National Semiconductor

74VHC123A
Dual Retriggerable Monostable Multivibrator

General Description

The 'VHC123A is an advanced high speed CMOS Monostable Multivibrator fabricated with silicon gate CMOS technology. It achieves the high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation. Each multivibrator features both a negative, A, and a positive, B, transition triggered input, either of which can be used as an inhibit input. Also included is a clear input that when taken low resets the one-shot. The 'VHC123A can be triggered on the positive transition of the clear while A is held low and B is held high. The output pulse width is determined by the equation: PW = (Rx)(Cx); where PW is in seconds, R is in ohms, and C is in farads.

Limits for R_X and C_X are:

External capacitor, C_X	No limit
External resistors, R_X	V_{CC} = 2.0V, 5 kΩ min
	V_{CC} > 3.0V, 1 kΩ min

An input protection circuit ensures that 0 to 7V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5V to 3V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

Features

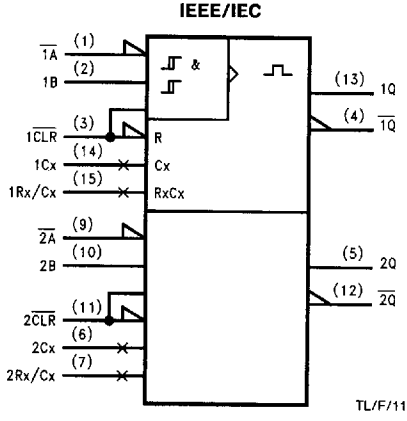
- Low Power Dissipation: I_{CC} = 4 μA (Max) at T_A = 25°C
- Active State: I_{CC} = 600 μA (Max) at T_A = 25°C
- High Noise Immunity: $V_{NIH} = V_{NIL}$ = 28% V_{CC} (min)
- All inputs are equipped with a power down protection function
- Balanced Propagation Delays: $t_{PLH} \cong t_{PHL}$
- Pin and function compatible with 74HC123A

Ordering Code: See Section 6

Commercial	Package Number	Package Description
74VHC123AM	M16A	16-Lead Molded JEDEC SOIC
74VHC123ASJ	M16D	16-Lead Molded EIAJ SOIC
74VHC123AMSC	MSC16	16-Lead Molded EIAJ Type 1 SSOP
74VHC123AMTC	MTC16	16-Lead Molded JEDEC Type TSSOP
74VHC123AN	N16E	16-Lead Molded DIP

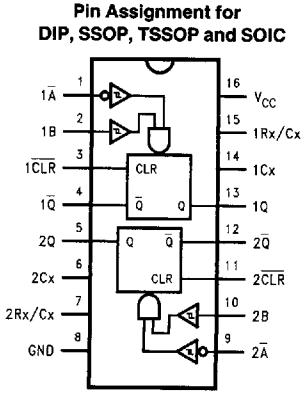
Note: Surface mount packages are also available on Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.
EIAJ Type 1 SSOP available on Tape and Reel only, order MSCX.

Logic Symbol



TL/F/11621–1

Connection Diagram



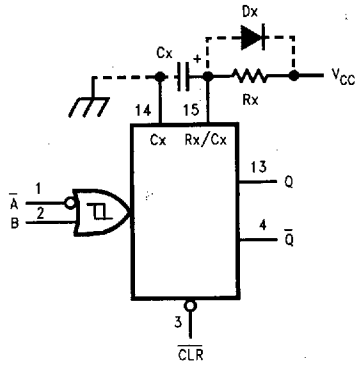
TL/F/11621–2

Truth Table

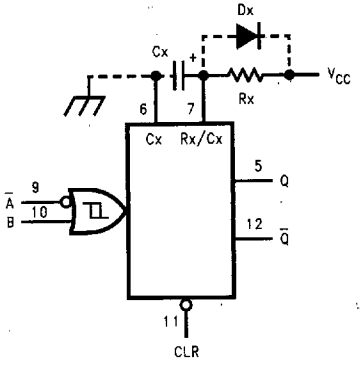
Inputs			Outputs		Function
$\overline{A}$	B	$\overline{CLR}$	Q	$\overline{Q}$	
↓	H	H	⎍	⎎	Output Enable
X	L	H	L	H	Inhibit
H	X	H	L	H	Inhibit
L	↑	H	⎍	⎎	Output Enable
L	H	↑	⎍	⎎	Output Enable
X	X	L	L	H	Reset

X: Don't Care

Block Diagram



TL/F/11621–3



TL/F/11621–4

Note 1: Cx, Rx, Dx are external Capacitor, Resistor, and Diode, respectively.

Note 2: External clamping diode, Dx;

External capacitor is charged to V_{CC} level in the wait state, i.e. when no trigger is applied.
If the supply voltage is turned off, Cx discharges mainly through the internal (parasitic) diode. If Cx is sufficiently large and V_{CC} drops rapidly, there will be some possibility of damaging the IC through in rush current or latch-up. If the capacitance of the supply voltage filter is large enough and V_{CC} drops slowly, the in rush current is automatically limited and damage to the IC is avoided.
The maximum value of forward current through the paracitic diode is ±20 mA. In the case of a large Cx, the limit of fall time of the supply voltage is determined as follows:

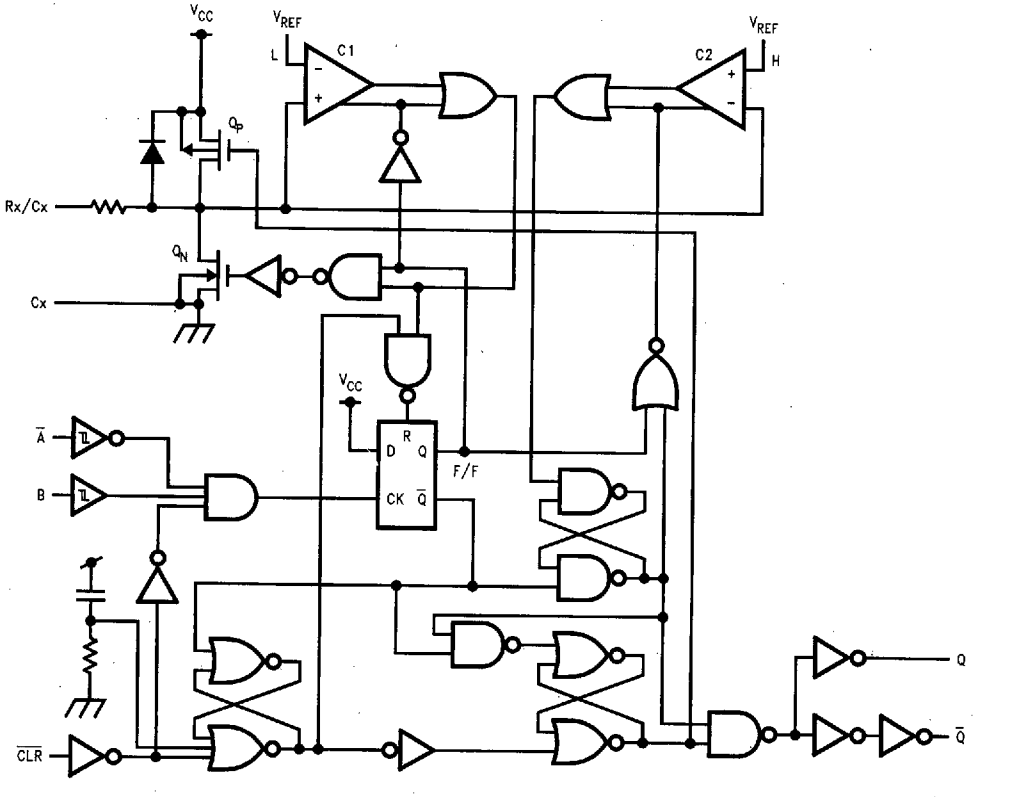
$t_f \geq (V_{CC} - 0.7)\ Cx/20\ mA$

(t_f is the time between the supply voltage turn off and the supply voltage reaching 0.4 V_{CC})

In the event a system does not satisfy the above condition, an external clamping diode (Dx) is needed to protect the IC from rush current.

System Diagram

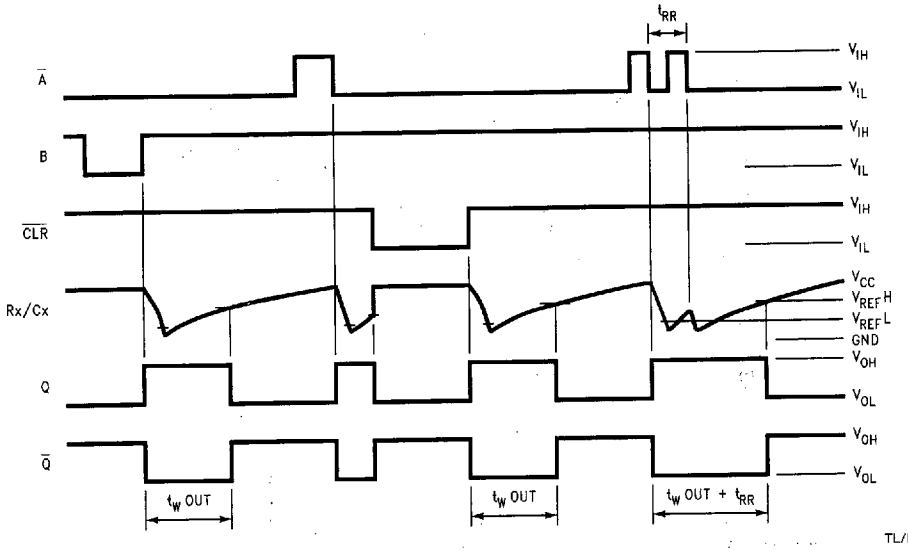
74VHC123A



TL/F/11621–5

Timing Chart

74VHC123A



TL/F/11621–6

Functional Description

1. Stand-by State

   The external capacitor (Cx) is fully charged to V_{CC} in the Stand-by State. That means, before triggering, the Q_P and Q_N transistors which are connected to the Rx/Cx node are in the off state. Two comparators that relate to the timing of the output pulse, and two reference voltage supplies turn off. The total supply current is only leakage current.

2. Trigger Operation

   Trigger operation is effective in any of the following three cases. First, the condition where the $\overline{A}$ input is low, and B input has a rising signal; second, where the B input is high, and the A input has a falling signal; and third, where the $\overline{A}$ input is low and the B input is high, and the $\overline{CLR}$ input has a rising signal.

   After a trigger becomes effective, comparators C1 and C2 start operating, and Q_N is turned on. The external capacitor discharges through Q_N. The voltage level at the Rx/Cx node drops. If the Rx/Cx voltage level falls to the internal reference voltage $V_{ref}L$, the output of C1 becomes low. The flip-flop is then reset and Q_N turns off. At that moment C1 stops but C2 continues operating.

   After Q_N turns off, the voltage at the Rx/Cx node starts rising at a rate determined by the time constant of external capacitor Cx and resistor Rx.

   Upon triggering, output Q becomes high, following some delay time of the internal F/F and gates. It stays high even if the voltage of Rx/Cx changes from falling to rising. When Rx/Cx reaches the internal reference voltage $V_{ref}H$, the output of C2 becomes low, the output Q goes low and C2 stops its operation. That means, after triggering, when the voltage level of the Rx/Cx node reaches $V_{ref}H$, the IC returns to its MONOSTABLE state.

   With large values of Cx and Rx, and ignoring the discharge time of the capacitor and internal delays of the IC, the width of the output pulse, t_W (OUT), is as follows:

   $$t_W \text{ (OUT)} = 1.0 \text{ Cx Rx}$$

3. Retrigger operation (74VHC123A)

   When a new trigger is applied to either input $\overline{A}$ or B while in the MONOSTABLE state, it is effective only if the IC is charging Cx. The voltage level of the Rx/Cx node then falls to $V_{ref}L$ level again. Therefore the Q output stays high if the next trigger comes in before the time period set by Cx and Rx.

   If the new trigger is very close to a previous trigger, such as an occurrence during the discharge cycle, it will have no effect.

   The minimum time for a trigger to be effective 2nd trigger, t_{RR} (Min), depends on V_{CC} and Cx.

4. Reset Operation

   In normal operation, the $\overline{CLR}$ input is held high. If $\overline{CLR}$ is low, a trigger has no affect because the Q output is held low and the trigger control F/F is reset. Also, Q_p turns on and Cx is charged rapidly to V_{CC}.

   This means if $\overline{CLR}$ is set low, the IC goes into a wait state.

Absolute Maximum Ratings (Note 1)

Supply Voltage (V_{CC})	−0.5V to +7.0V
DC Input Voltage (V_{IN})	−0.5V to +7.0V
DC Output Voltage (V_{OUT})	−0.5 to V_{CC} +0.5V
Input Diode Current (I_{IK})	−20 mA
Output Diode Current (I_{OK})	±20 mA
DC Output Current (I_{OUT})	±25 mA
DC V_{CC}/Current (I_{CC})	±50 mA
Storage Temperature (T_{STG})	−65°C to 150°C
Lead Temperature (T_L) Soldering, 10 sec.	260°C

Note 1: *Absolute maxmimum ratings are values beyond which the device may be damaged or have its useful life impaired. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. National does not recommended operation outside data book specifications.*

Recommended Operating Conditions

Supply Voltage (V_{CC})	2.0V to +5.5V
Input Voltage (V_{IN})	0V to +5.5V
Output Voltage (V_{OUT})	0V to V_{CC}
Operating Temperature (T_{opr})	−40° to +85°C
Input Rise and Fall Time (t_r, t_f) (CLR only)	
V_{CC} = 3.3V ±0.3V	0 ~ 100 ns/V
V_{CC} = 5.0V ±0.5V	0 ~ 20 ns/V
External Capacitor - Cx	No Limitation** F
External Resistor - Rx	>5 kΩ** (V_{CC} = 2.0V) >1 kΩ** (V_{CC} > 3.0V)

**The maximum allowable values of Cx and Rx are a function of the leakage of capacitor Cx, the leakage of the device, and leakage due to board layout and surface resistance.

Susceptibility to externally induced noise signals may occur for Rx> 1 MΩ.

DC Characteristics for 'VHC Family Devices

Symbol	Parameter	V_{CC} (V)	74VHC T_A = 25°C Min	Typ	Max	74VHC T_A = −40° to 85°C Min	Max	Units	Conditions	
V_{IH}	High Level Input Voltage	2.0 3.0–5.5	1.50 0.7 V_{CC}			1.50 0.7 V_{CC}		V		
V_{IL}	Low Level Input Voltage	2.0 3.0–5.5			0.50 0.3 V_{CC}		0.50 0.3 V_{CC}	V		
V_{OH}	High Level Output Voltage	2.0 3.0 4.5	1.9 2.9 4.4	2.0 3.0 4.5		1.9 2.9 4.4		V	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −50 μA
		3.0 4.5	2.58 3.94			2.48 3.80		V		I_{OH} = −4 mA I_{OH} = −8 mA
V_{OL}	Low Level Output Voltage	2.0 3.0 4.5		0.0 0.0 0.0	0.1 0.1 0.1		0.1 0.1 0.1	V	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA
		3.0 4.5			0.36 0.36		0.44 0.44			I_{OL} = 4 mA I_{OL} = 8 mA
I_{IN}	Input Leakage Current	0–5.5			±0.1		±1.0	μA	V_{IN} = 5.5V or GND	
I_{IN}	Rx/Cx Terminal Off-State Current	5.5			±0.25		±2.50	μA	V_{IN} = V_{CC} or GND	
I_{CC}	Quiescent Supply Current	5.5			4.0		40.0	μA	V_{IN} = V_{CC} or GND	
I_{CC}	Active—State* Supply Current	3.0 4.5 5.5		160 380 560	250 500 750		280 650 975	μA	V_{IN} = V_{CC} or GND Rx/Cx = 0.5 V_{CC}	

* Per Circuit

AC Electrical Characteristics: See Section 2 for waveforms

Symbol	Parameter	V_{CC} (V)	74VHC $T_A = 25°C$ Min	Typ	Max	74VHC $T_A = -40°C$ to $+85°C$ Min	Max	Units	Conditions	Fig. No.
t_{PLH} t_{PHL}	Propagation Delay Time (A, B–Q, $\overline{Q}$)	3.3 ± 0.3		13.4	20.6	1.0	24.0	ns	C_L = 15 pF	2-5, 6
				15.9	24.1	1.0	27.5		C_L = 50 pF	2-5, 6
		5.0 ± 0.5		8.1	12.0	1.0	14.0	ns	C_L = 15 pF	2-5, 6
				9.6	14.0	1.0	16.0		C_L = 50 pF	2-5, 6
t_{PLH} t_{PHL}	Propagation Delay Time (CLR Trigger—Q, $\overline{Q}$)	3.3 ± 0.3		14.5	22.4	1.0	26.0	ns	C_L = 15 pF	2-5, 6
				17.0	25.9	1.0	29.5		C_L = 50 pF	2-5, 6
		5.0 ± 0.5		8.7	12.9	1.0	15.0	ns	C_L = 15 pF	2-5, 6
				10.2	14.9	1.0	17.0		C_L = 50 pF	2-5, 6
t_{PLH} t_{PHL}	Propagation Delay Time (CLR—Q, $\overline{Q}$)	3.3 ± 0.3		10.3	15.8	1.0	18.5	ns	C_L = 15 pF	2-5, 6
				12.8	19.3	1.0	22.0		C_L = 50 pF	2-5, 6
		5.0 ± 0.5		6.3	9.4	1.0	11.0	ns	C_L = 15 pF	2-5, 6
				7.8	11.4	1.0	13.0		C_L = 50 pF	2-5, 6
t_{WOUT}	Output Pulse Width	3.3 ±0.3		160	240		300	ns	C_L = 50 pF, Cx = 28 pF, Rx = 2 kΩ	*
		5.0 ± 0.5		133	200		240			
		3.3 ± 0.3	90	100	110	90	110	μs	C_L = 50 pF, Cx = 0.01 μF, Rx = 10 kΩ	*
		5.0 ± 0.5	90	100	110	90	110			
		3.3 ± 0.3	0.9	1.0	1.1	0.9	1.1	ms	C_L = 50 pF, Cx = 0.1 μF, Rx = 10 kΩ	*
		5.0 ± 0.5	0.9	1.0	1.1	0.9	1.1			
Δt_{WOUT}	Output Pulse Width Error Between Circuits (In same Package)			±1				%		
C_{IN}	Input Capacitance			4	10		10	pF	V_{CC} = Open	
C_{PD}	Power Dissipation Capacitance			73				pF	(Note 1)	

Note 1: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation:

I_{CC} (opr.) = $C_{PD} * V_{CC} * f_{IN} + I_{CC}{}^1 * Duty/100 + I_{CC}/2$ (per Circuit)

$I_{CC}{}^1$: Active Supply Current

Duty: %

*Refer to 74VHC123A Timing Chart.

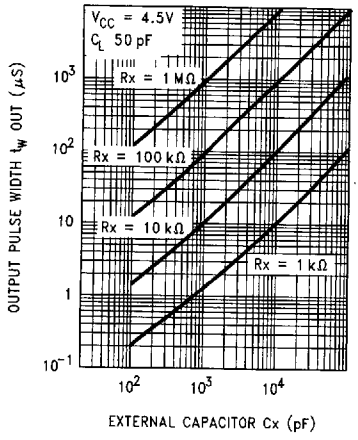
AC Operating Requirement: See Section 2 for waveforms

Symbol	Parameter	V_{CC} (V)	74VHC $T_A = 25°C$ Min	Typ	Max	74VHC $T_A = -40°C$ to $+85°C$ Min	Max	Units	Conditions	Fig. No.
$t_W(L)$ $t_W(H)$	Minimum Trigger Pulse Width	3.3		5.0			5.0	ns		2-6
		5.0		5.0			5.0			
$t_W(L)$	Minimum Clear Pulse Width	3.3		5.0			5.0	ns		2-6
		5.0		5.0			5.0			
t_{RR}	Minimum Retrigger Time	3.3 ± 0.3		60				ns	Rx = 1 kΩ, C_X = 100 pF	*
		5.0 ± 0.5		39						
		3.3		1.5				μs	Rx = 1 kΩ, C_X = 0.01 μF	
		5.0		12						

*Refer to 74VHC123A Timing Chart.

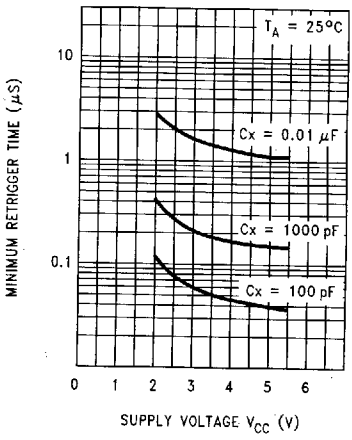
Device Characteristics

t_{wout}*C_x Characteristics (typ)



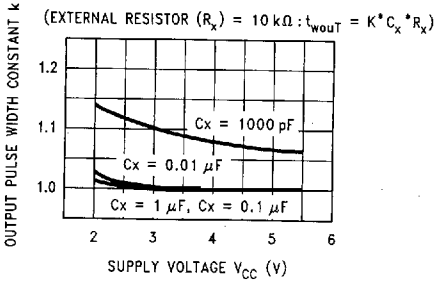
TL/F/11621–7

t_{RR}*V_{CC} Characteristics (typ) (74VHC123A)



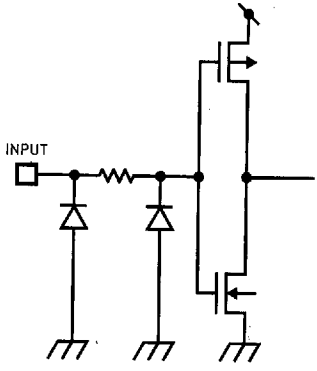
TL/F/11621–8

Output Pulse Width Constant K-Supply Voltage (Typical)



TL/F/11621–9

Input Equivalent Circuit



TL/F/11621–10