

DESIGN AND CONSTRUCTION OF POWER MONITORING AND CIRCUIT BREAKER DEVICES FOR PLN CUSTOMERS BASED ON IoT

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Abstract—Along with the modern Indonesian society's need for electricity consumption, the level of electricity consumption continues to increase. Electricity consumption among postpaid PLN customers with single-phase connections is often poorly regulated due to inadequate monitoring of power usage and frequent payment delays between the 1st and 20th of each month. This study involved the development of a monitoring device designed to track power usage for single-phase PLN customers. Additionally, an electricity circuit breaker was created that can be controlled remotely via the officer's smartphone. This monitoring system uses PZEM-0004T as the sensor. The voltage, current, power and energy data will be read by the sensor and then sent by the ESP8266 to the Internet of Things (IoT) based Blynk Website. This breaker tool uses a relay as an electrical circuit breaker on the customer side. With this tool, it is possible to reduce illegal use of PLN electricity and reduce the number of arrears in customer electricity bill payments to PLN

Keywords: *Electrical Power Monitoring, PZEM-0004T, Internet of Things (IoT), Breaking Device*

1. INTRODUCTION

Based on the use of electrical energy provided by PLN, customers are obliged to pay their electricity bills. Payment of this bill must be made by customers every month, between the 1st and 20th. However, in practice, many customers are often late or even do not pay their bills. Due to late or non-compliance in payment, customers can be subject to sanctions, including temporary power outages or even total dismantling. If payment has not been made by the due date, customers will be subject to late fees and temporary disconnection sanctions. Power outages are usually carried out by officers in the field. However, in its implementation, officers often face several obstacles, one of which is a locked gate, which hinders the process of disconnecting the power and is often intimidated by officers because they do not want their electricity to be temporarily disconnected. In a previous study (Armando, 2023) an automatic breaker was created using a remote control, but the system still could not be integrated with the

Android system. In the second study (L Mahendra, 2023) an Android-based breaker was used, but the system still had problems monitoring power where it still used an LCD.

2. RESEARCH METHODS

A. Monitoring System

In this study, the monitoring developed is focused on monitoring and supervising electricity usage. This system is designed to present direct and timely information about electricity consumption and power usage to customers. With this monitoring, officers can monitor or control electricity usage more effectively.

B. Internet Of Things

The Internet of Things (IoT) is a dynamic global infrastructure network designed to be configurable based on standard communication protocols. This system includes identities, physical attributes, robust characteristics, and intelligent interfaces. All these components are seamlessly connected and integrated into an information network.

C. Power Supply

The power supply functions to provide and regulate the energy needed to be distributed to electrical loads, which are usually electronic components. The use of the power supply is very crucial, especially for electronic components or devices that require a certain type of voltage, such as direct current (DC) voltage, and to ensure the stability of the required voltage.

D. Modul LM2596

The LM2596 module is a monolithic integrated circuit that includes all the active functions required for a step-down or buck switching regulator. It is available in several fixed output voltage options, namely 3.3 V, 5 V, and 12 V, and is also available in a version with an adjustable output voltage.

E. Nodemcu ESP8266

The ESP8266 module is a microcontroller module that functions almost the same as Arduino. However, its specialty is that this module is equipped with a WiFi feature, which allows the ESP8266 to connect directly to a WiFi network.

F. PZEM-004T

The PZEM-004T sensor is a multifunctional sensor module, for example it is used to measure voltage, amperes, and RMS power in an electric current.

G. Relay

Relay is a device that functions based on the principle of electromagnetics and operates several contactors. This contactor plays a role in connecting or disconnecting contacts, influenced by magnetic induction generated by the coil when electric current flows through it.

H. Oled

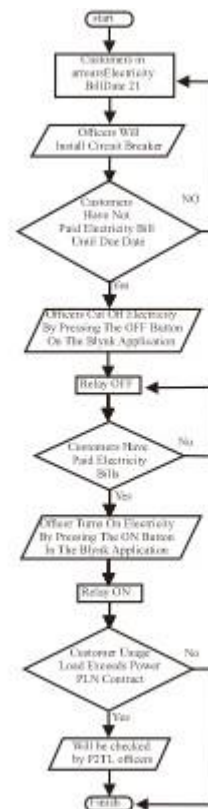
OLEDs are displays that use layers of organic compounds to emit light when an electric current is passed through them. OLEDs are used in a variety of devices, including mobile phones, televisions, computer monitors, and more.

I. Blynk

Blynk is a platform that provides applications for iOS and Android devices. By using the Blynk application, users can control devices such as LEDs or motors directly from their smartphones, even without the need for programming skills.

3. RESEARCH RESULTS

A. FLOWCHAT



Based on the flowchat above, it can be explained as follows:

1. Every 21st, electricity bills will be paid to PLN customers. If a customer is found to be in arrears, an officer will install a breaker at the customer's house.
2. After installation, the officer will provide a payment due date letter to the customer.
3. If the customer passes the due date, the officer will disconnect the electricity by pressing the Off button on the blynk application, after which the electricity will be cut off.
4. If the customer has paid the electricity bill, the officer will turn the electricity back on by pressing the On button on the blynk application.
5. If a customer's usage is found to exceed the PLN contract capacity, the P2TL officer will follow up.

B. VARIABLES AND OPERATIONAL DEFINITIONS OF VARIABLES

1. Independent Variable

In this study, the independent variables are Voltage and Current, which show the results

of measured usage in the device will change over time from the use of PLN customers.

2. Dependent Variable

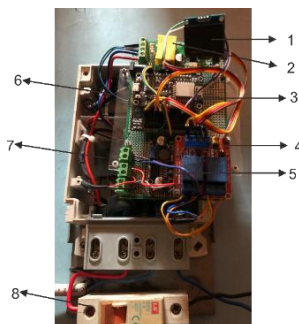
In this study, the dependent variables are the Display in Blynk and the OLED display, which show the results of PLN customer usage which will change over time.

C. DATA ANALYSIS METHODS

The study was conducted using survey and observation methods. The survey method was used to collect data from billing officers on which customers were often in arrears and when billing was carried out the officers received rejection from customers. The observation method which will later follow up on data collection based on the results of the tool objects that have been made aims to automatically disconnect and monitor customer energy.

4. DISCUSSION

A. Product Results



Picture 4.1 Tool Components

Components of the tool used:

1. Oled Display
2. PZEM-004T Sensor
3. NodeMCU ESP8266
4. 5 VDC Relay Module
5. LM2596 Module
6. Power Supply
7. Relay
8. MCB

B. Data Presentation

1. Current Sensor Testing

This test is carried out to determine the results of current measurements carried out by the sensor. This measurement will be compared by the ampere clamp, where this monitoring tool will be tested for current 3 times.

Measurement error can be calculated by referring to the following formula

$$:\%Error = \left| \frac{A_{monitoring\ tool}}{A_{tang\ amper}} \right| - 1 \times 100$$



picture 4.1 Current Test With Ampere Clamp

NO	Burden	Measurement results		Percentage of Error
		Monitoring Tools	Ampere Clamp	
1	Vacum	6,76	6,69	1,04%
2	Iron	6,36	6,31	0,79%
3	Fan	0,6	0,59	1,6%
4	Incandescent lamps	6,61	6,53	1,2%
5	Rice cooker	5,66	5,64	0,3%

2. Voltage Sensor Testing

This test is carried out to determine the results of the voltage measurements carried out by the sensor. This measurement will be compared by the ampere clamp, where this monitoring tool will be tested for voltage 3 times.

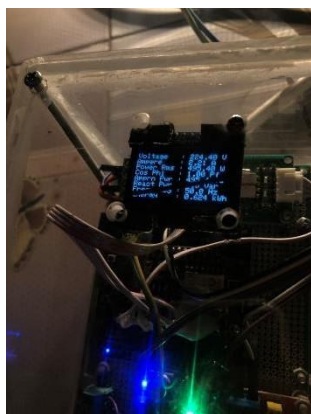
The measurement error can be calculated by referring to the following formula:

$$:\%Error = \left| \frac{A_{monitoring\ tool}}{A_{tang\ amper}} \right| - 1 \times 100$$

Table 4.2 Voltage Sensor Test

No	Burden	Measurement results (V)		Percentage of Error
		Monitoring Tools	Ampere Clamp	
1	Vacum	673	675	-0,2%
2	Iron	675	676	0,1%
3	Fan	684	684	0%
4	Incandescent lamps	674	675	-0,1%
5	Rice cooker	672	675	-0,4%

cooker



Picture 4.3 Voltage Test With Monitoring Equipment

3. Power Measurement Testing

This test is carried out to determine the results of the power measurements carried out by the sensor. This measurement will be compared by the ampere clamp, where this monitoring tool will be tested for power 3 times.



picture 4 4 Incandescent Lamp Power Test

The measurement error can be calculated by referring to the following formula:

$$\%Error = \left| \frac{A_{monitoring\ tool} - A_{tang\ amper}}{A_{tang\ amper}} \right| \times 100$$

Table 4.3 Power Sensor Test

No	Burden	Measurement results (W)		Percentage of Error
		Monitoring Tools	Ampere Clamp	
1	Vacum	1487	1476	0,74%
2	Iron	1432	1418	0,98%
3	Fan	121	120	0,83%
4	Incandescent lamps	1476	1454	1,51%
5	Rice cooker	1272	1262	0,39%

4. Relay Testing

This test is carried out to determine if the relay can function properly as a power outage by pressing the on/off button on the Blynk application. To find out if the relay is working or not, a "click" sound is heard on the relay.

5. Oled Display Testing

This test is carried out by connecting to the ESP8266 with the aim of displaying data. In the Oled Display control system, it functions to display voltage (V), current, active P (W), Energy (KwH), Frequency, Power Factor (Cos Phi), Apparent P (VA), R Power (VAR) which passes through the PZEM-004T sensor which will be displayed on the Oled Display..

C. Discussion



Gambar 4 2 Pengujian Display Oled

It is known that the prototype of this tool can be applied to monitor power and power outages. The results of this study obtained an error value based on the results of 3 trials from the results of the load current test on the vacuum of 1.04%, the iron current test of 0.79%, the fan current test of 1.6%, the incandescent lamp current test of 1.2%, the rice cooker current test of 0.3%, from the results of the vacuum voltage test of -0.2%, the iron voltage test of 0.1%, the fan voltage test of 0%, the incandescent lamp voltage test of -0.1%, the rice cooker voltage test of -0.4%, from the results of the vacuum power test of 0.74%, the iron power test of 0.98%, the fan power test of 0.83%, the incandescent lamp power test of 1.51%, the rice cooker power test of 0.39%. With a relatively small error difference, it can be concluded that this tool is quite effective in monitoring power accurately.

D. One House Simulation Testing

Table 4 4 Tension Tests Under House Loads

Measurement Results (V)		Percentage of Error
Monitoring Tools	Ampere Clamp	
231	232	-0,4%

Table 4 5 Current Tests on House Loads

Measurement Results (A)		Percentage of Error
Monitoring Tools	Ampere Clamp	

0,89	0,88	1,1%
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Table 4 6 Power Test On Home Load

Measurement Results (W)		Percentage of Error
Monitoring Tools	Ampere Clamp	
155	153	1,3%

In this test, the monitoring tool will be compared to the ampere clamp, the error value for the house voltage is -0.4%, then for the current it is 1.1%, and for the power it is 1.3%. Considering the relatively small margin of error, it can be concluded that this device has a fairly good performance in monitoring power.

CONCLUSION AND SUGGESTIONS

A. Conclusion

Based on the results of the design and testing process that has been carried out, it can be concluded that:

1. This tool will monitor power and power outages using Android which is done remotely. This monitoring design tool will continue to store reading data in real time even if there is a power outage, so sensor readings will still take place when the electricity is back on.
2. This tool can disconnect and turn on the electricity using the blynk application by pressing the on/off button on the blynk.
3. The level of accuracy in measuring electrical energy usage is very good because the error difference with the ampere clamp is quite small, namely 1% where the recommendation is not to exceed -2% or 2%.

B. Suggestions

Here are some recommendations that can be given for future studies:

1. To add a Gsm Sim Card module (to provide more stable network access).
2. To add a calculation of customer usage rupiah to the program coding.
3. For on/off on the monitoring tool by PLN, so that customers cannot turn it off themselves so that it cannot be accessed from PLN

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