Light Intensity Meter Using LM324

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Abstract**-- The sun is our most important source of light in many areas of our daily life. However, artificial lighting is used in certain circumstances. When an environment includes artificial lighting, it is important to ensure that the lighting is designed to provide a satisfactory level of lighting for the user and a comfortable level of lighting for viewing without eye strain or fatigue. Lighting is important as it deals with visibility level, colour and glare. Illumination can be measured with a light intensity meter. In this project we used a light intensity meter to get a lux reading for 4 different intensity levels. Different light sources give different intensity of illumination. The light intensity meter is adapted to the spectral sensitivity of the eye and measures brightness in lux. The device captures the light intensity in its sensor and compares it to a reference and outputs the output using LEDs.**

Keywords**-- Light Intensity Meter, Lux Meter, lighting, luminance, LM324, LDR**

I. INTRODUCTION

A light intensity meter (also known as a lux meter) is a device that measures illuminance and light emission in the SI unit, lux. It effectively measures the power of light falling on a given unit area, except that the power measurement is weighted to reflect the sensitivity of the human eye to different wavelengths of light. A simpler way to describe a light intensity meter is to say that it measures how bright the light is falling on the sensor. Commercially available light intensity meters vary in price (ranging from 1000 to 3000 rupees) but it is cheaper to build one yourself.
The light intensity meter uses several types of light sensors, including photodiodes and phototransistors, but the easiest sensor type to use and often the most readily available is a photoresistor, or light dependent resistor (LDR), which was used in this project.

For convenience, illumination in lux can be divided by 10 to get illumination in lumens/sqft. An idea of illuminance levels can be obtained from the following data:

TABLE I
ILLUMINANCE OF DIFFERENT LOCATIONS

Location	Illuminance
Average living room	50 to 60 Lux
Corridors and passages	10 to 30 Lux
Entrances	100 Lux
Stairs	100 Lux
Living room	300 Lux
Kitchen	200 Lux
Study room	300 Lux
Bathroom	100 Lux
General offices	80 to 110 Lux
Office with good lighting	600 to 800 Lux
Drawing offices	200 to 250 Lux
Hospital operation table	1000 to 2000 Lux
Classrooms	100 Lux
Laboratories	150 Lux

Level of illumination was influenced by many factors. For example, we don't get much natural light in the corridor in the middle of the building. This area is blocked by surrounding walls. In addition, the artificial lighting provided along the corridor is not fully functional, so the corridor receives less light during daylight hours.

II. COMPONENTS AND PRINCIPLE

TABLE II
LIST OF COMPONENTS

Sr. No	Component	Value / Specification
1.	Op-Amp	LM324
2.	Light Sensor	LDR
3.	Potentiometer	10KΩ
4.	Resistors	220Ω and 10KΩ
5.	LEDs	Red, Yellow, Green and Blue
6.	Battery	9V

The electronic components used in this project are:

A. *Resistors:* Resistors are passive devices that restrict current flow or divide voltage through circuitry. Input power is passed through these resistors and then to the sensors to prevent damage..

B. *Potentiometer:* The potentiometer is the most common variable resistor. It acts as a resistive divider and is typically used to generate a voltage signal depending on the position of the potentiometer.

C. *Breadboard:* The breadboard is the fundamental component of any circuit building process. All components, be they input sensors or output indicators, are connected to the power supply microcontroller via wire connections through a breadboard. The holes in the breadboard are in line. There are different sizes like full-size, half-size and mini-breadboard.

D. *LEDs:* Light Emitting Diode is a semiconductor device which is commonly used visual indicator for the output. When current flows through it, it emits light.

E. *Wires:* These are the main components that are used to make the connections between different devices of the circuit.

F. *LDR:* LDR is a photoresistor that works on the principle of photoconductivity. The photoconductive light sensor does not generate electricity, but simply changes its physical properties when exposed to light energy. The most common type of photoconductive device is the photoresistor, which changes its electrical resistance in response to changes in light intensity. Photoresistors are semiconductor devices that use light energy to control the flow of electrons and therefore the current flowing through them. The photoconductive cell commonly used is called a light dependent resistor or LDR.

As the name suggests, the Light Dependent Resistor (LDR) is constructed from a piece of exposed semiconductor material (for example, cadmium sulfide) that changes its electrical resistance from few hundred ohms when light falls to several thousand ohms in the absence of light by breaking electrons hole pairs in the material.

The net effect is an improvement in its conductivity, since with an increase in illumination the resistance decreases. In addition, photoresistive cells have a prolonged response time requiring many seconds to respond to a change in the light intensity.

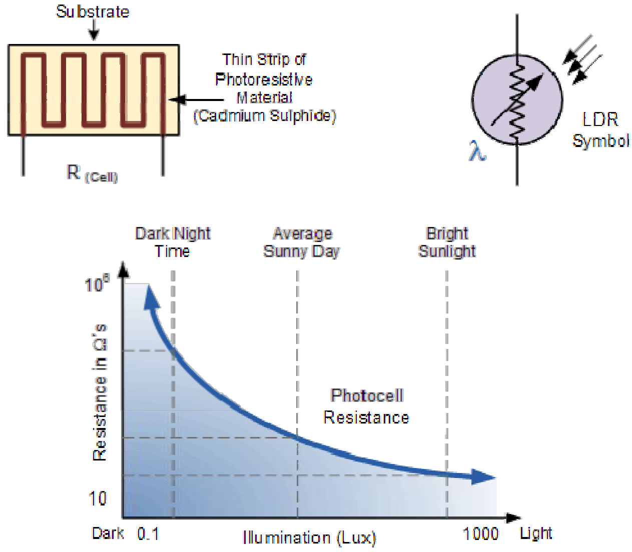

Fig. 1 Characteristics of LDR

G. *Opamp:* The LM324 IC consists of 14 pins with four independent operational amplifiers in one package. These electronic voltage amplifiers are available in high gain with a differential input as well as a single output. The voltage difference between the input terminals of the IC is very less than the output voltage. These comparators operate from a single power supply, eliminating the need for a dual supply. These ICs can be used as comparators, oscillators, amplifiers, rectifiers, etc. Pin configuration of the LM324 is:

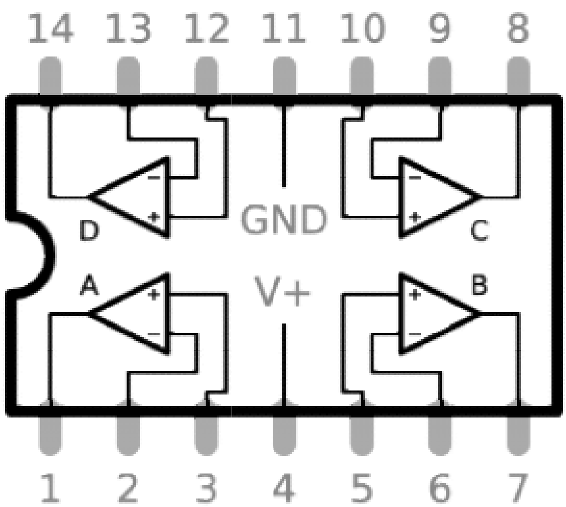

Fig. 2 Pin Configuration of LM324

H. *Battery:* It is used to supply dc voltage the circuit.

The equipment used in this project is:

Multimeter: Multimeter is a multifunctional electrical measuring device. Its main function is to measure the properties of the electrical signal. Multimeter combines functions of an ammeter, a voltmeter and an ohmmeter, as well as other electrical measuring devices.

The software which was used to make the schematic/circuit diagram and block diagram are Circuit Diagram and Smart Draw respectively. Also, the stimulation software used for this project is Multisim.

III. WORKING

A. Design and Operational Details

The proposed 4-LED Light Intensity Meter circuit uses comparators in the form of operational amplifiers of the LM324 IC.

This IC is much more versatile than the other opamp counterparts due to its higher voltage tolerance and quad op amp in one package.

All four operational amplifiers were used in the proposed LED light intensity meter circuit. As can be seen from the circuit diagram, the configuration is simple, but the result is effective.

Here the non-inverting pins of all four op amps are clamped to a fixed reference level determined by the voltage divider circuit, which is not critical and is decided by the LDR.

The inverting pins of the opamps are configured as the sensing inputs and are terminated with variable resistors or the potentiometers.

The shown Light Intensity Meter (fig) is configured in the “bar graph" mode, i.e., the cathodes of all the LEDs are connected to the ground or the negative line.

If we want to configure it in the "dot" mode (, i.e., only one LED glows at any instant indicating the relevant voltage/intensity level), then simply disconnect the cathodes of all the LEDs from the existing points and connect them as shown in fig below

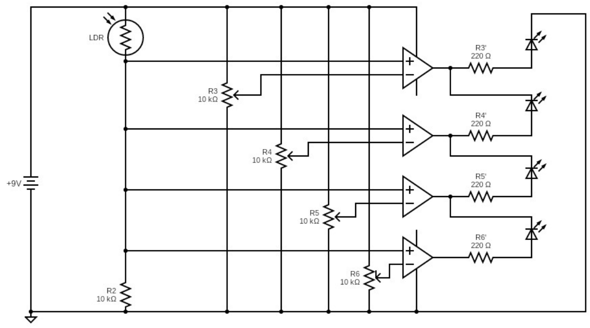

Fig. 3 Circuit Diagram of Light Intensity Meter in “Dot” Mode Configration

B. Voltage Divider Circuit

Connecting a light dependent resistor in series with a standard resistor like this across a single DC supply voltage has a major advantage that a different voltage will appear at their junction for different levels of light. The magnitude of the voltage drop across the series resistor R2 is determined by the resistance value of the light-dependent resistor. R_{LDR}. This ability to generate a range of voltages produces a very useful circuit called a "Potential Divider" (or Voltage Divider Network as we know). In this the current through a series circuit is common and as the LDR changes its resistive value due to the light intensity, the voltage present at V_{OUT} will be determined by the voltage divider formula. An LDR’s resistance, R_{LDR} can vary from about 100Ω's in the sun light, to over 100kΩ's in absolute darkness with this variation of resistance being converted into a voltage variation at V_{OUT} as shown.

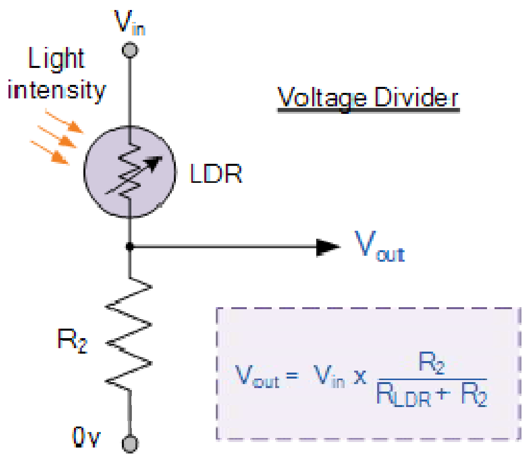

Fig. 4 Voltage Divider Network

IV. BLOCK DIAGRAM

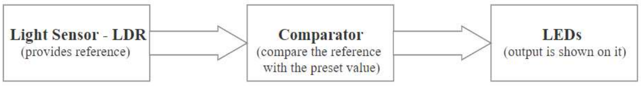

Fig. 5 Block Diagram of Light Intensity Meter

V. CIRCUIT & SCHEMATIC DIAGRAM

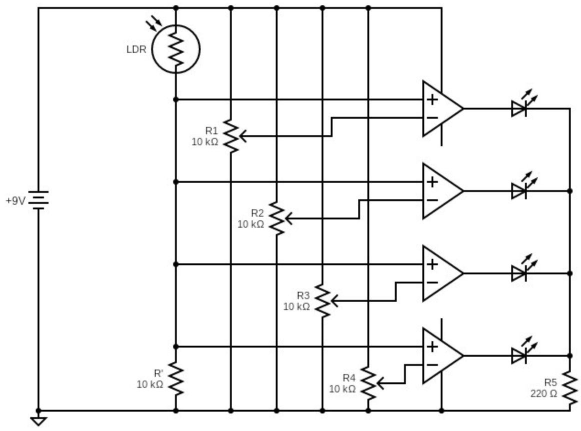

Fig. 6 Circuit Diagram of Light Intensity Meter

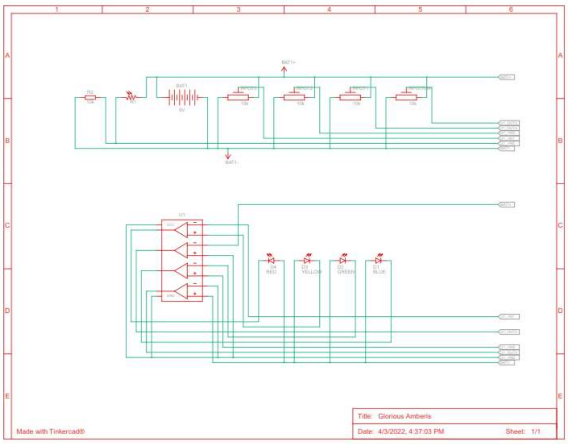

Fig. 7 Schematic Diagram of Light Intensity Meter

VI. APPLICATIONS

Light Intensity Meter is used to calculate light intensity in different areas. For example, every display and photo device has a light intensity meter built into its hardware. Means that the automatic brightness of the smartphone display or the TV display or the display of another device is controlled by measuring the ambient brightness with a light intensity meter in its hardware. And we use light intensity meters in our labs to measure and maintain visibility with additional bulbs/tubes so we can provide good visibility to comfortably complete daily tasks. We also record the daily luminance in our environmental balance register.

VII. CONCLUSION

At the end of this project we were able to compare the illuminance for 4 different intensity levels. The LDR light intensity meter is cheap and easy to manufacture. Not incredibly accurate, but can be good enough in most conditions. So, from using this light intensity meter in different places, we can conclude that the right lighting depends on the position and design of windows, light sources, the type of lighting fixtures, the choice of light source, the intensity and distribution of the light source and fixture combination and the room environment. A high average level of illumination comes mainly from places that are wide open and naturally receive light from solar resources, as well as places provided by the high output of fluorescent lamps.

One of the major problem associated with this light intensity meter is:

Problem: As you would expect, the resistance of an LDR changes with the amount of light falling. If you can measure the resistance of the LDR and know the characteristics of your particular LDR, you can quantify the amount of lux falling on the LDR. In general, the brighter the light, the lower the resistance, but unfortunately the relationship between resistance and lux isn't a nice linear relationship for an LDR. Instead, it is an exponential relationship that is a separate task.

This problem can be solved by taking some measurements to determine the mathematical relationship between resistance and lux and programming the relationship into a microcontroller to create a simple and reasonably effective lux meter.

VIII. ACKNOWLEDGEMENTS

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