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DESIGN AND DEVELOPMENT OF INTERLEAVED BOOST CONVERTER AS A POWER QUALITY IMPROVEMENT IN ONE PHASE ROTARY WITH INDUCTIVE AND RESISTIVE LOADS

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Abstract — The unidirectional voltage source is obtained through an uncontrolled 220 Volt single phase full wave rectifier circuit. Installation of large amount capacitors as a filter affect input waveform. Due to the harmonics distort sinusoidal input voltage from the PLN grid. The difference in voltage waveforms and input currents that occur can affect the value of the resulting factor. Based on this problem, a study was made on the improvement of power factors using a series of Interleaved Boost Converter which functioned as a series of Power Factor Correction (PFC) and voltage regulators with a setting method using Fuzzy logic. This Interleaved Boost Converter circuit is made to work in the condition of the Discontinues Conduction Mode (DCM) so that any load that is supplied to the circuit will make the system resistive. So, it is expected that the voltage and input current waveforms will produce a factor value close to the unity value. The results of this study are the Interleaved Boost Converter series that can be used as a Power Factor Correction circuit and also as a voltage regulator. It improves power factor from 0.9 to 0.93.

Keywords: interleaved boost converter, PFC, power factor

I. INTRODUCTION

The quality of electrical power distribution is a demand to improve the power factor of a circuit. This also applies to DC power distribution [1]. So that the power quality of using a series of one-phase rectifiers must also be maintained. The working principle of a one-phase rectifier circuit is to change the AC voltage (alternating current) into a DC voltage (direct current) [2]. To achieve the desired output voltage, for example to reduce the voltage ripple a filter C (capacitor) is used at the end/output of a rectifier circuit [3]. But the use of filter C in this rectifier circuit must be balanced with the consequences that cause the waveform of the rectifier to contain harmonics. This will cause the quality of the power in the rectifier circuit to decrease which is caused by harmonics and the temperature of the electronic components increases (stress on electronic components) [4].

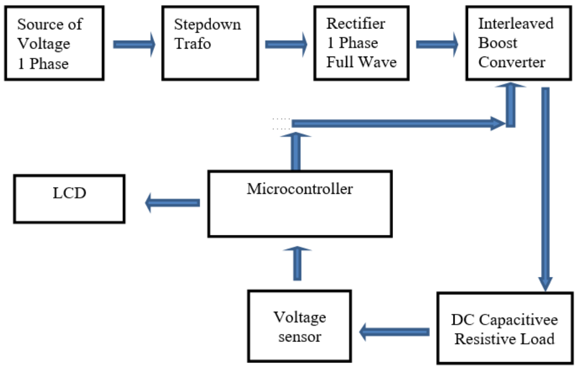
The rules on harmonic standards are also one of the considerations for conducting this research. Based on the IEC 61000-3-2 standard used by several countries in the world, that there is a harmonic value constant that is permitted in an electrical system. The standard commonly used in Indonesia (PUIL 2000) also stipulates the permissible harmonic value of 10% of the nominal voltage and 5% of the nominal current running. Therefore, we need a rectifier circuit that has a high standard of power quality (power factor approaches value 1 and harmonics are minimal) [5].

II. RESEARCH METHODS

The term electric power quality is a concept that gives an idea of the good or bad quality of electric power due to the existence of several types of disturbances that occur in the electrical system. In detail, the understanding of the quality of electric power is any electrical power problem in the form of voltage, current or frequency deviations that result in failure or operating errors in equipment that occurs in consumers of electrical energy. One of the parameters of good electrical power quality is to have a power factor value that is close to a value of 1 and a small harmonic value.

A. Product Design

In order to facilitate the process of making tools in this study, it needs good planning. The following is a block diagram of the system of the tools made.



Picture 1. Block System Diagram.

In this study, the Interleaved Boost Converter that was made was applied as a power factor correction that was expected to improve the quality of electrical power that was channeled to the load [6]. The output voltage produced by Interleaved Boost Converter is used to supply a load of 48 volts DC. Based on the diagram block shown in Picture 1 above, the planning and manufacturing of the hardware needed are as follows [7]:

1. Planning and making 1 phase full wave rectifier uncontrolled
2. Planning and making a series of Interleaved Boost Converter
3. Planning and making MOSFET drivers
4. Planning and manufacturing of inductors
5. Planning and making Snubber Circles
6. Planning and manufacturing voltage sensor circuits
7. Tightening the controller system

Picture 2. Full wave rectifier circuit

B. Testing Tools

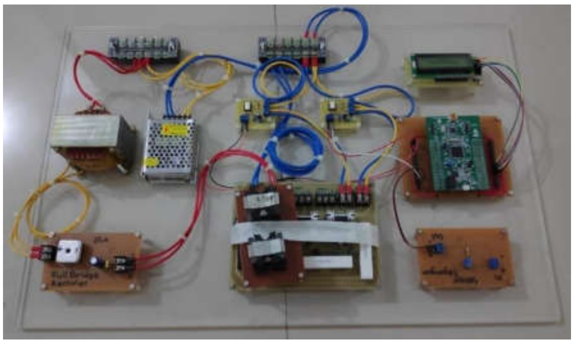
Testing tools is carried out in two separate processes, namely partial tool testing and tool testing for the whole system. Where the two processes must be carried out sequentially in order to get the expected results. The explanation of the two processes is as follows.

1. Partial Testing

In this partial test, each component/module used will be tested first before being assembled in a complete system. This test aims to ascertain whether the components/modules are working normally.

2. Testing the entire system

In testing the whole system, the tool will be assembled in full and connected to the load. Where when connected to a load, it can be measured the amount of the power factor value from the circuit. The resulting power factor value will be used for system analysis.



Picture 3. Total circuit System

C. Analysis Method

The analytical method that will be used is by testing a system that is made where the system created will be tested in two parts, namely testing the system without setting the output voltage and testing the system by setting the output voltage. And for comparative data testing is also done on the 48V switching power

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supply that is sold. The data focus taken is the value of the power factor and some additional parameters that have been designed.

III. RESULTS AND DISCUSSION

A. Results

1. Results and Evaluation of Tools

In this section, we will discuss system testing that has been made both partially and throughout the system. The tests to be carried out are as follows:

a. Testing full wave voltage rectifier.
b. Testing the PWM signal generator using a microcontroller.
c. Voltage sensor testing.
d. System Testing.

2. Presentation of Data

Present the data - the results of experimental data in the form of tables so that it can be easier to understand and also some calculations in the form of equations - the equations used in the presentation of the data displayed.

a. Test Results for Rectifying Wave Voltage Full Phase.
b. Data of Voltage Sensor Testing Results.
c. Data System Test Results Without Output Voltage Settings.
d. Data Test Results of the System with Output Voltage Settings.

3. Data Analysis

In this section, we will discuss the results of the three tests carried out in relation to comparing which systems are better when compared directly with the 48V 10A Power Supply which is a lot in the market. The following is a comparison table of the three system tests that have been carried out

B. Discussion

In this section we will discuss the suitability of planning tools with the results of testing that has been done. The initial planning of this tool is used as a series of improvements to the power factor (power factor correction) in a series of one-phase rectifiers with the following parameters:

a. Input Voltage : 28.82 Volt DC
b. Output Voltage : 48 Volt DC
c. Power Factor : ≥ 0.95
d. Frequency : 40KHz

It can be seen that in the initial planning of this tool, the value of the power factor to be achieved is more than 0.95 with an output voltage of 48 Volt. To more easily compare the test results data with the initial planning parameters can be seen in Table 1 below.

Table 1. Suitability of Planning with Test Results

Data Parameters	Initial Planning	Test result	Error
V_{in} Penyearah	32V_{AC}	20.66V_{AC}	35.43%
V_{out} Penyearah (V_{in} Interleaved Boost Comverter)	28.82V_{DC}	18.94V_{DC}	34.28%
V_{out} Interleaved Boost Converter	48V_{DC}	48.1V_{DC}	0.2%
I_{out} Interleaved Boost Converter	1.25A	1.3A	4.0%
Power Factor	0.95	0.93	2.1%

From the above table it can be seen that there is a deviation (error percentage) with a fairly high value at rectifier input voltage (Vin Rectifier) of 35.43% and at rectifier output voltage (Vout Rectifier) used for circuit input voltage Interleaved Boost Converter of 34.28%. This happens because the inductor design is not good, where to get the value of Q (the quality of the inductor) which is good the number of turns of the inductor must be added.

In this research, the system from Interleaved Boost Converter that is used as Power Factor Correction is functioning properly, where the value of the generated power factor is 0.93 and this value is far better than the switching power supply circuit which in this test only produces a power factor value amounting to 0.90.

IV. CONCLUSION

From the results of testing the tools and analysis that have been done, it can be concluded that:

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1. The Interleaved Boost Converter series designed and made in this study can function as a Power Factor Correction well with the value of the generated power factor of 0.93.
2. The Interleaved Boost Converter circuit which is also used as a voltage regulator can maintain an output voltage of 48 volts with a fuzzy logic controller system.
3. The design of power factor correction using the Interleaved Boost Converter circuit can reduce the THD Current value from 39.0% (System Without Output Voltage Settings) to a value of 33.5% (System with Output Voltage Settings) and this value is far better than Power Supply Switching which are widely used with THD values of 58% to 60%.

In the preparation of this research, there are still many shortcomings that must be corrected. This can be seen from the results that are slightly incompatible with the initial planning of the author. In addition, the authors encountered several obstacles during the process of making this research. For this reason, here are some suggestions that the author can convey:

1. In designing the inductor so that it is carried out more carefully so that no errors occur in the manufacturing process In addition, in the inductor winding process to be done better so that it gets an inductor value that is close to the design value and has a better Q value (quality inductor.

2, In the selection of components must also be taken into account in order to choose components with a higher rating value compared to the design value. This is done so that the components used are not susceptible to damage due to high voltage or spike and other disturbances

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