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Improve Power Quality of Microgrid using Dual Voltage converters

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ABSTRACT—*This paper presents a dual voltage source converter 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 control algorithms are developed based on instantaneous symmetrical component theory (ISCT) to operate DVSI in grid sharing and grid injecting modes. 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. These features make the DVSI scheme a promising option for microgrid supplying sensitive loads. The topology and control algorithm are validated through extensive simulation and experimental results.*

***Index Terms*—**Grid-connected inverter, instantaneous symmetrical component theory (ISCT), microgrid, power quality.

I.INTRODUCTION:

Technological progress and environmental concerns drive the power system to a paradigm shift with more renewable energy sources integrated to the network by means of distributed generation (DG). These DG units with coordinated control of local generation and storage facilities form a microgrid [1]. In a microgrid, power from different renewable energy sources such as fuel cells, photovoltaic (PV) systems, and wind energy systems are interfaced to grid and loads using power electronic converters. A grid interactive inverter plays an important role in exchanging power from the microgrid to the grid and the connected load [2], [3]. This microgrid inverter can either work in a grid sharing mode while supplying a part of local load or in grid injecting mode, by injecting power to the main grid. Maintaining power quality is another important aspect which has to be addressed while the microgrid system is connected to the main grid. The proliferation of power electronics devices and electrical loads with unbalanced nonlinear currents has degraded the power quality in the power distribution network. Moreover, if there is a considerable amount of feeder impedance in the distribution systems, the propagation of these harmonic currents distorts the voltage at the point of common coupling (PCC). At the same instant, industry automation has reached to a very high level of sophistication, where plants like automobile manufacturing units, and semiconductor industries require clean power. For these applications, it is essential to compensate nonlinear and unbalanced load currents [4].

II. LITERATURE SURVEY:

Load compensation and power injection using grid interactive inverters in microgrid have been presented in the literature [5], [6]. A single inverter system with power quality enhancement

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is discussed in [7]. 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. In [8], 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. A multifunctional power electronic converter for the DG power system is described in. This scheme has the capability to inject power generated by WES and also to perform as a harmonic compensator. Most of the reported literature in this area discuss the topologies and control algorithms to provide load compensation capability in the same inverter in addition to their active power injection. When a grid-connected inverter is used for active power injection as well as for load compensation, the inverter capacity that can be utilized for achieving the second objective is decided by the available instantaneous microgrid real power. Considering the case of a grid-connected PV inverter, the available capacity of the inverter to supply the reactive power becomes less during the maximum solar insolation periods. At the same instant, the reactive power to regulate the PCC voltage is very much needed during this period. It indicates that providing multi functionalities in a single inverter degrades either the real power injection or the load compensation capabilities.

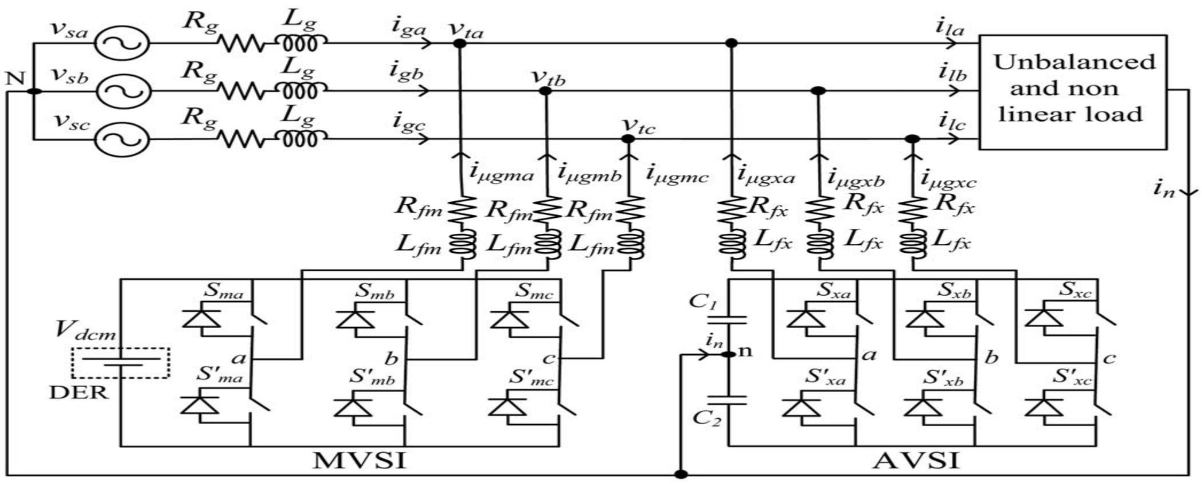

Fig. 1. Topology of proposed DVSI scheme.

III. DUAL VOLTAGE SOURCE INVERTER:

The proposed DVSI topology is shown in Fig. 1. It consists of a neutral point clamped (NPC) inverter to realize AVSI and a three-leg inverter for MVSI [18]. These are connected to grid at the PCC and supplying a nonlinear and unbalanced load. The function of the AVSI is to compensate the reactive, harmonics, and unbalance components in load currents. Here, load currents in three phases are represented by *ila*, *ilb*, and *ilc*, respectively. Also, *ig*(*abc*), *iμgm*(*abc*), and *iμgx*(*abc*) show grid currents, MVSI currents, and AVSI currents in three

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phases, respectively. The dc link of the AVSI utilizes a split capacitor topology, with two capacitors *C*1 and *C*2. The MVSI delivers the available power at distributed energy resource (DER) to grid. The DER can be a dc source or an ac source with rectifier coupled to dc link. Usually, renewable energy sources like fuel cell and PV generate power at variable low dc voltage, while the variable speed wind turbines generate power at variable ac voltage. Therefore, the power generated from these sources use a power conditioning stage before it is connected to the input of MVSI. In this study, DER is being represented as a dc source.

Values of dc capacitors of AVSI are chosen based on the change in dc-link voltage during transients. Let total load rating is *S* kVA. In the worst case, the load power may vary from minimum to maximum, i.e., from 0 to *S* kVA. AVSI needs to exchange real power during transient to maintain the load power demand. This transfer of real power during the transient will result in deviation of capacitor voltage from its reference value. Assume that the voltage controller takes *n* cycles, i.e., *nT* seconds to act, where *T* is the system time period. Hence, maximum energy exchange by AVSI during transient will be *nST*.

Advantages of DVSI scheme is Increased Reliability, reduction of filter size, improved flexibility, better utilization of microgrid power, reduced DC link voltage

IV SIMULATION RESULTS:

Proposed power system network with dual voltage source converters are shown in figure.2.

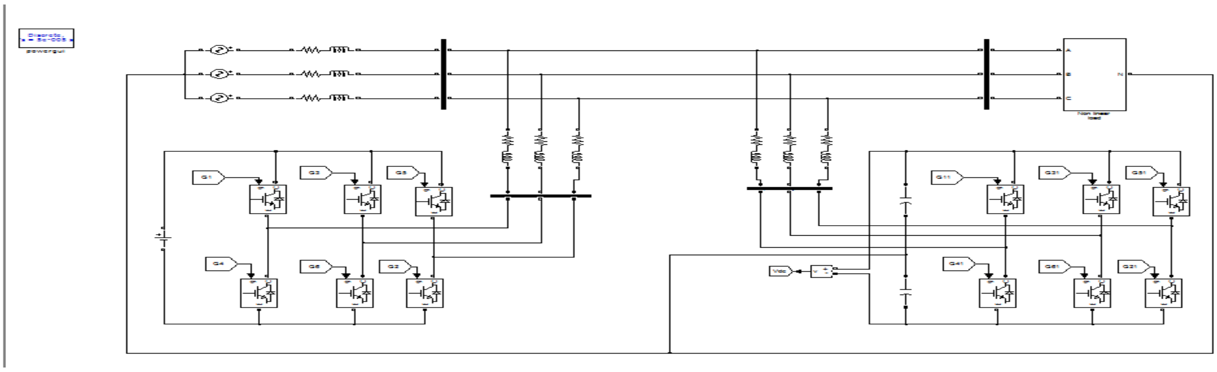

Fig.2. MATLAB Simlink model

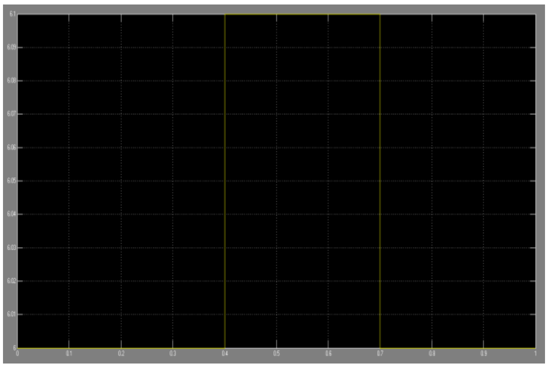

Fig.1.load active power

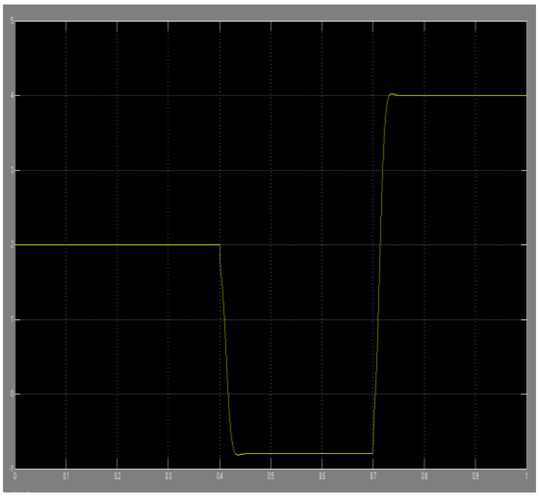

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Fig.2. Active power supplied by grid

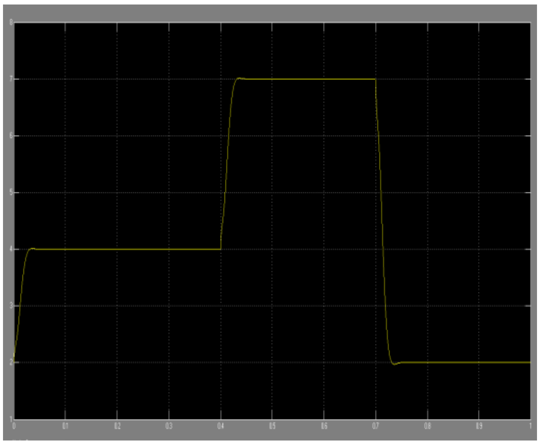

Fig.3. active power supplied by MVSI;

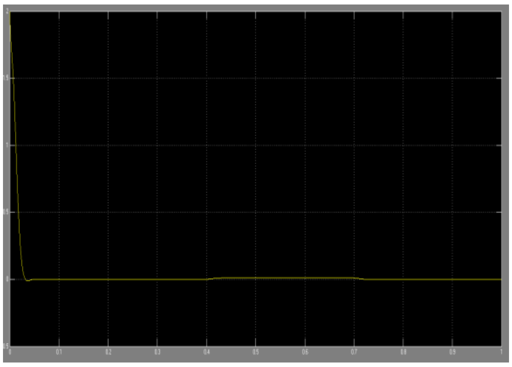

Fig.4. active power supplied by AVSI.

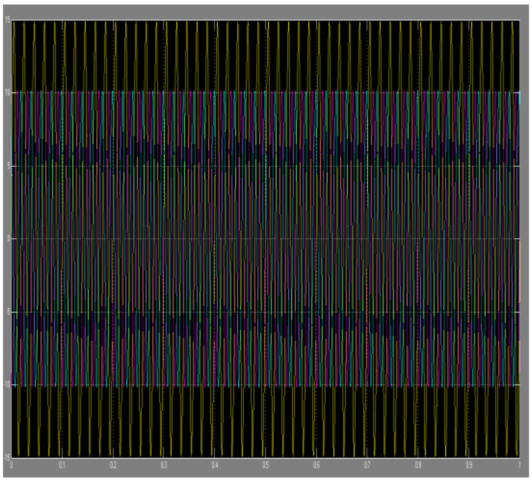

Fig.5. load currents

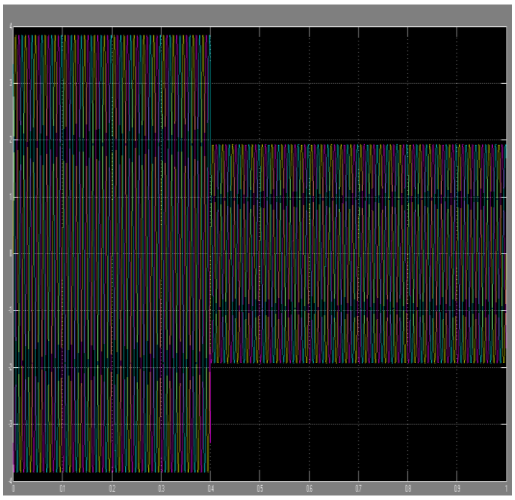

Fig 6. grid currents

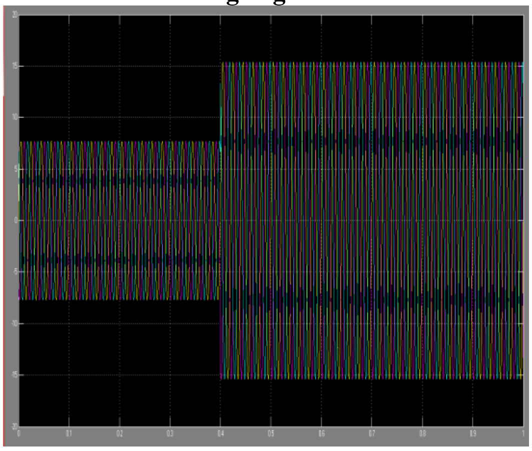

Fig.7. MVSI currents

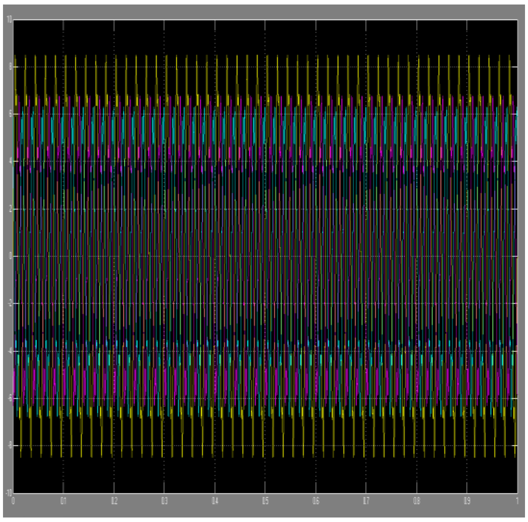

Fig.8. AVSI currents

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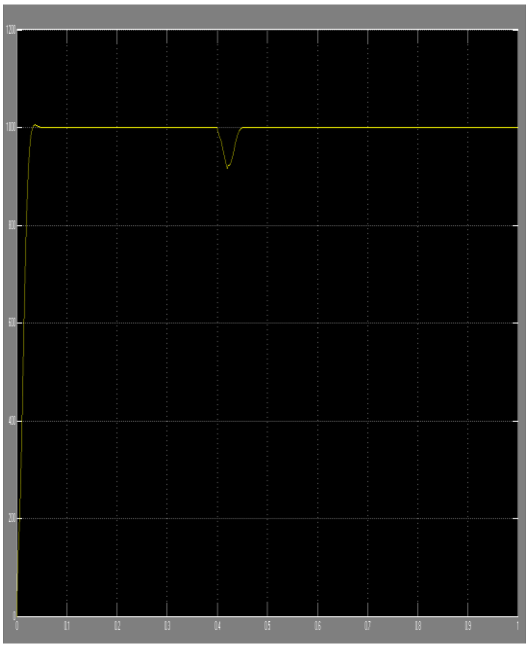

Fig.9. DC Link voltage

V. CONCLUSION:

Voltage Source Converter scheme is proposed for microgrid systems with enhanced power quality. Control algorithms are developed to generate reference currents for Dual converters 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 experimental studies. As compared to a single inverter with multifunctional capabilities, a VSI has many advantages such as, increased reliability, lower cost due to the reduction in filter size, and more utilization of inverter capacity to inject real power from DGs to microgrid. Moreover, the use of three-phase, three wire topology for the main inverter reduces the dc-link voltage requirement. Thus, a Dual VSI scheme is a suitable interfacing option for microgrid supplying sensitive loads.

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