CURRENT AND VOLTAGE MONITORING SYSTEM BASED ON MEASUREMENTS ON SOLAR PANEL BASED ON ARDUINO UNO

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ABSTRACT

The performance of solar panels can be directly monitored for parameters such as voltage and current. From the monitoring results, information can be obtained whether the installation of solar panels is as expected. However, in some existing studies there are still shortcomings, namely both current and voltage measurements are still carried out manually using a multimeter, so the data taken cannot be recorded continuously. Therefore, the purpose of this tool is to create a measurement monitoring system on the output of solar panels. At the time of measurement to detect current and voltage, a lot of measurement data is needed. Tools and materials used to obtain Solar Panel output data, this system uses two measurement sensors, namely the ACS712 current sensor as a current meter and a voltage sensor. These two measurement sensors will send the current and voltage values to the Arduino Uno microcontroller. The microcontroller will give a command to the stepper motor to move the rheostat wiper so that the resistance on the rheostat will change. Any data that is read by the microcontroller will be continuously sent to the flash that has been installed. The method used is by testing the tool by measuring the output on the solar panel. The results of the measurement of the system as a whole show that the difference between the sensor and the multimeter is 0.126 V for the voltage value and 0.018 A for the current value. The microcontroller will give a command to the stepper motor to move the rheostat wiper so that the resistance on the rheostat will change. Any data that is read by the microcontroller will be continuously sent to the flash that has been installed. The method used is by testing the tool by measuring the output on the solar panel. The results of the measurement of the system as a whole show that the difference between the sensor and the multimeter is 0.126 V for the voltage value and 0.018 A for the current value. The microcontroller will give a command to the stepper motor to move the rheostat wiper so that the resistance on the rheostat will change. Any data that is read by the microcontroller will be continuously sent to the flash that has been installed. The method used is by testing the tool by measuring the output on the solar panel. The results of the measurement of the system as a whole show that the difference

between the sensor and the multimeter is 0.126 V for the voltage value and 0.018 A for the current value.
Keywords: Arduino Uno, Solar Panel, ACS712 Sensor, Voltage Sensor

PRELIMINARY

In this era of globalization, a source of electrical energy is very necessary, given the current number of equipment that really requires a source of electrical energy. As household consumption, school buildings, offices and as street lighting. Because of the importance of street lighting at this time which aims to be the safety of motorists on the road, and to reduce the costs incurred in terms of street lighting currently still using PLN's electricity source, many have now switched to using solar panels (photovoltaic) as a source of electricity. electricity stored in the battery.

Renewable alternative energy sources are needed to meet current electricity needs, one of which is using solar energy. Solar panels function to convert solar energy into electrical energy. Solar panel technology is a semiconductor expanse that can absorb photons from sunlight and convert them into electricity. Solar panels (photovoltaic) is a technology that functions to convert or convert solar radiation into electrical energy directly. Photovoltaic is usually packaged in a unit called a module. In a solar module consists of many solar cells that can be arranged in series or parallel.

In addition to the depletion of fossil energy reserves and the issue of global warming. The energy produced is also very cheap because solar energy sources are very abundant and can be obtained for free.

As one of the renewable energy sources, solar cells are now also included in the educational curriculum, especially studied by electrical engineering students in terms of research. The solar cell research conducted by this student studied the characteristics of the solar cell module and was able to make I – V graphs on the module. However, in measuring solar cells, students still use a multimeter, where in the measurement there are still shortcomings in terms of sampling due to changes in the intensity of sunlight.

With current technological advances, this is not a difficult problem to overcome, the author will create a photovoltaic output measurement system based on the Arduino UNO microcontroller. This system uses the Arduino UNO microcontroller as the control center and uses the ACS712 sensor as a current meter and a voltage sensor as a voltage meter. To get the maximum power increase data accurately this system uses a rheostat as a resistance.

RESEARCH METHODOLOGY

The method used is trial and literature study from previous research. The trial method aims to examine the effect of the input signal on the actuator. In this study, the trials carried out were on the input, process, and output sections.

At this stage the testing of the tool has been carried out repeatedly through checking and experimentation. Using current sensors and voltage sensors to measure the output value on the solar panel which can be seen through the LCD and flash as backup data storage.

Tools and materials

In this design using the following tools and materials:

Table 1 Tool Table

TOOL	FUNCTION
Multimeter	To Measure Current and Voltage
Screwdriver	To Tighten the Screw
Scissor	For Cutting Material
Cutter	For Cutting Material
Drill	To Make a Hole
Saw	For Cutting Material
Laptops	To Program

Table 2 Material Table

INGREDIENT	FUNCTION	SPECIFICATION
Solar Panel	Capturing Energy From the Sun	Shinyoku Polycrystalline, 10wp
Arduino Uno	To As Controller	Arduino Uno R3 ATMEGA328P-PU
Stepper Motor	As a Rheostat Drive Motor	Stepper Motor 28BYJ-48 12V Unipolar
ULN2003 Drivers	To Control Stepper Motor	12V . SMD driver motor
Rheostat Resistor	As a resistance or load in photovoltaic	Chiba Green 200Ohm 50W
USB Module	USB Host Interface Module with Pendrive	SanDisk 4Gb
Voltage Sensor	As a Voltage Value Meter	25V . DC Voltage Sensor
Current Sensor	As Measuring Current Value	ACS712 5A . Sensor
Toggle Switch	As System Remeasure Button	3 Pin 2 Way Toggle Switch 3A
Timing Pulley	As Belt Holder	MXL 30T 10mm
Timing Belt	To Spin the Pulley	Belt Kit 1:2 30T
Limit Switch	As a limiting sensor at 0 ohm resistance Rheostat	Mini Limit Switch 3pin 5A
Battery Holder	As a Battery Case	Quad Battery Holder 18mm
Jumper Cable	To Connect Components to Other Components	Male to Female 20cm

Acrylic	For Tool Chasing	Genea Cipta 5mm
Copper Tin	To Glue Cables	Sunshine 0.3mm
Glue Shoot	For Sticking Acrylic	-
Double Tape	To Paste Components	-
16x2 . LCD	To Display Voltage And Current Values	LCD Module 16x2 Yellow Green

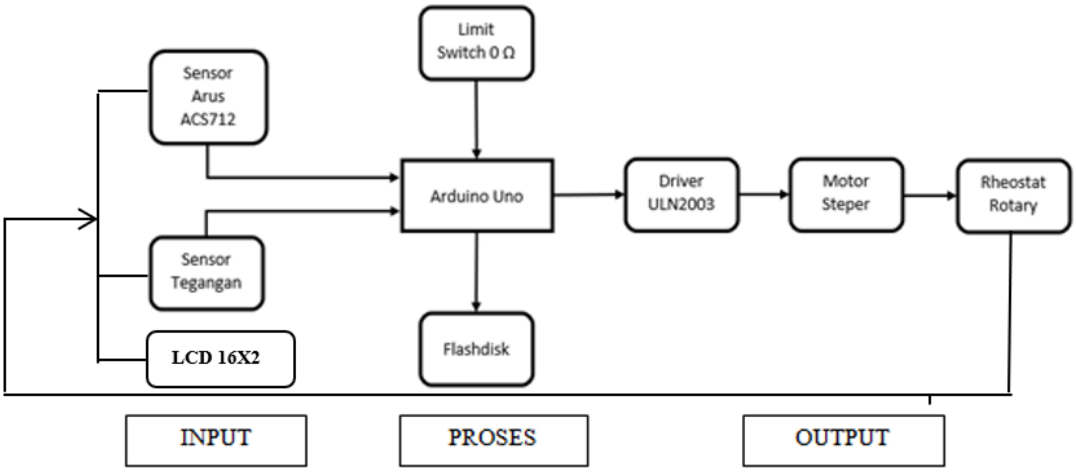

Figure 1 Block Diagram

The use of this Solar Panel output measurement system is designed to make it easier to measure current (Isc) and voltage (Voc) when it will reach maximum power (Pmax) on the solar panel. In the operation of this system, the ACS712 current sensor and voltage sensor are connected to the solar panel to obtain the current and voltage values that are connected to the Arduino Uno microcontroller as the brain of all processes. When the measurement will reach the maximum power, the microcontroller gives an order to the stepper motor driver to move the stepper motor which has been connected to the rheostat resistor which aims to inhibit or slow down the solar panel to reach maximum power. This is intended to obtain accurate photovoltaic output measurements. The function of the installed limit switch aims to re-measure and turn the rheostat resistor back at 0 (ohms). And from the output data that is read by the microcontroller it will continuously be sent via a flash that has been installed, this is to make it easier for researchers to graph the characteristics of the Solar Panel.

The workings of the entire circuit flowchart is as follows:

1. The circuit is started by pressing the toggle lever to turn on the circuit.
2. Reading limit switch 1, the rheostat must be in the 0 Ohm position or touch the limit switch 1. If not, turn the stepper motor manually to the right until it touches the limit switch 1.
3. Limit switch 1 is depressed starting to measure current and voltage. The stepper motor will start to rotate moving the rheostat towards the left per 1 step and the LCD will start displaying the current and voltage values.

4. In each round of steps there is a measurement of current and voltage data stored in the flash.
5. When you have saved the data to the flash drive, the rheostat rotation will go to limit switch 2 (reset). When limit switch 2 is depressed, the stepper motor will move the rheostat to the right towards limit switch 1 and the circuit will re-measure. Otherwise, the system will stop (END).

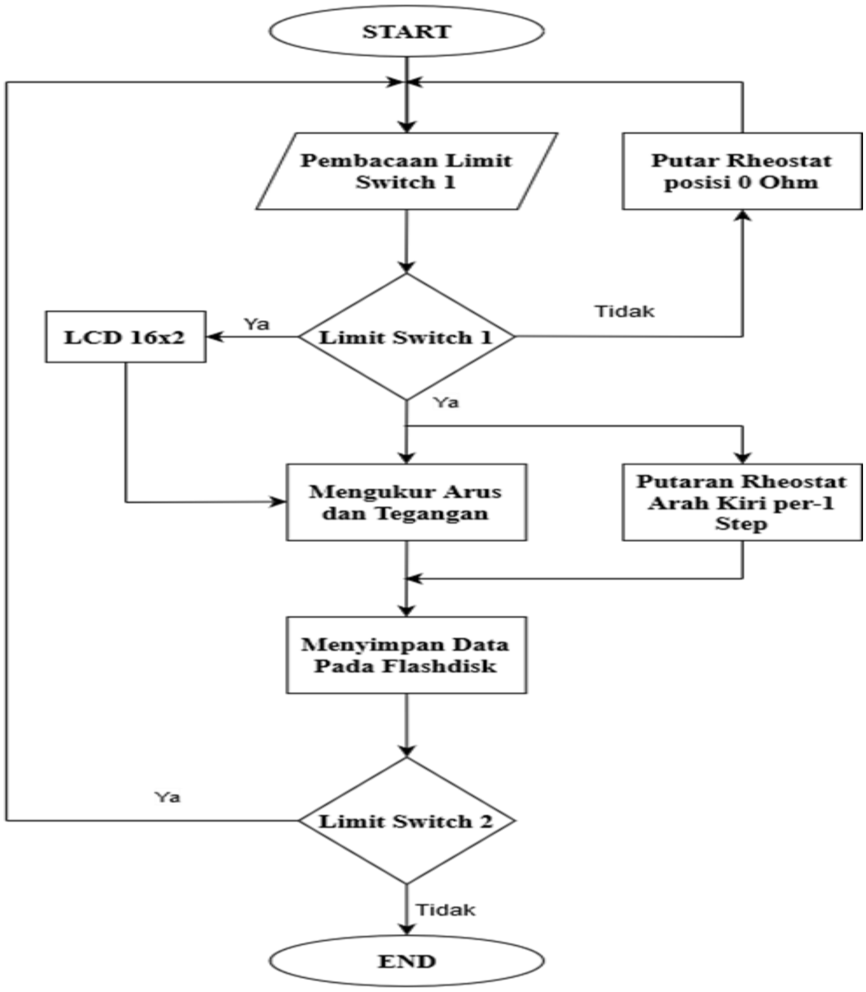

Figure 2 Flowchart

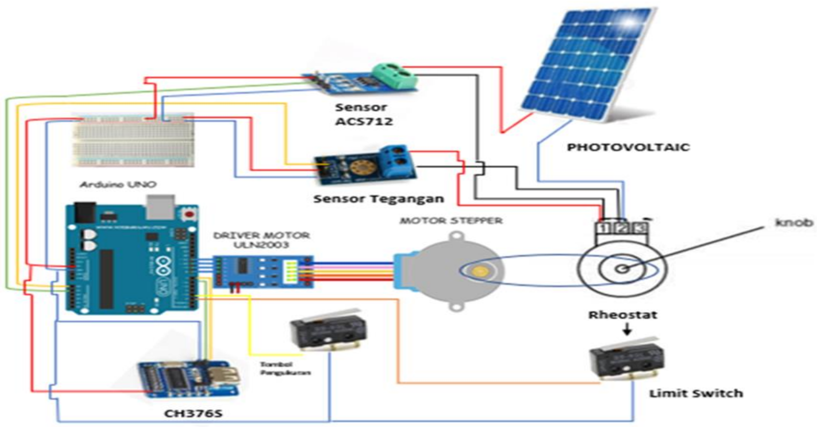

Figure 3 Hardware Design

In the picture above, the design of all components is the same as the original hardware component. The design of this software is needed to simplify the process of making the wiring system on the tool.

RESULTS AND DISCUSSION

The application of the system discusses the results of the application of the theory that the author has successfully developed so that it becomes a fairly stable system. To find out whether the objectives of making this tool have been carried out properly or not, it is necessary to test and analyze the tool made.

Voltage Sensor Test

Voltage sensor testing is carried out to determine the results of DC voltage measurements that can be read by the voltage sensor. The voltage sensor will be calibrated using a SANWA CD711 multimeter to determine the ratio of the difference in voltage / error. By flowing the voltage source provided by the DC power supply through the two input pins, the output voltage (Vout) and the sensor are able to measure any given output voltage.

Table 3 Voltage Sensor Test Results

Multimeter (V)	Voltage Sensor (V)	Difference	*Error*(%)
5.06	4.96	0.10	1.97%
10.02	9.84	0.18	1.79%
15.03	14.87	0.16	1.06%
20.04	19.85	0.19	0.95%
25.02	24.76	0.26	1.04%
Average value :		0.18	1.36%

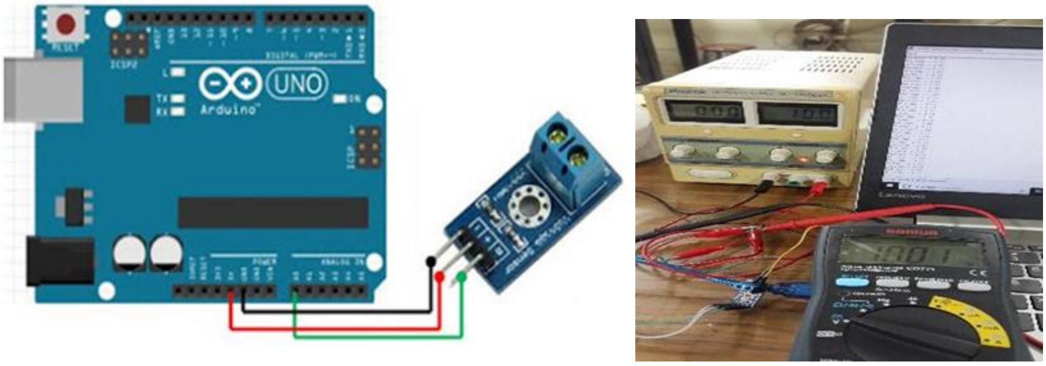

Figure 4 Testing the Hand Sensor

Current Sensor Test

ACS712 current sensor testing is carried out to determine the results of DC current measurements that can be read by the ACS712 sensor. The ACS712 sensor will be calibrated using a SANWA CD771 multimeter to determine the ratio of the difference in current / error. The output data on the ACS712 sensor will be taken periodically or sampling and processed for later calibration with current readings on the SANWA CD771 multimeter. The test method carried out on the ACS712 sensor is to provide a fixed voltage of 29.3 volts and vary the current flowing from the voltage source through both output current pins and the sensor measures each of the given currents. The current is varied by varying the resistor which is connected in series with the conductor wire through which the current passes.

Table 4 Current Sensor Test Results

Multimeter (A)	**ACS712 Sensor (A)**	**Difference (A)**	***Error*(%)**
0.39	0.37	0.02	5.12%
0.78	0.76	0.02	2.56%
1.06	1.05	0.01	0.94%
1.33	1.31	0.02	1.50%
1.52	1.50	0.02	1.31%
Average value :		0.02	2.28%

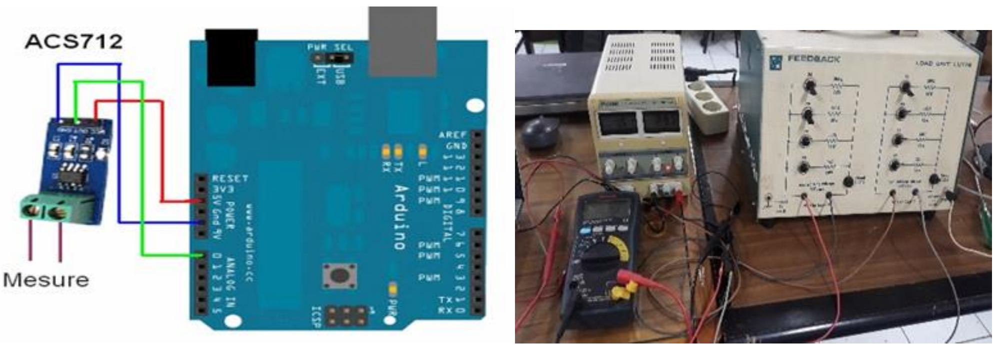

Figure 5 Current Sensor Test

Rheostat Test

The increase test on the rheostat is carried out with the aim of knowing the continuity of the resistance when the wiper rotates so that it is feasible to use. The method of testing carried out on the rheostat is to connect a rotary arm rheostat with a stepper motor, where the stepper motor uses the ULN2003 driver as the recipient of commands from the microcontroller to rotate. This data sampling is based on the rotation of the stepper motor which has been set at a speed of 200 steps and a delay of 5 seconds on the Arduino program, with rheostat measurements using a multimeter connected to 2 terminals (one of the fixed terminals and the sliding terminal) rheostat.

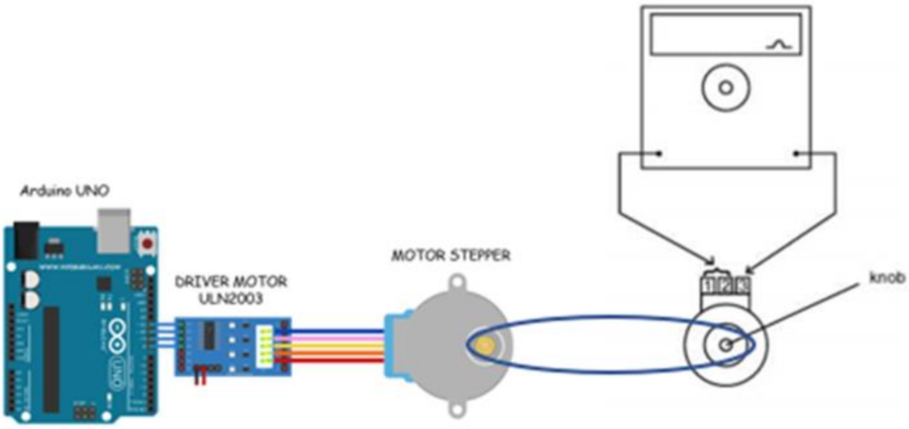

Figure 6 Rheostat Pengujian Testing

Table 5 Rheostat Test Results

No	Measurement Result (Ω)	Difference (Ω)
1	0.4	
2	1.6	1.2
3	2.9	1.3
4	4.2	1.3
5	5.5	1.3
6	6.9	1.4
7	8.1	1.2
8	9.0	0.9
9	10.1	1.1
10	11.7	1.6
11	13.0	1.3
12	14.1	1.1
13	15.1	1.0
14	16.6	1.5
15	17.6	1.0
16	18.9	1.3

17	20.6	1.7
18	22.0	1.4
19	23.4	1.4
20	25.0	1.6
Average difference:		1.29

Sampling of the rheostat resistance data was carried out 20 times with the data collection method, namely rotating the rheostat wiper according to the instructions from the Arduino program which had been set at a speed of 200 steps with a delay of 5 seconds. Based on the results of the continuity test of the increase in resistance to the rheostat that has been carried out, it is found that the average value difference is 1.29 ohms (Ω) in each increase, the rheostat resistance value shows a continuous increase and is different for each increase. This difference in measurement is caused by the value of the resistance being variable or variable.

Overall Tool Test

Alignment testing of all components in one circuit, aims to determine the performance of the tool to function in harmony and as it should, namely the voltage sensor reads the voltage (Voc) and the ACS712 sensor reads the current (Isc) on the photovoltaic where there is a rheostat function as resistance for each increase before reaching maximum power (Pmax) so that it will get accurate data and be able to make a photovoltaic characteristic graph curve.

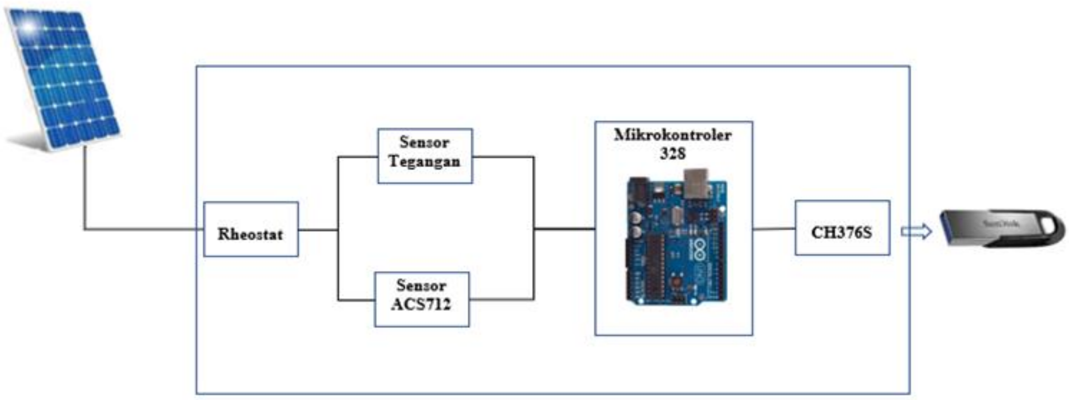

Figure 7 Overall Test

The process carried out by the Solar Panel output system based on the Arduino Uno microcontroller is as follows:

1. Place the Solar Panel in a place that gets direct sunlight.
2. Prepare the design of the tool, then assemble the tool as a whole by connecting the voltage sensor in parallel to the rheostat that has been connected to the photovoltaic and connecting the ACS712 current sensor in series to the photovoltaic with the rheostat.

3. At the time of turning on the rheostat device will return to 0 with the stepper motor as the driver that has been connected, during the process it will display "homing process". If it has returned to 0 the measurement starts with the rheostat will move in the opposite direction to provide resistance to the photovoltaic measurement where the voltage sensor and ACS712 sensor will continuously measure until it reaches the maximum power (Pmax). During this measurement process the data obtained is continuously sent to the flash that has been installed.

Table 6 Overall Tool Test Results

Time	**Sensor**		**Multimeter**		**Difference**	
Measurement	**V**	**I**	**V**	**I**	**V**	**I**
09.00 WIB	5.12 VDC	0.35 A	5.22 VDC	0.37 A	0.10	0.02
10.00 WIB	7.50 VDC	0.32 A	7.63 VDC	0.34 A	0.13	0.02
11.00 WIB	9.85 VDC	0.25 A	9.97 VDC	0.27 A	0.12	0.02
12.00 WIB	12.75 VDC	0.20 A	12.90 VDC	0.22 A	0.15	0.02
13.00 WIB	14.60 VDC	0.20 A	14.75 VDC	0.21 A	0.15	0.01
14.00 WIB	15.70 VDC	0.15 A	15.81 VDC	0.17 A	0.11	0.02
Average Difference					0.126	0.018

Based on the measurements that have been made, the maximum voltage value is 15.70 V and the maximum current value is 0.35 A. The table shows that the photovoltaic output power value will reach its maximum power (Pmax) when the photovoltaic output voltage approaches Voc. When approaching Voc, the current value will drop drastically and it means that the voltage value before the drastic current decrease is the voltage value at Pmax. The point at which Pmax is reached is the product of the maximum voltage and maximum current. The maximum voltage and current values are generally smaller than Voc and Isc, but produce maximum power. This is because at Voc the current that occurs becomes 0 and vice versa at Isc the voltage that occurs becomes 0 as well.

CONCLUSION

From the results of the design, manufacture and testing of devices that have been carried out, the following conclusions can be drawn:

In testing the voltage sensor, the average value between the voltage sensor and the multimeter is 0.18 V with an error percentage value of 1.36% by sampling 5 times with simultaneous measurements between the voltage sensor and the multimeter. Based on the test results of the ACS712 sensor, the average value between the ACS712 sensor and the multimeter is 0.02 A with an error percentage value of 2.28% with 5 sampling times with simultaneous measurements between the ACS712 sensor and the multimeter.

The results of the overall device measurements that have been carried out, the difference between the sensor and multimeter values is 0.126 V for the voltage value and 0.018 A

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