Research Paper

International Journal of Research and Review
Vol. 10; Issue: 12; December 2023
Website: www.ijrrjournal.com
E-ISSN: 2349-9788; P-ISSN: 2454-2237

Design a Realtime Datalogger on a Simple House KWH Meter with a Capacity of 1300 VA

Suparmono[1], Trahman Sitepu[2], Nobert Sitorus[3], Sutan Pardede[4], Cholish[5], Irfan Nofri[6]

[1,2,3,4,5]Program Study Electrical Engineering Polytechnic Negeri Medan
[6]Kost Art Medan; Program Post Graduate Universitas Muhammadiyah Sumatera Utara

Corresponding Author: Nobert Sitorus

DOI: https://doi.org/10.52403/ijrr.20231238

ABSTRACT

At this time, monitoring tools that directly monitor electricity usage in the home are very necessary, because in this era of global warming, it requires us to be a little careful in order to use electricity effectively. Where if we do not control electricity usage, the costs charged per month could increase and become burdensome in the payment process. This research designs a KWH meter monitoring tool with output estimates of usage costs so that the tool created can minimize costs in the field of electricity usage. Design a circuit where the tool can display the values of voltage, current, frequency and cos phi flowing through the KWH, then also display the usage costs for a week which is indicated by a buzzer sound if usage has exceeded normal limits. The next step is the validation or calibration process for the designed tool which is planned to be able to test the tool that has been made. The results obtained from designing a realtime datalogger tool on this KWH meter can monitor household electrical energy usage with a capacity of 1300 VA where the monitoring aspects that can be displayed include voltage, current, power factor, usage power and usage costs while this tool is installed. The main system of this tool is driven by an Arduino UNO microcontroller which is programmed so that it can display voltage, current, power factor, usage power and usage costs. In the tool system that has been created, the error rate of voltage measurements is <1%. The error rate in reading current and power factor (PF) is <3%. Meanwhile, the error rate in reading power and usage costs is <9%.

Keywords: Monitoring, KWH, Data Logger

INTRODUCTION

Technological developments are increasingly rapid, as a result of which electronic devices are designed and engineered to help human needs in everyday life. Very simple electrical devices can be found in our lives, so the presence of electronic devices helps human work become faster, more efficient and effective. Using these electronic devices of course requires a supply of electricity and is in accordance with Law number 30 of 2009 concerning electricity discourse which regulates the increase in basic electricity rates for residences and small industries due to the removal of electricity subsidies. as many as 23 million Indonesians enjoy subsidies provided by the Government. Electricity usage uses a capacity of 900 VA by paying IDR 575 per kilo Watt hour (kWh), then the government adds a subsidy of IDR 876 per kilo Watt hour (kWh).

It is necessary to regulate electrical energy consumption during use, regulating electrical energy does not only use KWH meters. Because KWH meters can only monitor existing electricity usage and limit overall household electricity usage. Therefore, to manage household expenses, each individual requires awareness of how we can use electricity effectively and efficiently so that the cost of using electrical energy is not so high. In order to be able to monitor electricity usage, we need a tool that can monitor and display the estimated costs that have been used, so that when the displayed costs have increased, we can immediately save on electricity usage so that costs do not move higher quickly. Monitoring tools will be made easier if they can be used remotely, such as using IoT, this can make things easier for us because we don't need to look at the monitoring tool, but from the smart phone that we have, we can also see the results of the electricity usage that has been used.

To be able to realize this KWH meter data logger monitoring tool, researchers will create a tool with the advantage of being able to simultaneously view the cost data that has been used. Where later this tool can display voltage data assisted by the ZMPT101B voltage sensor, current assisted by the ACS 712 sensor, then the flowing frequency and cost estimation data that has been used. These components will be assembled into a tool that can monitor the KWH meter with an estimated output of the electricity costs that have been used.

In developing progress like today, we worked to include the implementation of an observation system. One of the objectives of developing checks is the power factor (Cos Phi) and an iterative perception system (M Irsan, 2017). One of the benefits of assessing the power factor (Cos Phi) and its emphasis is paying attention to the use of electrical energy. This perception should get the latest data and work with a variety of data.

Power factor or often called Cos Phi is the ratio between the unique power in W and the first power in VA. Most of the time power factor is used as an indication of positive or negative power supply to the frame. The power factor value will not be more striking than one, expect the more similar the power factor value to one, the better for the system.

Repetition is the extent to which an event repeats itself within a certain time span. To guarantee repeatability, one divides the points into time periods, counts the number of events from chance and divides the count by the length of the time span. The results of this meter are expressed in hertz (Hz) which is the name of the German physicist Heinrich Rudolf Hertz who observed this very interesting oddity. The 1 Hz loop controls events that occur once consistently. So Repeat can be described as a typical event. If T is one hour of n repetitions, the redundancy is $f = n/T$ (Ageng, 2012). In this way redundancy is a measure of additional time.

Until now, the assessment of force and cycle components is still in the form of a simple construction, so there are still numbers that are in the wrong direction due to human error or human error factors when looking at the assessment results. In this regard, this test was coordinated to separate the repetition and phi costs of using electrical power using a microcontroller in a motel with a power breaking point of 1300 Kva.

Monitoring energy consumption is very necessary to know the load characteristics, especially for simple residential homes with a power capacity of 1300 Kva. Power usage will be influenced by factors such as: frequency and Cos phi on load usage so it is necessary to record data using a microcontroller system. Then how can the tool issue a usage cost report every week which is marked by a cost display on the LCD if the electricity usage is "WASTE" or is already more than normal limits.

LITERATURE REVIEW

2.1. PLN specifications

The electricity source produced by PLN is produced by alternating generators or AC (Alternating Current). The generators used by PLN to generate electricity usually use prime movers such as steam and diesel or power plants with other prime movers that produce AC current (Dinata , 2015). AC is described in a sinusoidal form, which means that the signal shape of the AC current is wavy and has a changing magnitude.

The electric charges that move us are connected as electric currents. The size of the electric flow is described as the amount of charge passing through a point for each unit of time. The electric flow is expressed by figure I and the unit is the ampere, summarized by A. So, the significance of the electric flow can be plotted as follows:

$$I = \frac{Q}{t} \quad (1)$$

Where: I = Electric current in amperes (A)
Q = Electric charge in coulomb units (C)
t = Time in seconds (s)

Voltage is the way in which the magnitude of the potential energy contrast between two foci is rated in volts (V). Voltage can also be described as joules per coulomb. Accept the battery has a voltage of 12.6 V, and that means that each 1 coulomb charge provides 12.6 joules of energy. Assuming the light is connected to a battery, every 1 coulomb of charge that travels through the light will convert more than 12.6 joules of energy into heat energy and light energy. Additionally, the voltage conditions are as follows:

$$V = \frac{E}{Q} \quad (2)$$

Where : V = Voltage in volts (V)
E = Energy in joules (J)
Q = Charge in coulomb units (C)

2.2. Active Power (Real Power)

Active power means real power or power that can actually be used by the existing load, the unit of active power is Watts. Active power can be calculated using the following equation 2.1:

P = V. I . Cos phi (3)

Where :P = Active Power (Watt)/W
V = Voltage (Volts)/V
I = Flowing current (Ampere)/A
Cos_{phi} = Power Factor

2.3. Reactive Power (Reactive Power)

Reactive power is power that cannot be used by the load, but this power is taken or absorbed but returned to its source.

The unit of reactive power is VAR. Reactive power can be calculated using equation 2.2 as follows:

Q = V . I . Sin phi (4)

Where :Q = Reactive Power (VAR)
V = Voltage (Volts)/V
I = Flowing current (Ampere)/A

2.4. Apparent Power

Apparent power is power that is the sum of active power and reactive power. The symbol for apparent power is S with the unit being VA. Apparent power can be calculated using the following equation

S = V . I (5)

Where :S = Apparent Power (VA)
V = Voltage (Volts)/V
I = Flowing current (Ampere)/A

2.5. Arduino UNO

According to (Destriani, 2019) Arduino is an electronic board where the electronic board contains an ATMega328 microcontroller. The Arduino UNO can be used as an electronic circuit from simple to complex levels. Such as controlling LED lights to making robots with Arduino as the brain or controller.

Figure 1. Arduino UNO board.

In Figure 1 you can see the shape and image of the Arduino Uno. There are several chip transfers that help the Arduino to run a program to other connected devices. In the Arduino Uno system, software is needed to set or control the output from the Arduino by inserting a program into it. Where the program created using software called Arduino will be input into the Arduino memory so that the commands we have created are still stored and executed on the Arduino. We can make commands according to what we want and we can use tools such as existing sensors.

Figure 2. Arduino Software

Figure 2 can be seen as a display of cxprogrammer which is software for inputting programs that will be commanded to a tool that has been designed and created.

2.6. ACS 712 Current Sensor

ACS 712 is a current sensor that can detect the amount or value of current flowing in an electrical circuit. Where the ACS 712 can detect flowing AC and DC currents. Usually this sensor application is used to control motor performance, detect electrical loads, or protect changing loads in a circuit. (Titi Ratnasari, 2017)

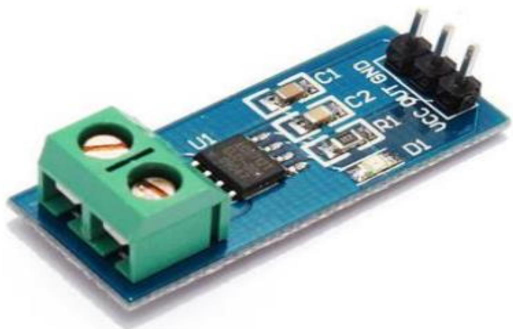

Figure 3. Illustration of the ACS712 Sensor

In Figure 3, the shape of the ACS 721 sensor is illustrated. This sensor has 3 pins which include voltage, grounding and output pins or output from the sensor.

2.7. ZMPT101B Voltage Sensor

The ZMPT101B voltage sensor can measure AC and DC electrical voltage up to a maximum of 250 Volts, this sensor is very suitable for use in voltage measurement tools because this sensor can see the difference in electrical potential between two points in a circuit.

Figure 4. Voltage Sensor

An illustration of the voltage sensor can be seen in Figure 2.4, where this sensor is equipped with 4 pins as sensor input and output.

RESEARCH METHODS

This system working process can make it easier to understand how the system in this research works in general.

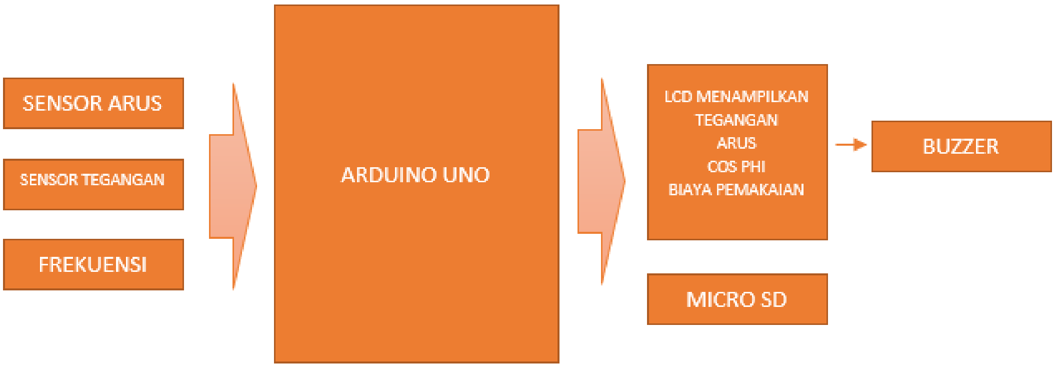

Figure 5. Diagram Channel Tool

In Figure 5 is the overall system circuit, there are several sensors, namely voltage, frequency and current, then there is an Arduino Uno then an LCD and a microSD card as output. Where below can be described the entire circuit which includes the pins connected to the Arduino as follows:

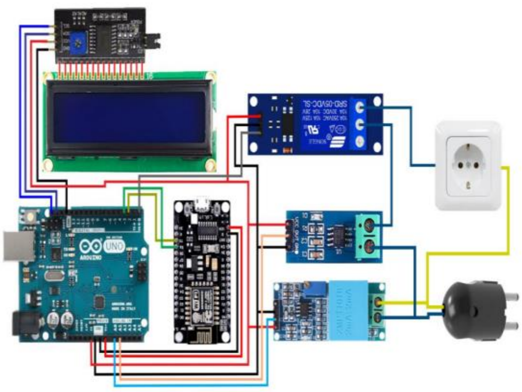

Figure 6. Tool circuit

Figure 7. Front view tool design

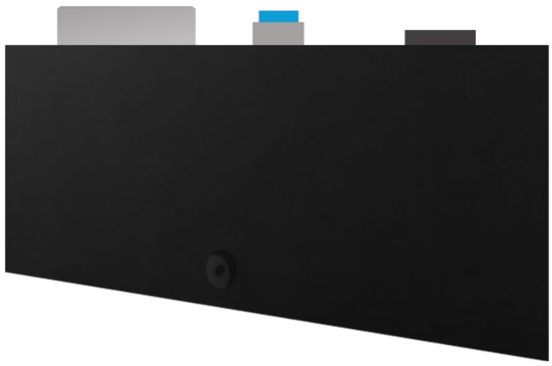

Figure 8. Front view tool design

This study centers around a microcontroller framework by storing it in stages through a datalogger framework so that information on house load usage is generally known through the house's KWH Meter. The exploration only calculates and thinks about repetitions and Cos phi on the utilization of electrical loads and tabulates the amount of usage in rupiah every week using a microcontroller.

Research Objects and Subjects

In this research, a research approach was carried out using quantitative methods, where the tools that have been designed and made will be tested for the level of effectiveness of the tool's performance. This process is carried out to obtain an effective and efficient tool so that the tool created can be useful for partners who have been determined to view the KWH meter datalogger.

In the research process, some data is needed to make a conclusion about the final result of the tool that has been made. The data

taken includes the performance of the tool that has been made, comparison with the results of KWH meter readings at partners and the level of effectiveness of the tool that has been made.
The subject of this research is tools real time datalogger on a simple house kwh meter with a capacity of 1300 kva which has been designed and made in this research. Observations of this tool were carried out to determine the level of effectiveness and performance of the tool that had been made. The data that will be taken on research subjects are:
Tool performance
Comparison of tool results with KWH meter

RESULTS AND DISCUSSION

4.1. Voltage Sensor Measurement

In the tool that has been made, the AC source is connected via a KWH meter whose voltage will be read. However, in the process of testing the voltage sensor measurement results, the AC source is connected to a voltage regulator to get an incoming voltage that can be adjusted. To get the error value on the sensor with the following equation:

$$\text{Error (\%)} = \left|\frac{V\ masuk - V\ sensor}{V\ masuk}\right| x\ 100\% \quad (6)$$

The test results data table is as follows:

Table 1. Voltage Sensor Test Data

Input Voltage (V)	Measuring Results on the Tool (V)	Errors (%)
110	108.6	1.27
120	119.2	0.67
130	128.3	1.31
140	138.9	0.79
150	149.2	0.53
160	158.9	0.69
170	169.1	0.53
180	179.5	0.28
190	188.9	0.58
200	199.3	0.35
210	209.0	0.48
220	218.9	0.50
230	227.8	0.22
Average Error		0.63

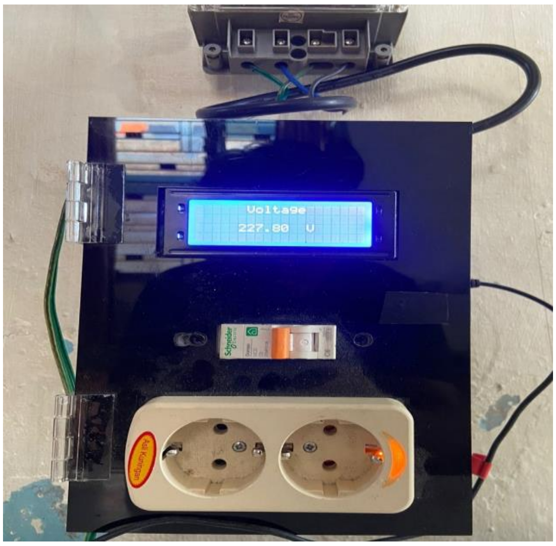

Figure 9. Display of voltage on the tool

From data table 1, it is known that the level of error presentation in the voltage reading results on the tool that has been made is relatively small, namely 0.63%.

4.2. Current Sensor Measurement

Current sensor measurements are carried out by utilizing a load of 35 Watts to 200 Watts. Where the reading results of the tool that has been made are compared with the multimeter measuring tool. The results of the instrument readings will see the level of error presentation from the results of the measuring instrument readings. To determine the error presentation of the current reading results on the device, the equation is used:

$$\text{Error}\ (\%) = \frac{I\ ukur - I\ alat}{I\ ukur}\ x\ 100\% \quad (7)$$

The test results data table is as follows:

Table 2. Current Test Data

Burden	Inflow (I)	Measuring Results on Tool (I)	Errors (%)
35	0.139	0.132	5.04
40	0.162	0.158	2.47
80	0.344	0.341	0.87
100	0.431	0.427	0.93
200	0.853	0.832	2.46
Average Error			2.35

From data table 2, it can be seen that the error presentation of the current reading results on the device that has been made is relatively small, namely 2.35%.

4.3. Power Factor Measurement

Power factor measurements are carried out by connecting a realtime KWH meter datalogger with the load on the house with a power capacity of 1300 VA. The power factor comparison is carried out by comparing the reading results of the instrument made with a power factor meter measuring instrument. To determine the error level, the power factor is determined by the equation:

$$\text{Error}\ (\%) = \frac{PF\ alat\ ukur - PF\ alat}{PF\ alat\ ukur}\ x\ 100\% \quad (8)$$

The test results data table is as follows:

Table 3. Power Factor Test Data

Test	PF Meter	PF tool	Errors (%)
1	0.95	0.93	2.11
2	1.00	0.97	3.00
3	0.93	0.90	3.23
4	0.96	0.94	2.08
5	1.00	1.00	0.00
Average Error			2.08

From data table 3, it can be seen that the error presentation of the PF reading results on the tool that has been made is relatively small, namely 2.08%.

CONCLUSION

From the process of making the tool to testing the performance of the tool in this research, the conclusions from the results of this research are:

The results obtained from designing a realtime datalogger tool on a KWH meter with a capacity of 1300 VA can monitor the use of household electrical energy with a capacity of 1300 VA where the monitoring aspects that can be displayed include voltage, current, power factor, usage power and usage costs while this tool is installed.

The main system of this tool is driven by an Arduino UNO microcontroller which is programmed so that it can display voltage, current, power factor, usage power and usage costs.

In the tool system that has been created, the error rate of voltage measurements is <1%. The error rate in reading current and power factor (PF) is <3%. Meanwhile, the error rate in reading power and usage costs is <9%.

Declaration by Authors

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Furqon, AB Prasetijo, and ED Widianto, "Design of an Electrical Power Monitoring and Control System in a Boarding House Using Android-Based NodeMCU and Firebase," Ilm. Electron., vol. 18, no. 2, pp. 93–104, 2019.
2. Aryza, S., Lubis, Z., & Lubis, S. A. (2020). Penguatan Industri 4.0 Berbasiskan Arduino Uno Dan GSM SIM900A DiDalam Pintu

Geser. *JET (Journal of Electrical Technology)*, *5*(2), 80-87.

3. Aryza, S., Pratama, S., & Ikbal, M. (2022). AN ENHANCE SYSTEM SMART TOILET BASED ON RECYCLE GREEN CONTROL. *INFOKUM*, *10*(02), 1156-1163.
4. T. Nusa, SRUA Sompie, and EM Rumbayan, "Real Time Electrical Energy Consumption Monitoring System Based on Microcontrollers," E-Journal Tech. Electrical and Comput., vol. 4, no. 5, pp. 19–26, 2015.
5. R. Sulistyowat and DD Febriantoro, "Designing a Microcontroller-Based Electrical Power Limiter Control and Monitoring System Prototype," J. IPTEK Vol 16 No.1 May 2012, vol. 16, no. 1, pp. 10–21, 2012.
6. I. Dinata and W. Sunanda, "Implementation of Wireless Monitoring," Nas. Tech. Electro, vol. 4, no. 1, pp. 83–88, 2015.
7. BG Melipurbowo, "Real Time Electrical Power Measurement Using the ACS712 Current Sensor," Orbith, vol. 12, no. 1, pp. 17–23, 2016
8. PE Wicaksono, "Electricity Tariffs for 900 VA Affordable Customers Rise Again in May," Liputan6, 2017.
9. S. Sultan, U. Rana, I. Ahmed, and S. Rabbani, "A New Technology of Online-Condition Monitoring of Energy Conservation Generation & Loads," Smart Grid Renew. Energy, vol. 4, no. February, pp. 18–22, 2013
10. Ardiansyah, A. (2020). IoT (Internet of Things) Based Electric Power Monitoring. Indonesian Islamic University. https://dspace.uii.ac.id/handle/123456789/23561
11. Destiarini, & Kumara, PW (2019). Line Follower Robot Based on Arduino Uno Atmega328 Microcontroller. Journal of Informanics, 5(1), 18–25.
12. Ratnasari, T., & Senen, A. (2017). Design of a prototype of an Arduino microcontroller based Ac and DC electric current measuring instrument with a 30 ampere Acs-712 current sensor. Sutet Journal, 7(2), 28–33.

How to cite this article: Suparmono, Trahman Sitepu, Nobert Sitorus, Sutan Pardede, Cholish, Irfan Nofri. Design A realtime datalogger on a simple house KWH meter with a capacity of 1300 VA. *International Journal of Research and Review*. 2023; 10(12): 352-359. DOI: *https://doi.org/10.52403/ijrr.20231238*

******