

# 74VHC221A

## Dual Non-Retriggerable Monostable Multivibrator

### General Description

The 'VHC221A 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 'VHC221A can be triggered on the positive transition of the clear while A is held low and B is held high. The 'VHC221A is non-retriggerable, and therefore cannot be retriggered until the output pulse times out. The output pulse width is determined by the equation:  $PW = (R_x)(C_x)$ ; where PW is in seconds, R is in ohms, and C is in farads.

Limits for  $R_x$  and  $C_x$  are:  
 External capacitor,  $C_x$   
 External resistors,  $R_x$

No limit  
 $V_{CC} = 2.0V, 5\ k\Omega\ min$   
 $V_{CC} > 3.0V, 1\ k\Omega\ min$

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

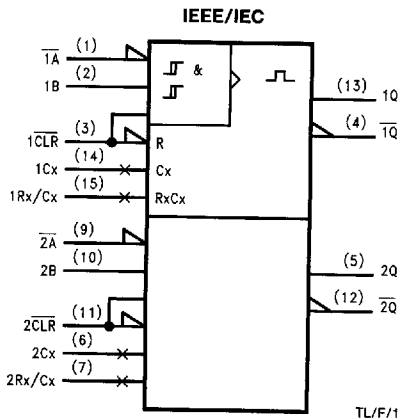
- Low Power Dissipation:  
 $I_{CC} = 4\ \mu A$  (Max) at  $T_A = 25^\circ C$
- Active State:  $I_{CC} = 600\ \mu A$  (Max) at  $T_A = 25^\circ C$
- High Noise Immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- All inputs are equipped with a power down protection function
- Balanced Propagation Delays:  $t_{PLH} \cong t_{PHL}$
- Pin and function compatible with 74HC221A

**Ordering Code:** See Section 6

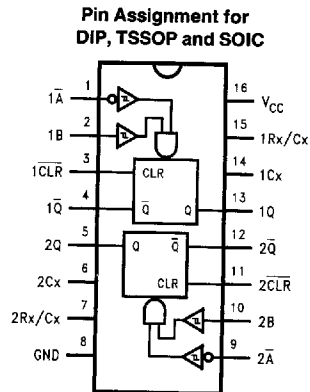
Commercial	Package Number	Package Description
74VHC221AM	M16A	16-Lead Molded JEDEC SOIC
74VHC221ASJ	M16D	16-Lead Molded EIAJ SOIC
74VHC221AMTC	MTC16	16-Lead Molded JEDEC Type 1 TSSOP
74VHC221AN	N16E	16-Lead Molded DIP

**Note:** Surface mount packages are also available on Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

### Logic Symbol



### Connection Diagram

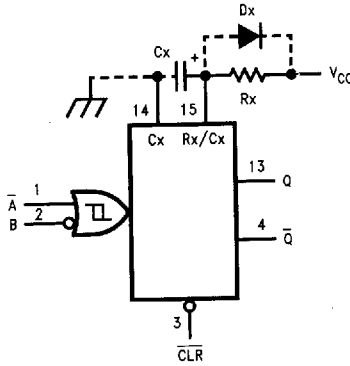


## Truth Table

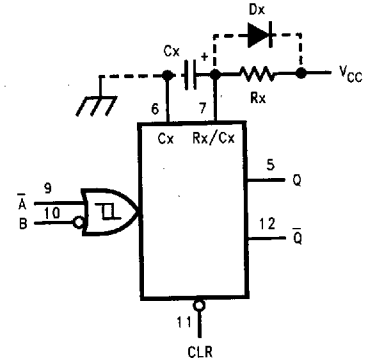
Inputs			Outputs		Function
$\bar{A}$	B	CLR	Q	$\bar{Q}$	
	H	H			Output Enable
X	L	H	L	H	Inhibit
H	X	H	L	H	Inhibit
L		H			Output Enable
L	H				Output Enable
X	X	L	L	H	Reset

X: Don't Care

## Block Diagrams



TL/F/11680-3



TL/F/11680-4

**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 inrush current or latch-up. If the capacitance of the supply voltage filter is large enough and  $V_{CC}$  drops slowly, the inrush current is automatically limited and damage to the IC is avoided.

The maximum value of forward current through the parasitic diode is  $\pm 20$  mA. In the case of a large Cx, the limit of fall time of the supply voltage is determined as follows:

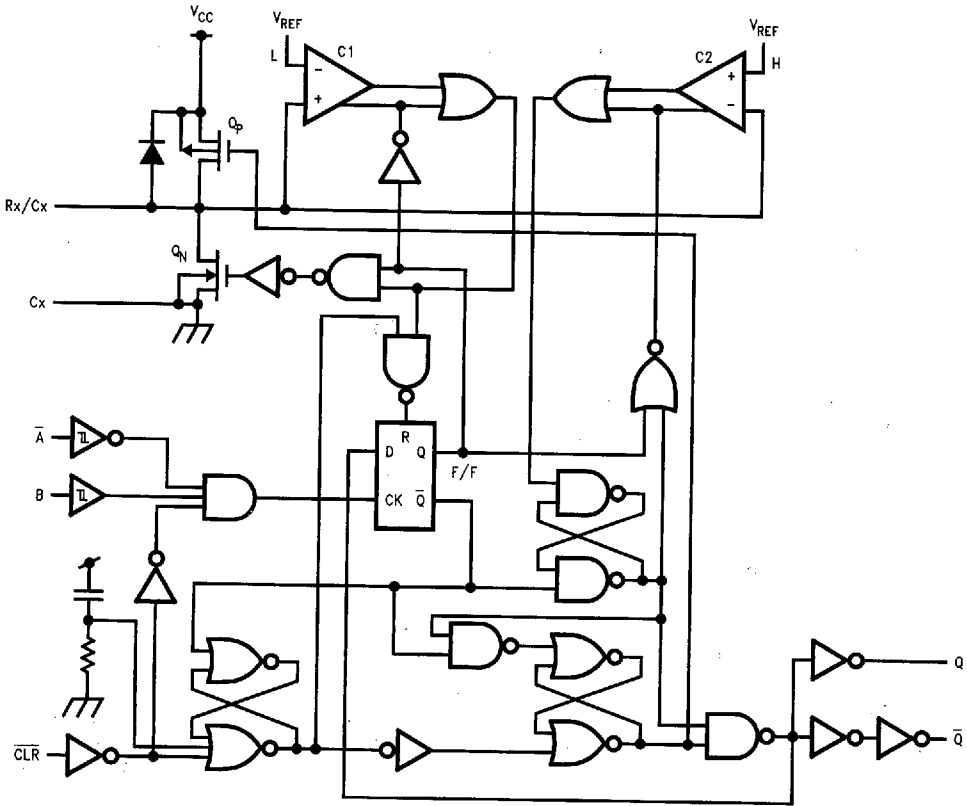
$$t_f \geq (V_{CC} - 0.7) C_x / 20 \text{ mA}$$

( $t_f$  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 inrush current.

# System Diagram

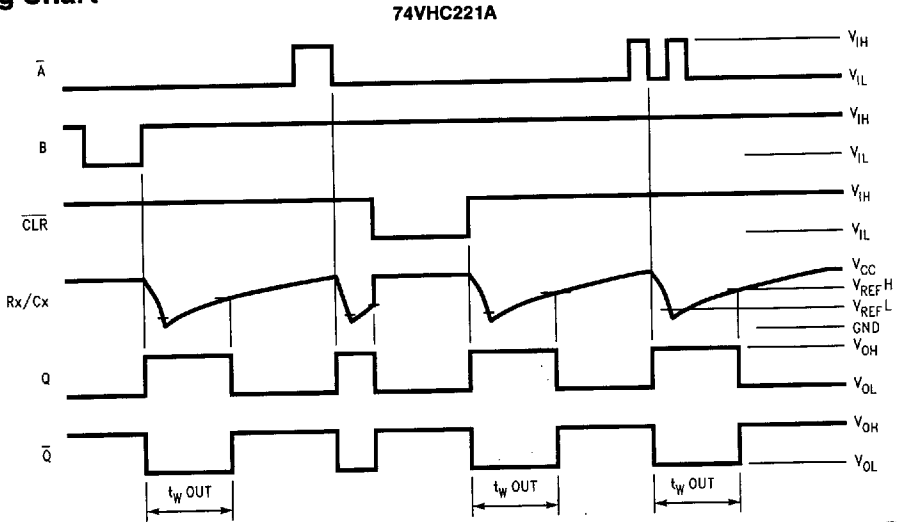
74VHC221A



TL/F/11680-5

221A

## Timing Chart



## Functional Description

## 1. Stand-by State

The external capacitor ( $C_x$ ) 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  $\bar{A}$  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  $\bar{A}$  input is low and the B input is high, and the  $\bar{CLR}$  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  $V_{refL}$ , 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  $C_x$  and resistor  $R_x$ .

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  $V_{refH}$ , 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  $V_{refH}$ , the IC returns to its MONOSTABLE state.

With large values of  $C_x$  and  $R_x$ , 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:

$$t_W \text{ (OUT)} = 1.0 C_x R_x$$

## 3. Reset Operation

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

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

### Absolute Maximum Ratings (Note 1)

Supply Voltage (V <sub>CC</sub> )	-0.5V to +7.0V
DC Input Voltage (V <sub>IN</sub> )	-0.5V to +7.0V
DC Output Voltage (V <sub>OUT</sub> )	-0.5 to V <sub>CC</sub> + 0.5V
Input Diode Current (I <sub>IK</sub> )	-20 mA
Output Diode Current (I <sub>OK</sub> )	±20 mA
DC Output Current (I <sub>OUT</sub> )	±25 mA
DC V <sub>CC</sub> /Current (I <sub>CC</sub> )	±50 mA
Storage Temperature (T <sub>STG</sub> )	-65°C to 150°C
Lead Temperature (T <sub>L</sub> ) Soldering, 10 sec.	260°C

### Recommended Operating Conditions

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

Note 1: Absolute maximum 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 recommend operation outside data book specifications.

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

\* Per Circuit

## AC Electrical Characteristics for VHC Family Devices: See Section 2 for waveforms

Symbol	Parameter	V <sub>CC</sub> (V)	74VHC			74VHC		Units	Conditions	Fig. No.
			T <sub>A</sub> = 25°C			T <sub>A</sub> = -40°C to +85°C				
			Min	Typ	Max	Min	Max			
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (A, B-Q, Q̄)	3.3 ± 0.3	13.4	20.6	1.0	24.0	ns	C <sub>L</sub> = 15 pF	2-5, 6	
			15.9	24.1	1.0	27.5		C <sub>L</sub> = 50 pF	2-5, 6	
		5.0 ± 0.5	8.1	12.0	1.0	14.0	ns	C <sub>L</sub> = 15 pF	2-5, 6	
			9.6	14.0	1.0	16.0		C <sub>L</sub> = 50 pF	2-5, 6	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (CLR Trigger-Q, Q̄)	3.3 ± 0.3	14.5	22.4	1.0	26.0	ns	C <sub>L</sub> = 15 pF	2-5, 6	
			17.0	25.9	1.0	29.5		C <sub>L</sub> = 50 pF	2-5, 6	
		5.0 ± 0.5	8.7	12.9	1.0	15.0	ns	C <sub>L</sub> = 15 pF	2-5, 6	
			10.2	14.9	1.0	17.0		C <sub>L</sub> = 50 pF	2-5, 6	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (CLR-Q, Q̄)	3.3 ± 0.3	10.3	15.8	1.0	18.5	ns	C <sub>L</sub> = 15 pF	2-5, 6	
			12.8	19.3	1.0	22.0		C <sub>L</sub> = 50 pF	2-5, 6	
		5.0 ± 0.5	6.3	9.4	1.0	11.0	ns	C <sub>L</sub> = 15 pF	2-5, 6	
			7.8	11.4	1.0	13.0		C <sub>L</sub> = 50 pF	2-5, 6	
t <sub>WOUT</sub>	Output Pulse Width	2.0	415				ns	C <sub>L</sub> = 50 pF C <sub>X</sub> = 28 pF R <sub>X</sub> = 6 kΩ		
		3.3 ± 0.3	345							
		5.0 ± 0.5	312							
		3.3 ± 0.3	160	240	300		ns	C <sub>L</sub> = 50 pF C <sub>X</sub> = 28 pF R <sub>X</sub> = 2 kΩ	*	
		5.0 ± 0.5	133	200	240					
		3.3 ± 0.3	90	100	110	90	110	μs	C <sub>L</sub> = 50 pF C <sub>X</sub> = 0.01 μF R <sub>X</sub> = 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 <sub>L</sub> = 50 pF C <sub>X</sub> = 0.1 μF R <sub>X</sub> = 10 kΩ	*
5.0 ± 0.5	0.9	1.0	1.1	0.9	1.1					
Δt <sub>WOUT</sub>	Output Pulse Width Error Between Circuits (In same Package)		±1				%			
C <sub>IN</sub>	Input Capacitance		4	10	10		pF	V <sub>CC</sub> = Open		
C <sub>PD</sub>	Power Dissipation Capacitance		73				pF	(Note 1)		

**Note 1:** C<sub>PD</sub> 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:  
 $I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC1} \cdot \text{Duty}/100 + I_{CC}/2$  (per Circuit)  
 I<sub>CC1</sub>: Active Supply Current  
 Duty: %

\*Refer to 74VHC221A Timing Chart.

## AC Operating Requirement: See Section 2 for waveforms

Symbol	Parameter	V <sub>CC</sub> (V)	74VHC			74VHC		Units	Conditions	Fig. No.
			T <sub>A</sub> = 25°C			T <sub>A</sub> = -40°C to +85°C				
			Min	Typ	Max	Min	Max			
t <sub>W(L)</sub>	Minimum Trigger Pulse Width	3.3	5.0	5.0		ns			2-6	
t <sub>W(H)</sub>		5.0	5.0	5.0						
t <sub>W(L)</sub>	Minimum Clear Pulse Width	3.3	5.0	5.0		ns			2-6	
		5.0	5.0	5.0						

# Device Characteristics

