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Monitoring of Electrical Energy during the Covid-19 Pandemic Using SMS on Microcontrollers

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ABSTRACT

PT. PLN (Persero) has been getting prepaid and postpaid electricity program services, but in postpaid electricity programs, human errors often occur when officers read the kwh meter and PLN officials do not go down to residents' homes to record consumer usage due to the co-19 pandemic. In this research, an electrical energy monitoring tool was built using SMS (short massage service) based on the ATMEGA 2560 microcontroller that can measure and monitor the electrical energy consumption in real time using a voltage sensor and current sensor SCT013-030. The results of the current and voltage sensor readings will be forwarded to the ATMEGA 2560 microcontroller to be converted to the amount of electrical energy consumption and the amount of payment in accordance with the rates set by the PLN.

Keywords: energy consumption, kwh meter, energy monitoring.

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1. INTRODUCTION

PT. PLN (Persero) is a state-owned company engaged in electricity, both from starting to operate electric power plants, namely from generators to consumers by transmitting to all regions of Indonesia, consumers of PT. PLN Persero has been getting prepaid and postpaid electricity program services, but in the postpaid electricity program human error often occurs when the officer reads kwh meter, on digital or prepaid kwh meter we can see the amount of per meter power that we have filled, but often also power loss occurs or not measured how much power we spend per day when using electrical equipment in the household (Noor, Ananta & Sunardiyo, 2017; Dinata & Sunanda, 2015; Ramadhianti, 2018)

In this research, an electrical energy monitoring device is designed to be used using SMS (short massage service) based on the ATmega2560 microcontroller which has a larger data capacity and quite a lot of input pins that function to add sensors if needed. Record and read electrical energy usage in real time and periodically. In addition there is also RTC DS3231 which functions for more accurate measurement of time in other words real time clock, because in IC Rtc 3231 there is a crystal component inside that makes the data more accurate. For sending data via sms using sim 800L which has the advantage of lower power usage. For data retrieval used ADS 1115 which functions to retrieve data to be more accurate and precise.

2. LITERATURE REVIEW

(RA Gusti Ramadhianti, et al, 2018) The first research design of electrical energy monitoring using Arduino-based ATMEGA 2560 sms was designed by Raden Ajeng Gusti Ramadhianti, Ir Cok Gede Indra Sensha Partha, and I Gusti Agung Pt Raka Agung in June 2018, in This research they designed a tool that is able to read and monitor electrical energy using SMS that can measure and monitor electrical energy usage in real time, using direct measurement methods. The results of the current sensor and voltage sensor readings are forwarded to the ATMEGA 328 micro controller for conversion into the amount of electrical energy and the amount of payment in accordance with the tariff determined by PLN. This research was conducted in the Basic Electrical Engineering Laboratory, Laboratory Workshop & Electrical Installation, Electrical Engineering Study Program,

Diah Risqiwati, et al (2016) The second study was conducted by Diah Rizqiwati, Ahmad Ghzali Rizal and Zamah Sari on August 1, 2016, researchers proposed to create a control device using Arduino Uno, so that the owner can control the use of electricity in real time. The Arduino Board functions as a data retrieval control system, before the data is processed on the server. There is a sensor system that functions to collect Ampere data, namely the AC712-20A sensor and the relay module as an electrical switch that functions to cut off electrical power when the pulse is insufficient. From the results of tests that have been done, there is an average measurement error of the ACS712-20A sensor with a multitester of 26%, whereas for prepaid electricity billing measurements there is an error of 6% (Fitriandi, Komalasari & Gusmedi, 2016; Saftari, 2015; Jufri, 2016)..

A. Current Sensor STC013-030

Current sensor is a sensor that measures current and detects AC (alternating current) or DC (direct current) electrical currents on a wire, producing a comparable signal in the form of analog or digital signals as will be processed [13]. In this study the current sensor used is the current sensor type STC013-030. Current sensor technology is almost the same as voltage sensor technology, namely by using a current transformer known as Current Transformer (CT) and by using hall effect technology. This sensor is classified as a component that has a good level of stability.

Figure 1. Current sensor STC013-030

B. Voltage sensor

In this design the voltage sensor functions as a sensor that measures the voltage given by PLN, in this study used a voltage sensor that has an output voltage of 5 volts using a transformer ct 500 mA which functions to reduce AC voltage (altenating current) 220 volts to 5 volts, then the voltage is aligned and converted to a DC voltage with a rectifier diode, the voltage sensor is used to retrieve voltage data towards the terminals connected to the load.

Figure 2. voltage sensor

C. Arduino microcontroller

Arduino Atmega is an electronic prototype making platform that is open-source hardware that is based on flexible and easy-to-use hardware and software. Arduino is intended for artists, designers, and anyone who is interested in creating interactive objects or environments. According to Solomon (2012:

1), Arduino is a platform that consists of software and hardware. Arduino hardware is the same as a microcontroller in general, but Arduino adds a naming pin so that it's easy to remember. Arduino software is open source software so it can be downloaded freely. This software is made to include programs in Arduino. Arduino programming is not as much as conventional microcontroller stages because Arduino has been designed to be easy to learn, so beginners can start learning microcontroller with Arduino.

Based on the description above, it can be concluded that Arduino is an electronic prototype making platform consisting of hardware and software. According to Feri djuandi (2011: 8), the main component in the arduino board is an 8-bit brand of Atmega that was made by Atmel Corporation. Different arduino boards use different types of Atmega depending on the specifications, for example arduino uno uses Atmega328 while arduino Atmega2560.

Figure 3. Atmega 2560 Mickrocontroller

following new features:

a. 1.0 pin out: add SDA pin and SCL pin close to AREF pin and two other new pins are placed near the reset pin, IOREF allows the shield to adapt to the voltage available on the board. In the future, the shield will be compatible both with boards that use AVR that operate with 5 volts and with Arduino due which operate with a voltage of 3.3 volts. And there are two pins that are not connected, which are provided for future purposes.
b. RESET circuit.
c. The Atmega 16U2 chip replaces the Atmega8U2 chip.

D. Electrical voltage

Voltage is the potential difference (voltage) is the work done to move a charge (equal to one coulomb) on an element or component from one terminal or pole to another terminal or pole, or at the two terminals or poles will have a potential difference if we move or move a charge of one coulomb from one terminal to another. The link between work done is actually the energy expended, so the above understanding can be simplified that voltage is energy per unit charge. (Irwan Dinata, 2015)

Mathematically:

At direct voltage (DC)

$$V = I / R \text{ (volts)} \quad (1)$$

At alternating voltage (AC).

$$V = p / I.\cos \text{phi} \quad (2)$$

E. Electric Current

An electric current is an electron that flows in a conductor that is moved by a potential difference (voltage). Basically, there is a flow of electrons inside the wirea very large number, if the number of electrons moves to the right and the left is equal then as if nothing happened. But if the right end of the wire attracts electrons while the left end releases it, there will be an electron flow to the right. The flow of electrons, hereinafter referred to as electric current. To drive the current it takes a voltage or potential difference generated by the generator (Temy Nusa, 2015).

The current formula at direct voltage are:

$$I = V / R \quad (3)$$

And the current formula at alternating voltage ie:

$$I = P / V.\cos \text{phi} \quad (4)$$

3. RESEARCH METHODOLOGY

A. Hardware Design

In the research of electric energy monitring using SMS based on the Atmega 2560 microcontroller, using a software, the Diptrace software for schematic and PCB layout. The block diagram of the electrical energy monitoring system using SMS based on the ATmega328 microcontroller is shown in the Figure below.

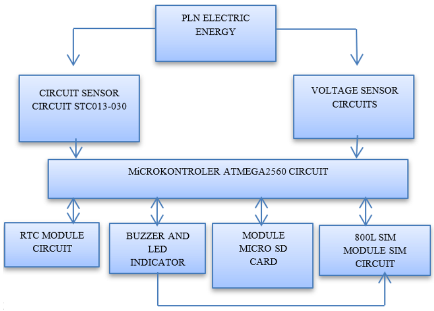

Figure 4. Hardware Design

In general, the implementation of the design of an electrical energy monitoring system uses SMS based on the Atmega2560 microcontroller, using the SCT013-030 current sensor and the Atmega2560 microcontroller based voltage sensor, with input from electrical energy (PLN). Electrical energy (PLN) will go through the current sensor SCT013-030 and pass the voltage sensor, the output of the current sensor and the voltage sensor is electrical energy, which is then passed on to the microcontroller. The amount of incoming electrical energy will be converted to the payment amount set by PLN. The results of the reading and price conversion will be displayed on the LCD.

The circuit scheme of the design of electric energy monitring using SMS based on Atmega2560 Microcontroler as follows:

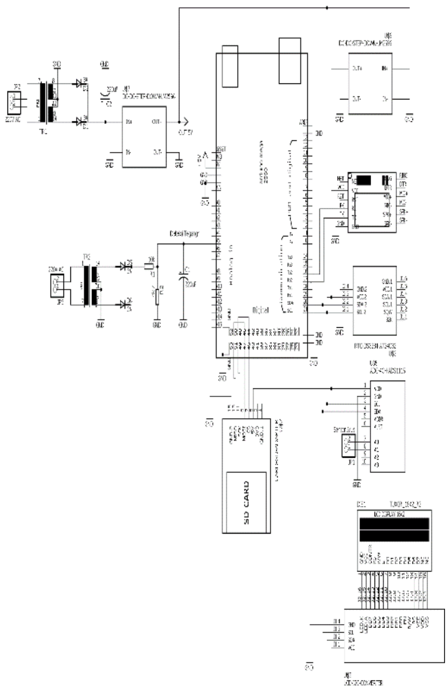

Figure 5. Schematic Drawing: a series of studies

Current used by consumers will be detected by the STC 013-030 current sensor and the voltage will be detected by a voltage sensor using a 500 mA transformer and rectifier diode which will be input to the ATmega 2560 microcontroller.

Hardware design consists of:

1. Atmega2560 microcontroller circuit.
2. SCT013-030 current sensor circuit.
3. Voltage sensor circuit.
4. LCD circuit.
5. Micro SD Card module series.
6. Real Time Clock module series.
7. SIM800L GSM GPRS Module series as an SMS sender.
8. A series of Buzzer modules and LED indicators.
9. DC to DC converter step down module.
10. Modules Converter i2c to LCD.

4. RESULTS AND DISCUSSION

Testing tool by comparing the data Current, voltage, electric power in measuring devices As for the test data taken is as follows:

A. Experiment comparison of the current with the load between the experiment device and the measuring instrument.

In this experiment the experiment will compare the value of the electric current to the load with a measuring instrument, where the load contained incandescent lamps, blenders, irons, TVs, and fans. Experimental table comparison of the current with the load between the experiment device and the measuring instrument.

Table 1. Experiment comparison of the current with the load between the experiment device and the measuring instrument

Electric load	Flow measuring instrument (A)	Test current (A)
incandescent lamps	.34	0.32
Blender	0.65	0.75
An iron	1.46	1.46
The TV	0.4	0.54
Fan	.24	0.23

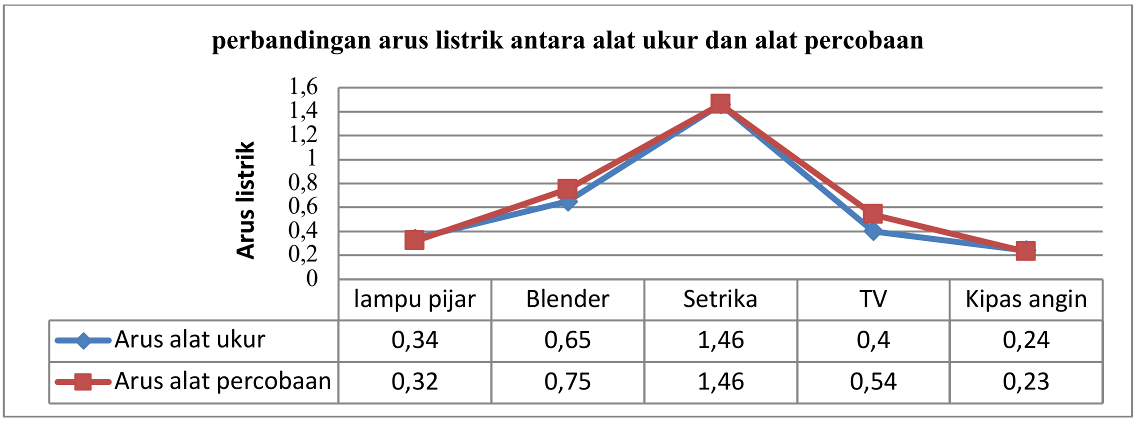

Figure 6. Experiment comparison of the current with the load between the experiment device and the measuring instrument

B. Experiments comparing the burden of power between the test equipment and the measuring instrument

In this experiment the experiment will compare the value of electrical power to the load with a measuring instrument, where the load contained incandescent lamps, blenders, irons, TVs, and fans.

Table 2. Experiments comparing the burden of power between the test equipment and the measuring instrument

Electric load	Voltage measuring devices	Test tool voltage
Incandescent lamps	210	209
Blender	209	208
an iron	209	208
The TV	213	210
Fan	215	214

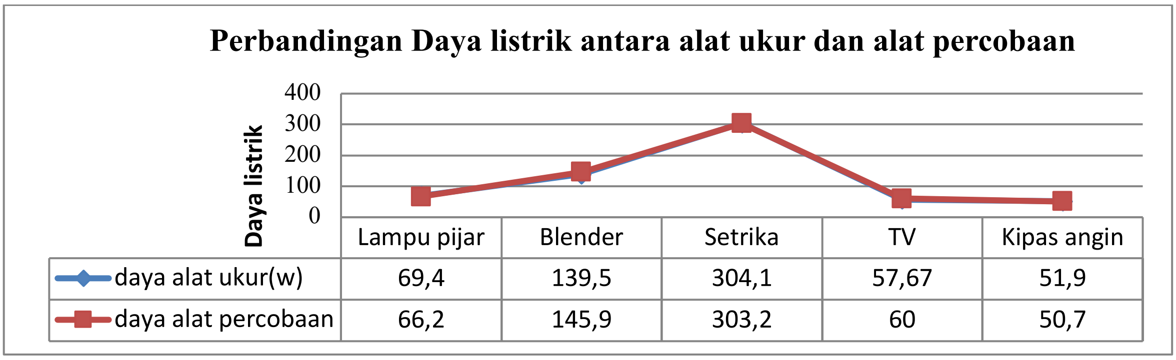

Figure 7. Experiment comparison of power and load between an experiment and a measuring instrument.

C. Experiment comparing the electrical voltage with the load between the experiment device and the measuring instrument.

In this experiment the experiment will compare the value of the voltage against the load with a measuring instrument, where the load contained incandescent lamps, blenders, irons, TVs, and fans.

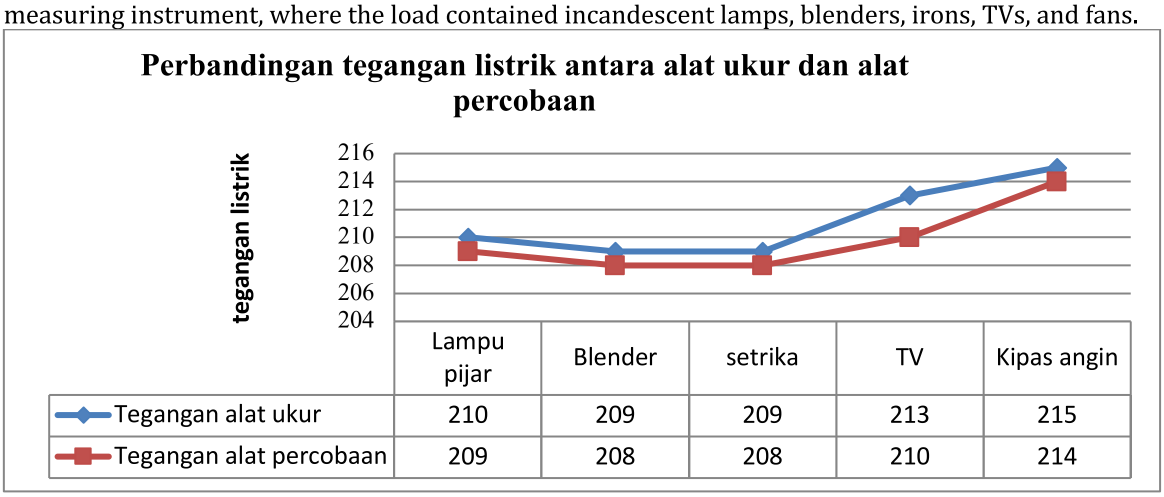

Figure 8. Experiment comparison of voltage and load between the experiment device and the measuring instrument.

Testing and response of the GSM module is done by sending a command in the form of a short message to the system, where the user has sent an SMS with the code "* CHECK" then this command will be verified by the GSM module, and processed by the microcontroller. SMS display when a customer sends a message with the verification code "* check" and the response of the GSM module to find out information on electricity usage, shown in the picture below.

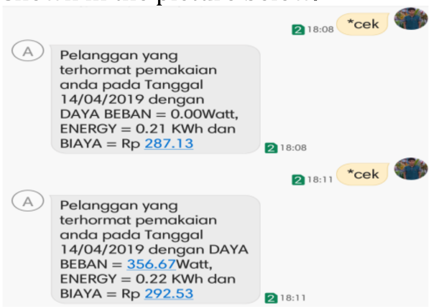

Figure 9. sms response tool trial

The reply text contains the date and time information, the amount of power that has been used, the amount of electricity consumption (KWh) in real time and the amount that must be paid (Rupiah). Power (Watt) is obtained from the following calculation .

P. = VI cos phi
= 229. 1.73. 0.9
= 356 watts

Energy (kWh) is obtained from the following calculation:
Energy = VI Cos phi / 3600 s
= 356 w / 3600 s
= 0.098 kwh

Cost (Rupiah) is obtained from the following calculation:
Cost = ((kwh) x Price / kwh x 1.05)
= 0.098 x 1,428 x 1.05
= 0.146 Rupiah

In this study the data electrical energy monitoring logger aims to determine whether the data logger in the system is running according to measurements. Data collection was carried out for 24 hours, namely from the 26th of August 2019 at 22.33 West Indonesia Time until August 27, 2019 at 22.44 West Indonesia Time.

Table 3. Data logger table measurement results.

Date	**Time**	**Current**	**Volt**	**Watt**	**Kwh**	**Rp**
08/27/2019	22:33	1,431	204	292.52	0868	1174
08/27/2019	23:34	1,442	205	295.97	1,148	1552
08-28/2019	0:34	1,389	207	288.19	1,457	1970
08-28/2019	1:35	1,393	210	292.54	1,745	2360
08-28/2019	2:35	1,439	212	304.56	2,029	2743
08-28/2019	3:35	1,271	213	270.54	2,310	3123
08-28/2019	4:36	1,214	213	258.26	2,591	3503
08-28/2019	5:36	1,460	207	302.80	2,874	3885
08-28/2019	6:37	1,245	207	257.73	3,195	4319
08-28/2019	7:37	1,208	212	256.60	3,464	4683
08-28/2019	8:38	1,013	209	212.11	3,699	5001
08-28/2019	9:38	2,207	208	458.69	4034	5454
08-28/2019	10:39	1,022	206	210.85	4,293	5805
08-28/2019	11:39	0.983	208	204.13	4,507	6094
08-28/2019	12:40	0.989	209	206.34	4,734	6400

08-28/2019	13:40	1,032	207	213.33	4,944	6684
08-28/2019	14:41	1,163	206	239.20	5,171	6991
08-28/2019	15:41	1,173	207	243.29	5,545	7497
08-28/2019	16:42	1,217	210	255.22	5,805	7849
08-28/2019	17:42	1,323	208	275.75	6,061	8194
08-28/2019	18:42	1,528	199	304.56	6,335	8565
08-28/2019	19:43	2,230	198	441.91	6,766	9148
08-28/2019	20:43	2,349	203	477.43	7.213	9753
08-28/2019	21:44	2,108	200	422.24	7,675	10376
08-28/2019	22:44	2,437	204	498.12	8,136	10999

5. CONCLUSION

The conclusions that can be drawn based on the results of the testing and discussion carried out are as follows:

1. After doing research on the design and monitoring of electrical energy using SMS-based microcontroller ATmega 2560 consumers PT. PLN (Persero) can find out the power that has been used and the price of electricity that has been used every day
2. In this study, we can find out the working principle of electric energy monitoring design using SMS based on micromeal controller atmega 2560 that is the current used by consumers will be detected by the STC current sensor 013-030 and the voltage will be detected by a voltage sensor using a 500 mA transformer and rectifier diode that will be input to the Atmega 2560 microcontroller, then the data generated is processed using the ADS 1115 module and then will be displayed on the LCD so that the resulting sensor data is more precise in calculations, for displaying the date and time on the LCD display using the module RTC ds 3231 which functions to calculate time continuously starting from date, day, month, year, hour, minute and second.To send data that has been used in use 800 L SIM module which functions to send data that has been used to consumers via SMS, for data storage use a micro sd card module with 32 GB of external memory for storing data loggers every day.
3. In this experiment we can find out the components used in the electrical energy monitoring design using SMS based microcontroller atmega 2560 namely current sensor STC013-030 for current sensors, voltage transformer ct 500mA for voltage sensors, LCD 20x4 for data display, RTC DS3231 module to calculate time, date, month and year continuously, the Sim 800L module for sending data via sms, stepdown module dc to dc for microcontroller power supply, micro sd card module for data storage, module ads 1115 for current sensor and trade sensor calculations more precise calculation, i2c to lcd module for LCD pin input.

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