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# Survey Paper on Power Quality Grid-Connected Dual Voltage Source Inverter

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***Abstract*— This project presents a dual voltage source inverter (DVSI) scheme to enhance the power quality and reliability of the microgrid system. The proposed scheme is comprised of two inverters, which enables the microgrid to exchange power generated by the distributed energy resources (DERs) and also to compensate the local unbalanced and nonlinear load. The proposed scheme has increased reliability, lower bandwidth requirement of the main inverter, lower cost due to reduction in filter size, and better utilization of microgrid power while using reduced dc-link voltage rating for the main inverter.**

**Keywords— Microgrid, Voltage source inverter, Power quality improvement**

## I. INTRODUCTION

The integration of renewable energy into existing power system presents technical challenges and that requires consideration of voltage regulation, stability, power quality problems [14]. The power quality is an essential customer focused measure and it's greatly affected by the operation of a distribution and transmission network. Nowadays, generation of electricity from renewable sources has improved very much. Since most renewable energy sources are intermittent in nature, it is a challenging task to integrate a significant portion of renewable energy resources into the power grid infrastructure. Traditional electricity grid was designed to transmit and distribute electricity generated by large conventional power plants. The electricity flow mainly takes place in one direction from the centralized plants to consumers. In contrast to large power plants, renewable energy plants have less capacity, and are installed in a more distributed manner at different locations. The integration of distributed renewable energy generators has great impacts on the operation of the grid and calls for new grid infrastructure. UPQC was widely studied by many researchers as an eventual method to improve power quality in distribution system. With expansion in the interest for Electricity because of expansion in populace and industrialization, the Generation of power was truly a test now a day. In the event that we need to expand the power produced in the customary path1,2 i.e., by method for non-renewable vitality sources like coal, diesel, normal gasses and comparative fossil energizes, the contamination builds which debases the Environment and human way of life. The reasons for power quality issues are by and large mind boggling and hard to identify when we coordinate a wind turbine to the network. Therefore, the power electronic based forced commutated converters are preferred in distribution systems for maintenance of system stability, reliability and quality of power as the point of common coupling. A shunt device is a compensating device i.e. which is connected between the grid connected point called as Power Control Center (PCC) and the ground. Shunt device either can absorb or generate the reactive power for controlling the magnitude of voltage at point of common coupling. The reactive power compensation is also one of the applications of shunt converter devices4. Figure 1 shows the basic diagram for the shunt connected inverter based grid connected system. The UPQC is controlled to regulate the WF terminal voltage, and to mitigate voltage fluctuations at the point of common coupling (PCC), caused by system load changes and pulsating WF generated power, respectively. The voltage regulation at WF terminal is conducted using the UPQC series converter, by voltage injection "in phase" with PCC voltage. On the other hand, the shunt converter is used to filter the WF generated power to prevent voltage fluctuations, requiring active and reactive power handling capability. The sharing of active power b
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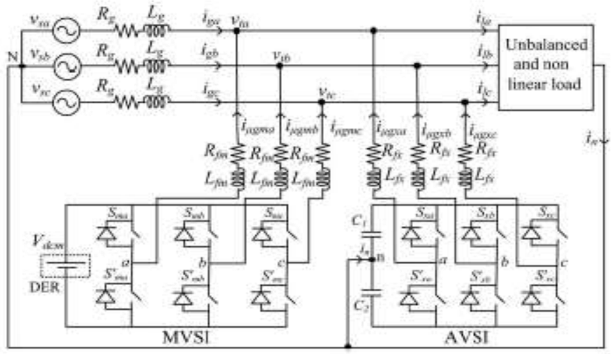

Figure 1: Circuit diagram of a DVSI scheme

## II. LIITERATURE REVIEW

Nabae et al (2013) and Bhagwat and Stefanovic (2000) presented the general idea behind the multilevel converter technology is to create a sinusoidal output voltage from several small voltage steps (Nabae et al 1999) There are several advantages to this approach when compared with traditional two-level converters. Traditional 2-level high-frequency pulse width modulation (PWM) inverters for motor drives have several problems associated with high frequency switching, which produce common-mode voltages and high voltage change(dv dt) rates to the motor windings. The smaller voltage steps lead to the production of higher quality waveforms (therefore a multilevel converter distinguishes itself by being the converter with the lowest demands on the input filters) and also reduce the (dv dt) stresses; the series-type connection of the semiconductors allows operation at higher voltages. Brumsickle et al (2014) stated that the switching frequency of the multilevel converter could be reduced to 25% of the switching frequency of a two level converter. These converters recently have found many applications in the medium and high power applications. Large electric drives will require advanced power electronics inverters to meet the high power demands (1>MW) required of them. Advantages of this multilevel approach include good power quality, good electromagnetic compatibility (EMC), low switching losses, and high voltage capability. One clear disadvantage of multilevel power conversion is stated by Stemmler et al (2012), and Kawabatta (2011) is the larger number of semiconductor switches required, 35 however lower voltage rated switches can be used and the active semiconductor cost is not significantly increased when compared with the two level case. The most commonly reported disadvantage of the multilevel converters is that, a larger number of switching semiconductors are required for lower-voltage systems and the small voltage steps must be supplied on the DC side either by a capacitor bank or isolated voltage topologies. When isolated voltage sources are not available, series capacitors require voltage balance. According to Strzelecki et al (2015), for three level converters this problem is not very serious because the voltage balancing can be overcome by using redundant switching states, which exist due to the high number of semiconductor devices. Diode-clamped multilevel inverters are very similar to the conventional back-to-back voltage source inverters. Even though having a larger number of switches it should be pointed out that in a three level converter the voltage rating of the transistors is half that of the transistors in a two level converter. Furthermore, the switching losses, which are reduced by the lower transistor blocking voltage and increased by the higher number of transistors, for this converter will be lower than that of a two level converter. Additionally, it should be noted that each transistor switches only during a portion of the network period, which again reduces the switching losses. Grzegorz Benysek (2015) stated that for three level converters maintaining voltage balance on the capacitors can be accomplished through selection of the redundant switching states which lead to the same output voltages, but yield different capacitor currents. In this thesis a three level, three phase diode clamped converter has been developed and its performance is compared with the performance of the two levels, three phase voltage source inverter for both simulation and hardware.

The existing method describes the power quality is an important aspect which has to be addressed while the microgrid system is connected to the main grid Load compensation and power injection using grid interactive inverters in microgrid have been presented in the literature single inverter system with power quality enhancement is discussed. The main focus of this work is to realize dual functionalities in an inverter that would provide the active power injection from a solar PV system and also works as an active power filter, compensating unbalances and the reactive power required by other loads connected to the system.

## III. VOLTAGE SOURCE INVERTER

The main objective of static power converters is to produce an ac output waveform from a dc power supply. These are the types of waveforms required in adjustable speed drives (ASDs), uninterruptible power supplies (UPS), static var compensators, active filters, flexible ac transmission systems (FACTS), and voltage compensators, which are only a few applications. For sinusoidal ac outputs, the magnitude, frequency, and phase should be controllable. For instance, the ac output voltage produced by the VSI of a standard ASD is a three-level waveform. Although this waveform is not sinusoidal as expected its fundamental component behaves as such. This behavior should be ensured by a modulating technique that controls the amount of time and the sequence used to switch the power valves on and off. The modulating techniques most used are the carrier-based technique (e.g., sinusoidal pulse width modulation, SPWM), the space-vector (SV) technique, and the selective-harmonic-elimination (SHE) technique.

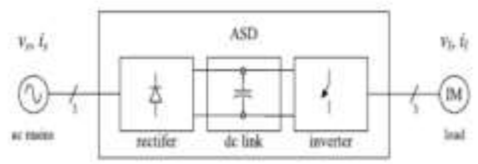

Figure 2: The ac output voltage produced by the VSI of a standard ASD

Simulation has become a very powerful tool for industrial application as well as in academics, nowadays. It is now essential for an electrical engineer to understand the concept of simulation to study the system or circuit behavior without damaging it. The tools for doing the simulation in various fields are available in the market for engineering professionals. Many industries are spending a considerable amount of time and money in doing simulation before manufacturing their product. In most of the research and development (R&D) work, the simulation plays a very important role. Without simulation it is quiet impossible to proceed further.

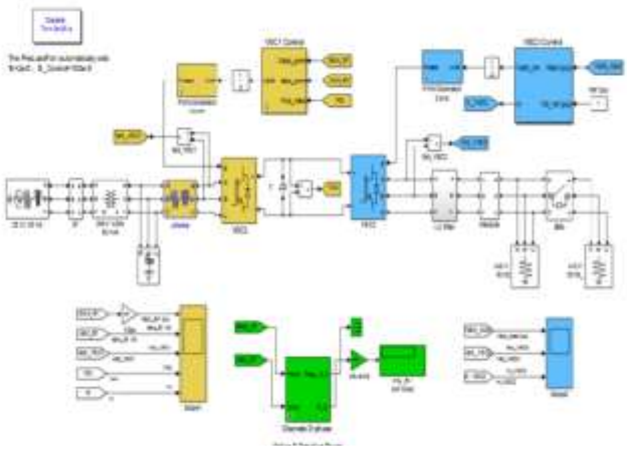

Figure 3: Simulink Result of VSI

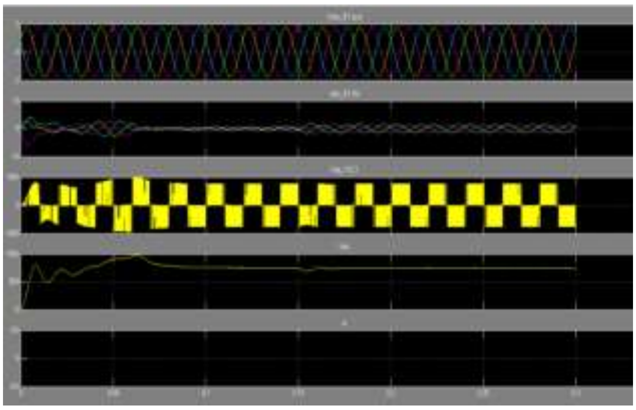

Figure 4: Scope 1 Output Waveform

## IV. PROPOSED METHODOLOGY

This paper also presents a new nine level inverter topology for UPQC application and is shown in Fig.6 and Fig. 7. To achieve the 9-level, the traditional cascaded inverter topologies need 20 power switches and 24 switches in diode clamped arrangement. But, the proposed nine level inverter has only seven IGBT switches in the power circuit. Input Vdc is divided into four levels using DC link capacitors of each Vdc/4 magnitudes. Four identical reference signals that are identical to each other with an offset that is equivalent to the amplitude of the triangular carrier signal were used to generate the PWM signals from the DC supply voltage. The operation of nine level inverter topology switching sequences is presented.

The proposed method describes a voltage regulation and power flow control scheme for a wind energy system (WES) is proposed. A distribution static compensator (DSTATCOM) is utilized for voltage regulation and also for active power injection. The control scheme maintains the power balance at the grid terminal during the wind variations using sliding mode control This paper demonstrates a dual voltage source inverter (DVSI) scheme, in which the power generated by the microgrid is injected as real power by the main voltage source inverter (MVSI) and the reactive, harmonic, and unbalanced load compensation is performed by auxiliary voltage source inverter (AVSI).

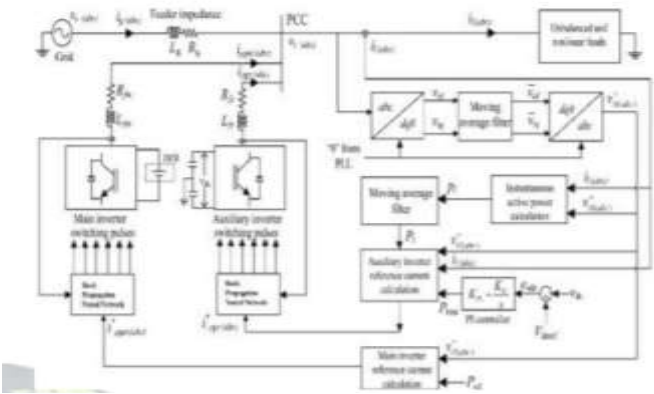


Figure 5: Functional Block Diagram of BPNN DVSI

Back Propagation Neural Network controller:

The reference current and the actual current from the inverter circuit is compared with each other is given into the neural network controller. The controller is responsible to create the gate pulses for the both inverters. A back-propagation neural network is only practical in certain situations.

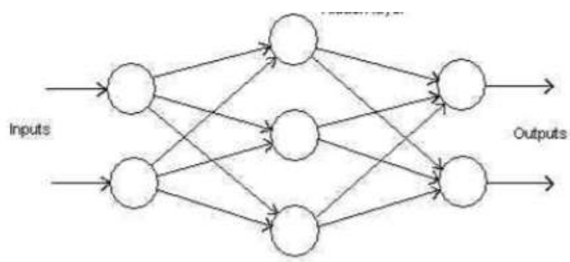

Figure 6: Structure of BPNN

Following are some guidelines on when you should use another approach:

• A large amount of input/output data is available, but you're not sure how to relate it to the output.

• The problem appears to have overwhelming complexity, but there is clearly a solution

## V. CONCLUSION

A BPNN based DVSI scheme is proposed for microgrid systems with enhanced power quality. Control algorithms are developed to generate reference currents for DVSI using ISCT. The proposed scheme has the capability to exchange power from distributed generators (DGs) and also to compensate the local unbalanced and nonlinear load. The performance of the proposed scheme has been validated through simulation and experiment al studies. As compared to a single inverter with multifunctional capabilities, a BPNN many advantages such as, increased reliability, cost due to the reduction in filter size, and more utilization of inverter capacity to inject real power from DGs to microgrid.

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