IoT-Based Monitoring Of Voltage, Current And Power Of Solar Panel Units

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Abstrac. This research uses a NodeMCU ESP8266 microcontroller and an INA219 sensor to monitor voltage, current and power in a solar power generation system, then the data will be sent via the internet to Blynk.
The monitoring results are read on the LCD and smartphone by testing the solar panel unit in no-load and load conditions with an average error in voltage of 0.08%, current of 0.00% and power of 0.21%.
From the results of voltage, current and power errors on the 10WP solar panel unit with NodeMCU ESP8266 and INA219 on the Blynk application can developed for solar power generation systems.
Keyword: LCD, monitoring, nodeMCU,solar panel, blynk.

1. INTRODUCTION

In solar power generation systems, batteries are used as power storage, the power stored in the battery will be used when solar radiation is low or at night, for this reason the battery voltage and current must remain in good condition so that it can work properly [1]–[3].

Status of charge (SOC) monitoring is quite complicated because it reflects the internal state of the battery [4], [5]. There are no instruments or sensors that can measure SOC directly. Therefore, the term SOC estimation is used instead of SOC measurement. There are many approaches to determine battery SOC parameters [6]. where each approach has its own weaknesses.

Batteries in solar power plants require checking so that the battery voltage and current are maintained. Checks are currently still carried out manually by officers. Manual checks carried out by officers can actually be overcome by using a microcontroller and utilizing Internet of Things (IoT) technology. IoT technology can monitor battery voltage and current online and in real-time and can be displayed on smartphones [7].

NodeMCU is a microcontroller similar to Arduino [8], [9]. NodeMCU has an advantage over Arduino, namely that there is an ESP8266 system on chip that has been embedded in the nodeMCU. ESP8266 functions for Wifi network connectivity. NodeMCU is based on various programming languages but can also use the Arduino IDE for programming [10]

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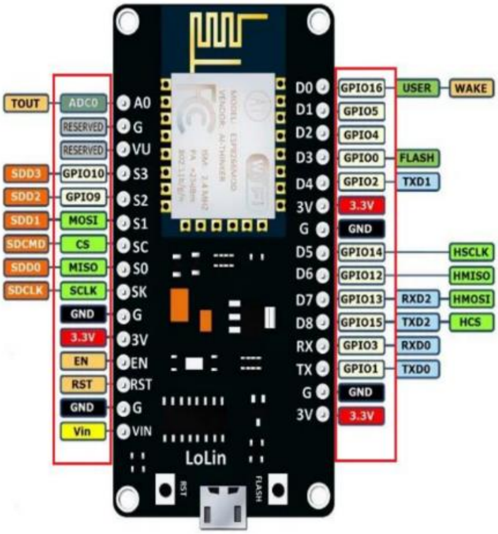

Fig.1. Block I/O pins on NodeMCU

The INA219 sensor is used to measure voltage, current and battery power [11]. The INA219 sensor is a sensor module with measuring capabilities of up to 26 VDC, 3.2 amperes of current and 75 watts of power. The INA219 sensor is a small sensor with a precision level of 1%.

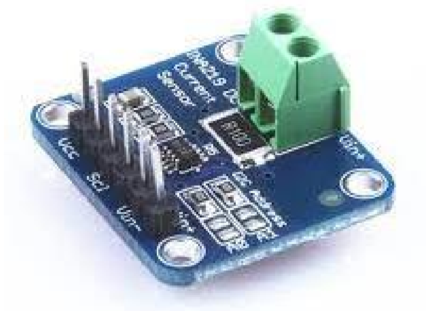

Fig.2. The INA219 sensor

2. EXPERIMENTAL SET UP

This research uses a NodeMCU ESP8266 microcontroller and an INA219 sensor to monitor battery voltage and current in a solar power generation system, then the data will be sent via the internet to Blynk.

The background to this research is that batteries in solar power generation units are used as power storage, the stored power will be used when solar radiation is low or at night, for this reason the voltage and current in the battery must remain in good condition

This IoT-based research aims to monitor batteries in solar power generation units in no-load and load conditions in real time.

This research method is testing monitoring equipment from the design results.monitor solar power generation units in the form of voltage, current and battery power using IoT and the Blink application. The LCD installed on the monitoring tool will display the voltage, current and power values. This value is sent via the Blink application and detected on the smartphone. Testing of monitoring tools on solar power generating units with no-load conditions at 12.00-18.00 WIB and load conditions at 18.00-24.00 WIB.

The battery monitoring system on solar panels uses the main component, namely: a NodeMCU ESP8266 type microcontroller which has a WiFi module, so monitoring can be accessed via the internet [12]–[14]. INA219 type sensor. The INA219 sensor will be connected to the NodeMCU ESP8266 microcontroller so that users can monitor the voltage, current and power values on the battery via LCD and smartphone. Monitoring on a smartphone using the Blynk application.

The design of the block diagram for monitoring battery voltage and current in a solar power generation system is shown in Figure 3

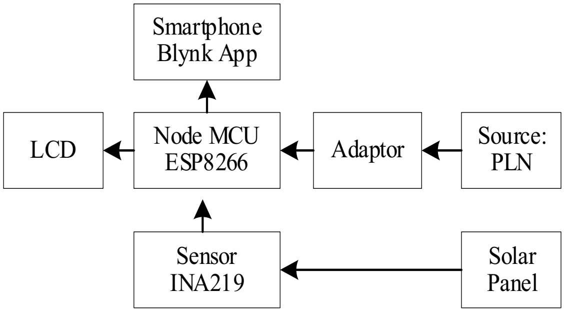

Fig.3. Block diagram design

Description of the Fig.3

a. The ESP8266 MCU node functions as a microcontroller. This ESP8266 MCU node will send data that is read by the INA219 sensor and displayed on the LCD and to the Blynk application on the smartphone.
b. The INA219 sensor functions as a voltage, current and power reader with DC loads
c. The LCD functions as a display of data read by the INA219 sensor which is installed on the monitoring tool panel.
d. The adapter functions as a supply node for MCU ESP8266.
e. The PLN source is the source for turning on the supply adapter.

Hardware design is a design of the device that will be used. The aim of this design is to plan or design hardware according to the specifications and working system of the battery voltage and current monitoring system on the solar panel system using NodeMCU ESP8266. The hardware design can be seen in Figure 4.

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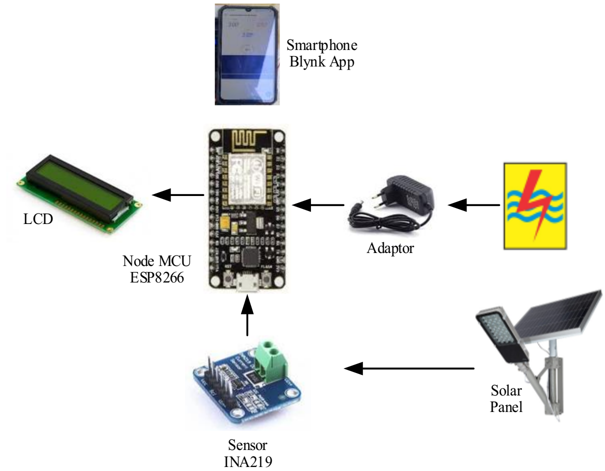

Fig. 4. Hardware Design

The software design process includes creating flow diagrams and designing program code. The NodeMCU ESP8266 program code design uses Arduino IDE and Blynk to display data from sensors.

The purpose of making a flow diagram is to describe the stages of reading battery voltage and current values and sending them to the Blynk application. In general, the software design used in this research is in the form of a flow diagram and is shown in Figure 5.

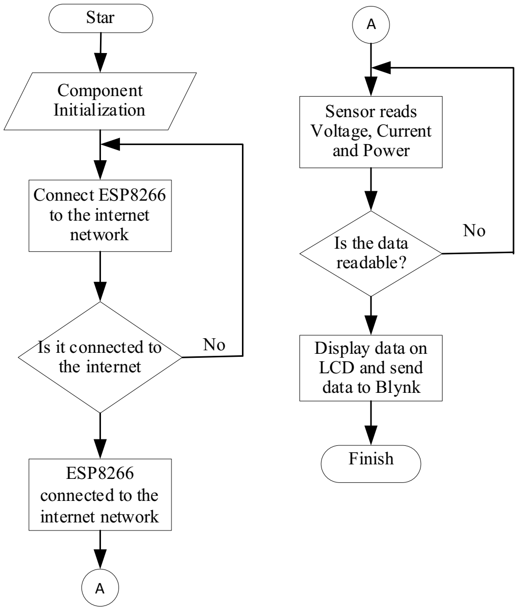

Fig 5. Software design flowchart

3. RESUTS AND DISCUSSIONS

This monitoring device is packaged in an outdoor panel box. The results of the design of the solar panel monitoring device are shown in Figure 6.

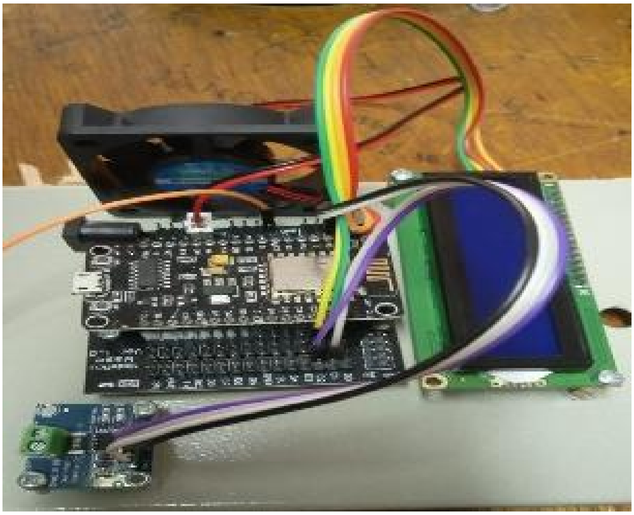

Fig. 6. The results of the device design

The pin configuration between the INA219 sensor module and NodeMCU ESP8266 can be seen in table 1:

TABLE 1. CONFIGURE INA219 SENSOR TO NODEMCU ESP8266

NodeMCU ESP8266	INA219
5 V	VCC
GND	GND
D1	SCL
D2	SDA

Description of the table 1.

a. 5V NodeMCU ESP8266 is connected to the VCC sensor INA219
b. GND NodeMCU ESP8266 is connected to GND sensor INA219
c. D1 NodeMCU ESP8266 is connected to SCL sensor INA219
d. D2 NodeMCU ESP8266 is connected to SDA sensor INA219

This system uses an IIC LCD 16x2 LCD White Blue, used to display data that has been read by the INA219 sensor on the LCD screen. The pin configuration between LCD and NodeMCU ESP8266 is shown in table 2:

TABLE 2. CONFIGURE LCD TO NODEMCU ESP8266

NodeMCU ESP8266	**LCD**
5 V	VCC
GND	GND
D1	SCL
D2	SDA

Description of the table 2.

a. 5V NodeMCU ESP8266 connected to VCC LCD
b. The GND of the NodeMCU ESP8266 is connected to the GND of the LCD
c. D1 NodeMCU ESP8266 is connected to LCD
d. D2 NodeMCU ESP8266 connected to SDA LCD

Testing of solar panel monitoring tools with no-load conditions at 12.00-18.00 WIB and loaded conditions at 18.00-24.00 WIB.

The results of observations of the solar panel monitoring tool are shown in table 3, where the no-load condition, current and power have a value of zero (0), while the load, current and power conditions already have values.

TABLE 3. OBSERVATION RESULTS ON LCD AND BLINK

Time	Observation					
	LCD			Blink		
	Voltage (Volt)	Current (Amper)	Power (Watt)	Voltage (Volt)	Current (Amper)	Power (Watt)
14.21	6.36	0.00	0.00	6.36	0.00	0.00
16,27	6.30	0.00	0.00	6,29	0.00	0.00
17.15	5,62	0.00	0.00	5,61	0.00	0.00
18,35	3,14	0,65	2,03	3,14	0,65	2,03
19.02	3,17	0,53	1,68	3,17	0,53	1,69
20.31	3,21	0,35	1,13	3,21	0,35	1,13
21.30	3,21	0,29	0.92	3,22	0,29	0,93
22.07	3,23	0,19	0,61	3,23	0,19	0,61

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At 14.21, 16.27 and 17.15 monitored by the LCD and the Blink application, the current and battery power on the solar panel unit is zero (0), this condition indicates that the battery on the solar panel unit is in a no-load state and the no-load curve is shown in Figure 9 and at 18.35, 19.02 to 22.07 monitored with LCD and the Blink application, the current and battery power on the solar panel unit show values, this condition shows that the battery on the solar panel unit is under load and the load curve is shown in Figure 10.

From table 3, we get the difference and error values for voltage, current and power on the solar panel monitoring tool, as shown in the table 4

TABLE 4. DIFFERENCE AND ERROR

Observational differences between LCD and Blink			Observation error (%)		
Voltage (Volt)	Current (Amper)	Power (Watt)	Voltage (Volt)	Current (Amper)	Power (Watt)

0,00	0,00	0,00	0,000	0,000	0,000
0,01	0,00	0,00	0,159	0,000	0,000
0,01	0,00	0,00	0,178	0,000	0,000
0,00	0,00	0,00	0,000	0,000	0,000
0,00	0,00	0,01	0,000	0,000	0,595
0,00	0,00	0,00	0,000	0,000	0,000
0,01	0,00	0,01	0,312	0,000	1,087
0,00	0,00	0,00	0,000	0,000	0,000

From table 4 above, it is explained that the results of observations on LCDs and smartphones by testing solar panel units in no-load and load conditions with an average error in voltage of 0.08%, current of 0.00% and power of 0.21%.

Example of the display of the voltage, current and power monitoring tool which is read on the LCD and blinks is shown in Figure 7, without load conditions and Figure 8, conditions with load.

Fig. 7. Display of voltage, current and power

monitoring tools No-load

Fig. 8. Display of voltage, current and power monitoring tools with load

Examples of voltage, current and power monitoring curves are shown in Figure 9 for no-load conditions and Figure 10 for load conditions

Fig .9. No-load solar panel monitoring curve

Fig .10. Solar panel monitoring curve with load

4. CONCLUSION

This research succeeded in monitoring voltage, current and power on solar panel system units using IoT and the Blink application.The LCD installed on the monitoring tool will display the voltage, current and power values.These values are sent via the Blink application and monitored on the smartphone.

At 14.21 WIB, it was observed on the LCD, smartphone and monitoring curve, voltage 6.36 V, current 0.00 A and power 0.00 W. Current and power 0.00 because the solar panel unit was in no-load condition (lights off).

At 18.35 WIB, it was observed on the smartphone LCD and the monitoring curve, the voltage, current and power read on the LCD were the same as those read on the smartphone and the monitoring curve, voltage 3.14 V, current 0.65A and power 2.03 W. There are values current and power because the solar panel unit is under load (the lights are on).

Observation results on LCDs and smartphones by testing on solar panel units in no-load and load conditions with an average errors in voltage of 0.08%, current of 0.00% and power of 0.21%.

The results of this research are certainly not perfect, but they can be used as a basis research related to solar panel monitoring

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