

# Lab1: Power in home appliances

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**Abstract**—This report presents the design and implementation of a security box and a dimmer circuit using DIACs and TRIACs. The reader also can find the validation review with the theoretical model seen in class.

**Keywords**—

## I. INTRODUCTION

The main purpose of this practice is to perform an analysis on the wave form and measurements of three different type of load. Inside the security box there is a fuse to protect the equipment from any shortcut. We used a shunt resistor of  $1 \Omega$  and  $10 \text{ W}$  to measure current dividing the voltage by 1 to obtain the actual current value. All electronics devices are composed of resistances, capacitors and inductances, a soldering iron is a resistive linear load, they require heat to work. The voltage measured would be the same as the source but the current will vary depending on the power consumption of the device. We expect the same waveform for the voltage and current and no phase shift between them.

A drill would be an inductive linear load, based on the fact that motors are made of inductive coils. It should be a phase shift between voltage and current. The laptop is a nonlinear load, the voltage waveform would be the same but we expect a different shape for the current [1].

The second part consists on designing and developing an AC controller made of DIACs and TRIACs. This kind of circuit is able to change the RMS voltage on the terminals of a linear load by manipulating the firing angle of the TRIAC using a potentiometer. The load will not be linear anymore because of the electronic circuit resultant of the resistive load in series with the AC controller.

## II. PROCEDURE

### A. Power Computations

The purpose of this practice is to measure the power consumption on electrical home devices, such as a laptop, a drill and a soldering iron. Taking into account that they work with high values of voltage and current compared with previous labs, precautions were taken in order to protect the devices and our integrity. The Figure 1 shows the circuit proposed by the teacher to measure voltage and current safely.

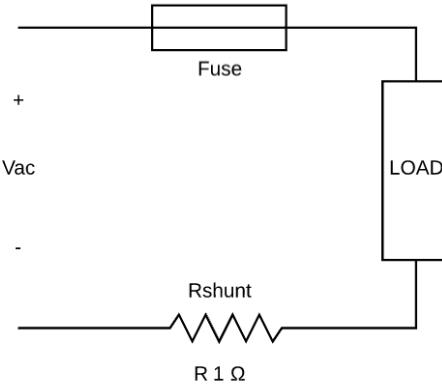


Fig. 1. Circuit Diagram.

$V_{ac}$  represents the  $120 \text{ Vrms}$  sine wave obtained from the university phase line, *Fuse* represents a  $3\text{A}$  circuit breaker, *Load* represents the load and *Rshunt* represents the  $1 \Omega$  and  $10 \text{ W}$  power resistor. We chose a small value for the resistor to do not affect the functioning of the circuit.

The circuit is inside a  $4 \times 4$  box with a fuse holder to change the breaker, 4 measuring terminals; the white one for neutral, green one for ground and both black one for phase. The box is shown in the Figure 2.



Fig. 2. Circuit box.

For this practice we chose three different loads to analize their voltage and current waveform: a soldering iron like resistive load, a drill like inductive load and a laptop like non-linear load.

In the following section are the results obtained in the practice:

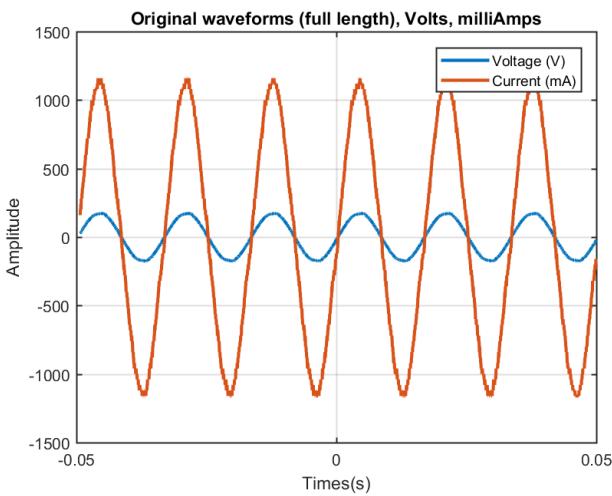


Fig. 3. Voltage and current waveforms of a resistive load.

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1 T      = 0.0167 s
2 f0     = 59.9520 Hz
3 Vrms  = 123.3322 V
4 Irms  = 0.7860 A
5 S      = 96.9336 VA
6 Pavg  = 96.8309 W
7 P      = 96.8309 W
8 Q      = -1.8282 VAR
9 D_fast= 4.0701 VA
10 D     = 4.0562 VA
11 PF    = 0.9989
12 THD_V = 1.8878 %
13 THD_I = 4.0154 %

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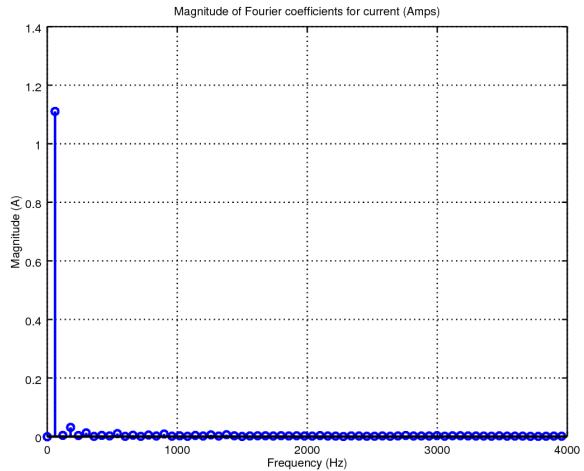


Fig. 4. Furier current coefficients for resistive load.

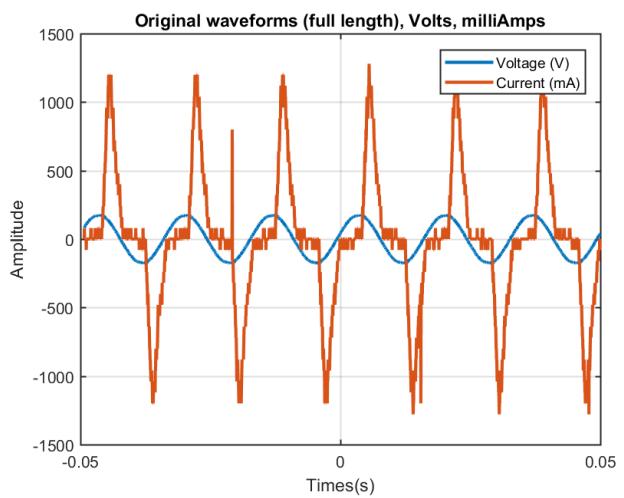


Fig. 5. Voltage and current waveforms of a inductive load.

|          |   |             |
|----------|---|-------------|
| 1 T      | = | 0.0167 s    |
| 2 f0     | = | 59.9520 Hz  |
| 3 Vrms   | = | 123.8850 V  |
| 4 Irms   | = | 0.4831 A    |
| 5 S      | = | 59.8537 VA  |
| 6 Pavg   | = | 30.4372 W   |
| 7 P      | = | 30.4372 W   |
| 8 Q      | = | 38.7767 VAR |
| 9 D_fast | = | 33.9472 VA  |
| 10 D     | = | 33.9434 VA  |
| 11 PF    | = | 0.5085      |
| 12 THD_V | = | 1.8561 %    |
| 13 THD_I | = | 69.7550 %   |
| 1 T      | = | 0.0167 s    |
| 2 f0     | = | 59.9520 Hz  |
| 3 Vrms   | = | 124.3447 V  |
| 4 Irms   | = | 0.3916 A    |
| 5 S      | = | 48.6915 VA  |
| 6 Pavg   | = | 23.9965 W   |

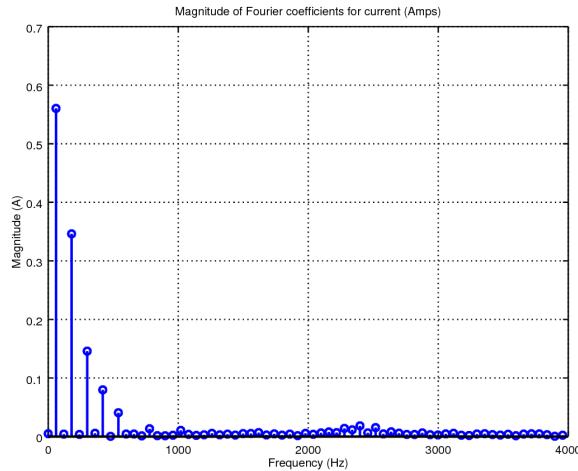


Fig. 6. Furier current coefficients for inductive load.

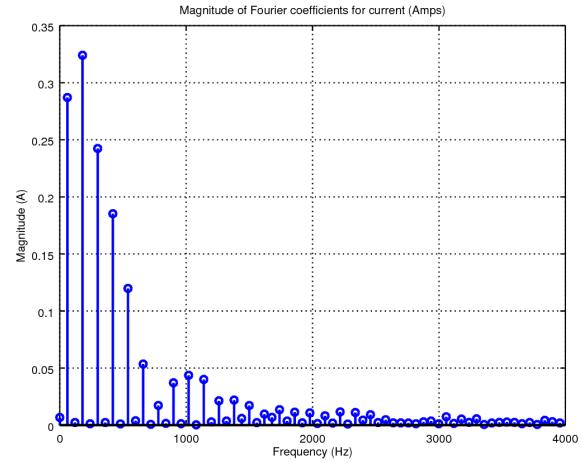


Fig. 8. Furier current coefficients for non-linear load.

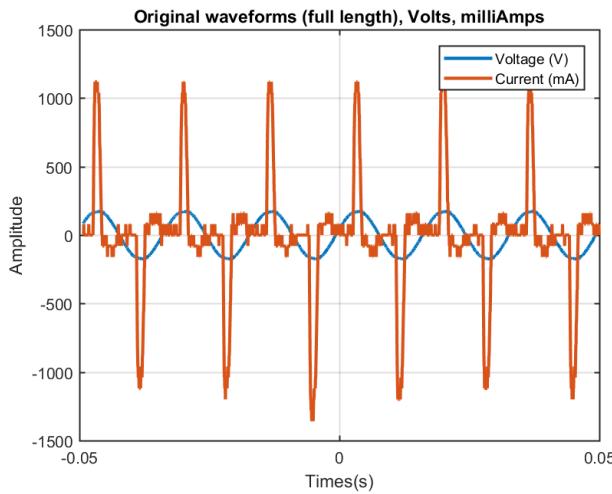


Fig. 7. Voltage and current waveforms of a non-linear load.

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7 P      = 23.9965 W
8 Q      = -5.7979 VAR
9 D_fast= 41.9692 VA
10 D     = 41.9644 VA
11 PF    = 0.4928
12 THD_V = 2.2668 %
13 THD_I = 164.9239 %

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### B. AC controller

For the second part of the practice, we have to propose a circuit using thyristors to control the amount of power delivered to the light bulb. The input is the 120 V AC and the output is an AC waveform where there is a delay angle before triggering the AC voltage. The phase control is done

with a potentiometer. The circuit designed is shown in the Figure 9.

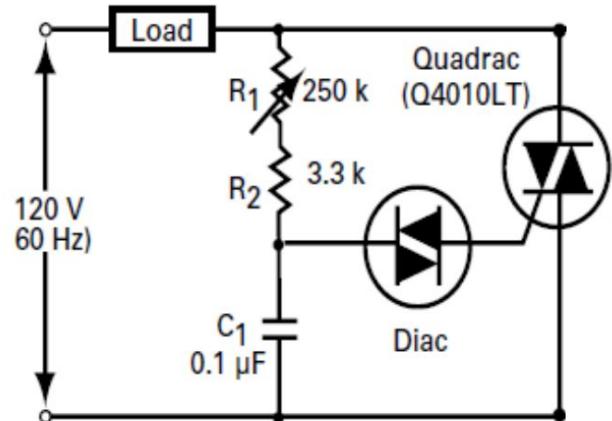


Fig. 9. AC controller circuit.

### III. CONCLUSIONS

The resistive load shows a power factor of almost 1. The inductive load has a curly current shape, thanks to the type of motor being used in the drill. The non-linear load shows a kinky wave shape that depends on the circuit inside the electronic device.

Power computations let us understand better the circuits, taking into account the meaning behind the power factor and the different kinds of power related to a circuit.

The dimmer allows us to regulate the power taken by the light bulb. Taking into account that a light bulb is resistive, the effectiveness depends on the efficiency voltage and effective current.

The circuit is controlling the AC power to the light bulb by switching on and off during the positive and negative regions of the input sinusoidal signal. During the negative part of the input signal, the same type of response will be obtained since both the DIAC and TRIAC can be triggered in the reverse direction. Varying the resistance R, it is possible to control the driving angle. [3]

About inductive and non-linear loads, you shouldn't use the dimmer circuit, because both rely on the PF and the voltage and current wave shape.

As we learned in class, electronic devices, such as, DIACs and TRIACs let us build circuits to control the power taken by a resistive load.

## REFERENCES

- [1] H. Kopka and P. W. Daly, *A Guide to L<sup>T</sup>E<sub>X</sub>*, 3rd ed. Harlow, England: Addison-Wesley, 1999.