


## A Simulation of Digital Device to Calculate Electrical Energy Usage Costs Based on Kwh Metres

Mahrizal Masri<sup>1</sup>, Hermansyah Alam<sup>2</sup>, Zulfadli Pelawi<sup>3</sup>  
<sup>1,2,3</sup>Department Of Engineering , Universitas Islam Sumatera Utara, Indonesia

### ABSTRACT

The electricity payment system in Indonesia is by calculating the power used. The tool that records the use of electrical energy is a KWH meter. From this problem, an idea was obtained to record the KWH meter digitally so that we can easily find out how much electricity is used. This tool provides a value every time a pulse is detected by a photo diode against the KWH disc movement indicator. The function of this tool is a simulation with assumptions based on the KWH meter disc movement indicator detected by the photo diode, after which the pulses are processed on the AT89S51 microcontroller, and presented via a seven segment display. So that customers can easily find out the cost of electricity that has been used. Overall tool testing is done by connecting all parts of the tool and the KWH Meter is connected to the power grid and to the load. Simple testing is done by connecting the tool to a load of 100 watts and 200 watts

Keyword : Electrical Energy, Microcontroller, KWH Meter, Electrical Load

 This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Corresponding Author:  
Mahrizal Masri  
Department of Engineering  
Universitas Islam Sumatera Utara  
Jl. Sisingamangaraja Medan, North Sumatera, Indonesia  
Email : masrimahrizal@yahoo.com

**Article history:**  
Received Feb 1, 2025  
Revised Feb 20, 2025  
Accepted Mar 10, 2025

### 1. INTRODUCTION

The main parts of a KWH meter are the voltage coil, current coil, aluminum disc, permanent magnet and mechanical gear that records the number of rotations of the aluminum disc. When the meter is connected to a single-phase power supply, the disc gets a torque that can make it rotate like a motor with a high level of precision. KWH meter is a measuring instrument that is widely used in residential, office and industrial environments. This measuring instrument has experienced extraordinary development in recent years.

The development of this KWH meter is supported by the extraordinary development in the world of information technology, especially the internet, so that now data delivery can be carried out easily and the delivery process is fast. Unfortunately, electricity providers in Indonesia still cannot provide automatic meters, so conventional electricity meters are still used in the homes of electricity customers. The problem that often occurs is the problem of recording errors due to the location KWH meter which is difficult to see with the eye so that the bill becomes inaccurate.

On this occasion, researchers will modify conventional KWH meters so that customers can more easily find out how much electricity they use. In this experiment KWH meter The conventional system will be improved by having an electricity bill calculation system so that customers or household electricity consumers can easily find out the amount of their electricity bill in rupiah The tool created is a simulation with the assumption based on the KWH meter disc movement indicator, not placed on the actual load power, but only using a load of 100 watts, 200 watts, 300 watts and 400 watts of incandescent lamps.

### 2. RESEARCH STAGES

The story of Mr. Khoni Iswantomo, designing and making a digital odometer. An odometer is a distance measuring tool applied to motor vehicles where the tool has a display in the form of decimal numbers. This tool consists of several blocks including a pulse generator that functions to generate pulses obtained from the movement of the wheel rotation, the AT89C51 microcontroller as the main controller and also the signal processor obtained, This digital odometer is designed and made to be used as a distance measuring tool on a motorbike.

Jaenal Arifin, making the design Temperature Data Acquisition System Using AT89S51 Microcontroller With LCD Display, This design discusses a temperature data acquisition system that uses basic components in the form of a temperature sensor, microcontroller and LCD as a display facility. The temperature data acquisition system is a very important thing in industrial activities, because it is a small part of a control process. Regarding the importance of the system, a temperature data acquisition system is designed that is capable of monitoring the temperature of a plant. The data to be measured is a physical quantity of temperature so that it can be processed and displayed in the form of an electrical system, an LM35 temperature sensor is used which is capable of converting the quantity with an increase of  $10\text{mV}/^{\circ}\text{C}$ . To be able to design the system, the first process is carried out to convert the temperature into an analog voltage using the LM35 temperature sensor. After going through the signal conditioning process by amplifying it, the analog voltage is converted into digital data using the ADC 0804. The digital data obtained is then processed by the AT89S51 Microcontroller and displayed, so that information is obtained about the plant temperature in  $^{\circ}\text{C}$  units on an LCD. From the design of the temperature data acquisition system, it was found that this system has the ability to measure temperatures from  $25^{\circ}\text{C}$  to  $100^{\circ}\text{C}$ .

Microcontrollers, as a breakthrough in microcontroller and microcomputer technology, are here to meet the market (market need) and new technology. As a new technology, namely semi-conductor technology with more transistor content but only requires a small space and can be mass-produced (in large quantities) so that the price becomes cheaper (compared to microprocessors). As a market need, microcontrollers are here to meet the tastes of industry and consumers for the needs and desires of more sophisticated tools and toys as well as in the field of education.

Unlike computer systems, which are capable of handling a variety of application programs (e.g. word processors, number processors, and so on), microcontrollers can only be used for one specific application. Another difference lies in the ratio of RAM and ROM. In computer systems, the ratio of RAM and ROM is large, meaning that user programs are stored in a relatively large RAM space, while hardware interface routines are stored in a small ROM space. Whereas in microcontrollers, the ratio of ROM and RAM is large, meaning that control programs are stored in a relatively larger ROM, while RAM is used as a simple storage place.

*KWH Meter* means Kilo Watt Hour Meter and if interpreted becomes n thousand watts in one hour. If you buy a KWH Meter then it will be listed x rotations per KWH, meaning to reach 1 KWH it takes x rotations per hour. For example if 900 rotations per KWH then there must be 900 rotations per hour to be said to be one KWH. The number of KWH is cumulatively calculated and at the end of the month the officer records the amount of usage then multiplied by the basic electricity ecomp or TDL plus the subscription fee and tax resulting in the amount of the bill that must be paid each month. For example, the tool made here, the KWH Meter has a specification of 900 rotations per KWH, meaning there must be 15 rotations per minute to reach one KWH. The calculation of the current cost per KWH based on TDL R1 (900 Watt) is Rp. 450.00 (including VAT) meaning per minute = Rp. 7.5. If so, if the holes are made into 10 points, the number of pulses per KWH is 15 rotations x 10 points = 150 points. From the calculation above, the value of each hole per minute is Rp. 7.5: 150 = Rp. 0.05

### 3. RESULTS AND DISCUSSION

To realize this digital electricity usage calculator, the first step taken is to create a block diagram of the tool as in Figure 1.

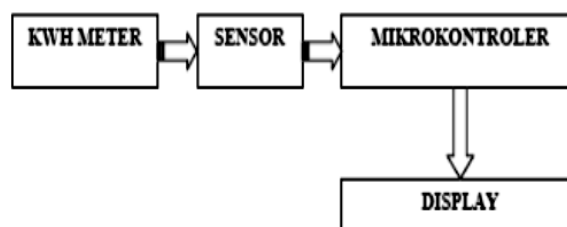


Fig 1. Tool block diagram

Tools used

- KWH Meter,
- 1 Ampere Transformer,
- Power Supply Circuit,

- Photo Diode,
- Amplifier IC circuit (IC LM 358),
- Microcontroller Circuit,
- 5 100 watt incandescent light bulbs.

SeriesPhoto diode functions as input for the microcontroller system. This Photo diode circuit will detect the rotation of the aluminum disc on the KWH Meter. A hole is made in the aluminum disc so that the Photo diode can detect the rotation of the aluminum disc as seen in Figure 2.

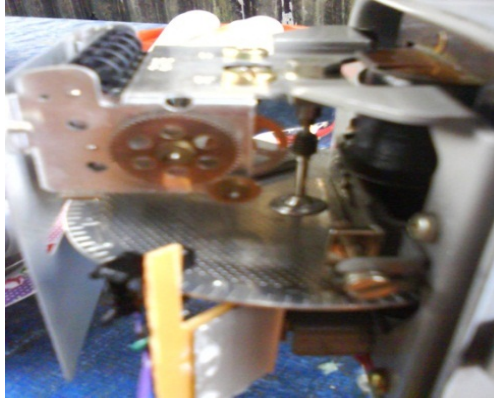


Fig 2. Perforated Aluminum KWH Meter Disc

After being drilled, the KWH Meter is modified by making a position for the Photo diode so that it will be like in Figure 3. The number of holes will affect the calculation formula that will later be entered into the microcontroller. Figure 3 shows After being drilled, the KWH Meter is modified by making a position for the Photo diode so that it will be like in Figure 3. The number of holes will affect the calculation formula that will later be entered into the microcontroller. Figure 3. shows how to place the Photo diode on the KWH Meter frame.

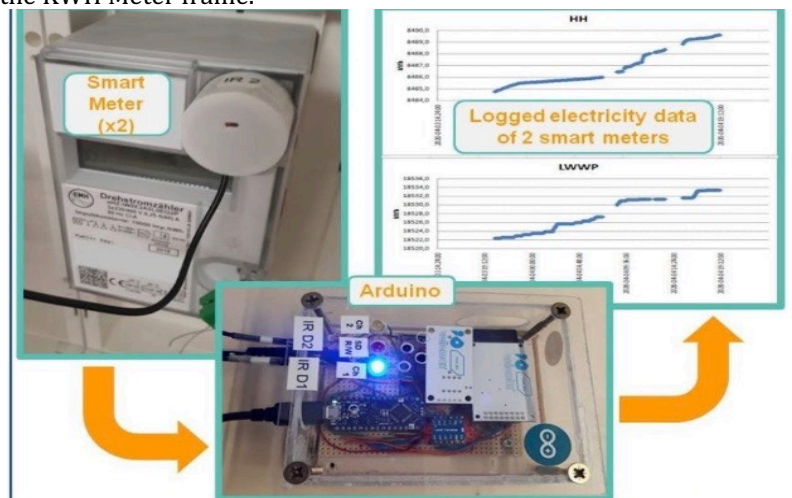


Fig 3. Photo diodegiven a position on the KWH Meter.

The way the sensor circuit works is as follows:

1. When the aluminum disc rotates, the holes in the aluminum disc also rotate.
2. Hole -the hole is detected by a photo diode where the output is in the form of *pulses*electricity
3. At the time Photo diode When it meets a hole in the aluminum plate, the infrared light or LED light will penetrate so that the photo diode will conduct electric current, whereas if it is closed, the photo diode will stop conducting electric current.
4. Electricity pulsesit is then processed so that the output matches the input requirements. *microcontroller*.

The following is a photo diode circuit which can be seen in Figure 4.

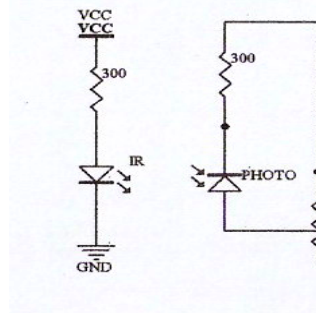


Fig 4.SeriesPhoto diode

After realizing the system hardware circuit, the next step is to create a program to run the device. The program for the AT89S51 microcontroller is created using the ASM51 assembler language. After being compiled into a hexa file (\*.hex), the program is then downloaded into the microcontroller using a microcontroller programmer. The program on this microcontroller consists of a signal receiver program, a program to calculate pulses per minute, a cost calculation program and a seven segment display program. The program on this microcontroller consists of a signal receiver program. input, a program to calculate pulses per minute, a cost calculation program and a seven segment display program.

### 3.1 Result.

After all components are installed and the program is completed, the next step is to test the tool. This testing is done in stages from one circuit to the next. The photo diode circuit is tested by measuring the output voltage of the circuit if the aluminum disc is rotated. The measurement begins by providing a supply voltage to the sensor circuit of 5 volts DC and the KWH Meter is given a load of 100, 200, 300 and 400 watts. The microcontroller circuit is tested by entering a simple program to turn on an LED connected to one of the microcontroller output ports. In this test, Port 0 is used. The first step of testing is to create a circuit consisting of 8 LEDs whose anodes are connected together to a voltage of +5 volts DC and whose cathodes are connected to the pins of the microcontroller port 0 via jumpers. The next step is to create a simple program to turn on the LEDs. The program created for this test is as follows:

```

ORG 0H
MOV A,#0FEH
START: MOV P0,A
      ACALL DELAY
      RL A
      SJMP START
DELAY: MOV R0,#0
DELAY1:MOV R1,#0
DELAY2:DJNZ R1,DELAY2
      DJNZ R0,DELAY1
      RET
      END

```

The program is then compiled and inserted into the microcontroller with the help of a programmer. After the microcontroller is installed into the circuit, from the results of the experiments carried out, the program runs well with the LED shifting to the left. This means that the microcontroller circuit is running well. The program on this microcontroller functions to read the input pulses sent by the sensor and then perform calculations and display the amount of electrical energy usage in rupiah which is displayed by the seven segment.

The next step after the hardware part is finished being tested is to test the program part that has been entered into the microcontroller. This test can be done by giving electrical pulses of 5 volts to the input part of the microcontroller. Because the refresh is every 1 minute, we need to wait for each change for 1 minute later. The more pulses given, the greater the rupiah value will be. To test the calculations that we input into the microcontroller, we need to provide pulses with the correct calculations, for example, if there are one hundred pulses in one minute, the amount of rupiah must show Rp. 5.

### 3.2 Overall Tool Testing.

Overall tool testing is done by connecting all parts of the tool and the KWH Meter is connected to the electrical grid and to the load. Simple testing is done by connecting the tool to a load of 100 watts and 200 watts

By calculation we get:

100 watts x 10 minutes

100 watts x 10 minutes x  $\frac{1 \text{ jam}}{60 \text{ menit}}$

100 watts x  $\frac{10}{60}$  hours = 16.66 WH

16.66 WH = 0.017 KWH

So at a load of 100 watts in 10 minutes you get 0.017 KWH,

1 KWH = Rp. 450,

Or, Power x TDL = 0.0166 KWH x Rp 45 = Rp 7.5

By calculation we get:

200 watts x 1 minute

200 watts x 1 minute x  $\frac{1 \text{ jam}}{60 \text{ menit}}$

200 watts x  $\frac{1}{60}$  hours = 3.333 WH

3.333 WH = 0.00333 KWH

So at a load of 200 watts in 1 minute, 0.00333 KWH is obtained,

1 KWH = Rp. 450,

Or,

Power x TDL = 0.00333 KWH x Rp 450  
= Rp 1.5

Table 1. Test Results at Loads of 100, 200, 300 and 400 watts

Burden (watt)	Time (minute)	Theoretical cost calculation	Practical cost calculation
100	5	Rp 3.75	Rp 4
100	10	Rp.7.5	Rp.8
200	50	Rp. 37.5	Rp 40
200	60	Rp. 45	Rp. 48
300	2	Rp 4	Rp 5
300	4	Rp. 8	Rp 10
400	6	Rp. 12	Rp15
400	10	Rp.18	Rp.25

In the overall tool test, there was a difference between the theoretical cost calculation and the practical cost calculation, this was because the KWH meter used was not in a good classification, in the practical calculation it was obtained from every two rotations on the KWH meter disc producing a value of one Rupiah on the seven segment, so the greater the power used, the greater the rotation produced and the rupiah value will also increase.



Fig 6. Modified KWH Meter

#### 4. CONCLUSION

After testing the results of the design of the electricity payment system tool on the KWH meter in Rupiah, several conclusions can be drawn:

1. The display of the power recorder is in the form of 6 digits of Rupiah value plus 2 digits of the Rupiah currency symbol (Rp).
2. The available power is 900 Watts, 220 Volts and the load used is 200 Watts of incandescent lamps
3. The value of each hole on the KWH meter disc is Rp0.05
4. Two rotations of the disc on the KWH meter produce a value of 1 Rp.
5. The more pulses the sensor detects, the greater the rupiah value will be.

#### REFERENCES

- Aryza S, et al (2024) A ROBUST OPTIMIZATION TO DYNAMIC SUPPLIER DECISIONS AND SUPPLY ALLOCATION PROBLEMS IN THE MULTI-RETAIL INDUSTRY. *Eastern-European Journal of Enterprise Technologies*,
- Arabelli et al (2020) Smart street light management system for conservation of electrical energy. In *IOP conference series: materials science and engineering* (Vol. 981, No. 3, p. 032041). IOP Publishing
- Babu, N. P., Chandra, A. V., Rishikesh, C., Pooja, M., Krishna, T. M., Kumar, A. A., ... & Chatterjee, D. (2023, September). Solar Energy Monitoring and Management System Using IoT. In *2023 IEEE 2nd International Conference on Industrial Electronics: Developments & Applications (ICIDeA)* (pp. 493-498). IEEE.
- Masri, M., Liestyowati, D., Andiyan, A., & Husolihah, A. (2024, February). Smart Energy Public Street Lighting System. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1301, No. 1, p. 012008). IOP Publishing.
- Masri, M., Siregar, M. F., Suprianto, S., Mungkin, M., Syahputra, S. A., Syafriwel, S., & Alam, H. (2024, November). Implementation Of Solar Electric Energy Monitoring For Household Electricity Loads Using IOT. In *Proceeding of International Conference on Science and Technology UISU*(pp. 87-92).
- Rafiq, A. A. (2017). Optimalisasi Smart Relay Zelio sebagai Kontroler Lampu dan Pendingin Ruangan. *Jurnal Teknologi Elektro*, 8(2), 142135.
- Rahmat, R., Nugroho, B., & Purwono, A. H. (2024). IoT Application for Monitoring and Recording Solar Power Plant Data. In *E3S Web of Conferences* (Vol. 500, p. 01008). EDP Sciences.
- Lobo, E. T. S., Takaya, P. R., & Paledung, I. B. (2022, December). Realtime Monitoring Design of Solar Cell Power Plant Based on IoT. In *Journal of Physics: Conference Series*(Vol. 2394, No. 1, p. 012028). IOP Publishing
- Sari, I.P., IH Batubara, AK Al-Khowarizmi, PP Hariani, (2022), Perancangan Sistem Informasi Pengelolaan Arsip Digital Berbasis Web untuk Mengatur Sistem Kearsipan di SMK Tri Karya, *Wahana Jurnal Pengabdian kepada Masyarakat* 1 (1), 18-24
- Sari, I.P., IH Batubara, M Basri, (2023), Pengenalan Bangun Ruang Menggunakan Augmented Reality sebagai Media Pembelajaran, *Hello World Jurnal Ilmu Komputer* 1 (4), 209-215
- Ramadhani, F., Sari, I.P., & Al-Khowarizmi, (2021), Pemanfaatan Aplikasi Online dalam Digitalisasi Pasar Tradisional di Medan, *Prosiding Seminar Nasional Kewirausahaan* 2 (1), 806-811
- AK Al-Khowarizmi, IR Nasution, M Lubis, AR Lubis, (2020), The effect of a SECoS in crude palm oil forecasting to improve business intelligence, *Bulletin of Electrical Engineering and Informatics* 9 (4), 1604-1611
- AK Al-Khowarizmi, F Fauzi, IP Sari, AP Sembiring, (2020), The effect of Indonesian and Hokkien mobile learning application models, *Journal of Computer Science, Information Technology and Telecommunication*

- AK Al-Khowarizmi, (2020), Model Classification Of Nominal Value And The Original Of IDR Money By Applying Evolutionary Neural Network, *Journal of Informatics and Telecommunication Engineering* 3 (2), 258-265
- Salmec. (2022, Januari 05). Project Hub. Retrieved from Mowerino-Arduino Project Hub: [https://create.arduino.cc/projecthub/salmec/mowerino-81b09e?ref=search&ref\\_id=mowerino&offset=0](https://create.arduino.cc/projecthub/salmec/mowerino-81b09e?ref=search&ref_id=mowerino&offset=0)
- Syahminan. (2020). Pengembangan Pembelajaran Teknik Digital Dengan Media Perangkat Lunak Proteus Dan Emulator Jurusan Teknik Informatika Universitas Kanjuruhan. *Jurnal SPIRIT*, 12(2), 41-45.
- Ulinuha Latifa dan Joko Slamet Saputro. (2018). Perancangan Robot Arm Gripper Berbasis Arduino Uno Menggunakan Antarmuka Labview. *Barometer*, 3(2), 138-141.
- Yohana Tri Utami, Yuri Rahmanto. (2021). Rancang Bangun Sistem Pintu Parkir Otomatis Berbasis Arduino Dan RFID. *JTST*, 2(2), 25-35.
- Zulkarnain, Dikki. (2017). Perancangan Sistem Parkir Dengan Rekomendasi Lokasi Parkir. 14(2).