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# DESIGN AND CONSTRUCTION OF A SMARTPHONE-BASED MONITORING AND CONTROL SYSTEM FOR GENERATOR SET CURRENT, VOLTAGE AND FREQUENCY USING AN ATMEGA328 MICROCONTROLLER

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## ABSTRACT

The current sensor, voltage sensor and frequency sensor circuits for generator set control can work automatically when the voltage is between 220 V and 230 V. The measured current is <−1 A, the average voltage is 218.6 V, and the average frequency is 50.6 Hz. The current, voltage and frequency of the generator set can be viewed on the screen of a smartphone running the Android operating system that is connected via Bluetooth.

## 1. INTRODUCTION

### 1.1. *Background*

Electrical energy is one of the main needs in various activities in society, including universities, such as teaching and learning, staff administration, data processing, and so on, and its quality needs to be maintained. This quality is important to know because it can affect the performance and service life of the equipment used. Among the factors that influence the quality of electrical energy are the voltage, current, and power factor of the system.

Besides being economical and efficient, another matter to consider is comfort in the use of electrical energy. Electrical quantities should be kept within the permitted standard conditions or limits. To know this, a device that can monitor these electrical quantities is needed. At present, monitoring of electrical quantities such as voltage, current, power, and power factor is mostly done in 2 ways, by installing electrical measuring instruments on the electrical panel before the load. This method has a drawback: to find out the values, one must look directly at the location where the measuring instrument is installed, so it is inefficient because the results cannot be known immediately. For this reason, a device needs to be designed and built to monitor and store electrical quantity data in real time. In addition to providing information on electrical quantities, it can also be used as a reference for power system analysis.

The problem formulation is how to design the ACS712 current sensor, the ZMPT101B voltage sensor, and a frequency sensor circuit that can measure the voltage, current, and frequency of a generator set and perform automatic control when the voltage rises or falls within the range of 220–230 V, and how to create Android software that can display the sensor readings on the Android screen using

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Bluetooth.

The scope of this research is limited to using the ACS712 sensor, the ZMPT101B voltage sensor, a frequency sensor, and a Bluetooth transmitter together with an Android application.

The objective of this research is to design the ACS712 current sensor, the ZMPT101B voltage sensor, and a frequency sensor circuit so that they can measure the current, voltage, and frequency of a generator set, perform automatic control when the voltage rises and falls, and display the data on an Android operating system application using Bluetooth.

### *1.2. Previous Research*

In 2017, Najib Amaro designed an electrical quantity monitoring system using IoT (*Internet of Things*) technology [4]. The concept of monitoring via the internet allows users to connect, control, and monitor the system directly over the internet.

In 2015, Dadan Nur Ramadan, Agus Ganda Permana, Galuh Mardiansyah, and Dyah Puspaningrum designed a device, namely the design and implementation of a measuring instrument and information system for single-phase electricity, a system for monitoring electricity usage in both prepaid and postpaid modes [1].

In 2006, Dali S. Naga, Thomas, and Rudy Arto designed and implemented a personal computer-based single-phase alternating-current electric power meter. This electric power meter is composed of a digital part and an analog part. There are three main parts in a measuring instrument: the detector, the data processor, and the data display. First, conditioned voltage measurement of the alternating current (AC) by measuring the current flowing in the PLN (state electricity company) supply, and second, conditioned voltage measurement using a voltage divider.

In 2012, Dwi Wahyu Suryawan, Sudjadi, and Karnoto designed a monitoring system for voltage, current, and temperature in an electrical power supply system in electrical engineering, based on the ATmega328 microcontroller. The monitored parameters include the voltage and current of each phase on the load side, generator temperature, genset motor temperature, cubicle temperature, LVMDP room temperature, and transformer fin temperature. This power supply measuring instrument uses a step-down transformer as the voltage sensor, capable of measuring voltages between 0 V and 240 V, and a 100/5 A CT ratio as the current sensor, capable of measuring currents between 0 A and 87 A.

In 2017, Rawan Hiba and Diana Wati designed a detector for 50–60 Hz electrical frequency at 220 Vac in telecommunication equipment [5]. This device is used to detect wires carrying a 220 V / 50–60 Hz electric current in telecommunication equipment without direct contact with the voltage source, which is dangerous when the electricity is in its normal state.

### *1.3. Android*

Android is an operating system for mobile phones based on Linux. Android provides an open platform for developers to create their own applications so that they can be used by a variety of devices. Initially, Google Inc. bought Android Inc., a newcomer that made software for mobile phones. Then, to develop Android, the Open Handset Alliance was formed, a consortium of 34 hardware, software, and telecommunications companies, including Google, HTC, Intel, Motorola, Qualcomm, T-Mobile, and NVidia (Firdan Ardiansyah, 2011).

### *1.4. ACS712 Current Sensor*

A current sensor is a device that detects electric current (AC or DC) in a wire and produces a proportional signal (Robin Mahendra, 2014).

### *1.5. ZMPT101B Voltage Sensor*

The ZMPT101B sensor is one of the sensors used to monitor voltage parameters, and it has the advantages of an ultra-micro voltage transformer, high accuracy, and good consistency for measuring voltage and power (http://repository.umy.ac.id).

### *1.6. Frequency Sensor*

This device is used to detect wires carrying a 220 V / 50–60 Hz electric current in telecommunication equipment without direct contact with the voltage source, which is dangerous when the electricity is in its normal state (Sapta Ajie, 2014).

### *1.7. Bluetooth Module*

The HC-05 Bluetooth module is a wireless communication module that operates at a frequency of 2.4 GHz with two connectivity modes. Mode 1 acts as a slave, i.e., a data receiver only, and mode 2 acts as a master, i.e., it can act as a transceiver. This component is well suited to electronics projects with wireless communication (Fahmi Faizal, 2017).

## 2. METHODS

The research was carried out in stages of hardware design and software design.

### 2.1. *Hardware Design*

*Current sensor design.* The current sensor can be used to measure AC or DC current. This sensor is used in industrial, commercial, and communication applications. The design of the current sensor is shown in Figure 1.

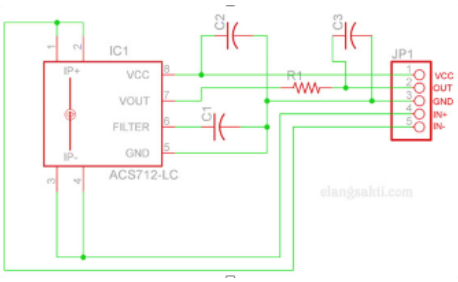



**Figure 1** Current sensor circuit

*Voltage sensor design.* The voltage sensor is used to measure voltage. Voltage is always a difference between two measured points, that is, the voltage difference between one point and another.

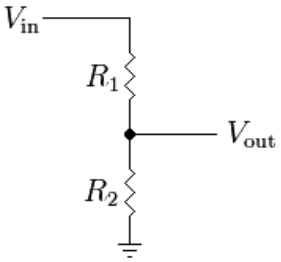



**Figure 2** Voltage sensor circuit

*Frequency sensor design.* This device is used to detect wires carrying a 220 V / 50–60 Hz electric current in telecommunication equipment without direct contact with the voltage source, which is dangerous when the electricity is in its normal state. The circuit is shown in Figure 3.

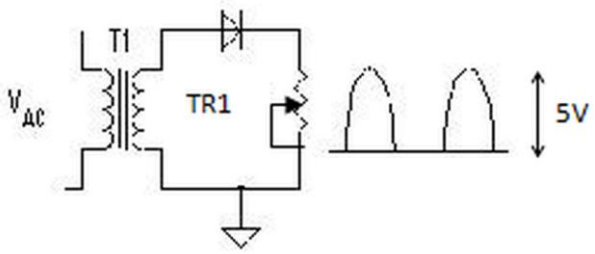



**Figure 3** Frequency sensor circuit

*Servo motor design.* The movement of the servo motor shaft can be controlled using the PWM (*Pulse Width Modulation*) method, as shown in Figure 4.

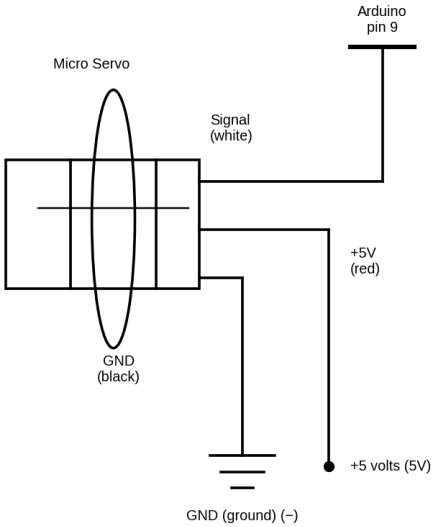



**Figure 4** Servo motor circuit

*2.2. Software Design*

The ATmega328 microcontroller is programmed using the Arduino IDE, with a sketch/code based on a flowchart to make the program easier to write. The software design flowchart is shown in Figure 5.

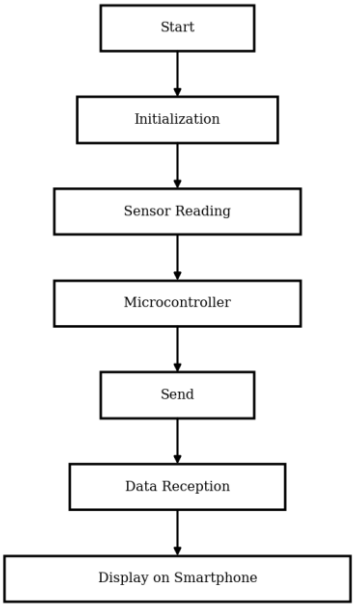



**Figure 5** Flowchart of the software design

## 3. RESULTS AND DISCUSSION

*3.1. Test Results*

*ACS712 current sensor test.* The ACS712 current sensor test was carried out to detect electric current. The test used a flowing current, with the ACS712 current sensor having been programmed beforehand through the Arduino board and the program stored in the ATmega328P microcontroller IC.

**Table 1** ACS712 Current Sensor Test

| Trial | Current Load | Digital Measuring Device (A) | Tangmeter VIP 3803C (A) |
|---|---|---|---|
| 1 | Television | 0.54 | 0.55 |
| 2 | Sound system | 0.25 | 0.23 |
| 3 | Electric fan | 0.11 | 0.10 |
| 4 | Rice cooker (magic jar) | 0.19 | 0.15 |
| 5 | Soldering iron | 0.6 | 0.7 |

*Source: Research results.*

From Table 1, the ACS712 current sensor test was carried out by comparison with a Tangmeter VIP 3803C clamp meter, and the highest current value obtained was for the television at 0.55 A and the lowest was for the soldering iron at 0.7 A.

*ZMPT101B voltage sensor test.* This sensor test used mains voltage. The ZMPT101B voltage sensor is connected to the Arduino pins, with the ZMPT101B voltage sensor having been programmed beforehand through the Arduino board and the program stored in the ATmega328P microcontroller IC.

**Table 2** ZMPT101B Voltage Sensor Test

| Trial | Time (s) | Digital Measuring Device (V) | Heles AVOmeter (V) | Error (%) |
|---|---|---|---|---|
| 1 | 5 | 220 | 218 | 0.909091 |
| 2 | 10 | 220 | 210 | 0.545455 |
| 3 | 15 | 220 | 221 | 0.454545 |
| 4 | 20 | 220 | 218 | 0.909091 |
| 5 | 25 | 220 | 226 | 2.727273 |
| **Average** | | **220** | **218.6** | **1.909091** |

*Source: Research results.*

From Table 2, the ZMPT101B voltage sensor test, compared with the Heles AVOmeter measuring instrument, gave an average of 220 V, with the ZMPT101B sensor reading 218.6 V, and an average error of 1.909091% was obtained.

*Frequency sensor test.* The frequency sensor test was carried out to detect the magnitude of the frequency. The frequency sensor had been programmed beforehand through the Arduino board and the program stored in the ATmega328P microcontroller IC.

**Table 3** Frequency Sensor Test

| Trial | Time (s) | Digital Measuring Device (Hz) | Heles Hz Meter (Hz) | Error (%) |
|---|---|---|---|---|
| 1 | 5 | 47 | 50 | 6.382979 |
| 2 | 10 | 47 | 51 | 8.510638 |
| 3 | 15 | 47 | 51 | 8.510638 |
| 4 | 20 | 47 | 50 | 6.382979 |
| 5 | 25 | 47 | 51 | 8.510638 |
| **Average** | | **47** | **50.6** | **7.659574** |

*Source: Research results.*

From Table 3, the frequency sensor, compared with the Heles Hz meter measuring instrument, gave an average of 47 Hz, with the frequency sensor reading 50.6 Hz, and an average error of 7.659574% was obtained.

*Servo motor test.* To obtain good results, the servo motor was tested by connecting it to the pins of the minimum system that had been programmed through the Arduino software and stored in the ATmega328 microcontroller IC. If the movement of the servo motor is as expected, then the servo motor works well and can be used.

**Table 4** Servo Motor Test

| No | Command | Servo Motor Response |
|---|---|---|
| 1 | Voltage rises and falls | On |
| 2 | Voltage stable | Off |

*Source: Research results.*

From Table 4, if the voltage of the current flow suddenly rises or suddenly falls, the servo motor response will be *on* to stabilize the voltage. Meanwhile, if the voltage of the current flow is stable, the servo motor response will be *off*.

*Overall device test.* This stage aims to determine the performance of the overall circuit, which includes testing the ACS712 current sensor, the ZMPT101B voltage sensor, the frequency sensor, and the servo motor. The test results are shown in the following table.

**Table 5** Overall Device Test Results

| Trial | Current (A) | Voltage (V) | Frequency (Hz) | Servo |
|---|---|---|---|---|
| 1 | 0.11 | 220 | 51 | Off |
| 2 | 0.25 | 210 | 50 | On |
| 3 | 0.11 | 230 | 53 | On |
| 4 | 0.19 | 220 | 51 | Off |
| 5 | 0.6 | 200 | 48 | On |
| 6 | 0.6 | 230 | 53 | On |

*Source: Research results.*

## 4. CLOSING

### *4.1. Conclusion*

1. The current sensor, voltage sensor, and frequency sensor circuits for automatic generator set control at a voltage of 220–230 V can work well. From this research, a current value of −1 A, an average voltage of 218.6 V, and an average frequency of 50.6 Hz were obtained.
2. The measured values of current, voltage, and frequency can be viewed on the Android screen connected via Bluetooth.

### *4.2. Recommendations*

1. Further development of Android software connected to the internet is needed.
2. If possible, the control of current, voltage, and frequency should not be limited to generator sets, but could also be applied to remote home control.
3. A comparison instrument whose measurements are better matched to the sensor measurements should be used.

## REFERENCES

[1] N. R. Dadan, “Design and implementation of a measuring instrument and information system for single-phase electricity” (in Indonesian), Universitas Telkom, Jakarta, Indonesia, 2015.

[2] G. H. Nachbach, *Rangkaian Elektronika Populer* [Popular Electronic Circuits]. Jakarta, Indonesia: Elek Media Komputindo, Kelompok Gramedia, 1998.

[3] I. Hidayat, Kurniawan, and L. Hayat, “Design and implementation of a personal computer-based measuring instrument for single-phase alternating-current voltage, current and frequency” (in Indonesian), *Techno*, vol. 15, no. 1, ISSN 1410-8607, 2014.

[4] A. Najib, “Electrical quantity monitoring system using IoT (Internet of Things) technology” (in Indonesian), Universitas Lampung, Indonesia, 2017.

[5] H. Rawan, “Design of a 50–60 Hz, 220 Vac electrical frequency detector for telecommunication equipment” (in Indonesian), Akademi Teknik Telekomunikasi Sandhy Putra, Jakarta, Indonesia, 2012.

[6] OpenEnergyMonitor, “CT sensors – Interfacing with an Arduino,” Apr. 27, 2010. [Online]. Available: https://openenergymonitor.org/emon/buildingblocks/ct-sensors-interface (accessed Jan. 21, 2018).

[7] [Online]. Available: http://digilib.unila.ac.id/21107/13/13.%20BAB%20I.pdf (accessed Jan. 10, 2018).

[8] [Online]. Available: http://storage.jakstik.ac.id/students/paper/penulisan%20ilmiah/20402272/BAB%20II.pdf (accessed Jan. 10, 2018).