

DUAL MONOSTABLE MULTIVIBRATOR

- **HIGH SPEED**
 $t_{PD} = 25 \text{ ns (TYP)}$ at $V_{CC} = 5V$
- **LOW POWER DISSIPATION**
 STANDBY STATE $I_{CC} = 4 \mu A \text{ (MAX.)}$ AT $T_A = 25^\circ C$
 ACTIVE STATE $I_{CC} = 700 \mu A \text{ (MAX.)}$ 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 C²MOS 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 K Ω to 1 M Ω

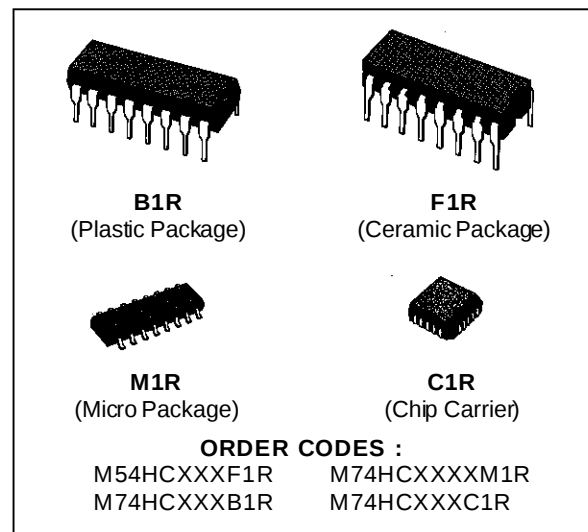
$V_{CC} \geq 3.0 \text{ V}$ 1 K Ω to 1 M Ω

Two different pulse width constants are available:

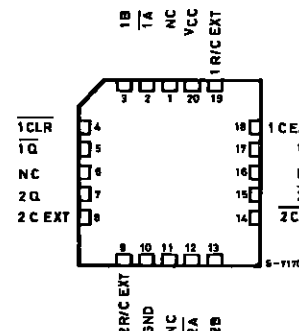
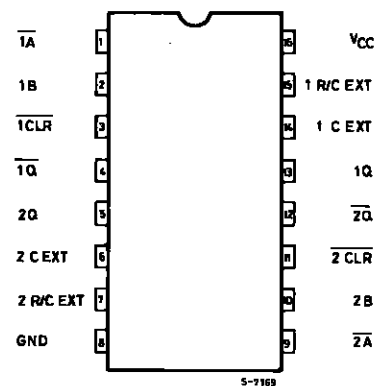
$K \cong 0.7$ for HC221

$K \cong 1$ for HC221A

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

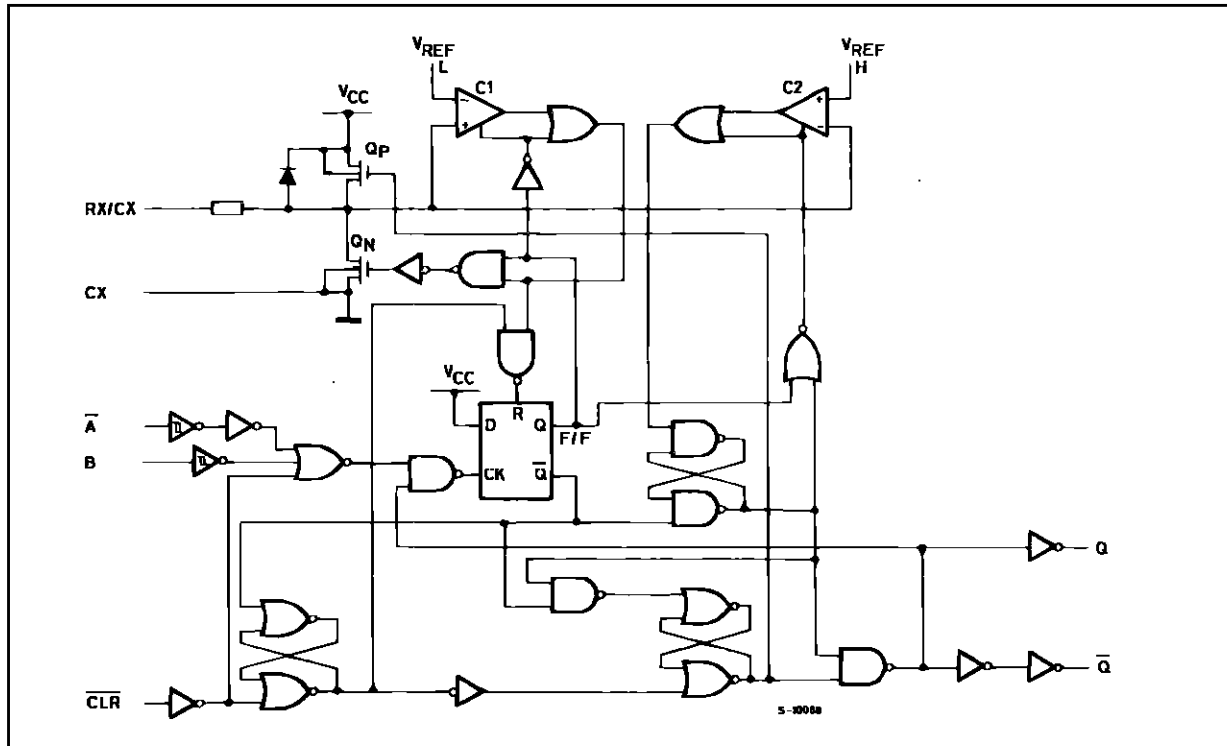


PIN CONNECTIONS (top view)

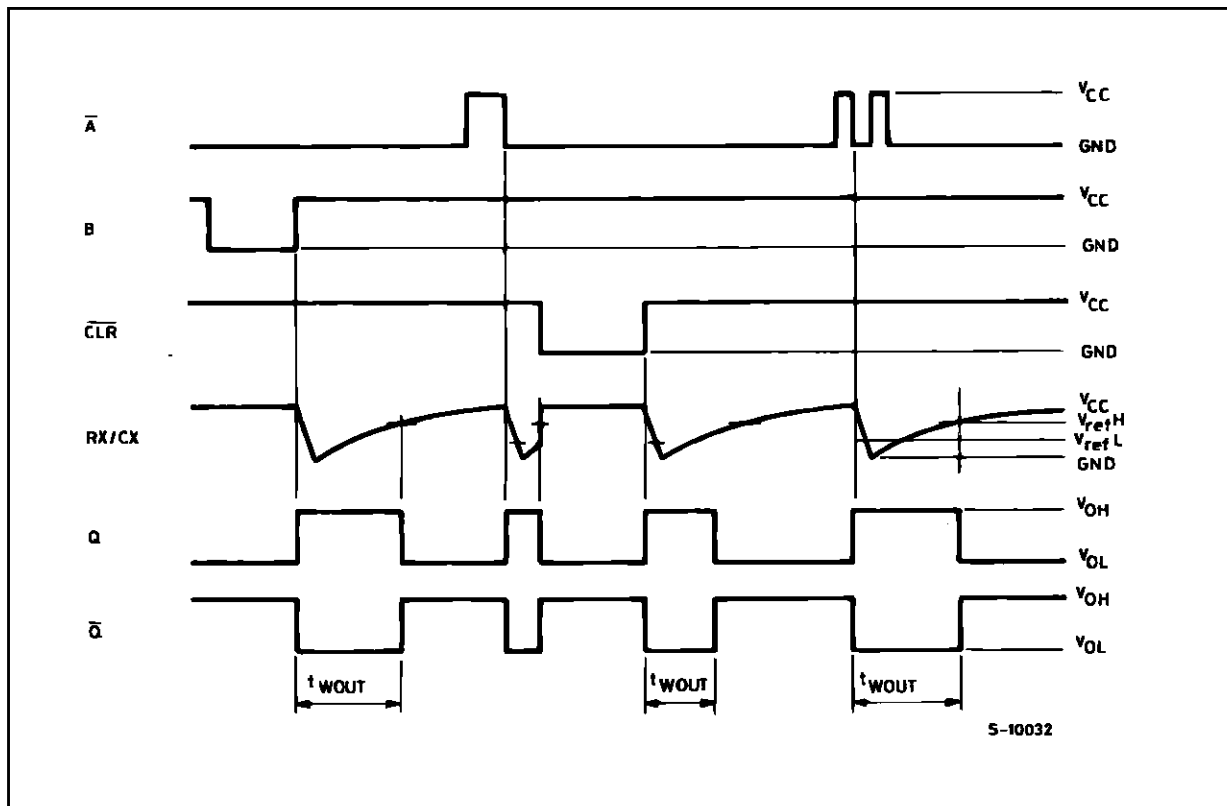


NC =
No Internal
Connection

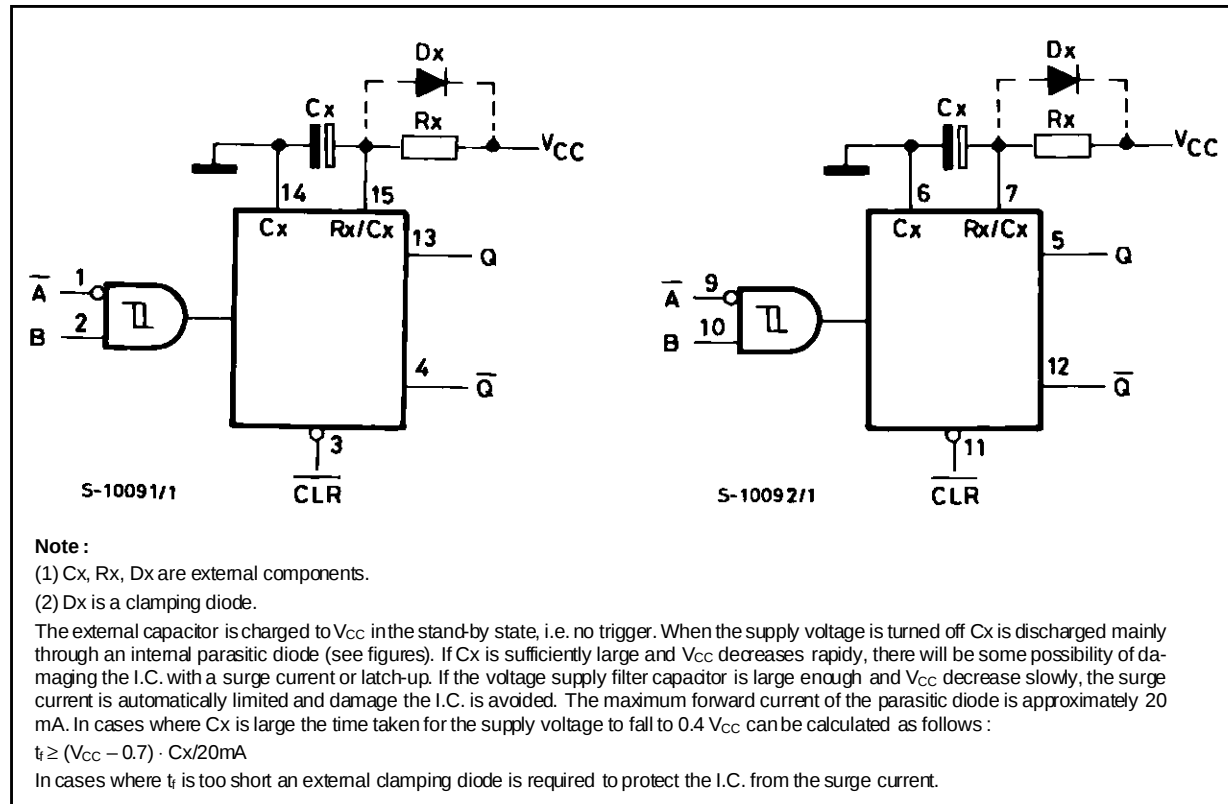
SYSTEM DIAGRAM



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 :

- 1st) A is "low" and B has a falling edge ;
- 2nd) B is "high" and A has a rising edge ;
- 3rd) 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 $t_{w(OUT)}$ is as follows :

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

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

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.

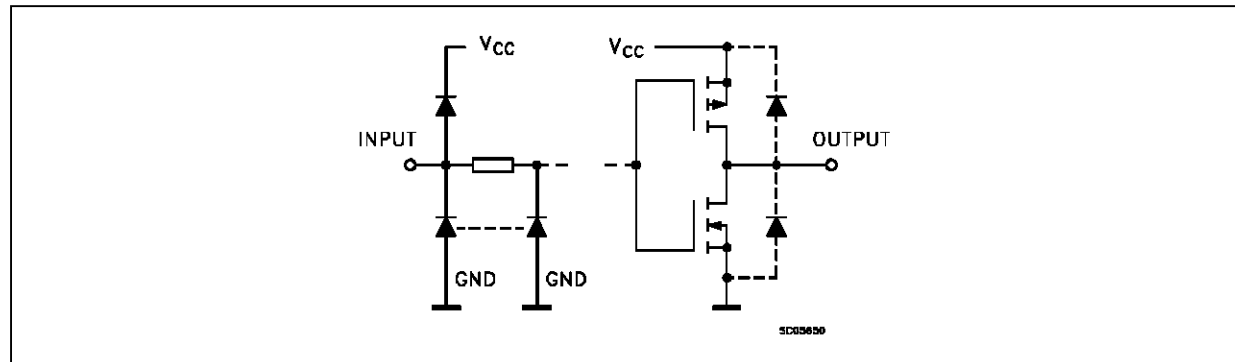
Also transistor Op is turned on and Cx is charged quickly to V_{CC} . This means if CL input goes low, the IC becomes waiting state both in operating and non operating state.

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 monostble period

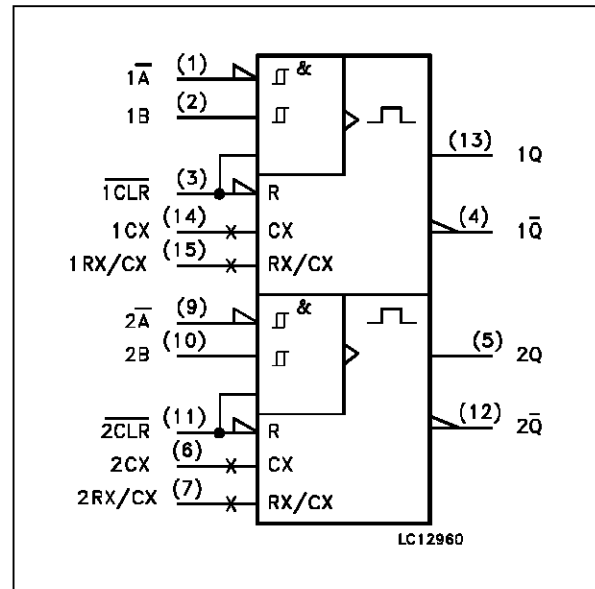
INPUT AND OUTPUT EQUIVALENT CIRCUIT



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 _{EXT} /C _{EXT}	External Resistor Capacitor Connection
13, 5	1Q, 2Q	Outputs (Active HIGH)
14, 6	1C _{EXT} , 2C _{EXT}	External Capacitor Connection
15	1R _{EXT} /C _{EXT}	External Resistor Capacitor Connection
8	GND	Ground (0V)
16	VCC	Positive Supply Voltage

IEC LOGIC SYMBOL



ABSOLUTE MAXIMUM RATING

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	^o C ^o C
t _r , t _f	Input Rise and Fall Time ($\overline{\text{CLR}}$ and $\overline{\text{A}}$ only)	V _{CC} = 2 V	0 to 1000	ns
		V _{CC} = 4.5 V	0 to 500	
		V _{CC} = 6 V	0 to 400	
C _X	External Capacitor		> 100 (*)	pF
R _X	External Resistor	V _{CC} < 3 V	5K to 1M (*)	Ω
		V _{CC} ≥ 3 V	1K to 1M (*)	

(*)The maximum allowable values of C_x and R_x are a function of leakage of capacitor C_x, 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_x > 1MΩ

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 (Q, Q Output)	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 (Q, Q Output)	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 _I	R/C Terminal Off State Current	6.0	V _I = V _{CC} or GND				±0.5		±5		±10	µA		
I _{CC}	Quiescent Supply Current	6.0	V _I = V _{CC} or GND				4		40		80	µA		
I _{CC} '	Active State Supply Current (1)	2.0	V _I = V _{CC} or GND V _{IN} = V _{CC} /2			45	250		260		350	µA		
		4.5				400	530		650		850	µA		
		6.0				0.7	1		1.3		1.7	mA		

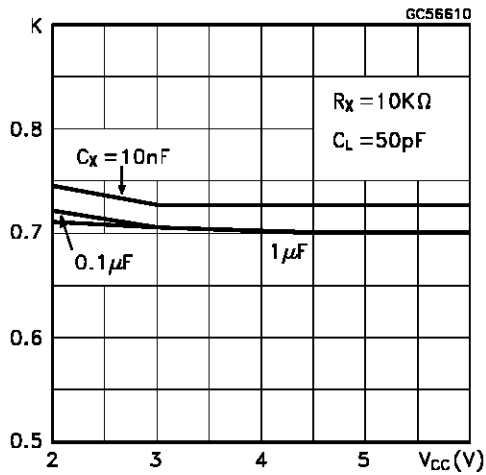
(1): Per Circuit

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

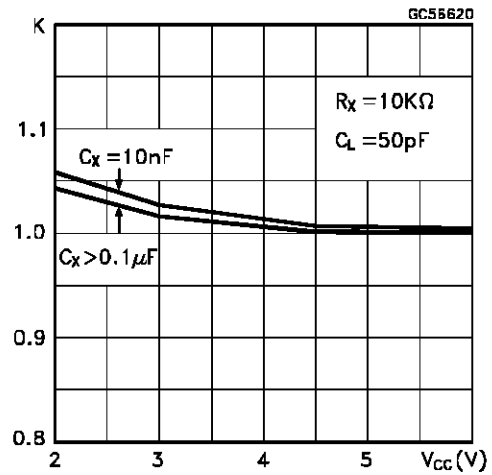
Symbol	Parameter	Test Conditions		Value						Unit	
		V _{CC} (V)		T _A = 25 °C 54HC and 74HC			-40 to 85 °C 74HC		-55 to 125 °C 54HC		
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.
t _{TLH} t _{THL}	Output Transition Time	2.0			30	75		95		110	ns
		4.5			8	15		19		22	
		6.0			7	13		16		19	
t _{PLH} t _{PHL}	Propagation Delay Time (<u>A</u> , B - Q, <u>Q</u>)	2.0			102	210		265		315	ns
		4.5			30	42		53		63	
		6.0			24	36		45		54	
t _{PLH} t _{PHL}	Propagation Delay Time (<u>CLR TRIGGER</u> - Q, <u>Q</u>)	2.0			102	235		295		355	ns
		4.5			30	47		59		71	
		6.0			24	40		50		60	
t _{PLH} t _{PHL}	Propagation Delay Time (CLR - Q, <u>Q</u>)	2.0			67	160		200		240	ns
		4.5			20	32		40		48	
		6.0			16	27		34		41	
t _{WOUT}	Output Pulse Width (for HC221)	2.0	C _X = 100 pF R _X = 10 KΩ		1.5						μs
		4.5			1.3						
		6.0			1.2						
		2.0	C _X = 0.1 μF R _X = 100 KΩ		7						ms
		4.5			6.9						
		6.0			6.9						
t _{WOUT}	Output Pulse Width (for HC221A)	2.0	C _X = 100 pF R _X = 10 KΩ		1.8						μs
		4.5			1.5						
		6.0			1.4						
		2.0	C _X = 0.1 μF R _X = 100 KΩ		10						ms
		4.5			9.7						
		6.0			9.6						
Δt _{WOUT}	Output Pulse Width Error Between Circuits in Same Package				±1						%
t _{W(H)} t _{W(L)}	Minimum Pulse Width	2.0				75		95		110	ns
		4.5				15		19		22	
		6.0				13		16		20	
t _{W(L)}	Minimum Pulse Width	2.0				75		95		110	ns
		4.5				15		19		22	
		6.0				13		16		20	
C _{IN}	Input Capacitance				5	10		10		10	pF
C _{PD} (*)	Power Dissipation Capacitance				174						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 operating current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}'$ Duty/100 + $I_C/2$ (per monostable) (I_{CC}' : Active Supply Current) (Duty:%)

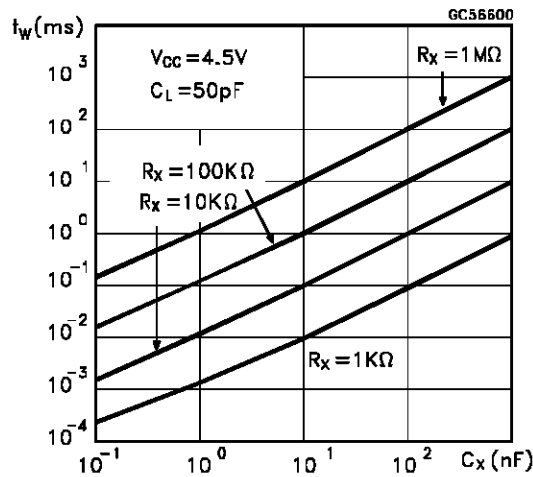
Output Pulse Width Constant Characteristics (for HC221)



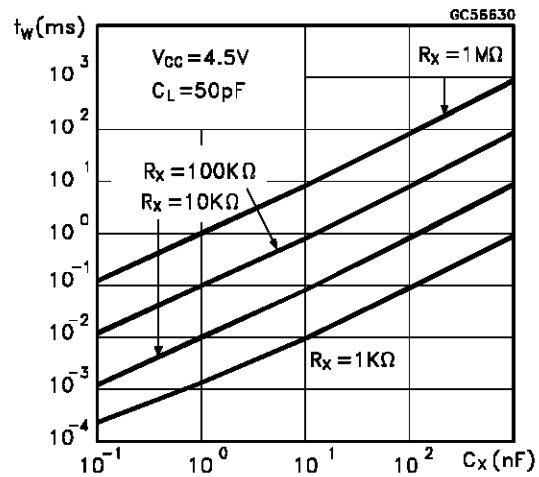
Output Pulse Width Constant Characteristics (for HC221A)



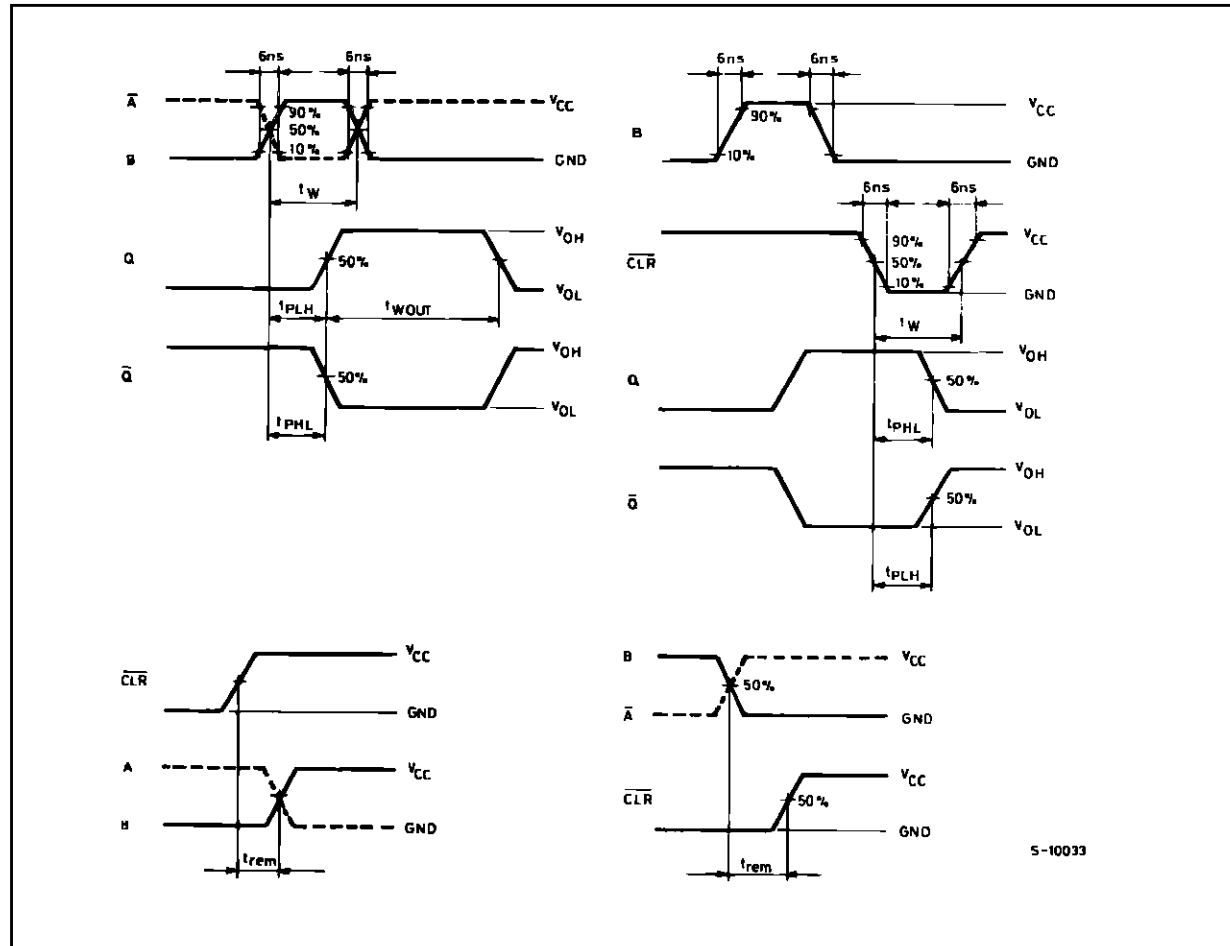
Output Pulse Width Characteristics (for HC221)



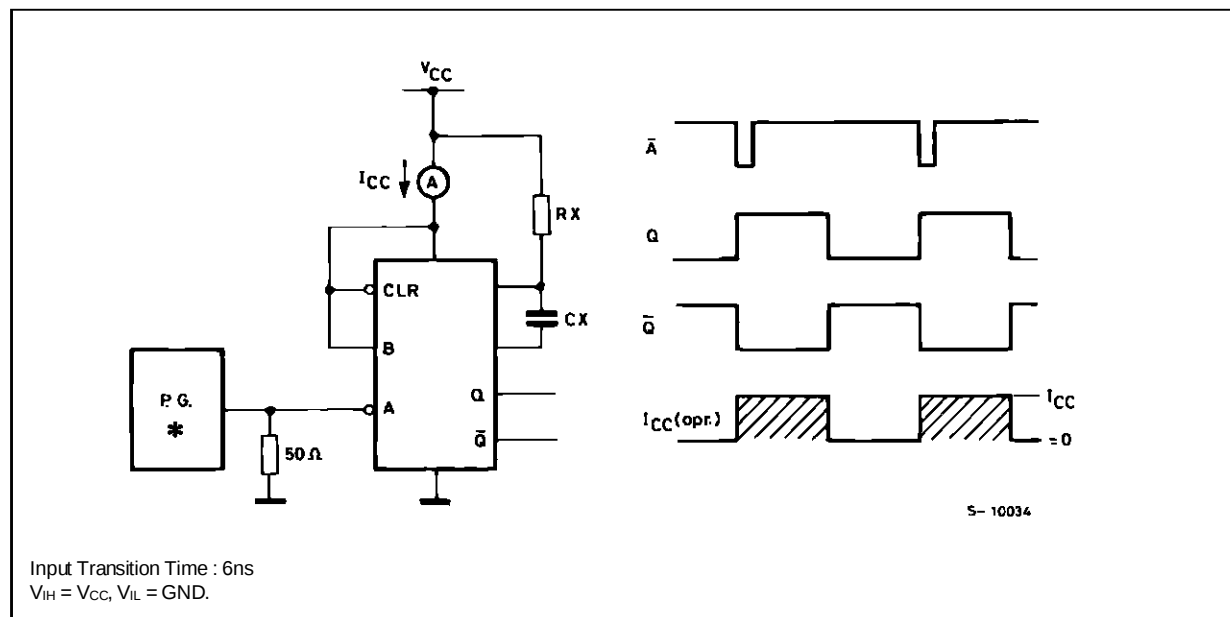
Output Pulse Width Characteristics (for HC221A)



SWITCHING CHARACTERISTICS TEST WAVEFORM

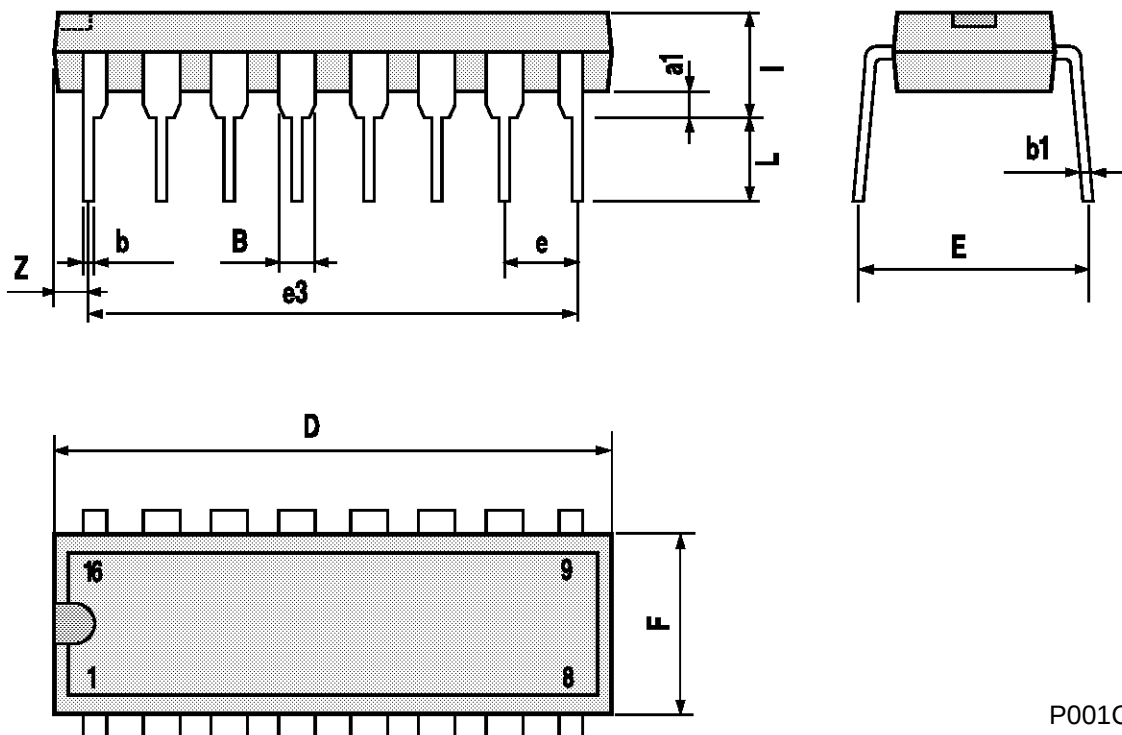


TEST WAVEFORM



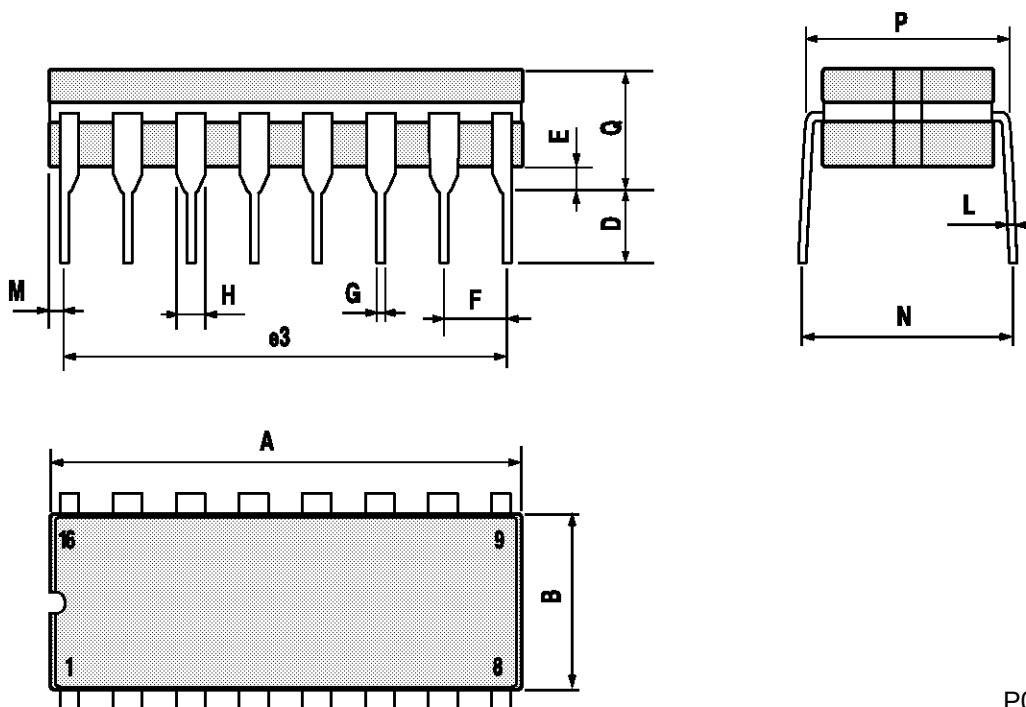
Plastic DIP16 (0.25) MECHANICAL DATA

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



Ceramic DIP16/1 MECHANICAL DATA

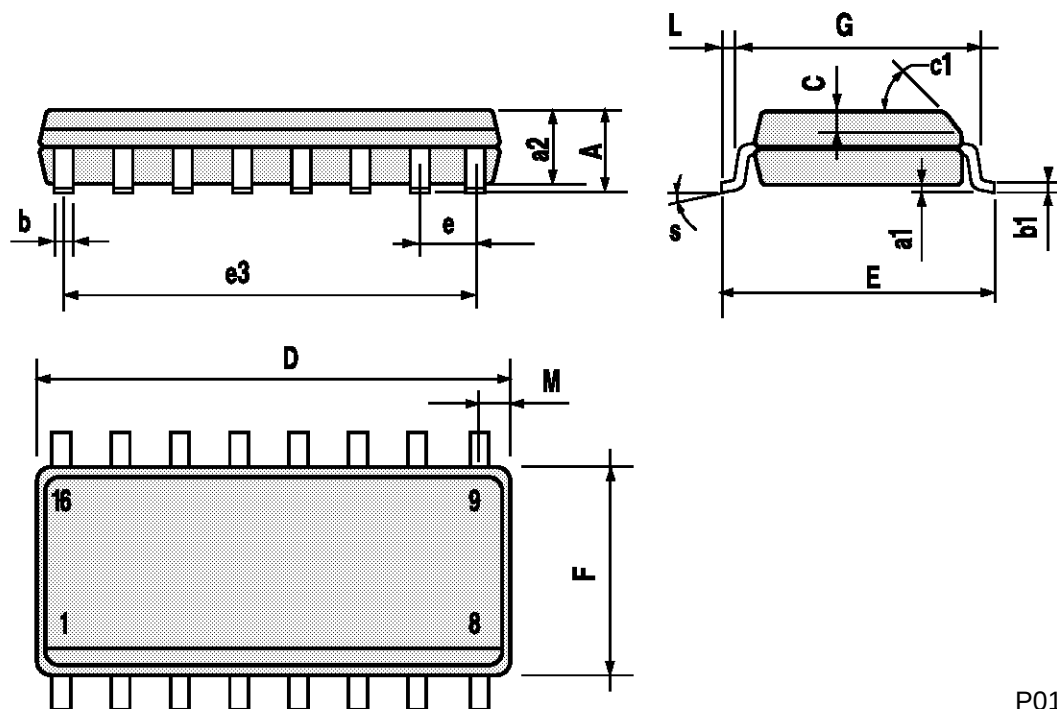
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			20			0.787
B			7			0.276
D		3.3			0.130	
E	0.38			0.015		
e3		17.78			0.700	
F	2.29		2.79	0.090		0.110
G	0.4		0.55	0.016		0.022
H	1.17		1.52	0.046		0.060
L	0.22		0.31	0.009		0.012
M	0.51		1.27	0.020		0.050
N			10.3			0.406
P	7.8		8.05	0.307		0.317
Q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



P053D

SO16 (Narrow) MECHANICAL DATA

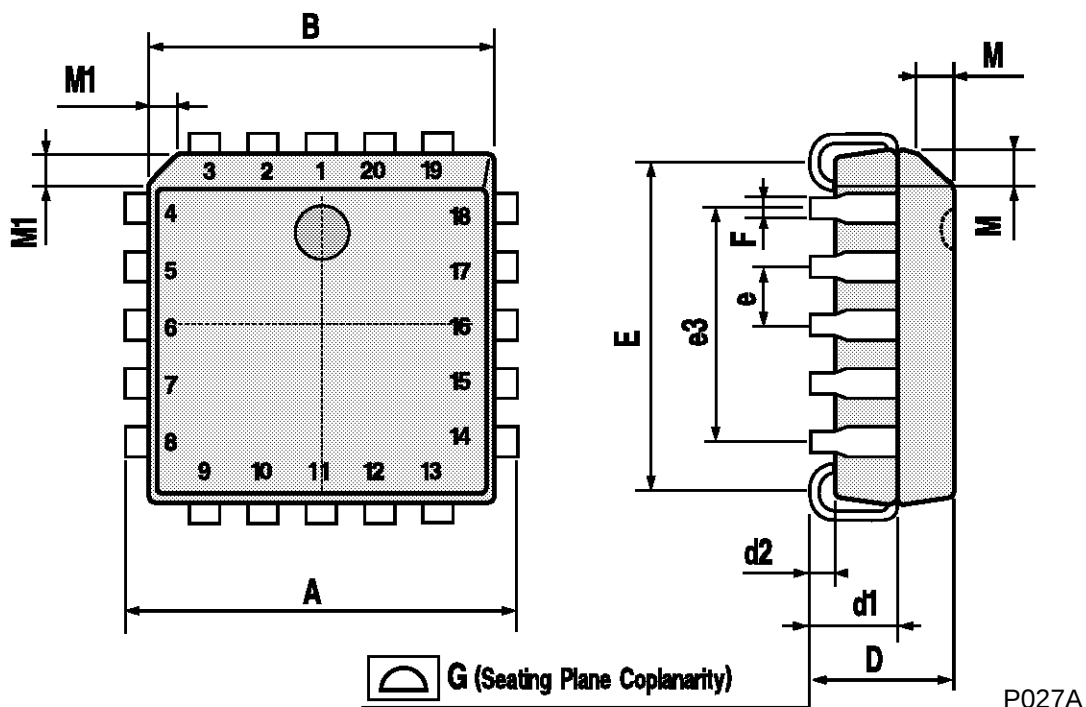
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.004		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157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