National Semiconductor

54123/DM74123 Dual Retriggerable One-Shot with Clear and Complementary Outputs

General Description

The '123 is a dual retriggerable monostable multivibrator capable of generating output pulses from a few nano-seconds to extremely long duration up to 100% duty cycle. Each device has three inputs permitting the choice of either leading-edge or trailing edge triggering. Pin (A) is an active-low transition trigger input and pin (B) is an active-high transition trigger input. The clear (CLR) input terminates the output pulse at a predetermined time independent of the timing components.

National's '123 device features a unique logic realization not implemented by other manufacturers. The "Clear" input will not trigger the device, a design tailored for applications where it shall only terminate or reduce a timing pulse.

To obtain the best and trouble free operation from this device please read the operating rules as well as the NSC one–shot application notes carefully and observe recommendations.

Features

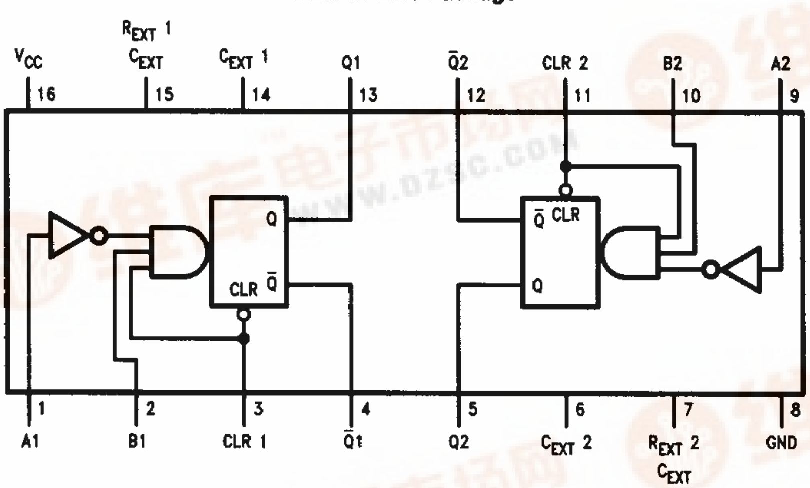
- DC triggered from active-high transition or active-low transition inputs
- Retriggerable to 100% duty cycle
- Direct reset terminates output pulse
- Compensated for V_{CC} and temperature variations
- DTL, TTL compatible
- Input clamp diodes

Functional Description

The basic output pulse width is determined by selection of an external resistor (R_X) and capacitor (C_X). Once triggered, the basic pulse width may be extended by retriggering the gated active-low transition or active-high transition inputs or be reduced by use of the active-low transition clear input. Retriggering to 100% duty cycle is possible by application of an input pulse train whose cycle time is shorter than the output cycle time such that a continuous "HIGH" logic state is maintained at the "Q" output.

Connection Diagram

Dual-In-Line Package



TL/F/6539–1

Order Number 54123DMQB, 54123FMQB or DM74123N
See NS Package Number J16A, N16A or W16A

Triggering Truth Table

Inputs			Response
A	B	CLR	
X	X	L	No Trigger
↘	L	X	No Trigger
↘	H	H	Trigger
H	↗	X	No Trigger
L	↗	H	Trigger
L	H	↗	Trigger

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial

Absolute Maximum Ratings (Note)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	7V
Input Voltage	5.5V
Operating Free Air Temperature Range	
54	−55°C to +125°C
DM74	0°C to +70°C
Storage Temperature	−65°C to +150°C

Note: *The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the "Electrical Characteristics" table are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.*

Recommended Operating Conditions

Symbol	Parameter		54123			DM74123			Units
			Min	Nom	Max	Min	Nom	Max	
V_{CC}	Supply Voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High Level Input Voltage		2			2			V
V_{IL}	Low Level Input Voltage				0.8			0.8	V
I_{OH}	High Level Output Current				−0.8			−0.8	mA
I_{OL}	Low Level Output Current				16			16	mA
t_W	Pulse Width (Note 5)	A or B High				40			ns
		A or B Low				40			
		Clear Low				40			
T_{WQ} (Min)	Minimum Width of Pulse at Q (Note 5)	A or B			80			65	ns
R_{EXT}	External Timing Resistor					5		50	kΩ
C_{EXT}	External Timing Capacitance					No Restriction			μF
C_{WIRE}	Wiring Capacitance at R_{EXT}/C_{EXT} Terminal (Note 5)							50	pF
T_A	Free Air Operating Temperature		−55		125	0		70	°C

Electrical Characteristics

over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions		Min	Typ (Note 1)	Max	Units
V_I	Input Clamp Voltage	V_{CC} = Min, I_I = −12 mA				−1.5	V
V_{OH}	High Level Output Voltage	V_{CC} = Min, I_{OH} = Max V_{IL} = Max, V_{IH} = Min	54	2.4	3.4		V
			DM74	2.5			
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = Max V_{IH} = Min, V_{IL} = Max			0.2	0.4	V
I_I	Input Current @ Max Input Voltage	V_{CC} = Max, V_I = 5.5V				1	mA
I_{IH}	High Level Input Current	V_{CC} = Max V_I = 2.4V	Data			40	μA
			Clear			80	
I_{IL}	Low Level Input Current	V_{CC} = Max, V_I = 0.4V	Clear			−3.2	mA
			Data			−1.6	
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 2)	54	−10		−40	mA
			DM74	−10		−40	
I_{CC}	Supply Current	V_{CC} = Max (Notes 3 and 4)			46	66	mA

Note 1: All typicals are at V_{CC} = 5V, T_A = 25°C.

Note 2: Not more than one output should be shorted at a time.

Note 3: Quiescent I_{CC} is measured (after clearing) with 2.4V applied to all clear and A inputs, B inputs grounded, all outputs open, C_{EXT} = 0.02 μF, and R_{EXT} = 25 KΩ.

Note 4: I_{CC} is measured in the triggered state with 2.4V applied to all clear and B inputs, A inputs grounded, all outputs open, C_{EXT} = 0.02 μF, and R_{EXT} = 25 kΩ.

Note 5: T_A = 25°C and V_{CC} = 5V.

Switching Characteristics at V_{CC} = 5V and T_A = 25°C (See Section 1 for Test Waveforms and Output Load)

Symbol	Parameter	From (Input) To (Output)	54123 C_L = 15 pF, R_L = 400Ω C_{EXT} = 0 pF, R_{EXT} = 5 kΩ		DM74123 C_L = 15 pF, R_L = 400Ω C_{EXT} = 1000 pF, R_{EXT} = 10 KΩ		Units
			Min	Max	Min	Max	
t_{PLH}	Propagation Delay Time Low to High Level Output	$\overline{A}$ to Q		33		33	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	B to Q		28		28	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	$\overline{A}$ to $\overline{Q}$		40		40	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	B to $\overline{Q}$		36		36	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Clear to $\overline{Q}$		40		40	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	$\overline{Clear}$ to Q		27		27	ns
$t_{W(out)}$	Output Pulse Width*	A or B to Q	3.08	3.76	3.08	3.76	μs

*C_{ECT} = 1000 pF, R_{EXT} = 10 kΩ

Operating Rules

1. An external resistor (R_X) and external capacitor (C_X) are required for proper operation. The value of C_X may vary from 0 to any necessary value. For small time constants high-grade mica, glass, polypropylene, polycarbonate, or polystyrene material capacitors may be used. For large time constants use tantalum or special aluminum capacitors. If the timing capacitors have leakages approaching 100 nA or if stray capacitance from either terminal to ground is greater than 50 pF the timing equations may not represent the pulse width the device generates.
2. When an electrolytic capacitor is used for C_X a switching diode is often required for standard TTL one-shots to prevent high inverse leakage current *(Figure 2)*. However, its use in general is not recommended with retriggerable operation.
3. The output pulse width (T_W) for C_X > 1000 pF is defined as follows:

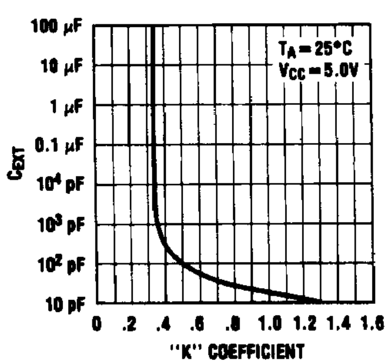
   $T_W = K\, R_X\, C_X\, (1 + 0.7/R_X)$

   where [R_X is in Kilo-ohm]

   [C_X is in pico Farad]

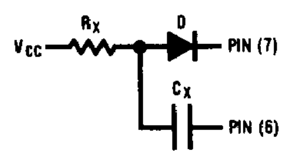
   [T_W is in nano second]

   [K ≈ 0.34]
4. The multiplicative factor K is plotted as a function of C_X below for design considerations:



TL/F/6539-2

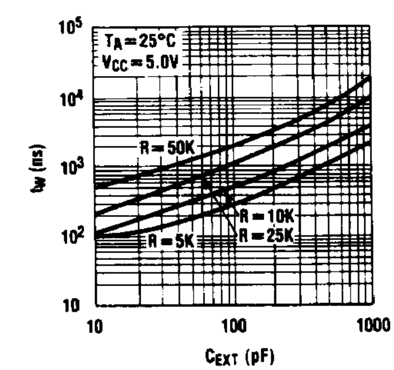
FIGURE 1



TL/F/6539-3

FIGURE 2

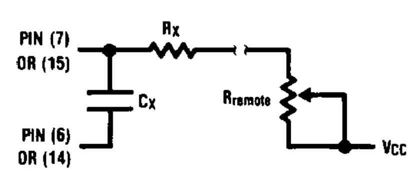
5. For C_X < 1000 pF see *Figure 3* for T_W vs C_X family curves with R_X as a parameter:



TL/F/6539-4

FIGURE 3

6. To obtain variable pulse width by remote trimming, the following circuit is recommended:



TL/F/6539-5

Note: "R_{remote}" should be as close to the one-shot as possible.

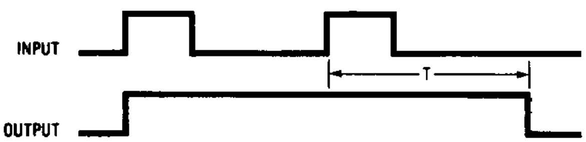
FIGURE 4

Operating Rules (Continued)

7. The retriggerable pulse width is calculated as shown below:

$$T = T_W + t_{PLH} = K \times R_X \times C_X + t_{PLH}$$

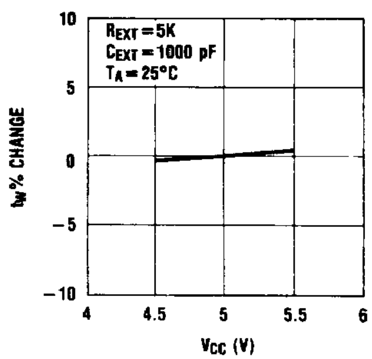
The retriggered pulse width is equal to the pulse width plus a delay time period *(Figure 5).*



TL/F/6539-6

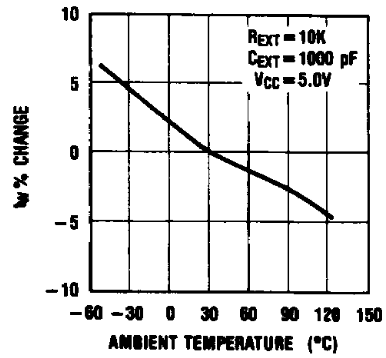
FIGURE 5

8. Output pulse width versus V_{CC} and Temperatures: *Figure 6* depicts the relationship between pulse width variation versus operating V_{CC}. *Figure 7* depicts pulse width variation versus ambient temperatures.



TL/F/6539-7

FIGURE 6



TL/F/6539-8

FIGURE 7

9. Under any operating condition C_X and R_X must be kept as close to the one-shot device pins as possible to minimize stray capacitance, to reduce noise pick-up, and to reduce I × R and Ldi/dt voltage developed along their connecting paths. If the lead length from C_X to pins (6) and (7) or pins (14) and (15) is greater than 3 cm, for example, the output pulse width might be quite different from values predicted from the appropriate equations. A non-inductive and low capacitive path is necessary to ensure complete discharge of C_X in each cycle of its operation so that the output pulse width will be accurate.

10. The C_{EXT} pins of this device are internally connected to the internal ground. For optimum system performance they should be hard wired to the system's return ground plane.

    * However, it should be noted that although the 74221 series one-shot is pin-for-pin compatiable with the '123 device, its C_{EXT} pin is not an internal connection to ground. Hence, if substitution of an '221 on to an '123 design layout whose C_{EXT} pin is wired to the ground is attempted, the '221 device will not function!

11. V_{CC} and ground wiring should conform to good high-frequency standards and practices so that switching transients on the V_{CC} and ground return leads do not cause interaction between one-shots. A 0.01 μF to 0.10 μF bypass capacitor (disk ceramic or monolithic type) from V_{CC} to ground is necessary on each device. Furthermore, the bypass capacitor should be located as close to the V_{CC} pin as space permits.

***For further detailed device characteristics and output performance please refer to the NSC one-shot application note, AN-366.**