National Semiconductor

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DM74LS123 Dual Retriggerable One-Shot with Clear and Complementary Outputs

General Description

The DM74LS123 is a dual retriggerable monostable multivibrator capable of generating output pulses from a few nanoseconds 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. The clear input also serves as a trigger input when it is pulsed with a low level pulse transition (⊔). To obtain the best 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

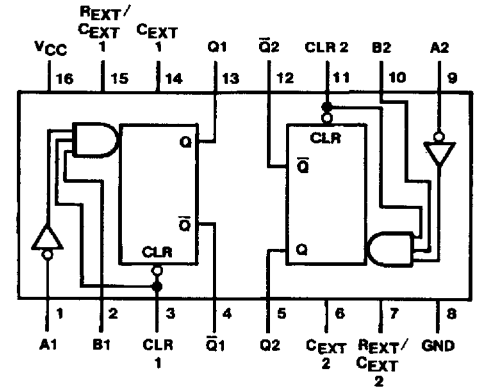
- DC triggered from active-high transition or active-low transition inputs
- Retriggerable to 100% duty cycle
- Compensated for V_{CC} and temperature variations
- Triggerable from CLEAR input
- DTL, TTL compatible
- Input clamp diodes

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 or 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



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Order Number DM74LS123M or DM74LS123N
See NS Package Number M16A or N16E

Function Table

Inputs			Outputs	
CLEAR	A	B	Q	Q̄
L	X	X	L	H
X	H	X	L	H
X	X	L	L	H
H	L	↑	⎍	⊔
H	↓	H	⎍	⊔
↑	L	H	⎍	⊔

H = High Logic Level
L = Low Logic Level
X = Can Be Either Low or High
↑ = Positive Going Transition
↓ = Negative Going Transition
⎍ = A Positive Pulse
⊔ = A Negative Pulse

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RRD-B30M105/Printed in U. S. A.

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	7V
Operating Free Air Temperature Range	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		Min	Nom	Max	Units
V_{CC}	Supply Voltage		4.75	5	5.25	V
V_{IH}	High Level Input Voltage		2			V
V_{IL}	Low Level Input Voltage				0.8	V
I_{OH}	High Level Output Current				−0.4	mA
I_{OL}	Low Level Output Current				8	mA
t_W	Pulse Width (Note 6)	A or B High	40			ns
		A or B Low	40			
		Clear Low	40			
R_{EXT}	External Timing Resistor		5		260	kΩ
C_{EXT}	External Timing Capacitance		No Restriction			µF
C_{WIRE}	Wiring Capacitance at R_{EXT}/C_{EXT} Terminal				50	pF
T_A	Free Air Operating Temperature		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 = −18 mA			−1.5	V
V_{OH}	High Level Output Voltage	V_{CC} = Min, I_{OH} = Max V_{IL} = Max, V_{IH} = Min	2.7	3.4		V
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = Max V_{IL} = Max, V_{IH} = Min		0.35	0.5	V
		I_{OL} = 4 mA, V_{CC} = Min		0.25	0.4	
I_I	Input Current @ Max Input Voltage	V_{CC} = Max, V_I = 7V			0.1	mA
I_{IH}	High Level Input Current	V_{CC} = Max, V_I = 2.7V			20	µA
I_{IL}	Low Level Input Current	V_{CC} = Max, V_I = 0.4V			−0.4	mA
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 2)	−20		−100	mA
I_{CC}	Supply Current	V_{CC} = Max (Notes 3,4 and 5)		12	20	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, and the duration should not exceed one second.

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: With all outputs open and 4.5V applied to all data and clear inputs, I_{CC} is measured after a momentary ground, then 4.5V is applied to the clock.

Note 6: T_A = 25°C and V_{CC} = 5V.

Switching Characteristics at V_{CC} = 5V and T_A = 25°C

Symbol	Parameters	From (Input) To (Output)	R_L = 2 kΩ				Units
			C_L = 15pF C_{EXT} = 0 pF, R_{EXT} = 5 kΩ		C_L = 15pF C_{EXT} = 1000 pF, R_{EXT} = 10 KΩ		
			Min	Max	Min	Max	
t_{PLH}	Propagation Delay Time Low to High Level Output	A to Q		33			ns
t_{PLH}	Propagation Delay Time Low to High Level Output	B to Q		44			ns
t_{PHL}	Propagation Delay Time High to Low Level Output	A to $\overline{Q}$		45			ns
t_{PHL}	Propagation Delay Time High to Low Level Output	B to $\overline{Q}$		56			ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Clear to $\overline{Q}$		45			ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clear to Q		27			ns
$t_{WQ(Min)}$	Minimum Width of Pulse at Output Q	A or B to Q		200			ns
$t_{W(out)}$	Output Pulse Width	A or B to Q			4	5	μs

Operating Rules

1. An external resistor (R_X) and an 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. This switching diode is not needed for the 'LS123 one-shot and should not be used. In general the use of the switching diode is not recommended with retriggerable operation.

Furthermore, if a polarized timing capacitor is used on the 'LS123 the negative terminal of the capacitor should be connected to the "C_{EXT}" pin of the device *(Figure 1)*.

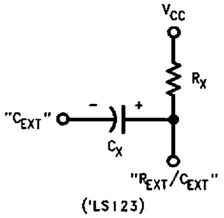

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FIGURE 1

3. For C_X >> 1000 pF the output pulse width (T_W) is defined as follows:

   $T_W = KR_X C_X$

   where [R_X is in kΩ]

   [C_X is in pF]

   [T_W is in ns]

   $K \approx 0.37$
4. The multiplicative factor K is plotted as a function of C_X below for design considerations:

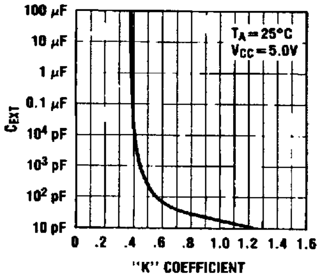

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FIGURE 2

Operating Rules (Continued)

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

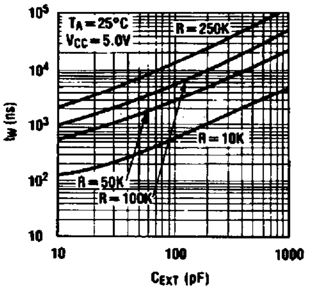

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FIGURE 3

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

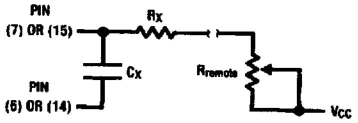

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FIGURE 4

Note: "R_{remote}" should be as close to the device pin as possible.

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).*

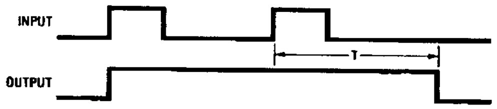

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FIGURE 5

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

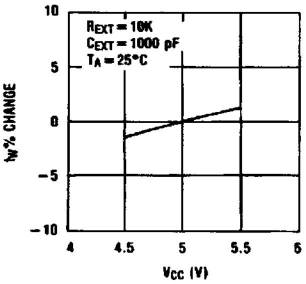

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FIGURE 6

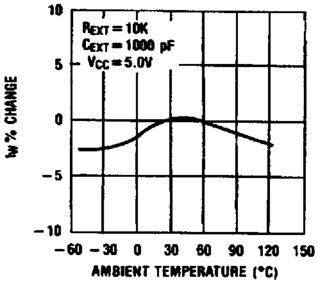

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FIGURE 7

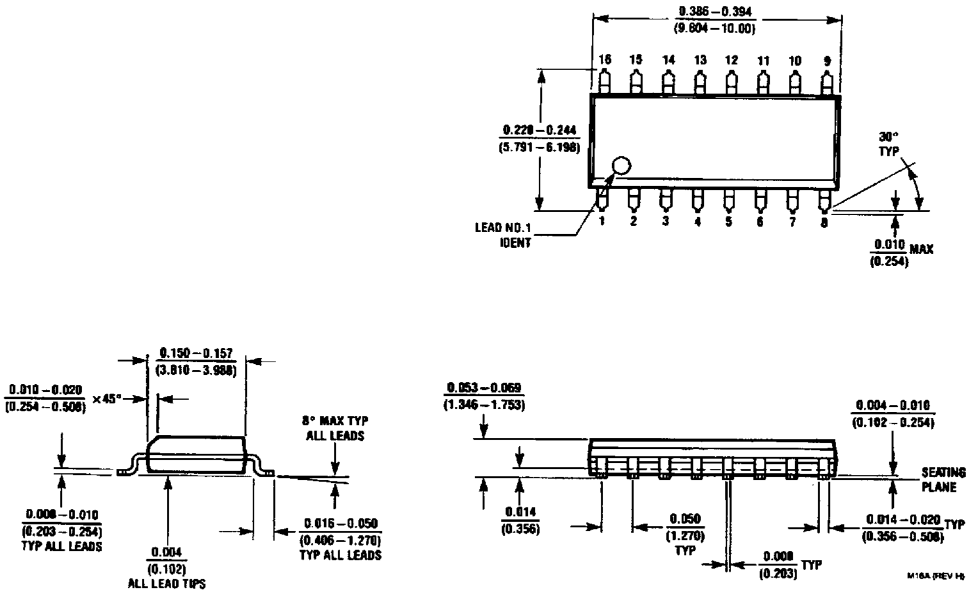
9. Under any operating condition C_X and R_X must be kept as close to the one-shot device pins as possible to minimize stray capacitance, to reduce noise pick-up, and to reduce I-R and Ldi/dt voltage developed along their connecting paths. If the lead length from C_X to pins (6) and (7) or pins (14) 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.

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.

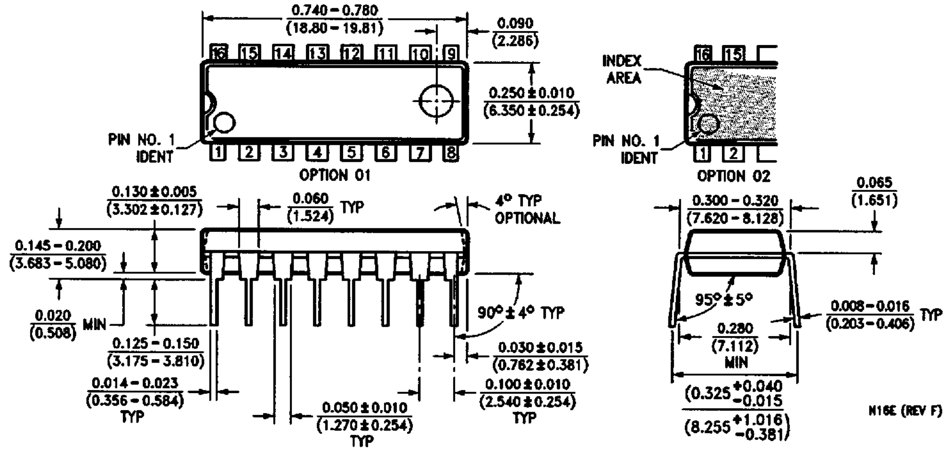
For further detailed device characteristics and output performance please refer to the NSC one-shot application note AN-372.

Physical Dimensions inches (millimeters)



16-Lead Small Outline Molded Package
Order Number DM74LS123M
NS Package Number M16A

Physical Dimensions inches (millimeters) (Continued)



16-Lead Molded Dual-In-Line Package (N)
Order Number DM74LS123N
NS Package Number N16E

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