

DUAL RETRIGGERABLE MONOSTABLE MULTIVIBRATOR

- **HIGH SPEED**
 $t_{PD} = 28 \text{ ns (TYP)}$ at $V_{CC} = 5V$
- **LOW POWER DISSIPATION**
 STANDBY STATE $I_{CC} = 4 \mu A \text{ (MAX.)}$ at $T_A = 25^\circ C$
 ACTIVE STATE $I_{CC} = 200 \mu A \text{ (TYP)}$ 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**
 $V_{CC} \text{ (OPR)} = 2V \text{ to } 6V$
- **WIDE OUTPUT PULSE WIDTH RANGE**
 $t_{WOUT} = 120\text{ns} \sim 60\text{s}$ over at $V_{CC} = 4.5V$
- **PIN AND FUNCTION COMPATIBLE**
 WITH 54/74LS123

DESCRIPTION

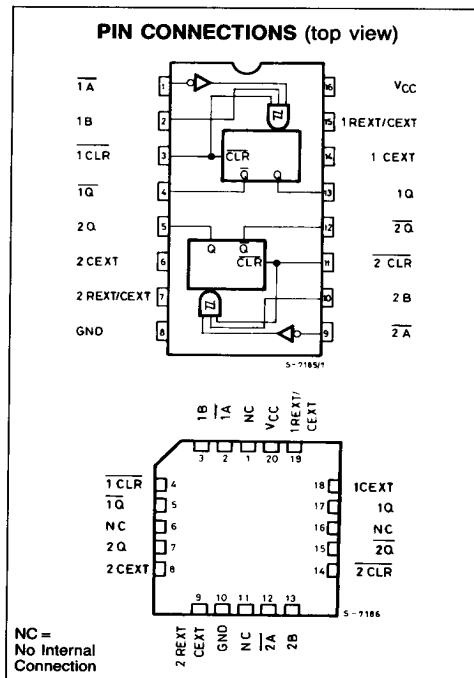
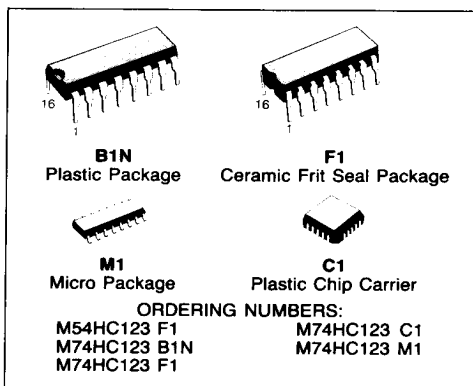
The M54/74HC123 is a high speed CMOS MONOSTABLE multivibrator fabricated with silicon gate C²MOS technology. It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation. There are two trigger inputs, A INPUT (negative edge) and 8 INPUT (positive edge). These inputs are valid for rising/falling signals, (t_r - t_f sec).

The device may also be triggered by using the 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 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 :

Cx: NO LIMIT

Rx: $V_{CC} = 2.0V$ 5K Ω to 1M Ω
 $V_{CC} = 3.0V$ 1K Ω to 1M Ω

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



TRUTH TABLE

INPUTS			OUTPUTS		NOTE
\overline{A}	B	\overline{CL}	Q	\overline{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

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	$^{\circ}C$

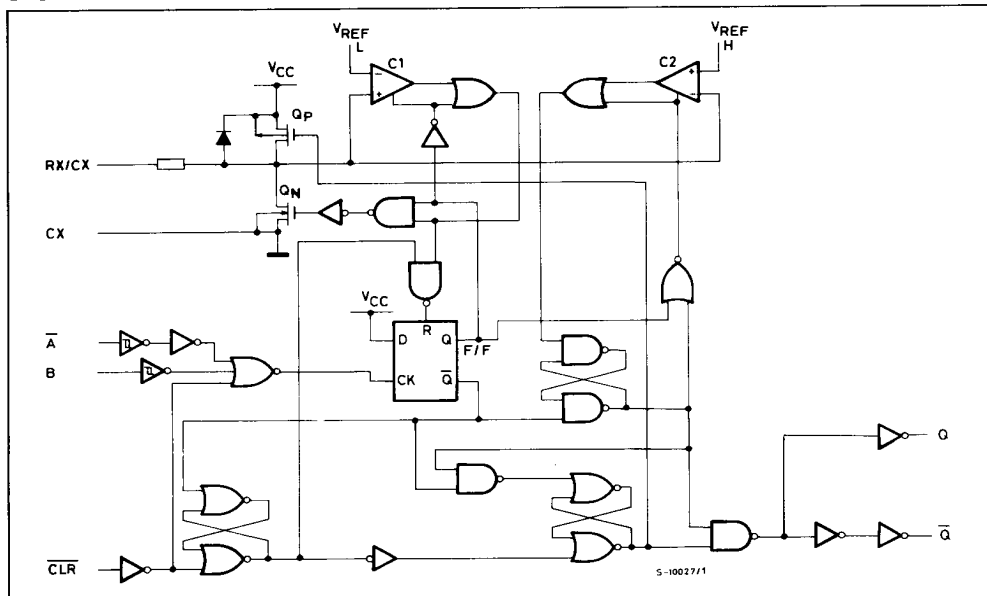
Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

(*) 500 mW: $\cong 65^{\circ}C$ derate to 300 mW by 10 mW/ $^{\circ}C$: $65^{\circ}C$ to $85^{\circ}C$

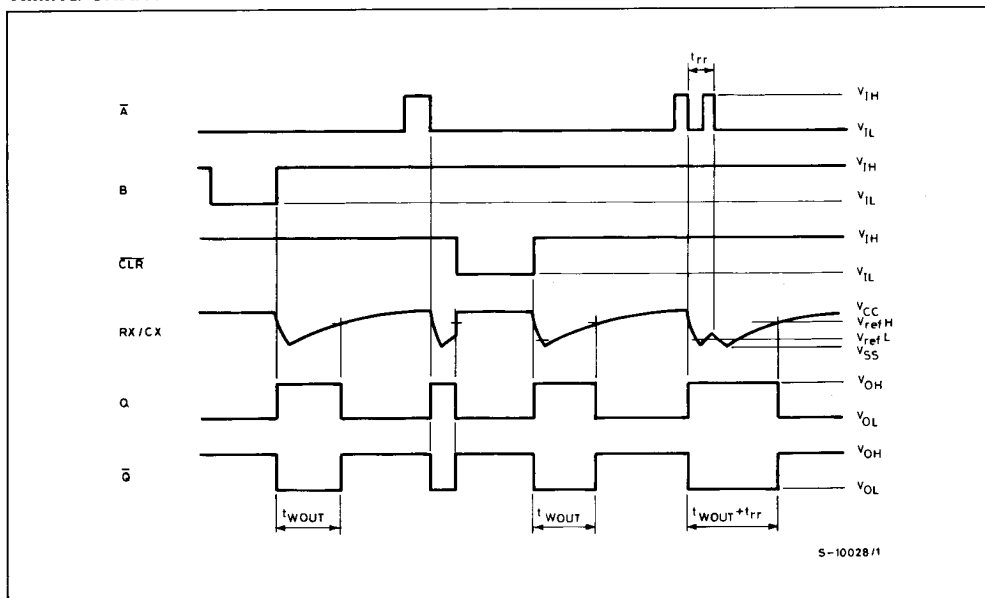
RECOMMENDED OPERATING CONDITIONS

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_A	Operating Temperature 74HC Series 54HC Series	- 40 to 85 - 55 to 125	$^{\circ}C$
t_r, t_f	Input Rise and Fall Time (\overline{CLR} only)	$V_{CC} \begin{cases} 2 \text{ V} & 0 \text{ to } 1000 \\ 4.5 \text{ V} & 0 \text{ to } 500 \\ 6 \text{ V} & 0 \text{ to } 400 \end{cases}$	ns
C_x	External Capacitor	NO LIMITATION	
R_x	External Resistor	$V_{CC} \begin{cases} 3 \text{ V} & 5K \text{ to } 1M \\ 3 \text{ V} & 1K \text{ to } 1M \end{cases}$	Ω

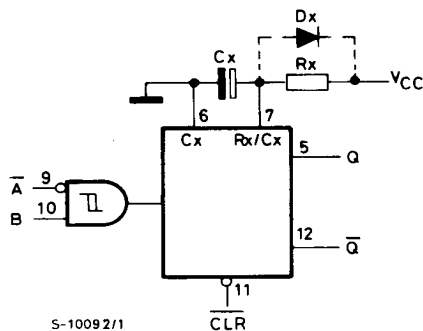
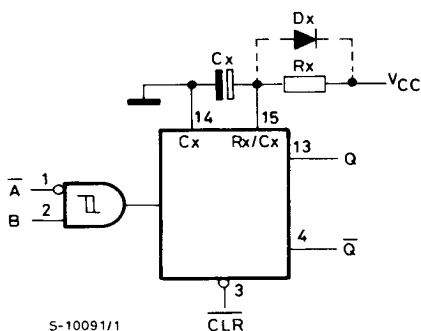
SYSTEM DIAGRAM



TIMING CHART



BLOCK DIAGRAM



Note:

- (1) Cx, Rx, Dx are external components.
- (2) Dx is a clamping diode

The external capacitor is charged to V_{CC} in the stand-by state, i.e. no trigger. When the supply voltage is turned off Cx is discharged mainly through an internal parasitic diode (see figures). If Cx is sufficiently large and V_{CC} decreases rapidly, there will be some possibility of damaging the I.C. with a surge current or latch-up. If the voltage supply filter capacitor is large enough and V_{CC} decrease slowly, the surge current is automatically limited and damage the I.C. is avoided. The maximum forward current of the parasitic diode is approximately 20 mA. In cases where Cx is large the time taken for the supply voltage to fall to $0.4 V_{CC}$ can be calculated as follows:

$$t_f \geq (V_{CC} - 0.7) \cdot C_x / 20 \text{ mA}$$

In cases where t_f is too short an external clamping diode is required to protect the I.C. from the surge current.

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 st) A is "low" and B has a falling edge;
- 2 nd) B is "high" and A has a rising edge;
- 3 rd) 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 Q goes low. C2 stops operating. That means that after triggering when the voltage R/C external returns 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:

$$t_w(\text{OUT}) = 0.46 C_x \cdot R_x$$

FUNCTIONAL DESCRIPTION (Continued)**Re-trigger operation**

When a second trigger pulse follows the first its effect will depend on the state of the multivibrator. If the capacitor C_x is being charged the voltage level of R/C external falls to V_{refl} again and Q remains high i.e. the retrigger pulse arrives in a time shorter than the period $R_x \cdot C_x$ seconds, the capacitor charging time constant. If the second trigger pulse is very close to the initial trigger pulse it is ineffective; i.e., the second trigger must arrive in the capacitor discharge cycle to be ineffective.

Hence the minimum time for a second trigger to be effective depends on V_{CC} and C_x .

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 C_x 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.

DC SPECIFICATIONS

Symbol	Parameter	V_{CC}	Test Condition	$T_A = 25^\circ\text{C}$ 54HC and 74HC			-40 to 85°C 74HC		-55 to 125°C 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
V_{IH}	High Level Input Voltage	2.0 4.5 6.0		1.5 3.15 4.2	— — —	— — —	1.5 3.15 4.2	— — —	1.5 3.15 4.2	— — —	V
V_{IL}	Low Level Input Voltage	2.0 4.5 6.0		— — —	— — —	0.5 1.35 1.8	— 1.35 1.8	0.5 1.35 1.8	— 1.35 1.8	0.5 1.35 1.8	V
V_{OH}	High Level Output Voltage (Q, \bar{Q} Output)	2.0	V_I	$I_{OH} = -20\mu\text{A}$	1.9	2.0	—	1.9	—	1.9	V
		4.5	$V_I = V_{IH} = V_{IL}$		4.4	4.5	—	4.4	—	4.4	
		6.0			5.9	6.0	—	5.9	—	5.9	
		4.5		$I_{OH} = -4\text{mA}$	4.18	4.31	—	4.13	—	4.10	
V_{OL}	Low Level Output Voltage (Q, \bar{Q} Output)	2.0			—	0.0	0.1	—	0.1	—	V
		4.5	$V_I = V_{IH} = V_{IL}$	$I_{OL} = 20\mu\text{A}$	—	0.0	0.1	—	0.1	—	
		6.0			—	0.0	0.1	—	0.1	—	
		4.5		$I_{OL} = 4\text{mA}$	—	0.17	0.26	—	0.33	—	
I_{IN}	Input Leakage Current	6.0	$V_I = V_{CC}$ or GND	—	—	± 0.1	—	± 1.0	—	± 1.0	μA
		6.0	$V_I = V_{CC}$ or GND	—	—	± 0.5	—	± 5.0	—	± 10	μA
I_{CC}	Quiescent Supply Current	6.0	$V_I = V_{CC}$ or GND	—	—	4	—	40	—	80	μA
I_{CC}'	Active State (1) Supply Current	2.0	$V_I = V_{CC}$ or GND	—	40	120	—	160	—	200	μA
		4.5	Pins 2, 14	—	0.1	0.3	—	0.4	—	0.5	mA
		6.0	$V_{IN} = V_{CC}/2$	—	0.2	0.6	—	0.8	—	1.0	mA

(1): Per Circuit

AC ELECTRICAL CHARACTERISTICS ($V_{CC} = 5V$, $T_A = 25^\circ C$, $C_L = 15pF$, Input $t_r = t_f = 6ns$)

Symbol	Parameter	54HC and 74HC			Unit
		Min.	Typ.	Max.	
t_{TLH} t_{THL}	Output Transition Time		4	8	ns
t_{PLH} t_{PHL}	Propagation Delay Time (A, B - Q, \bar{Q})		27	41	ns
t_{PLH} t_{PHL}	Propagation Delay Time (CLEAR, TRIGGER - Q, \bar{Q})		29	45	ns
t_{PLH} t_{PHL}	Propagation Delay Time (CLEAR - Q, Q)		21	33	ns

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

Symbol	Parameter	V_{CC}	Test Condition	$T_A = 25^\circ C$ 54HC and 74HC			- 40 to $85^\circ C$ 74HC		- 55 to $125^\circ C$ 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t_{TLH} t_{THL}	Output Transition Time	2.0 4.5 6.0		— — —	30 8 7	75 15 13	— — —	95 19 16	— — —	110 22 19	ns
t_{PLH} t_{PHL}	Propagation Delay Time (A, B - Q, \bar{Q})	2.0 4.5 6.0		— — —	124 31 26	240 48 41	— — —	300 60 51	— — —	360 72 61	ns
t_{PLH} t_{PHL}	Propagation Delay Time (CLR TRIG - Q, Q)	2.0 4.5 6.0		— — —	136 34 29	265 53 45	— — —	335 66 56	— — —	400 80 68	ns
t_{PLH} t_{PHL}	Propagation Delay Time (CLR - Q, \bar{Q})	2.0 4.5 6.0		— — —	100 25 21	195 39 33	— — —	245 49 42	— — —	295 59 50	ns
t_{rr}	Minimum Retrigger Time	4.5 6.0	$C_x = 100pF$ $R_x = 1K\Omega$	— —	70 60	— —	— —	— —	— —	— —	ns
		4.5 6.0	$C_x = 0.01\mu F$ $R_x = 1K\Omega$	— —	1.0 0.9	— —	— —	— —	— —	— —	μs
Δt_{WOUT}	Output Pulse Width Error Between Circuits in Same Package			—	± 1	—	—	—	—	—	%
t_{WOUT} (Min)	Output Pulse Width	4.5	$C_x = 0$ $R_x = 1k\Omega$	—	118	—	—	—	—	—	ns
t_{WOUT}	Output Pulse Width	4.5	$C_x = 100pF$ $R_x = 10k\Omega$	—	1.0	—	—	—	—	—	μs
		4.5	$C_x = 0.1\mu$ $R_x = 100k\Omega$	—	4.7	—	—	—	—	—	ms

AC ELECTRICAL CHARACTERISTICS (Continued)

Symbol	Parameter	V _{CC}	Test Condition	T _A = 25°C 54HC and 74HC			- 40 to 85°C 74HC		- 55 to 125°C 54HC		Unit
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t _{W(H)} t _{W(L)}	Minimum Pulse Width (Trigger)	2.0 4.5 6.0		—	40 10 9	100 20 17	—	125 25 21	—	150 30 26	ns
t _{W(L)}	Minimum Clear Pulse Width	2.0 4.5 6.0		—	30 8 7	75 15 13	—	95 19 16	—	110 22 19	ns
C _{IN}	Input Capacitance			—	5	10	—	10	—	10	pF
C _{PD} (*)	Power Dissipation Capacitance			—	113	—	—	—	—	—	pF

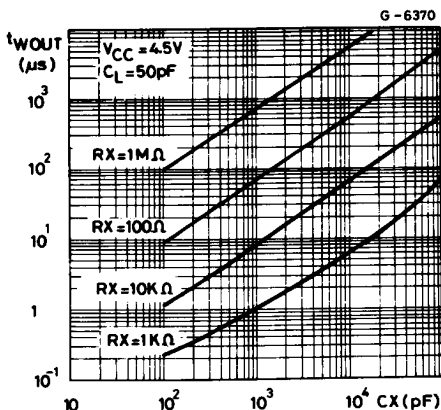
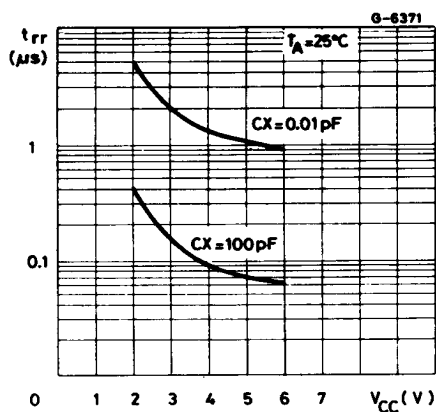
Note (*) C_{PD} is defined as the value the IC's of internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit)

Average operating current can be obtained by the equation hereunder.

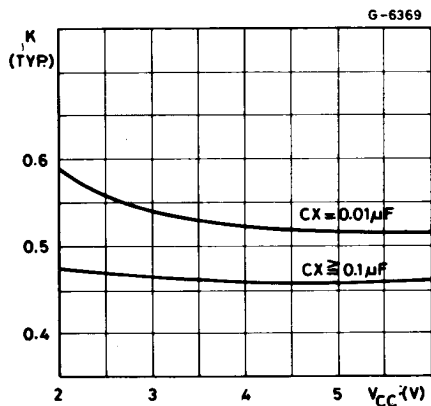
$$I_{CC(opr.)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}' \text{ Duty}/100 + I_{CC}/2 \text{ (per monostable)}$$

(I_{CC}': Active Supply Current)

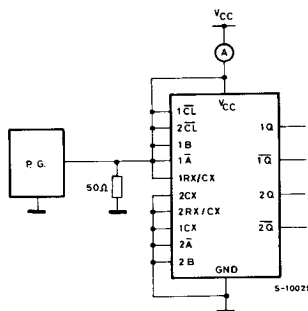
(Duty: %)

t_{WOUT} - C_x Characteristics (Typ)t_{rr} - V_{CC} Characteristics (Typ)

Output Pulse Width Constant,
K-Supply Voltage $R_x \geq 10k\Omega$



TEST CIRCUIT I_{CC} (Opr)



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

SWITCHING CHARACTERISTICS TEST WAVEFORM

