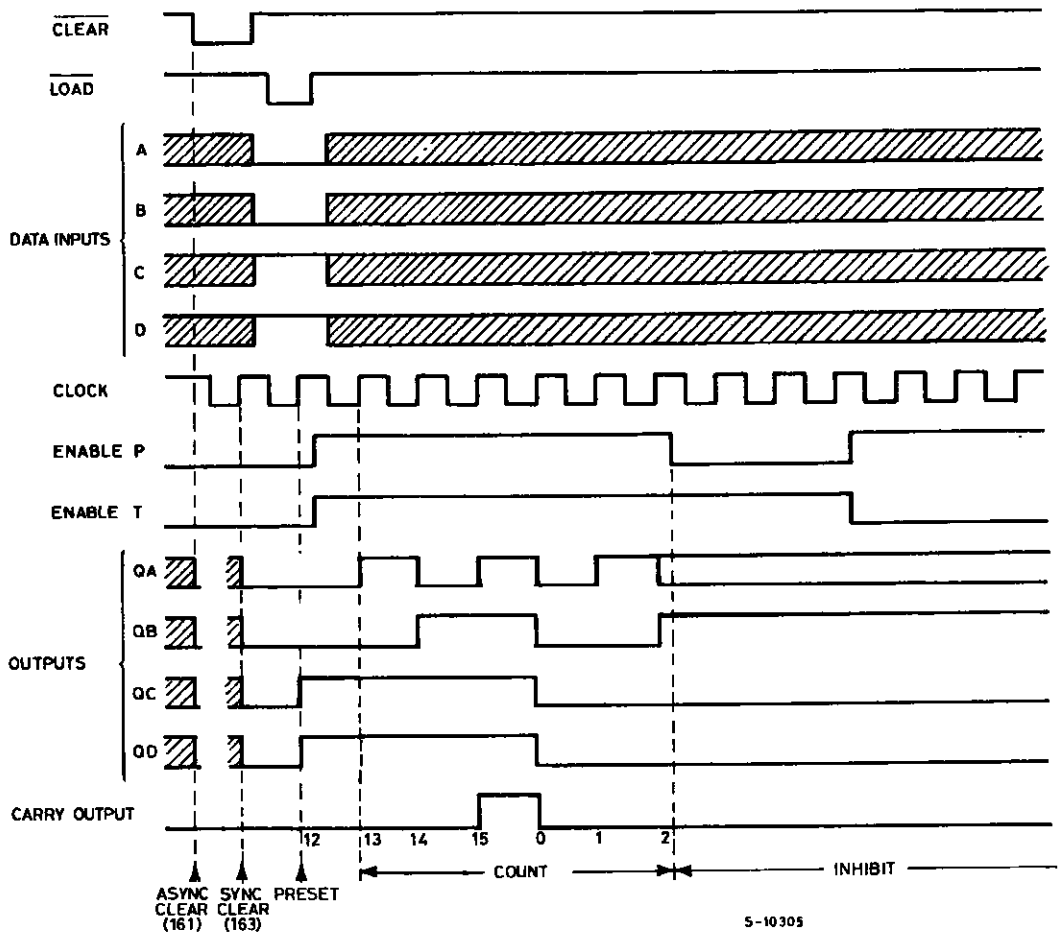
M54/74HC160/161					M54/74HC162/163					OUTPUTS				FUNCTION
INPUTS					INPUTS									
$\overline{CLR}$	$\overline{LD}$	PE	TE	CK	$\overline{CLR}$	$\overline{LD}$	PE	TE	CK	QA	QB	QC	QD	
L	X	X	X	X	L	X	X	X	⌐	L	L	L	L	RESET TO "0"
H	L	X	X	⌐	H	L	X	X	⌐	A	B	C	D	PRESET DATA
H	H	X	L	⌐	H	H	X	L	⌐	NO CHANGE				NO 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 • Q_A • Q_B • $\overline{Q_C}$ • Q_D ..... (M54/74HC160/162)
: CARRY = TE • Q_A • Q_B • Q_C • Q_D ..... (M54/74HC161/163)

TIMING CHART (HC160/162 : decade counter)

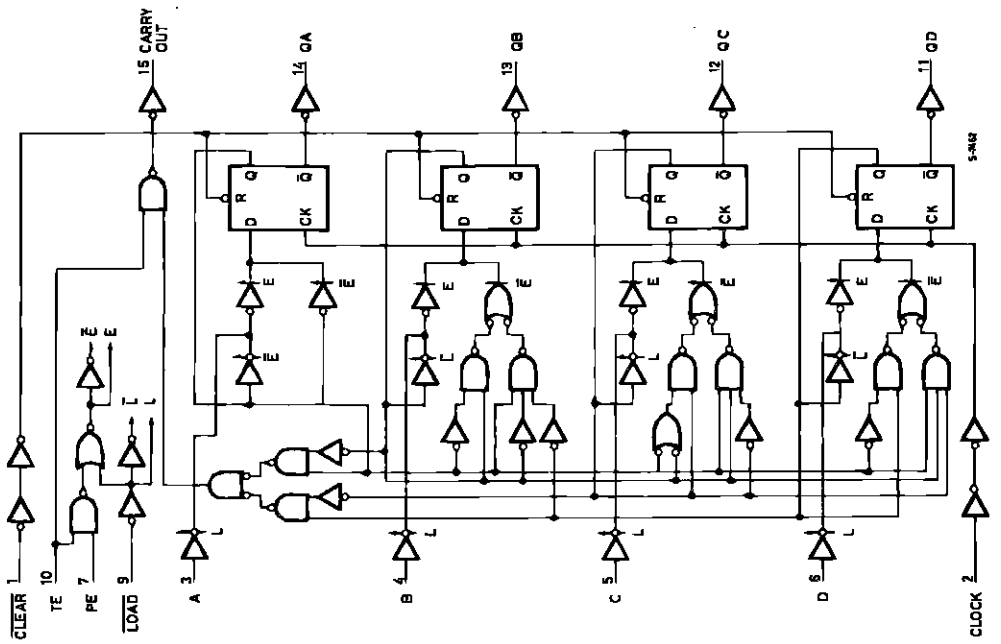


TIMING CHART (HC161/163 : binary counter)



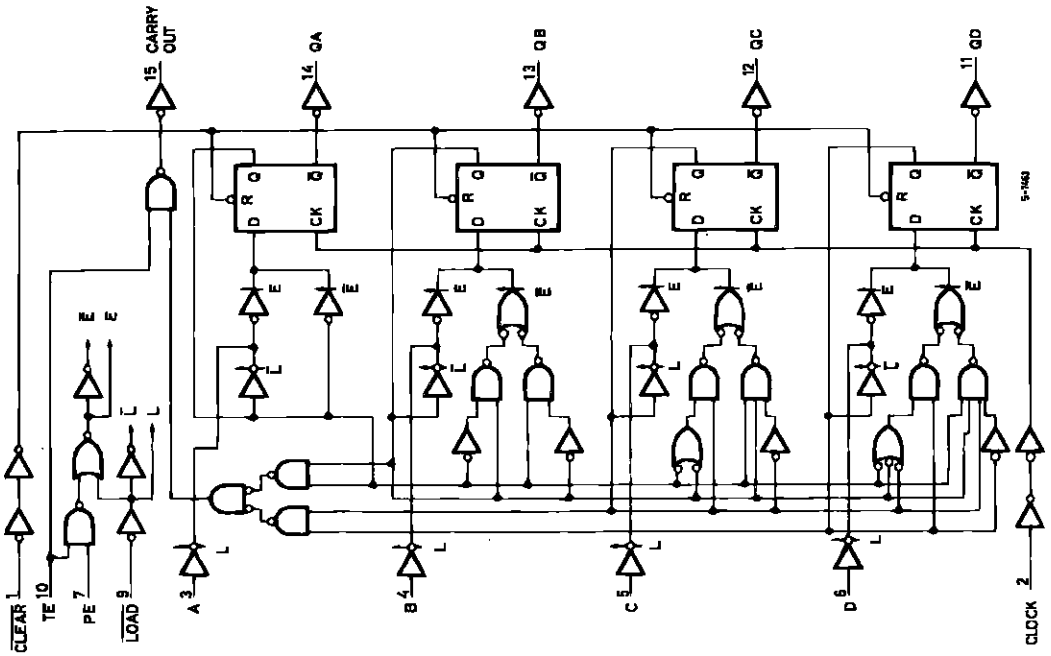
LOGIC DIAGRAM

HC160



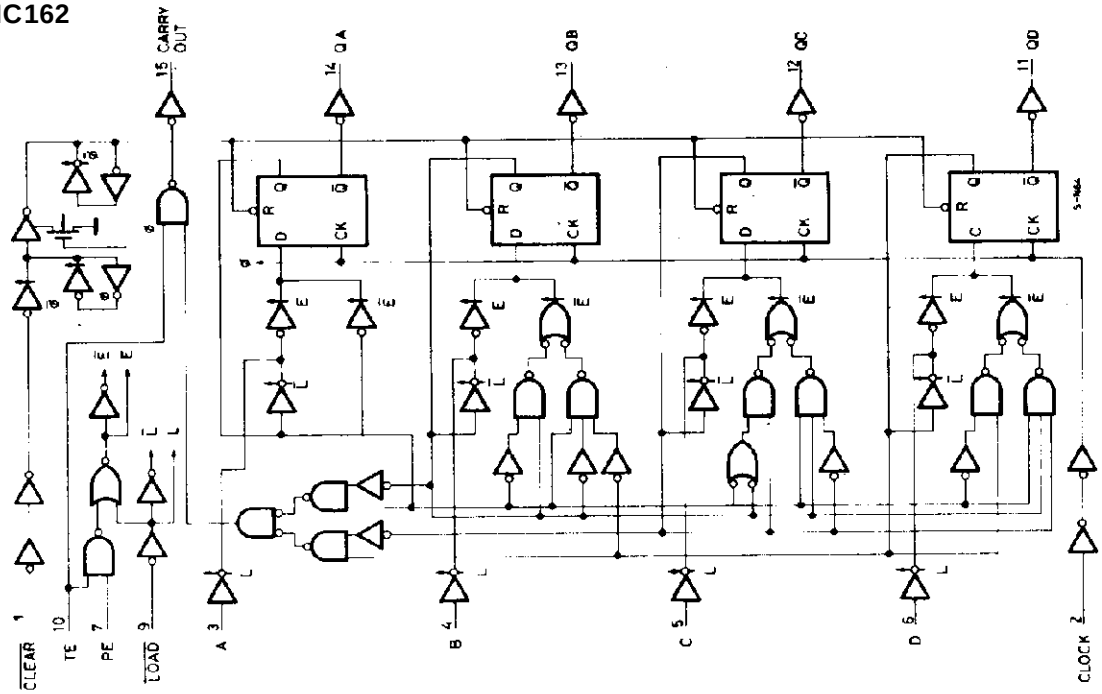
LOGIC DIAGRAM

HC161



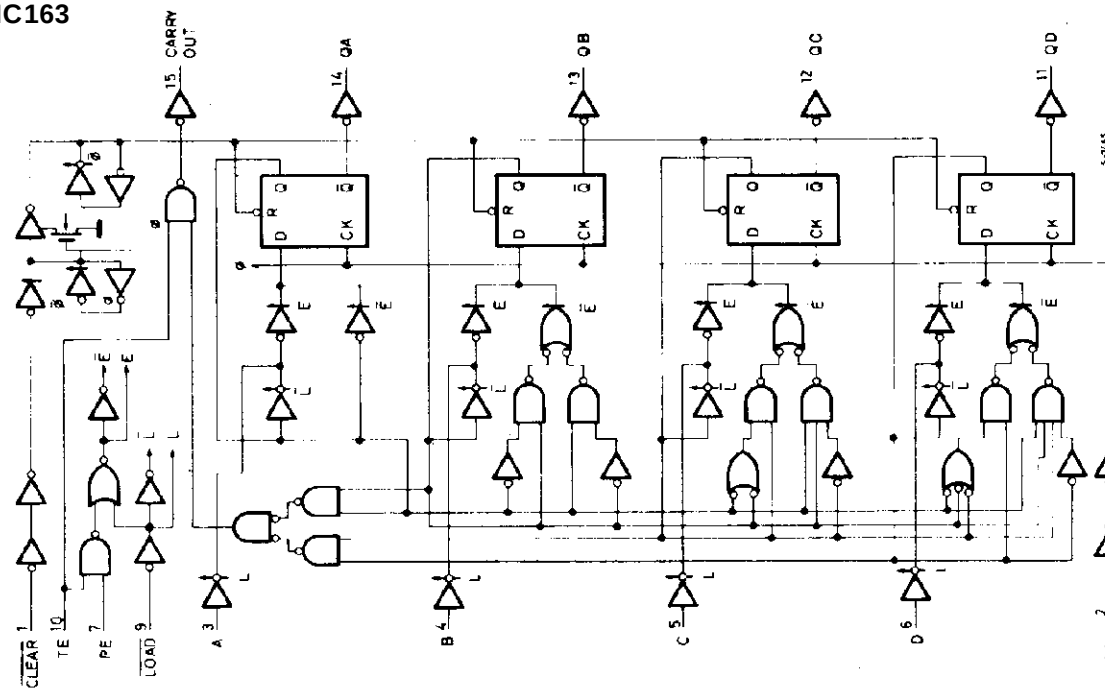
LOGIC DIAGRAM

HC162



LOGIC DIAGRAM

HC163



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			25	75		95		110	ns
		4.5			7	15		19		22	
		6.0			6	13		16		19	
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK - Q)	2.0			48	125		155		190	ns
		4.5			16	25		31		38	
		6.0			14	21		26		32	
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK-CARRY)	2.0	COUNT MODE		57	150		190		225	ns
		4.5			19	30		38		45	
		6.0			16	26		32		38	
t_{PLH}	Propagation Delay Time (CLOCK-CARRY)	2.0	PRESET MODE		66	175		220		265	ns
		4.5			22	35		44		53	
		6.0			19	30		37		45	
t_{PHL}	Propagation Delay Time (CLOCK-CARRY)	2.0	PRESET MODE		72	200		250		300	ns
		4.5			24	40		50		60	
		6.0			20	34		43		51	
t_{PLH} t_{PHL}	Propagation Delay Time (ENT-CARRY)	2.0			39	100		125		150	ns
		4.5			13	20		25		30	
		6.0			11	17		21		26	
t_{PLH}	Propagation Delay Time ($\overline{CLEAR}$ - Q)	2.0	for HC160/161 only		60	150		190		225	ns
		4.5			20	30		38		45	
		6.0			17	26		32		38	
t_{PHL}	Propagation Delay Time ($\overline{CLEAR}$-CARRY)	2.0	for HC160/161 only		72	200		250		300	ns
		4.5			24	40		50		60	
		6.0			20	34		43		51	
f_{MAX}	Maximum Clock Frequency	2.0		6.2	18		5		4.2		MHz
		4.5		31	53		25		21		
		6.0		37	62		30		25		
$t_{W(H)}$ $t_{W(L)}$	Minimum Pulse Width (CLOCK)	2.0			18	75		95		110	ns
		4.5			6	15		19		22	
		6.0			6	13		16		19	
$t_{W(L)}$	Minimum Pulse Width ($\overline{CLEAR}$)	2.0	for HC160/161 only		24	75		95		110	ns
		4.5			7	15		19		22	
		6.0			6	13		16		19	
t_s	Minimum Set-up Time (LOAD, PE, TE)	2.0			40	100		125		150	ns
		4.5			10	20		25		30	
		6.0			8	17		21		26	
t_s	Minimum Set-up Time (A, B, C, D)	2.0			20	75		95		110	ns
		4.5			5	15		19		22	
		6.0			3	13		16		19	
t_s	Minimum Set-up Time ($\overline{CLEAR}$)	2.0	for HC162/163 only		20	75		95		110	ns
		4.5			5	15		19		22	
		6.0			3	13		16		19	

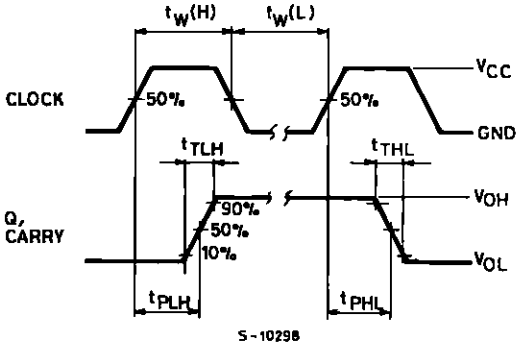
AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, Input $t_r = t_f$ = 6 ns)

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_h	Minimum Hold Time (A, B - CK)	2.0				0		0		0	ns
		4.5				0		0		0	
		6.0				0		0		0	
t_{REM}	Minimum Removal Time	2.0			18	50		65		75	ns
		4.5			4	10		13		15	
		6.0			3	9		11		13	
C_{IN}	Input Capacitance				5	10		10		10	pF
C_{PD} (*)	Power Dissipation Capacitance				50						pF

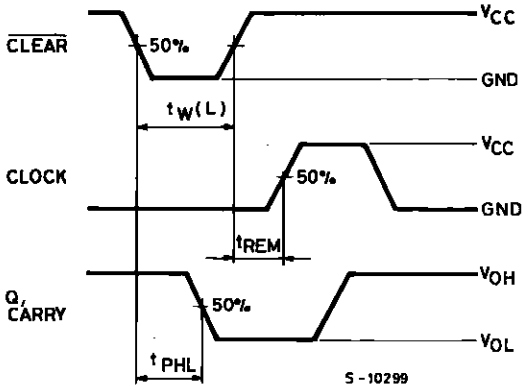
(*) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operting current can be obtained by the following equation. $I_{CC}(opr) = C_{PD} \bullet V_{CC} \bullet f_{IN} + I_{CC}$

SWITCHING CHARACTERISTICS TEST WAVEFORM

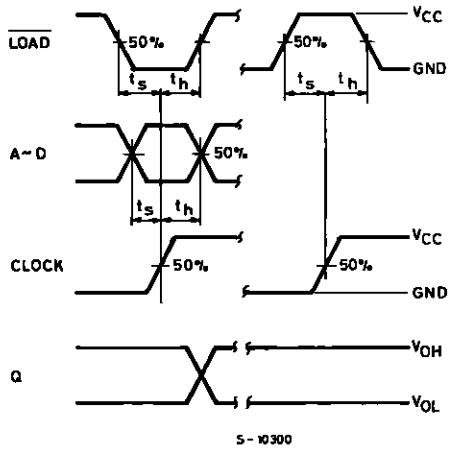
COUNT MODE



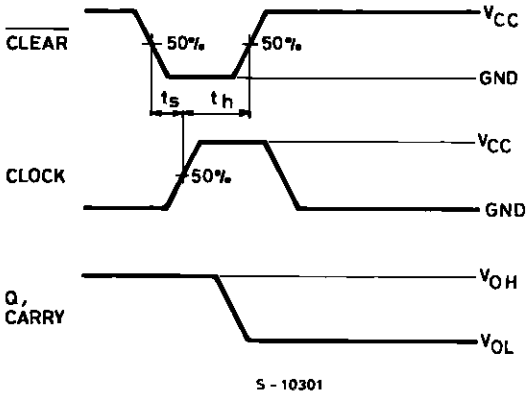
CLEAR MODE (HC160/161)



PRESET MODE

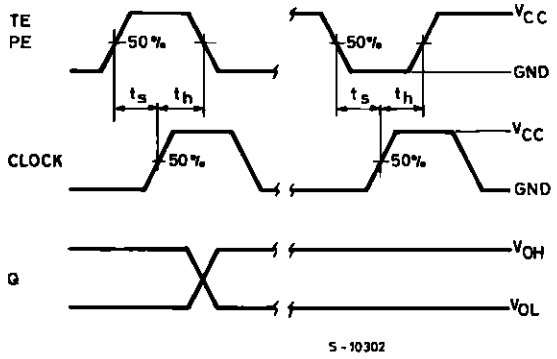


CLEAR MODE (HC162/163)



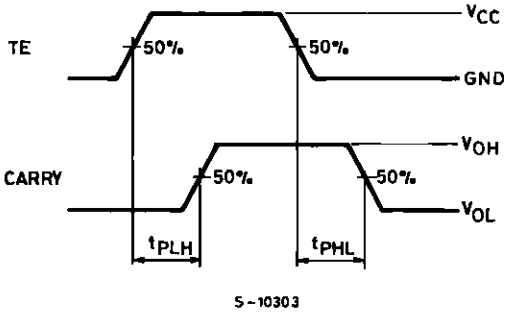
SWITCHING CHARACTERISTICS TEST WAVEFORM (continued)

COUNTENABLE MODE



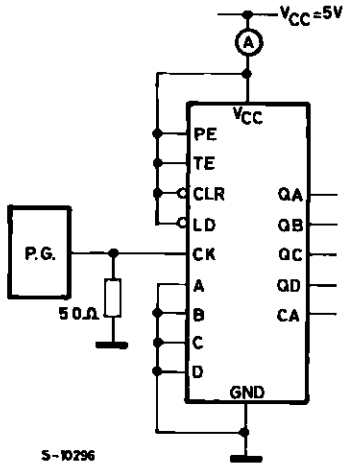
S-10302

CASCADE MODE
(fix maximum count)



S-10303

TEST CIRCUIT I_{CC} (Opr.)



S-10296

TOTAL OPERATING CURRENT WHEN USING A CAPACITIVE LOAD

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

For M74HC160/162 :

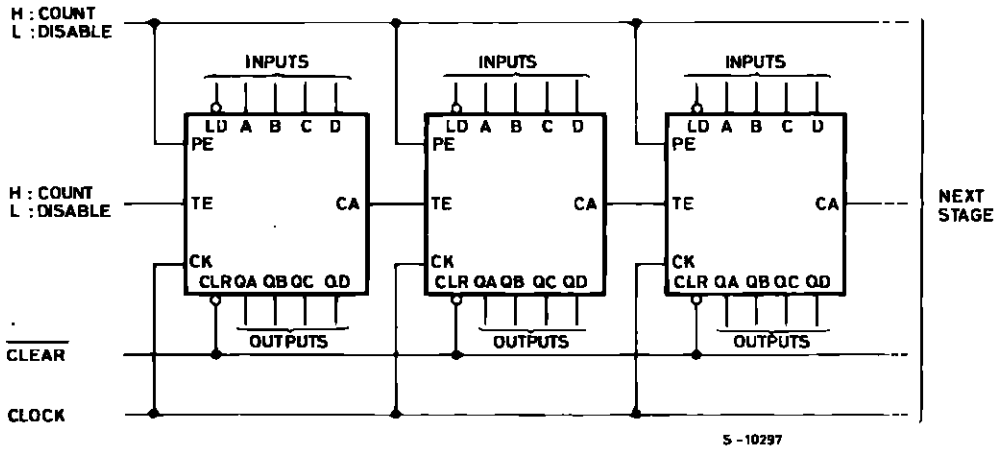
$$\Delta I_{CC} = f_{CK} \cdot V_{CC} \cdot \left(\frac{C_a}{2} + \frac{C_b}{5} + \frac{C_c}{10} + \frac{C_d}{10} + \frac{C_{ca}}{10} \right)$$

For M74HC161/163 :

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

C_a to C_{ca} are the capacitors loading the outputs.

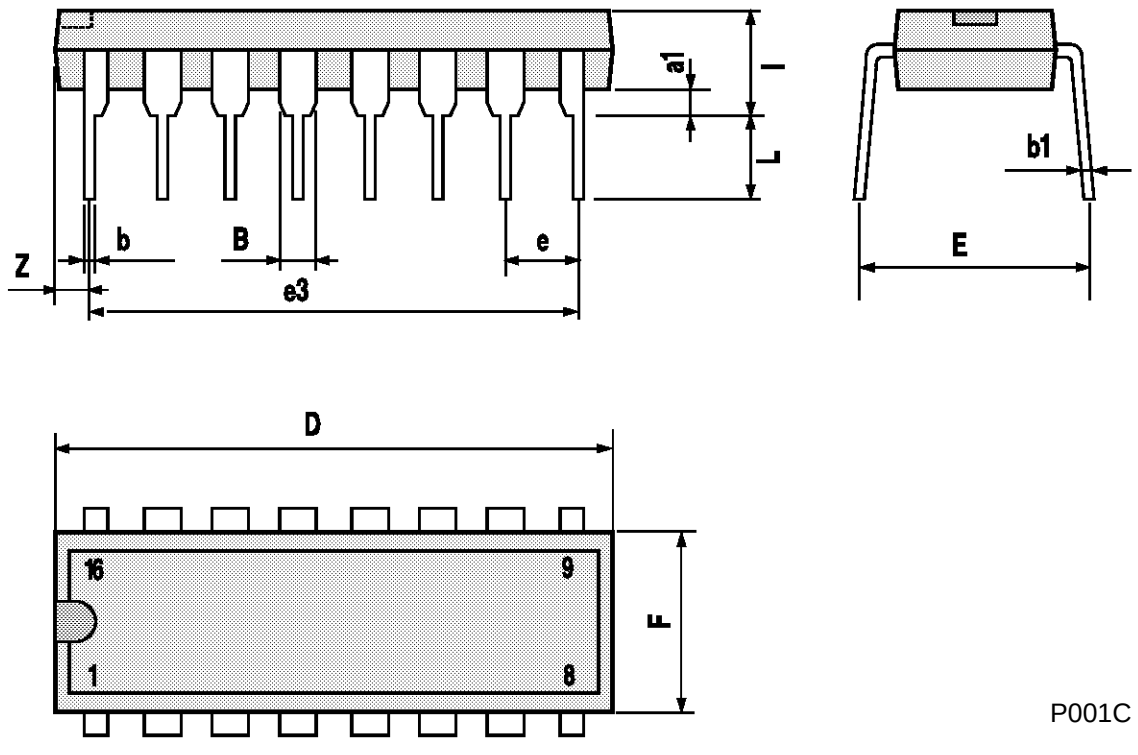
TYPICAL APPLICATION



S-10297

Plastic DIP16 (0.25) MECHANICAL DATA

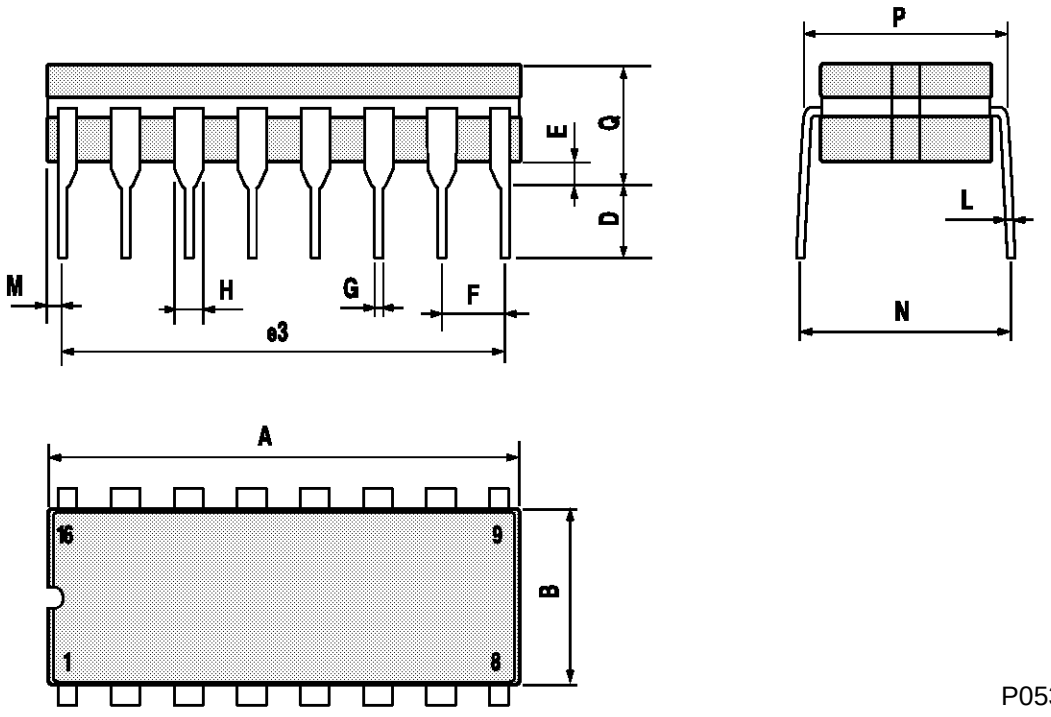
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050



P001C

Ceramic DIP16/1 MECHANICAL DATA

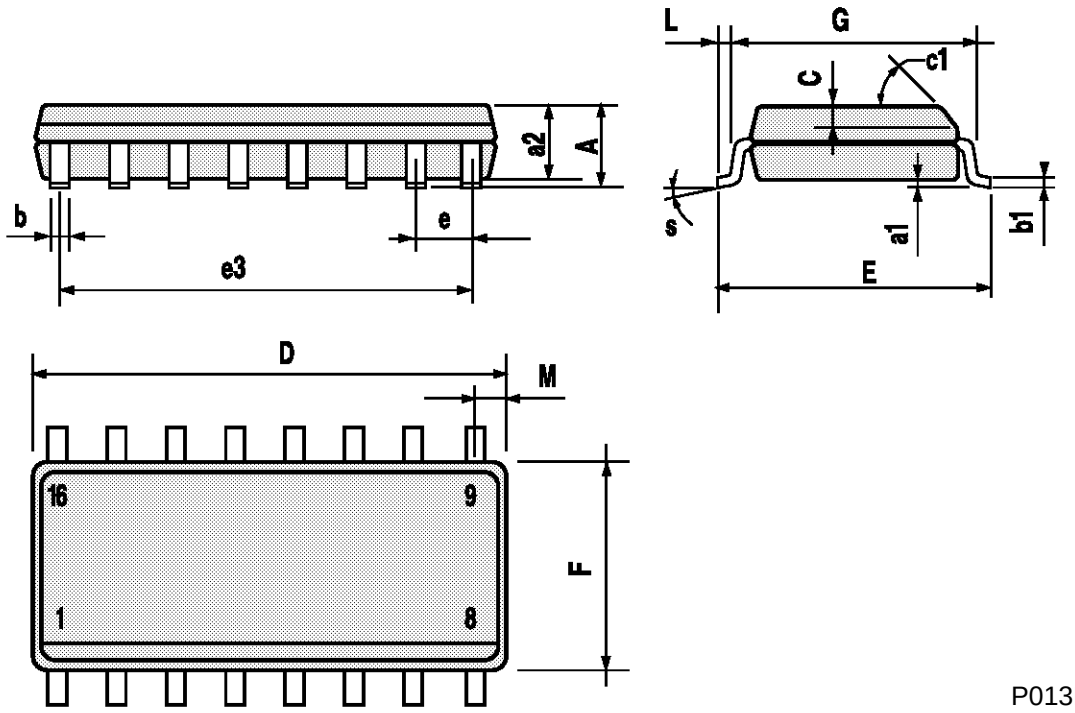
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			20			0.787
B			7			0.276
D		3.3			0.130	
E	0.38			0.015		
e3		17.78			0.700	
F	2.29		2.79	0.090		0.110
G	0.4		0.55	0.016		0.022
H	1.17		1.52	0.046		0.060
L	0.22		0.31	0.009		0.012
M	0.51		1.27	0.020		0.050
N			10.3			0.406
P	7.8		8.05	0.307		0.317
Q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



P053D

SO16 (Narrow) MECHANICAL DATA

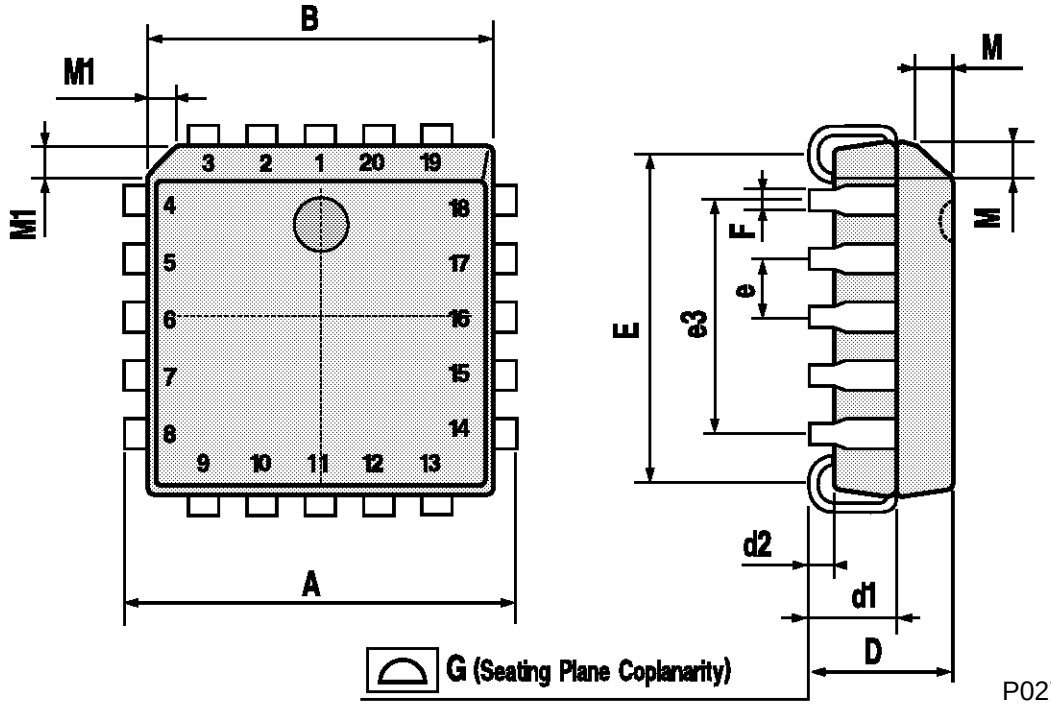
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.004		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157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



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