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LED Test Pulse Unit

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In my early photometer work test pulses were injected into the electronics to simulate a laser pulse signal. Later, an LED test signal of short duration was activated in the optical path to test the whole system. But, those tests were only grossly qualitative and did not simulate a laser signal in a way that was satisfactory for system sensitivity characterization. Since then, several versions of LED pulsers have been developed. The latest version comes closest to fulfilling the needs. The pulse length can be adjusted from 1 to 60 ns and pulse amplitude adjustable from singly detected photo-electrons to double and triple coincident pmt photoelectron pulse heights.

The pulser board is mounted inside the photometer with external adjustments for pulse width, amplitude, repetition rate and for a simulated stellar background with a dc stimulated LED.

Functional description: Power is applied via computer keyboard control. Referring to Figure 1, a crystal oscillator with two CD 4060 ripple counters produces selectable periodic pulses from 0.00019 Hz to to 2 Hz. The periodic pulses are fed to a set of nand gates arranged to produce an output pulse which top width is settable from 1 to 50 ns by the voltage applied to a varactor. The varactor was necessary to allow the pulse width to be set by an off-board potentiometer where lead length would otherwise be a limiting factor.

Following the gates, an emitter follower transistor provides the pulsed output to the LED. A second LED of the same type is mounted near the pulsed LED, and with DC applied, is used to simulate any settable stellar background level. That is, the two LEDs simulate a stellar background with a pulsed laser signal embedded in the total photon flux.

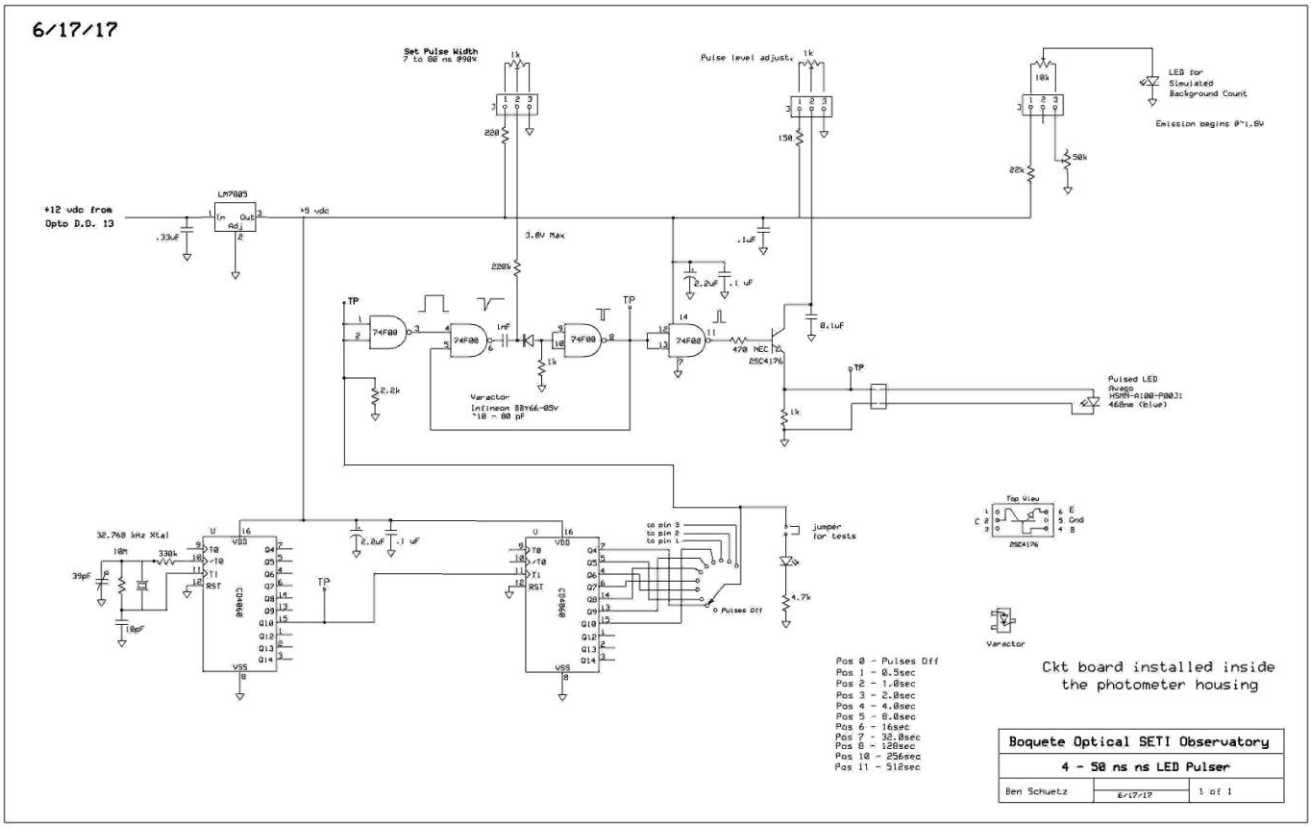

Figure 1.

The LED light output (photon flux) can be described as:

$$\Phi = \eta_{ex} I/e \quad \text{(photons/sec)}$$

Where:

η_{ex} (external quantum efficiency) is the product of the LED internal quantum efficiency and the package extraction efficiency. This may be less than 1 percent given the small amplitude applied currents and pulse brevity.

I is the input current,
e is the electron charge.

After pulse emission, and before the light reaches the photomultiplier, there are at least two reflections off of flat black surfaces followed by passage through a small aperture. With the combined effects of low surface reflectance, angular dispersion, a 0.01" diameter pmt aperture plate and the pmt window surface reflection the number of photons reaching the pmt photocathode is very small. For example, it has become routine to adjust the LED energizing pulse parameters for single height (non-coincident photons) and one to five pmt photoelectron output pulses during a 30 ns LED pulse. With an increase in LED energizing pulse amplitude, coincident photons can be generated and detected.

Recent advancements in the periodicity detection method of long period signals, i.e., <1 pulse per 100 seconds, required the addition of a crystal oscillator to minimize signal timing drift.

Given the unknowable features of an actual laser signal from ETI, every photon is a precious commodity. For small telescope apertures, it is especially important to optimize the entire system's sensitivity for the best chance of success. That optimization would not have been possible without this test pulse device.