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Design of Electrical Power Transfer Automation System Between PLN, PLTS and Genset Using Relay

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Abstract: *Electrical system use one single source are often vulnerable to disruptions, especially in area with unstable electricity supply. This study presents the development and implementation of an automation system for seamless power transfer management between three primary sources: PLN, PLTS and Genset. The primary objective of this system are to improve electricity supply, optimize renewable use energy, and reduce operational cost. Relay are used as crucial actuator to automatically switch between power source based on pre-set priority logic. When the PLN power source voltage range from 180.3 to 260.2 volt, the automation system immediately switch to the first backup power source, the PLTS, with a voltage range of 220.2 volt. When the PLN and PLTS voltage are 0 volt, the automation system switch to the second backup power source, the genset, with a voltage range of 220.2 volt. If the PLTS and Genset are 0 volt, the system will return to the primary priority source, the PLN, with a voltage range of 220.2 volt. Simulation test results show that the system is afford of detecting power availability and quality from each power source and automatically transitioning power with a fast response time. The implementation of relay ensures effective isolation and reliable switching control.*

Keywords: Automation System, Power Transfer, Relay, Power Reliability

INTRODUCTION

Systems manual were the methods used before modern technologies like computers, Currently, electrical voltage energy can be used in everyday life and over time the population is increasing, but it is not accompanied by an increase in electrical energy, so new renewable energy or backup energy sources are needed, one of the backup energy sources is using sunlight absorbed by solar cell modules (photovoltaic modules), and processed systematically into electrical energy power which can also be said to be PLTS (solar power plants), current energy also has an important role for the lives of every human being and electrical equipment for the process of continuing technology and innovation that continues to develop (Majid, 2018).

A generator set, often abbreviated as genset, is a device designed to generate electrical power. This device plays an important role in providing a backup power source, especially in locations or situations where the main power supply is unavailable or disrupted. A genset is a combination of two different but complementary main components, namely an engine and a generator or alternator.

The engine is the component that functions as the main driver that rotates the generator. The generator or alternator is the component responsible for converting the mechanical energy produced by the engine into electrical energy. The alternator has two main parts, the stator and the rotor. The engine is the device that functions as the main driver, which can be a diesel engine device that uses diesel fuel or gasoline, while the generator or alternator is the component that converts the mechanical energy from the engine, this is a copper coil or coil consisting of a stator and a rotor (Asriyadi, 2021).

Researchers based on the background above, the researchers will experiment in This researcher has an idea by creating an automation circuit with the main component of a relay that functions as a transfer of electrical power supply by involving three main input sources, namely PLTS, PLN and Genset with one output that has a way of working, namely when one of the supply voltages experiences interference such as (undervoltage) then the automation system will immediately switch to another voltage source. In the automation system is equipped with a control board unit and also an indicator to display the voltage and current being used. The aim of this research is to create an automation system for transferring electrical power from PLTS, PLN and Genset automatically so that there is no delay when transferring voltage and reducing operational errors.

Relay

Relays shown in Figure 1 function as devices that can separate control signals from load circuits. Control signals are usually signals with low current or voltage, while load circuits are circuits that require higher current or voltage, relays allow safe and efficient control, because control signals with small power can be used to regulate the flow of larger power in the end device. When a control signal is given, the relay will work by connecting or disconnecting the load circuit. This allows the relay to control the flow of electric current or signals on a particular load. In addition, relays are also used as protective devices in electrical systems. Relays can work based on the principle of electromagnetics, when an electric current passes through the coil inside the relay, the magnetic field then moves a mechanism inside the relay. This mechanism then changes the position of the contacts inside the relay so that it can disconnect or connect the flowing electrical circuit (Saputro, 2015).

Figure 1. Relay.

MCB

MCB (Miniature Circuit Breaker) or miniature voltage and current breaker shown in figure 2 is an electronic device used to protect electrical circuits from disturbances in the form of excessive current. This device is designed to detect and automatically cut off the electric current when the current passing through the circuit exceeds the specified safe limit. Electrical circuits from excessive current and voltage in other words, MCB is designed to be able to cut off the electric current automatically when the electric current passing through the MCB exceeds the specified value. However, when the current is in normal conditions, MCB can also function as a switch that can connect and disconnect the electric voltage manually, the nominal current that can be seen on the MCB includes 1A, 2A, 4A, 6A, 10A, 16A, 20A, 25A, 32A and so on. Figure 2.5 is one of the forms of MCB (Saleh, 2017).

Figure 2. MCB

LM393

LM393 IC shown in Figure 3 has one thing in common with the two comparators in the LM393 IC. The following features: The IC can operate with a single power source with a voltage of 2 volts to 36 volts, can operate with input voltages of -3 volts to +36 volts, and can work with various types of logic waveforms that can process digital or analog logic signals effectively. This IC is capable of comparing voltages close to ground. The way this comparator works is based on the voltage entering both input pins. That is, if the voltage on the positive (+) input pin is greater than the voltage on the negative (-) input pin, the comparator output can move towards the V+ direction, the maximum positive voltage from the power source. And if the voltage on the negative (-) input pin is greater than the voltage on the (+) input pin, the comparator output will move towards the negative V- voltage.

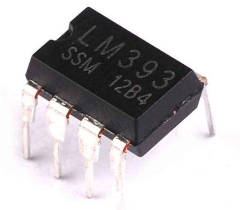


Figure 3. IC LM393

Current Sensor

Sensors are devices designed to detect and measure changes in certain physical quantities, these physical quantities can be pressure, force, electric current, light, movement, humidity, temperature, speed and environmental phenomena around us, sensors play an important role in various technological applications, industry, to everyday life. After detecting changes the sensor will convert the detected physical input into output in the form of signals that can be understood by humans or electronic systems. This output is in the form of visual data and signals will be converted into output that can be directly displayed on the sensor device itself and understood by humans, displayed or processed into information that can be read and seen to be useful for its users, the current sensor can be seen in Figure 4.

Figure 4. Current Sensor.

Voltage Sensor

This sensor plays an important role in electronic systems to ensure the voltage remains within a safe range and in accordance with the needs of the circuit. This sensor can be used to detect and measure AC voltage, depending on the specifications and features of its capabilities. The input received by this sensor is in the form of electrical voltage from the circuit being measured, this voltage can come from various main power supply sources. After detecting the voltage, this sensor converts it into an output that can be used for monitoring purposes. Switches can activate or disconnect the circuit based on a certain voltage value. Analog signals are signals that represent the magnitude of the measured voltage. From several sensors of this type, they can produce output signals in the form of sine waves or certain pulses, such as PWM (pulse width modulation) signals in the form of pulses with a certain width, AM (amplitude modulation) signals with varying amplitudes based on the input voltage and FM (frequency modulation) signals that vary according to the detected voltage (Zaini, 2020).

Figure 5. Voltage Sensor.

RESEARCH METHOD

Research often includes flowcharts, such as those shown in Figure 1, which visualize the steps or processes involved in a study. These diagrams help visualize the logical flow from planning to completion, including problem identification, problem formulation and objectives, literature review, research methodology, data collection, data analysis, conclusions, and recommendations.

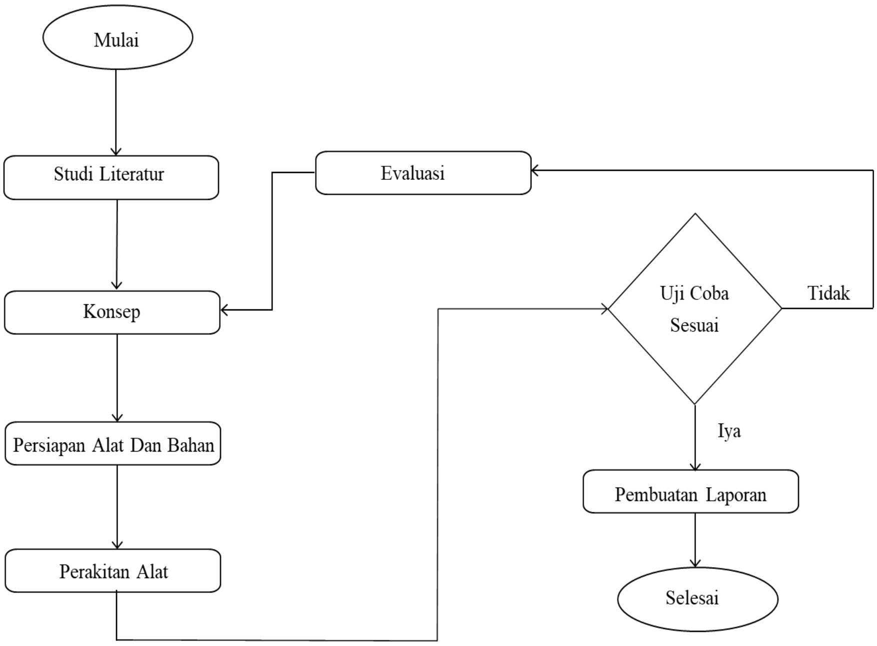
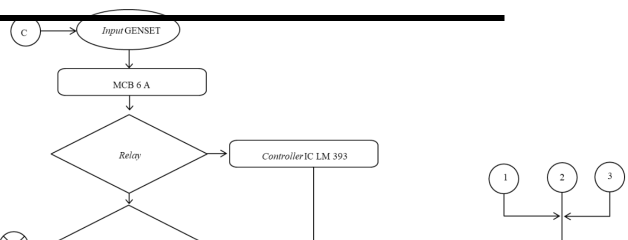


Figure 6. Research Method Flowchart

Flowchart System



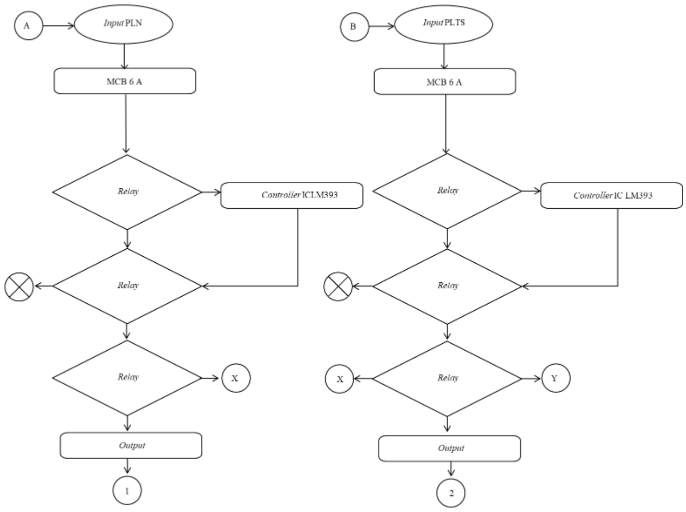


Figure 7. Flowchart Sytem

In addition to the flowchart for this research process, there is also a flowchart showing how the automation system works, as shown in Figure 2. Part A represents the solar power plant input, and part B represents the PLN input. Furthermore, part C represents the generator input, which is then routed to the output and then combined between outputs 1, 2, and 3, alternating according to the desired voltage priority through control, as shown in the flowchart in Figure 2.

Block Diagram

The diagram panel or layout is part of the automation system design where there are three input sources and one output source using a control and relay system.

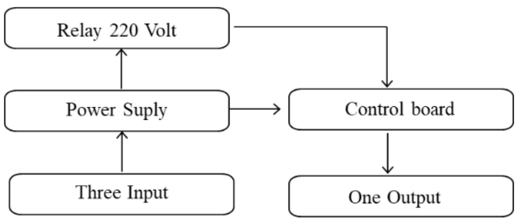


Figure 8. Block Diagram the System Automatic

Design

Before testing the automation system tool, the layout of the components on the perforated PCB board was designed by considering the distance between the components so that they were not too close and also considering the connection path so that during the soldering process there would be no short circuit between the component legs. After all the components were placed on the perforated PCB, the next step was to solder the component legs by adding jumper cables for connection, after all the soldering and connection were completed, the next step was to cut the component legs that were still long. The final step was to ensure that all components were connected by measuring using a multimeter, where the component installation process can be seen in Figure 9.

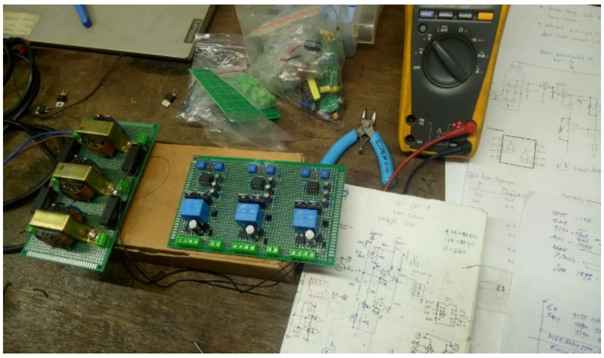


Figure 9. Mounting Components on a PCB with Holes

After designing and installing the components, a tool is produced that is ready for testing. The tool is shown in Figure 10, which contains block parts such as: relay, power supply, control board, MCB and connector terminal.

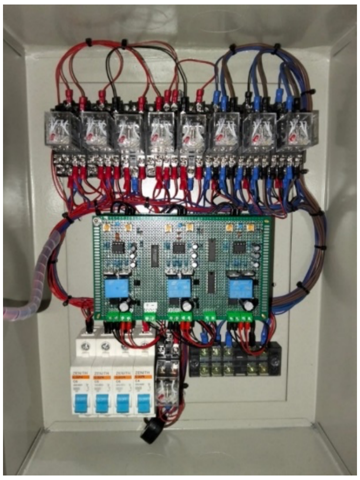


Figure 10. Component.

There is also a voltage indicator display to monitor and know the conditions when the voltage is used from any source, the indicator is shown in Figure 6 below.

Figure 13. Voltage Indicator Display

A panel diagram or layout is part of an automation system design, featuring three input sources and one output source using a control system and relays. Figure 7 shows the power transfer process regulated by a controller unit that controls a series of relays. The relays operate according to the controller's commands and the selected voltage priority. Relays are used for their reliability, ability to handle large currents, and cost-effectiveness.

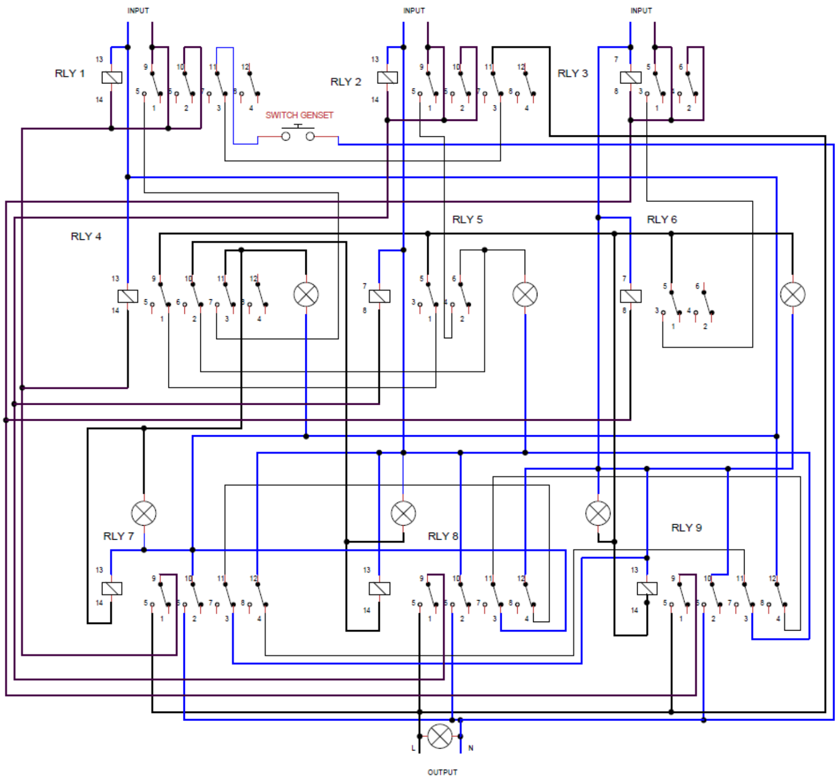


Figure 14. Automation System Layout Diagram

RESULT AND DISCUSSION

From the simulation results that have been carried out using an electric voltage source, the tool that has been designed and made works according to the initial plan and functions automatically when one of the voltages experiences undervoltage or overvoltage, it will switch to the available voltage, at the time of automatic switching of electric voltage without any pause in the output voltage, so the load is in normal condition. Table 1 is the switching of electric voltage.

Table 1. Electrical Voltage Transfer

V_{in} PLN	V_{in} PLTS	V_{in} Genset	*Output*	Monitoring
180.3	220.2	0	220.1	ON
220.2	0	0	220.2	ON
260.2	220.1	0	220.1	ON
0	180.3	220.3	220.2	ON
0	220.2	0	220.3	ON
0	260.2	220.2	220.2	ON
180.2	0	220.3	220.1	ON
220.1	0	0	220.2	ON
260.2	0	220.2	220.3	ON
0	220.3	180.4	220.2	ON
0	0	220.2	220.1	ON
0	220.4	260.2	220.2	ON

Table 2 shows that the automatic power transfer system operates according to the initial design. One of the main advantages of this system is its ability to prioritize electricity sources from PLN (State Electricity Company) and the main backup sources, namely solar power plants (PLTS) and generators. Generators are only activated as a last resort, significantly saving fuel consumption and operational costs. This system provides a higher level of energy independence, especially important in areas with unstable electricity infrastructure or for users who want to be more independent. The ability to integrate these three power sources offers great flexibility in energy management, allowing users to adapt power usage strategies according to needs and source availability. Tests show that the power transfer process takes place with a stable output voltage, without drastic spikes or drops that could damage equipment. This indicates that the control algorithm and switching components work well in maintaining power quality.

Tabel 2. Table Simulation

Simulation	Lamp Indicator PLN	Lamp Indicator PLTS	Lamp Indicator Genset
Condition PLN I	I	O	O
Condition PLN O	O	I	O
Condition PLTS I	O	I	O
Condition PLTS O	I	O	O
Condition Genset I	O	O	I
Condition Genset O	I	O	O

CONCLUSION

Based on the research findings, it was successfully proven that the designed automated power transfer system, which manages electricity resources from PLN, PLTS, and Genset, is highly effective. This system demonstrates high responsiveness, reliability, and the ability to automatically optimize energy consumption. The integration of this automated system not only enhances the operational efficiency but also makes it a very promising solution for a wide range of applications, from smart homes and offices to manufacturing.

The test results show that when the PLN input voltage is in the range of 180.3 V to 260.2 V, the automation system immediately switches to the first backup power source, the PLTS, with a range of 220.2 V. When the main power source voltage returns to 220.2 V, the system will switch back to the primary priority source. When the PLTS voltage is in the range of 180.3 V to 260.2 V, the system will automatically switch to the second backup power source, the Genset, with a range of 220.2 V. When the second backup power source is in the range of 180.4 V to 260.2 V and the priority source is 0 V, the system will automatically use the first backup power source.

Overall, the results of this study confirm that the automated power transfer system using PLN, PLTS, and a Genset as sources, with relays as switching components, is highly effective and reliable. This system is capable of responding intelligently and quickly to changes in power source conditions, ensuring an uninterrupted supply of electricity to the load.

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