**Development of Optical Sensor with Photoresistor Monitoring Sun Location for Photovoltaic Solar Panels in Proteus Software**

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**Abstract.** This article photovoltaic gives information about modules, solar collectors and another on devices the sun location situation determiner photo-resistor photo sensors of developments new appearance about common in the article photodiode optical sensors and photo-resistor photo sensors. This type photo-resistor mutually compared to photo sensors with simple photovoltaic to systems when used, photovoltaic of the system energy efficiency of PV modules to the sun constant respectively upright in case to stand provide the way through, energy efficiency to increase is achieved.

**Key words:** sun, photoresistor, photodiode, photosensor, photovoltaic power stations, PROTEUS

**INTRODUCTION**

Today, the world is experiencing a global energy transition. Countries are seeking to expand their renewable energy capacity in order to lessen reliance on volatile and environmentally unsustainable non-renewable energy sources, including traditional fuels such as coal, oil, and natural gas.”

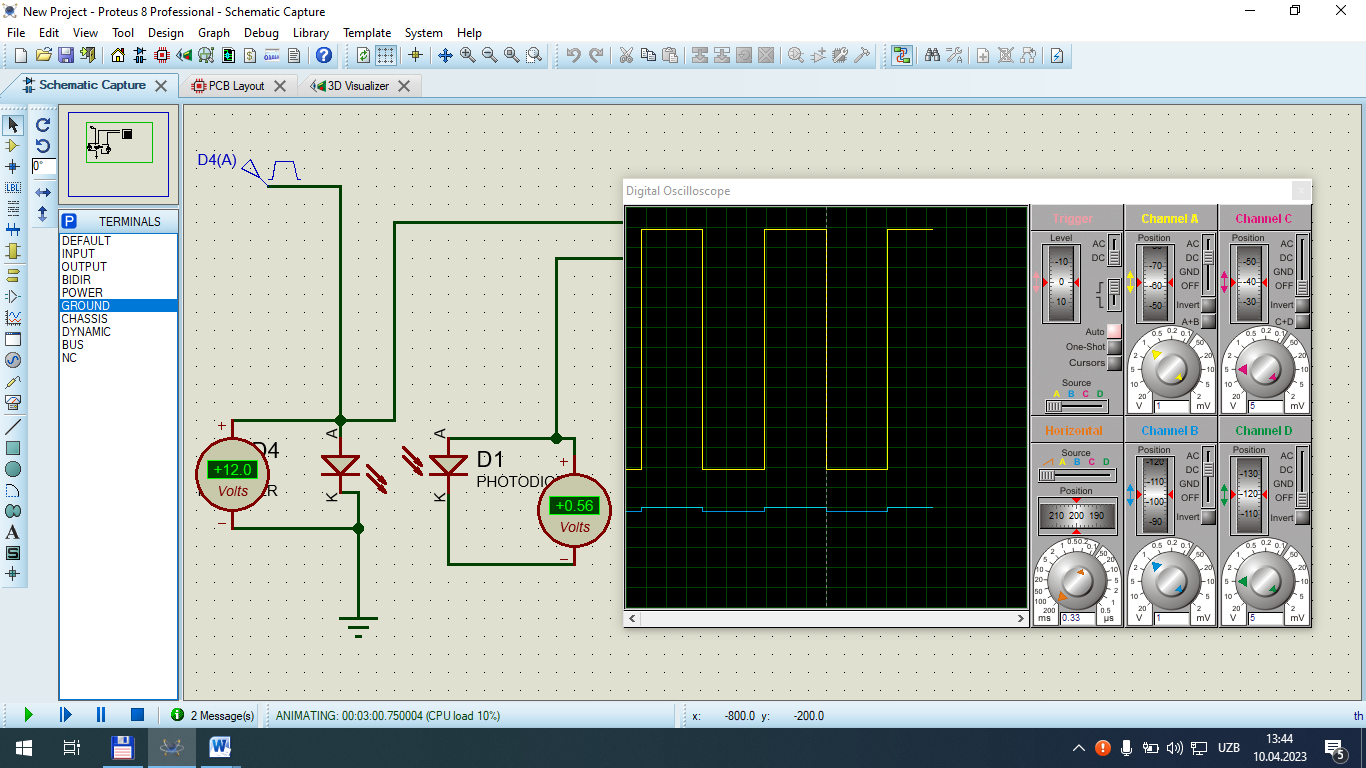
[According to IEA,](https://www.iea.org/reports/renewable-energy-market-update-may-2022/renewable-electricity)  the world's renewable energy capacity is expected to exceed 8 percent in 2022. In addition, solar energy accounts for 60 percent of this growth organize does [1].

The above fact shows that the solar photovoltaic (PV) system is the fastest growing method of generating electricity from renewable energy sources. Therefore, increasing the efficiency of PV modules is becoming the most urgent issue of our day. Scientists of our country and the world are conducting various researches on several methods of increasing the efficiency of PV modules. Examples of such research include obtaining new types of photovoltaic structures, increasing their efficiency by introducing various fractions into the silicon content, and introducing a system for automatically pointing existing PV modules to the sun. Currently, the leading scientists of our time are conducting research on single-axis and two-axis methods of the solar observation system. Photovoltaic panels can usually be controlled using a single-axis or dual-axis solar tracking system [2]. Both methods show good results in increasing the energy efficiency of PV modules. An analytical paper by researchers Pratik A. Thorat, APEdalabadkar, RBChadge, Anuja Ingles shows that the annual energy efficiency of PV modules can be increased by about 15% to 45% depending on the geographical location by implementing a solar tracking system [3]. The above data shows that the high-precision operation of solar tracking system used in PV modules leads to further improvement of PV module efficiency. Consequently, this paper presents an investigation of an innovative optical sensing device intended for precise solar position detection within a dual-axis solar tracking system.

**Methods.** Solar tracking systems outperform all types of fixed PV modules, with studies showing 25% in Malaysia [4], 31% in Jordan [5], 13%–18% in Brazil [6], 41% in Thailand [ 7], 30%–40% in Tunisia [8], 30%–45% in the USA [9], 12%–29% in Nigeria [10] and 12%–26% in Mexiko.

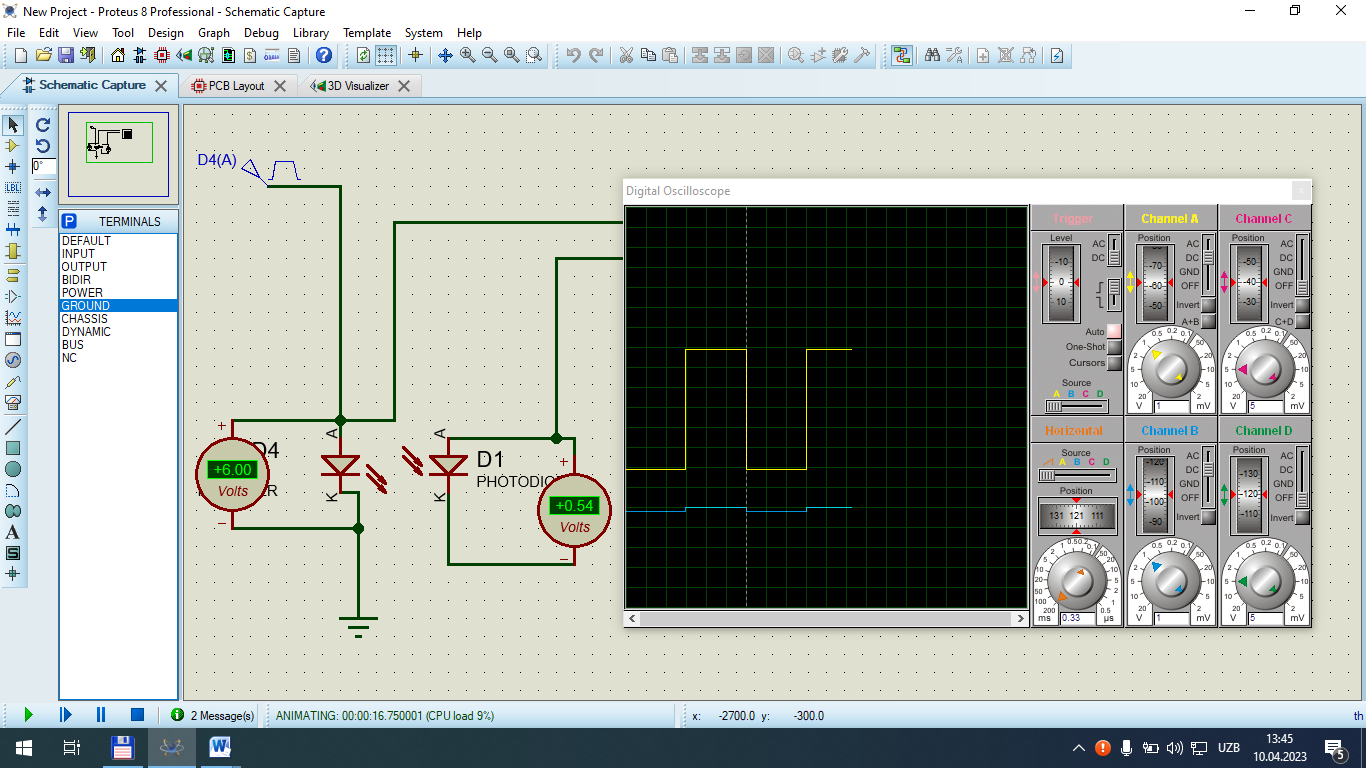
Any solar tracking system will not work without an optical sensor to guide it to the position of the sun. This requires us to conduct many experiments on optical sensors. The results of experiments on light sensitivity of optical photodiodes and photoresistors used in the experiments were obtained and analyzed in the PROTEUS program.

At first, the circuit was made using a light-emitting diode and a photodiode in the program (figures 1, 2, 3) and the potential generation in the photodiode was studied by applying different voltages to the light-emitting diode. In the first experiment, the circuit shown in Figure 1 was constructed and a 12 volt 0.5 Hz pulse was applied to the emitter and the receiver voltage was observed. As a result, it was determined that a voltage of 0.56 volts is generated in the photodiode. Signals are also clearly visible in the oscillogram that the signal generated in the photodiode is very small.



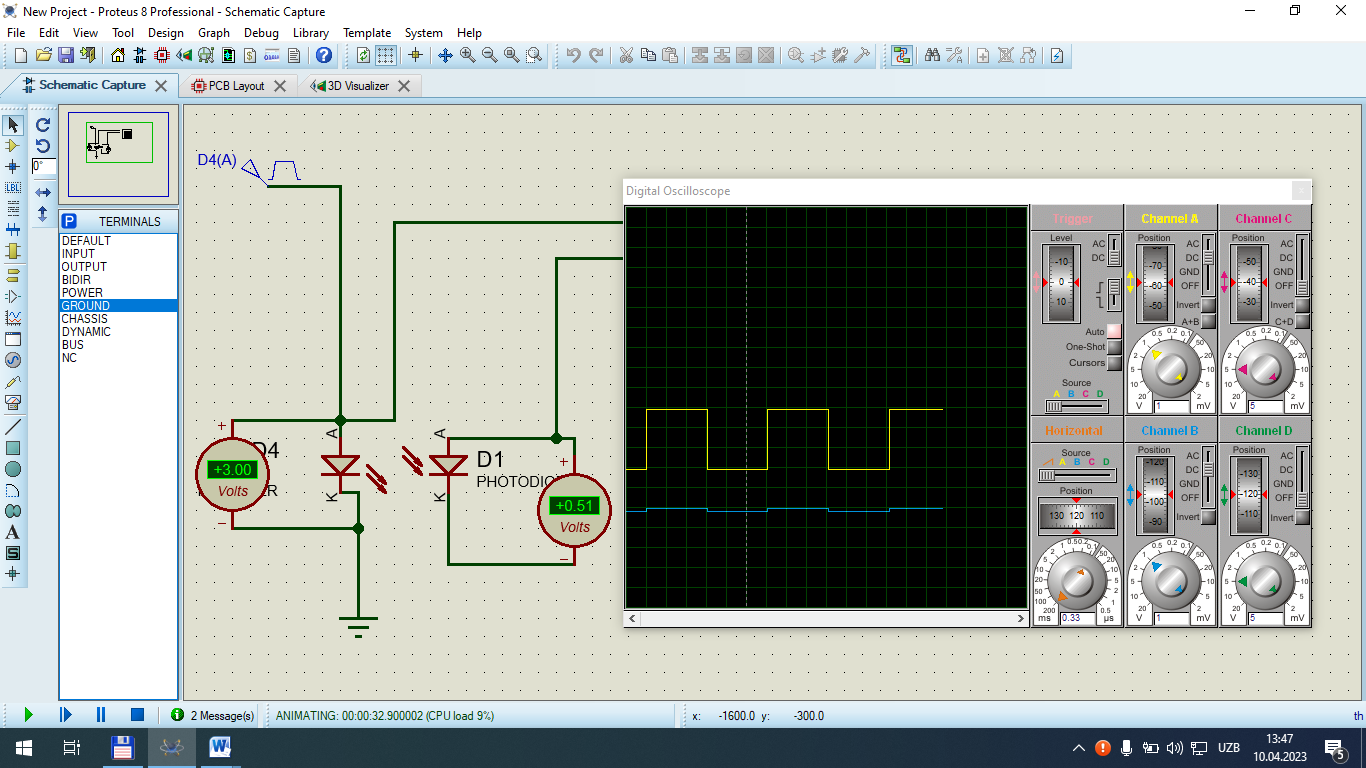
**FIGURE** **1.** Photodiode at 12 volts check scheme.

In the second experiment, a 6 volt 0.5 Hz pulse was given to the emitter and the receiver voltage was again observed. In Figure 2, it was observed that a voltage of 0.54 volts is generated in the photodiode.



**FIGURE 2.** Photodiode at a voltage of 6 volts check scheme

In third experiment, a 3-volt 0.5 Hz pulse was applied to the emitter, and the receiver voltage was again monitored. In Figure 3, it was observed that a voltage of 0.51 volts is generated in the photodiode. The obtained results showed that a sharp change in the light flux did not cause a sharp change in the potential in the photodiode.



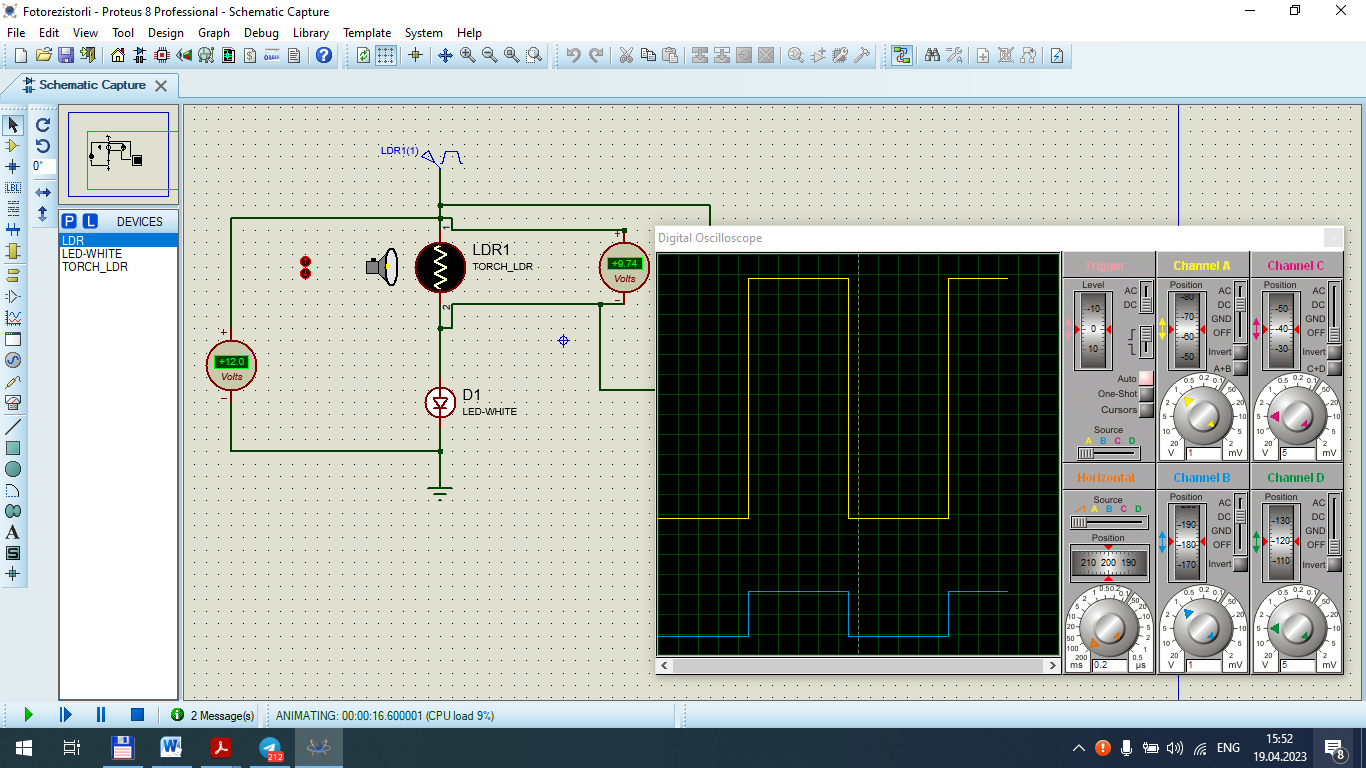
**FIGURE 3.** Photodiode at a voltage of 3 volts check scheme

In the photodiode in Table 1 below harvest happening potential change linear it's not that and very even small that showing is standing and this the photodiode optical acceptance doer as to use one so much complicates.

**TABLE 1.** Comparison of photodiode voltage response at different illumination levels

|  |  |  |  |
| --- | --- | --- | --- |
| Experiments | Illuminator voltage, V | Photodiode voltage, V | Tensions difference, V |
| Experiment 1 | 12 | 0.56 | 11.44 |
| Experiment 2 | 6 | 0.54 | 11.46 |
| Experiment 3 | 3 | 0.51 | 11.49 |

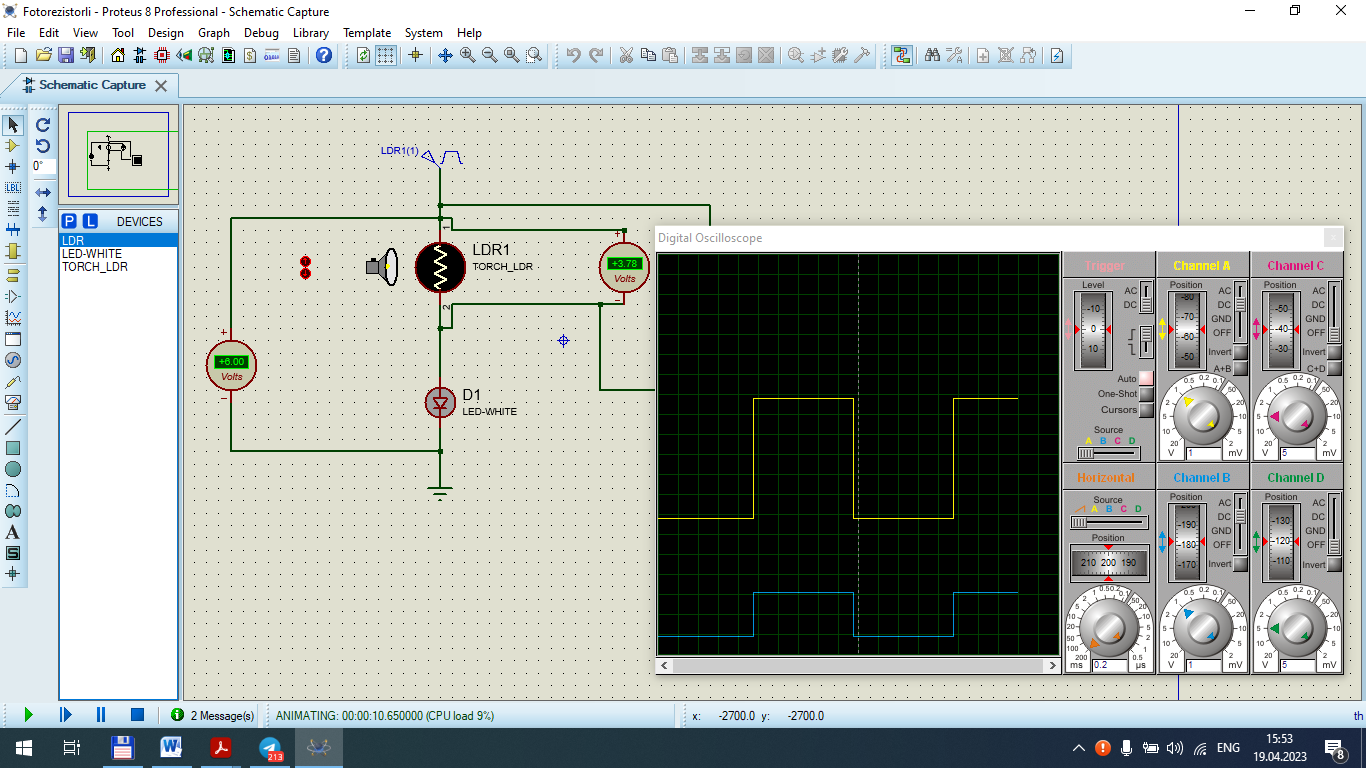
Above experiences we will do for photo-resistor. Initially, the program was designed using a photoresistor with light (Figures 4, 5, 6) and the potential of the photoresistor with different voltages was studied. In the fourth experiment, the circuit in Figure 4 was constructed and a 12 volt 0.5 Hz pulse was applied and the receiver voltage was observed. As a result, it was determined that a voltage of 9.74 volts is generated in the photoresistor. Signals are also clearly visible in the oscillogram that the signal generated in the photoresistor is several times higher than the signal generated in the photodiode.



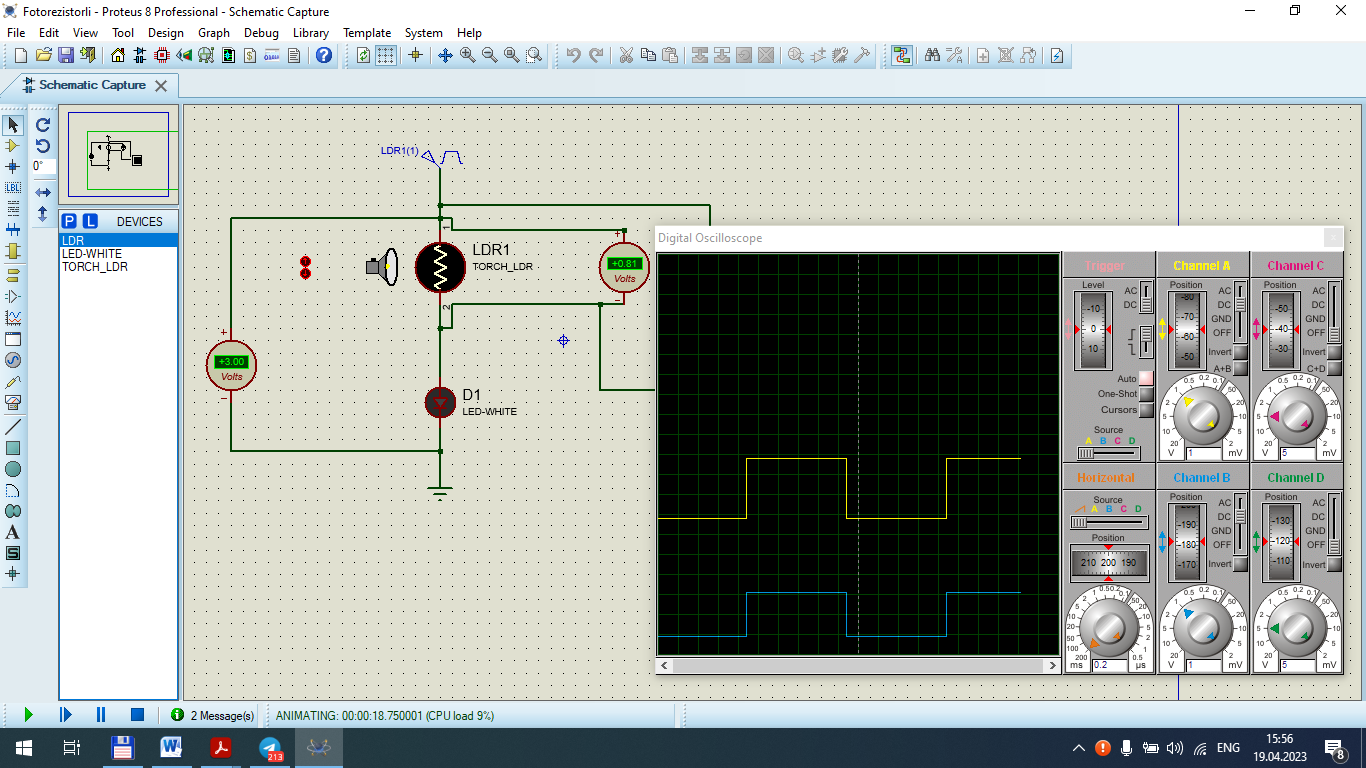
**FIGURE 4.** Photo-resistor at a voltage of 12 volts check scheme

In the fifth experiment, a 6 volt 0.5 Hz pulse was given and the receiver voltage was again observed. In Figure 5, it was observed that a voltage of 3.78 volts is generated in the photoresistor.

In the sixth experiment, a 3 volt 0.5 Hz pulse was given and the receiver voltage was again observed. In Figure 6, it was observed that a voltage of 0.81 volts is generated in the photoresistor. The obtained results showed that a sharp change in the light flux led to a sharp change in the potential in the photo-resistor. This makes it easier to determine the level of illumination.



**FIGURE 5.** Photo-resistor at a voltage of 6 volts check scheme



**FIGURE 6:** Photo-resistor at a voltage of 3 volts check scheme

**RESULTS AND DISCUSSIONS**

Table 2, compares the potential change in the photoresistor and the potential change in the photodiode, and it can be seen that the change in both sensors is not linear. But it was found that the potential generated in the photoresistor is much higher. This makes the use of the photoresistor as an optical receiver impossible.

**TABLE 2.** Comparative analysis of photoresistor and photodiode voltage responses

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Experiments | Illuminator voltage, V | Photoresistor voltage, V | Photodiode voltage, V | Tensions difference, V |
| Experiment 1 | 12 | 9.74 | 0.56 | 9.28 |
| Experiment 2 | 6 | 3.78 | 0.54 | 3.24 |
| Experiment 3 | 3 | 0.81 | 0.51 | 0.30 |

Figures 7 and 8 show graphs of the potentials generated in the photodiode and photoresistors and the voltage applied to the irradiator.

**FIGURE 7.** Graph of dependence of the potential generated in the photodiode on the voltage applied to the irradiator.

**FIGURE 8.** The graph of the dependence of the potential generated in the photoresistor on the voltage applied to the irradiator

# CONCLUSION

In conclusion, our overall experimental study on optical sensors in the PROTEUS simulation platform has indicated that there are vast differences in the performance features of photodiodes and photoresistors in terms of their use in solar tracking. The photoresistor had significantly higher light sensitivity with 9.74V at 12V light illumination, versus 0.56V in the photodiode—a 17-fold enhancement in signal value. This drastic characteristic in electrical performance renders photoresistors the material of choice in the most dependable sun position measurement in photovoltaic tracking.The objective of the experimental results shows that photoresistor displays enhance the changes in their parametric variation under diverse light conditions, and under different illumination conditions, voltage outputs vary between 0.81 V and 9.74 V. The broad dynamic range allows a greater differentiation of the solar positions and intensities, which is essential in control algorithms of precise tracking. Moreover, the larger signal-to-noise ratio of the system based on photoresistors demands a more elaborate signal amplification circuit, lessens the design of the system, and reduces the total costs in implementation.These results have enormous implications for developing cost-effective solar tracking systems, especially in developing regions where the affordability of the components is paramount. We can have the reported efficiency gains of 25-45 percent in the PV systems with the use of photoresistor-based optical sensors, and at the same time, the hardware cost is lower than those using photodiode-based systems. The high signal properties of photoresistors also imply improved performance of such devices in harsh environmental factors such as partial shading and atmospheric interference.The study that we have conducted will help add to the existing literature on the optimization of the renewable energy systems and will contribute to the worldwide shift towards renewable energy sources. The validated simulation models that are created during the current study have the potential to support future researchers to consider the development of superior sensor configurations and control strategies without the high cost of hardware prototyping..

**FUTURE SCOPE**

The better response of photoresistors (9.74V vs 0.56 V response) opens up a research pathway to a number of investigations. The accuracy of the tracking at variable weathers could be improved with integration of machine learning algorithms and may surpass the existing efficiency improvements of 25-45 percent. Whether this would be implemented in IoT-enabled wireless sensor networks to allow real-time monitoring and predictive maintenance to large-scale solar farms. Even more promising spectral response and stability are advanced materials, such as perovskite photodetectors and graphene junctions. Lastly, to verify the laboratory findings, it would be necessary to test a field over multiple seasons in different geographical locations to come up with consistent metrics of LCOE that can be used in a commercial application.

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