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Single Phase Inverter Design for Solar Panel Output Voltage

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ABSTRACT: Inverter is a devices that functions to convert DC input voltage to AC. One technique for optimizing the inveter output is SPWM. In this final project, a single–phase SPWM inverter with bipolar SPWM switching is designed. This inverter has 1 phase H-Bridge spesifications, with IGBT components, resistors, warehouse and inductors where there are 4 MOSFETs that can be connected. By carrying out 3 test with different sources for a 244.44 volt DC source it produces 0,47 % harmonic, a variable DC source produces 54,81 % harmonics and for a PV sources 9,91 % harmonics. Of the three test, the largest harmonic value is by using a variable DC source. Large harmonic can affect the shape of the wave to be non-sine and the wave has lots of ripples. This simulation aims to facilitate the design of real inverter devices.

KEYWORDS: SPWM, PWM, Inverter, Full-Bridge, bipolar switching.

1. INTRODUCTION

In the modern era like now, it is used electrical energy from renewable sources such as wind energy, cells fuels and solar cells are now very well developed in Indonesia. For this, you need a inverter that can convert DC to AC [1]. Solar panels change the intensity of sunlight into electrical energy. Solar panels produce electricity used to charge the battery. Solar panels consist of energy solar energy that produces electricity from light intensity, current light intensity is reduced (cloudy, rainy, overcast) the electric current produced is also reduced. Addition (expansion of) solar panels means increased energy conversion sun [2]. Solar panels have a weakness in power its production depends on sunlight conditions. When solar radiation is low, the solar module output current can drop sharply, so that the output power is not used properly maximum. Hence the need for an inverter on solar panels where the inverter has an important role in the whole solar panel installation circuit. This is because of function inverter that can convert DC (direct) current into AC (back and forth) [3,4]. An inverter is a circuit that is used to convert the DC voltage source remains the AC voltage source on certain frequency. Deviations from the inverter source can be in the form of AC voltage with a sine, square wave shape and a modified sine wave inverter is required as a backup electricity supplier, especially for needs house electricity when sometimes the power goes out. Apart from that, the inverter It plays an important role in converting direct current from AC power solar panels for daily use [5,6]. Inverters, commonly called DC-AC converters, represent a wide range of science electrical energy conversion. An inverter is a static device that does not use moving components to change voltage [7,8]. Several techniques for generating pure sine wave AC signals have been investigated using various types of inverter circuits. Sinusoidal Pulse Width Modulation (SPWM) is a widely used technique to control inverter circuits [9,10]. Using SPWM in an inverter circuit by adjusting the pulse width produces an AC output voltage that can be used to drive an AC motor [11].

2. MATERIAL AND METHODS

2.1 Research conceptual framework

The research conceptual framework is a flow of thought for researchers related to the scope, limitations of the material, and the results to be achieved in the research stages, explained in the form of a flow diagram. about the voltage stability of solar power plants (PLTS) using Proportional Integral (PI), and simulated in MatlabR2016b software with a Single-phase Full-Bridge inverter circuit model.

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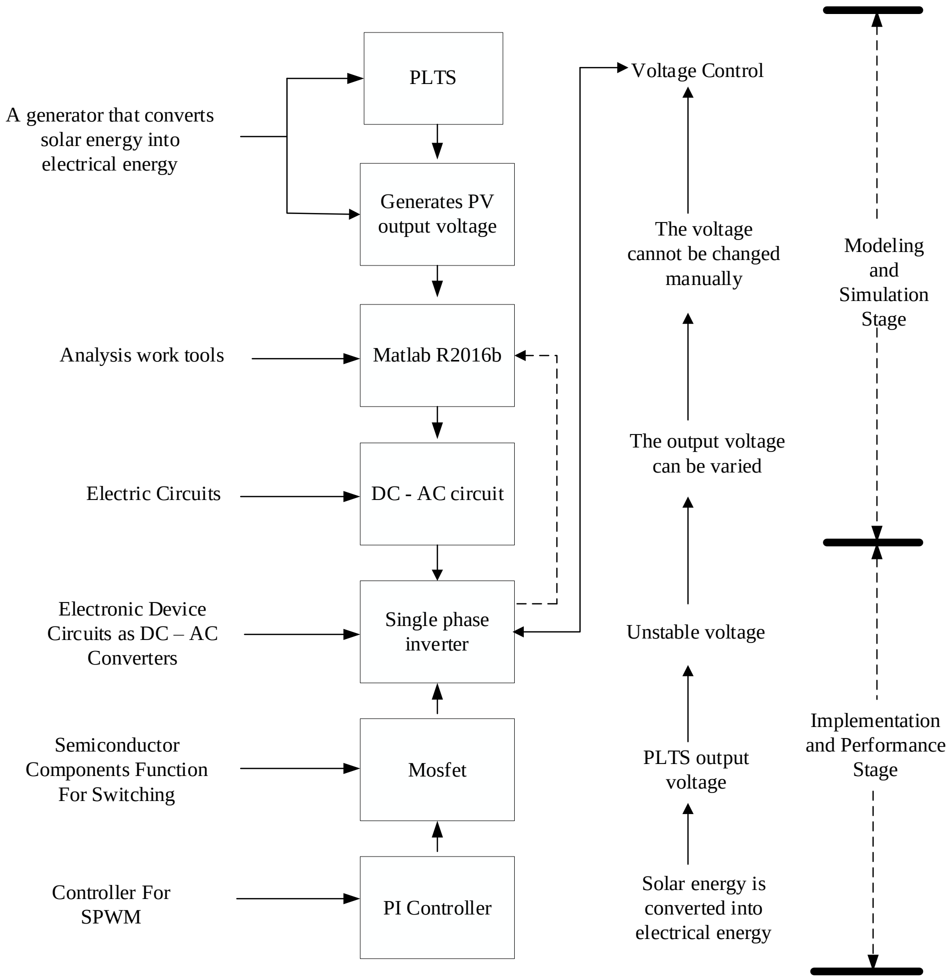

Figure I : Research Conceptual Framework.

Apart from that, there is an element of interference in the photovoltaic output voltage system, therefore this voltage converter was created to be able to change DC voltage to AC, where the controller uses Proportional Integral (PI) under normal conditions after a disturbance occurs. In addition to reducing losses in distribution, it is also to reduce the occurrence of disturbances that are detrimental to electrical energy users. The conceptual framework above shows that when instability occurs in the output voltage, system performance will be disrupted, resulting in the output voltage not being able to be varied or changed manually, therefore one way to reduce the impact of this disturbance is to use Proportional Integral (PI) control. The inverter contains variable semiconductor components that function as switching which are called MOSFETs. With a single-phase inverter circuit, Full-Bridge type via a bipolar type Sinusoidal Pulse Width Modulation (SPWM) switching technique. When the photovoltaic output enters the inverter, in the inverter the voltage is changed from DC to AC, then sinusoidal pulse width modulation (SPWM) is the switching technique used in this design. That's where Proportional Integral (PI), which controls the voltage, works when a disturbance occurs and requires quick control to help change the system. Based on the description above, the research conceptual framework consists of two stages, namely as follows :

1. Modeling and simulation stage to model a single phase inverter circuit with a Full-Bridge bridge model using the Sinusoidal pulse width Modulation (SPWM) method in the form of a simulation using Matlab R2016b software, then tested to see that the design is ready to be analyzed for a voltage stabilizer using Proportional control Integral (PI).
2. The implementation and performance stage is an analysis of the design that has been created under conditions when only using Proportional Integral (PI) control, and when using Proportional Integral Derivative (PID) control.

2.2 Research operational framework

Figure 3.2 shows the flow diagram of the research operational framework, that the research process starts from a literature study consisting of literature studies and case studies, until the results of the literature study are obtained in the form of varying output voltages and Proportional Integral (PI) control specifications. The program (software) for designing a single-phase Full-Bridge inverter circuit using the SPWM method and designing a Proportional Integral (PI) control system and analyzing it is using Matlab R2016b and Microsoft Office 2013 (Microsoft Word 2013) software. The research continues with testing the circuit that has been designed, then the data obtained from the circuit simulation results will be processed and analyzed whether it is appropriate or not, for comparison the data will be adjusted to the limits used. Next, the final stage is the results and discussion obtained in the form of a circuit model and simulation of a single-phase Full-Bridge inverter using the SPWM method when only using Proportional Integral (PI) control.

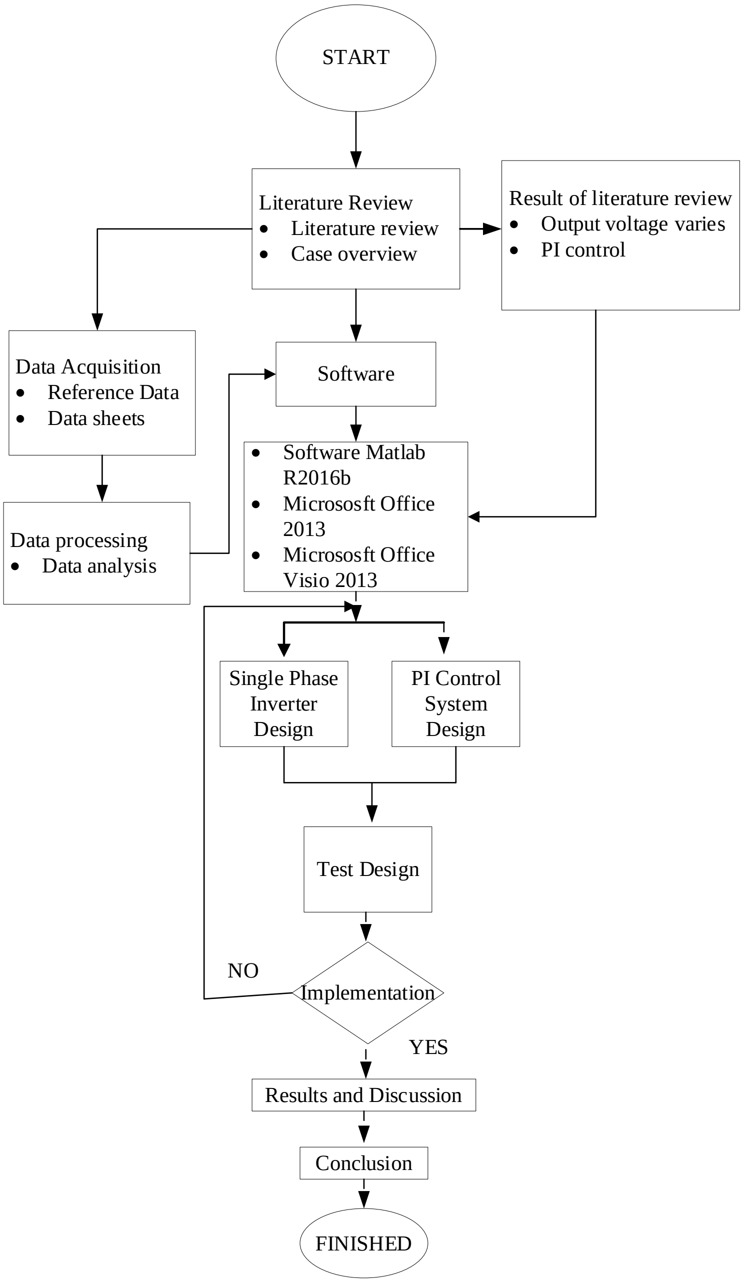

Figure II : Research Operational Framework.

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2.3 Proportional Integral (PI) Design

Proportional-Integral (PI) control is a control method commonly used in inverters to regulate and maintain a desired output voltage or frequency. The PI Control Principle works by using two basic components, namely the proportional component (P) and the integral component (I). The proportional component provides a response proportional to the difference between the actual output value and the target value.

2.3.1 Proportional-Integral (PI) Control Block Diagram

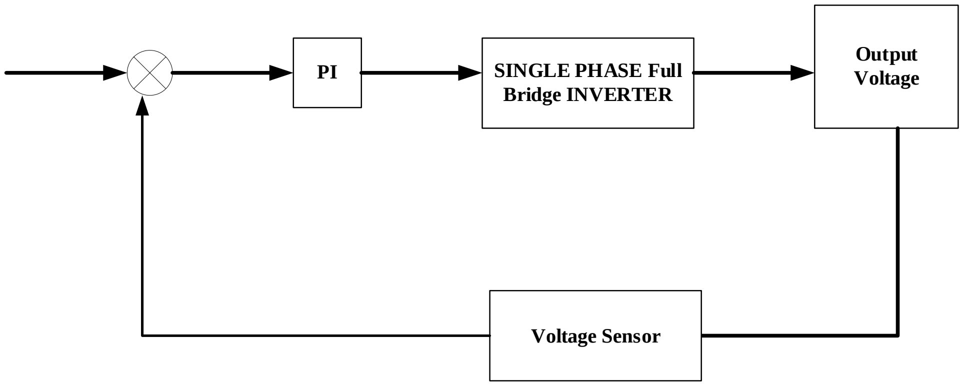

Figure III : Proportional Integral (PI) block diagram.

3. RESULT AND DISCISSION

3.1 Testing stage

Testing is carried out by providing changes input to each DC source to be tested. From the test results, data will be obtained Later it will be analyzed to serve as a basis for internal reference preparation of conclusions. After determining the type of component that will be used The next step is to determine the value of the components by calculating. Among them are calculating values input DC source, calculate output current, maximum power, load value, desired output voltage, then calculate Kp and Ki values. After getting the results of the value of each component then create a circuit with the help of software Matlab R2016b.

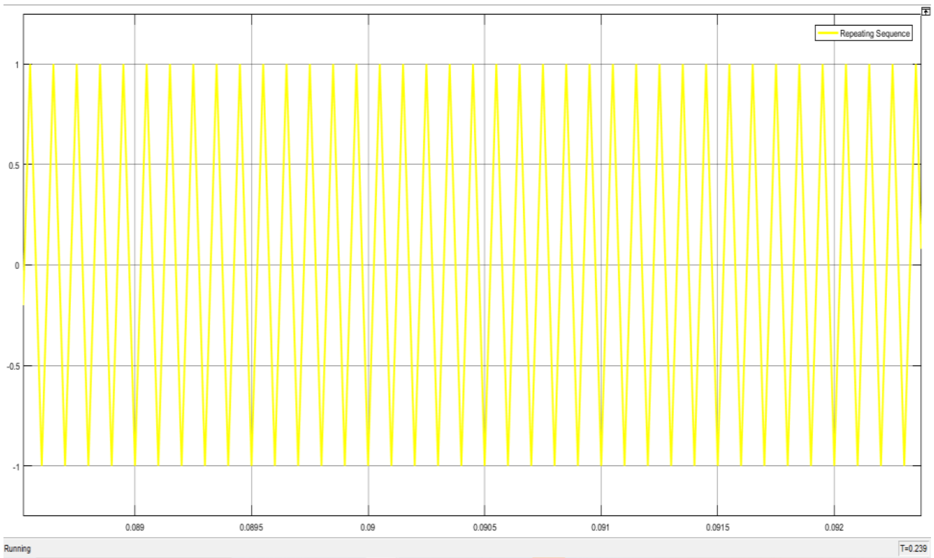

Figure IV : Sinusoidal Pulse Width Modulation (SPWM) Output Waveform.

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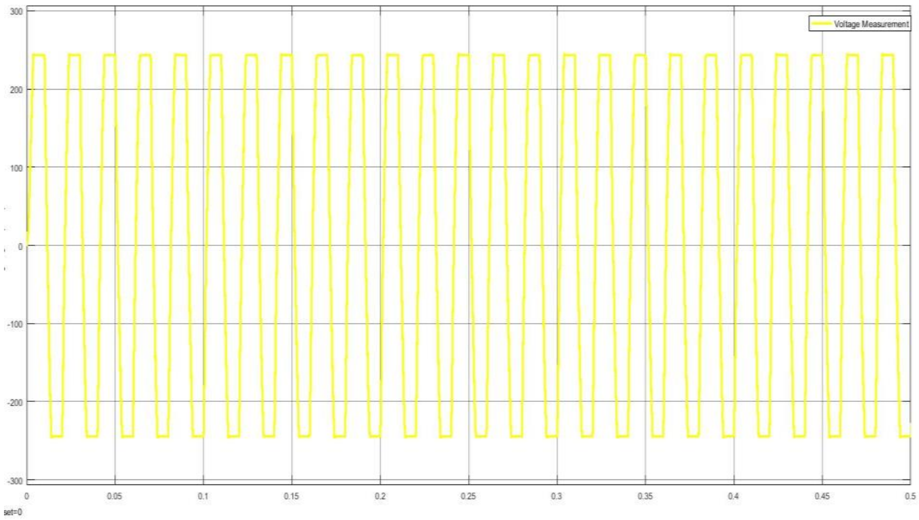

Figure V : Inverter Output Voltage Waveform Using a 244.44V DC Source.

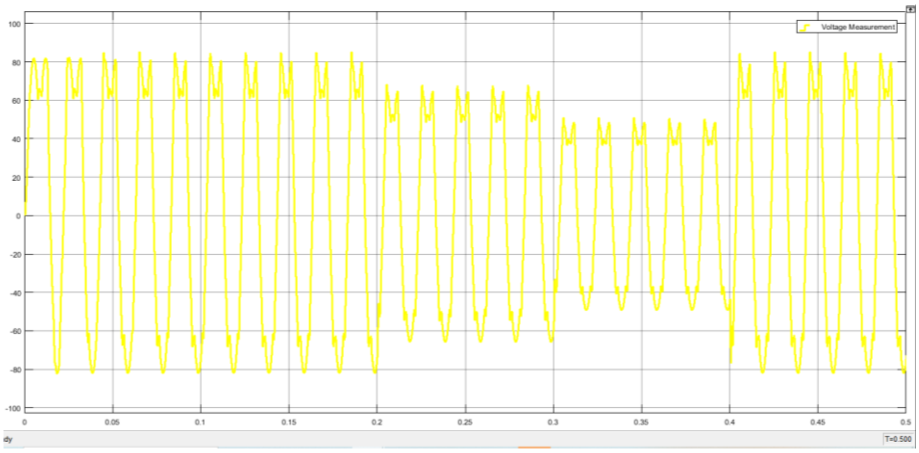

Figure VI : Output Voltage Waveform Using a Variable Source.

The output wave produced before the filter appears unstable. Because if the voltage from the DC source is unstable so the inverter output waveform will also be affected therefore using a variable source causes The voltage is not constant because there are many ripples.

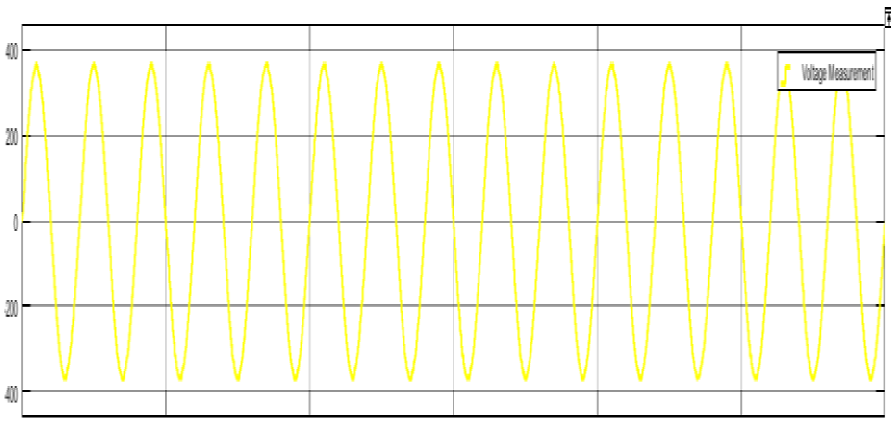

Figure VII : Inverter Output Voltage Wave Using a Photovoltaic (PV) Source After Using an LC Filter.

In determining the PV value, the datasheet from the PVMJT250GB module is used as a reference. Testing is carried out on models under irradiance conditions of 1000W/m2 with PV panel temperature 25C, by connecting PV with loads varying between 0-1000Ω. Result of Waves with a PV source can be seen as sinusoidal currents. With a current reaching 5.5 A. For output results in RMS shows constant 250 V.

Table I : Testing fixed input voltage value (350 V) with R load Varies

V Input	Setpoint	Load R	P Output
350	250	50	251.4
350	250	55	251
350	250	60	250.8
350	250	75	250.2
350	250	80	250.1

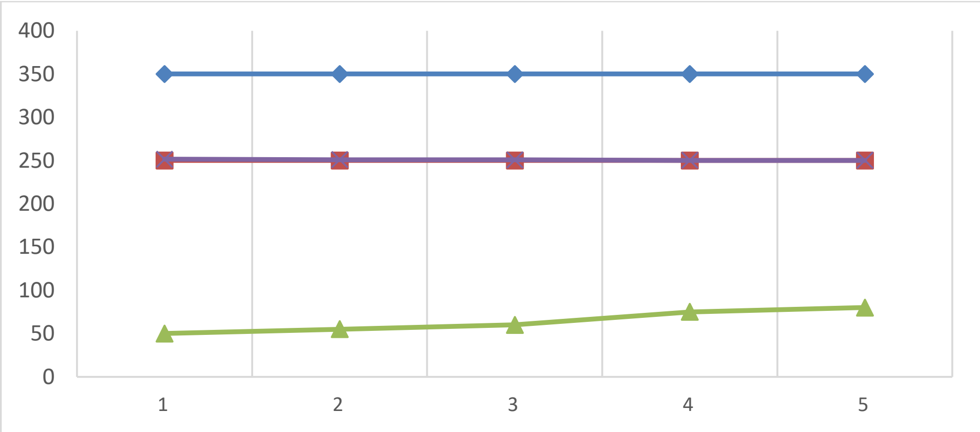

Figure VIII : Simulation Result Data Graph

Graphic image of simulation data based on table I above V input is blue, set point is red, P output is purple, and load R is green, it is said that the third test uses fixed input namely 350 V with a varying R load of 50 ohms. On This test is given an input of 350 V with an output voltage inverter according to the desired setpoint, namely 250 V. The PI parameters are Kp = 0.0285, Ki = 20. For that reason in this third test using input fixed but the varying load R shows the output value which is relatively constant according to the desired setpoint. This test aims to find out whether the system can maintain stability in accordance with the desired setpoint even if it decreases burden. Resistance / Resistors block the flow of electrons passes through it, thereby producing a voltage drop. Matter This causes the inverter voltage to drop when connected to load.

4. CONCLUSION

Based on the results of the research carried out, it can be concluded that :

1. The single-phase Full-Bridge type SPWM inverter is capable of changing an input voltage of 244.4 VDC to an output of 221.9 VAC. So that the device can function according to theory. Its function is to convert DC voltage to AC voltage.
2. It can be concluded that the greater the triangular wave frequency applied, the better the quality of the resulting current (lower distortion). Likewise, the higher the amplitude of the triangle wave, the worse the quality of the output current power obtained. In 3 single phase inverter circuit tests using the SPWM value method. The largest harmonics are in tests using a variable DC source where the unstable voltage affects the current.

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