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Implemantion of DC-DC Converter for lighting

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A B S T R A C T

Lighting is still largely dependent on PLN, which can be replaced with sunlight, the electrical energy of which can be stored in batteries. To regulate this electrical energy source, a DC-DC converter is needed. This converter functions to change the voltage according to needs, one of the methods applied is using a bidirectional dc/dc converter. In this method the charging and discharging processes are controlled using proportional integral control analytical methods. Implementation of a bidirectional dc-dc converter for lighting using a DC system is more efficient compared to an AC system because part of the system's power is absorbed by the inverter.

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INTRODUCTION

The main energy sourcein Indonesian for lighting comes from PLN. At certain times, there are times when PLN experiences problems, for example when it rains or during transformer maintenance, so blackouts are necessary. As electricity users, we hope that the need for electrical energy will never be disrupted, especially at night, so we need to prepare emergency equipment for lighting in anticipation of blackouts from PLN. This equipment can use batteries as energy storage. Meanwhile, the energy in the battery is a function of time as the stored energy capacity decreases and dc-dc converter equipment is needed to charge the battery.

THEORETICAL REVIEW

Buck Converte

Buck converter is a converter that works as a step down DC (Direct Current) with an output voltage lower than the voltage ($V0 < Vs$). The working principle is to reduce the DC voltage by regulating the size of the duty cycle shift. The Buck converter circuit in Figure 1 consists of input voltage (Vs), active switch (MOSFET), diode, inductor, capacitor and resistor. The switch on the buck converter will work continuously. The buck converter circuit is shown in Figure 1.1

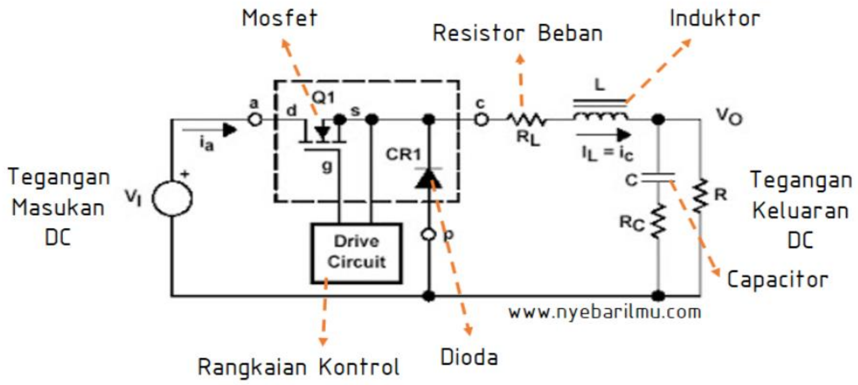

Figure 1. Buck converter circuit

Boost Convertere

Boost Converter is a step up converter or DC-DC converter with an output voltage that is greater than the input voltage ($V0 > Vs$). The working principle is to increase the DC voltage by adjusting the switching duty cycle size. The Boost converter circuit in Figure 4 consists of input voltage (Vs), active switch (MOSFET), diode, inductor, capacitor and resistor. The working principle of the boost converter has 2 conditions, namely when the switch is in the "ON" condition. When the switch is "ON" the diode works in reverse, so the output is open/isolated and the input supplies energy to the inductor. The buck converter circuit is shown in Figure 2.

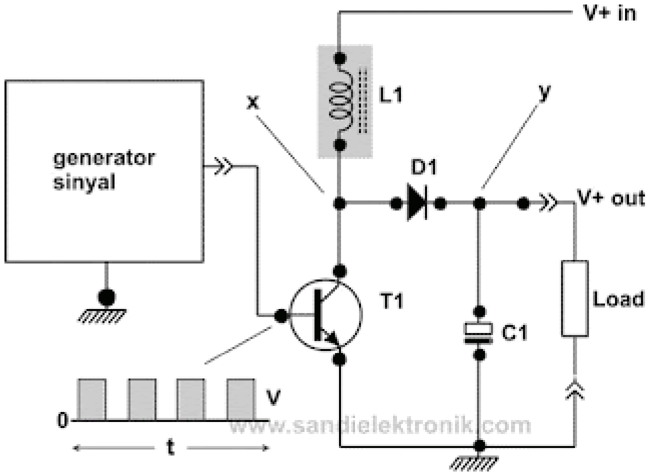

Figure 2. Boost converter circuit

DC-DC Bidirectional Convertere

DC–DC Bidirectional Converters are used in this system to fulfill the process of regulating the power output from PLTS. DC–DC Bidirectional Converter is 1 converter which can have 2 functions. Buck Mode and Boost Mode. Buck Mode is used when there is more power for the battery charging process.

Bidirectional converter is a converter that can flow power in two different directions. The current flow in a bidirectional converter must be able to carry current in both opposite directions through the converter switch. Using a bidirectional system can reduce costs, increase efficiency and performance in the circuit. Bidirectional converters are usually applied using power switches such as MOSFETs and IGBTs. A diode connected in series with the switch will be used to flow two-way current. Bidirectional converters work in 2 modes, namely buck mode and boost mode. The converter will work in buck mode when charging the battery. Then boost mode is used when the battery is discharging or charging

Voltage Sensor

Voltage sensor is a device that measures voltage on electronic devices. The voltage sensor used is a voltage divider circuit. The voltage on the battery will be converted into a voltage that can be read by the microcontroller, namely zero to three point three volts or five volts, using an ADC (Analog to Digital Conversion) system. Then the voltage is translated into digital units via a microcontroller so that it can be further regulated.

Current Sensor

The ACS712 current sensor is a sensor that works based on field effects so it can measure AC and DC currents. The current sensitivity of the ACS712 is very detailed and can measure fairly small currents because the ACS712 is equipped with an operational amplifier circuit. The ACS712 current sensor can detect AC and DC current. If the ACS detects a DC current, the polarity will affect the current reading, this is because point 0 of the ACS is in the middle, so that if the polarity of the DC current being sensed is reversed, the value read is less than half the VCC voltage.

Battery

There are many types of batteries that can be used to store electrical energy, one of which is the 18650 battery which works at 3.7 Volts. The maximum charge can be 4.2 Volts and the battery is empty at 3.0 Volts. Meanwhile, the ability to store electric current varies depending on production. And in general it is known that this battery has a maximum capacity of 3600 mAH. The name Lithium-Ion Battery (Li-Ion) 18650 refers to its cylindrical physical size. The number 18 is for the battery diameter, 18 mm and the number 650 is for the battery height, 65.0 mm. The number "0" after the comma refers to the total battery high tolerance based on the type of 18650 battery product.

METHODOLOGY

In the research, the need for solar panels was obtained from the results of planning calculations. The battery capacity used is a 12V 32Ah Accumulator. The battery voltage used is 12V because it is adjusted to the voltage on the DC lamp. Based on load planning, the lamps used are 12 V DC lamps with several watt differences. The block diagram of the system planned in this research is shown in Figure 3.

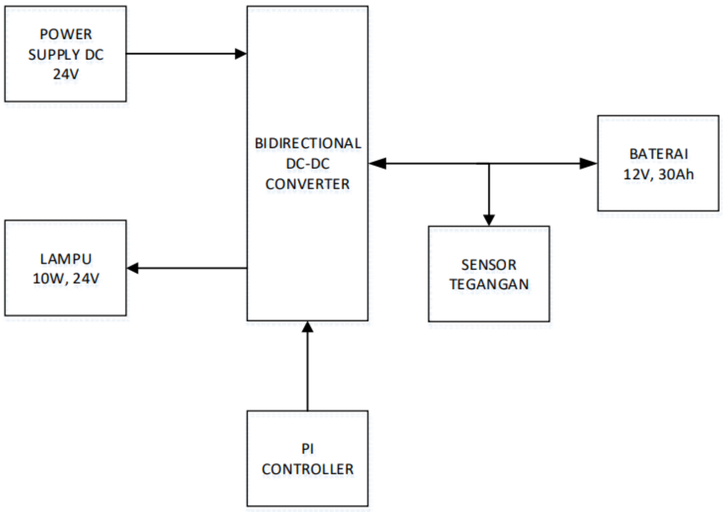

Figure 3. Block Diagram System

Buck Converter Testing

Test the buck converter, it is planned to use PSIM software, the buck converter circuit consists of an input voltage (Vs) of 24V, the addition of a capacitor (C), the output voltage ($V0$) is set at 14V with regulation using the duty cycle on the PWM. Theoretically, the converter output will be proportional to the duty cycle of the PWM used to power the mosfet.

Boost Converter Testing

Test the boost converter, the circuit consists of an input voltage (Vs) of 12V, the addition of a capacitor (C), the addition of an inductor (L), and the output voltage ($V0$) is expected to be 24V with a duty cycle setting of the input voltage of 12V. Theoretically, the converter output will be proportional to the duty cycle of the PWM used to power the mosfet.

RESULTS

PLTS System

The PLTS system used in this research is a communally managed off-grid and on-grid system or what is often called a stand-alone PLTS system, operating independently without being connected to the PLN network. This system requires a battery to store electrical energy produced during the day to meet electricity needs at night. Off-grid solar PV system configuration uses a DC connection or DC-coupling system which is shown in Figure 4.

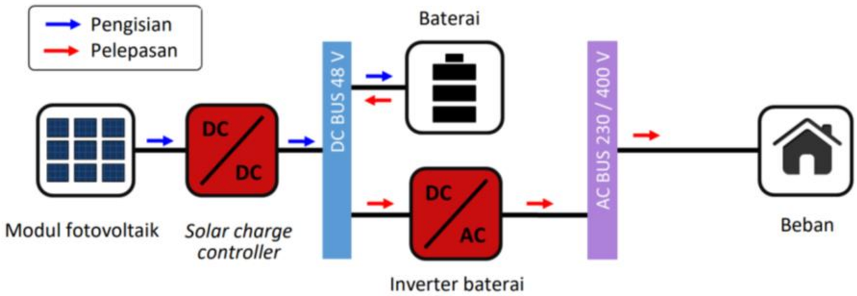

Figure 4. DC Coupling System

Boost Converter Test Results

This test is to determine the function of the Boost converter as a dc-dc converter which is used to increase the voltage. Apart from that, this test also aims to determine the converter's response to changes in the duty cycle
and the performance of the converter by looking at the efficiency value it produces. The source used in this test is a 12V 10 A power supply. The boost converter in this system is expected to be able to supply voltage during the battery charging process where the boost converter input is 11 V and the output from the boost converter is 12V. Testing was carried out with an input voltage of 18.2 volts, a sliding resistor load, a switching frequency of 40KHz and the duty cycle was changed from 10% to 60%

Table 1. Boost Converter measurement results with power supply source

Duty (%)	Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efisiensi (%)
10	11	1,35	12,04	0,52	13,04	5,92	39,99
20	11	1,54	12,07	0,63	13,27	6,26	43,25
30	11	1,79	12,11	0,82	13,58	6,78	53,21

40	11	2,21	12,15	1,05	13,83	6,91	69,17
50	11	2,62	12,23	1,25	13,98	7,02	75,55

Table 1 is the test result of the converter by changing the duty from 10% to 50%. The boost converter has succeeded in increasing the voltage. Boost converter testing aims to determine the function of the Boost converter as a dc-dc converter which is used to increase voltage. Apart from that, this test also aims to determine the converter's response to changes in the duty cycle

and the performance of the converter by looking at the efficiency value it produces. The source used in this test is a 100WP solar panel. Testing was carried out with input voltage from the solar panel, resistor load, switching frequency of 50 KHz and duty cycle changed from 5% to 50%. MPPT testing with a DC-DC Converter in the form of a boost converter installed between the PV array and the load. The device that functions as a tracker is a DC-DC Converter whose duty cycle value changes depending on the results of the MPPT program. Based on the design that has been made in the software which consists of input and output, the design results are entered into Simplified block C FLC in the PSIM 9.1 software shown in Figure 6

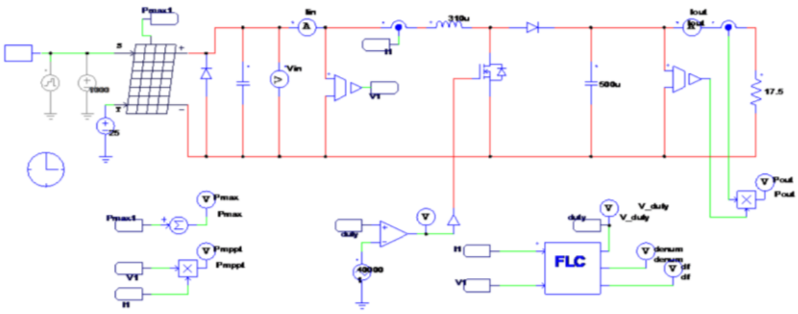

Figure 6. Simulation MPPT

Hardware Integration Testing

Integration testing is carried out with a power supply source whose input voltage is varied. The load used in the test is a 17 ohm lime resistor. Integration testing is carried out by looking at the voltage, current, power and duty cycle values shown in Table 2

Table 2. Result Hardware integration testing

Tegangan Input (V)	Daya tanpa MPPT (W)	Daya MPPT (W)	Peningkatan Daya (%)
10	12,3	12,5	0,87
11	12,5	12,7	0,83
12	12,8	12,8	0,96

Based on test data using a power supply source, the resulting power does not reach maximum power. Due to the limited current in the power supply, the maximum is 3A, while the current in the 100 WP solar panel specifications is 4.6A. Apart from that, the duty cycle achieved by the system is constant, namely 37%, which is the duty cycle limit value in the program. Based on the comparison of close loop test data in Table 2, MPPT has worked quite well, because there is an average power increase of 1.02%.

Table 3. Result Testing using LED loads

Battery	Load	DC System	AC System
12V 32AH	Lamp LED 6 watt	52 hour	30 hour
	Lamp LED 7 watt	50 hour	24 hour
	Lamp LED 9 watt	36 hour	19 hour
	Lamp LED 15 watt	24 hour	14 hour
	Lamp LED 27 watt	12 hour	7 hour

Based on load testing, solar energy used for night lighting must be stored in the battery. The bidirectional system can be applied to DC lighting installation systems but diodes must be added before the input converter. Lighting using a DC system is more efficient compared to an AC system because some of the system's power is absorbed by the inverter.

DISCUSSION

The test results have been obtained, so there are parts that need to be looked at again and require improvements in the manufacture of the tool and in the testing process. The implementation of a bidirectional dc-dc converter for lighting using a DC system is more efficient compared to an AC system because part of the system's power is absorbed by the inverter.

CONCLUSIONS AND RECOMMENDATIONS

Designing a solar panel system should use an application that specifically supports solar power generation, because to determine the angle of installation of solar panels, determine cash flow if using an off-grid or on-grid system. So that as a user you can understand and comprehend how much investment must be spent and when the break event point

FURTHER STUDY

This research is expected to provide deep insight into the implementation of DC-DC converters for efficient and reliable lighting. The results can be used to develop lighting systems that are more energy-efficient, environmentally friendly and economical. In addition, this research can also serve as a foundation for the development of future lighting technologies that are more advanced and efficient.

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