DESIGN AND CONSTRUCTION OF EQUIPMENT FOR TESTING AN AUTOMOTIVE LED LAMP

Mihaela Molnar, *„Babeș-Bolyai” University of Cluj-Napoca, ROMÂNIA*
Cornel Hațiegan*, *„Babeș-Bolyai” University of Cluj-Napoca, ROMÂNIA*
Roberta Răduca, *„Babeș-Bolyai” University of Cluj-Napoca, ROMÂNIA*
Eugen Răduca, *„Babeș-Bolyai” University of Cluj-Napoca, ROMÂNIA*

ABSTRACT: In the current technological and economic context, LED lamps have gained significant popularity thanks to their high energy efficiency, long life and low environmental impact, the pollution created by them being significantly reduced compared to traditional lighting sources. They are widely used in vast fields, from commercial, residential or street lighting, to industrial and automotive applications. LED technology is now widely accepted for lighting in the automotive industry, as vehicles become more energy efficient, durable and safer. In particular, for vehicle lighting systems, the use of LEDs over conventional classic bulbs has been determined by the ability to generate intense, concentrated and constant light during operation. The approach of the presented work is based on a combination of theoretical research, software simulation in a graphical programming language, equipment development and testing of an LED lamp using the equipment made.

KEY WORDS: automotive, LED lamp, LabVIEW, equipment, testing.

1. INTRODUCTION

LED lighting has become indispensable and essential in the automotive industry, replacing, over time, traditional light sources, such as incandescent bulbs or gas lamps.
This evolution, but also transition, is due to the motivation of manufacturers to reduce energy consumption, increase lifespan, improve road safety, but also to offer more modern design options.
LED technology is versatile, being used both for exterior lighting (headlights, taillights, signals), but also for interior lighting (ambient lights, dashboards)[2].
LED lamp testing is a necessary activity to verify their compliance with quality and performance standards [14]. This process involves the measurement and analysis of key parameters, such as electrical current intensity and luminous intensity, energy efficiency, optimum temperature for correct and uninterrupted operation, stability over time and their behavior under conditions of use for long phase and short phase [6]. In general, LED lamp testing involves the use of appropriate equipment, capable of providing precise information about their performance and identifying possible irregularities or manufacturing problems [8].

2. DEVELOPMENT AND SIMULATION OF THE VIRTUAL INSTRUMENT FOR TEST EQUIPMENT IN LabVIEW

2.1. Development the virtual instrument for test equipment in LabVIEW

2.1.1. Front panel of the virtual instrument for the automotive LED lamp test equipment

The front panel for the test equipment is shown in Figure 1.

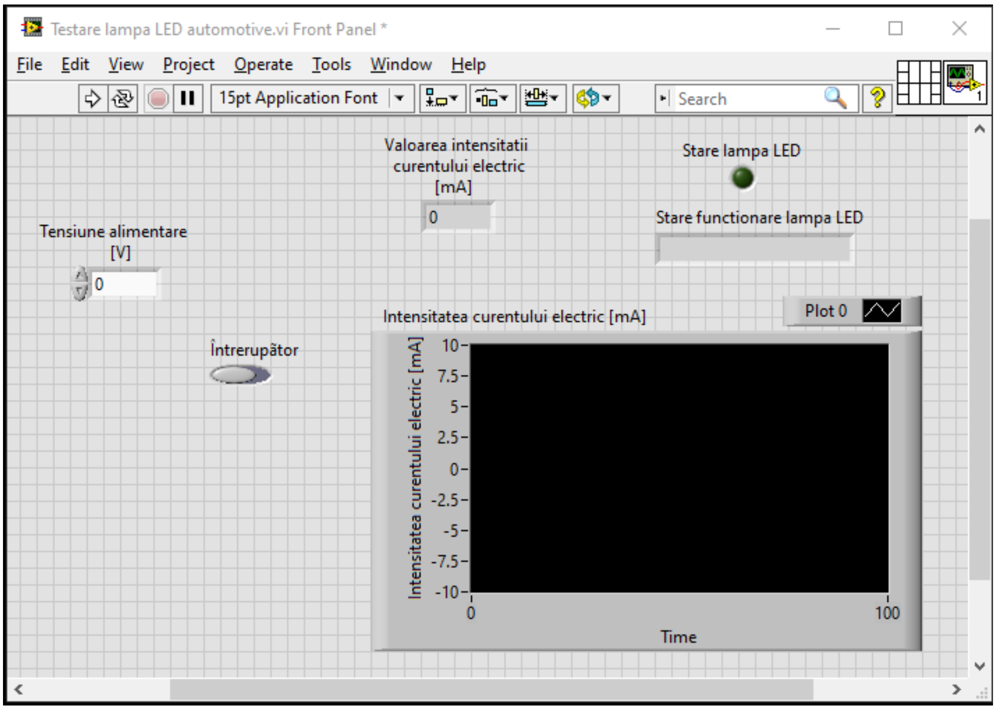

Figure 1. Front panel of the virtual instrument for the automotive LED lamp test equipment

The front panel (Figure 1) contains two control elements [1] and four indicator elements [5], respectively:

- A numeric control element called "Tensiune de alimentare"("Power Voltage"), an element through which the LED lamp's power supply voltage is selected.
- A boolean control element called "Întrerupător" ("Switch"). If this button is pressed, i.e. it changes its value from "False" to "True", the LED lamp is powered at the prescribed voltage.
- A numeric indicator element called "Valoarea intensității curentului electric" ("Electric current intensity value") in which the electric current from the LED lamp will be visualized.
- A boolean indicator element called " Stare lampa LED" ("LED lamp status") which will be activated in light green when the LED lamp is powered by electric voltage.
- A string indicator element called "Stare functionare lampa LED" ("LED lamp operating status") which, depending on the electric current intensity value, will indicate the phase of the LED lamp. The LED lamp can be in long phase or short phase operating mode.
- A graphic indicator element called "Intensitatea curentului electric" ("Electric current intensity") which shows the value of the electric current intensity in the form of a wave.

2.1.2. Block diagram of the virtual instrument for the testing equipment of an automotive LED lamp

After making all the connections [11], [13], the block diagram of the developed virtual instrument is presented in figure 2.

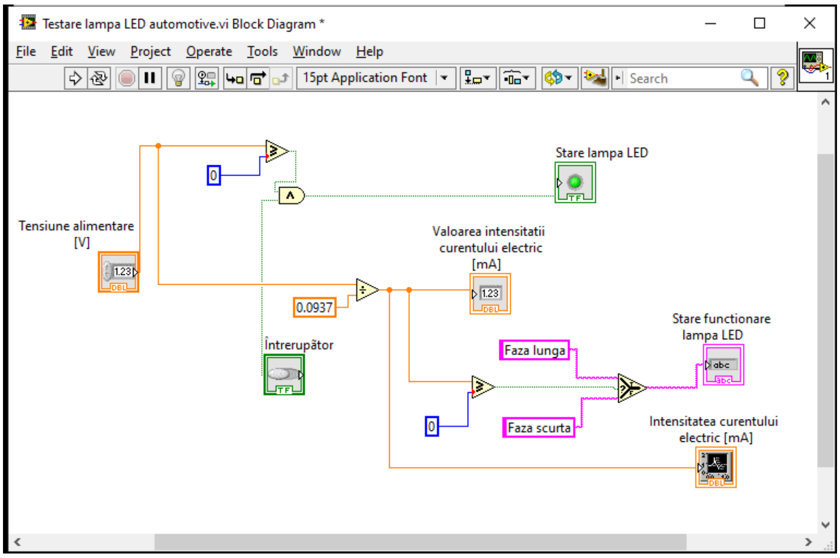

Figure 2. Block diagram of the virtual instrument for the automotive LED lamp test equipment

2.2. Simulation of the virtual instrument for the testing equipment of an automotive LED lamp

2.2.1. Simulating the virtual instrument for the long phase

To simulate the high phase of the LED lamp, in the block diagram the value of the constant corresponding to the selection function is 120, and in the front panel the supply voltage is set to 12 V, the switch is switched to the activation position (the button on the left). After running the virtual instrument the results illustrated in figure 3 are obtained.

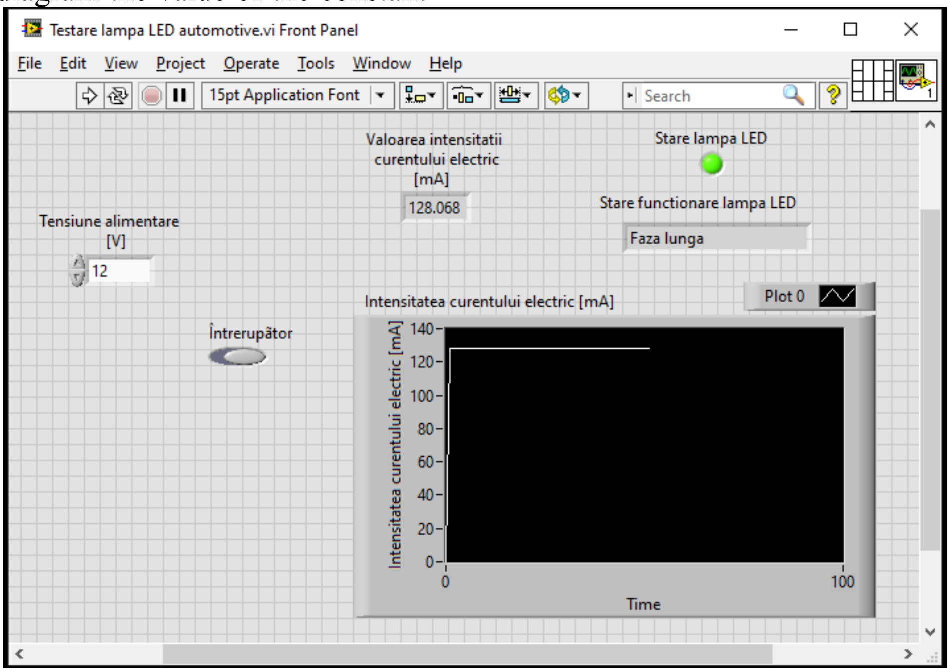

Figure 3. Virtual instrument simulation for long phase

2.2.2. Simulating the virtual instrument for the short phase

To simulate the short phase of the LED lamp, in the block diagram the value of the constant corresponding to the selection function is 122, and in the front panel the supply voltage is set to 12 V, the switch is switched to the activation position (the button on the left) and after running the virtual instrument the results illustrated in figure 4 are obtained.

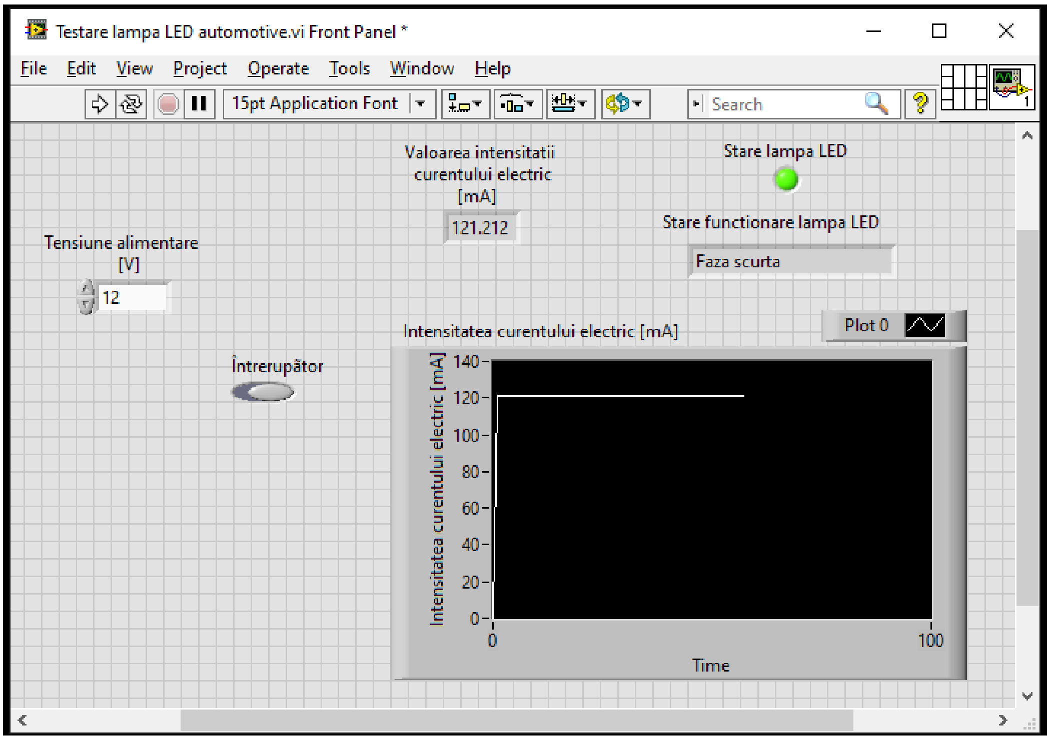

Figure 4. Virtual instrument simulation for short phase

3. BUILDING OF THE LED LAMP TESTING EQUIPMENT AND TESTS

3.1. Description of components of LED lamp testing equipment

The test equipment made consists of:

- OSB board for supporting the testing equipment
- Power supply
- LED lamp
- Switch [4] for setting the high beam and low beam functions
- Wires for connections between components.

Figure 5 shows the LED lamp testing equipment built.

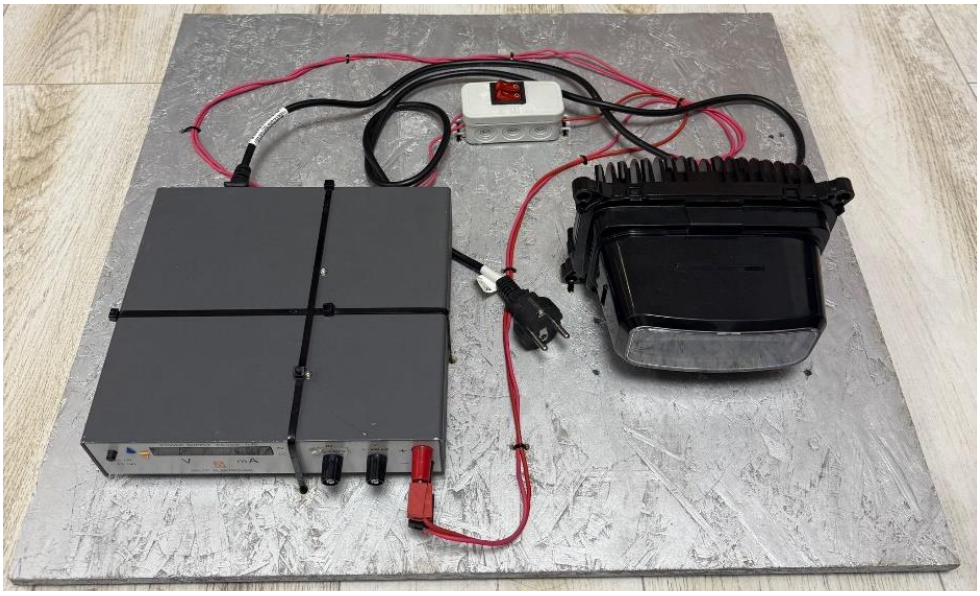

Figure 5. LED lamp test equipment

3.2. Electrical testing of led lamp testing equipment

3.2.1. Electrical testing of the LED lamp long phase equipment

To switch the LED lamp to long phase, press the corresponding switch button in the test equipment switch [9], then change the supply voltage according to the standards.
When reaching the standardized electrical voltage of 12 V [14] for the operation of the long phase of the LED lamp [7], the current absorbed during the operating mode is 128 mA (Figure 6).

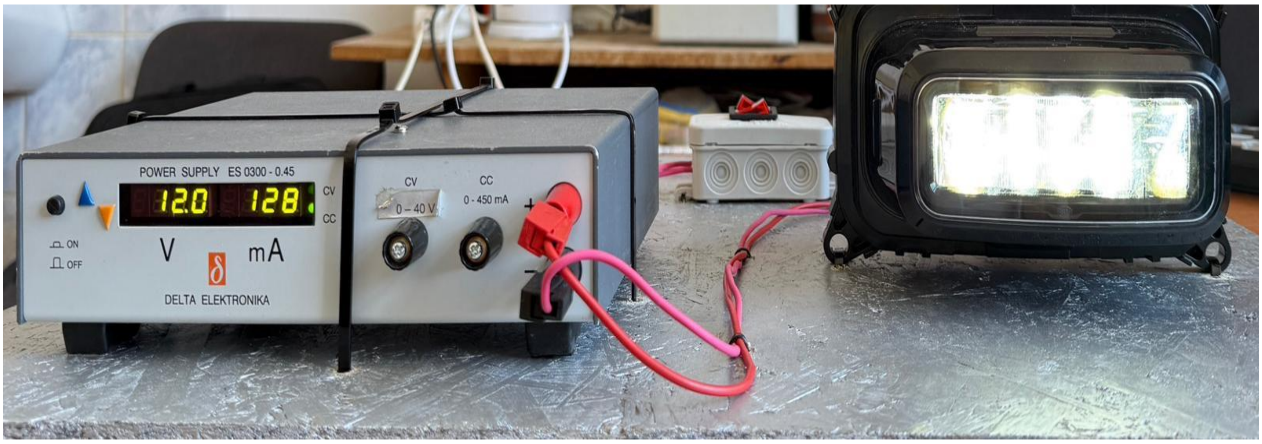

Figure 6. Electrical testing of the LED long phase lamp equipment

3.2.2. Electrical testing of the LED lamp short phase equipment

Electrical testing of the short phase equipment consists of turning on the LED lamp for the short phase function by pressing the switch corresponding to this phase [9], subsequently setting the standardized electrical voltage [14] of 12V for the short phase operation of the LED lamp [10], via the adjustable button on the equipment power supply interface.
During the short phase operation of the LED lamp [12], the electrical voltage is 11.9 V, and the current absorbed during the operating mode was 120 mA (Figure 7).

Figure 7. Electrical testing of the LED short phase lamp equipment

4. CONCLUSION

The values obtained from LabVIEW are slightly higher than those obtained from physical testing because in physical testing copper losses due to cables and terminal connections also occur, but these fall within the technical specifications.

Several aspects were monitored during testing, including the stability of current consumption, which was constant during operation in both phases, there were no significant fluctuations, indicating predictable consumption.

Another aspect monitored is the continuous operation of the LEDs, the lighting being uniform and without interruptions, which confirms the good connection of the elements.

In both cases, the technical solution is an efficient one, the light distribution being optimal and without overloading the electrical network in the vehicle.

The results confirm that the test equipment made is functional and stable, the electrical connections were made correctly, and the LED lamp complies with the performance requirements for both phases.

REFERENCES

[1] Carmen Bujoreanu, LABVIEW, prietenul nostru, Iași, 2015

[2] Cârstea E.M., Râpă M, Evaluation od LED light quality and energy efficiency in vehicular lighting, Revista română de Tehnică și Mecatronică, vol.8, pag 77-85, 2021

[3] Murat Demir, Effect of Potting Material on Reliability and EMC Performance of LED Drivers, Transactions and Components, vol.9, pag.1542-1548, 2019

[4] R. W. Erickson and D. Maksimovic, Fundamentals of Power Electronics. Ediția a 2-a. NJ, SUA, 2018

[5] Cristian Foşalău, Introducere în instrumentaţia virtuală, Editura CERMI, Iaşi, 2010

[6] X.Long, J.He, J.Zhou, A review on Light-Emitting Diode Based Automotive Headlamps, Renewable and Sustainable Energy Reviews, vol.41, pag. 29-41, 2016

[7] Michael F. Morgan, Understanding CRI and CCT, LEDs Magazine, vol.1, 2019

[8] Popa C-L, Study on LED characteristics, Optoelectronica, vol.23 (4), pag. 45-52, 2019

[9] Mihaela Răduca, Sisteme de măsurare şi instrumentaţie, Editura „Eftimie Murgu", Reşiţa, 2010

[10] A. Root, The Lighting Product EMC Problem and Testing Technology, Lisun, 2017

[11] Constantin Rusu, Introducere în LabVIEW. Bistrița, 2018

[12] E.Fred Schubert, Light Emitting Diodes. Ediția a 4-a, SUA: Cambridge University Press, 2020

[13] Ciprian Şorândaru, Instrumentaţie virtuală în ingineria electrică. Editura Orizonturi Universitare, 2003

[14] IEC62722-2-1:Luminaire performance – Part 2-1: Particular requirements for LED luminaires, 2014

*Correspondent author