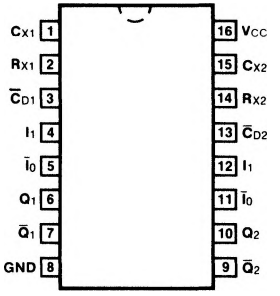
9602
96L02

DUAL RETRIGGERABLE RESETTABLE MONOSTABLE MULTIVIBRATOR

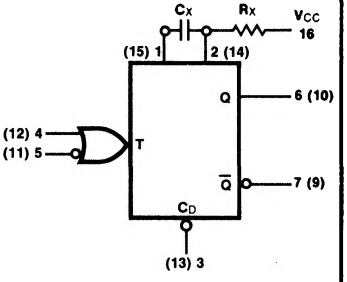
DESCRIPTION — The 9602 is a dual TTL monostable multivibrator with trigger mode selection, reset capability, rapid recovery, internally compensated reference levels and high speed capability. Output pulse duration and accuracy depend on external timing components, and are therefore under user control for each application. It is well suited for a broad variety of applications, including pulse delay generators, square wave generators, long delay timers, pulse absence detectors, frequency detectors, clock pulse generators and fixed-frequency dividers. Each input is provided with a clamp diode to limit undershoot and minimize ringing induced by fast fall times acting on system wiring impedances.

- **RETRIGGERABLE, 0% TO 100% DUTY CYCLE**
- **DC LEVEL TRIGGERING, INSENSITIVE TO TRANSITION TIMES**
- **LEADING OR TRAILING-EDGE TRIGGERING**
- **COMPLEMENTARY OUTPUTS WITH ACTIVE PULL-UPS**
- **PULSE WIDTH COMPENSATION FOR ΔV_{CC} AND ΔT_A**
- **50 ns TO ∞ OUTPUT PULSE WIDTH RANGE**
- **OPTIONAL RETRIGGER LOCK-OUT CAPABILITY**
- **RESETTABLE, FOR INTERRUPT OPERATIONS**

CONNECTION DIAGRAM
PINOUT A



LOGIC SYMBOL



VCC = Pin 16
GND = Pin 8

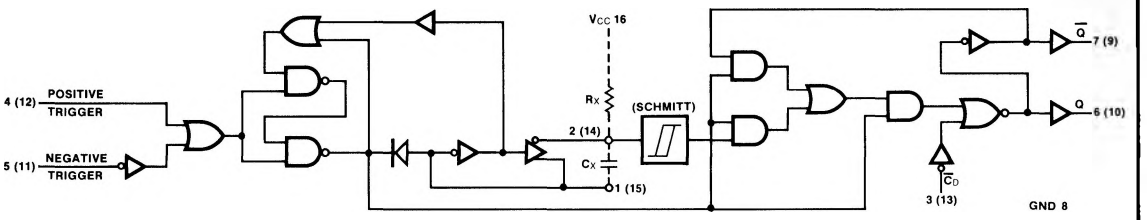
ORDERING CODE: See Section 9

PKGS	PIN OUT	COMMERCIAL GRADE V_{CC} = +5.0 V ±5%, T_A = 0°C to +70°C	MILITARY GRADE V_{CC} = +5.0 V ±10%, T_A = -55°C to +125°C	PKG TYPE
Plastic DIP (P)	A	9602PC, 96L02PC		9B
Ceramic DIP (D)	A	9602DC, 96L02DC	9602DM, 96L02DM	6B
Flatpak (F)	A	9602FC, 96L02FC	9602FM, 96L02FM	4L

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

PIN NAMES	DESCRIPTION	96XX (U.L.) HIGH/LOW	96L (U.L.) HIGH/LOW
$\overline{I}_0$	Trigger Input (Active Falling Edge)	1.5/1.0	0.5/0.25
I_1	Trigger Input (Active Rising Edge)	1.5/1.0	0.5/0.25
$\overline{C}_D$	Direct Clear Input (Active LOW)	1.5/1.0	0.5/0.25
Q	Positive Pulse Output	24/7.0 (6.2)	9.0/3.0
$\overline{Q}$	Complementary Pulse Output	24/7.0 (6.2)	9.0/3.0

FUNCTIONAL BLOCK DIAGRAM



OPERATION NOTES

1. TRIGGERING — can be accomplished by a positive-going transition on pin 4 (12) or a negative-going transition on pin 5 (11). Triggering begins as a signal crosses the input V_{IL}:V_{IH} threshold region; this activates an internal latch whose unbalanced cross-coupling causes it to assume a preferred state. As the latch output goes LOW it disables the gates leading to the Q output and, through an inverter, turns on the capacitor discharge transistor. The inverted signal is also fed back to the latch input to change its state and effectively end the triggering action; thus the latch and its associated feed-back perform the function of a differentiator.

   The emitters of the latch transistors return to ground through an enabling transistor which must be turned off between successive triggers in order for the latch to proceed through the proper sequence when triggering is desired. Pin 5 (11) must be HIGH in order to trigger at pin 4 (12); conversely, pin 4 (12) must be LOW in order to trigger at pin 5 (11).

2. RETRIGGERING — In a normal cycle, triggering initiates a rapid discharge of the external timing capacitor, followed by a ramp voltage run-up at pin 2 (14). The delay will time out when the ramp voltage reaches the upper trigger point of a Schmitt circuit, causing the outputs to revert to the quiescent state. If another trigger occurs before the ramp voltage reaches the Schmitt threshold, the capacitor will be discharged and the ramp will start again without having disturbed the output. The delay period can therefore be extended for an arbitrary length of time by insuring that the interval between triggers is less than the delay time, as determined by the external capacitor and resistor.

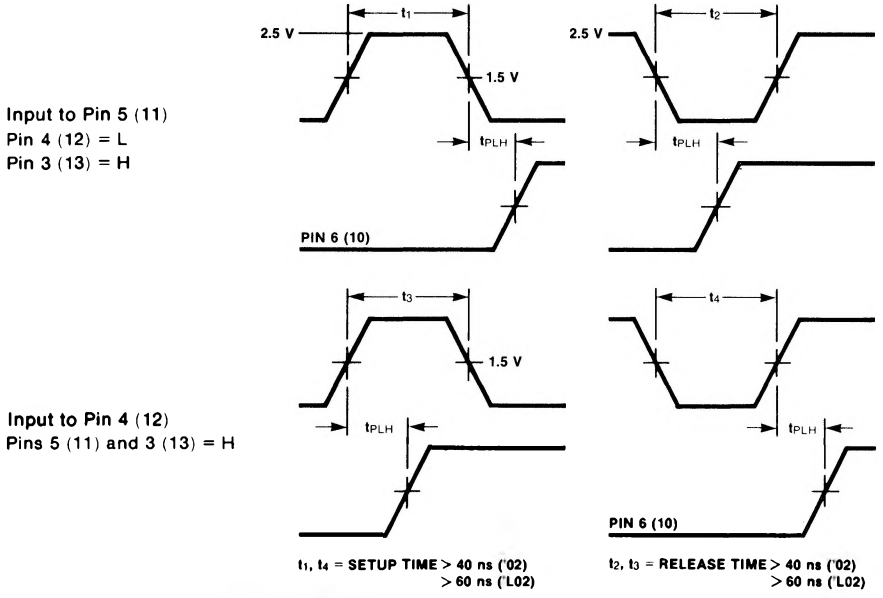
3. NON-RETRIGGERABLE OPERATION — Retriggering can be inhibited logically, by connecting pin 6 (10) back to pin 4 (12) or by connecting pin 7 (9) back to pin 5 (11). Either hook-up has the effect of keeping the latch-enabling transistor turned on during the delay period, which prevents the input latch from cycling as discussed above in the section on triggering.

4. OUTPUT PULSE WIDTH — An external resistor R_X and an external capacitor C_X are required, as shown in the functional block diagram. To minimize stray capacitance and noise pickup, R_X and C_X should be located as close as possible to the circuit. In applications which require remote trimming of the pulse width, as with a variable resistor, R_X should consist of a fixed resistor in series with the variable resistor; the fixed resistor should be located as close as possible to the circuit. The output pulse width t_w is defined as follows, where R_X is in kΩ, C_X is in pF and t_w is in ns.

   (9602) $t_w = 0.31\ R_X C_X\ (1 + 1/R_X)$ for $C_X \geq 10^3$ pF
   $5\ k\Omega \leq R_X \leq 50\ k\Omega$ for 0° C to +75° C
   $5\ k\Omega \leq R_X \leq 25\ k\Omega$ for -55° C to +125° C
   (96L02) $t_w = 0.33\ R_X C_X\ (1 + 3/R_X)$ for $C_X \geq 10^3$ pF
   $16\ k\Omega \leq R_X \leq 220\ k\Omega$ for 0° C to +75° C
   $20\ k\Omega \leq R_X \leq 100\ k\Omega$ for -55° C to +125° C
   C_X may vary from 0 to any value. For pulse widths with C_X less than 10^3 pF see *Figures a and b*.

OPERATION NOTES (Cont'd)

5. SETUP AND RELEASE TIMES — The setup times listed below are necessary to allow the latch-enabling transistor to turn off and the node voltages within the input latch to stabilize, thus insuring proper cycling of the latch when the next trigger occurs. The indicated release times (equivalent to trigger duration) allow time for the input latch to cycle and its signal to propagate.



6. RESET OPERATION — A LOW signal on $\overline{C}_D$, pin 3 (13), will terminate an output pulse, causing Q to go LOW and $\overline{Q}$ to go HIGH. As long as $\overline{C}_D$ is held LOW, a delay period cannot be initiated nor will attempted triggering cause spikes at the outputs. A reset pulse duration, in the LOW state, of 25 ns is sufficient to insure resetting. If the reset input goes LOW at the same time that a trigger transition occurs, the reset will dominate and the outputs will not respond to the trigger. If the reset input goes HIGH coincident with a trigger transition, the circuit will respond to the trigger.

7. CAPACITOR LEAKAGE — For recommendations on electrolytic capacitors and larger values of R_X, please see the 9600 data sheet.

96L02 PULSE WIDTH vs R_X AND C_X

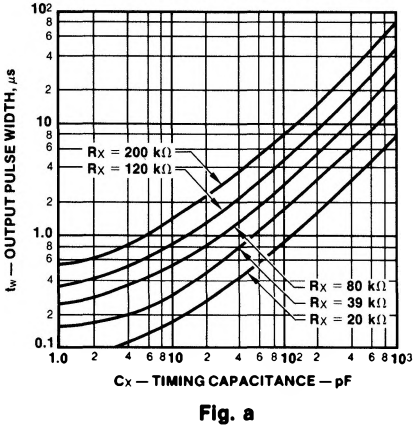


Fig. a

9602 PULSE WIDTH vs R_X AND C_X

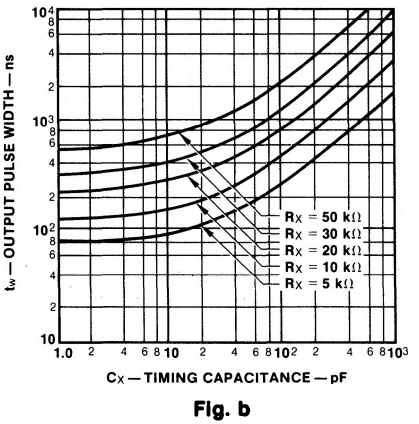
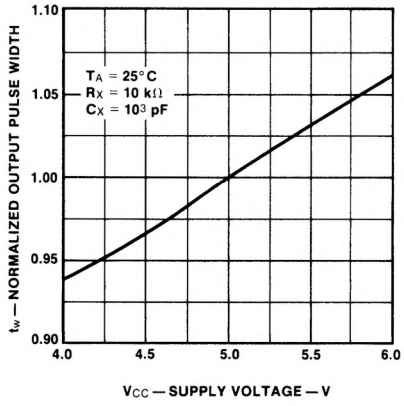


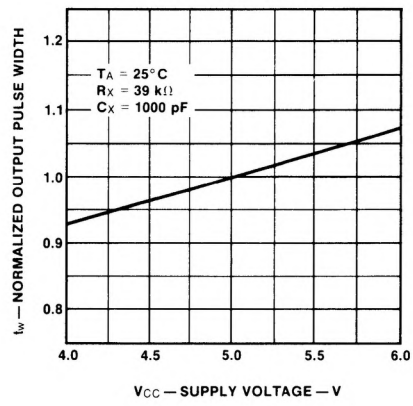
Fig. b

TYPICAL CHARACTERISTICS

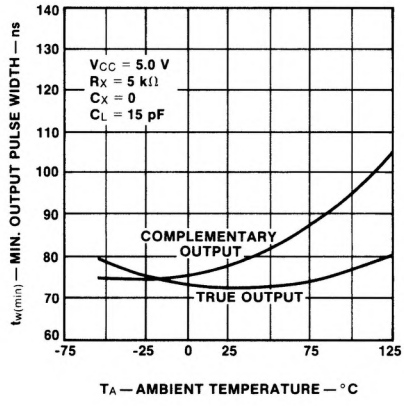
9602 t_W vs V_{CC}



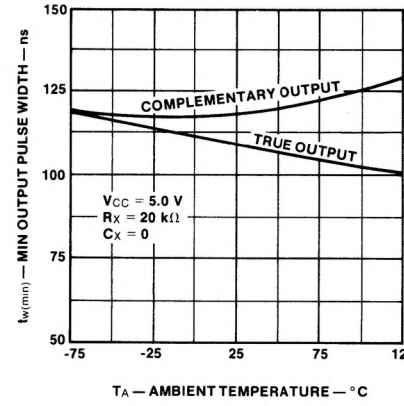
96L02 t_W vs V_{CC}



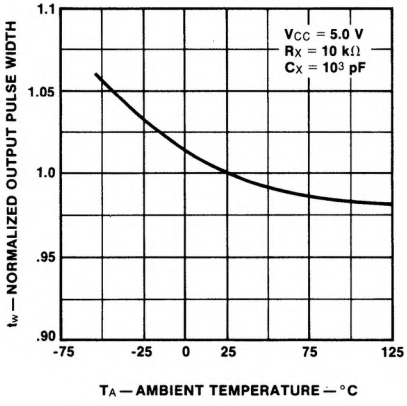
9602 $t_{W(min)}$ vs T_A



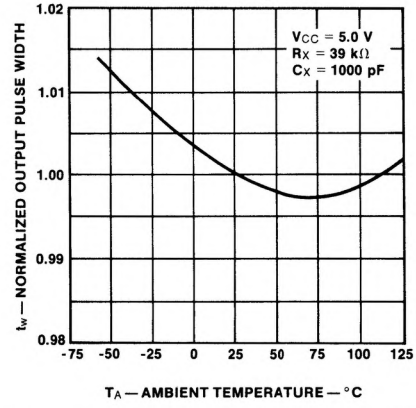
96L02 $t_{W(min)}$ vs T_A



9602 t_W vs T_A



96L02 t_W vs T_A



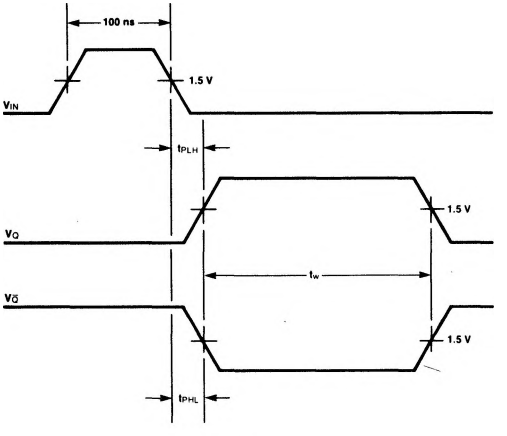
DC AND AC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (unless otherwise specified)

SYMBOL	PARAMETER		96XX Min	96XX Max	UNITS	CONDITIONS
V_{OH}	Output HIGH Voltage		12.4		V	V_{CC} = Min, I_{OH} = -9.6 mA
V_{OL}	Output LOW Voltage	XM		0.4	V	V_{CC} = 4.5 V, I_{OL} = 9.92 mA
						V_{CC} = 5.5 V, I_{OL} = 12.8 mA
		XC		0.45	V	V_{CC} = 4.75 V, I_{OL} = 11.3 mA
						V_{CC} = 5.25 V, I_{OL} = 12.8 mA
V_{IH}	Input HIGH Voltage	XM	2.0		V	Guaranteed Input HIGH Threshold
		XC	1.9			
V_{IL}	Input LOW Voltage			0.85	V	Guaranteed Input LOW Threshold
I_{IL}	Input LOW Current			-1.6	mA	V_{CC} = Max, V_{IN} = V_{OL}
I_{IL}	Input LOW Current	XM		-1.24	mA	V_{CC} = Min, V_{IN} = V_{OL}
		XC		-1.14		
I_{IH}	Input HIGH Current			60	μA	V_{CC} = Max, V_{IN} = 4.5 V
I_{OS}	Output Short Circuit Current	XM		-25	mA	V_{CC} = Max, V_{OUT} = 1.0 V
		XC		-35		
I_{CC}	Power Supply Current	XM		45	mA	V_{CC} = 5.0 V
		XC		52		
t_{PLH}	Propagation Delay $\overline{I_0}$ to Q	XM		35	ns	R_X = 5 kΩ, C_X = 0 C_L = 15 pF, Fig. c
		XC		40		
t_{PHL}	Propagation Delay $\overline{I_0}$ to $\overline{Q}$	XM		43	ns	R_X = 5 kΩ, C_X = 0 C_L = 15 pF, Fig. c
		XC		48		
t_w (min)	Minimum Output Pulse Width at Q	XM		90	ns	R_X = 5 kΩ, C_X = 0 C_L = 15 pF, Fig. c
		XC		100		
	Minimum Output Pulse Width at $\overline{Q}$	XM		100		
		XC		110		
t_w	Output Pulse Width		3.08	3.76	μs	R_X = 10 kΩ C_X = 1000 pF, Fig. c
C_{STRAY}	Maximum Stray Capacitance from Pin 2 (14) to Gnd			50	pF	
R_X	Timing Resistor Range	XM	5.0	25	kΩ	
		XC	5.0	50		

DC AND AC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (unless otherwise specified)

SYMBOL	PARAMETER		96L Min	96L Max	UNITS	CONDITIONS
V_{OH}	Output HIGH Voltage		2.4		V	V_{CC} = Min, I_{OH} = -0.36 mA
V_{OL}	Output LOW Voltage			0.3	V	V_{CC} = Min, I_{OL} = 4.8 mA
V_{IH}	Input HIGH Voltage		2.0		V	Guaranteed Input HIGH Threshold
V_{IL}	Input LOW Voltage			0.7	V	Guaranteed Input LOW Threshold
I_{IH}	Input HIGH Current			20 1.0	μA mA	V_{IN} = 2.4 V V_{IN} = 5.5 V V_{CC} = Max
I_{IL}	Input LOW Current			-0.4	mA	V_{CC} = Max, V_{IN} = 0.3 V
I_{OS}	Output Short Circuit Current		-2.0	-13	mA	V_{CC} = Max, V_{OUT} = 1.0 V
I_{CC}	Power Supply Current			16	mA	V_{CC} = Max
t_{PLH}	Propagation Delay $\overline{I_0}$ to Q	XM XC		75 80	ns	V_{CC} = 5.0 V, R_X = 20 kΩ C_X = 0, C_L = 15 pF T_A = 25°C
t_{PHL}	Propagation Delay $\overline{I_0}$ to $\overline{Q}$	XM XC		62 65	ns	V_{CC} = 5.0 V, R_X = 20 kΩ C_X = 0, C_L = 15 pF T_A = 25°C
t_w (min)	Minimum Output Pulse Width at Q		110*		ns	V_{CC} = 5.0 V, R_X = 20 kΩ C_X = 0, C_L = 15 pF T_A = 25°C
t_w	Output Pulse Width		12.4	15.2	μs	V_{CC} = 5.0 V, R_X = 39 kΩ C_X = 1000 pF, T_A = 25°C
Δt	Change in Q Pulse Width Over Temperature	XC		1.6	%	R_X = 39 kΩ, C_X = 1000 pF
R_X	Timing Resistor Range	XM XC		100 220	kΩ	

*Typical Value



INPUT PULSE
f ≈ 25 kHz
Amp ≈ 3.0 V
Width ≈ 100 ns
$t_r = t_f \leq 10$ ns

Fig. c