Sandia Light Pulse Simulator

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Goal

The purpose of the project is to create a system to simulate a light pulse of a certain wavelength and duration. Since the project is replacing an outdated design, it must fit within the same dimensions.

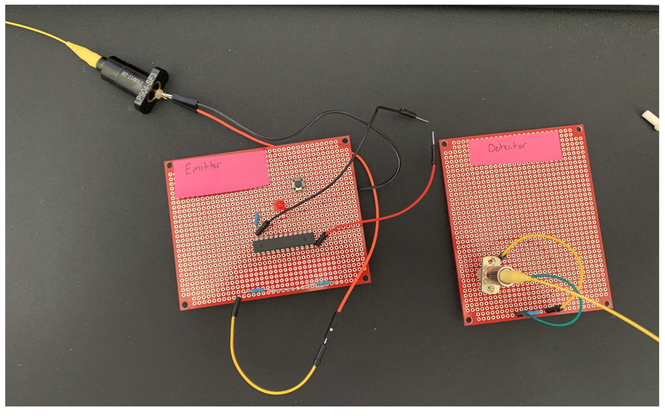
Background

The Air Delivered Tester Development Department builds test equipment for a variety of Department of Energy devices. The goal of this project is to develop new testing equipment that can represent a part that would ordinarily be destroyed in a test, and is expensive to produce. While there is currently a simulator that fulfills the purpose, the simulator is outdated, and parts to construct it are becoming obsolete and difficult to come by.

Project Objectives

- Emit a light pulse with a wavelength of 904nm, with an allowable deviation of +/- 2%.
- The light pulse shall have an adjustable duration between 1-10us.
- The time between the trigger signal being sent and the light pulse being detected shall be no greater than 0.1us.
- Each system shall fit within a 4”x4”x2” sized box.
- Each system shall weigh no more than 1lb.
- The simulator shall be triggered by a rising pulse.

Prototype

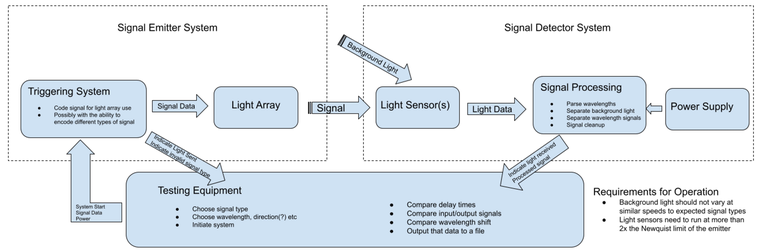


Overview of Design

The system is divided into two parts. One, which will emit the signal of a certain duration and wavelength, and a second, which will receive the light signal and output an analog signal to the testing equipment.

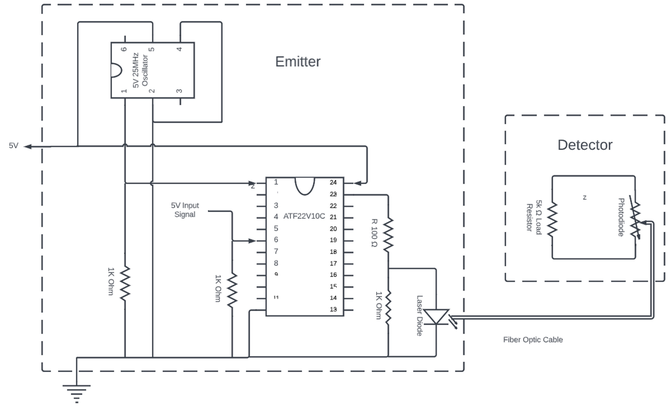
The emitter system will be composed of two main components, the triggering and timing system, and the light array which will output the light pulse.

The detector system will be composed of two components as well, the light sensing system, and the system that processes the signal that is output into the analog signal of correct magnitude.



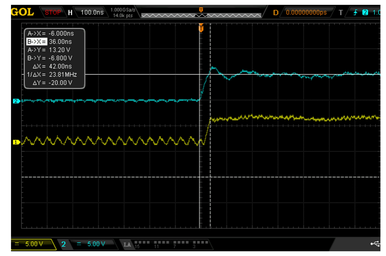
Technical Design

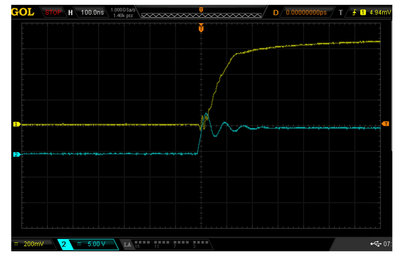
For the technical design of the system, the following parts were chosen to accomplish the goals and previous design. The ATF22V10C was chosen to be the triggering system and timing system for it’s fast maximum clock timing. A laser diode was selected that emitted the desired wavelength of 904 nm, had the fastest response time, and was already coupled with a fiber-optic cable. In addition, the laser diode had a recommended photodiode from the manufacturer. Below is a circuit diagram showing all included parts



Status

The cost of the prototype is extremely under-budget, with $5,500 allotted, $1,275.45 used over the course of prototyping, and with a prototype that costs a total of $847.42. While the system does output a 2.2us pulse when given a rising edge trigger, which is well within the specifications, the smallest delay achieved was 0.25us, which is significantly greater than the required delay of 0.1us. However, there are ways to improve this that will be implemented in the future, such as biasing the photodiode. The systems are well within specifications for size and weight.





Two waveforms, the one on the left shows the pulse delay caused by the timing circuit, where the blue line is the trigger signal, and the yellow line is the output of the timing circuit. The waveform on the right shows the pulse delay caused by the light system.

Requirement Verification

Wavelength of 904nm	Wavelength guaranteed by manufacturer
Pulse duration between 1-10us	Average pulse duration: 2.2us
Delay no greater than 0.1us	Did not meet requirement, approximately 0.25us delay achieved
Triggered by a rising pulse	Rising pulse begins a 50% duty cycle pulse train
Fit within a 4”x4”x2” sized box each	Chosen protoboards are 3”x4”, and no parts have more than 0.5” height.

Conclusion

While the system does emit a pulse train of the required specifications, there is an unfortunately large delay between the trigger signal and the pulse being received by the photodiode. With a voltage bias on the photodiode, it is expected to be able to meet the timing requirements.

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