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Development of KWH Equipment Based Microcontroller Atmega 8535

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***Abstract*— This research aims to the development of reader equipment as well as control the load limitation of electric power using Atmega 8535 microcontroller. In the development of equipment of reading and controlling electrical energy consumptions, the modified KWH (Kilo Watt Hour) meter was used by placing the optocoupler sensor as the enumerator indicator the electric power consumption on the disc. Atmega 8535 microcontroller was used to control and limitation of the electric power consumption. In this research, the measuring and control system was developed to record the amount of electrical power load used, and it can be used as an alternative to the current divider for the achievement of the efficiency of practical electrical energy consumption. The results of the measurement comparison between the measured load and the output load tended to be stable with an average percentage error of 6.3%, and it was still below the optimum threshold value of the error factor, which around 10%. Therefore, results of testing developed equipment KWH digital meter using Atmega 8535 microcontroller that was produced a good performance.**

Keywords— ***Atmega 8535 microcontroller, KWH meter equipment, optocoupler sensor.***

I. INTRODUCTION

The main function of KWH meter reading is to calculate electricity consumption that is widely used both in community and industrial environments. The manual KWH meter system, the amount of electricity consumption would be recorded manually by a PLN official without being known the value of electricity that has been used by customers accurately. The manual KWH meter reading can cause problems for consumers and PLN if the meter reading staff accidentally reduce or increase customer bills. While the KWH meter digital system uses "tokens" the amount of electrical energy used and the usage price can be determined according to the customer's needs [1]. This system does not need officers employed to check the meter reading or handle termination of customers who do not pay, such as the manual KWH meter system. But the two KWH meter measuring systems above are still not optimal in recording and controlling or limiting the use of electricity used for each appliance such as electronic equipment, machines, lighting lamps, etc. So that the use of electricity is less controlled and less efficient, therefore the cost of spending on electricity becomes expensive. Thus, the manual KWH meter system and the token system are likely not optimal in the recording of electrical energy, and it may not be able to control the users of electrical energy for practical consumptions.

To control the use of energy in electrical devices, the microcontroller is one of the choices for the public using electricity [2]. The microcontroller is a series of electronic components consisting of a microprocessor with unit ranges from 4 bit to 32 or 64-bit processors, RAM, ROM, timer, parallel and serial I/O components, and 3 to 8 numbers of Interrupts controller [3]. The advantages of using microcontroller can increase reliability and flexibility systems and effortless for breakdown and maintenance [3,4].

Several studies for measuring and controlling electrical energy use systems using microcontrollers as processors of electric current quantities and power consumption. In the example, Loss et al. [5] developed a single phase microcontroller for energy meter. Next, Sulistiyo et al. [6] developed a digital KWH meter using a microcontroller to calculate and know the power of electricity used. A prototype of a microcontroller-based digital power meter for counting and informs the amount of power consumed was designed by Widiana & Harjoko [7]. While Setiono [8] studied to measure electricity consumption and the cost of electricity for one room with a digital KWH meter using the Amega 8535 microcontroller.

This paper aims to develop and test a power counter and control or limiter, which using the Atmega 8535 microcontroller by placing the optocoupler sensor as an indicator of the used power number counter. This equipment is useful to know the value of practical electrical energy consumption and can limit the use of electrical power, which used the microcontroller. The use of controlled and efficient electrical energy consumptions can save the cost of electric energy expenditure.

II. RESEARCH METHODS

A. *Triangulasi method on machine vision*

The development of a digital KWH meter recording and control device made consists of several components, namely: KWH meter, optocoupler sensor, adapter, relay, and Atmega 8535 microcontroller. The design of the tool uses a modified

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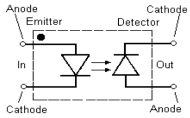
KWH meter by placing the optocoupler sensor as an indicator of the used power number counter on the disc. To control and limit the use of power used the Atmega 8535 microcontroller. The recording and control system developed measures the amount of electrical power used by the load and can be used as an alternative flow divider to achieve efficient use of electricity.

The developing proposed equipment was modified an analog KWH meter, which works using the method of magnetic field induction, where the magnetic field moves a disc made of aluminum. The voltage coils, current coils, and aluminum plates, fixed magnets whose job to neutralize aluminum plates from magnetic field induction and mechanical gear that record the number of rotations of aluminum plates. Then, an AVR microcontroller from Atmega 8535 is used due to this microcontroller has complete facilities, fast instruction process and supported by AVR Vision Evaluation software for simulation and compiling. The Atmega8535 microcontroller is a low-power 8-bit CMOS based on the AVR enhanced RISC architecture, by executing instructions in one cycle and allowing the system to optimize electrical power consumption [9]. In addition, this microcontroller has a special feature to convert analog signals to digital signals, because the sensor output is an analog signal, while this signal needs to be processed as a digital signal on the microcontroller. Furthermore, the C language was used for programming the Atmega8535 microcontroller. Code Vision AVR is one of the software compilers based on C language for AVR applications integrated by ANSI in the system. Code Vision AVR provides a code generator or AVR code wizard that provides facilities to develop the desired program.

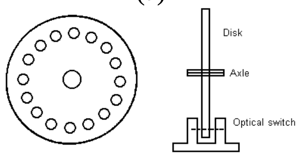
Next, this system used the relay of opto-isolated 2 channels 5 V DC, the output of 250 VAC 10 A. An adapter was used as a device consisting of a series of components that convert alternating electric current (AC) into direct current (DC). The components on the adapter were transformers, rectifiers, filters and voltage regulators [10]. A sensor of optocoupler was implemented in this equipment proposed, which function as a tool to detect changes in infrared off-trigger light that was used to detect the distance or movement of an object. Part of the optocoupler sensor was an infrared LED as a transmitter and a phototransistor as a receiver.

An optocoupler is a series of electronic devices or packages consisting of infrared Light-Emitting Diode (LED) and photodetectors such as photosensitive silicon diodes, Darlington transistor pairs, or Rectifier-Controlled Silicon (SCR) [11]. In Figure 1a can see an array of optocoupler schemes. Whereas example 1b can be seen an example of the application of a slotted optocoupler with the working principle of a thin metal disk with a slot on the outer edge rotated inside the optocoupler slot, the slot in the slot results in infrared light that can detect electric current flowing at the coupler and when infrared light is blocked by the opaque part of the dish, there is no electric current output [11].

The digital KWH control system proposed the Atmega8535 microcontroller using a closed loop system as shown in Figure 2 [12]. In Figure 2, the electrical energy as input was fed on analog meter KWH, which provides the energy value consumptions calculated by the disk. Next, the Atmega8535 microcontroller controlling the use of electric loads according to that determined by the value fed on the sensor auto coupler. After the load usage limit was met according to quota, which was informed via a digital viewer seven segments, the microcontroller automatically would activate the relay function as energy breaker electricity.



(a)



(b)

Figure 1: (a) Scheme of optocoupler and (b) implementation of slotted optocoupler [11].

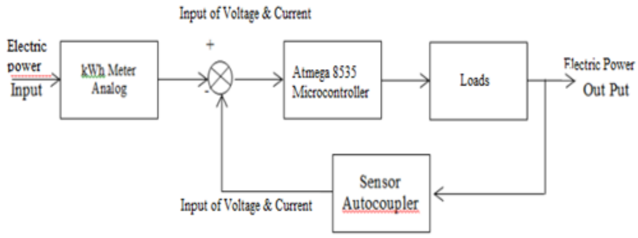


Figure 2: The digital KWH control system proposed microcontroller Atmega 8535 [12].

The KWH meter equipment developed, carried out several tests: (1) tested by the measuring value of the optocoupler sensor with the condition that the sensor was blocked and un-obstructed, (2) testing the adapter by measuring the input voltage (AC) and output voltage (DC), (3) testing the seventh segments at the foot of the microcontroller output and (4) testing the system with a variety of load or power measured using 4 incandescent lamps.

III. RESULTS AND DISCUSSION

All tables must have a table label with the font size 9 before the Development of a digital KWH meter was based on input from an optocoupler sensor, which was attached to the lid of the KWH meter plate. The optocoupler sensor gave a low output value when the infrared sensor was blocked or disconnected, which the high and low logic would be the input for the microcontroller as the main controller to provide seven segments output. The design of the development of a KWh meter recording and control device using the Atmega 8535 microcontroller that was presented in Figure 3.

The developed KWH meter system testing was carried out by measuring the incoming and outgoing power using 4

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incandescent light bulbs of 15 W, 25 W, 40 W and 55 W. Before testing the performance of the equipment, optocoupler sensors were tested, adapter testing and seventh segments test at the foot of the microcontroller output. The test results can be seen in Table 1-5.

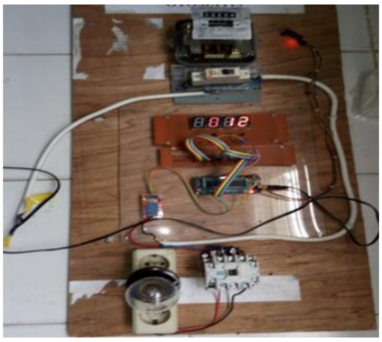

Figure 3: Design of a digital KWH.

A. *Optocoupler Sensor Testing*

Table 1: Testing of optocoupler sensor

Sensor of Optocoupler			
Tests	Input Voltage	Sensor Condition	
		Sensor is blocked	The sensor is not blocked
1	5 V	5 V	0.1 V
2	5 V	5 V	0.1 V
3	5 V	5 V	0.1 V
4	5 V	5 V	0.1 V
5	5 V	5 V	0.1 V

The results of testing the measuring value of the optocoupler sensor with the condition of the sensor being blocked and un-obstructed were presented in Table 1. Based on the test results from the optocoupler sensor in Table 1, it can be concluded that the sensor works well. The output of this sensor, which is in the form of logic high if blocked and low when not blocked.

B. *Testing of Adaptor*

The results of testing the measuring value of adapter testing were presented in Table 2.

Table 2: Testing of the adaptor

Adaptor		
Test	Input Voltage (AC)	Output Voltage (DC)
1	185 V	5.1 V
2	185 V	5.1 V
3	185 V	5.1 V
4	185 V	5.1 V
5	185 V	5.1 V

Testing was performed by measuring input and output voltages using a multimeter tool on the adapter. The test results can be seen in Table 2. The input and output voltages on the adapter were stable. This shows that the adapter can work properly.

C. *Seven Segments Testing*

The test results of measuring seven segments 1 and 2 as well as seven segments 3 and 4 can be seen in Table 3 and Table 4. From the results of the seven segments test that it has worked well and can be seen the results of the voltage measurement at the seven segments foot showing a 1.8 V.

D. *Measuring Load and Output Load*

The results of a comparison of measured loads and output loads were presented in Table 5.

Table 5: Comparison of measured loads and output loads

No	Measured Load (W)	Voltage *Out* (V)	Current *Out* (I)	Loadout (Watt)	% Errors
1	Bulb15 W	225	0.07	16.07	10.08%
2	Bulb 25 W	224	0.12	26.48	5.03%
3	Bulb 40 W	224	0.18	44.32	4.89%
4	Bulb 55 W	225	0.23	57.35	4.03%

In Table 5 can be seen the results of the measurement comparison between the measured load and the output load that tended to be stable with an average percentage error of 6.3% and it was still below the optimum threshold value of the error factor, which around 10%.

Table 3: Test of seven segments 1 and 2

seven segments															
Test	Voltage of Input	Seven segments 1(Volt)							Seven segments 1(Volt)						
		A	B	C	D	E	F	G	A	B	C	D	E	F	G
1	5 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V
2	5V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V
3	5V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V
4	5V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V
5	5V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V

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Table 4: Test of seven segment 3 and 4

seven segments															
Tes	Voltage of Input	Seven segments 3 (Volt)							Seven segments 4 (Volt)						
		A	B	C	D	E	F	G	A	B	C	D	E	F	G
1	5 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V
2	5V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V
3	5V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V
4	5V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V
5	5V	1.8 V	1.8 V	1.8 V	1.8 V	1.8V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V	1.8 V

IV. CONCLUSION

This study aims to develop and test the counter and control or limiting electric power using the Atmega 8535 microcontroller. Based on the results of testing the optocoupler sensor was worked well with the results of testing, i.e. when blocked with a value of 5 V and un-blocked of 0.1 V. Based on the test results were revealed the tool proposed that was quite stable. This can be approved based on several times testing of the adapter input (AC) voltage indicator in the 185 V range and the output voltage (DC) in the range of 5 V. Besides the output voltage at seven segments was stable at 1.8 V. The average error factor in the comparison of load measurement results was measured by a measuring load of 6.3%. It can be concluded that the development of a digital KWh meter using the Atmega 8535 microcontroller produces a quite good performance and is feasible to use.

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