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Survey on Zeta Converter Topology

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ABSTRACT
This paper leads to the study of zeta converters and its future scope. Mainly it is analyzed for its induction into modular hybrid microgrid system. Here the main points of importance are design of zeta converters, its working, compatibility, feasibility etc. Apart from this our focus would be mainly on various research papers.

Keywords:- Power Converters, Zeta Converter, Renewable Energy, Micro grids, Hybrid Power Systems.

INTRODUCTION

In the present scenario conventional energy sources are moving towards depletion at a faster rate this has resulted in research and development of non conventional sources of energy like solar, wind, hydel, bio-energy etc. In order to improve these systems power electronics are augmented and interfaced with them. With the irregular nature of harvesting systems of renewable energy hybrid systems there has been rise in the development of a number of different topologies of DC/DC converters that can help maintain the output voltage of these systems at a constant level. Nowadays, multiple-input converters (MIC) that can integrate various types of renewable energy hybrid systems using a single converter power stage are becoming popular. Multiple-input converters topologies had been analyzed, synthesized, and evaluated in a many literatures.

However, there have not been much light on Zeta converter topology. A Zeta topology takes over the advantages that include the wide range of input voltage that it can handle because it can both step up and step down the input voltage. Also a Zeta converter is capable of providing output voltage with positive polarity. This acts as an added advantage as most types of load require this voltage polarity. A Zeta converter also helps in power factor correction and this characteristic is typically a boon for highly reactive systems. This topology showcases potential modularity i.e. its design can provide scalable architecture and more flexibility. Apart from this by using this topology the replacement of multiple inputs of the converter can be done in a much simpler way.

II OVERVIEW OF POWER CONVERTER

In the field of electrical engineering and the related field of electric power industry, power conversion is a method of converting electric energy from one form to another like converting from AC to DC, AC to AC, DC to AC ,DC to DC or changing the frequency or voltage etc. Hence we can say that a power converter is an electrical or electro-mechanical device for converting electrical energy. This could be a very basic transformer to change the voltage of AC power along with some combinations of more complex systems. The converter can also be referred as a class of electrical machinery that is used to convert one frequency of alternating current into another frequency. Power conversion systems usually incorporate redundancy and voltage regulation.

III OVERVIEW OF DC/DCCONVERTERS

An electrical or electro- mechanical device to convert one level of DC to another level is termed as a DC/DC Converter in simple terms. The properties of the converters such as efficiency, ripple, load response, transient response etc can be changed with the help of their external parts and designs. These external parts are generally dependent on external conditions such as input and output specifications. The power supply circuits are often used as a part of commercially available circuitry products and are designed in order to satisfy the constraints such as electrical specifications, size, cost etc. Usually they are designed and selected according to the properties they emit and standard operating conditions.

1.1 A. Types of DC/DC Converters

The availability of DC/DC Converters is in two circuit types:-

- ❖ NON ISOLATEDTYPE
  - One Coil Type(Basic)
  - Two Coil Type (Capacity Coupling) : SEPIC, ZETA
  - Switched Capacitor/Coil Less Charge Pump) Type
- ❖ ISOLATED TYPE
  - Forward Transformer Type
  - Transformer Coupling Types
  - Fly Back Transformer Type

IV OVERVIEW OF ZETACONVERTER

In present scenario DC/DC converters are widely used as power supply in electronic systems. Zeta converter forms a major source of this part. It is a fourth order DC/DC converter that is capable of amplifying as well as reducing the input voltage levels without inverting the polarities. The main reason for this is the presence of capacitors and inductors that act as a dynamic storage elements. It is also a non linear system which can be seen as a buck-boost-buck converter with respect to output and boost-buck-boost converter with respect to the input.

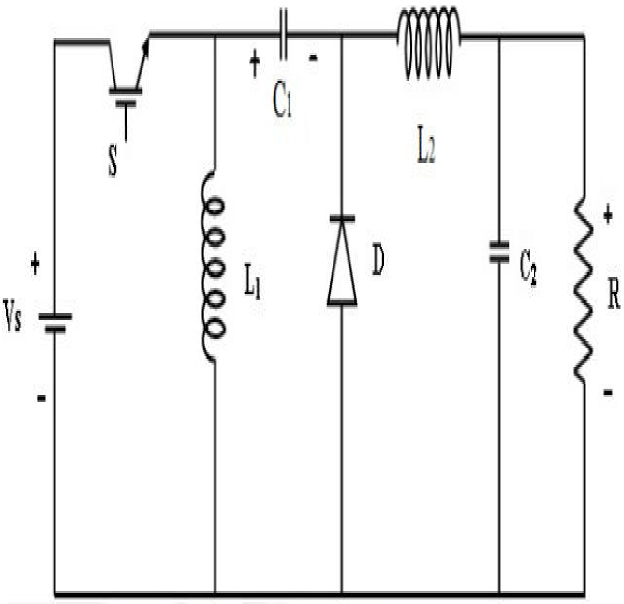

Fig. 1: Basic Zeta converter circuit.

The above figure depicts the basic non isolated zeta converter. Based on the value of inductance, capacitance, load resistance and operating frequency there can be different operating modes. We can make use of state space analysis method for continuous inductor current. Following assumptions are made for this method:-

Converter operates in continuous inductor current mode.

switching devices are considered to be ideal.

Frequency ripples in DC voltages are neglected.

A. MODES OF OPERATION OF ZETA CONVERTER

The following are the two modes in which a Zeta converter works.

MODE 1 : CHARGINGMODE

- switch isON
- Diode D isoff
- the inductors L_1 and L_2 draws current from voltage sourceV_s

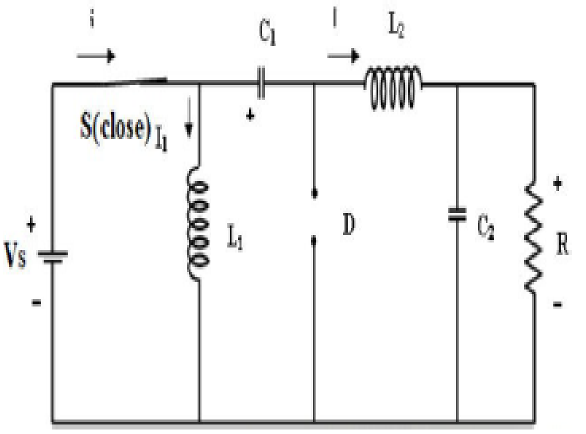

Fig. 2: Mode 1 equivalent circuit.

MODE 2 :
DISCHARGING MODE

- Switch is OFF
- Diode D is ON
- The energy stored in inductor L_2 is transferred to R(load)

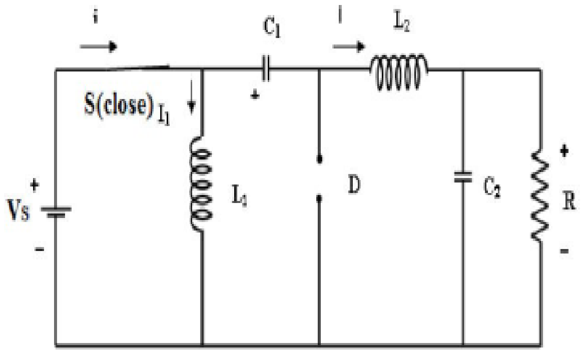

Fig. 3: Equivalent circuit of mode 2.

V OVERVIEW OF RENEWABLEENERGY

Those sources of energy that do not deplete or can be replenished within human beings life time is termed as renewable energy. Wind, solar, geothermal, biomass etc form the major examples of these sources. Most of this energy is derived directly or indirectly from the sun. For example solar energy is derived from direct tapping of sun energy using solar technologies. The wind energy is derived from winds via wind mills, winds flow as a result of sun's heat. Another source bio-energy that is related to plants is also derived from sun's energy as plats use sunlight to grow.

But all renewable energy sources does not rely on sun like the geothermal energy uses the earth's internal heat whereas the tidal energy uses the moons gravitational pull and hydropower uses the energy of water flow.

The renewable energy makes up to 13-14% of world's energy supply and 22% of world's electricity.

The renewable energy sources are the major source of discussion in the present scenario due to two main reasons:

- The energy sources would noted plete
- The green house gas emission is comparatively less with that of fossil fuels

Though these are termed as the globes energy future but still they face difficulties while deployment at a large scale, technological barriers, intermittent challenges, high initial capital etc.

VI OVERVIEW OFMICROGRIDS

Microgrids can be defined as a group of interconnected loads and energy resources distributed within a clearly defined electrical boundary that works together as a single controllable unit with respect to the grid. It can work in both grid connected mode or island mode by connecting or disconnecting from the grid. Micrograds are majorly of two types, the one that is near to a traditional utility customer and wholly on one site are termed as customer microgrids, True microgrids (μ grids) and the other one involves a segment of regulated grid called milligrids (mgrids).Microgrids offer various advantages to customers and utilities like reduced environmental impact, improved energy efficiency, reduced energy consumption, reliability of power supply, reduction in loss, better voltage control, congestion relief, economical infrastructure replacement etc. Microgrids have an ability to coordinate all these assets together and present them to the mega grid in such a manner that it is consistent with current grid operations and also avoiding any new investments which may be needed to integrate the emerging decentralized resources.

VII OVERVIEW OF HYBRIDSYSTEMS

Hybrid power systems can be termed as a combination of different energy generation systems that are complementary as well like renewable sources of energies , there combination along with other sources such as LPG, diesel, gasoline genset. These hybrid systems make use of the best features of the energy resources and provide grid quality electricity (1KW to several 100 KW). Another important feature is that they can be developed to integrated designs within mini grids and village electrification. They also make an effective source of backup solution to main power grids during the time of blackouts and weak grids etc due to their high efficiency, long term performance and reliability.

VII OVERVIEWOFHYBRIDMICROGRIDS INTEGRATING RENEWABLEENERGY

These are the innovative energy solutions that offer significant low operating costs through incorporating renewable energy resources to the hybrid micro grids. This whole system includes Solar Photovoltaic's, wind turbines, robust batteries, gensets, highly efficient & reliable power electronics etc. They can be customized to the working system as per the specifications. These systems effectively reduce the operating costs and the fuel consumption. They find a wide range of application in the fields of telecommunication, mining, remote communities etc.

IX LITRATURESURVEY

A. Design, Analysis and Performance of Zeta converter in Renewable Energy Systems

In this paper zeta converter is used as dc-dc converter which is designed, simulated and analyzed in solar energy system. The complete model of solar energy system is simulated in MATLAB 8.1 using Simulink. This model has solar arrays, zeta converter, inverter and single phase asynchronous motor which is used as a load in this system. Maximum power point tracking algorithm is used to achieve maximum power from photovoltaic array and PID controller is used to control the switching of dc-dc converter

B. Highly Efficient Integrated Zeta-Fly back DC-DC Converter for High Gain Application with a Compact Structure

A positive output DC-DC converter high gain has been proposed in this paper. The converter has been synthesized with the help of a Zeta converter, whose two inductors is replaced by Flyback transformers and a diode and filter capacitor connected to the secondary side of each one of them. The output of this converter can reach up to a very high level so that it can be used to interface low-voltage renewable energy sources like PV, fuel cell, battery etc. to the utility grid. Operating modes of the proposed converter have been explained, showing the various current flow paths within the circuit during these modes. To verify these explanations, simulations for the proposed circuit has been carried out in Matlab-Simulink. The expressions of the voltage gain and the efficiency with respect to the variation in the transformer turn ratio and the duty ratio have been derived including various parasitic elements. Plots showing the variation of gain and the frequency for various duty cycle at different power levels has also been obtained.

C. Zeta Converter for Power Quality Improvement for Multi-String LED

This paper presents a Zeta converter fed power factor correction (PFC) for high power light emitting diode (LED) driver. The application is targeted for multiple string red- green-blue (RGB) LED drivers with lumen control. A pulse width modulation (PWM) technique is used for light output control to achieve required light without compromising the efficiency. The Zeta converter is used to feed a bi-flyback DCDC converter which supplies power to the synchronous buck based constant current switching regulator and PMDC motor required for forced cooling of LED module. The proposed converter designed for discontinuous output inductor current mode for PFC at universal AC mains at entire load regulation. The developed prototype of the proposed LED driver is experimentally verified. The power quality parameters of the proposed

LED driver are evaluated at rated and light load conditions for universal AC mains (90-265V) with lumen control. The power quality parameters are measured and found acceptable ranges of international harmonic standard.

D. Zeta converter modelling analysis based on pulse waveform integral approach

The circuit topology of a Zeta converter is very complicated, which made it difficult to use the conventional modelling approaches for its common modelling. In this paper, the pulse waveform integral approach is utilized to model and analyze the Zeta converter, then the unified circuit topology can be obtained, and in accordance with this unified circuit, the small-signal dynamic mathematical model has been established. Modelling results show that the mathematical model of control variables to the output voltage contains two zeros in the right half of the plane, and the system is a non- minimum phase system. This paper has analyzed the unified modelling theory by using the conventional modelling approaches for its common modelling in detail, and the unified modelling approach then has been given. The modelling and analysis process has a clear physical concept, and its course is simple, which contributes to an effective tool for unified modelling of high-order switching converters. Finally, the simulation results have been verified the validity of the modelling consequences which is based on the pulse waveform integral approach.

E. The Zeta Boost: a step-up DC/DC topology derived from the Zeta converter

This work investigates a step-up topology derived from the Zeta converter: the Zeta Boost. A Zeta Boost converter design for consumer applications is presented and its steady-state performances are compared to a classical Boost converter with the support of computer simulations and measurements. The results presented include the efficiency and output voltage ripple.

X CONCLUSION & FUTURESCOPE

This paper represents the study of zeta converter for its inclusion into modular hybrid micro grid systems. In this we have referred various research papers that throw light on zeta converter topology, its application such as zeta boost, fly back integrated zeta converter. Apart from this we have seen power quality improvement and pulse integral design analysis. Hence from above studies we can infer that a zeta converter is much more feasible and reliable when compared with other converter topologies such as cuk, sepic, buck, boost etc. Apart from this the zeta converter has a wide range of scope to be utilized in the coming scenario in consideration with research and development in the field of renewable energy resources.

The main advantages that have been inferred are that this fourth order converter topology is capable of operating in both step up and step down mode i.e. it can perform individually the activity of buck converter and boost converter. Apart from this due to presence of capacitors and inductors there is automatic insulation between input and output, lower ripples are there, better load transient response and easy compensation. Another added advantage is that we can replace the inductors with transformers; diode etc and can work with high ranges of power from low input sources. The implementation of feedback technology is very easy. The outputs so obtained are usually constant for wide range of uneven inputs i.e. this feature makes it a favorite for renewable energy utilizations which are mainly uneven sources of supply. The presence of feedback loop also reduces noise, distortions, precise control of frequency, system response, gain and bandwidth, independent working parameters etc. There gird connections are also easier as compared to other topologies.

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