PULSE DURATION COUNTER

Measures positive- or negative-going pulses independent of repetition rate

By Roy Hartkopf

FREQUENCY counters are ideal for measuring the *number* of pulses per unit of time contained in a given signal. However, there are occasions when the *duration* of a pulse must be measured—something a standard frequency counter can't do.

Timers often require that a pulse be of fairly precise duration, with the duration independent of the repetition rate. If, in fact, the pulse in question is triggered on when some other event takes place, the repetition rate may appear to be random. For reasonable repetition rates and reasonably narrow pulses, an oscilloscope can be used. Random timing and long pulse duration require the use of an expensive storage scope.

The low-cost Pulse Duration Counter described in this article will measure pulse *duration* from microseconds to seconds accurately to three digits. It can measure either positive- or negative-going pulses and is completely independent of the repetition rate of the pulses.

In essence, an incoming pulse opens a gate that allows a crystal-controlled frequency to be incremented on a counter and displayed on three 7-segment LED displays. When the pulse stops, the gate closes and the count remains on the readout until it is reset.

Circuit Operation. As shown in Fig. 1, the pulse to be measured is applied via *J1* to *Q1* with diodes *D1* and *D2* in conjunction with *R1* limiting the signal swing. Because of this protection, the circuit will accept signals with maximum amplitude of 50 volts. The trigger level is dependent on the *Q1* gain, and is typically about 2.5 volts. The output of *Q1* is applied to the combination of *IC1C, IC1D, R3* and *D3,* which form a Schmitt-like trigger circuit to produce a clean negative- and positive-going pulse selected by *S2.* The selected pulse drives flip-flops *IC3A* and *IC3B* via gate *IC2B.*

The Q outputs of *IC3A* and *IC3B,* along with the pulse selected by *S2* and the crystal-controlled time base signal, are used as the four inputs to *IC2A.* Each time the output of *IC2A* (pin 6) goes high, it increments the count in the three-digit counter formed by *DIS1, DIS2,* and *DIS3.* These particular devices include a counter, decoder, driver, and seven-segment display all in one package. The first two input pulses from *J1* set up the correct flip-flop conditions to gate *IC2A,* while the third input pulse is the one that is measured.

The time base consists of a 10-MHz crystal-controlled oscillator formed by *IC1A* and *IC1B* and their associated components. This oscillator drives a series of decade counters formed by *IC5* through *IC8* to deliver pulses at 1 and 10 microseconds, and 0.1 and 1 millisecond, selectable via *S3.* The selected clock signal is fed to *IC2A.*

Thus as long as *IC2A* is properly driven, the readouts will continue to increment for the duration of the pulse present at input connector, *J1.* When the input pulse ends, *IC2A* is disabled, the count to the display stops, and they remain in their last state until the RESET pushbutton is depressed. The duration of the input pulse can be read off the displays as microseconds or milliseconds as indicated by *S3.*

The latches formed by *IC4A, IC4B,* and the RESET pushbutton *(S1),* along with *IC4C, IC4D* and *Q2,* are used to reset the flip-flops and the displays. The circuit is arranged so that contact bounce will not produce false signals.

The power supply (not shown) can be any type that provides 5 volts at about 1 ampere.

Construction. The circuit can be assembled using point-to-point wiring or a pc board. For the latter, use the pattern shown in Fig. 2. The display foil pattern is shown in Fig. 3. The component layout for both boards is shown in Fig. 4.

If desired, the three displays *(DIS1* through *DIS3)* can be replaced by any decade counter/latch/driver/7-segment display combination.

Once the circuit has been built, it can be mounted, along with a power supply, in any suitable enclosure. The front panel should have a cutout large enough to accommodate the three LED displays, the polarity switch, and the time switch.

Operation. Set polarity switch *S2* for either "−" or "+," depending on the polarity of the pulse to be measured. Set the time range switch, *S3,* to some convenient value, and apply the pulse whose width is to be measured to connector *J1.*

PARTS LIST

- C1—100-pF disc capacitor
- C2—3-30-pF trimmer capacitor
- C3—0.001-µF disc capacitor
- C4 through C7—0.1-µF disc capacitor
- C8—220-µF, 10-V electrolytic
- DIS1 through DIS3—TIL307 numeric display
- D1 through D4—1N914
- IC1, IC4—7400 quad 2-input NAND
- IC2—7420 dual 4-input NAND
- IC3—7473 dual JK flip-flop
- IC5 through IC8—7490 decade counter
- J1—RCA phono connector
- Q1,Q2—2N3565 transistor
- R1,R6,R7—10-kilohm resistor
- R2—1.8-kilohm resistor
- R3—680-ohm resistor
- R4,R5—470-ohm resistor
- S1—Spdt press switch
- S2—Spdt toggle or slide switch
- S3—Single-pole, 4-position rotary switch
- Misc.—Suitable enclosure; 5-V, 1-A power supply; press-on type; etc.

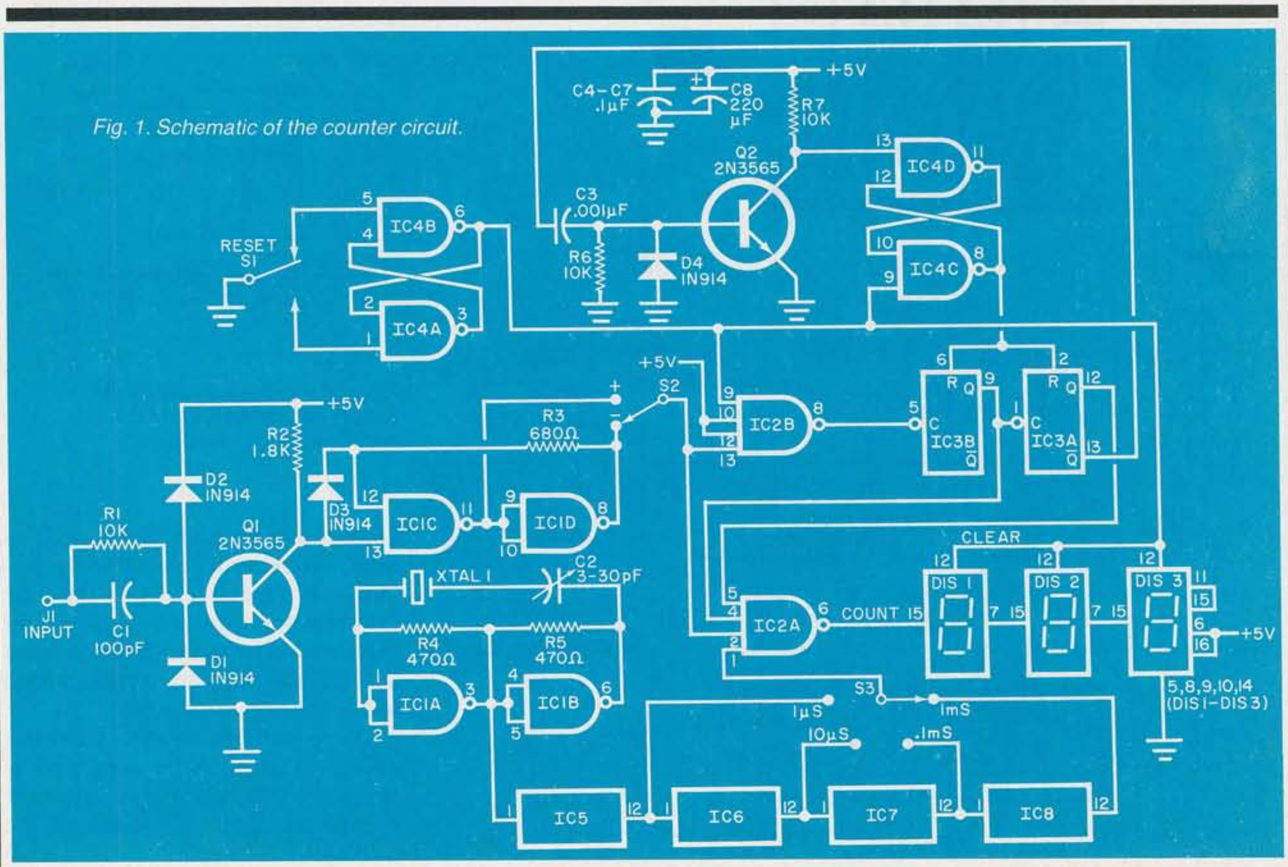


Fig. 1. Schematic of the counter circuit.

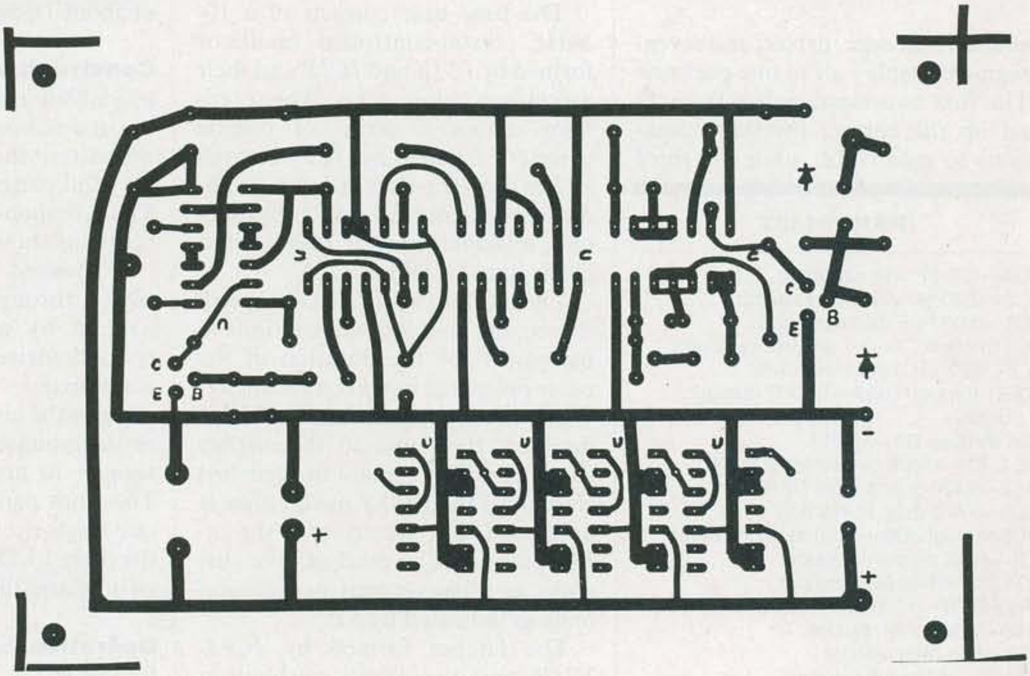


Fig. 2. Foil pattern for a pc board is shown above.

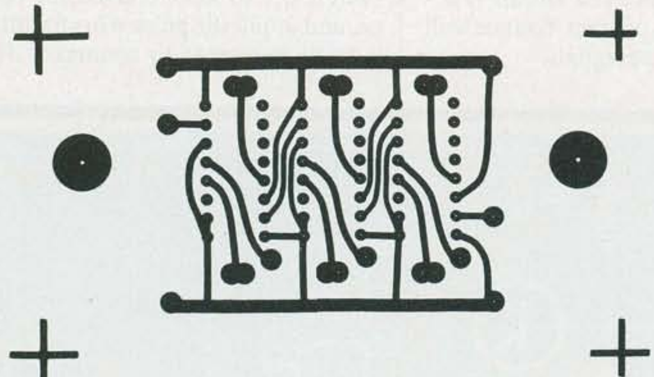
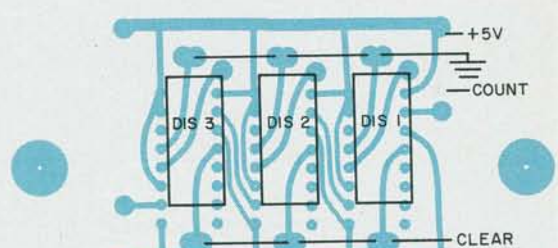


Fig. 3. Foil pattern at left is for display board.



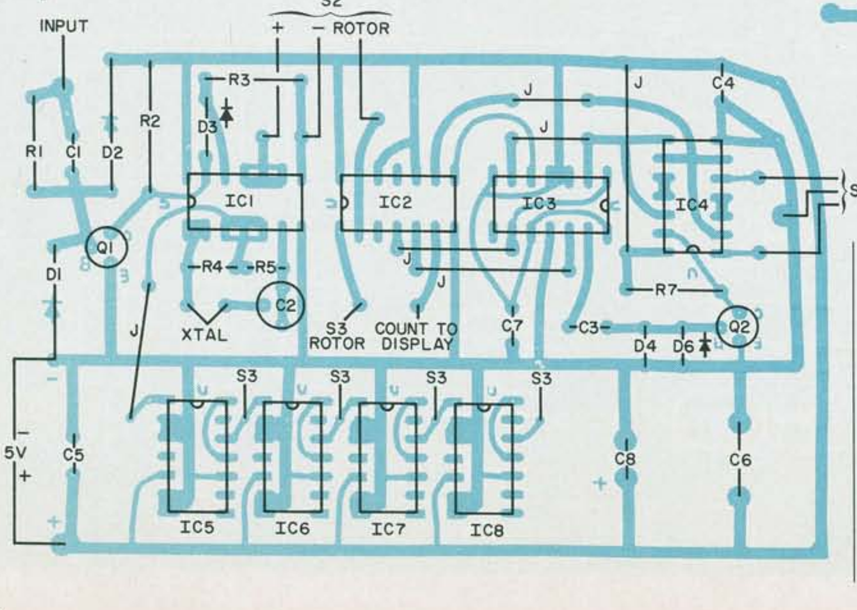


Fig. 4. Component layout for the display board (above) and the main counter pc board (left).

Once a display is shown, it will remain visible until the RESET pushbutton is depressed. Reset the time range switch until the display indicates within its range. Keep in mind that it is the third input pulse whose width is being measured.

It is possible to measure pulse durations to six digits by using a higher range on *S3* and shifting the most significant digits to the left of the display. ◊