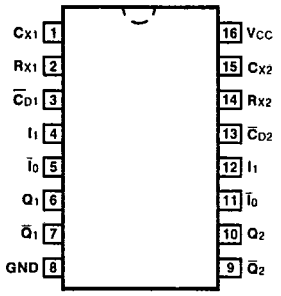
# 96S02
# 96LS02

## DUAL RETRIGGERABLE RESETTABLE MONOSTABLE MULTIVIBRATOR

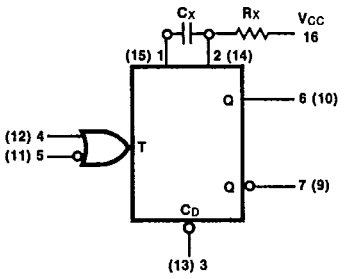
**DESCRIPTION** — The 96S02 and 96LS02 are dual retriggerable and resettable monostable multivibrators. These one-shots provide exceptionally wide delay range, pulse width stability, predictable accuracy and immunity to noise. The pulse width is set by an external resistor and capacitor. Resistor values up to 1.0 MΩ for the 96LS02 and 2.0 MΩ for the 96S02 reduce required capacitor values. Hysteresis is provided on both trigger inputs of the 96LS02 and on the positive trigger input of the 96S02 for increased noise immunity.

- **REQUIRED TIMING CAPACITANCE REDUCED BY FACTORS OF 10 TO 100 OVER CONVENTIONAL DESIGNS**
- **BROAD TIMING RESISTOR RANGE — 1.0 kΩ to 2.0 MΩ**
- **OUTPUT PULSE WIDTH IS VARIABLE OVER A 2000:1 RANGE BY RESISTOR CONTROL**
- **PROPAGATION DELAY OF 35 ns 96LS02, 12 ns 96S02**
- **0.3 V HYSTERESIS ON TRIGGER INPUTS**
- **OUTPUT PULSE WIDTH INDEPENDENT OF DUTY CYCLE**
- **35 ns TO ∞ OUTPUT PULSE WIDTH RANGE**

**CONNECTION DIAGRAM**
PINOUT A




**LOGIC SYMBOL**




VCC = Pin 16
GND = Pin 8

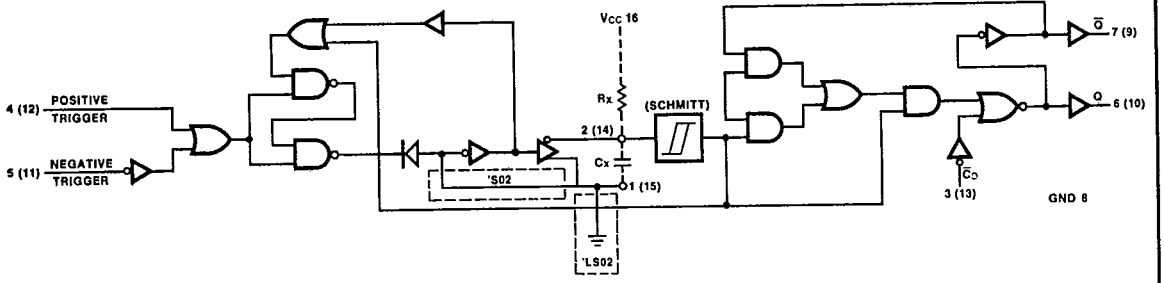
**ORDERING CODE:** See Section 9

| PKGS | PIN OUT | COMMERCIAL GRADE: VCC = +5.0 V ±5%, TA = 0°C to +70°C | MILITARY GRADE: VCC = +5.0 V ±10%, TA = -55°C to +125°C | PKG TYPE |
|---|---|---|---|---|
| Plastic DIP (P) | A | 96S02PC, 96LS02PC | | 9B |
| Ceramic DIP (D) | A | 96S02DC, 96LS02DC | 96S02DM, 96LS02DM | 6B |
| Flatpak (F) | A | 96S02FC, 96LS02FC | 96S02FM, 96LS02FM | 4L |

**INPUT LOADING/FAN-OUT:** See Section 3 for U.L. definitions

| PIN NAMES | DESCRIPTION | 96S (U.L.) HIGH/LOW | 96LS (U.L.) HIGH/LOW |
|---|---|---|---|
| $\bar{I}_0$ | Trigger Input (Active Falling Edge) | 0.5/0.625 | |
| $\bar{I}_0$ | Schmitt Trigger Input (Active Falling Edge) | | 0.5/0.25 |
| $I_1$ | Schmitt Trigger Input (Active Rising Edge) | 0.5/0.625 | 0.5/0.25 |
| $\bar{C}_D$ | Direct Clear Input (Active LOW) | 0.5/0.625 | 0.5/0.25 |
| Q | True Pulse Output | 25/12.5 | 10/5.0 (2.5) |
| $\bar{Q}$ | Complementary Pulse Output | 25/12.5 | 10/5.0 (2.5) |

## LOGIC DIAGRAM




**FUNCTIONAL DESCRIPTION** — The 96S02 and 96LS02 dual retriggerable resettable monostable multivibrators have two dc coupled trigger inputs per function, one active LOW ($\overline{I}_0$) and one active HIGH ($I_1$). The $I_1$ input of both circuit types and the $\overline{I}_0$ input of the 96LS02 utilize an internal Schmitt trigger with hysteresis of 0.3 V to provide increased noise immunity. The use of active HIGH and LOW inputs allows either rising or falling edge triggering and optional non-retriggerable operation. The inputs are dc coupled making triggering independent of input transition times. When input conditions for triggering are met the Q output goes HIGH and the external capacitor is rapidly discharged and then allowed to recharge. An input trigger which occurs during the timing cycle will retrigger the circuit and result in Q remaining HIGH. The output pulse may be terminated (Q to the LOW state) at any time by setting the Direct Clear input LOW. Retriggering may be inhibited by tying the $\overline{Q}$ output to $\overline{I}_0$ or the Q output to $I_1$. Differential sensing techniques are used to obtain excellent stability over temperature and power supply variations and a feedback Darlington capacitor discharge circuit minimizes pulse width variation from unit to unit. Schottky TTL output stages provide high switching speeds and output compatibility with all TTL logic families.

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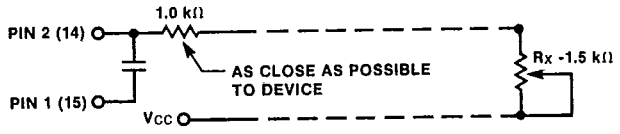
**Operation Notes**

TIMING

1. An external resistor ($R_X$) and an external capacitor ($C_X$) are required as shown in the Logic Diagram. The value of $R_X$ may vary from 1.0 kΩ to 1.0 MΩ (96LS02) or 2.0 MΩ (96S02).
2. The value of $C_X$ may vary from 0 to any necessary value available. If, however, the capacitor has significant leakage relative to $V_{CC}/R_X$ the timing equations may not represent the pulse width obtained.
3. Polarized capacitors may be used directly. The (+) terminal of a polarized capacitor is connected to pin 1 (15), the (-) terminal to pin 2 (14) and $R_X$. Pin 1 (15) will remain positive with respect to pin 2 (14) during the timing cycle. In the 96S02, however, during quiescent (non-triggered) conditions, pin 1 (15) may go negative with respect to pin 2 (14) depending on values of $R_X$ and $V_{CC}$. For values of $R_X \geq 10$ kΩ the maximum amount of capacitor reverse polarity, pin 1 (15) negative with respect to pin 2 (14) is 500 mV. Most tantalum electrolytic capacitors are rated for safe reverse bias operation up to 5% of their working forward voltage rating; therefore, capacitors having a rating of 10 WVdc or higher should be used with the 96S02 when $R_X \geq 10$ kΩ.
4. The output pulse width $t_w$ for $R_X \geq 10$ kΩ and $C_X \geq 1000$ pF is determined as follows:
   (96S02) $t_w = 0.55\ R_X C_X$
   (96LS02) $t_w = 0.43\ R_X C_X$
   Where $R_X$ is in kΩ, $C_X$ is in pF, t is in ns *or* $R_X$ is in kΩ, $C_X$ is in μF, t is in ms.
5. The output pulse width for $R_X < 10$ kΩ or $C_X < 1000$ pF should be determined from pulse width versus $C_X$ or $R_X$ graphs.
6. To obtain variable pulse width by remote trimming, the following circuit is recommended:

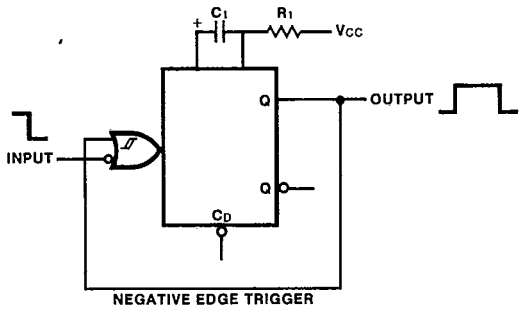


**Operation Notes** (Cont'd)

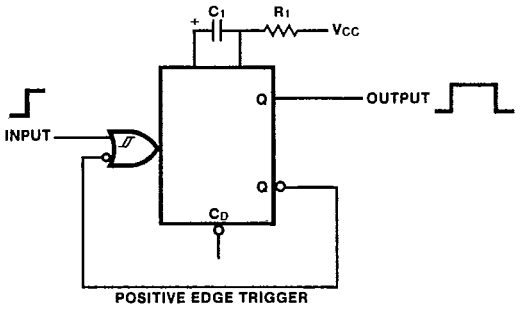
7. Under any operating condition, $C_X$ and $R_X$ (Min) must be kept as close to the circuit as possible to minimize stray capacitance and reduce noise pickup.
8. $V_{CC}$ and ground wiring should conform to good high frequency standards so that switching transients on $V_{CC}$ and ground leads do not cause interaction between one shots. Use of a 0.01 $\mu$F to 0.1 $\mu$F bypass capacitor between $V_{CC}$ and ground located near the circuit is recommended.

TRIGGERING

1. The minimum negative pulse width into $\overline{I}_0$ is 8.0 ns; the minimum positive pulse width into $I_1$ is 12 ns.
2. Input signals to the 96S02 exhibiting slow or noisy transitions should use the positive trigger input $I_1$ which contains a Schmitt trigger. Input signals to the 96LS02 exhibiting slow or noisy transitions can use either trigger as both are Schmitt triggers.
3. When non-retriggerable operation is required, i.e., when input triggers are to be ignored during quasi-stable state, input latching is used to inhibit retriggering.



NEGATIVE EDGE TRIGGER



POSITIVE EDGE TRIGGER

4. An overriding active LOW level direct clear is provided on each multivibrator. By applying a LOW to the clear, any timing cycle can be terminated or any new cycle inhibited until the LOW reset input is removed. Trigger inputs will not produce spikes in the output when the reset is held LOW. A LOW-to-HIGH transition on $\overline{C}_D$ will not trigger the 96S02 or 96LS02. If the $\overline{C}_D$ input goes HIGH coincident with a trigger transition, the circuit will respond to the trigger.

**TRIGGERING TRUTH TABLE**

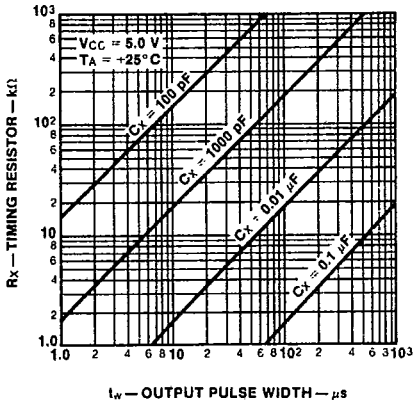
| PIN NO'S. 5 (11) | 4 (12) | 3 (13) | OPERATION |
|---|---|---|---|
| H→L | L | H | Trigger |
| H | L→H | H | Trigger |
| X | X | L | Reset |

H = HIGH Voltage Level ≥ $V_{IH}$
L = LOW Voltage Level ≤ $V_{IL}$
X = Immaterial (either H or L)
H→L = HIGH to LOW Voltage Level transition
L→H = LOW to HIGH Voltage Level transition

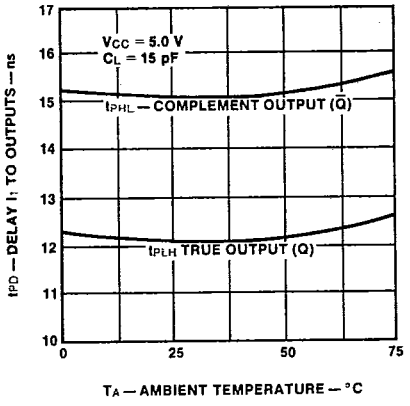
## TYPICAL CHARACTERISTICS
96S02

T-51-19

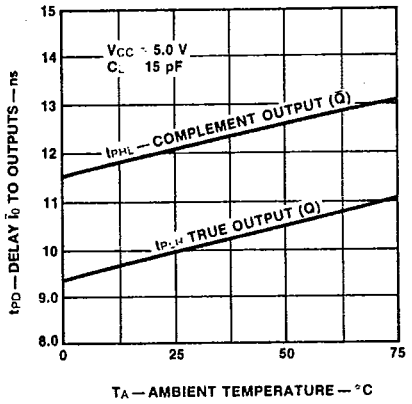
### OUTPUT $t_W$ vs $R_X$ and $C_X$



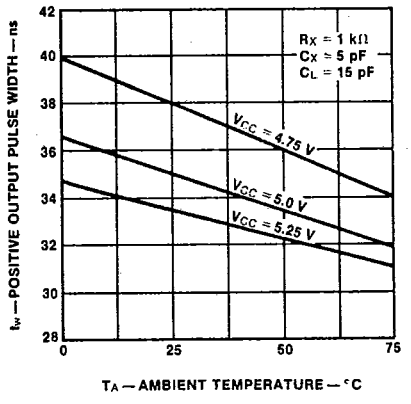

### $I_1$ DELAY TIME vs $T_A$



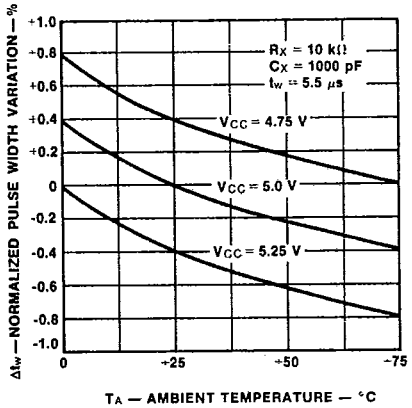

### $\bar{I}_0$ DELAY TIME vs $T_A$



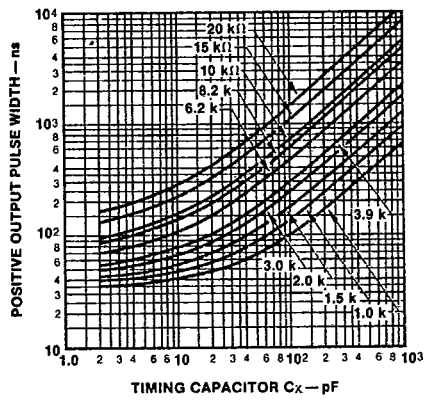

### OUTPUT $t_W$ vs $T_A$




### NORMALIZED $\Delta t_W$ vs $T_A$




### PULSE WIDTH vs $R_XC_X$

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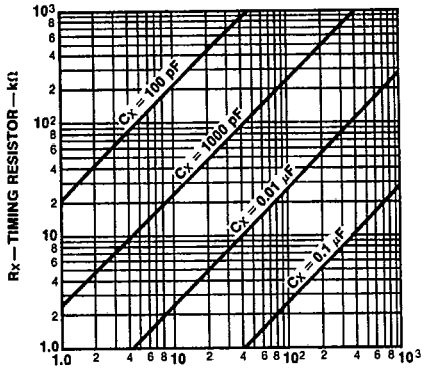
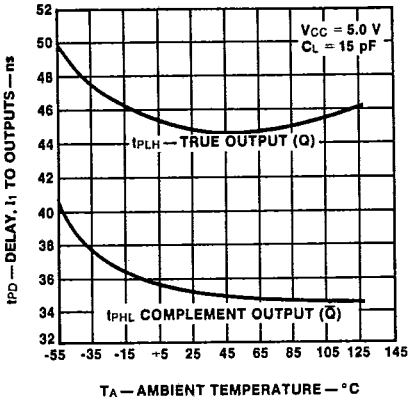
S----09602-4x

## TYPICAL CHARACTERISTICS
### 96LS02

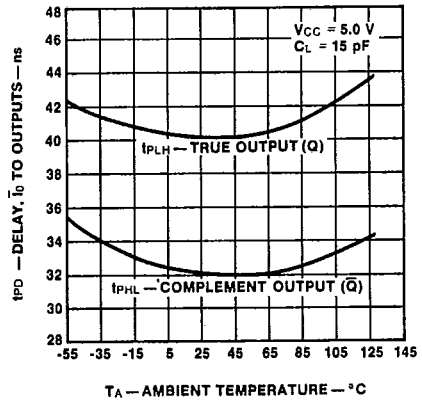
**OUTPUT $t_W$ vs $R_X$ and $C_X$**



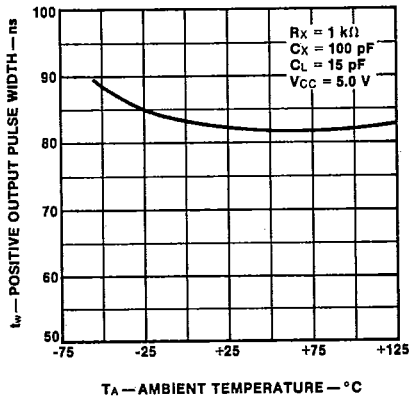

**$I_1$ DELAY TIME vs $T_A$**



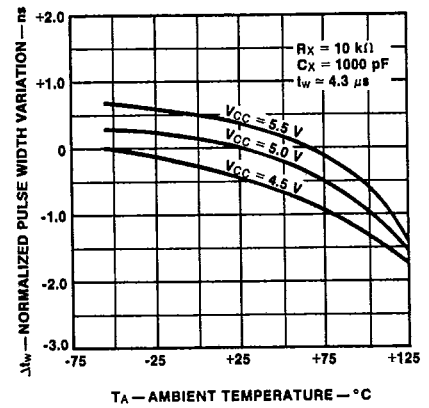

**$\bar{I}_0$ DELAY TIME vs $T_A$**



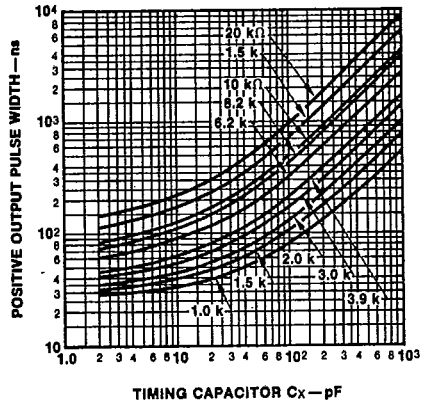

**OUTPUT $t_W$ vs $T_A$**




**NORMALIZED $\Delta t_W$ vs $T_A$**




**PULSE WIDTH vs $R_XC_X$**



**DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE** (unless otherwise specified)

| SYMBOL | PARAMETER | | 96S Min | 96S Max | 96LS Min | 96LS Max | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|---|---|
| $V_{T+}$ | Positive-going Threshold Voltage, $\overline{I_0}$, $I_1$ (96LS02) $I_1$ (96S02) | | | 2.0 | | 2.0 | V | $V_{CC}$ = 5.0 V |
| $V_{T-}$ | Negative-going Threshold Voltage $\overline{I_0}$, $I_1$ (96LS02) $I_1$ (96S02) | XM<br>XC | 0.8<br>0.8 | | 0.7<br>0.8 | | V | $V_{CC}$ = 5.0 V |
| $V_{OH}$ | Output HIGH Voltage | XM<br>XC | 2.7<br>2.7 | | 2.5<br>2.7 | | V | $V_{CC}$ = Min, $V_{IN}$ = $V_{IH}$ or $V_{IL}$<br>$I_{OH}$ = -400 μA ('LS02)<br>$I_{OH}$ = -1.0 mA ('S02) |
| $V_{OL}$ | Output LOW Voltage | XM<br>XC | | 0.5<br>0.5 | | 0.5<br>0.4 | V | $V_{CC}$ = Min, $V_{IN}$ = $V_{IH}$ or $V_{IL}$ |
| $V_{CX}$ | Capacitor Voltage Pin 1 (15) Referenced to Pin 2 (14) | | -0.85<br>-0.5<br>-0.4 | 3.0<br>3.0<br>3.0 | 0<br>0<br>0 | 3.0<br>3.0<br>3.0 | V | $R_X$ = 1.0 kΩ<br>$R_X$ = > 10 kΩ<br>$R_X$ > 1.0 MΩ<br>$V_{CC}$ = 4.75 V to 5.25 V |
| $I_{IH}$ | Input HIGH Current | | | 20<br>0.1 | | 20<br>0.1 | μA<br>mA | $V_{IN}$ = 2.7 V<br>$V_{IN}$ = 5.5 V ('S02)<br>$V_{IN}$ = 10 V ('LS02)<br>$V_{CC}$ = Max |
| $I_{IL}$ | Input LOW Current | | | -1.0 | | -0.4 | mA | $V_{IN}$ = 0.4 V, $V_{CC}$ = Max |
| $I_{OS}$ | Output Short Circuit Current | | -40 | -100 | -20 | -100 | mA | $V_{CC}$ = Max, $V_{OUT}$ = 0 V |
| $I_{CC}$ | Power Supply Current | | | 75 | | 36 | mA | $V_{IN}$ = Open, $V_{CC}$ = Max |

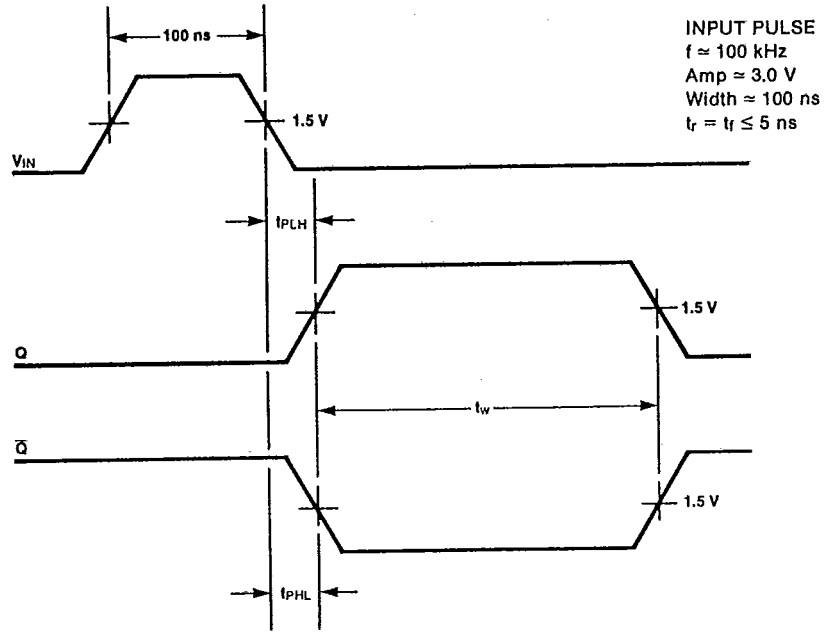



**Fig. a**

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**AC CHARACTERISTICS:** $V_{CC}$ = +5.0 V, $T_A$ = +25°C (See Section 3 for waveforms and load configurations)

| SYMBOL | PARAMETER | 96S $C_L$ = 15 pF Min | 96S $C_L$ = 15 pF Max | 96LS $C_L$ = 15 pF Min | 96LS $C_L$ = 15 pF Max | UNITS | CONDITIONS |
|---|---|---|---|---|---|---|---|
| $t_{PLH}$ | Propagation Delay $\overline{I}_0$ to Q | | 15 | | 55 | ns | Fig. a |
| $t_{PHL}$ | Propagation Delay $\overline{I}_0$ to $\overline{Q}$ | | 19 | | 50 | ns | |
| $t_{PLH}$ | Propagation Delay $I_1$ to Q | | 19 | | 60 | ns | |
| $t_{PHL}$ | Propagation Delay $I_1$ to $\overline{Q}$ | | 20 | | 55 | ns | |
| $t_{PHL}$ | Propagation Delay $\overline{C}_D$ to Q | | 20 | | 30 | ns | |
| $t_{PLH}$ | Propagation Delay $\overline{C}_D$ to $\overline{Q}$ | | 14 | | 35 | ns | |
| $t_w$ (L) | $\overline{I}_0$ Pulse Width LOW | 8.0 | | 15 | | ns | |
| $t_w$ (H) | $I_1$ Pulse Width HIGH | 12 | | 30 | | ns | |
| $t_w$ (L) | $\overline{C}_D$ Pulse Width LOW | 7.0 | | 22 | | ns | |
| $t_w$ (H) | Minimum Q Pulse Width HIGH | 30 | 45 | 25 | 55 | ns | $R_X$ = 1.0 kΩ, $C_X$ = 10 pF including jig and stray |
| $t_w$ | Q Pulse Width | 5.2 | 5.8 | 4.1 | 4.5 | μs | $R_X$ = 10 kΩ, $C_X$ = 1000 pF |
| $R_X$ | Timing Resistor Range* | 1.0 | 2000 | 1.0 | 1000 | kΩ | $T_A$ = -55°C to +125°C, $V_{CC}$ = 4.5 V to 5.5 V |
| t | Change in Q Pulse Width over Temperature XM | | | | 3.0 | % | $R_X$ = 10 kΩ, $C_X$ = 1000 pF |
| | XC | | 1.0 | | 1.0 | | |
| t | Change in Q Pulse Width over $V_{CC}$ Range | | 1.0 | | 0.8 | % | $T_A$ = 25°C, $V_{CC}$ = 4.75 V to 5.25 V, $R_X$ = 10 kΩ, $C_X$ = 1000 pF |
| | | | | | 1.5 | | $T_A$ = 25°C, $V_{CC}$ = 4.5 V to 5.5 V, $R_X$ = 10 kΩ, $C_X$ = 1000 pF |

*Applies only over commercial $V_{CC}$ and $T_A$ range for 96S02.