

## DUAL MONOSTABLE MULTIVIBRATOR

- HIGH SPEED  
 $t_{PD} = 25 \text{ ns (TYP) at } V_{CC} = 5V$
- LOW POWER DISSIPATION  
 STANDBY STATE  $I_{CC} = 4 \mu\text{A (MAX.) AT } T_A = 25^\circ\text{C}$   
 ACTIVE STATE  $I_{CC} = 700 \mu\text{A (MAX.) AT } V_{CC} = 5V$
- HIGH NOISE IMMUNITY  
 $V_{NIH} = V_{NIL} = 28 \% V_{CC} \text{ (MIN.)}$
- OUTPUT DRIVE CAPABILITY  
 10 LSTTL LOADS
- SYMMETRICAL OUTPUT IMPEDANCE  
 $I_{OH} = I_{OL} = 4 \text{ mA (MIN.)}$
- BALANCED PROPAGATION DELAYS  
 $t_{PLH} = t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE  
 $V_{CC} \text{ (OPR)} = 2 \text{ V TO } 6 \text{ V}$
- WIDE OUTPUT PULSE WIDTH RANGE  
 $t_{WOUT} = 150 \text{ ns} \sim 60 \text{ s OVER AT } V_{CC} = 4.5 \text{ V}$
- PIN AND FUNCTION COMPATIBLE WITH  
 54/74LS221

### DESCRIPTION

The M54/74HC221/221A are high speed CMOS MONOSTABLE multivibrators fabricated with silicon gate C<sup>2</sup>MOS technology. It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation. There are two trigger inputs,  $\overline{A}$  INPUT (negative edge) and B INPUT (positive edge). Triggering on the B input occurs at a particular voltage threshold and is not related to the rise and fall time of the applied pulse.

The device may also be triggered by using the  $\overline{CLR}$  input (positive-edge) because of the Schmitt-trigger input ; after triggering the output maintains the MONOSTABLE state for the time period determined by the external resistor  $R_x$  and capacitor  $C_x$ . Taking  $\overline{CLR}$  low breaks this MONOSTABLE STATE. If the next trigger pulse occurs during the MONOSTABLE period it makes the MONOSTABLE period longer. Limit for values of  $C_x$  and  $R_x$  :

$C_x$  : NO LIMIT

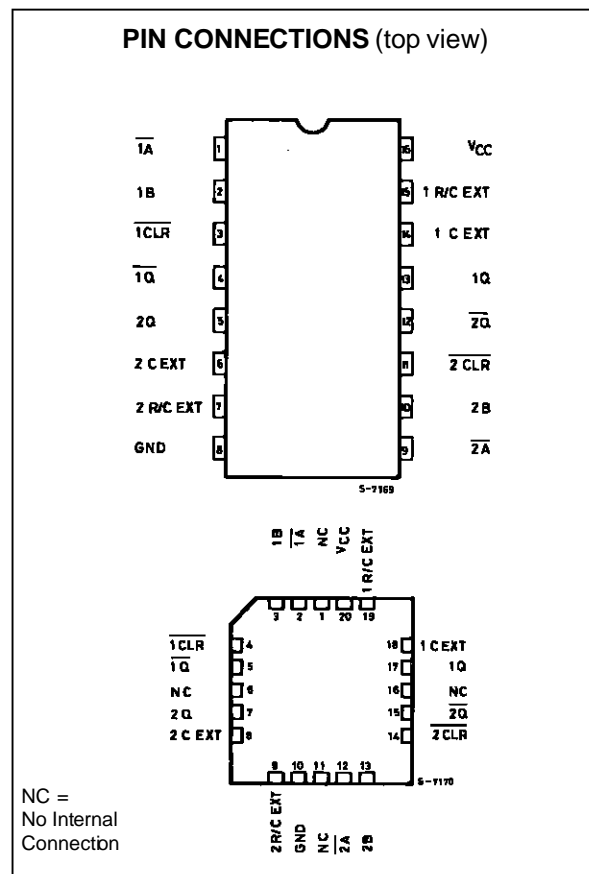
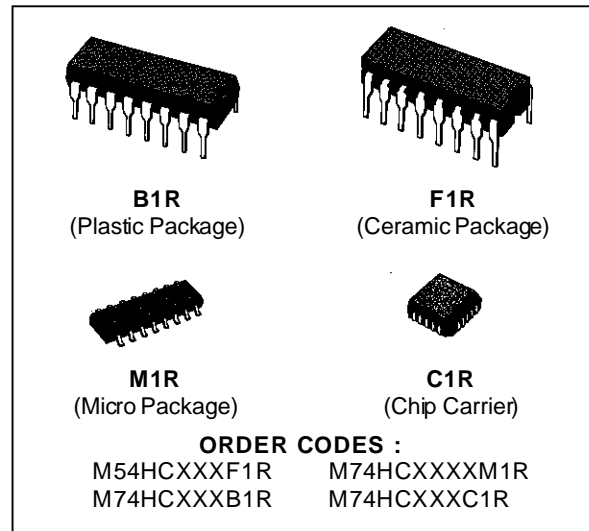
$R_x$  :  $V_{CC} < 3.0 \text{ V } 5 \text{ K } \Omega \text{ to } 1 \text{ M } \Omega$   
 $V_{CC} \geq 3.0 \text{ V } 1 \text{ K } \Omega \text{ to } 1 \text{ M } \Omega$

Two different pulse width constants are available:

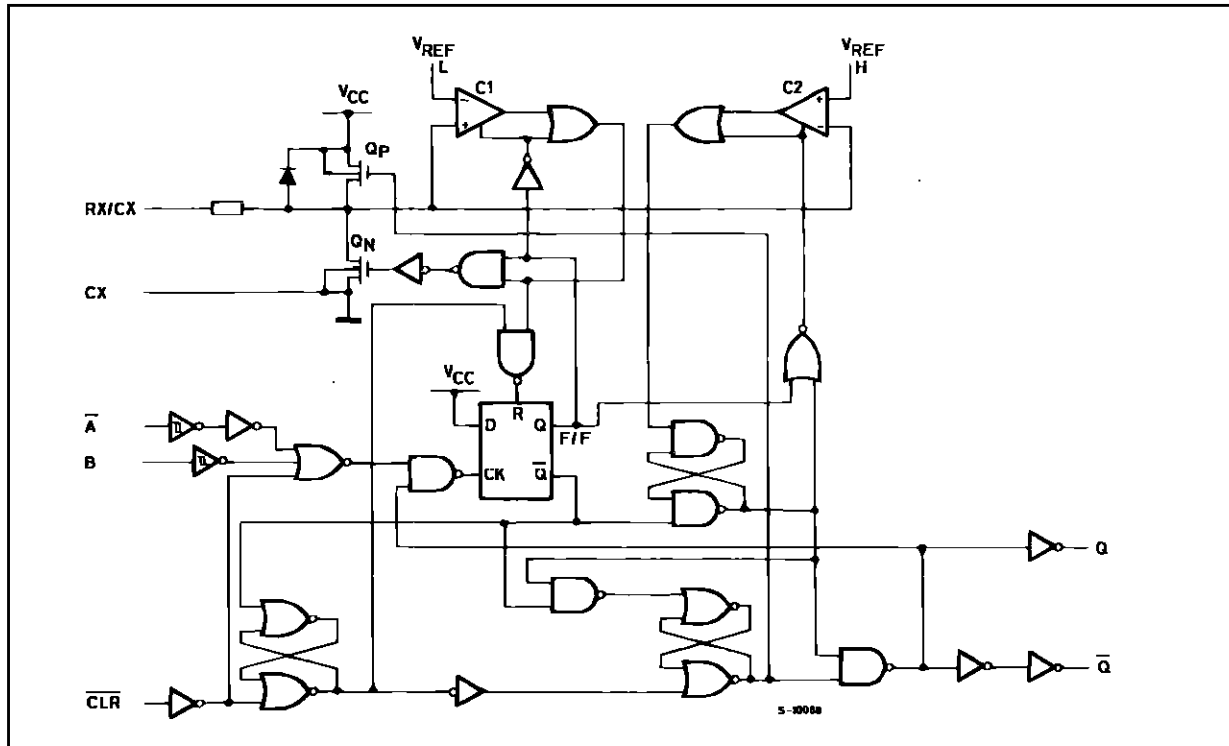
$K \cong 0.7$  for HC221

$K \cong 1$  for HC221A

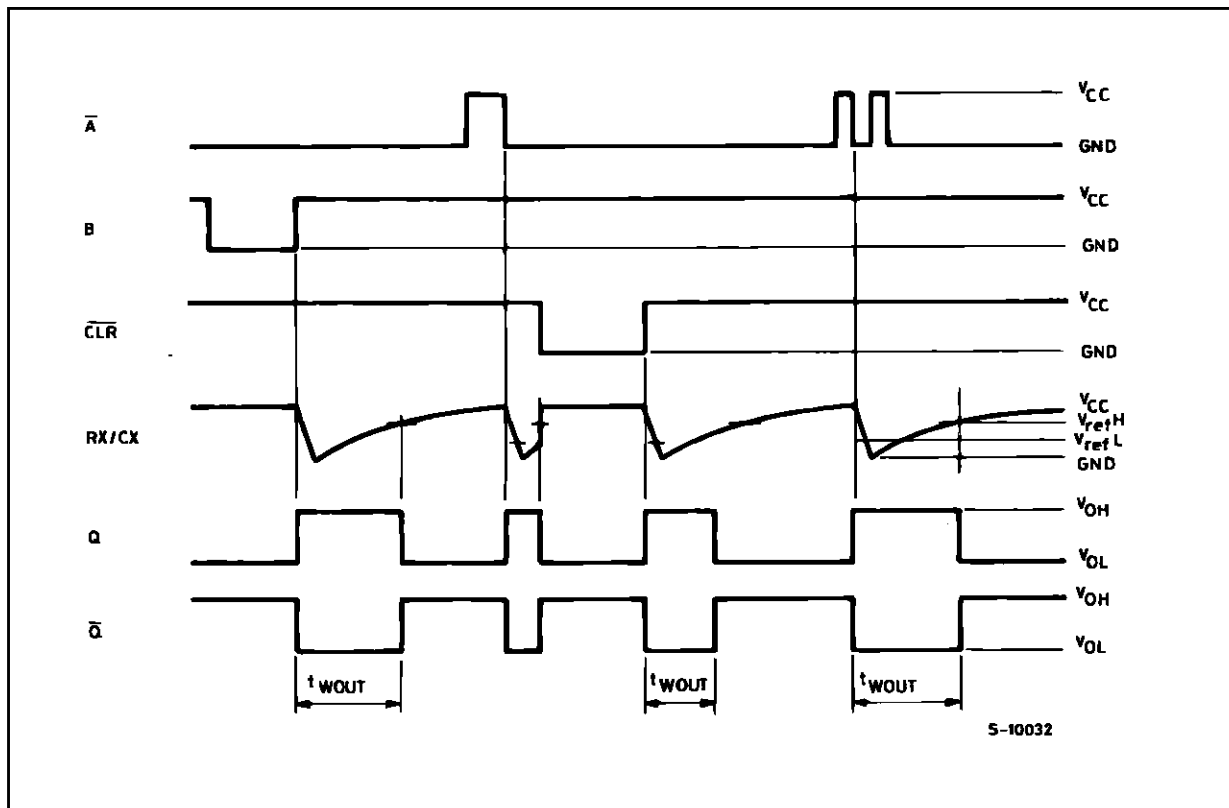
All inputs are equipped with protection circuits against static discharge and transient excess voltage.



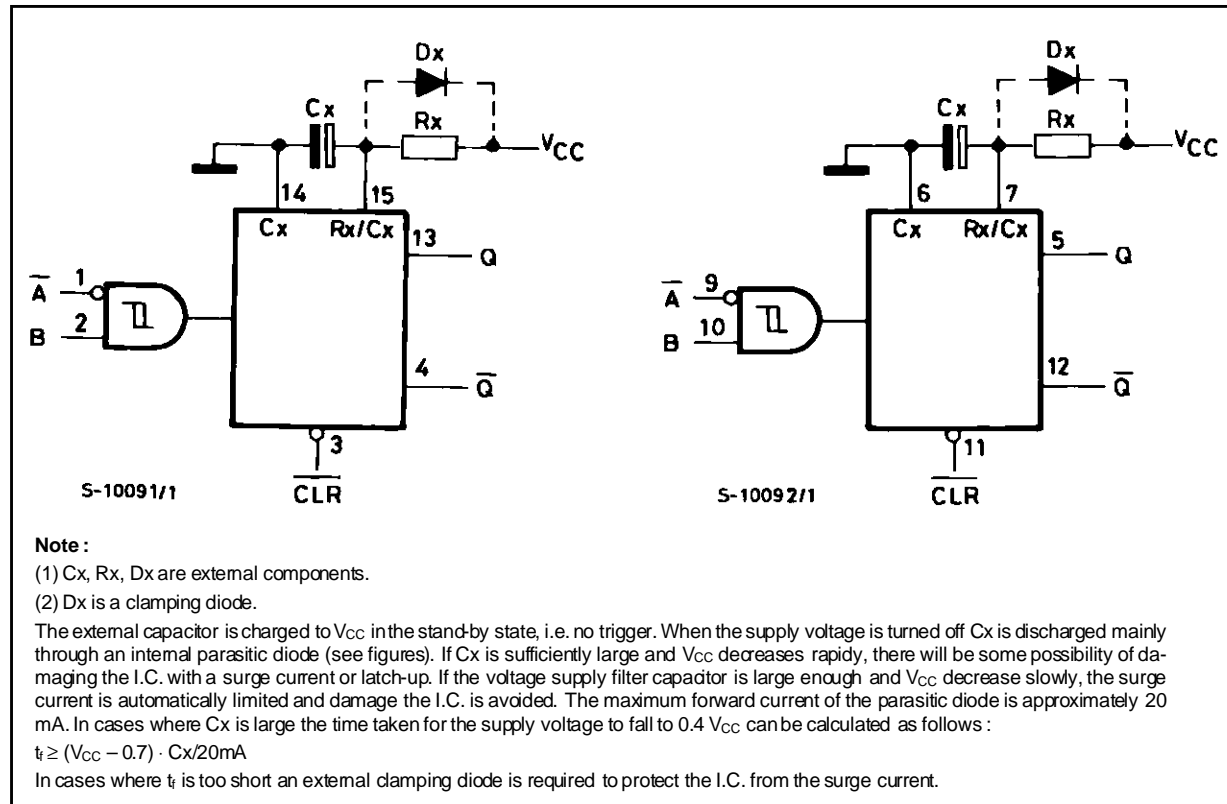
SYSTEM DIAGRAM



TIMING CHART



## BLOCK DIAGRAM



## FUNCTIONAL DESCRIPTION

## STAND-BY STATE

The external capacitor, Cx, is fully charged to  $V_{CC}$  in the stand-by state. Hence, before triggering, transistor Qp and Qn (connected to the Rx/Cx node) are both turned-off. The two comparators that control the timing and the two reference voltage sources stop operating. The total supply current is therefore only leakage current.

## TRIGGER OPERATION

Triggering occurs when :

- 1<sup>st</sup>) A is "low" and B has a falling edge ;
- 2<sup>nd</sup>) B is "high" and A has a rising edge ;
- 3<sup>rd</sup>) A is low and B is high and C1 has a rising edge.

After the multivibrator has been retriggered comparator C1 and C2 start operating and Qn is turned on. Cx then discharges through Qn. The voltage at the node R/C external falls.

When it reaches  $V_{REFL}$  the output of comparator C1 becomes low. This in turn resets the flip-flop and Qn is turned off.

At this point C1 stops functioning but C2 continues to operate.

The voltage at R/C external begins to rise with a time constant set by the external components Rx, Cx.

Triggering the multivibrator causes Q to go high after internal delay due to the flip-flop and the gate. Q remains high until the voltage at R/C external rises again to  $V_{REFH}$ . At this point C2 output goes low and O goes low. C2 stop operating. That means that after triggering when the voltage R/C external returns to  $V_{REFH}$  the multivibrator has returned to its MONOSTABLE STATE. In the case where Rx · Cx are large enough and the discharge time of the capacitor and the delay time in the I.C. can be ignored, the width of the output pulse  $t_w(\text{out})$  is as follows :

$$t_w(\text{OUT}) = 0.70 Cx \cdot Rx \text{ (HC221)}$$

$$t_w(\text{OUT}) = Cx \cdot Rx \text{ (HC221A)}$$

## RESET OPERATION

CL is normally high. If CL is low, the trigger is not effective because Q output goes low and trigger control flip-flop is reset.

Also transistor Op is turned on and Cx is charged quickly to  $V_{CC}$ . This means if CL input goes low, the IC becomes waiting state both in operating and non operating state.

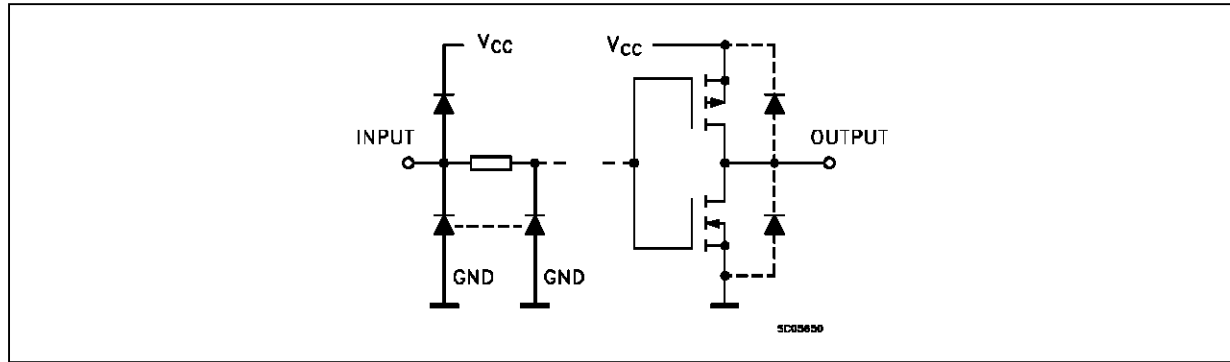
# M54/M74HC221/221A

## TRUTH TABLE

INPUTS			OUTPUTS		NOTE
A	B	CLR	Q	Q	
	H	H			OUTPUT ENABLE
X	L	H	L (*)	H (*)	INHIBIT
H	X	H	L (*)	H (*)	INHIBIT
L		H			OUTPUT ENABLE
L	H				OUTPUT ENABLE
X	X	L	L	H	INHIBIT

X: Don't Care (\*) : Except for monostable period

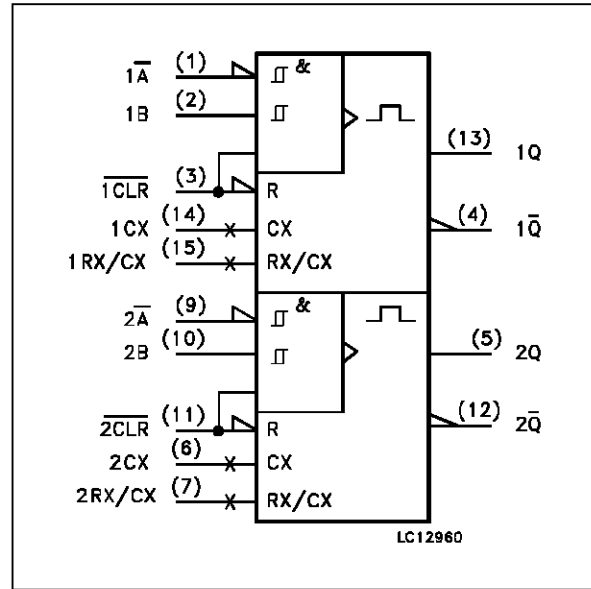
## INPUT AND OUTPUT EQUIVALENT CIRCUIT



## PIN DESCRIPTION

PIN No	SYMBOL	NAME AND FUNCTION
1, 9	1A, 2A	Trigger Inputs (Negative Edge Triggered)
2, 10	1B, 2B	Trigger Inputs (Positive Edge Triggered)
3, 11	1CLR, 2CLR	Direct Reset LOW and Trigger Action at Positive Edge
4, 12	1Q, 2Q	Outputs (Active LOW)
7	2R <sub>EXT</sub> /C <sub>EXT</sub>	External Resistor Capacitor Connection
13, 5	1Q, 2Q	Outputs (Active HIGH)
14, 6	1C <sub>EXT</sub> , 2C <sub>EXT</sub>	External Capacitor Connection
15	1R <sub>EXT</sub> /C <sub>EXT</sub>	External Resistor Capacitor Connection
8	GND	Ground (0V)
16	V <sub>CC</sub>	Positive Supply Voltage

## IEC LOGIC SYMBOL



## ABSOLUTE MAXIMUM RATING

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 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 <sub>CC</sub>	Supply Voltage	2 to 6	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 ( $\overline{\text{CLR}}$ and $\overline{\text{A}}$ only)	V <sub>CC</sub> = 2 V V <sub>CC</sub> = 4.5 V V <sub>CC</sub> = 6 V	0 to 1000 0 to 500 0 to 400	ns
C <sub>X</sub>	External Capacitor	> 100 (*)	pF	
R <sub>X</sub>	External Resistor	V <sub>CC</sub> < 3 V V <sub>CC</sub> ≥ 3 V	5K to 1M (*) 1K to 1M (*)	Ω

(\*)The maximum allowable values of C<sub>x</sub> and R<sub>x</sub> are a function of leakage of capacitor C<sub>x</sub>, the leakage of HC221/A, and leakage due to the board layout and surface resistance. Susceptibility to externally induced noise signals may occur for R<sub>x</sub> > 1MΩ

**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	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 <sub>IL</sub>	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 <sub>OH</sub>	High Level Output Voltage (Q, Q̄ Output)	2.0	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>O</sub> = -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 <sub>O</sub> = -4.0 mA	4.18	4.31		4.13		4.10			
		6.0	I <sub>O</sub> = -5.2 mA	5.68	5.8		5.63		5.60			
V <sub>OL</sub>	Low Level Output Voltage (Q, Q̄ Output)	2.0	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
		4.5				0.0	0.1		0.1		0.1	
		6.0				0.0	0.1		0.1		0.1	
		4.5	I <sub>O</sub> = 4.0 mA	0.17	0.26		0.33		0.40			
		6.0	I <sub>O</sub> = 5.2 mA	0.18	0.26		0.33		0.40			
I <sub>I</sub>	Input Leakage Current	6.0	V <sub>I</sub> = V <sub>CC</sub> or GND			±0.1		±1		±1	μA	
I <sub>I</sub>	R/C Terminal Off State Current	6.0	V <sub>I</sub> = V <sub>CC</sub> or GND			±0.5		±5		±10	μA	
I <sub>CC</sub>	Quiescent Supply Current	6.0	V <sub>I</sub> = V <sub>CC</sub> or GND			4		40		80	μA	
I <sub>CC</sub> '	Active State Supply Current (1)	2.0	V <sub>I</sub> = V <sub>CC</sub> or GND V <sub>IN</sub> = V <sub>CC</sub> /2		45	250		260		350	μA	
		4.5			400	530		650		850	μA	
		6.0			0.7	1		1.3		1.7	mA	

(1): Per Circuit

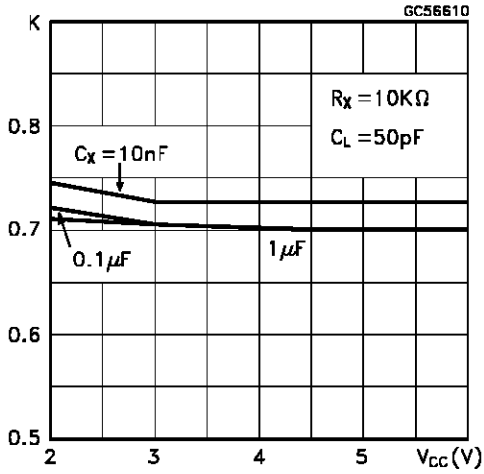
AC ELECTRICAL CHARACTERISTICS (C<sub>L</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 6 ns)

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	2.0			30	75		95		110	ns	
		4.5			8	15		19		22		
		6.0			7	13		16		19		
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (A, B - Q, Q̄)	2.0			102	210		265		315	ns	
		4.5			30	42		53		63		
		6.0			24	36		45		54		
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (CLR TRIGGER - Q, Q̄)	2.0			102	235		295		355	ns	
		4.5			30	47		59		71		
		6.0			24	40		50		60		
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (CLR - Q, Q̄)	2.0			67	160		200		240	ns	
		4.5			20	32		40		48		
		6.0			16	27		34		41		
t <sub>wOUT</sub>	Output Pulse Width (for HC221)	2.0	C <sub>X</sub> = 100 pF R <sub>X</sub> = 10 KΩ		1.5						μs	
		4.5			1.3							
		6.0			1.2							
		2.0	C <sub>X</sub> = 0.1 μF R <sub>X</sub> = 100 KΩ		7							ms
		4.5			6.9							
		6.0			6.9							
t <sub>wOUT</sub>	Output Pulse Width (for HC221A)	2.0	C <sub>X</sub> = 100 pF R <sub>X</sub> = 10 KΩ		1.8						μs	
		4.5			1.5							
		6.0			1.4							
		2.0	C <sub>X</sub> = 0.1 μF R <sub>X</sub> = 100 KΩ		10							ms
		4.5			9.7							
		6.0			9.6							
Δt <sub>wOUT</sub>	Output Pulse Width Error Between Circuits in Same Package				±1						%	
t <sub>w(H)</sub> t <sub>w(L)</sub>	Minimum Pulse Width	2.0				75		95		110	ns	
		4.5				15		19		22		
		6.0				13		16		20		
t <sub>w(L)</sub>	Minimum Pulse Width	2.0				75		95		110	ns	
		4.5				15		19		22		
		6.0				13		16		20		
C <sub>IN</sub>	Input Capacitance				5	10		10		10	pF	
C <sub>PD</sub> (*)	Power Dissipation Capacitance				174						pF	

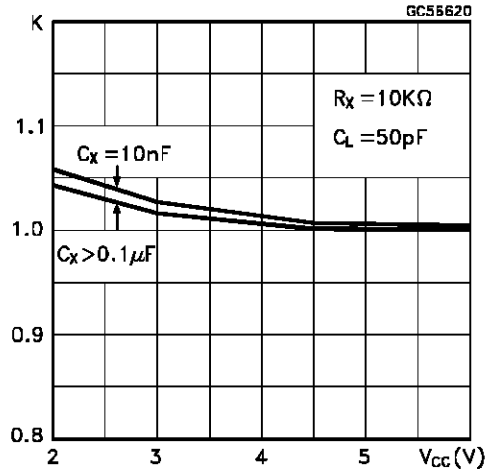
(\*) C<sub>PD</sub> is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. I<sub>CC</sub>(opr) = C<sub>PD</sub> • V<sub>CC</sub> • f<sub>IN</sub> + I<sub>CC</sub>' Duty/100 + I<sub>C</sub>/2 (per monostable) (I<sub>CC</sub>': Active Supply Current) (Duty:%)

# M54/M74HC221/221A

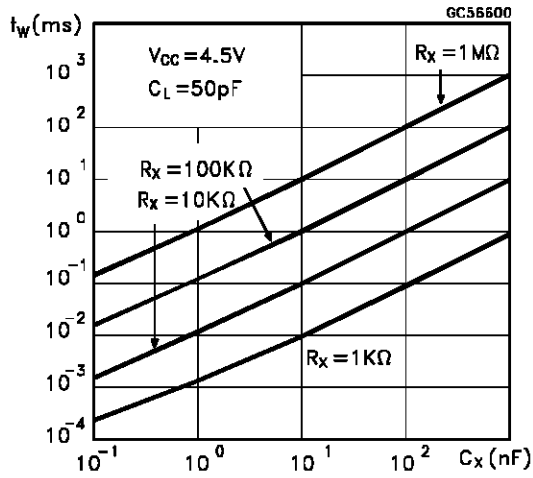
Output Pulse Width Constant Characteristics (for HC221)



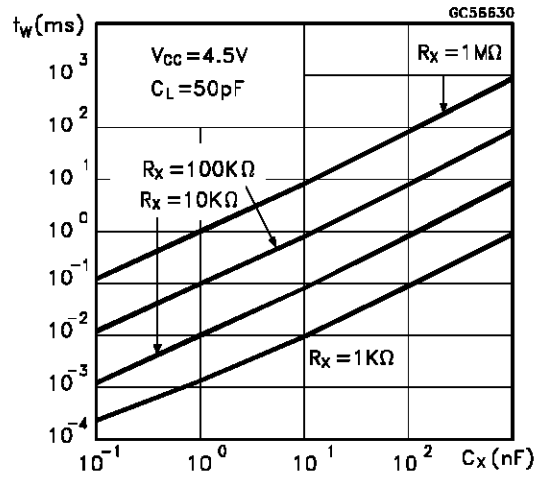
Output Pulse Width Constant Characteristics (for HC221A)



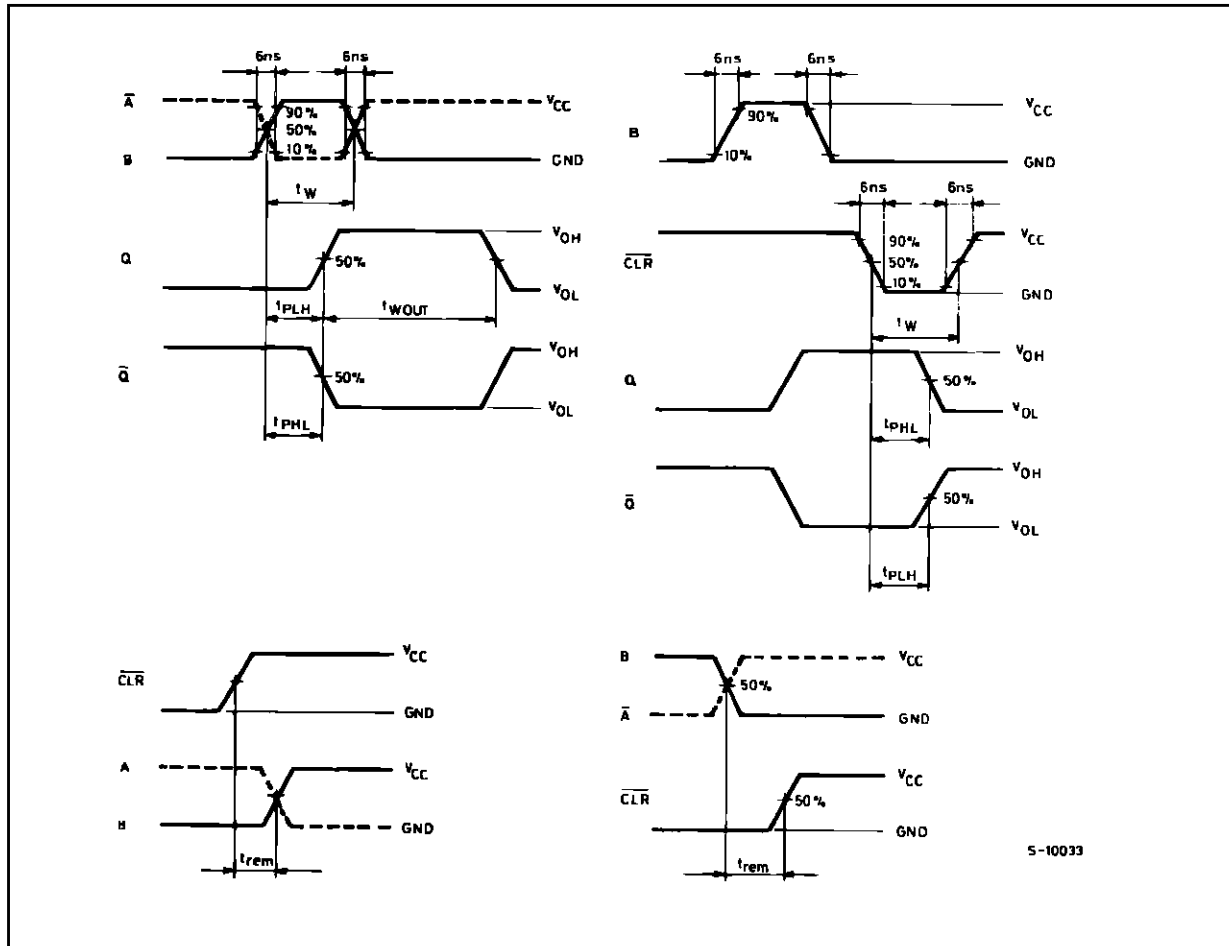
Output Pulse Width Characteristics (for HC221)



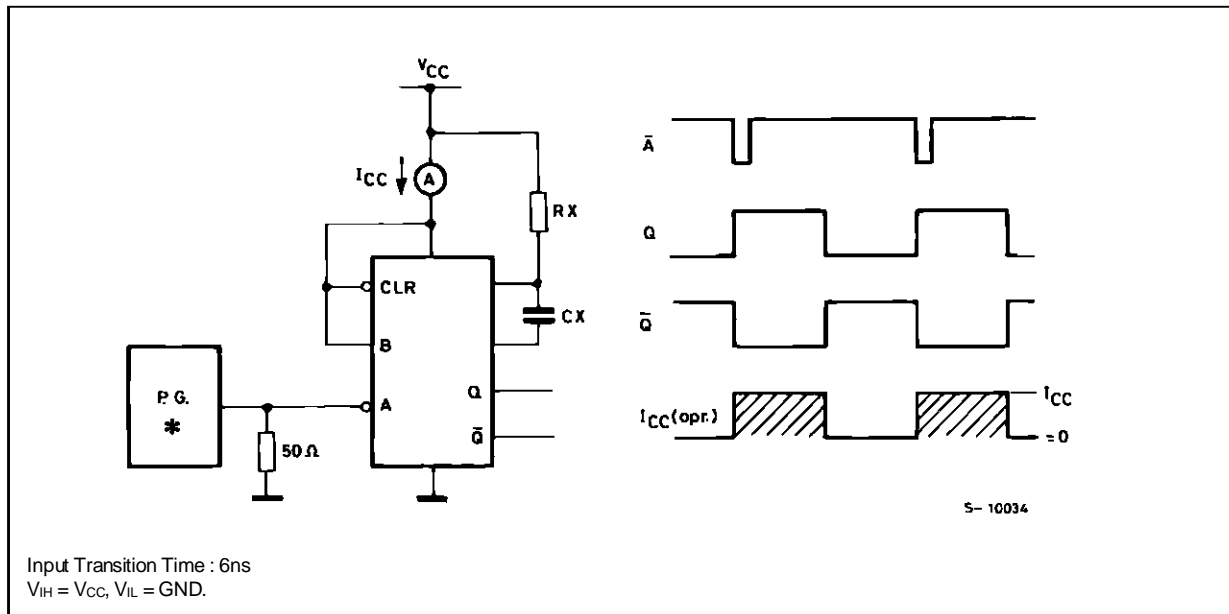
Output Pulse Width Characteristics (for HC221A)



SWITCHING CHARACTERISTICS TEST WAVEFORM

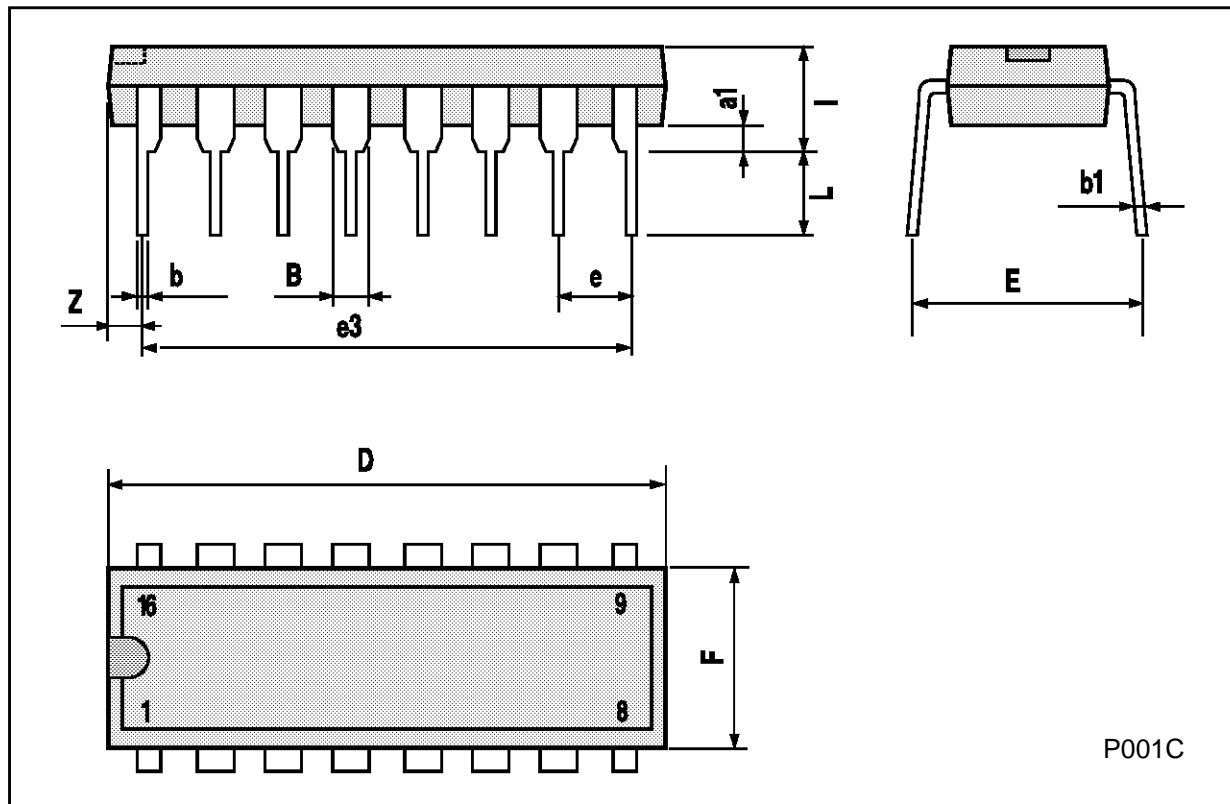


TEST WAVEFORM



**Plastic DIP16 (0.25) MECHANICAL DATA**

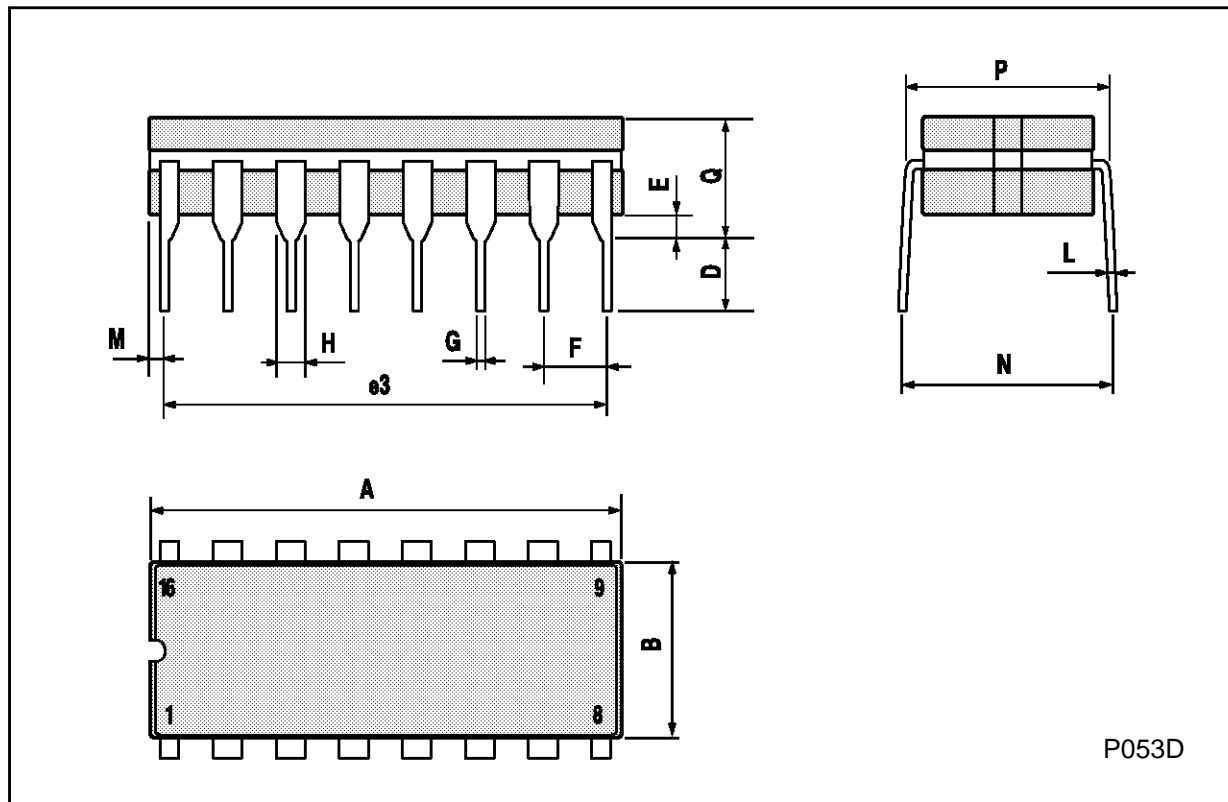
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050



P001C

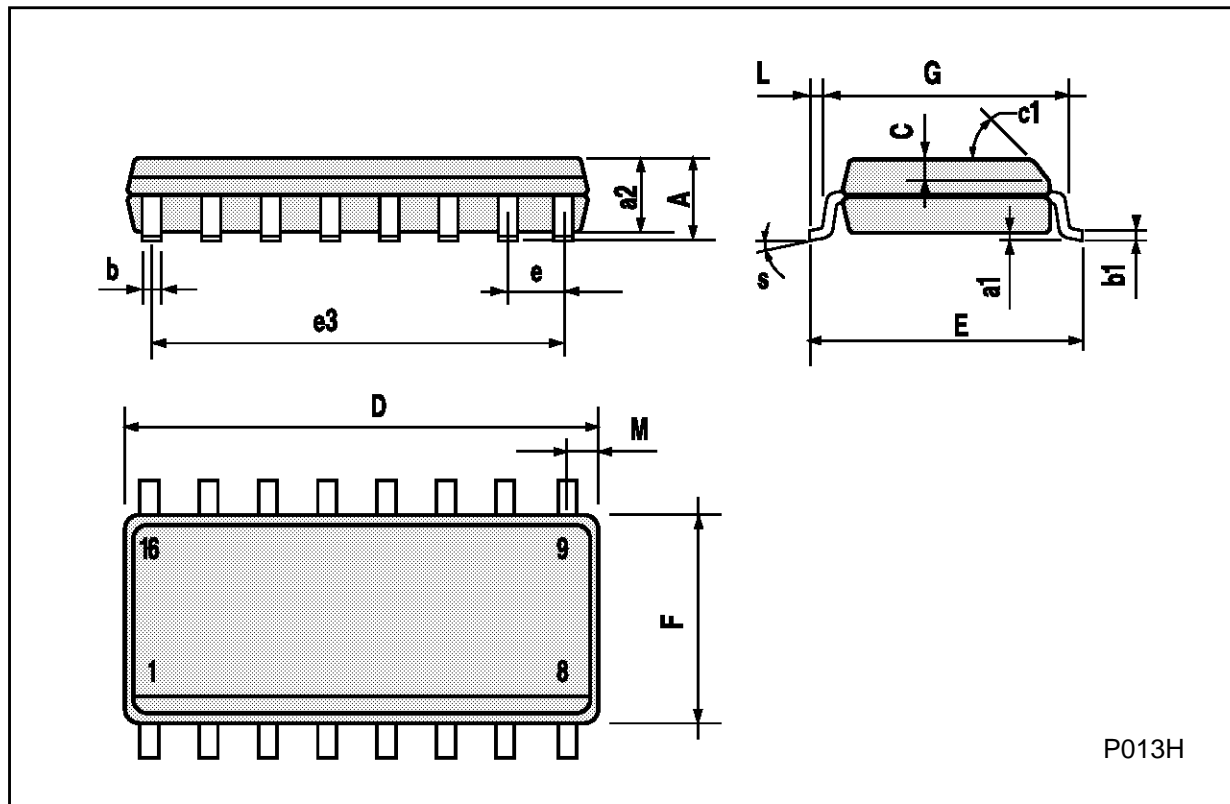
## Ceramic DIP16/1 MECHANICAL DATA

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



SO16 (Narrow) MECHANICAL DATA

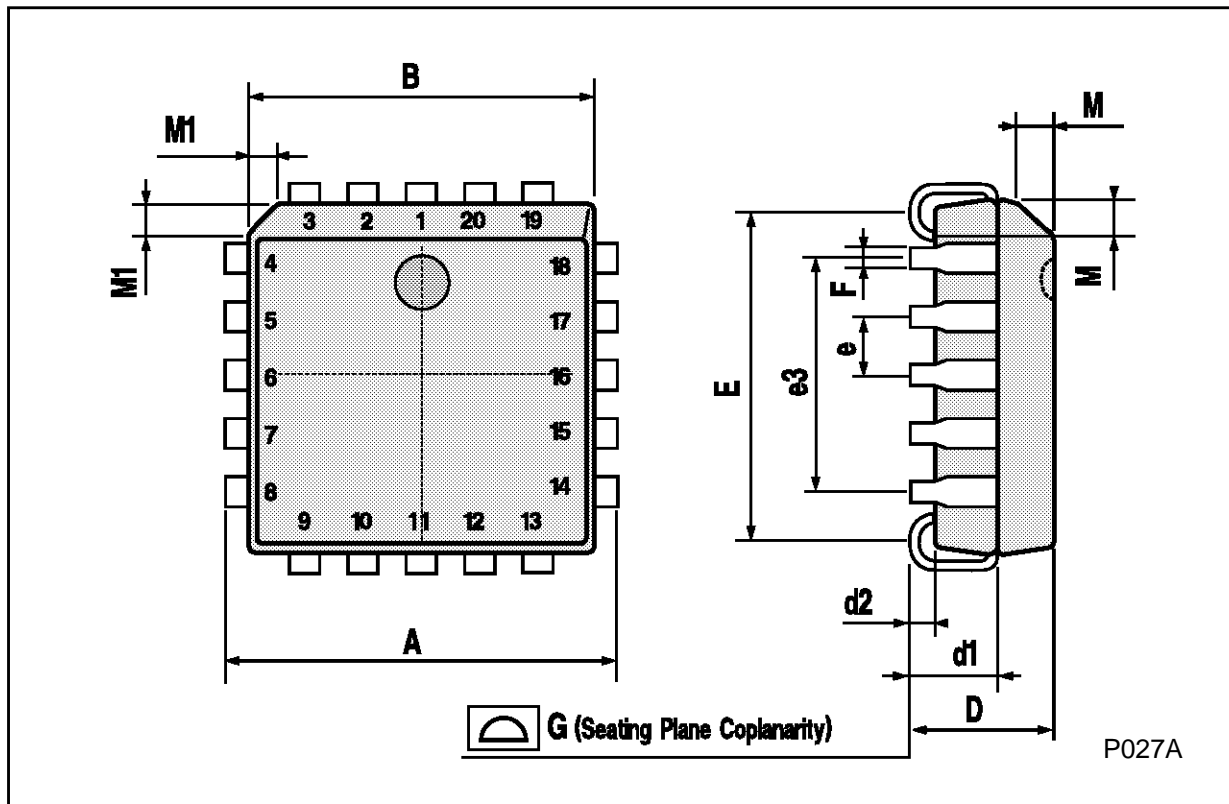
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.004		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157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