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SIMULATION OF ELECTRICAL LOAD WITH AN OVER LOAD SYSTEM SHEDDING

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Abstract

A break in one of the circuits in a double circuit transmission network system can cause the system to overload. Where excess load on the transmission network system can cause quite dangerous impacts. The Over Load Shedding system is a protection system for the electric power transmission network which aims to prevent widespread blackouts by removing certain predetermined loads. By using the Arduino Mega 2560 as a control center, security against load abnormalities can be carried out and can be monitored automatically using Scada, apart from that, PMT taping for load balancing can also be done using Scada. The Arduino Mega 2560 will read the current on each phase wire using the ACS712 current sensor to detect the load of one of the circuits to be aware of whether it is overloaded or not. This simulator tool has carried out several measurements and tested how to operate it. This tool has a fairly high level of work accuracy, reaching 85% success in operation. So it is hoped that this tool can provide knowledge to the wider community about over load shedding systems in maintaining the electric power transmission system properly and easily to understand.

Keywords— ACS712, Arduino Mega 2560, Overload, SCADA, Load Shedding

INTRODUCTION

Electrical power distribution is closely related to the role of the conductor components. Conductors on the transmission side must be given great attention and receive more attention. This is because the conductors in the transmission bear large voltages and currents in their distribution. So the conductor must be in condition in accordance with the conductor's delivery criteria, one of which is to pay attention to the amount of current carried by the conductor.[1]

In the electric power system at PT. PLN (Persero), if the measurement of the current value experiences an overload (excess load) borne by the conductor, then the actual system will carry out the Over Load Shedding (OLS) process. Overload shedding is the process of intentionally removing selected loads from an electrical system in response to abnormal conditions in order to maintain the integrity of the remainder of the system. Over Load Shedding aims to maintain the ability of transformers and transmission lines to carry loads according to the capacity of each component. OLS functions as load shedding by releasing the load if there is a sudden increase in load current caused by load shifting due to tripping. its conductor/IBT.[2,3,4]

Seeing this, the problem shows that the electric power transmission network system really needs to have a safety system, namely protection against overload interference. With the development of microcontroller technology, preventive monitoring, detection and security systems for electric power transmission systems by removing the load from other substations can be done using the Arduino Mega 2560.[5]

RESEARCH METHODS

Over Load Shedding[6]

Under certain conditions, for system operation purposes, the conducting bay relay can also be equipped with a Voltage Relay and Over Load Shedding (OLS). OLS is an overcurrent relay which functions as load shedding by releasing the load if there is a sudden increase in load current which occurs. caused by load shifting due to tripping of a conductor/IBT. OLS is installed on 150 kV and 70 kV transmission lines or transformers that do not meet the N - 1 criteria, namely where a dual network occurs if a temporary or permanent disruption occurs in one of the circuits then the other circuit is unable to support the load for both circuits.

- *OLS settings*

The load setting value is determined from the smallest nominal value of the equipment bay that does not meet N – 1[3]:

- Set I : 1.1 x In ………………………………………………………………… (1)

Where,
In: Smallest equipment nominal current (Amp)
Set t: Thermal capability of the equipment

Arduino Mega 2560

The Arduino Mega 2560 is a sophisticated microcontroller board built around the ATmega2560 microcontroller, designed to cater to a wide range of complex projects. It features 54 digital input/output pins, providing ample connections for various components and devices. Of these pins, 15 are capable of PWM (Pulse Width Modulation) output, which is essential for tasks such as controlling motor speed and generating audio signals. Additionally, the board includes 16 analog input pins, allowing for precise measurement and monitoring of analog sensors. The Arduino Mega 2560 also boasts 4 UARTs (hardware serial ports), which facilitate robust serial communication with multiple devices simultaneously, such as GPS modules, Bluetooth modules, and other serial peripherals.

This board operates at a clock speed of 16 MHz, maintained by a crystal oscillator that ensures accurate and stable timing. Connectivity is made easy with a USB port, which is used for programming the board and enabling communication with a computer. A power jack is provided for external power supply, accommodating projects that require more power than the USB can provide. Additionally, the board is equipped with an ICSP (In-Circuit Serial Programming) header, allowing for direct programming of the microcontroller and supporting firmware updates. The reset button on the Arduino Mega 2560 enables quick and convenient restarting of the program without needing to disconnect the power. This board's extensive features make it ideal for advanced robotics, home automation systems, and large-scale sensor networks, while its compatibility with a wide range of Arduino shields and software libraries further expands its versatility and functionality.

Figure 1. Arduino Mega 2560 configuration

1. Tool Design

System Block Diagram

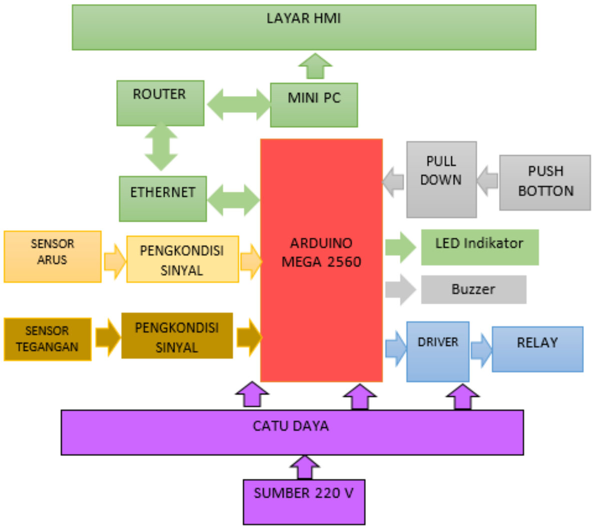

Figure 2 Role of Tools

Figure 2. System Block Diagram.

ACS712 Current Sensor

ACS712 is a series of current sensors that work based on field effects (Hall Effect). The magnitude of the magnetic field that appears will be detected and then processed into a voltage. The voltage produced by the sensor is DC voltage and is directly input to the Arduino Mega 2560.

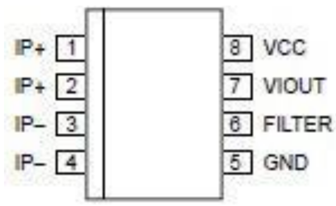

Figure 3. ACS712 configuration

Voltage Divider Circuit and Relay Driver Circuit

A voltage divider circuit is usually used to divide voltage or convert resistance into voltage. And this relay driver circuit uses the ULN2803 IC, the way it works is to give a HIGH (1) or LOW (0) signal to the digital pin output on the Arduino connected to the ULN2803 IC which is several transistors arranged into an IC and consists of 8 transistors. Darlington's NPN

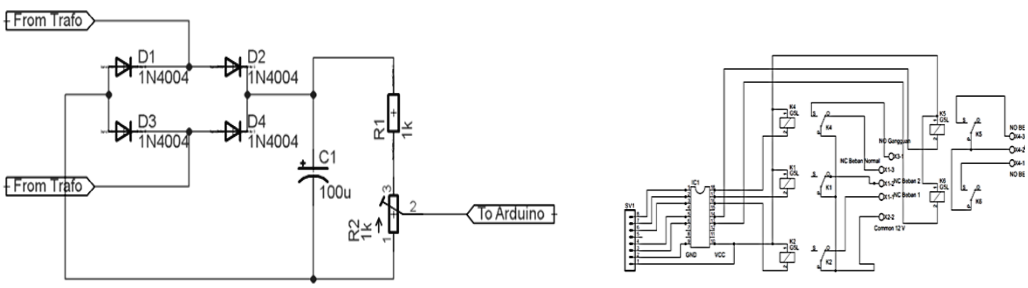

Figure 4 Voltage Divider Circuit and Relay Driver Circuit

Tool Assembly

Assemble (wiring) all the necessary hardware circuits so that the resulting design is as shown in the image below.

Figure 5. External view of the box and external appearance of the box.

RESULTS AND DISCUSSION

1. Tool Testing

The aim of the overall tool testing is to find out whether the performance of the 150 kV Transmission Network Monitoring and Metering simulator tool along with Load Shedding Simulation using an Over Load Shedding System as Protection for Electric Power Transmission Lines can function as expected.

2. Overload Disorders

This condition includes installing normal loads/10 watt lamps L1, L2, L3, L4, L5, and L6 on, while L7 is off. When circuit-1 experiences a disturbance in the form of a trip, the load of circuit-1 is automatically supported by circuit-2. So when a disturbance occurs, the L1 light is off, otherwise L7 is on. So the lights that are on during the disturbance are lights L2, L3, L4, L5, L6, and L7.

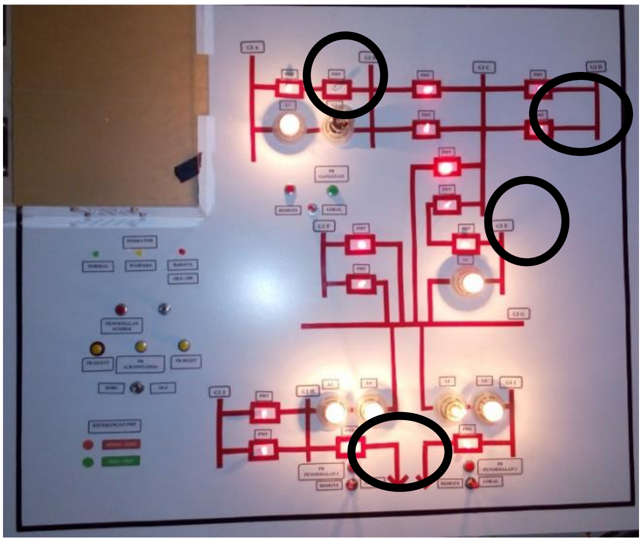

Figure 6. Tool Testing Points

This tool was tested 20 times. Table 1 below is the result of the test

Table 1. Test Result Data

No.	**Test Type**	**Desired Results**	**Experiment Results**	**Information**
1	Normal Condition	Relai A1, A2, A3 *NC*, dan relay A4,A5 *NO*	Relai A1, A2, A3 *on*, dan relay A4,A5 *off*	Relays Working
2	Normal Condition	Relai A1, A2, A3 *NC*, dan relay A4,A5 *NO*	Relai A1, A2, A3 *on*, dan relay A4,A5 *off*	Relays Working
3	Normal Condition	Relai A1, A2, A3 *NC*, dan relay A4,A5 *NO*	Relai A1, A2, A3 *on*, dan relay A4,A5 *off*	Relays Working
4	Normal Condition	Relai A1, A2, A3 *NC*, dan relay A4,A5 *NO*	Relai A1, A2, A3 *on*, dan relay A4,A5 *off*	Relays Working
5	State of Disorder	Relai A1 berubah menjadi *NO*	Relai A1 dalam keadaan *NO*	Relays Working
6	State of Disorder	Relai A1 berubah menjadi *NO*	Relai A1 dalam keadaan *NO*	Relays Working
7	State of Disorder	Relai A1 berubah menjadi *NO*	Relai A1 dalam keadaan *NO*	Relays Working
8	State of Disorder	Relai A1 berubah menjadi *NO*	Relai A1 dalam keadaan *NO*	Relays Working
9	After a Delay of 500 ms	Relai A2*NO*, relai A3 *NO*	Relai A2*NO*, relai A3 *NO*	Relays Working
10	After a Delay of 500 ms	Relai A2*NO*, relai A3 *NO*	Relai A2*NO*, relai A3 *NO*	Relays Working
11	After a Delay of 500 ms	Relai A2*NO*, relai A3 *NO*	Relai A2*NO*, relai A3 *NO*	Relays Working
12	After a Delay of 500 ms	Relai A2*NO*, relai A3 *NO*	Relai A2*NO*, relai A3 *NO*	Relays Working
13	Condition normalized	Relai A4*NC*	Relai A4*NC*	Relay Not Working
14	Condition normalized	Relai A4*NC*	Relai A4*NC*	Relay Not Working
15	Condition normalized	Relai A4*NC*	Relai A4*NC*	Relay Not Working
16	Condition normalized	Relai A4*NC*	Relai A4*NC*	Relays Working
17	Condition normalized	Relai A5*NC*	Relai A5*NC*	Relays Working
18	Condition normalized	Relai A5*NC*	Relai A5*NC*	Relays Working
19	Condition normalized	Relai A5*NC*	Relai A5*NC*	Relays Working
20	Condition normalized	Relai A5*NC*	Relai A5*NC*	Relays Working

From the test data above, the level of accuracy of relay work when there is a disturbance near relay B2 can be calculated as follows:
Work Accuracy Rate = number of successes/ number of tests x 100% = 17/20 x 100%
= 85%

Trip Time Testing

In this tool the compiler sets the value of the Iset as 2.2 Amperes. And the trip time is 500 ms. In accordance with the way OLS works, the compiler uses trip times using the definite method

Table 2. Trip Time Measurements

Trial To	Current (A)	Trip time (ms)
1.	2,3	500
1.	2,4	500
2.	2,5	500
3.	2,6	500
4.	2,7	500
5.	2,8	500

From the data above it can be concluded that the time in this tool meets the definite requirements. Where when the current exceeds the Iset limit, whatever the excess current value, the working time always corresponds to the trip setting time, namely 500 ms.

CONCLUSION

The test results from the Over Load Shedding simulation tool experiment have a work accuracy of opening and closing relays reaching 85% with a trip time accuracy of 500 ms. When a disturbance occurs, either a temporary disturbance or a permanent disturbance, in circuit-1 GI A bay GI B, This tool can simulate load transfer from circuit-1 to circuit-2. So the load on circuit-2 increases. The SCADA simulation on this tool can also be used, such as the application of SCADA to re-close the PMT GI of a disconnected load so that it can then be connected to another GI.

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