Journal of Electrical Engineering and Computer (JEECOM)
Vol. 7, No. 1 (2025), DOI: 10.33650/jeecom.v4i2
p-ISSN: 2715-0410; e-ISSN: 2715-6427

Design Of Monitoring System And Control Unit Battery On Solar Panels

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Article Info

Article history:

Received April 24, 2025
Revised April 27, 2025
Accepted April 28, 2025

Keywords:

Solar Panel Control
Current Sensor
NTC Sensor

ABSTRACT

Solar panels are the main devices in solar power generation systems that function to convert sunlight energy into electrical energy directly. The purpose of this study is to make it easier for users to monitor the voltage and current values produced by solar panels through the designed display (LCD). This tool was developed using the Arduino Nano microcontroller. With several sensors such as Current used to detect DC and AC electric currents. The Voltage Sensor is used to measure the voltage on the solar panel and the Kijo1250 lead acid battery. The NTC sensor is used as a setpoint for the bulk and float charging processes during the battery charging process. Research results In the battery controller system on the solar panel, the MOSFET produces an input voltage of 14.8V and a current of 4.73A at 12:44:57.

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1. INTRODUCTION

The need for electrical energy continues to increase along with population growth and technological developments. So far, most of the supply of electrical energy has depended on non-renewable fossil energy sources, such as petroleum, natural gas, and coal. This dependence causes various problems, one of which is the energy crisis due to limited fossil reserves and the environmental impacts it causes. Therefore, the use of renewable energy such as solar energy is one of the most potential solutions to reduce dependence on fossil energy and increase energy demand [1].

Solar energy can be utilized through a solar power generation system (PLTS) that relies on solar panels to convert sunlight energy into electrical energy. In the PLTS system, batteries play an important role as an energy storage medium, so that they can be used whenever needed, including when there is no sunlight [2]. However, optimal battery use requires a good monitoring and control system to determine the condition of the battery, such as voltage, current, temperature, and state of charge (SOC) [3][4].

SOC is an important parameter that shows the percentage of battery energy capacity to its maximum capacity [5]. Inaccurate SOC estimation can cause permanent damage to the battery due to overcharge or overdischarge [6]. Therefore, a monitoring and control system is needed that can monitor battery conditions in real time and regulate the charging process carefully [7].

This study aims to design a monitoring system and battery control unit on a solar panel that is able to display important information such as voltage and electric current, and control the charging process by considering the battery temperature as a control parameter. This system is designed using an Arduino Nano microcontroller and is equipped with a voltage sensor, current sensor, NTC temperature sensor, and LCD screen as a display media. It is hoped that this system can not only increase the efficiency of solar energy use, but also extend battery life by preventing damage due to uncontrolled charging.

2. METHOD

Research with the title of Monitoring System Design and Battery Control Unit on Solar Panels [8][13]. The writing process uses the following writing method :

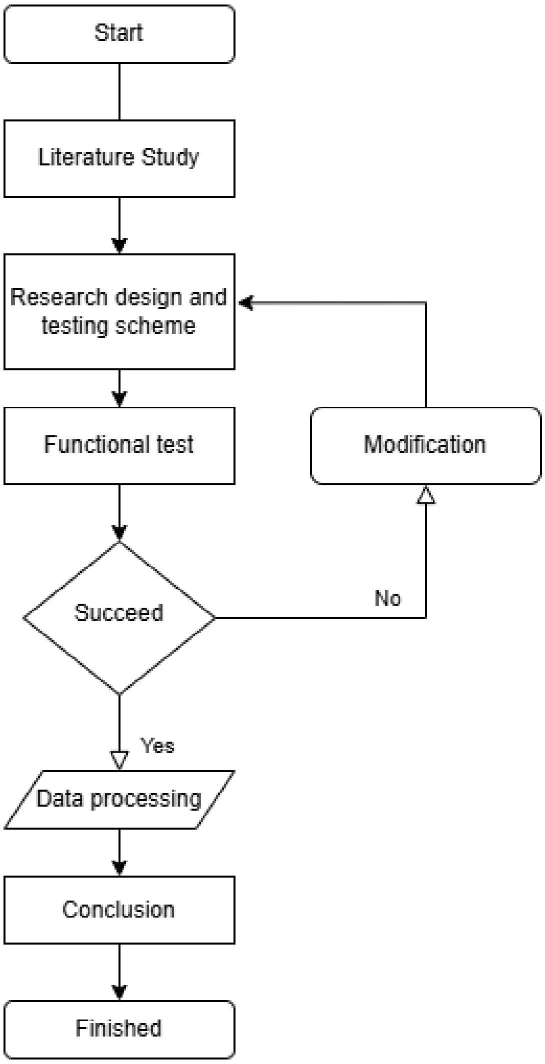


Figure 1. Research Flow Flowchart

In this thesis, there are materials used, which can be seen in table 1**.**

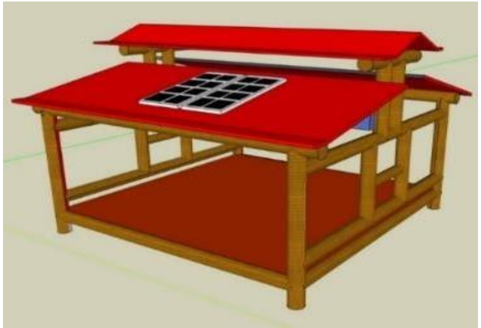
Table 1. Material Table

No	Material	Information
1.	Arduino Nano	Control Material
2.	Battery 50ah 12V	Power Supply Material
3.	LCD Character 20X4	Display Materials
4.	Kabel	Jumpers
5.	Mosfet PWM	Voltage Control
6.	Voltage Sensor	Voltage Sensor Material
7.	Current Sensor	Current Sensor Material
8.	Sensor NTC	T Sensor Material

2.1. Design Solar Panel Design on Gazebo

Tool design is a description of tool planning that is used as a reference for making state of charge tools. The design is made to place the tools on the campus Gazebo. Based on the design of the tool in Figure 2, the stateof charge tool will be placed in the right position of the solar panel [9] [15]. The state of charge will be put into a blue box to be protected from damage to the surrounding environment [10].

(a)



(b)

Figure 2. (a) Design Solar Panel, (b) Design on Gazebo

2.2. Overall System and Circuit Schematic Design

The way the monitoring system and battery control unit work on solar panels is as a tool that can monitor how the battery and solar panels work so that they function properly [11] [12]. And also as a tool that can be a charger for batteries where the input electricity comes from solar panels. This will also reduce dependence on conventional electricity. The entire system is explained in the block diagram below :

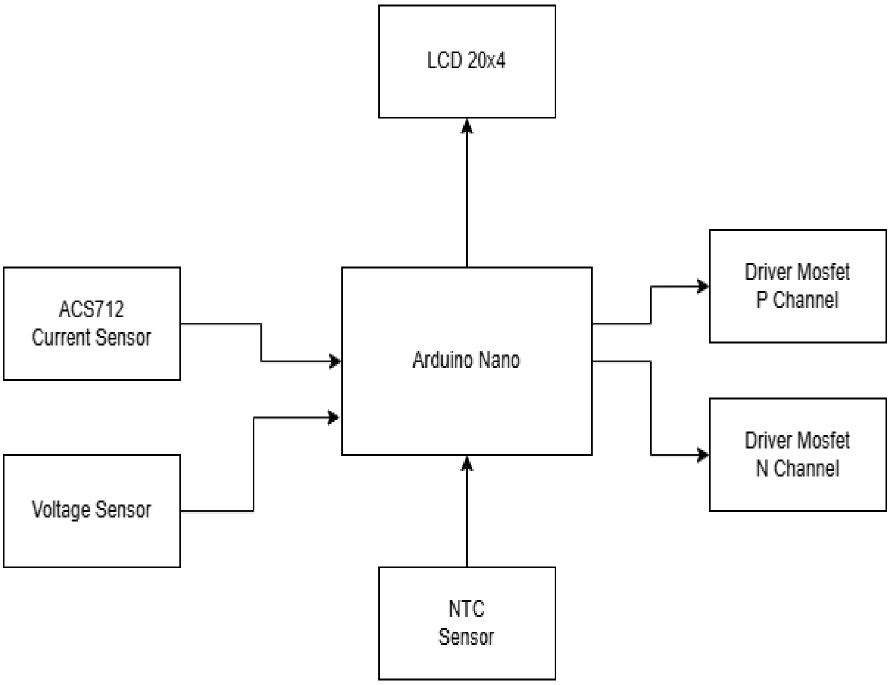


Figure 3. Overall System Block Diagram

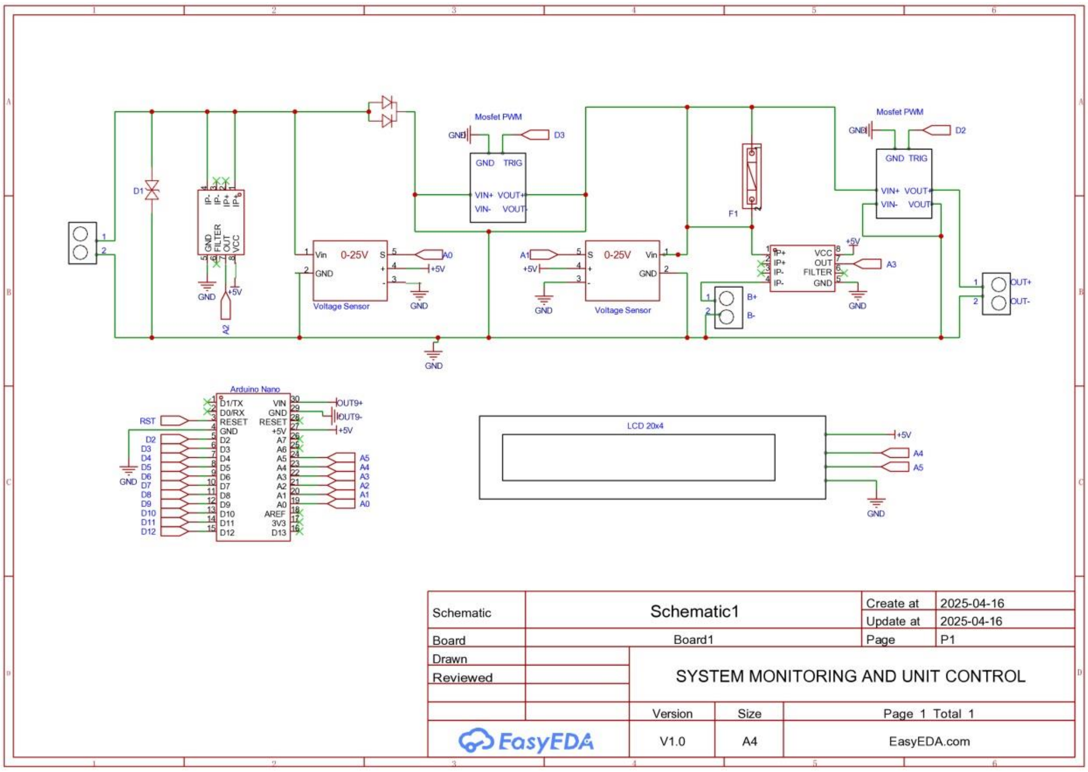


Figure 4. Overall Circuit Schematic Design

3. RESULTS AND DISCUSSION

The research conducted is the Role of the Design of Monitoring Systems and Battery Control Units on Solar Panels. The results of the study prove that the designed tool has performance that is in accordance with expectations [14]. At the design stage, the design tool was developed to support the function of the tool and can be placed in the campus Gazebo. The overall visualization of the tool design results is presented in Figure 5.

Figure 5. Overall Tool View

In Figure 5, the box used is 18 x 12 cm in size and is made of plastic that is able to protect the device circuit that is arranged on a perforated PCB, while the top cover of the box uses a closed-open type. On the top of the box cover, there is a 20x4 LCD component to display voltage, current, battery. The display in the tool consists of Arduino Nano is a microcontroller board based on Atmega328 designed for electronic projects or systems, 3A functions to convert higher DC input voltage into lower DC output so that it can become 3A current, voltage sensor functions to measure and combine electrical voltage in a system or data series obtained from the sensor, current sensor functions to measure the amount of electric current flowing through a circuit or system, mosfet functions to control the flow of current in a circuit, PWM is a technique used to regulate the power sent to the load, fuse functions as a protector of the electrical circuit that functions to protect the system from excess current, and 20x4 LCD is used as a display or serial communication on the microcontroller. The placement of all components is arranged in such a way in the box. Components that have been assembled or arranged, then soldering and connecting cables using jumper cables.

3.1. Voltage Sensor and Current Sensor Testing

The results of this test are intended to determine the condition of the voltage sensor and current sensor on the solar panel and battery, the results of the functional test of the current sensor are shown in the following table:

Table 2. Solar Panel Voltage Sensor Reading Results

No	Time	Solar Panel voltage (V)	Battery voltage (V)
1.	12:55	17,38	12,67
2.	12:56	17,94	12,67
3.	12:57	18,14	12,67
4.	12:58	18,14	13,33
5.	12:59	18,14	13,33
6.	13:00	18,14	13,33
7.	13:01	18,14	13,13
8.	13:02	18,14	13,13
9.	13:03	18,14	13,13
10.	13:04	17,31	13,13

Table 3. Current sensor reading results

No	Time	Current
1	12.44	4.73
2	13.00	4.73
3	14.00	4.73
4	15.00	4.73
5	16.00	4.73

In the table above the research was conducted during the day, and data collection was done every minute. The readings show that the solar panel voltage sensor is functioning properly. The results of this test are intended to determine the condition of the voltage sensor and current sensor on the solar panel and battery.

3.2. Tool Test Results

Table 4. Control system testing

Time	Solar Volt (V)	Solar Current (A)	Battery Volt (V)	Load Current (A)
12:44:55	17.38	4.73	16.09	3.03
12:44:56	17.94	4.73	16.09	3.03
12:44:57	18.14	4.73	16.09	3.03
12:44:58	18.14	4.73	16.09	3.03
12:44:58	18.14	4.73	16.09	3.03
12:44:59	18.14	4.73	16.09	3.03
12:45:01	18.14	4.73	16.09	3.03

Control system testing in the development of solar panel battery monitoring and control unit systems aims to ensure that the system functions according to the expected design and specifications. This testing covers various aspects of battery charging and discharging, system response to changing conditions, and the effectiveness of safety features.

This test is done by monitoring the battery charging process from almost empty to fully charged in various weather conditions (sunny, cloudy, rainy), while the control system automatically regulates the flow of power from the solar module to the battery based on the intensity of sunlight. In bright conditions, the charging current increases according to the maximum safe capacity of the battery. If the weather is cloudy or rainy, the controller will reduce the charging current to prevent overloading. This shows that the system can respond to input changes in real time.

Testing is done by connecting various loads to the battery and monitoring the energy release process. while when the battery capacity approaches low levels, the control system properly prioritizes critical loads to ensure that essential components continue to operate. Overdischarge protection works properly. When the battery is low, the control system automatically reduces or cuts off the power supply to non-essential consumers.

3.3. Panel to Battery Test Results

Table 5. Panel To Battery testing

No	Tanggal	Waktu	Daya
1	27 Juli 2024	06:00	0.00
2	27 Juli 2024	10:00	15.39
3	27 Juli 2024	12:00	20.14
4	27 Juli 2024	15:00	14.38
5	28 Juli 2024	06:00	0.00
6	28 Juli 2024	10:00	10.25
7	28 Juli 2024	12:00	20.14
8	28 Juli 2024	15:00	18.49
9	29 Juli 2024	06:00	0.00
10	29 Juli 2024	10:00	13.24
11	29 Juli 2024	12:00	0.00
12	29 Juli 2024	15:00	0.00

4. CONCLUSION

The solar powered charge controller design is modified to have a voltage of ±14 volts so that it can easily charge the battery using solar panels. For the input variable from the solar panel is changed by the solar charge controller using the MOSFET switching method, resulting in an input voltage from the solar panel that can be precisely adjusted to produce 14.8V and a current of 4.73A at 12:44:57 by the controller.

ACKNOWLEDGEMENTS

On this occasion, we would like to express our deepest gratitude to all parties who have provided support and contribution to this research. Without the help and cooperation of various parties, this research would not have been possible.

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