

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 ($\square\downarrow$). 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

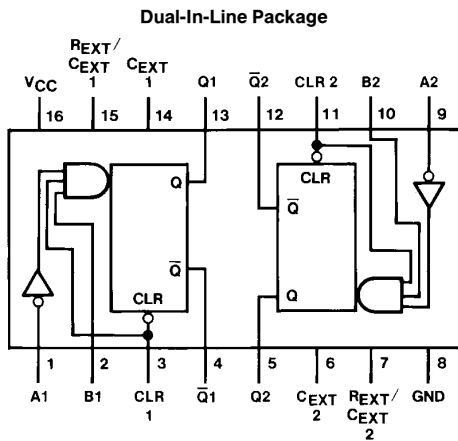
- DC triggered from active-high transition or active-low transition inputs
- Retriggerable to 100% duty cycle

- 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



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

Function Table

Inputs			Outputs	
CLEAR	A	B	Q	\bar{Q}
L	X	X	L	H
X	H	X	L	H
X	X	L	L	H
H	L	\uparrow	$\square\downarrow$	$\square\downarrow$
H	\downarrow	H	$\square\downarrow$	$\square\downarrow$
\uparrow	L	H	$\square\downarrow$	$\square\downarrow$

H = High Logic Level
 L = Low Logic Level
 X = Can Be Either Low or High
 \uparrow = Positive Going Transition
 \downarrow = Negative Going Transition
 $\square\downarrow$ = A Positive Pulse
 $\square\uparrow$ = A Negative Pulse

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 $T_A = 25^\circ C$

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

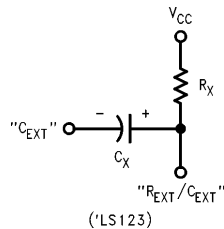


FIGURE 1

TL/F/6386-8

3. For $C_X \gg 1000\text{ pF}$ the output pulse width (T_W) is defined as follows:

$$T_W = KR_X C_X$$

where [R_X is in $\text{k}\Omega$]

[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:

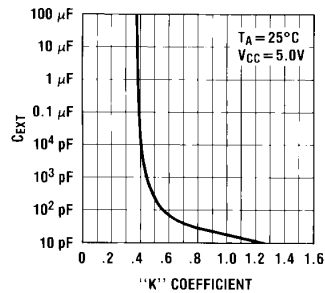


FIGURE 2

TL/F/6386-2

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:

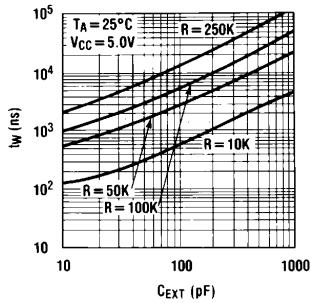


FIGURE 3

TL/F/6386-3

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

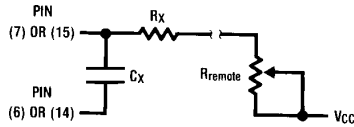


FIGURE 4

TL/F/6386-4

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*).

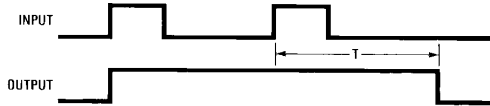


FIGURE 5

TL/F/6386-5

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.

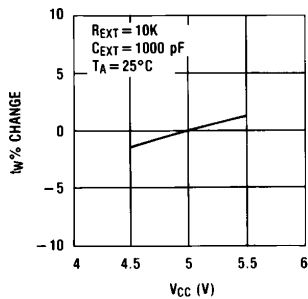
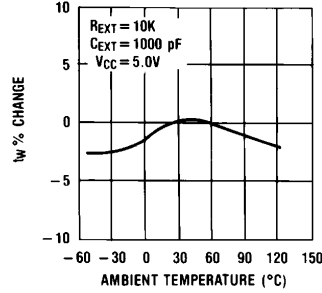


FIGURE 6

TL/F/6386-6



TL/F/6386-7

FIGURE 7

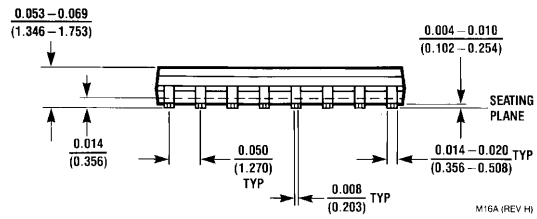
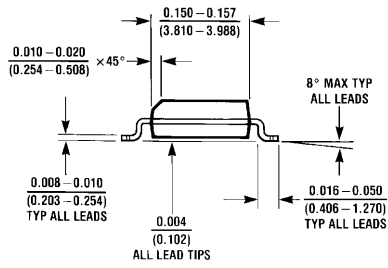
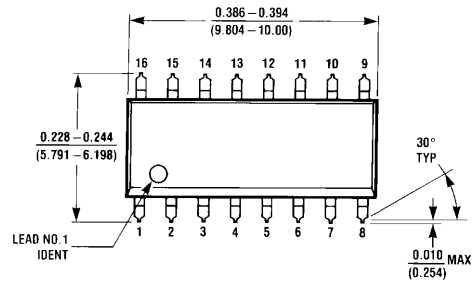
9. Under any operating condition C_X and R_X must be kept as close to the one-shot device pins as possible to minimize stray capacitance, to reduce noise pick-up, and to reduce I-R and Ldi/dt voltage developed along their connecting paths. If the lead length from C_X to pins (6) and (7) or pins (14) 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 $0.01 \mu F$ to $0.10 \mu F$ 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)

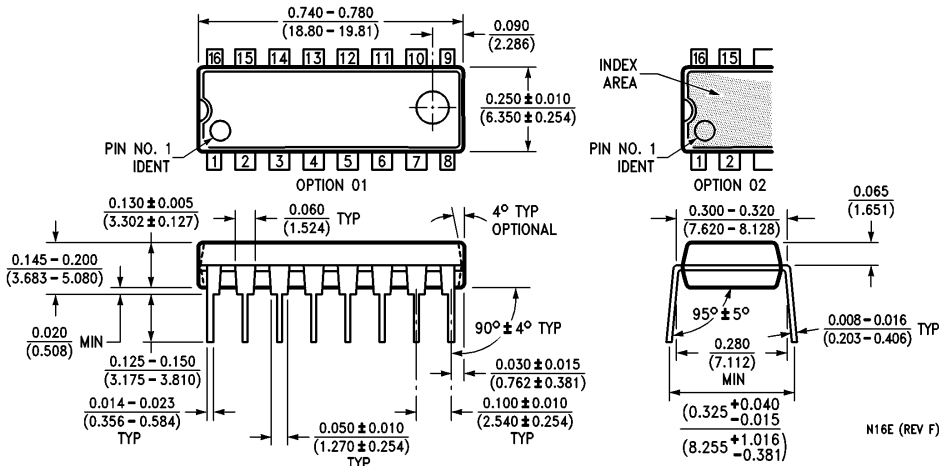


16-Lead Small Outline Molded Package
Order Number DM74LS123M
NS Package Number M16A

M16A (REV H)

**DM74LS123 Dual Retriggerable One-Shot
with Clear and Complementary Outputs**

Physical Dimensions inches (millimeters) (Continued)



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

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



National Semiconductor Corporation
 1111 West Bardin Road
 Arlington, TX 76017
 Tel: 1(800) 272-9959
 Fax: 1(800) 737-7018

National Semiconductor Europe
 Fax: (+49) 0-180-530 85 86
 Email: onjwge@tevm2.nsc.com
 Deutsch Tel: (+49) 0-180-530 85 85
 English Tel: (+49) 0-180-532 78 32
 Français Tel: (+49) 0-180-532 93 58
 Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
 19th Floor, Straight Block,
 Ocean Centre, 5 Canton Rd.
 Tsimshatsui, Kowloon
 Hong Kong
 Tel: (852) 2737-1600
 Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
 Tel: 81-043-299-2309
 Fax: 81-043-299-2408

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.