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Laser Diodeexcitationsystem Controlled By Software For Photothermal Applications

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SUMMARY: This article presents the development of an excitation diode laser system, the system is composed of software and hardware. The purpose of this system is to control the excitation of laser diode whose wavelength is 532 nm. The selection of this diode laser wavelength is because on previously developed works, we can obtain results in the amplitude and frequency phase. Based on the results obtained and considering the stability of the laser diode to the amplitude modulation of this, the analysis and electronic was designed to obtain the control of a response optical intensity. With this we want to propose that this actual article don’t need owner software dependency to control the system, you can use free software to develop any type of systems.

Abstract: In this paper we present the development of own laser diode excitation system. This system is compose by software and hardware. The purpose of this system is to excitation- control of laser diode with 532nm of wavelength. The selection of this diode laser is because we worked on previous investigations related with amplitude and frequency phase function. With this we starting to obtain results, considering the stability of laser diode for the amplitude modulation. We presents the analysis and electronic design to monitoring the responses of optical intensity. With this paper we want to emphasize that is NOT necessary to user the owner software to control the system, you can use a free software to develop a custom systems.

Keywords: *Control, Laser Diode, Electronic, photothermal, Power, Software.*

I. INTRODUCTION

The photoacoustic effect is based on the technique and is part of a set of experimental technique sknown as photothermal. In this case the light energy is impinged on a periodically form on the material to be studied which it could be solid, liquid or gas, some of this energy is absorbed and converted into heat as shown in Figure 1.

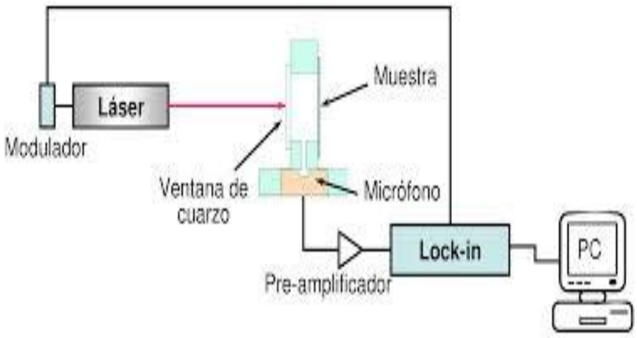


Figure 1. Technical Photoacoustic

The material temperature varies with the same frequency that makes the incident radiation, inducing changes in the parameters of the material and / or the environment in which it is located.

In Photoacoustic technique (Figure 1) the sample to be investigated is placed in a closed cell containing air or another gas. As a result of the modulated radiation absorption, the material is heated, the heat transmitted to a layer of hot gas periodically, expanding and contracting, and acting as a piston on the rest of the gas contained in the cell. An acoustic or pressure wave can be generated and detected with a microphone also positioned within the cell.

The photothermal techniques can be used to measure different properties of materials or for studying different physicochemical processes occurring in them [1]. The process of generating a photothermal signal consists of three basic steps: Absorption of light radiation, transformation of light energy into heat and diffusion of the heat generated by the sample.

Heat variations induced by the incidence of light emitted by the laser diode, commonly is use in photoacoustic techniques which uses a photoacoustic room where a microphone is incorporated for obtaining data.

And while the information is amplified by a Lock-in Amplifiers, whose function is to amplify signals of very low amplitude, such that through a Graphical User Interface (GUI) developed in a programming language owner such as LabView, will be displayed on the graphic display of amplitude and frequency phase function.

In this paper we present a composed hardware and software system designed to control the intensity of optical power of the laser diode, using as a free software developed in a language of object-oriented programming (Java Enterprise Edition) was mentioned.

It is important to clarify that the laser diode used has a maximum of 10mW optical power, which will be controlled using a pair differential configuration of transistors 2N2222A, although this action is possible using IC-HK circuit [2], which can be switched quickly and thereby control the voltage that makes the changes in power said diode, likewise is controlled by the current which excites the laser diode. But a disadvantage is the cost of this integrated so that the development of this work will be used the configuration of the differential pair of transistors.

I.I EXPERIMENTAL SETUP

The experimental setup is shown in Figure 2.

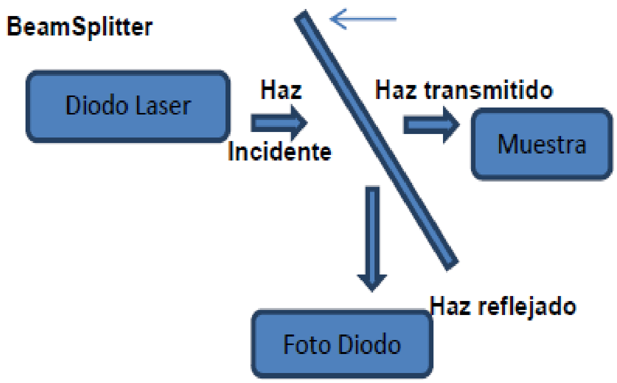


Figure 2. Experimental configuration using the Beam Splitter

Derived from the importance of photothermal analysis of phenomena, the main objective of this work focuses on controlling the excitation of the laser diode, and using the Beam splitter splitting the light beam is made to the photo diode and once the sample to be analyzed.
Although it could handle a second configuration only with the intention of measuring the optical intensity with which it is issuing the laser diode and this can be done by placing a second divider of beam after the first splitter (beam splitter), such that you may use a computer model and verify Newport optical intensity to get the relationship between voltage, current and optical power of the laser diode.

In Figure 3, a picture of the team with which you can make adjustments between optical power measurement and voltage control is shown.

Figure 3. Equipment for measuring optical power of Laser Diode.

It is important to note that there is the option of employing a configuration in said photodiode calibrated with the intention of measuring actual optical power.

In the next section the design and analysis of the system to control the optical power occurs.

II. SYSTEM DESIGN AND ANALYSIS.

In Figure 4 and 5 shows, the flowchart of the control system of PIC16F876 microcontroller.

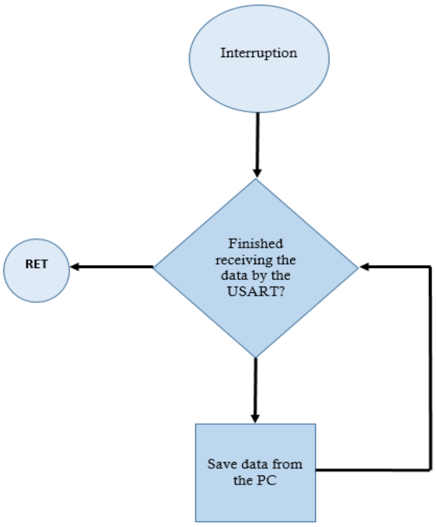


Figure 4. Program interruption

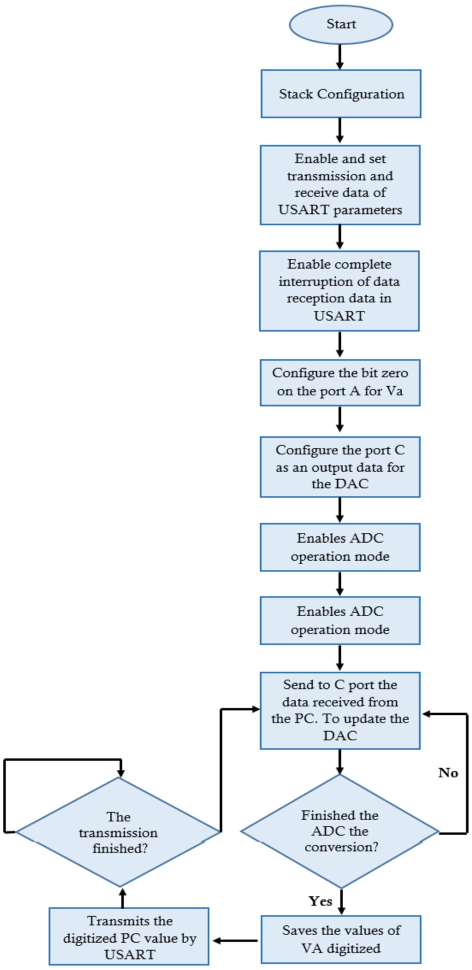


Figure 5. Partial diagram of the microcontroller interruption.

III. TESTS AND RESULTS OBTAINED

Among the results we obtained in Figure 6, the data acquired from the serial communication between the computer and the microcontroller, in this step of the tests must be configured according to the HyperTerminal protocol RS-232 communication; this is 8 data bits, 1 stop bit and one bit for parity, parity in the case was not necessary.

Should be mentioned that the acquired data representing the analog - digital conversion, voltage obtained from the operational amplifiers which configuration intends to convert the current flowing through the photodiode into a voltage.

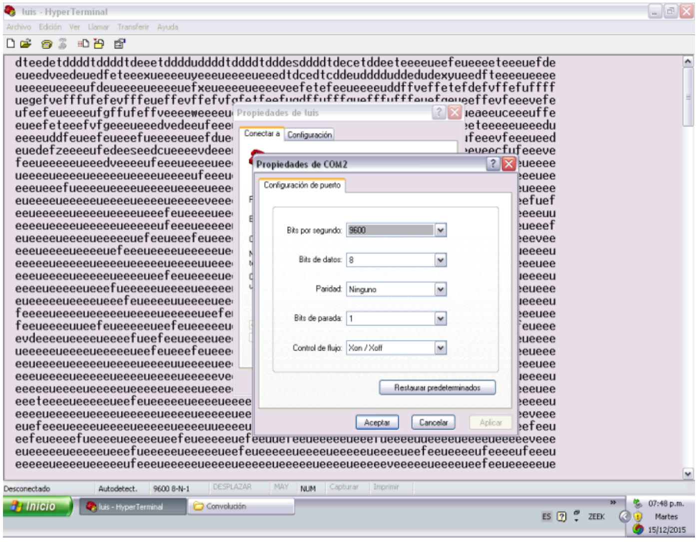


Figure 6. Configuring HyperTerminal for data acquisition

In Figure 7 shows the hardware implemented to control the actual Laser Diode optical power, whose wavelength is 532 nm. Note that in protoboard shows the half of this is placed where the atmega8535 microcontroller control system corresponds to the optical power, and to check the operation of the ADC of the microcontroller, were placed a set of LEDs.

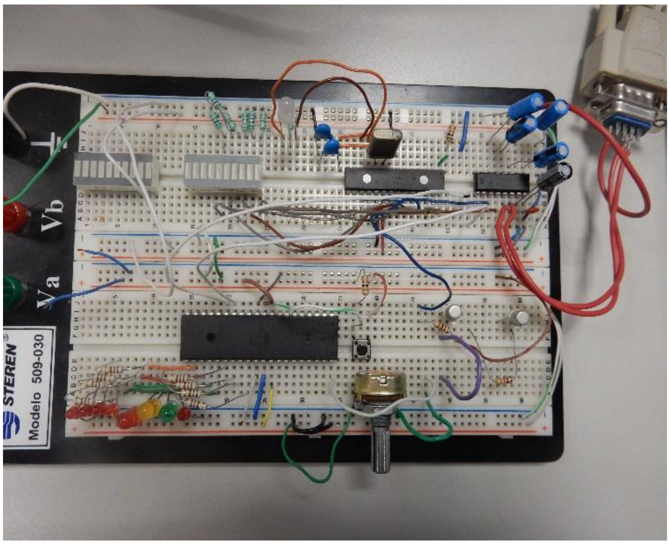


Figure 7. ATMEL Microcontroller for Control System

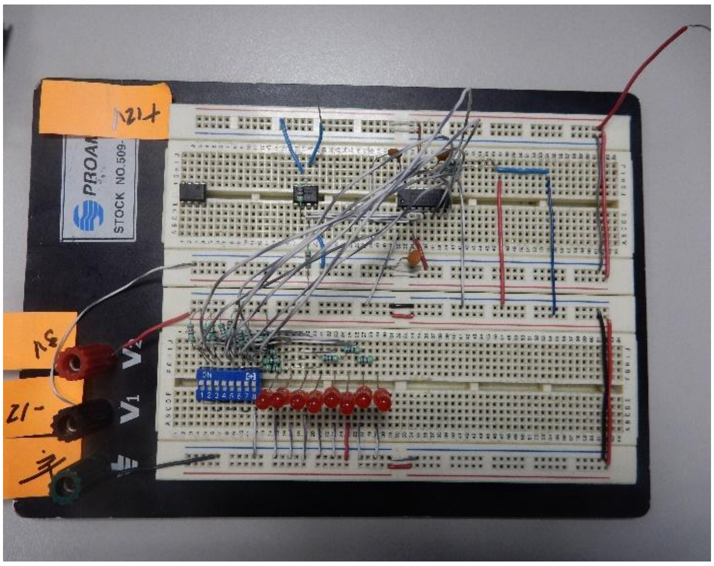
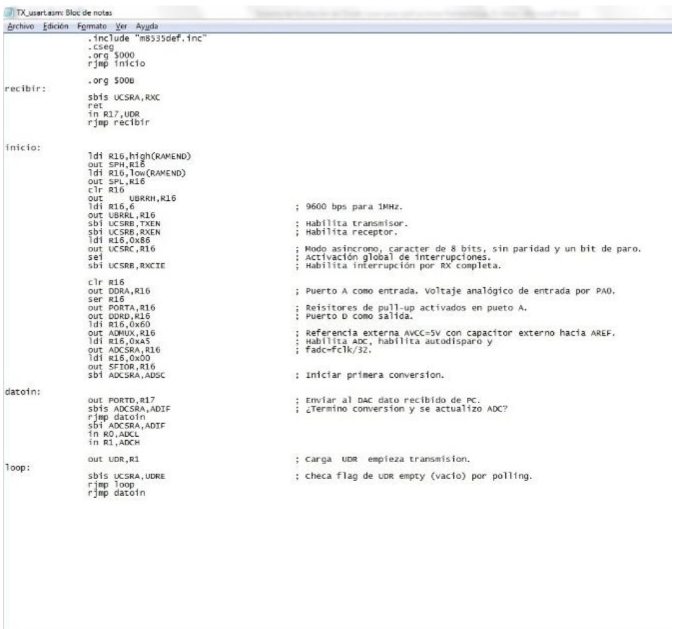


Figure 8. Digital to analog converter for system feedback.

With the only purpose of display scanning voltage delivered by OPAM's indicating the change of the analog value in a digital format. Subsequently, the digital data obtained directly from the ADC atmega8535 microcontroller feedback the laser diode wavelength of 532nm, this through the DAC0800 see Figure 8, which will convert the digital information into analog data for use by a set of differential pair transistors configured by this mode, It can to vary the voltage with the mentioned configuration that generates a change in current that flows through on laser diode, causing a change in the optical intensity diode.

Part of the evidence obtained through the programming code of low level (assembler) shown in Figure 9 were performed.



TX_usart.asm: Bloc de notas

Archivo Edición Formato Ver Ayuda

```
            .include "m8535def.inc"
            .cseg
            .org $000
            rjmp inicio

            .org $00B
recibir:
            sbis UCSRA,RXC
            ret
            in R17,UDR
            rjmp recibir

inicio:
            ldi R16,high(RAMEND)
            out SPH,R16
            ldi R16,low(RAMEND)
            out SPL,R16
            clr R16
            out    UBRRH,R16
            ldi R16,6                  ; 9600 bps para 1MHz.
            out UBRRL,R16
            sbi UCSRB,TXEN             ; Habilita transmisor.
            sbi UCSRB,RXEN             ; Habilita receptor.
            ldi R16,0x86
            out UCSRC,R16              ; Modo asincrono, caracter de 8 bits, sin paridad y un bit de paro.
            sei                        ; Activación global de interrupciones.
            sbi UCSRB,RXCIE            ; Habilita interrupción por RX completa.

            clr R16
            out DDRA,R16               ; Puerto A como entrada. Voltaje analógico de entrada por PA0.
            ser R16
            out PORTA,R16              ; Reisitores de pull-up activados en pueto A.
            out DDRD,R16               ; Puerto D como salida.
            ldi R16,0x60
            out ADMUX,R16              ; Referencia externa AVCC=5V con capacitor externo hacia AREF.
            ldi R16,0xA5               ; Habilita ADC, habilita autodisparo y
            out ADCSRA,R16             ; fadc=fclk/32.
            ldi R16,0x00
            out SFIOR,R16
            sbi ADCSRA,ADSC            ; Iniciar primera conversion.
datoin:
            out PORTD,R17              ; Enviar al DAC dato recibido de PC.
            sbis ADCSRA,ADIF           ; ¿Termino conversion y se actualizo ADC?
            rjmp datoin
            sbi ADCSRA,ADIF
            in R0,ADCL
            in R1,ADCH

            out UDR,R1                 ; Carga  UDR  empieza transmision.
loop:
            sbis UCSRA,UDRE            ; checa flag de UDR empty (vacio) por polling.
            rjmp loop
            rjmp datoin
```

Figure 9. Microcontroller code for Control System.

IV. CONCLUSIONS

We conclude that our minimum system can be controlled and monitored by software developed in JAVA, wherein the interfaces shown in Figure 10.

Figure 10. Interface to control the optical power

We can take control of the system, giving the freedom to modify settings where it is necessary to specify the changes between the optical intensity loop and the photodiode with the same Diode Laser, adjustments can be calibrated from the computer (Power Meter Newport) mentioned in this article, specifically see the image shown in Figure 3.

So that when a feedback system and controlled by software allows us to have automated control of optical power itself Laser Diode where his power displayed in the order of milliwatts is low and useful ratings to study on photothermal techniques, specifically for the use of photothermal microscope.

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