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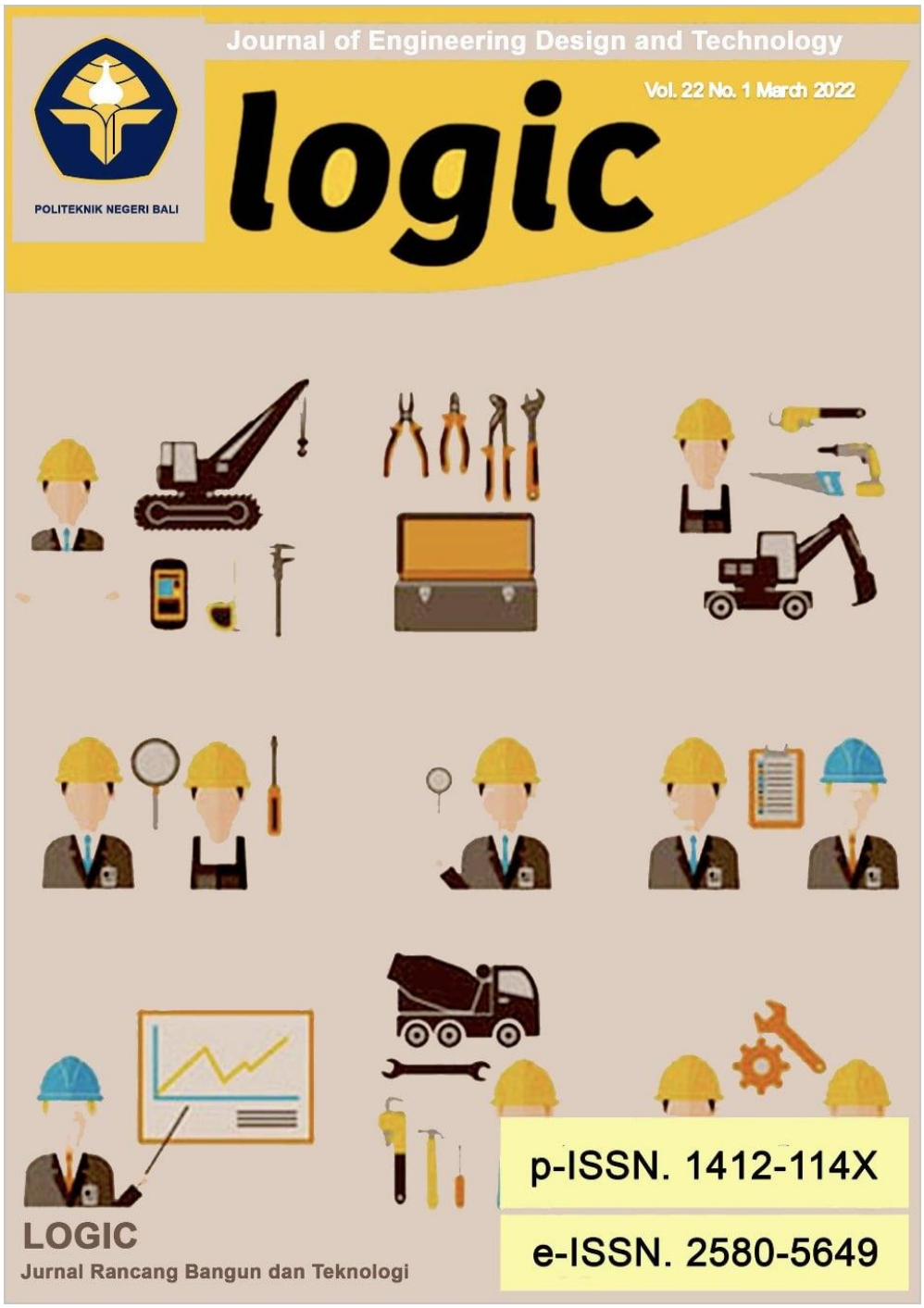

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DESIGN AN AUTOMATIC TRANSFER SWITCH FOR SOLAR POWER PLANT

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Abstract. This paper discusses the automatic transfer switch (ATS) in solar power plants. ATS is used to transfer the main electrical power to a backup power source (battery). PLN power cannot supply electricity continuously due to non-standard ATS installations, blackouts, disturbances to the generating system, and distribution system. Two ATS systems are proposed to control the switching process of PLN and PLTS automatically using inverter standby mode (ISM) and inverter off mode (IOM). The results of the application of ISM to PLN and PLTS can supply power needs based on switching techniques to avoid equipment damage. While IOM can save battery for inverter power supply.

Keywords: Automatic transfer switch, Solar power plant, ISM, IOM.

1. INTRODUCTION

Solar Power Plants (PLTS) are controlled by Automatic Transfer Switch (ATS) [1], [2]. ATS functions as an automatic switch to transfer the main electrical power to a backup power source (battery). ATS control will switch the main power automatically to PLTS when the PLN source experiences power dissipation [3]. However, when the PLTS power is used as the main power source, the ATS will switch the main power to the PLN source in the condition that the battery is used to supply the inverter [4]. The PLTS power dissipation factor is caused by cable installation, sunlight, ambient temperature, and the angle of inclination of the solar panels [5]. Solar panels charge electrons and protons based on the battery charge voltage. Charging stops when the battery reaches its maximum voltage [6]. PLN's electrical energy source affects the power to the load. The power generated by PLN cannot supply electricity continuously due to non-standard ATS installations, blackouts, disturbances to the generating system, and distribution systems [7]. So that the guarantee of the availability of electrical energy is not optimal [8].

Therefore, electrical energy reserves must be met to supply the load continuously [9]. The power requirement at the load is controlled by the ATS system design [10], [11]. The ATS system is used to transfer power automatically by adjusting the load. The basic principle of the ATS system applies logic to relays, timers, contactors, and MCBs. The greater the power used, the greater the load being controlled. Several types of ATS are distinguished based on the required power capacity or based on the phase and current through the panel. [12]. ATS is proposed to transfer the electricity source from PLN to PLTS in the event of a disturbance. ATS is designed with an inverter standby mode and inverter off mode system. Inverter standby mode is used as a power requirement generated by the ATS. Inverter off mode is used to save battery power on the inverter supply voltage. When the voltage is below 10 volts, the ATS switches to PLN. This process occurs repeatedly. The ATS system is expected to be able to replace electrical power by adjusting the load requirements during blackouts, saving battery power, and changes to the main power source in the backup power source can be controlled automatically.

2. METHODS

The method for supplying power from PLTS and PLN alternately uses ATS Inverter Standby Mode (ISM) and Inverter Off Mode (IOM). ISM is used for load power requirements because PLTS supplies power continuously even though PLN resources are used as the main power source [13]. The ISM switching technique is set at high speed to avoid faults in the power grid that cause damage to equipment [14]. IOM is used to save battery power supply to the inverter. IOM switching technique is not like ISM, because the inverter does not supply power

continuously, and the power is supplied during the switching process from PLN to PLTS [15], [16].

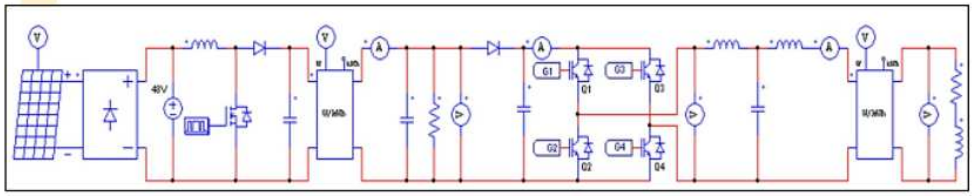

Figure 1 Inverter PLTS [17]

3. RESULTS AND DISCUSSION

An ISM applies a 3000 Watt inverter to convert 12 DC voltage into 220 AC voltage with pure sine wave technology at a frequency of 50Hz [18]. Then, the MPPT is connected to a contactor to control the solar panel voltage, battery voltage, and current feedback [17]. Low Voltage Disconnect (LVD) regulates the ATS system based on battery power [19]. ATS is triggered by the LVD when the battery voltage is below the minimum to activate the PLN power source [20]. The selector is used as the main power source of electricity. The auto system indicates the ATS selector is in off mode. The solar panel switches the power source using the MKP2P Relay. while ATS is triggered by the MKP2P relay.

The green and red indicator lights as a sign of the PLTS and PLN power switches. LVD is triggered by the M2Y relay when the condition is off and ATS is triggered by the SPDT relay. MCB 100A 220V disconnects the load when the solar panel exceeds the maximum power, and MCB 6A is used to cut off the maximum power load. However, in its application, this method has a weakness, namely the use of batteries to supply the inverter faster, because the battery is forced to continuously supply power to the inverter, besides that the inverter will heat up quickly and can reduce the life of the inverter. Therefore, this method is highly recommended for consumers who need electrical network stability on consumer electrical equipment. The inverter standby mode is described in figure 2.

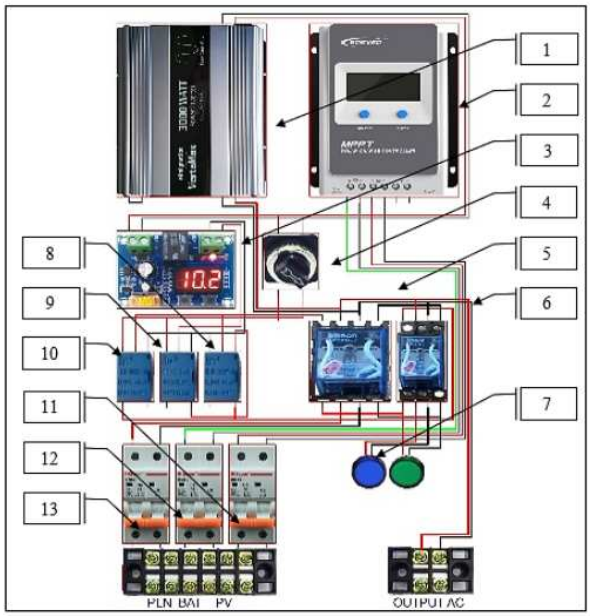

Figure 2. *Inverter Standby Mode*

The IOM design uses a 3000 Watt inverter which converts 12 DC voltage to 220 AC voltage with pure sine wave technology at a frequency of 50Hz. Then, the MPPT is connected to a contactor to control the solar panel voltage, battery voltage, and current feedback. Low Voltage Disconnect (LVD) regulates the ATS system based

on battery power. ATS is triggered by the LVD when the battery voltage is below the minimum to activate the PLN power source. The selector is used as the main power source of electricity. The auto system indicates the ATS selector is in off mode. The solar panel switches the power source using the MKP2P Relay. while ATS is triggered by the MKP2P relay.

The green and red indicator lights as a sign of the PLTS and PLN power switches. The LVD is triggered by the M2Y relay when the condition is off and ATS is triggered by the SPDT relay. MCB 100A 220V disconnects the load when the solar panel exceeds the maximum power, and MCB 6A is used to cut off the maximum power load. The application of the IOM method is not recommended for electrical loads that use Power Switching Low Energy technology, because long-term use can damage equipment due to unstable voltage when the inverter is working after a switch occurs in the ATS circuit. So that the application of the IOM method is used on electrical loads that use induction technology, capacitors, and electric motor loads. Inverter Off mode is described in figure 3.

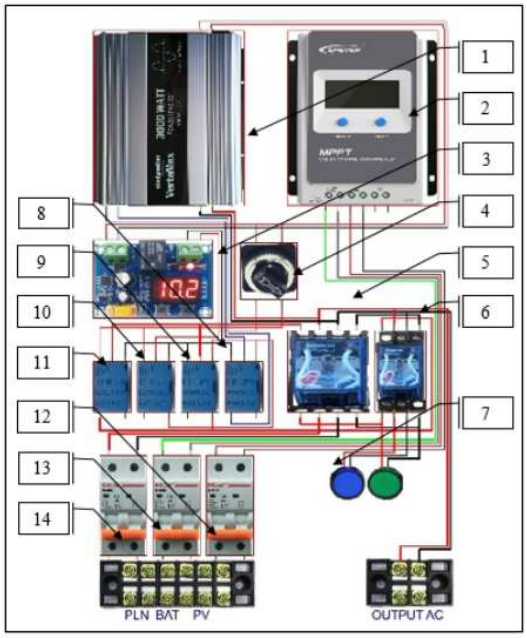

Figure 3 *Inverter Off Mode*

Table 1 shows the components inverter standby mode and inverter off mode. Inverter 300 Watt, Maximum Power Point Tracking Solar Charge Controller (MPPT SCC), Low Voltage Disconnect (LVD), selector 2 poles, relay MK2P, relay M2Y, lamp indicator, For relays SPDT single command, two MCB DC 100 A, and MCB AC 6A.

Table 1. Inverter Standby Mode and Inverter Off Mode Components

Components	Specifications	Volume
Inverter 3000 Watt	12Vdc to AC	2
MPPT SCC	100 Ampere	2
LVD	XH-M6009	2
Selector 2 Pole	CA10-A211	2
Relay AC 220V	MK2P	2
Lamp Indicator	PBT-AD22DS	2
Relay DC 12V	SPDT	4
Relay AC 220V	M2Y	2
MCB DC 100A 220V	2PDC	2
MCB AC 6A 220V	SCHNEIDER	1

4. CONCLUSION

The automatic transfer switch (ATS) system design uses two inverter standby mode and inverter off mode systems. Inverter standby mode is used to supply power requirements based on switching techniques. The switching technique is carried out as quickly as possible to avoid equipment damage. Inverter off mode is used to save battery on the inverter power supply. The inverter power supply is regulated by LVD so that when the battery cannot supply the load, the ATS will switch to PLN. But the inverter standby mode has a weakness, namely the use of batteries to supply the inverter faster, because the battery is forced to continuously supply power and heats up quickly. While the inverter off mode is not recommended for electrical loads that use Power Switching Low Energy technology, because long-term use can damage equipment due to unstable voltage when the inverter works after the switching process in the ATS circuit.

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