SIMULATION DEVELOPMENT OF A STEP DOWN DC CONVERTER BASED ON MULTICELL TOPOLOGY USING PSIM9

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Bachelor of Power Electronics and Drive

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A report submitted in partial fulfillment of the requirements for the degree of Power Electronic and Drives

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"I hereby declare that I have read through this report entitle "Simulation Development of Step Down DC Converter Based On Multicell Topology Using PSIM 9 (For Green Energy)" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Power Electronic and Drives)"

Signature :...

Supervisor's Name :...

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I declare that this report entitle "Simulation Development of Step Down DC Converter Based On Multicell Topology Using PSIM 9 (For Green Energy)" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Name :..

Date :..

DEDICATION

Special dedication goes to my beloved mother Puan Shamsuria Bte Ibrahim and my beloved father En. Ramli Bin Mohamad

For growing me up without, taking care of mend educating me all these while. Also thank for their continuous pray until I become what i'm now.

Also for my Family...
En. Mohd Khairi Bin Mohd Zambri
Pn. Nurul Ain Bte Mohd Said
Thank you very much...

And not forgetting to all my relatives...
All of my friends especially Electrical Engineering batch 2009-2012

May ALLAH bless all of us...Amin

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ABSTRACT

Nowadays power electronics plays a very important role in many sectors including in industrial, office and household applications. Implementation of power electronics, include the use of static converters in very broad functions such as power supply, control of electric machines and others. But in some applications are only available resources with a high voltage rating that required a converter to switch the appropriate rating to supply the load, but the problem is because the semiconductor components with suitable voltage capability are not available. On the other hand, the need to increase the voltage level of electrical energy conversion system and the difficulties to increasing the voltage capability of semiconductor components, triggering the efforts to create new structures of static converters, one of the new structure is multicell converters. This new structure not allows conversion of high voltage electrical energy especially all problem related to the harmonics ripple.

Electrical converters plays a very important of many engineering including transportation, of example in the electric railway transportation system is required the supply of a DC voltage with rating of 500 Volts, but the available DC voltage source is commonly in the level of 1500 Volt. This study will analyze the DC-DC converter of multicell topology and its modeling, and then proposed a voltage decreasing DC converter that can be applied as power supply of electrical train. By this method the converter can be operated on high enough voltage by using the standard semiconductors components only. One of the processes used to decrease the applied voltage is a direct reduction using a single DC chopper, but this way is very risky because if there is a damage of semiconductor component in the converter will experience a high voltage directly from the source to the load. Another way is to use the SRPS (series resonance power supply) but this way has a lot of stage that is not practical.

ABSTRAK

Pada masa kini elektronik kuasa memainkan peranan yang amat penting dalam banyak sektor termasuk dalam aplikasi industri, pejabat dan rumah. Pelaksanaan elektronik kuasa, termasuk penggunaan penukar statik dalam fungsi-fungsi yang sangat luas seperti bekalan kuasa, kawalan mesin elektrik dan lain-lain. Tetapi dalam sesetengah aplikasi hanya sumber-sumber yang sedia ada dengan kadar voltan yang tinggi yang memerlukan penukar untuk menukar penarafan yang sesuai untuk membekalkan beban, tetapi masalah ini adalah kerana komponen semikonduktor dengan keupayaan voltan yang sesuai tidak boleh didapati. Sebaliknya, perlu untuk meningkatkan tahap voltan sistem penukaran tenaga elektrik dan masalah untuk meningkatkan keupayaan voltan komponen semikonduktor, usaha untuk mewujudkan struktur baru penukar statik, salah satu struktur baru ini dikenali sebagai penukar multicell. Struktur baru ini tidak membenarkan penukaran tenaga elektrik voltan tinggi terutama semua masalah yang berkaitan dengan riak harmonik.

Elektrik penukar memainkan peranan yang sangat penting kejuruteraan banyak termasuk industri pengangkutan, contohnya dalam sistem pengangkutan keretapi elektrik diperlukan bekalan voltan DC dengan penarafan 500 Volt, tetapi sumber voltan DC yang disediakan biasanya berlaku di peringkat 1500 Volt. Kajian ini akan menganalisis penukar DC-DC multicell topologi dan pemodelan, dan kemudian mencadangkan penukar voltan DC menurun yang boleh digunakan sebagai bekalan kuasa kereta api elektrik. Melalui kaedah ini penukar boleh dikendalikan pada voltan yang cukup tinggi dengan menggunakan komponen semikonduktor standard sahaja. Salah satu proses yang digunakan untuk mengurangkan voltan yang dipohon adalah pengurangan langsung menggunakan pencincang DC tunggal, tetapi cara ini adalah sangat berisiko kerana jika terdapat kerosakan komponen semikonduktor di dalam penukar akan mengalami voltan tinggi terus daripada sumber kepada beban . Cara lain adalah dengan menggunakan Siri Resonans Bekalan Kuasa tetapi cara ini mempunyai banyak peringkat yang tidak praktikal.

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C - Capacitor

DT - Duty Ratio

F - Farad

H - Henry

I - Current

L - Inductor

M - Micro

Ms - Millisecond

P - Commutation Cell

R - Resistor

THD - Total Harmonic Distortion

V - Volt

Z - Impedance

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CHAPTER 1

INTRODUCTION

1.0 MULTICELL CONVERTER HISTORY

Multicell converters were introduced ten years ago and over this period, their properties have been thoroughly analyzed. This project summarizes the main results obtained through the research done on these converters over these periods: topology and derivation of multicell choppers and voltage source inverter, harmonics cancellation, open loop modulation techniques, self-balancing understanding and optimization. Since then, this concept have lead to some other innovative topologies which will be briefly presented in this project. Multilevel converter has been developed as a result of the increasing need for higher power converters. To achieve the power rating is higher, voltage and current capability of devices used in the converter must be increased. Current technology insulated gate bipolar transistor (IGBT) wide up to 6.5 kV, 900 per switching devices [1].

Multicell topology is formed when a number, the P cells change imprecated (overlapping) to form a leg inverter or chopper turn on input voltage of the converter circuit when the voltage is the same transformation of cells Vt / t. A general circuit topology shown in Figure 2.7.1 multicell. Depending on the trend to be an exception, the number of cells can be extended to cells of p. Output voltage waveform can be optimized with interference signals to control a variety of cells [1]. Output voltage waveform of the range of measures Vt / t and the frequency of single cell switching frequency, which reduces the output filter inductance around p^2. An important aspect to remember about that multicell topology is the balance booster. Introduce some booster circuit, basically called the notch filters are connected in parallel with the load. This notch filter's purpose is to provide the low impedance at multiples of the frequency change. The most common form of the balance booster the series RLC circuit. The reason for the name of the balance booster, follows from the effect that this circuit have the balance voltage cell capacitor. If the circuit is designed to have low impedance at the frequency change, it means that the load impedance is smaller then the switching frequency as the parallel combination of load impedance and the impedance of the balance booster circuit. The theory developed in this paper provide a way to measure the effects of some booster [1].

Converters use a series of switches, allowing the use of switches to reduce the voltage. This low-voltage switches with low loss and shift to higher frequencies In many cases, active switching element has been used for harmonics current filtering. They operate using pulse width modulation (PWM) techniques to inject the required non-sinusoidal current requirements of nonlinear loads. Many studies have been carried out on various aspects of active power filter implementations. Parallel active power filters (PAF) normally operate using pulse width modulation (PWM) inverter techniques to inject the required non-sinusoidal current requirements of nonlinear load but are complex with the number of switches in use.

In this work the principles of high switching technique is proposed, implemented as a new active power filtering technique that could reduce input current distortions when feeding a load. The proposed system uses only two switch to perform active current wave-shaping. This is done by injecting higher switching frequency to active switching element. The operation of the proposed filter structure is examined with computer simulation verified with selected experiment results.

1.1 PROBLEM STATEMENT

1. The component is difficult to find and some of the component are not suitable voltage.
2. Other step-down converters are obtained lower band-width of switching frequency.
3. Other step-down converters could not improve the output of converter and it also could not allow conversion of high voltage frequency electrical energy on the output side.
4. Other step-down converters also can play the same role as multicell topology such as a single DC Chopper, but this topology is going to be a very high risk topology because if semiconductors are damaged in the converter, it could produce a high voltage from source directly to the load.
5. Other method does not obtain higher band-width of switching frequency. It also cannot reduce Total Harmonic Distortion (THD).

1.2 OBJECTIVE

The main objectives of this project are:

1. To use a low cost devices to replace old topology like Buck converter and Full-Bridge converter.

2. To obtain higher bandwidth of switching.

3. To make specific purpose of the DC-DC converter such as power supply for transportation.

4. To increase performance of the converter by inserting more switches.

5. To produce high power improvement due to reducing efficiency, output ripple and comparison of Total Harmonic Distortion (THD).

1.3 SCOPE

The main purpose of the research is to design and developed DC-DC converter is based on multicell topology where by simulation and equipment to analyze the output performance from multicell topology method. It also will investigate and determine all parameters of the converter component based on simulation and equipment. From the development of the multicell converter, it also will compare this topology with other topology like buck converter and full-bridge converter to make comparison with their performance of the output dc voltage.

CHAPTER 2

LITEATURE REVIEW

2.1 INTRODUCTION OF POWER ELECTRONICS

Power electronics convert electrical energy from one form to another electronic device. Function of power electronic circuits using semiconductor devices such as switches, control or modify the voltage or current. Power electronic applications of high power conversion equipment such as DC power supply to each of the hardware that is available at this time, such as cordless screwdriver, charger power supply for computers, mobile phones and hybrid cars. Power Electronics, including applications in which the circuit milliwatts or megawatts. Typical applications of power electronics, including AC to DC conversion, DC to AC conversion, the conversion voltage control voltage is controlled, and change the AC power source to the intensity and frequency to another frequency and the amplitude.

The design of power conversion equipment, including many of the disciplines of electrical engineering. Power electronic applications including circuit theory, control theory, electronics, microprocessor control and heat transfer. Semiconductor switching power expansion in combination with the required to improve efficiency and performance of electronic devices has made an important area of power electronics and expanded rapidly in the field of electrical engineering [1].\

2.2 CONVERTER CLASSIFICATION

The goal of power electronics is to meet the electronic power load voltage and current sources. Power electronics convert one type or level of voltage or current wave and the other is known as an converter. Converter working relationship between the source and load as shown in figure 2.2.1.

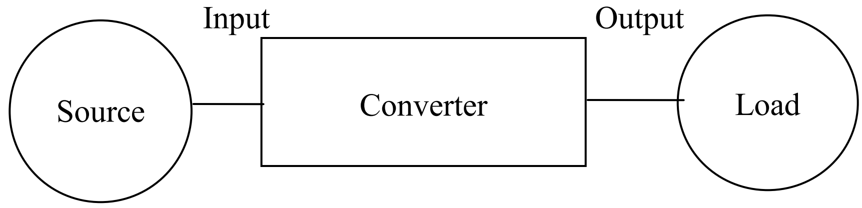

Figure 2.2.1 A Source and Load Interfaced by A Power Electronics Converter

Converters are classified by the relationship between the input and output:

2 **AC input/DC output**

The converter that converts an AC (input) to DC (output) is called converter. The power flows from AC sources and transferred it to a DC load. This converter is classified as rectifier. For the example, the converter integrated circuits to operate 50Hz AC line voltage by converting the AC signal to a DC signal.

3 **DC input/AC output**

The converter that converts a DC (input) to AC (output) is called inverter. The power flows from the DC source and transferred it to an AC load. The example of inverter applications is an array of solar cells. It produces a 120V from a 12V battery.

4 **DC input/DC output**

The DC (input) and DC (output) converter usually use as regulated. This converter is very useful when a DC load requires a specified voltage, but DC source have unregulated value. For the example, 12V load may be obtained to 24V source via DC-DC converter.

5 **AC input/AC output**

The converter that uses to charge level or frequency of AC signals is called as AC (input) - AC (output) converter. For the example, the speed control of ceiling fan and an induction motor.

Some of the converter circuit can operate in different ways, depending on the circuit and control parameters. For example, modify the semiconductor devices, some recovery circuit can act as a converter. In Fig.2.2.2, the converter has the characteristics of the rectifier, if the battery is charged from an AC power source. Thus, in others, the converter is characterized as a converter, if the battery is a source of AC power supply for system [2].

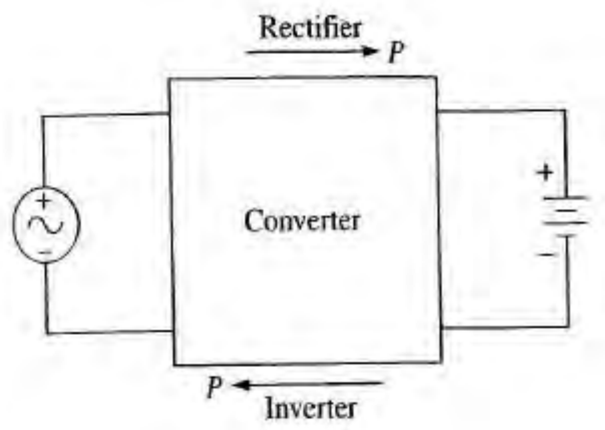

Figure 2.2.2 A Converter can Operate as Rectifier or an Inverter

Power conversion can be a multifactorial process that involves more than one type of converter. For example, an AC-DC-AC conversion can be used to modify an AC power source by first converting to DC and then converting the signal into a DC signal that is AC frequency range and different from those original source of AC power.

2.3 MODULATION TECHNIQUE

Converting a popular technique in electronic powertrain and drivetrain Pulse Width Modulation (PWM). To replace the classic line switching thyristor converter, PWM converter enables the use of rapid change high power transistor, MOSFET and GTO. The correct change and improve the pattern of pulse dead time for the application of micro-controllers, PWM can be realized. Comparison of the modulation carrier wave and triangular wave method PWM principle. Turn on the power points can be determined by the intersection. A common carrier may be used for all three phases of three-phase system. To achieve variable frequency, variable size and output voltage, frequency and size of the wave modulation can be changed [3].