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A Novel Method for Reducing PQ Problems by Using Fuzzy Logic and Neural Networks for PV Applications

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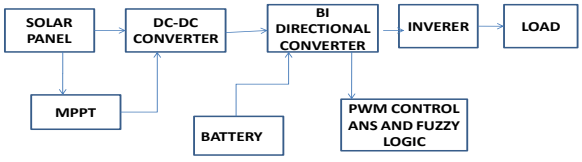
ABSTRACT: This paper proposes a novel methods of three port dc/dc converter based on RLC resonant topology for micro grid application the proposed Fuzzy logic and neural networks having future of the RLC converter and can achieve zero voltage switching primary side IGBT and zero current switching secondary side diodes and the advantage topology its simple circuit structure and lower cost compare to converters the Fuzzy logic and neural networks used for tracking maximum power for pv system and validated accuracy the analysis this the output voltage and input power can be regulated independently and simulation result from a 500w verify.

KEYWORDS: Dc/dc converter, three port ,LLC resonant converter, phase shift, phase frequency modulation

I. INTRODUCTION

Renewable energy sources such as Photo-Voltaic (PV) arrays are increasingly being used in automobiles, residential and commercial buildings. For stand-alone systems energy storage devices are required for backup power and fast dynamic response. A power electronic converter interfaces the sources with the load along with energy storage.
Existing converters for such applications use a common dc-link. High frequency ac-link based systems have recently been explored due to its advantages of reduced part count, reduced size and centralized control. Such a



Block diagram

high frequency ac-link based converter is termed as a multi-port converter in literature, to whose ports are connected the energy sources, energy storage devices and the load. In this chapter an introduction to multi-portconverter is given. This is followed by the context, scope, contributions and organization of this project. Compensation methodology implemented by using high speed power electronic devices is an effective solution for the power quality issues. Dispersion Generation (DG) is becoming popular in distribution system, because of the huge availability of the renewable energy source. It will provide large active power to customers in the remote areas and assist load sharing along with the utility system. Photovoltaic (PV) systems is being increasingly used to tap the huge resource of the sun, will play a key role in future sustainable energy system. They offer consumers the ability to generate electricity in a clean and reliable manner. However, PV can lead to negative effects on the existing power

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systems such voltage variation and harmonics In industrial plants where tripping of critical equipment can result in the stoppage of the whole production with high costs associated. In this case, it is the source that disturbs the load. To avoid consistent financial losses, industrial customers often decide to install mitigation equipment to protect their plants from such disturbances. Another prominent issue is the low quality of the current drawn by the load. In such case, it is the load which disturbs the source. A typical example is current harmonics drawn by disturbing loads like diode rectifiers or unbalanced currents drawn by unbalanced loads.

Customers should not incur in any direct production loss related to the occurrence of these power quality problems. But, poor quality of the current taken by many customers simultaneously will ultimately result in low quality of the power delivered to other customers. Both harmonics and unbalanced currents ultimately cause distortion and unbalance espectively in the voltage as well. Therefore, proper standards are stipulated to limit the quantity of harmonic currents, unbalance and flicker that a load may introduce. To comply with the limits set by standards, customers often have to install mitigation equipment .The present work proposes a combined operation of PV array and - along with Incremental conductance technique. The scope of the PV array is to compensate long voltage interruption and harmonics. The proposed system has the prominent capability of enhancing the quality of voltage and current and will be a highly effective solution for most of the power quality problems. The operation of the proposed system is modelled and simulated using Matlab / Simulink software. The results are presented to show the effectiveness of the proposed PV array system.

II. MODEL SYSTEM

Fuzzy sets were introduced by Zadehin1965 to represent/manipulate data and information possessing no statistical uncertainties. Fuzzy logic provides an inference morphology that enables approximate human reasoning capabilities to be applied to knowledge- based systems. The theory of fuzzy logic provides a mathematical strength to capture the uncertainties associated with human cognitive processes, such as thinking and reasoning. The conventional approaches to knowledge representation lack the means for representation the meaning of fuzzy concepts .As a consequence, the approaches based on first order logic and classical probability theory do not provide an appropriate conceptual framework for dealing with the representation of commonsense knowledge, since such knowledge is by its nature both lexically imprecise and non categorical. The development of fuzzy logic was motivated in large measure by the need for a conceptual frame work which can address the issue of uncertainty and lexical imprecision. Some of the essential characteristics of fuzzy logic relate to the following,

In fuzzy logic, exact reasoning is viewed as a limiting case of approximate reasoning.

In fuzzy logic, everything is a matter of degree.

In fuzzy logic, knowledge is interpreted a collection of elastic or, equivalently, fuzzy constraint on a collection of variables.

Inference is view edasaprocessof propagation of elastic constraints. Any logical system can be fuzzified.

There are two main characteristics of fuzzy systems that give them better performance for specific applications.

Fuzzy systems are suitable for uncertain or approximate reasoning, especially for the system with a mathematical model that is difficult to derive.Fuzzy logical lows decision making with estimated values under incomplete orun-certain information. *Artificial neural systems* can be considered as simplified mathematical models of brain-like systems and they function as parallel distributed computing networks. However, in contrast to conventional computers, which are programmed to perform specific task, most neural networks must be taught , or trained. They can learn new associations, new functional dependencies and new patterns. Perhaps the most important advantage of neural networks is their adaptively. Perhaps the most important advantage of neural networks is their adaptivity. Neural net- works can automatically adjust their weights to optimize their behavior as pattern recognizers, decision makers, system controllers, predictors, etc. Adaptivity allows the neural network to perform well even when the environment or the system being controlled varies over time.

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III. CONTROL STRATEGY OF GRID SIDE CONVERTER

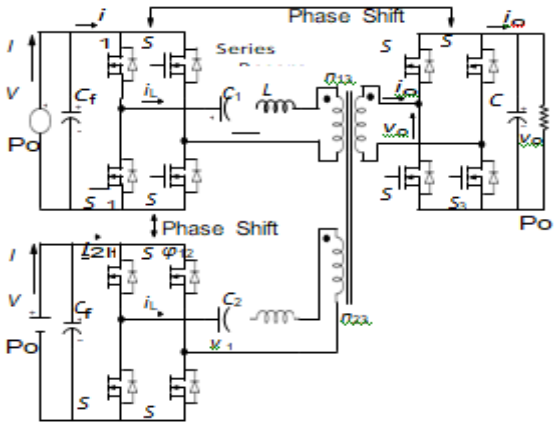

Figure 2 Three-port series resonant converter circuit

Three-port series resonant converter

The proposed three port series resonant converter circuit is shown in Fig 2.2. It has two series resonant tanks formed by L_1, $C_1$and L_2, C_2 respectively. The input filter capacitors for port1 and port2 are C_{f1} and C_{f2} respectively. A constant voltage dc source such as fuel-cell can be connected to port1. Batteries are connected to port2. The switches are realized using MOSFET enabling bidirectional current flow in all ports. The switches operate at 50% duty cycle since square wave outputs are required at the output of the bridges.

Two phase-shift control variables $\varphi_{13}$and $\varphi_{12}$are considered as shown in Fig. 2.2.They control the phase-shift between the square wave outputs of the active bridges. The converter is operated at constant switching frequency F_s above resonant frequency of both resonant tanks. Steady-state operation is analyzed assuming sinusoidal tank currents and voltages due to filtering action of resonant circuits, under high quality factor. The three-winding transformer is mostly a step-up transformer whose winding1 and winding2 leakage inductances come in series with the tank inductances. Winding3 leakage inductance is neglected in the analysis presented in the following sections. The effect of this leakage inductance is discussed in detail in Section 2.5.

IV. TEST SYSTEM MODEL

At any given phase shift angle and switching frequency, the quality factor which is load dependent, decides the voltage gain and peak currents. As an example, for a two- port converter as in Fig. 2.1, the voltage gain is given by (4.4) and the normalized peak current in the resonant tank is given by (4.5). For example, the normalized peak currentnottoexceedavalueof1.0,the lower limit on the quality actor is8.5,calculated from (4.4) and (4.5) at maximum phase-shift angle $\theta = 90^o$. But the voltage gain at this Q is very low. In the prototype the quality factor is chosen as 4.0. The ratio of switching frequency to resonant frequency is chosen as1.1andswitchingfrequencyas 100 *kHz*. Higher quality factor also ensures the validity of sinusoidal approximation in the analysis.

Transformer core area	$A_c = 113mm^2$
Primary side magnetizing inductance L_m	$70\mu H$
Primary side leakage inductance L_{lk1}	$0.6\mu H$
Secondary side leakage inductance L_{lk2}	$0.7\mu H$
Load side leakage inductance L_{lk3}	$2\mu H$
Turns ratio n_{13}	0.25
Turns ratio n_{23}	0.18

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Solar power is the conversion of energy from sunlight into electricity, either directly using photo voltaics (PV),indirectly using concentrated solar power, or a combination. Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaic cells convert light into an electric current using the photovoltaic effect. Photo voltaics were initially solely used as a source of electricity for small and medium-sized applications, from the calculator powered by a single solar cell to remote homes powered by an off-grid rooftop PV system. Commercial concentrated solar power plants were first developed in the 1980s.

V. SIMULATION ANALYSIS AND DISCUSSION

Fuzzy logic and neural networks

Fuzzy set s were introduced by Zadehin 1965 to represent/manipulate data and information possessing no statistical uncertainties. Fuzzy logic provides an inference morphology that enables approximate human reasoning capabilities to be applied to knowledge- based systems. The theory of fuzzy logic provides a mathematical strength to capture the uncertainties associated with human cognitive processes, such as thinking and reasoning. The conventional approaches to knowledge representation lack the means for representation the meaning of fuzzy concepts .As a consequence, the approaches based on first order logic and classical probability theory do not provide an appropriate conceptual framework for dealing with the representation of commonsense knowledge, since such knowledge is by its nature both lexically imprecise and non categorical. The development of fuzzy logic was motivated in large measure by the need for a conceptual frame work which can address the issue of uncertainty and lexical imprecision. Some of the essential characteristics of fuzzy logic relate to the following,

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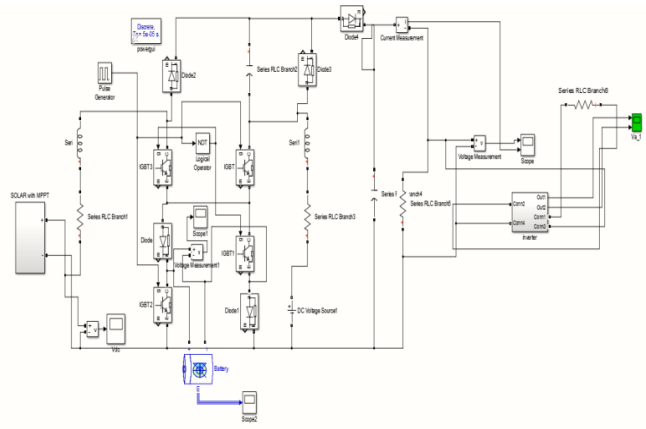
- There are two main characteristics of fuzzy systems that give them better performance for specific applications.
- Fuzzy systems are suitable for uncertain or approximate reasoning, especially for the system with a mathematical model that is difficult to derive. Fuzzy logic allows decision making with estimated values under in complete or un-certain information. *Artificial neural systems* can be considered as simplified mathematical models of brain-like systems and they function as parallel distributed computing networks. However, in contrast to conventional computers, which are programmed to perform specific task ,most neural networks must be taught, ortrained. They can learn new associations, new functional dependencies and new patterns. Perhaps the most important advantage of neural networks is their adaptively. Perhaps the most important advantage of neural networks is their adaptivity. Neural net- works can automatically adjust their weights to optimize their behavior as pattern recognizers, decision makers, system controllers, predictors, etc. Adaptivity allows the neural network to perform well even when the environment or the system being controlled varies over time.

SIMULATION DIAGRAM



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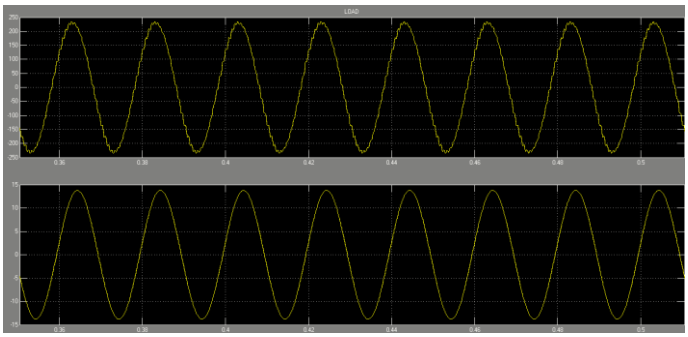
SIMULATION RESULTS



VI. CONCLUSION

An efficient dual input single-resonant LLC converter was proposed in this paper to interface with PV and Battery Source .this cost effective topology allows the two source share the same resonant circuit components .ZVS is achieved in two switches and voltage stress across the switches is low and does not exceed the input PV voltage . the PWM phase shift control was employed to source different amount of power from PV panel and battery when implementing MPPT . the effectiveness is verified by phase shift control on DC gain and power contribution of each source . the advantage of this topology is its simpler circuit structure and lower cost compared to two single – input converters. A 500 prototype was implemented in converter when implementing independent MPPT for each source.

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