National Semiconductor

May 1989

# DM74LS122 Retriggerable One-Shot with Clear and Complementary Outputs

## General Description

The DM74LS122 is a retriggerable monostable multivibrator featuring both positive and negative edge triggering with complementary outputs. An internal 10 kΩ timing resistor is provided for design convenience minimizing component count and layout problems. This device can be used with a single external capacitor. The 'LS122 has two active-low transition triggering inputs (A), two active-high transition triggering inputs (B), and a CLEAR input that terminates the output pulse width at a predetermined time independent of the timing components. The clear (CLR) input also serves as a trigger input when it is pulsed with a low level pulse transition (⎍⎍). To obtain optimum and trouble free operation please read operating rules and NSC one-shot application notes carefully and observe recommendations.

## Features

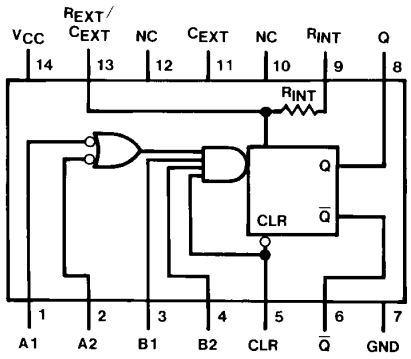
- DC triggered from active-high transition or active-low transition inputs
- Retriggerable to 100% duty cycle
- Over-riding clear terminates output pulse
- Internal 10 kΩ timing resistor
- TTL, DTL compatible
- Compensated for $V_{CC}$ and temperature variations
- Input clamp diodes

## Functional Description

The basic output pulse width is determined by selection of the internal resistor $R_{INT}$ or an external resistor ($R_X$) and capacitor ($C_X$). Once triggered, the output pulse width may be extended by retriggering the gated active-low (A) transition inputs or the active-high transition (B) inputs or the CLEAR input. The output pulse width can be reduced or terminated by overriding it with the active-low CLEAR input.

## Connection Diagram

**Dual-In-Line Package**




TL/F/6385–1

**Order Number DM74LS122M or DM74LS122N**
**See NS Package Number M14A or N14A**

## Function Table

| Inputs | | | | | Outputs | |
|---|---|---|---|---|---|---|
| CLEAR | A1 | A2 | B1 | B2 | Q | $\overline{Q}$ |
| L | X | X | X | X | L | H |
| X | H | H | X | X | L | H |
| X | X | X | L | X | L | H |
| X | X | X | X | L | L | H |
| H | L | X | ↑ | H | ⎍⎍ | ⎍⎍ |
| H | L | X | H | ↑ | ⎍⎍ | ⎍⎍ |
| H | X | L | ↑ | H | ⎍⎍ | ⎍⎍ |
| H | X | L | H | ↑ | ⎍⎍ | ⎍⎍ |
| H | H | ↓ | H | H | ⎍⎍ | ⎍⎍ |
| H | ↓ | ↓ | H | H | ⎍⎍ | ⎍⎍ |
| H | ↓ | H | H | H | ⎍⎍ | ⎍⎍ |
| ↑ | L | X | H | H | ⎍⎍ | ⎍⎍ |
| ↑ | X | L | H | 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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## 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 | |
| DM74LS | 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 | Parameters | | 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 = −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) | | 6 | 11 | mA |

## 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) | $R_L = 2\ k\Omega$ | | | | Units |
|---|---|---|---|---|---|---|---|
| | | | $C_L = 15\ pF$, $C_{EXT} = 0\ pF$, $R_{EXT} = 5\ k\Omega$ | | $C_L = 15\ pF$, $C_{EXT} = 1000\ pF$, $R_{EXT} = 10\ k\Omega$ | | |
| | | | 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 $\overline{Q}$ | | 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 | $\mu s$ |

**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, $C_{EXT} = 0.02\ \mu F$, and $R_{EXT} = 25\ k\Omega$.

**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, $C_{EXT} = 0.02\ \mu F$, and $R_{EXT} = 25\ k\Omega$.

**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 $V_{CC} = 5V$.

## Operating Rules

1. To use the internal 10 kΩ timing resistor, connect the $R_{INT}$ pin to $V_{CC}$.
2. An external resistor ($R_X$) or the internal resistor (10 kΩ) 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 use high-quality mica, glass, polypropylene, polycarbonate, or polystyrene capacitors. For large time constants use solid 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.
3. The pulse width is essentially determined by external timing components $R_X$ and $C_X$. For $C_X < 1000$ pF see *Figure 1;* design curves on $T_W$ as function of timing components value. For $C_X >> 1000$ pF the output is defined as:

$$T_W = KR_XC_X$$

where [$R_X$ is in kΩ]
[$C_X$ is in pF]
[$T_W$ is in ns]
$K \approx 0.37$

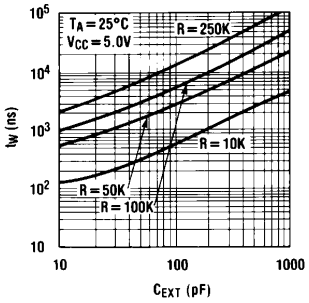


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**FIGURE 1**

## Operating Rules (Continued)

The K factor is not a constant, but, varies with $C_X$. See *Figure 2*.

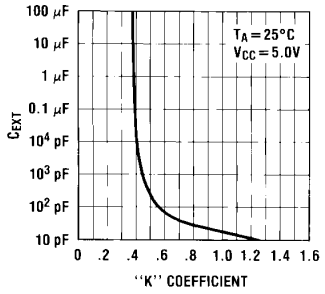


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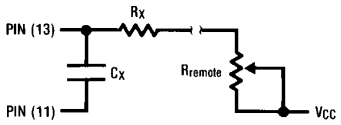
**FIGURE 2**

4. The switching diode required for most TTL one-shots when using an electrolytic timing capacitor is not needed for the 'LS122 and should not be used.
5. To obtain variable pulse width by remote trimming, the following circuit is recommended:

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

**FIGURE 3**

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

$$T = T_W + t_{PLH} = 0.50 \times R_X \times C_X + T_{PLH}$$

The retriggered pulse width is equal to the pulse width plus a delay time period *(Figure 4)*.

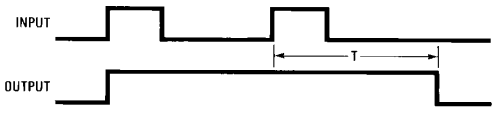


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**FIGURE 4**

7. Output pulse width variation versus $V_{CC}$ and operation temperatures: *Figure 5* depicts the relationship between pulse width variation versus $V_{CC}$; and *Figure 6* depicts pulse width variation versus temperatures.

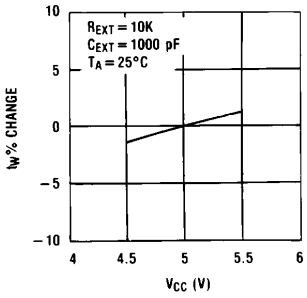


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**FIGURE 5**

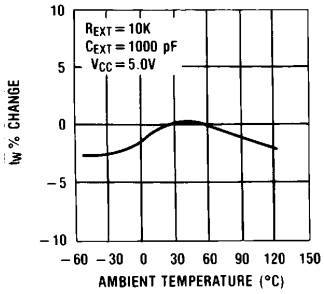


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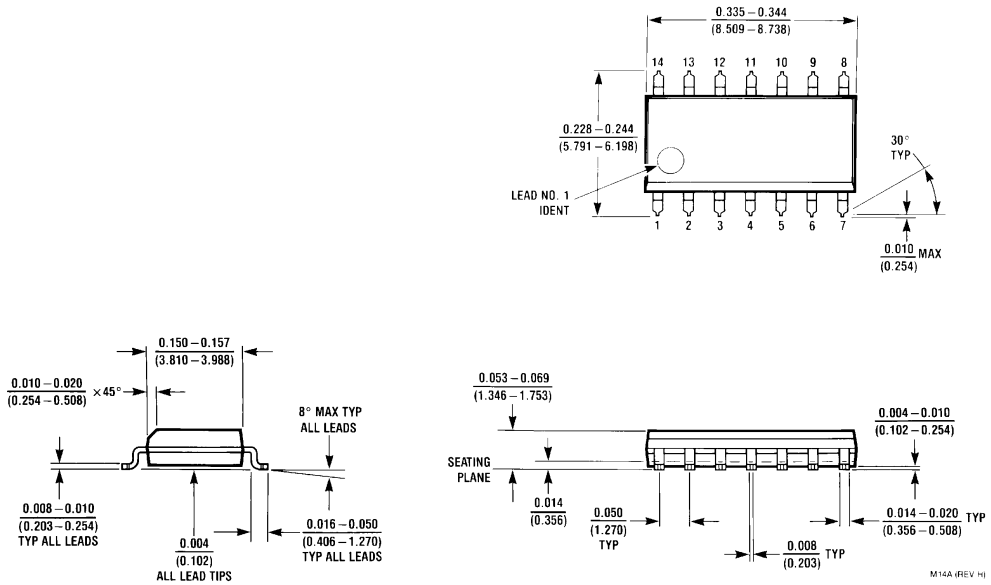
**FIGURE 6**

8. 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 (13) and (11) 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.
9. $V_{CC}$ 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.

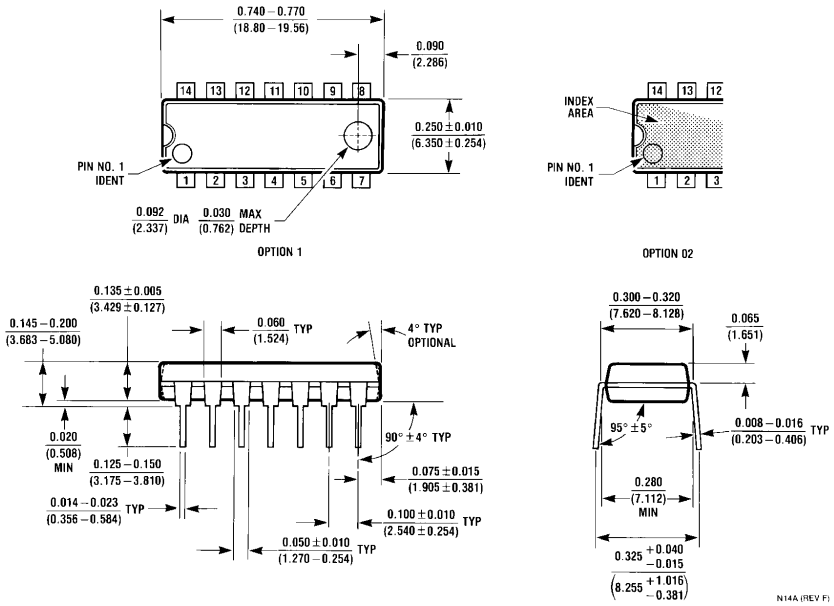
***For further detailed device characteristics and output performance please refer to the NSC one-shot application note AN-366.**

## Physical Dimensions inches (millimeters)




**14-Lead Small Outline Molded Package (M)**
**Order Number DM74LS122M**
**NS Package Number M14A**

## Physical Dimensions inches (millimeters) (Continued)




**14-Lead Molded Dual-In-Line Package (N)**
**Order Number DM74LS122N**
**NS Package Number N14A**

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