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REVIEW OF DC-DC CONVERTERS FOR DC NANO-GRID INTEGRATED WITH
SOLAR PV GENERATION

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Abstract

The wide use of DC characterized loads and more distributed power generation sources (DERs), the DC Nanogrid becomes more and more popular and seen as an alternative to the AC grid system in future. Therefore for safety considerations, DC Nano grid provides reliable grounding for residential loads like low voltage AC power system. Nano grid is a self-controlled entity and operated in either grid connection or island mode which connects local distributed energy sources and local distributed system. In this paper the review of performance analysis of DC-DC converters used in Nano grid is proposed. DC-DC converters are used for maintaining the voltage level of the system according to load demand.

Keywords- DC Nano grid, DC-DC converters, DER (Distributed Energy Sources)

Introduction

Electrical power system was designed to transfer alternating current (AC) power, via high voltage transmission lines and low voltage distribution lines, to consumers. There is need to rethink the model of today's consumer equipment and tomorrow's distributed energy generation. The distributed power generation is becoming more and more attractive due to long term lack of energy and environmental problems caused by burning the fossil energy[1]. Large number of DERs are connected to AC power system through different kinds of power converters, which may cause problems like current distortion, voltage fluctuation and also issues related to protection[2][3][4]. Nowadays, the major challenge for engineers and scientists is to generate energy in form of clean, efficient and environmental friendly sources. Renewable energy is a preferred solution to fossil fuels and their deployment in off-grid systems is growing steadily in both developed and developing countries[5]-[10]. Direct current nano-grids employing hybrid energy systems are increasingly considered as a viable option to electrify remote and sparsely populated areas[11]-[13]. They can provide reliable electricity supply with improved power quality to households and small-scale commercial users, thereby boosting commercial activities in the rural areas[12][14][15]. A nano-grid employs several power electronic converters to interface the generators and the loads to the nano-grid. The converters used in DC nanogrid transforms voltage level i.e. step up or step down the voltage levels. In this three basic dc-dc converters are used buck converter (that steps down the input voltage), boost converter (that steps up the input voltage) and buck-boost converter used for variable load demand.

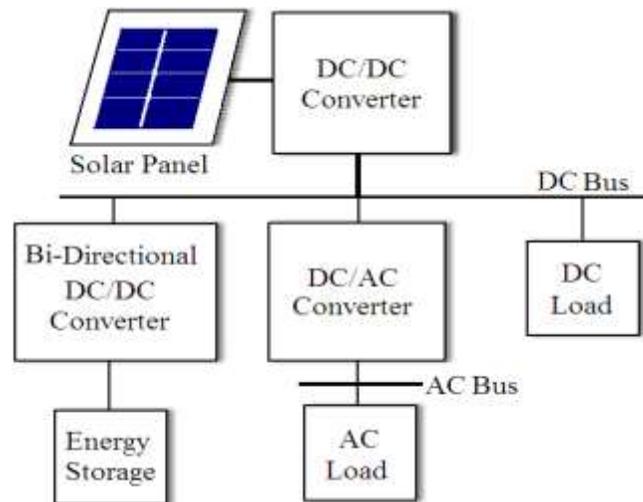


Figure 1: Basic Structure of DC Nano-grid System

Nano-grid

Nanogrid is meant for supplying domestic load of the order of few hundred watts to 5 kW generated from renewable sources like roof-top solar photovoltaic, fuel cell, wind farm, etc. The generators are primarily based on clean forms of energy such as fuel cells, solar arrays and wind turbines. A nanogrid consists of power electronic converters which interface the generators and the loads to the nanogrid. These converters also link the nanogrid to the power system grid. Each nanogrid should be efficient, reliable, self-sufficient and fault tolerant. The nanogrid distribution system can be based on AC or DC depending on design. DC nanogrid possesses the following advantages over AC nanogrid.

- DC based distribution provides higher system efficiency than AC based distribution as losses due to skin effect, no-load equipment losses are absent[16]-[17].
- Unlike AC distribution systems, frequency stability is not a concern for DC distribution systems.
- DC distribution systems do not have any reactive power issues

Figure. 1 shows the schematic diagram of a DC nanogrid. The DC nano grid constitutes of solar PV panels as energy source, power electronic converters, storage elements and local AC and DC loads. The power demanded by the local loads is met by the solar panels, with the storage elements maintaining power balance in the system. From Figure. 1 it can be seen that the sources, energy storing elements and different loads are connected to the DC bus through different power electronic converters. These converters regulate the DC bus and AC bus voltages at their rated values as well as transfers power from the storage elements to the load or from the source to the storage elements as required.

DC-DC Converters

Recently, the deployment of DC appliances is exponentially increasing in all sectors like domestic consumers, industrial consumers and commercial consumers. The solar PV module generates DC power and therefore it can be directly fed to DC load through DC-DC converters to minimize conversion losses and improve power quality and efficiency. It is used for noise cancellation, power bus regulation and for boosting the flow of current. Power electronic devices that are used whenever there is change of DC electrical power from one voltage level to another voltage level is needed in the output according to the demand of the load.

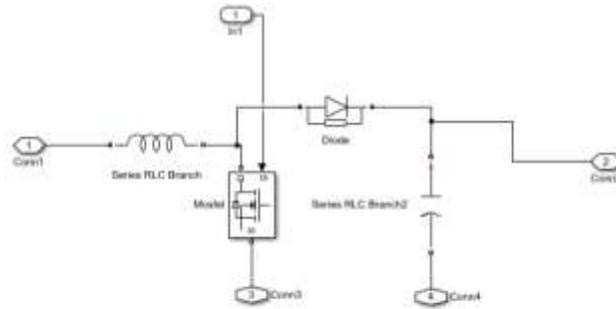


Figure2: Simulink Diagram of Boost Converter

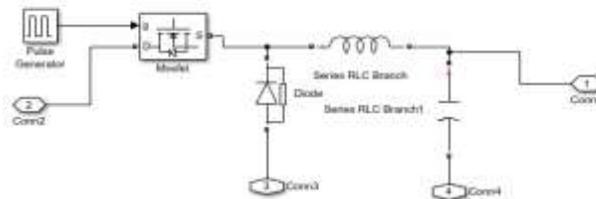


Figure 3: Simulink diagram of Buck Converter

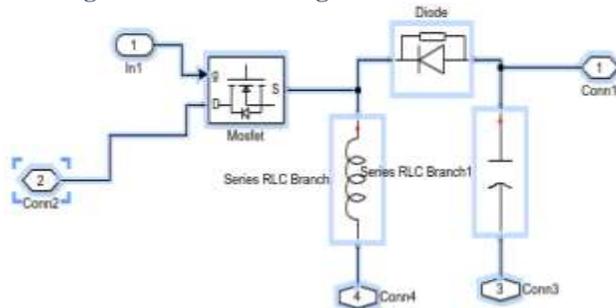


Figure 4: Simulink diagram for Buck-Boost Converter

Figure 2 represents the Simulink diagram for boost converter which step up the voltage input voltage level according to the load demand. Figure 3 represents the Simulink diagram for buck converter which step down the voltage level according to the load demand. Figure 4 represents the the diagram for buck boost converter which converts the voltage level according to the load demand i.e. it can step up and also can step down the voltage levels. It is controlled by pulse generator. If the pulse width of the pulse generator providing input pulse signal to buck-boost converter is above 50% then the input voltage is stepped up and the converter performs as boost converter and if the pulse width of the pulse generator providing input pulse signal to buck-boost converter is below 50% then the input voltage is stepped down and the converter performs as buck converter. In this paper I propose to perform an FFT (Fast Fourier Transform) Analysis and obtain the Total Harmonic Distortion for each converter for their performance analysis on DC Nano grid.

Conclusion

FFT analysis for obtaining the Total Harmonic Distortion is proposed through this paper which will help for performance analysis of the converters used in DC Nano grid. The applications of the proposal are smart lighting systems, smart house , EV charging stations , provides electrical connection without any distributor and is cost efficient etc. Nano grid systems may provide electrical power to such rural areas where the transmission lines cannot reach due to tough terrain which is beneficial for boosting the growth of that area as well as for country's economy. It is pollution free system and is main alternative for fossil fuel energy which is clean energy.

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