PROJECT OF THE MONTH

A 000-to-999 Event Counter

By Forrest M. Mims

THE CIRCUIT in Fig. 1 functions as a simple 000-to-999 event counter. It can be used to count such events as rotations of a wheel or shaft, objects passing by a point, and even flashes of lightning. It can also be configured to count events whose amplitude exceeds a programmable threshold.

The key to the simplicity of this circuit is an MC14553B (or 4553) three-digit BCD counter, a CMOS LSI chip that typically consumes only about 0.02 μA (25° C) between counts. The 4553 includes a quad latch at the output of each of its three counters to provide storage of the current BCD count status. The outputs from the quad latches are steered to the chip's four BCD output pins by a time-division multiplexing arrangement.

Three digit-select outputs indicate which of the outputs of the counter latches has been steered to the BCD outputs. This provides a means for driving a three-digit multiplexed readout.

A high-to-low transition at the clock input (pin 12) of the 4553 advances the circuit one count. The BCD status of the count is converted into a seven-segment format by an MC14511B (or 4511) BCD-to-seven segment latch/decoder/driver. The 4511 can directly drive the segments of a common-cathode LED display at a maximum current of 25 mA. Like the 4553, it is a CMOS device with a very low quiescent current (about 0.01 μA at 25° C).

Digits of the three-digit LED readout are sequentially strobed by the three digit-select outputs (pins 2, 1 and 15) and transistors *Q1* through *Q3*. The strobe rate is controlled by an internal scan oscillator whose frequency is determined by *C1*. For special-purpose applications, the internal scan oscillator can be overridden by omitting *C1* and applying an external clock signal directly to pin 4.

Triggering the Counter. The counter circuit can be triggered by external logic signals or by a relay or magnetic reed switch. Buffering is generally not required since the 4553 provides an internal pulse-shaping stage at its clock input.

Figure 2A shows a simple phototransistor input stage you can connect to the counter to provide an optically triggered input. A light pulse of sufficient magnitude turns on *Q1*, which forces the clock input of the 4553 low and advances the count. With this input, the counter can be triggered by a flashlight, an infrared LED, a xenon strobe, or lightning.

To trigger the circuit by interrupting a continuous light source, as when counting objects such as people or cars, you can use Fig. 2B. Here the phototransistor is normally illuminated, thus keeping the clock input high. When the illuminator is interrupted, the phototransistor is turned off and the input to the 4553 is brought low, thus causing a count to occur.

In both modes of operation, lasers and collimated infrared-emitting diodes make excellent light sources. A low-power (e.g. 1-mW) helium-neon laser, for example, easily actuates the circuit over a range of tens of feet. Since their near-infrared emission more closely matches the peak spectral response of silicon phototransistors, collimated beams from GaAs, GaAs:Si, and AlGaAs LEDs and diode lasers can activate the circuit over longer ranges.

For more sensitivity, hence longer ranges, an op-amp gain stage can be inserted between the phototransistor and the 4553 clock input. In the count-when-interrupted mode, the circuit will register a count immediately when a continuous light falling on the phototransistor is blocked. In the count-when-flashed mode, the circuit will indicate a count at the *trailing* edge of a light flash.

Be sure direct sunlight does not strike the phototransistor or it may not work properly. If sunlight or bright ambient light is a problem, try a filter and a light shield. Reverse-biased PIN photodiodes such as the TIL413 (Radio Shack catalog number 276-144) are more immune to sunlight and can be used in place of the phototransistor. ◇

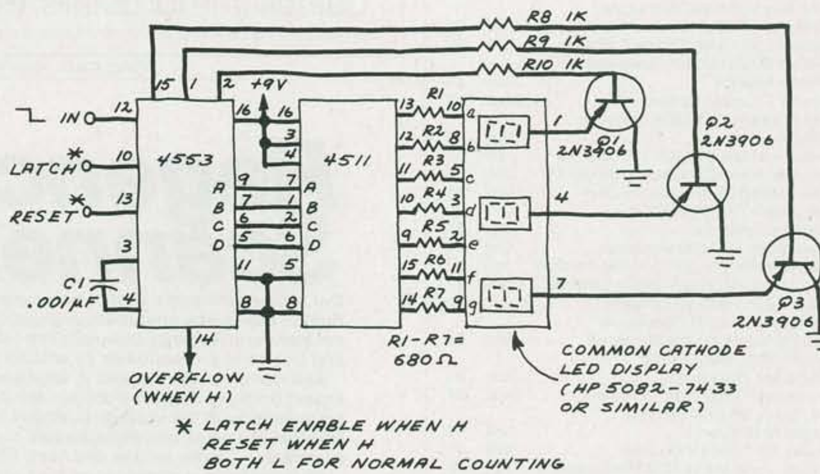

Fig. 1. Simplified block diagram of a 000-to-999 event counter.

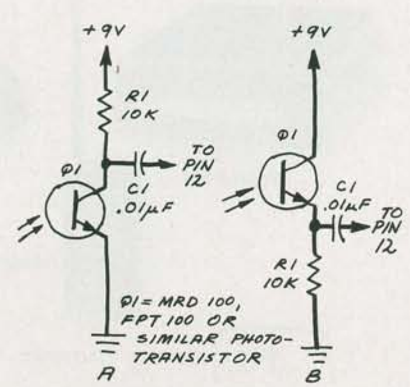

Fig. 2. Phototransistor inputs for 3-digit event counter.

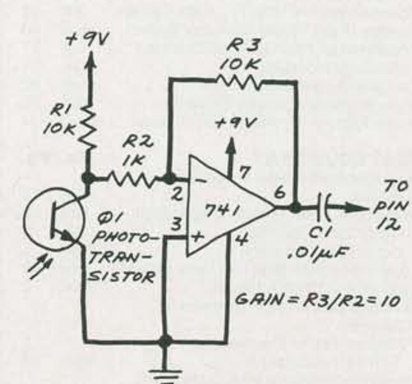

Fig. 3. Phototransistor gain stage for 3-digit event counter.