Light intensity measurement using LabVIEW graphical programming environment

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Abstract

Lighting and light distribution have a crucial influence on factors such as performance and occupational safety.

This paper aims to create a virtual instrument (VI), developed around the Arduino Uno development platform, designed to measure the light intensity using the BPW34 sensitive silicon PIN photodiode. The reverse-biased photodiode can be used as a light detector by monitoring the current flowing through it. Coupled to a 10Kohm resistor and considering the specifications of the BPW34 model, a simple relationship is offered between lux (light intensity) and the voltage across the resistance. The virtual instrument reads this voltage and converts it to a light intensity value in Lux. There is also an alarming function if the light intensity exceeds the set value. The VI also shows basic statistics like Max, Mean, and Min light intensity values.

Keywords: Light intensity, Photodiode, Arduino, LabVIEW

1. Introduction

A light source, like the filament of an incandescent bulb, emits light in all directions. Effectively, it sits at the center of a sphere of radiated light (which is why light units reference the steradian). The total energy of all the light given off is termed the "luminous flux." [4]

The light intensity is part of the light flux that falls on the surface of a certain size and depends on the light flux of the light source, the angle of the beam, and the distance between the surface and the light source.

An important feature when choosing a light source is the luminous flux which represents the total amount of light that is produced by the light source in all directions in one second.

$$E= \Delta\Phi/d\Omega \qquad (1)$$

Lumen is the unit of measurement of the total amount of perceived light emitted by a source (luminous flux or light power). The candle is the unit of measurement of light power emitted by a source in a certain direction (light intensity). Luminous flux or light power is a measure of the perceived power of light [1].

A photodiode is a PN junction diode that consumes light energy to produce electricity. It is sometimes called a photodetector, light detector, and photo-sensor. These diodes are specially designed to operate in reverse polarization conditions, which means that

the P-type part of the photodiode is associated with the negative terminal of the battery and the N-type part is connected to the positive terminal of the battery.

The PIN photodiode is a certain type of photodiode in which an intrinsic layer is placed between a strongly doped p-type layer and a strongly doped n-type layer. As the resistivity decreases with increasing impurity and vice versa, the p and n layers have a very low resistivity, while the resistivity in the first layer is very high. The PIN-Photodiode has a large depletion region that is used to receive light.
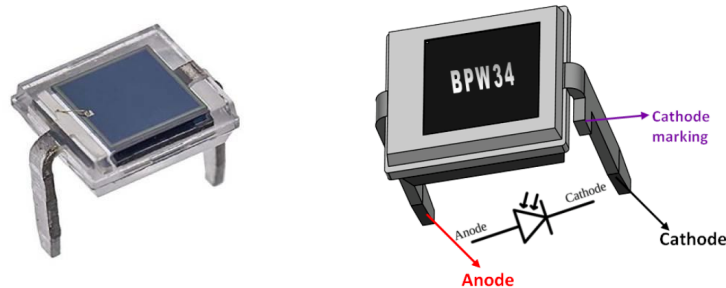

Figure 1 BPW34 Photodiode and BPW34 Pinout

For implement this project we will need the following materials: an Arduino UNO, a BPW34 Photodiode, one suitable resistor for the BPW34 Photodiode (10KΩ), breadboard, 1 LED, 1x220 ohm resistors, and jumpers wires to connect.
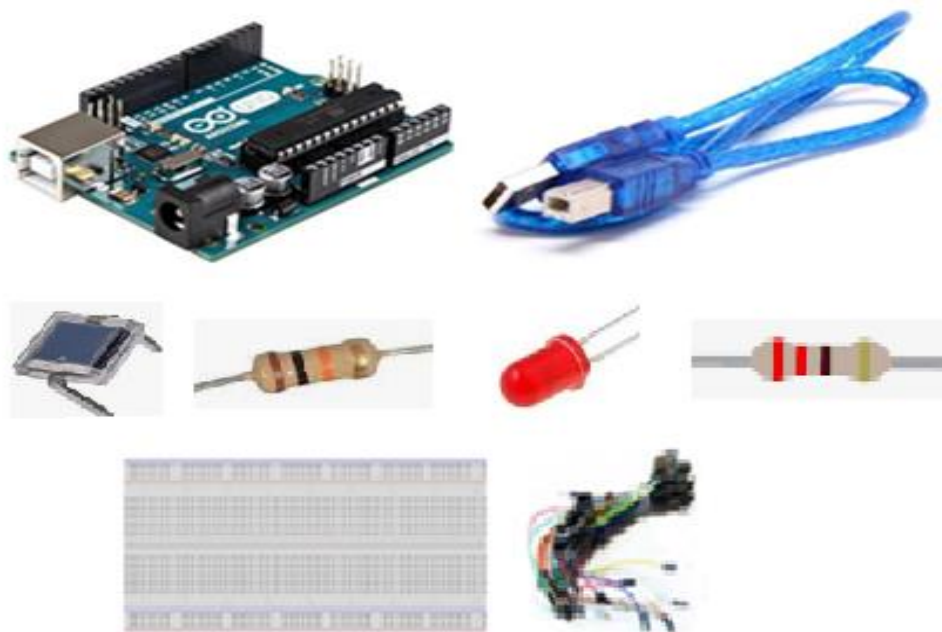

Figure 2 The components necessary for the elaboration of the technical project

The decor of a warm air home, of an accommodation unit that wants to be as welcoming as possible or of a veranda arranged for summer nights can never be complete without the right lighting equipment. In the process of choosing light sources, there are many criteria that can be applied. Their appropriate intensity, in relation to the demands they will respond to during use, must be at the top of their concerns, and the most important aspect in this regard is the indication of the luminous flux.

2. Build a VI and Data Acquisition

Graphical programming requires a specialized development environment in which the user places and/or manipulates graphical symbols and interconnects them in a block diagram to create a so-called graphical code [3].

In an application developed within the LabVIEW simulation, testing and programming environment, there are two major components:
- the front panel interface designed according to user requirements;
- command and control logic implemented through block diagrams;

The final application will therefore contain both the program part and the GUI part for interaction [8].

This paper aims to create a virtual instrument (VI), developed around the Arduino Uno development platform, designed to measure the light intensity using the BPW34 sensitive silicon PIN photodiode.

The reverse-biased photodiode can be used as a light detector by monitoring the current flowing through it. Coupled to a 10Kohm resistor and considering the specifications of the BPW34 model, a simple relationship is offered between lux (light intensity) and the voltage across the resistance. The virtual instrument reads this voltage and converts it to a light intensity value in Lux. There is also an alarming function if the light intensity exceeds the set value. The VI also shows basic statistics like Max, Mean, and Min light intensity values.
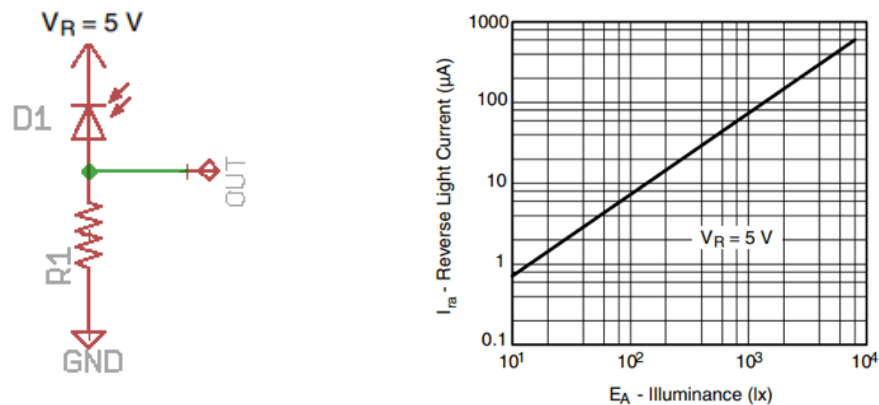

Figure 3 Measuring circuit and current- light intensity characteristic of the photodiode

Taking into account the specifications of the photodiode and taking into account the resistance of 10Kohm connected in series with it, between the light intensity and the voltage at the terminals of the resistance is given by the relation:

$$lux = 1333 * Vout \qquad (2)$$

Using the Arduino electronic platform together with a computer we will measure this voltage.

To create the interface between LabVIEW and Arduino, we will need the following software:
- LabVIEW;
- NI VISA;
- VIPM;
- LINX

NI VISA - National Instruments Virtual Instrument Software Architecture is an API that provides a programming interface to control Ethernet/LXI, GPIB, serial, USB, PXI, and VXI instruments in National Instruments application development environments like LabVIEW. The API is installed through the NI-VISA driver [8].

VIPM - VI Package Manager reduces project costs by helping you implement a code reuse process in your organization. VIPM makes it easy to manage and share reusable VIs across multiple projects, computers, and teams of developers [9].

LINX - LabVIEW for X (LINX) is designed to replace LabVIEW Interfaces for Arduino and to provide a LabVIEW generic protocol for the interface with any programmable device, but specifically targeting Microcontrollers and SoCs (System on a Chip). LINX will provide a high level of programming that allows users to communicate with several devices, including Arduino [10].

Represented in Figure 4 and Figure 5 is the Front Panel and respectively the Block Diagram of the VI.
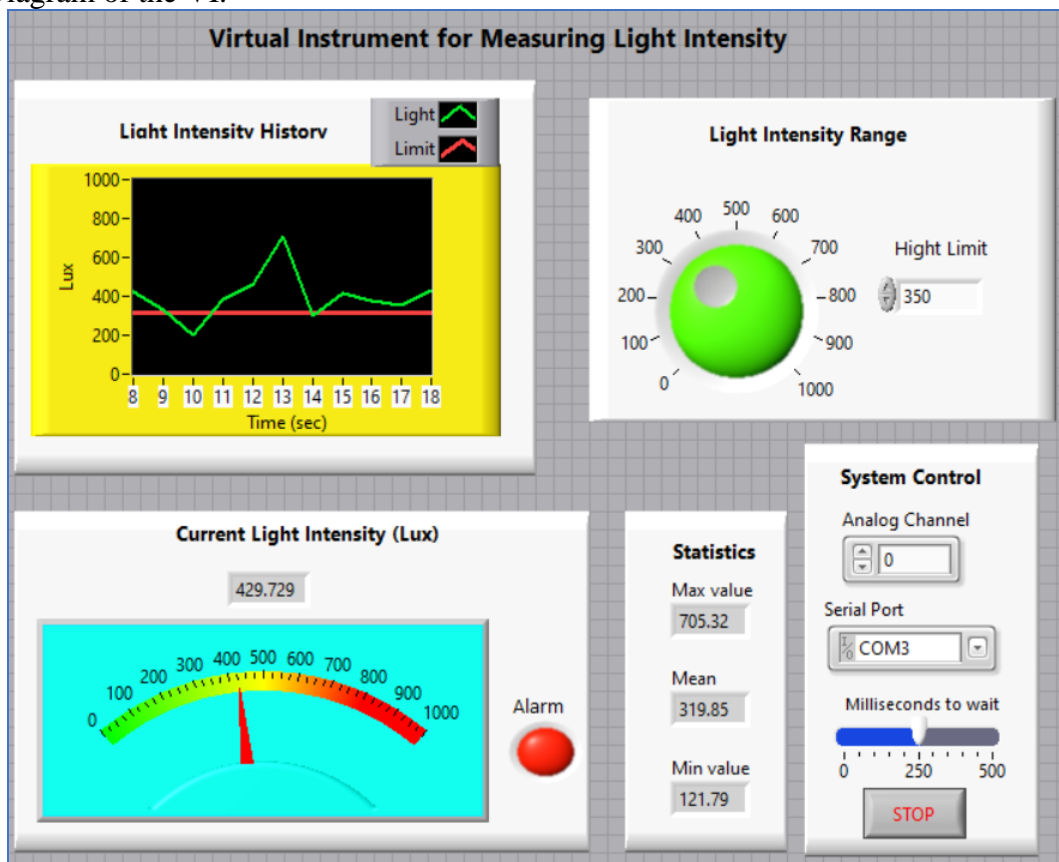
Figure 4. The Front Panel of the VI

In addition to the entire graphical interface, the LabVIEW environment (like the other simulation, testing and programming) allows connection to physical equipment (hardware). In addition to the dedicated equipment, compatible with LabVIEW, there are other platforms development devices such as Arduino, which can be used in the environment LabVIEW.

The Front Panel contains buttons, graphics, and other controls and indicators. The Block Diagram is the window that contains the source code of the virtual application. This window contains:

-terminals, which represent the correspondent of the objects in the Front Panel in the Block Diagram, and which are represented by suggestive symbols;

-nodes, which have inputs and outputs and are equivalent to instructions, functions, and routines in text-based programming languages;
-structures, which are equivalent to cycling and conditioning instructions in text-based programming languages;
-wires, which allow the circulation of data in the Block Diagram.
The Block Diagram created below, reads the voltage at 10 Kohm resistance terminals, using Arduino Uno development platform, and then converts this voltage into light intensity, using relation (2).
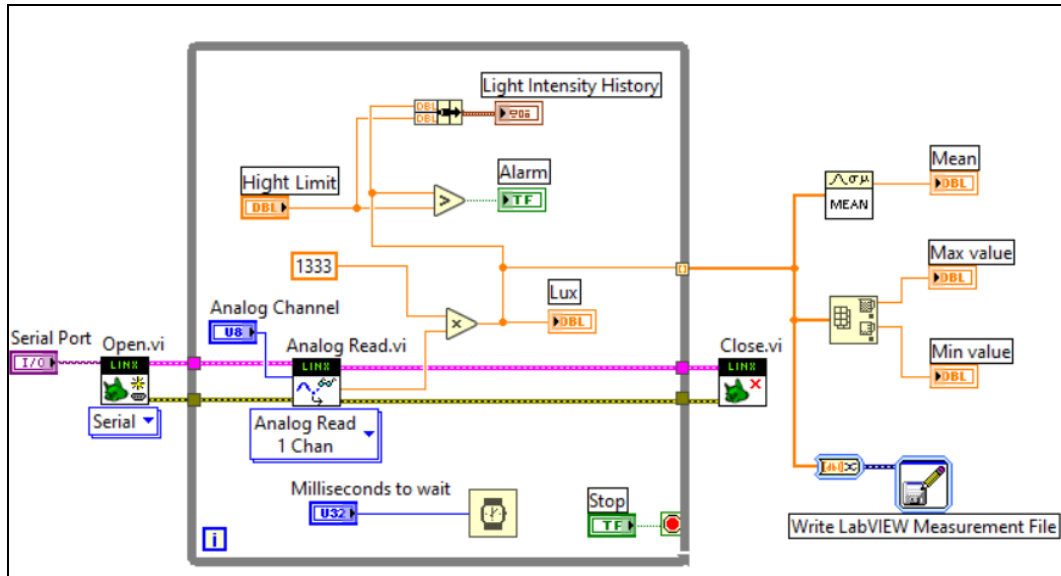

Figure 5. The Block Diagram of the VI

3. Conclusions

This paper explains how to use the Arduino Uno development platform, together with the LabView graphical programming language, to measure light intensity in an enclosure, using a photodiode as a sensor. This system could be used in applications where the user wants to control or monitor light intensity, such as hospitals or educational institutes.

LabVIEW integration with Arduino, makes prototyping even easier using LabVIEW's GUI environment with the Arduino platform. The LINX extension package enables a variety of built-in control development platforms, such as the Arduino Uno, to interface with electronic circuits, electromechanical components, and sensors, easily using LabVIEW software. LINX firmware enables the communication between interface components and embedded development platforms for development via USB, I2C, and SPI interfaces. Analog, digital and PWM signals can also be easily controlled using LabVIEW software.

Advantages of using the Arduino platform:
-it is open-source, so it has a wide community of users and troubleshooting possibilities;
- a lightweight USB interface. The chip on the card connects directly to the USB port and registers on the computer as a virtual serial port.
- very convenient power supply control and built-in voltage regulation;
- an easy-to-find and inexpensive microcontroller.

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