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System Modulation of Control in Laser Diode Amplitude for Multiple wavelengths with Photothermal Applications

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Abstract: This paper presents the development of both software and hardware to control the modulation in amplitude of different laser diodes whose wavelengths vary according to the detection of the type of substance which is required to identify, all this thanks to a thermal lens experiment for spectroscopic detection of contaminating species. The hardware design focuses on a laser diode whose wavelength is 532 nm y power of 10 mW, although it is important to consider that the design of the electronic card, which is presented in this research work, It has the ability to adjust to the excitation current of any laser diode. Allowing flexibility for a specific application required.

Keywords:- Power Control, Wavelength , Diode Laser, Interface.

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I. INTRODUCTION

The photothermal techniques allow analyzing various transport phenomena of temperature, charge and mass. Can be analyzed vibrations in solids, liquids and gases. Moreover they are useful in the study of photochemical reactions and phase transitions. Another major advantage of photothermal techniques is that this phenomenon can be detected in many different ways. Depending on the detection system, the name given to the technique. When we use microphones or piezoelectric talk about photoacoustic techniques , if we use pyroelectric detectors we mean photopyroelectric techniques , when using beam test for sensing the temperature through the change of local refractive index, we have the mirage effect , temperature thermoreflective and the thermal lens. One of the most promising methods is using remote sensing and is known as infrared photothermal radiometry.

The infrared radiometry allows studying the optical and thermal properties of the materials, without requiring contact with the samples and in principle any sanding or polishing treatment for the samples is not necessary. In the infrared radiometry is incident light beam on a material, this as consequently emits infrared radiation and is recorded by an infrared detector, suited to the emitted wavelength. There are basically two experimental configurations known transmission and reflection. Also you can work in two ways using pulsed or modulated radiation. Using these techniques, involves among other things, the modulation of a radiation source to which the sample is exposed for its characterization [1]. In most cases is chosen powerful lamps which are modulated by external devices. This set provides a more robust experiment, besides the price increase.

Finding sources of modulated radiation involving a lower cost and also remain practical is the aim of this work. A laser diode with an appropriate modulation may be a viable substitute for such sources. It will use a TTL signal, which will be generated by a PIC16F876 microcontroller medium scale. Making use of a driver enabling positive Laser Diode modulation to obtain the desired modulation results in a wide range of frequencies from its feed stream. It is important to note that this project is part of another system which is responsible for collecting the information through a photoacoustic chamber, which will be built-in microphone for obtaining data [2]. Later, this information will be amplified by a lock-in amplifiers, whose function is to amplify signals of very low amplitude, so that through a Graphical User Interface (GUI) will be displayed below the graphs (Amplitude vs Frequency and Phase vs Frequency) of the material response to the heat emitted by the beam of the Laser Diode. At the same time, we have other microcontroller ATMEGA8535 for controlled the power each diodo laser with different wavelength.

II. DESIGN AND ANALYSIS OF PROTOTYPE

Design and construction Electronic Prototype was developed according to the following parameters; 1. Power Laser Diode 2. Operating Temperature. 3. Wavelength. 4. Operating current. 5. Operating Voltage. In our case we chose the laser diode DJ532-10, but it is important to mention that we can use other laser diodes, under this prototype design.

In the Figure 1 we presented the System Control of Modulation.

Figure 1. System Control of Modulation.

One of the most important for controlling excitation laser characteristics is the current, in this case the diode reaches its operating area to 157mA. This is because depending of the electrical characteristics of laser photodiode, and as the design of the differential pair with bipolar transistors 2N2222A was developed the following analysis; First we have the current "If" flowing through the photodiode is increased if the transmission power of the laser diode is increased in the case of the first output voltage operational. U1:A

(TL062) depends by the current "If" flowing through the photodiode and the feedback resistance, display the Equation 1:

$$Vsal = -RI_f \qquad (1)$$

If R would have to be very large output voltage would be given by Equation 2:

$$V_{sal} = -\left[R_1\left(1+\frac{R_2}{R_3}\right)+R_2\right]I_f \qquad (2)$$

We presented all equations for design of Pair Differentiated of Transistors;

For emitter current one has to;

$$I_{E1} = I_{B1} + I_{C1}$$

$$We\ know: I_{C1} = \beta I_{B1}$$

$$= I_{B1} + \beta I_{B1}$$

$$I_{E1} = (1+\beta) I_{B1} \qquad (3)$$

Where in the term β Beta is the Transistor 2N2222A.

$$-V_{B1} + R_{B1} I_{B1} + V_{BE} + R_{E1} I_{E1} = 0 \qquad (4)$$

Whereas in equation 3, the emitter current I_{E1} is defined in terms of the base current I_{B1} and manifold I_{C1} , And substitute this we have Equation 4 that the current of the base I_{B1} of the first transistor is defined as shown in Equation 5.

$$I_{B1} = \frac{V_{B1} - V_{BE}}{R_{B1} + R_{E1}(\beta + 1)} \qquad (5)$$

Given that the Base Resistance R_{B1} is unknown, we can substitute in equation 5, being expressed R_{B1} terms as shown in Equation 6, substituting the values in each term of Equation 6.

$$R_{B1} = \frac{5V - 0.7V - (201)(\frac{100mA}{200})(18\Omega)}{\frac{100mA}{200}} = \frac{2.491V}{0.5mA} = 4.982K\Omega \approx 4.7K\Omega \tag{6}$$

Current base *B* 1 *I* is expressed by beta, and the collector current *C* 1 *I* as indicated in Equation 7.

$$I_{B1} = \frac{I_{C1}}{\beta} = \frac{100\,mA}{200} \tag{7}$$

In the case of the second transistor, the equation representing the branch of the voltage drops is expressed as shown in Equation 8.

$$-V_{CC} + V_D + V_{CE} + R_{E1}I_{E1} = 0 \tag{8}$$

Of the design we can observe the symmetry in the trasnsistors set Q1 y Q2, also we have the same value of resistance in the emitter R_{E2} , from Equation 9.

$$R_{B2} = \frac{5V - 0.7V - (201)(\frac{57mA}{200})(18\Omega)}{\frac{57mA}{200}} = \frac{3.26V}{0.285mA} = 11.4K\Omega \approx 12K\Omega \tag{9}$$

Importantly, for the current I_{B2} is considered sufficient;

$$I_{B2} = \frac{I_{C2}}{\beta} = \frac{57\,mA}{200} = 0.285\,mA \tag{10}$$

III. OBTAINED AND EXPECTED RESULTS

In Figure 2 the system is presented in amplitude modulation laser diodes for applications photothermals, also you can choose the oscillation frequency control for laser diodes, it is clear that in this article only the design and simulation of this is shown new phase of the project is to control excitation of a laser diode to regulate the optical intensity of this to be used in photothermal techniques in specific use with a photothermal microscope [3].

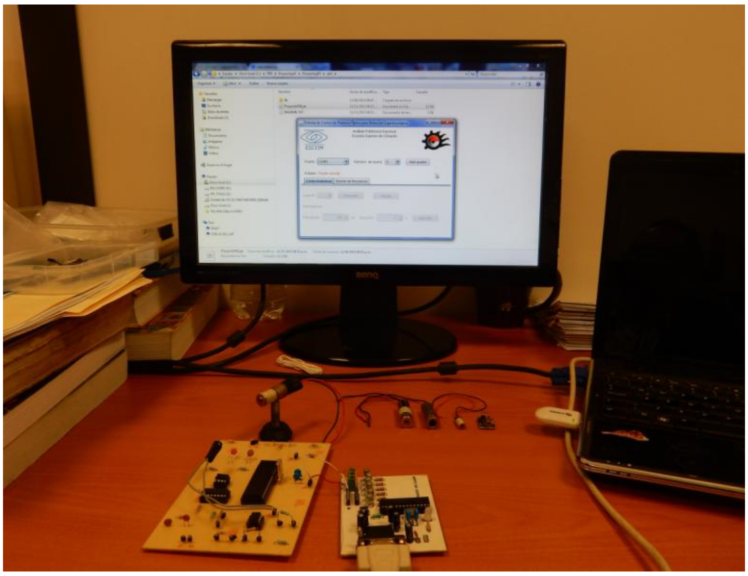

Figure 2. System is presented in amplitude modulation laser diodes for applications photothermals.

The figure 3 shows the flow diagram of the software;

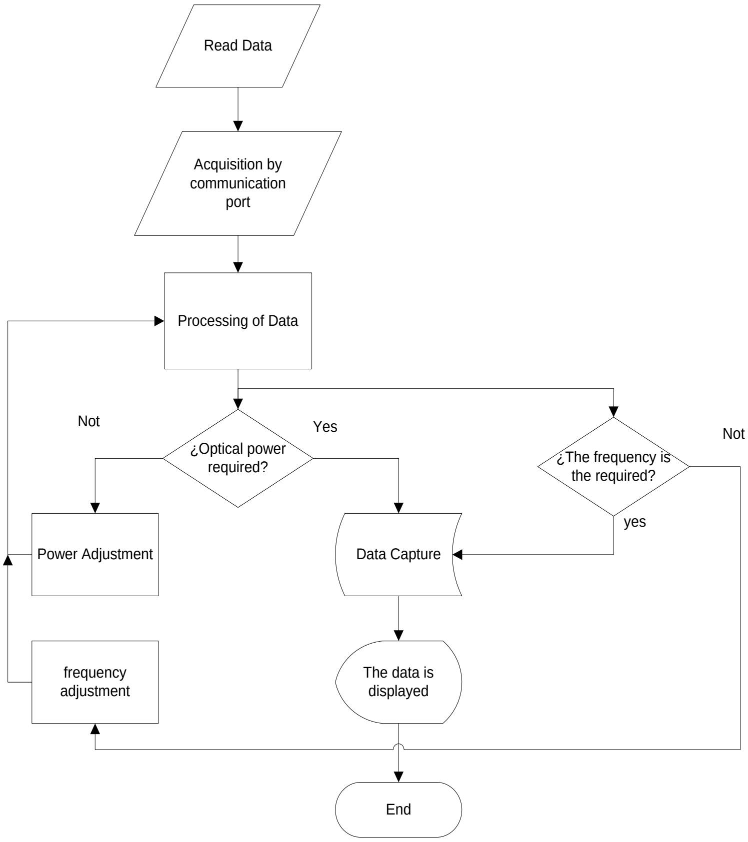

Figure 3. Flow Diagram of the software for control modulation of diode láser.

Finally the interface is presented in the figure 4.

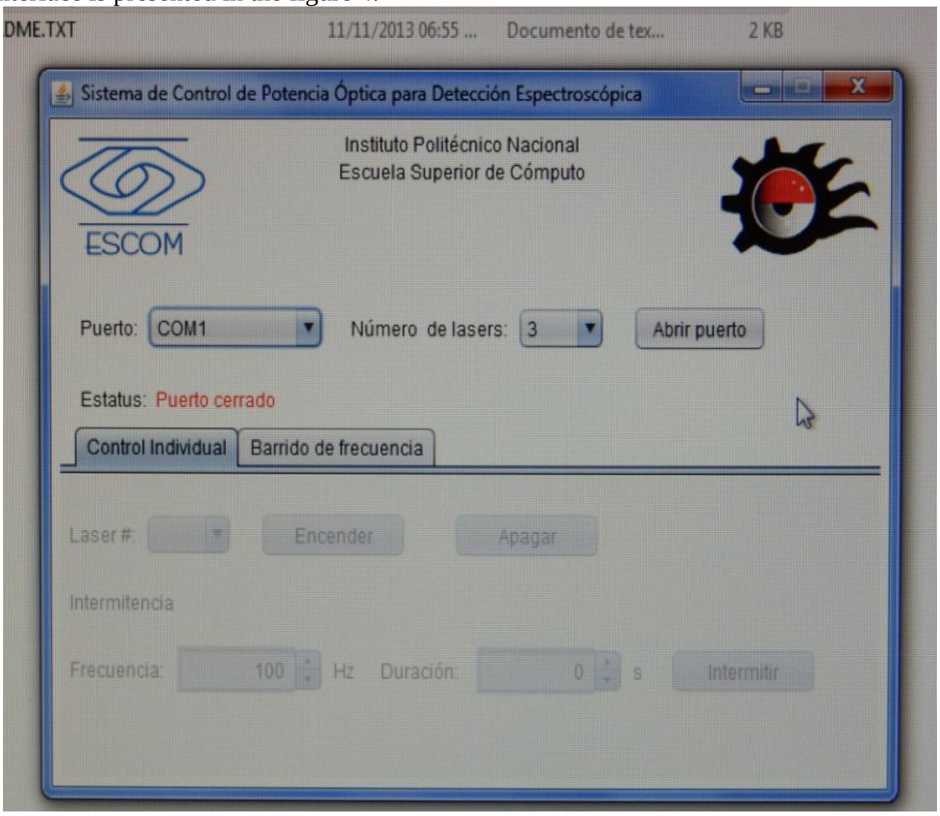

Figure 4. Friendly Interface.

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