Application of an Automotive Relay as Optical Beam Shutter

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Abstract— **Laser beam modulation is often required in many applications. Continuous wave (cw) gas lasers can be modulated only with devices external to the resonant laser cavity. Beam modulation can be achieved with several types of instruments like rotating wheel choppers, rotating blade shutters and electromagnetically actuated iris. In this work, an automotive relay model DNI0102 was modified to operate as an optical beam shutter. The electrical and optical characterization of the modified device are presented. The intrinsic resistance and inductance of the relay coil was measured as 80Ω and $117.1mH$, respectively. The switching time obtained with the use of a $0.65mm$ helium-neon gas laser beam was approx. $250\mu s$. In conclusion, the built device showed a fast switching speed that fits the demands of mostly experimental applications.**

Keywords— **Optical Beam Shutter, Automotive Relay, Laser Optical Modulation, Biomedical engineering.**

I. Introduction

Photodynamic Therapy (PDT) is an effective modality for cancer treatment and diseases of bacterial, fungal or even viral origins. Photosensitization occurs through the interaction between a nontoxic photosensitizer and visible light at the wavelength of absorption of the photosensitizing agent. In the presence of oxygen, the interaction generates cytotoxic substances that cause oxidative damage to targeted cells. Nowadays, laser is a major source of light applied to activate photosensitizers in PDT treatments and experiments [1, 2, 3, 4], as well as to investigate the photophysical and photochemical molecular properties of photosensitizers.

Laser stands for light amplification by stimulated emission of radiation. It means intensified light generated by the stimulation of a material inside a chamber, emitting energy in a continuous or pulsed way. There are different types of lasers (solid state lasers, liquid lasers, gas lasers and, semiconductor lasers) [5, 6]. Some of these types of lasers can be pulsed by intracavity devices, while others can be pulsed only by using extracavity devices. Semiconductor lasers have a major advantage of allowing modulation by electronically controlling the external current.

Gas lasers, in which the pumping mechanism is generally an electrical discharge in a gas filled tube, have a simpler design if compared to other types, finding a lot of use in medicine. Usually can be modulated only with the use of devices external to the cavity, which in simple words, modulate the gas laser beam periodically blocking or letting it pass [7].

Commercial electromechanical devices, known as optical beam shutters and choppers, fulfill this mission, allowing their users to interrupt or release a beam by inserting or removing an absorbing/reflecting actuator, frequently a blade or a rotating disc. These apparatuses are able to grant switching times of the order of $1-50ms$ for shutters and under $1ms$ for choppers. Many laser experiments requires fast switching, but commercial devices are expensive [8, 9].

A relay is an electrically operated switch, commonly actuated by an electromagnet, ensuring complete electrical isolation between a primary driver circuit and a secondary (controlled circuit) [10]. The primary circuit provides the control signal to operate the relay, typically connected to a low voltage DC supplier. It consists in an electromagnetic coil which generates a magnetic field due to current passing through the wire. At the end of the coil, there is a pivoted arm containing a switch contact, which will be attracted or repelled (returning to the original position) by the magnet field action. The secondary circuit is connected to the load which needs to be switched [11]. The relay is very useful when there is a need to control a high current circuit using a low power signal (low current) or when the electrical potential from the secondary to the primary is relatively large. In addition, the relay permits the control of several secondary circuits with a single primary circuit.

Electromagnetic relays have a large array of applications, from basic mass-produced products to specialized and critical system components [12]. In particular, automotive relays find use in the control of the ignitions wires, headlights, horns and ought to handle currents up to 30-40A [13].

The present work investigates the application of the DNI0102 automotive relay as a low-cost alternative optical beam shutter for gas laser-based photosensitizers molec-