DIDACTIC PLATFORM FOR STUDY OF AC-AC CONVERTERS

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***Abstract* - This paper will present the implementation of a flexible didactic platform conceived in a modular way for undergraduate student. To implement this platform creativity and low cost components were used, making possible the study of single phase and three phase AC-AC converters. In case of three phases AC-AC converter it will enable the different kind of connections like star load, with or without connection of neutral, and delta. The loads may be resistive or inductive, the soft start for AC motor is also possible. The power structure was conceived with SCR thyristors in anti-parallel connected, to generalize the system. The utilization of the AC-AC converter as Softstart for induction motors may also be studied with the aid of this platform. The student can program the start and stop curves, as well as to observe the system response with at the oscilloscope.**

KEYWORDS

AC-AC Converters, Softstart.

I. INTRODUCTION

Through the ambitionless effort of main excellence centers in Power Electronics, the area had a significant growth on national ambit, in the last years. Today the teaching of this science is done in a great part of Brazilian Universities by highly qualified professors, recognized nationally and internationally for their works. However in most of cases, these professionals do not have time to develop didactic experiments, to allow their students to exercise completely the concepts demonstrated on theoretical disciplines. This project was pictured to contribute with the Power Electronics teaching, in order to turn it more attractive for the students. In such way, the main objective of this paper is to relate the development of a flexible didactic platform to study the AC-AC converter [1][2], looking for to propitiate with this system a better understanding of the operation of AC-AC converters through a practical experience.

The didactic platform to study AC-AC converters, figure 1, is composed by three basic stages: the command and power circuit integrated, a source and main's zero detector circuit for system synchronism and for a control circuit based on a microcontroller which is responsible for the pulses generation for the different thyristors of the power circuit..

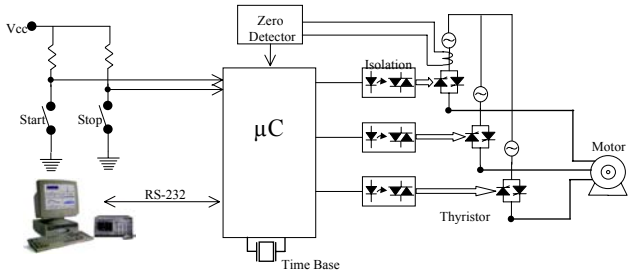

Figure 1: Block Diagram of the proposed system.

II. COMMAND AND POWER CIRCUIT

The command signals are applied in the power stage using optocouplers (MOC 3023) isolating it from the control circuit. The power stage is constituted by six thyristors (TIC 126) antiparallel connected as it can be observed in figure 2. This arrangement may be used as a three-phase AC-AC converter or like three single-phase AC-AC converters, which may be independently controlled. An array of two SCR thyristors phase connected in antiparallel was chosen unlike one TRIAC thyristors to allow to the student an experience closer to industrial reality.

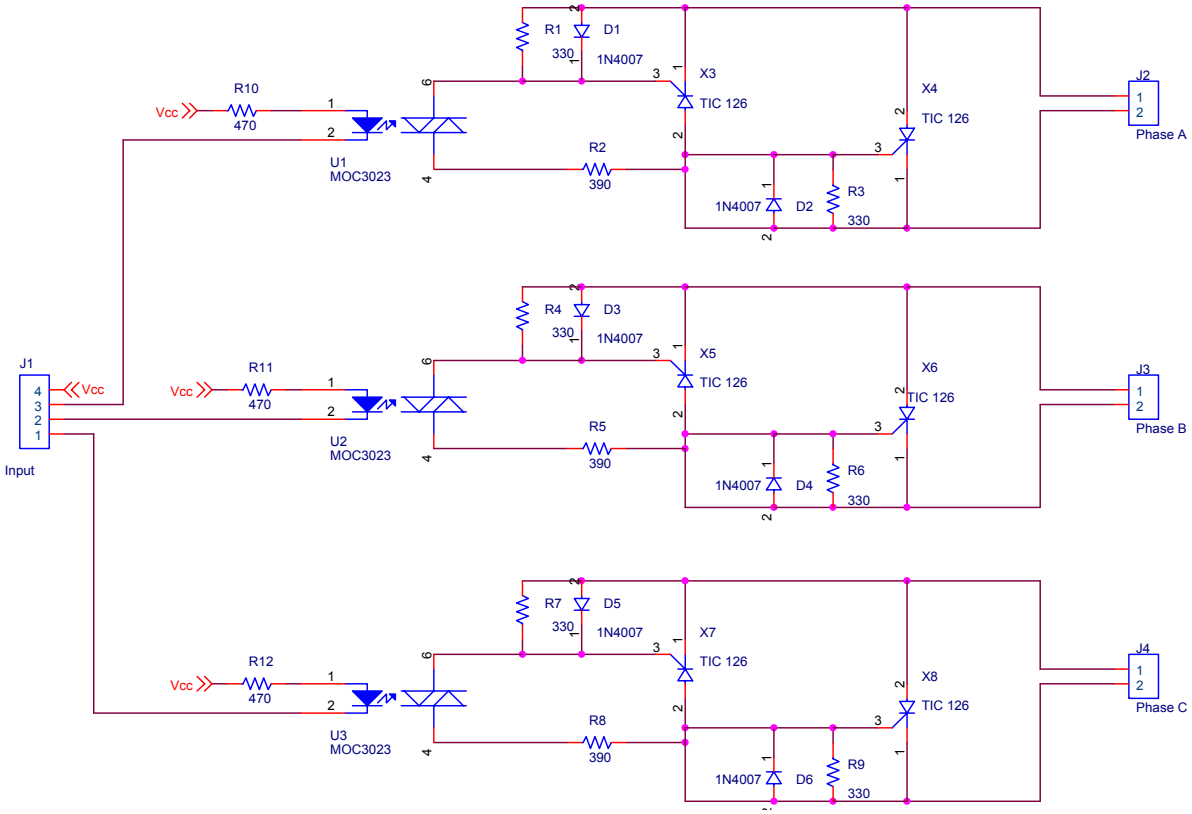

Figure 2: Command and power circuit.

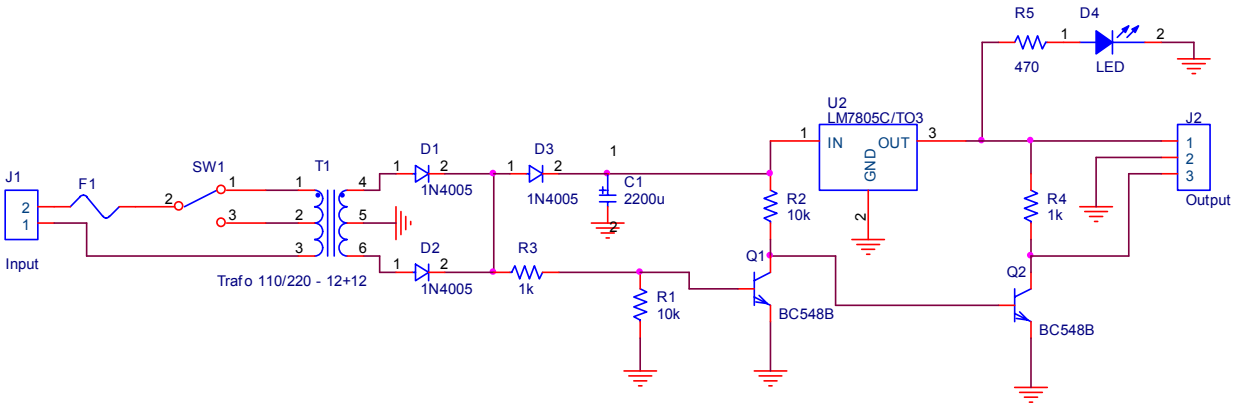

Figure 3: Source and zero detector circuit.

III. SOURCE AND ZERO DETECTOR

This stage was elaborated with the utilization of a step down transformer 110/220V to 12 V, used in the power supply and in the zero detector circuit. In each main cycle two pulses are generated, each one in the beginning of each half cycle. The microcontroller receives these pulses, which are used as time reference for the thyristor command. Figure 3 presents the source circuit and zero detector circuit.

IV. CONTROL CIRCUIT

One of the requirements of AC-AC converters is the power flow control between the main and the

AC load. Usually, the control is made using a well-known technique called phase angle control. The ON/OFF control technique are also well known technique, especially in resistive loads because the ON/OFF control reduces the harmonic content in the current injected in to the mains. Nowadays, the older delta-star switch is being changed by the Softstart circuits, which are basically AC-AC converter circuits. The AC motors Softstart may also be implemented with this platform.

The control circuit was implemented with an 8051 Atmel AT89C52 microcontroller. It receives the synchronism information by the zero detector and processes it giving the proper thyristors phase angle and generates the pulses for the thyristors appropriately. The ON/OFF control and the Softstart for AC motors were also implemented in this platform. To implement this circuits, the control circuit needs to temporize the zero detector pulses using interruptions. A PC may program several positive or negative acceleration curves, obtained through the continuous phase angle variations. The platform can operate autonomously or have its program changed directly through a PC using its RS-232 serial interface. For autonomous operation the platform incorporates a display and a keyboard that allows programming the parameters.

The illustration 4 presents the picture of the control system implemented.

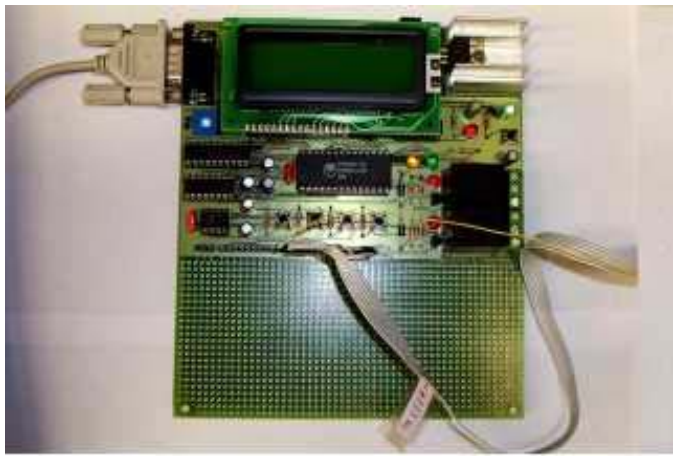

Figure 4: Circuit of Control based on the microcontroller AT89C52.

V. EXPERIMENTAL RESULTS

For a didactic classroom use of the platform a simple load assembly using incandescent light bulbs was made. Figure 5 presents the results obtained for a star load configuration using phase angle (α) control. It can be observed that the three phases thyristors had been turned on correctly.

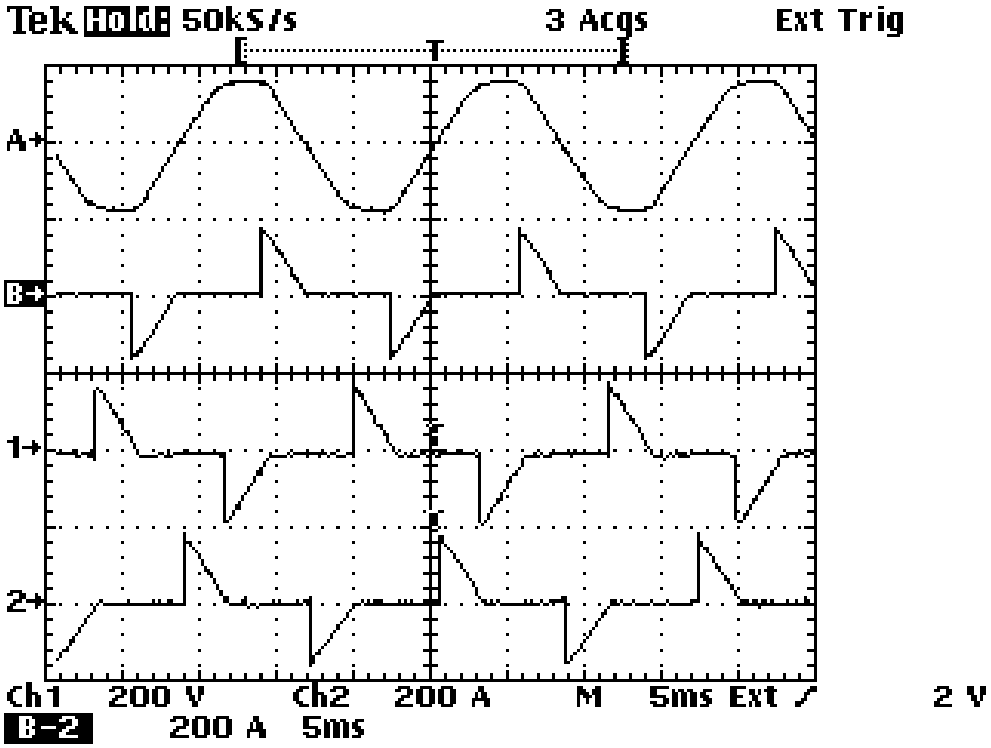

Figure 5: AC – AC converter experimental results

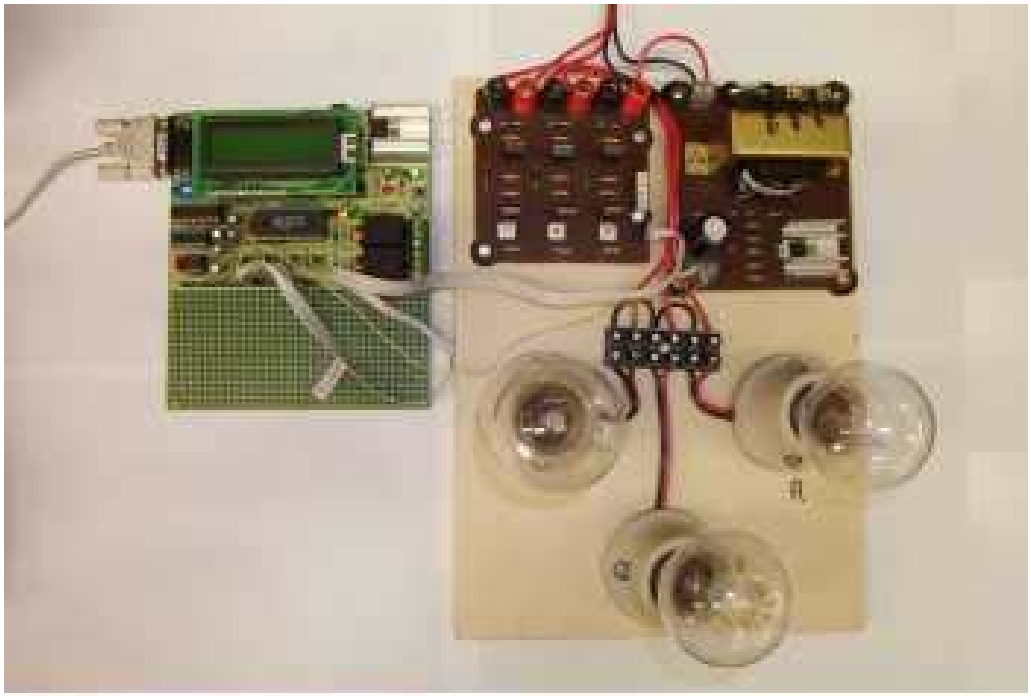

Figure 6: Full developed didactic platform.

The control circuit, the command circuit, the power stage, power supply and the loads are presented in figure 6. The voltage and current in the loads can be easily measured with the aid of a multimeter and an oscilloscope.

VI. CONCLUSIONS

In this article a didactic platform to teach Power Electronics was described. This work is inserted in the context of a solid pedagogic proposal for the Power Electronics teaching, based on the theoretical practical experience mainly in the field of the AC converters. The system now presented is inserted in a wider proposal, started with a didactic kit family, elaborated for the study of rectifiers circuits presented in [3] and inverters circuits [4]. After the implementation of these kits an expressive improvement of the learning process was observed, obtaining high approval indexes different from what happened when the discipline was presented in the traditional way. At PUCRS the teaching of power electronics is realized in two disciplines. The first one, theoretical, is called Power Electronics with duration of 60 hours. In this discipline the textbook is the Power Electronics by Prof. Ivo Barbi [1]. The second discipline offered is denominated Laboratory of Power Electronics which purpose is to develop experimentally the theoretical contents approached in the Power Electronics discipline, with duration of 30 hours.

We would like to remark the importance of the popularization of this kind of work, which approaches pedagogic aspects and is concerned with the formation of a new methodology of teaching the Power Electronics disciplines. Is important to observe that the work here presented constitutes the third stage of a more ambitious project in which the main objective is to develop didactic kits that assists the Power Electronics teaching. The versatility of the platform and the great economy obtained in relation to the available educational kits found on the market are additional advantages of the proposed system.

VII. REFERENCES

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