Hardware to Determine the Optimal Value of Resistance by Current Measurements for TRIACs and SCRs Control

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***Abstract*—At present there are some power devices such as SCR Silicon Controlled Rectifier: Silicon Controlled Rectifier) in which it is necessary to pass a current through its gate so that it can control, for it is necessary to estimate a resistance (Rg) that gives the device to control the current needed, but which in turn that this current is so large that no damage to the rectifier, commonly this resistance (Rg) is the voltage control circuit, these circuits are used as AC to DC converters and other applications, however in practice the calculation of this resistance is not easy because the ground circuit control is floated; Another problem of resistances is very common for a TRIAC power device is of the family of transistors commonly connected to an optocoupler is, where the resistance is obtained from the optocoupler Rg may vary and should be considered in series. These resistors (Rg) are not calculated, we propose, in many cases the results obtained by the resistance proposals could damage the device or are not sufficient to control it with us into the loss of money and time.**

To solve the problem of resistance was created a digital prototype that calculates the optimum strength for this prototype device contains a power interface that allows you to enter the desired current value, the system varies its internal resistance in series with resistor arrays and measures the current value, giving us the optimum resistance value for the desired current, obtained as not to lose significant quantities of materials and time savings in design. In the results of the response of the electronic device designed, there was a percentage of error in the ohmic value of resistance and current measurement of ±1%, which is very small, considering that this percentage is proportional to the error of each resistance involved and the type of resistance used.

***Index Terms*—Optimum current, power device, current, MOSFET, SCR, optimal resistance.**

I. INTRODUCTION

There is now software for electronic simulations, such as Multisim and Orcad, used to design electronic circuits. These programs simulate an electronic circuit and see the possible flaws or elements necessary for the circuit to meet its goal, yet there are not have the physical conditions in the software to be accurate at the time of building the circuit, such as temperature, radiation, etc. The circuit design is limited to design the circuit in ideal conditions and test physically, without taking into account that many embedded devices are not present in the libraries and that the actual conditions are not the same as in the simulation originates a problem of design, testing and loss of time, so we designed a prototype that helps physically simulate and calculate the effect of a resistance in a given circuit.

Power devices such as SCR and TRIAC are critical for various electronic applications, to relevant branch of the power electronics, such applications in most cases require a control system for low voltage, typically five volts, the mixing control signals to power signals is in practice difficult, since sometimes the power signals to alter or control these do not provide the current required to trigger the power devices.

There are several methods to calculate the optimum values of resistors for each device, the simplest is to Ohm's Law, as well as meshes and Nodes theorem, and however, in practice the power devices do not behave ideally as do passive devices and the calculation of this resistance may be inaccurate. In other cases to handle AC currents handled are variations in time and have spikes that can damage the device.

II. METHODOLOGY

The device consists of various elements shown in the block diagram of Fig

The first part of the prototype is an array of resistors and after analyzing the possible configurations in series and in parallel, the best option is taking up less and less resistance analog switches also provides that the jumps in the resistors are equal in every step, so he thought of an array of resistance based on an abacus, that is, on the abacus and you can get any number by dividing each element in unit,

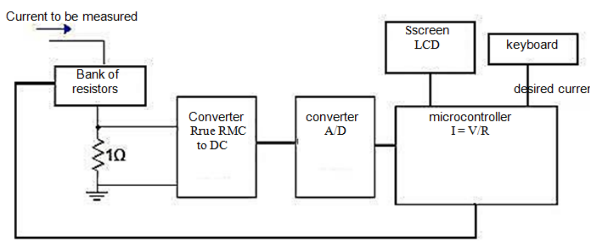

Fig. 1. Block diagram designed to find the optimal resistance of the TRIAC

tens and hundreds, was chosen to occupy nine resistors of 100 ohms and nine resistors 1000 ohms, and the minimum

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resistance that can be obtained in the configuration is 100 ohms, hence each jump will increase 100 ohms, after serving nine resistors of 100 ohms and have equivalent series resistance of 900 ohms, was selected another decade of 1000 ohms and can be combined with those of 100 ohms, meaning that the range is 100 ohms to 9900 ohms with jumps of 100 ohms, the diagram of Fig. 2 shows the configuration of the resistors used.

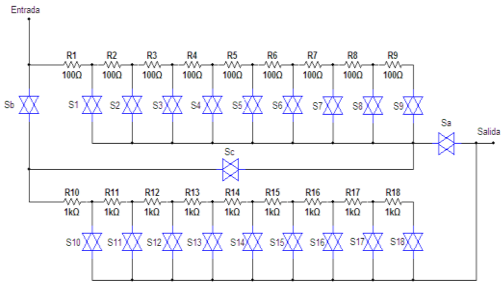

Fig. 2. Diagram of resistance in the form of Abaco

In the proposed device provides an RMS current value equal to the value that provides a direct current in a load, therefore the circuit is capable of measuring the rms current of an alternating current circuit can measure the current of the same by which was added a converter true RMS to DC, whose operation is to perform the operations of equation RMS current and voltage delivered at the end an equivalent direct current, which is connected to an A/D converter and in turn a microcontroller that performs the operation of the law of Ohm.

The DC converter which is the AD736 [5] uses providing a 1% error with a bandwidth of 10 KHz to 20m amplitudes mV to 200 mV rms rms. At the same time deliver a proportional value for each rms voltage level but in DC, this will convert to a digital value and run with it. The DC converter consists of an input amplifier gives the device a high input impedance which allows to combine the resistance of the circuit, this high impedance allows to connect in parallel the result of resistance does not alter measuring, in addition to occupying 25pA input which does not alter too much current to be measured. Fig. 3 shows the block diagram of the RSM to DC converter AD736.

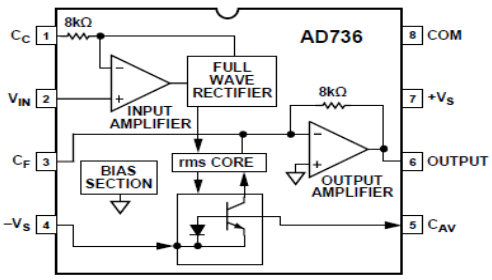

Fig. 3. Diagram functional RMS to DC Converter AD736

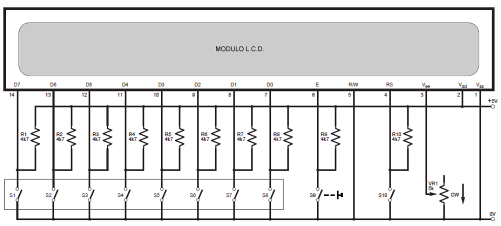

Fig. 4. Diagram of connections of a 16x2 LCD

The other part of the device has a graphical display that is an output device of a digital system which allows the user to see through graphics, numbers or messages, program information of a microcontroller using the graphic display is LCD liquid crystal , which allows users to send data and commands by eight or four bits, is it is possible to send data and a number like this would be a character on the screen and the same number could be sent as a command, which means a statement within the screen.

The most important part of the device is the micro controller of the digital system is a set of devices capable of processing information, data and make decisions based on a preprogrammed set of instructions comprises a data processing unit, memory and drives input and output.

Depending on the make and model of microcontroller features and capabilities vary, but the operation is based mainly on data acquisition in the form of voltage pulses representing zeros and ones, usually 5 to 0 volts to represent the one and logical zero respectively device programming is done using assembly language and C language in some cases, these devices are able to acquire and send data, store and process logic and arithmetically is why we used the PIC18F452 microcontroller [4], which has analog to digital converter, ports input and output and it can be programmed in C language using the MPLAB ® C18 C compiler, compiler. This microcontroller has 5 ports; Port A pin 2 to 10, the port B pin 33 to 40, the port C pin 15 to 18 and 23 to 27, the port C pin 19 to 22 and 27 to 30. These ports can be configured as inputs and outputs besides that the port A has analog to digital converter which is to take care for measuring the current. Pin 1 is the reset pin this pin allows you to reset the microcontroller in case of failure. The pins 13 and 14 are connected to the oscillator that allows the synchronization of program instructions and is indispensable for the microcontroller to begin operations. Finally the pins 11, 12, 32, 31, are the power of the microcontroller and connected to 5 volts and 0 volts. Fig. 5 shows the configuration of the PIC18F452 microcontroller.

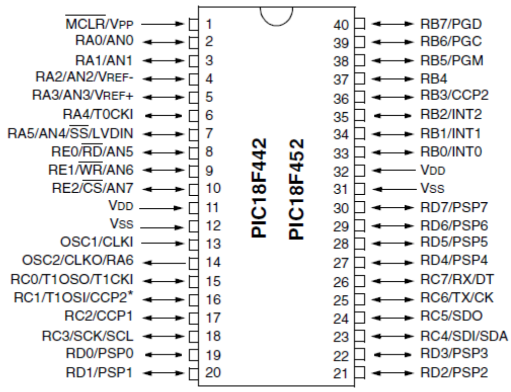

Fig. 5. Configuración Pin PIC18F452

The way that the user enters the data is through switches, touch screens and keys. One of the most common and practical devices to perform this function is the keyboard matrix, which consists of a series of buttons arranged in a matrix with the goal of using fewer lines or pins of a microcontroller what the keyboard was connected to port B, to detect which key is pressing was used a technique that consists in directing the columns to VDD and send zeros in each column, that row is checked control and influence are row and column is the key pressed is used as the low nibble outputs (rows) and the high nibble of port B as inputs (columns), Fig. 6 shows the configuration of the keyboard matrix.

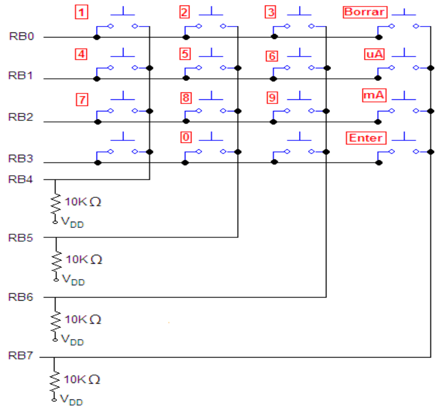

Fig. 6. Configuring the 4x4 matrix keyboard keys and the B port pins of the microcontroller

The power supplies are very important to the operation of the prototype, this section shows the general diagrams are two sources of ±15 Volts shown in Fig. 7a, the other of ±5 volts shown in Fig. 7b.

III. Results and Discussion

The arrays of resistors shown in Fig. 8 fitted with precision resistors of ± 1% error, were shown to have a greater variation in the resistance of 1kohm, therefore the error was increased by increasing the amount of ohms in the circuit.

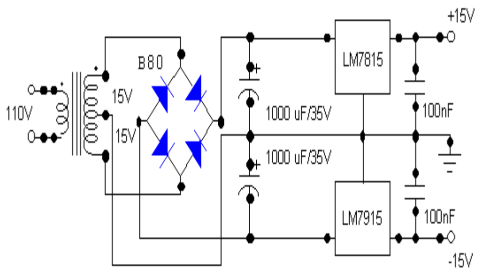

Fig. 7a. Diagram of the dual source of 15 Volts

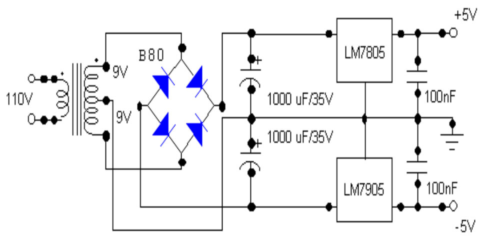

Fig. 7b. Diagram of the dual source of 5 volts.

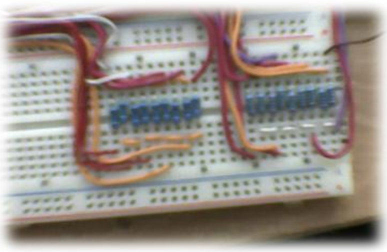

Fig. 8. Arrangements 1 kW resistors and 100Ω.

All the elements were assembled and tested, the results of this stage were optimal, Fig. 9 shows the test board with the microcontroller, LCD, matrix keyboard and decoders proposed.

For power supplies are physically put together the diagrams in Fig. 7a and Fig. 7b for dual sources of ±15 volts and ± 5 volts, the results were a source of +14.48 volts, -15.02 volts, +5.05 volts and - 4.98 volts respectively, the image of the test board is shown in Fig. 10.

In tests measuring voltage responses shown in Fig. 11 indicates that two main features to consider that the output response is not linear and that the device cannot detect values less than 10mV, from the considerations for this the prototype is that the valid range for measurement is 10mA to 190mA, which defines the initial value at the AD736 and the final value is defined by ADG1411 analog switches [6].

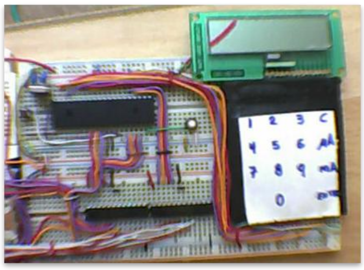

Fig. 9. Tablet digital system testing.

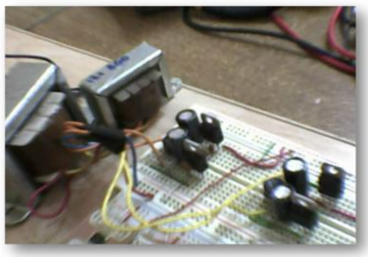

Fig. 10. Tablet testing voltage sources

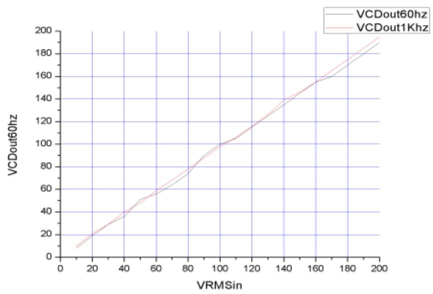

Fig. 11. Response of the output voltage signal as a function of the input

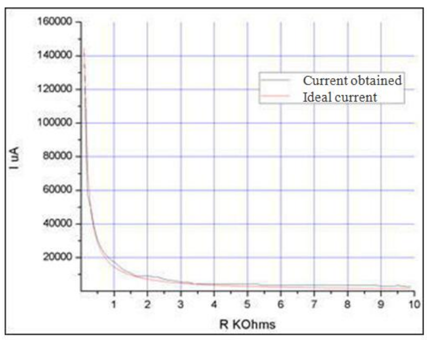

Fig. 12. Current measurements in the prototype with a source of 15 Volts

The current response was also mediated to a source of 15 volts and is shown in Fig. 12 which shows the ideal straight line against the response.

IV. Conclusion

The results of the response of the electronic device designed, there was a percentage of error in the ohmic value of resistance and current measurement of ±1%, which is very small, considering that this percentage is proportional to the error of each resistance involved and the type of resistance used.

The behavior of analog switches are very attractive in the design of prototypes that require the switching of analog signals, they are not very commercial, and have several disadvantages such as bandwidth, the input voltage range and above the maximum current that can lead. The response in the digital design with Microchip PIC18F452 microcontroller was feasible because it avoids problems in the management of digital and analog systems together. We solve the problem of obtaining an optimized solution that calculates the optimal resistance for the device to be used.

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