

Enhancement of Power Quality in Grid Connected System with Series and Shunt Compensation Technique

K.Surendhirababu¹, P.Rekha²Asst. Prof, Department of Electrical and Electronic Engineering, Ramapuram Campus, SRM University, Chennai,
Tamilnadu, India ¹PG Scholar, Department of Electrical and Electronic Engineering, Ramapuram Campus, SRM University, Chennai,
Tamilnadu, India²

ABSTRACT: 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. 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. This paper demonstrates a series and shunt voltage source inverter scheme, in which the power generated by the microgrid is injected as real power by the series voltage source inverter and the reactive, harmonic, and unbalanced load compensation is performed by shunt voltage source inverter. This has an advantage that the rated capacity of series voltage source inverter can always be used to inject real power to the grid, if sufficient renewable power is available at the DC link. In the series and shunt voltage source inverter scheme, as total load power is supplied by two inverters, power losses across the semiconductor switches of each inverter are reduced.

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 path 1,2 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

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

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 ground³. 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 application 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 between converters are managed through the common DC link. Simulations were carried out to demonstrate the effectiveness of the proposed compensation approach.

This paper presents a three-phase four-wire grid-interfacing power quality compensator for micro grid applications [1]. The compensator is proposed for use with each individual distributed generation (DG) system in the micro grid and consists of two four-phase-leg inverters (a shunt and a series). This paper presents a novel control strategy for achieving maximum benefits from these grid interfacing inverters when installed in 3-phase 4-wire distribution systems [2]. The inverter can thus be utilized as power converter to inject power generated from RES to the grid, and shunt APF to compensate current unbalance, load current harmonics, load reactive power demand and load neutral current. Due to its reduced communication overhead and robustness to failures, distributed energy management is of paramount importance in smart grids, especially in microgrids, which feature distributed generation (DG) and distributed storage (DS) [5]. The approach involves the actual renewable energy as well as the energy traded with the main grid, so that the supply– demand balance is maintained.

II. METHODOLOGY

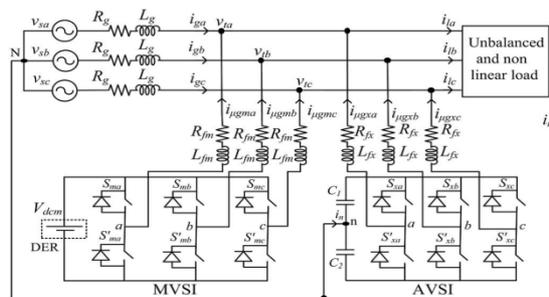


Fig. 1 Proposed Circuit Diagram

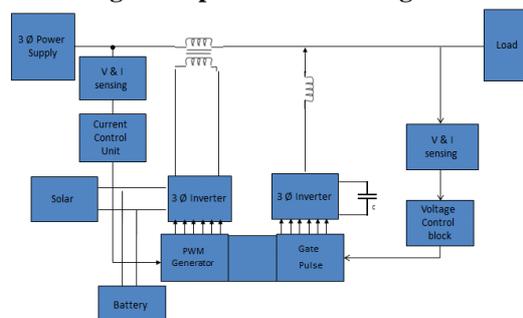


Fig. 2 Proposed Block Diagram

GRID

A Power from the different generating sources are interconnected with the grid. Four phase four wire grid interface with the dual voltage source inverter(VSI).

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

DISTRIBUTION TRANSFORMER

Distribution transformer are used for lower voltage distribution networks to end user connectivity. (11kv,6.6kv,3.3kv,440V,230V) and generally rated as less than 200MVA.

PWM CONTROL

Independent control of converters on either side of DC-link.

HYSTERESIS CONTROL

It reduce the transmission line losses and also reduce the eddy current losses.

3PHASE & 1 PHASE

Grid interfacing inverter to improve the quality of power at point of common coupling for a 3 phase 4 wire distribution generation system.

LOAD

Load which tap the energy from the network(eg: Motor.)

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.

III. PROPOSED SYSTEM

The quality of the power leads to a direct economic impact on utilities, their customers, and suppliers. Custom power devices including power electronic interface can be the effective solution for increasing power quality problems because they can provide fast response and flexible compensation. In this paper UPQC and hybrid power generation combined system has been presented as shown in Fig. 1. The advantage of proposed combined system is voltage interruption compensation and active power injection to grid in addition to the mentioned abilities. Also this proposed system has higher efficiency and functioning ability in compare with other common PVs and WECS also cause reduction in system total cost. In this strategy both load voltage and source current sensing is required for compensate current harmonics and source voltage interruption simultaneously.

Normally, UPQC has two voltage source inverters in three phase four wire or three phase three wire configuration. One inverter is called series inverter is connected through transformers between the source and the common connection point. The other inverter called shunt inverter is connected in parallel with the common connection point through transformers. The series inverter operates as voltage source, while the shunt inverter operates as a current source. UPQC has compensation capabilities for the harmonic current, reactive power compensation, the voltage disturbances, and the power flow control. But UPQC has no capability in compensating the voltage interruption because there is no energy storage. This paper proposes a new configuration of UPQC that has DG connected to the dc link through the rectifier. The UPQC can compensate the voltage interruption in the source, while the DG supplies power to the source and load or load only. There are two operating modes in the proposed system. One is called the interconnected mode, in which the DG provides power to the source and the load. The other is called islanding mode, in which the distributed generation provides power to the load within its power rating.

IV. RESULTS AND DISCUSSION

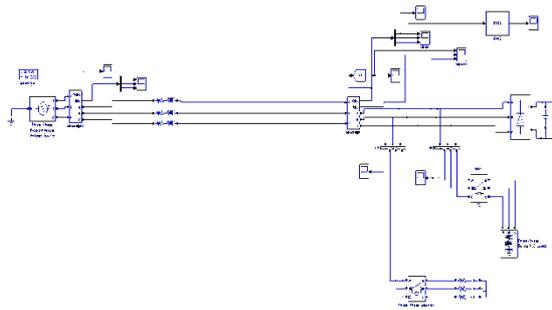


Fig. 3 Without compensation system

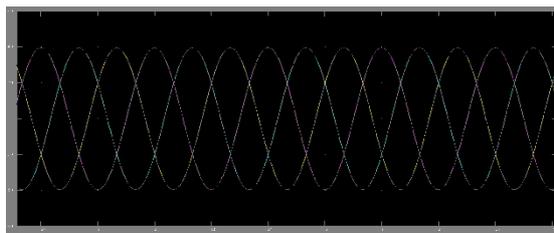


Fig. 4 Input Voltage

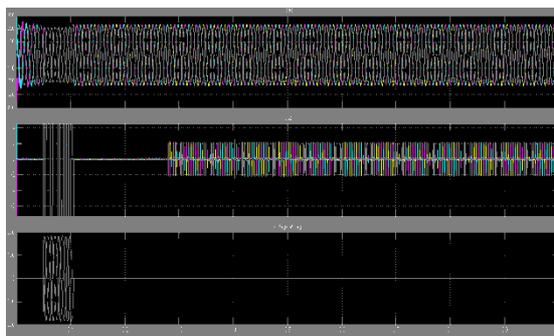


Fig. 5 Output Waveform

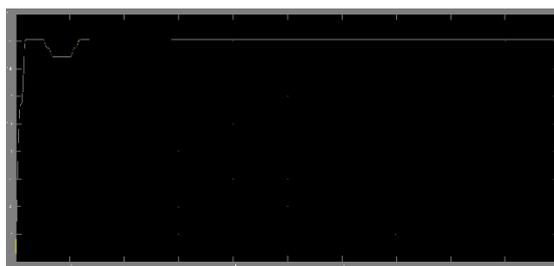


Fig. 6 Distortion in RMS value

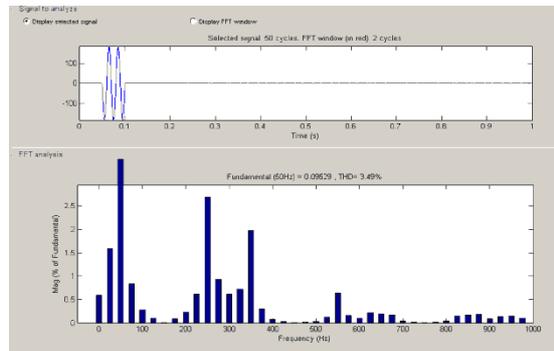


Fig. 7 THD Value

Proposed simulation

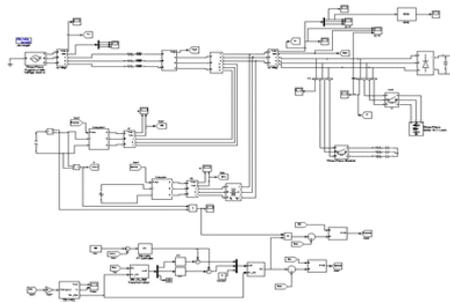


Fig. 8 Proposed Simulink diagram

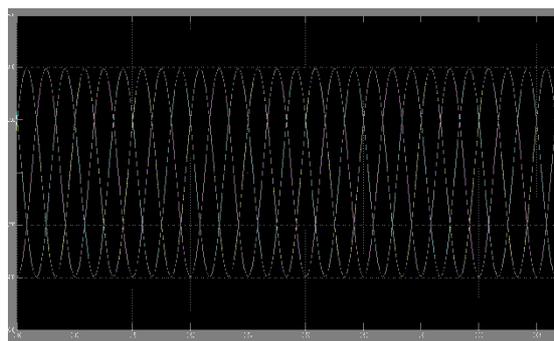


Fig. 9 Proposed Input Voltage

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

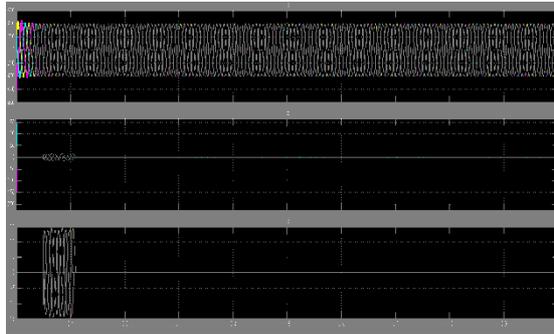


Fig. 10 Proposed Output Waveforms

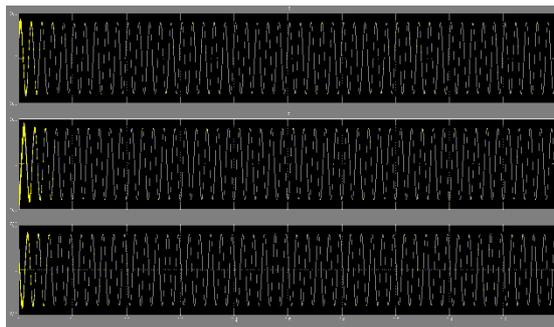


Fig. 11 Proposed Output Voltage

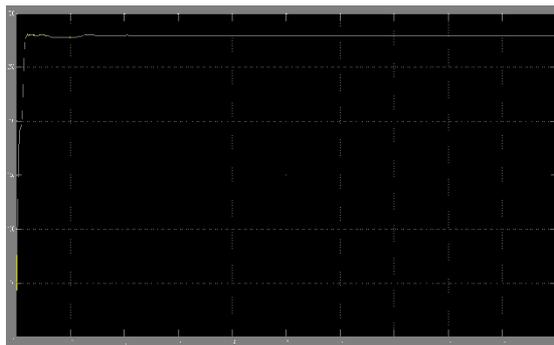


Fig. 12 Proposed Distortion in RMS value

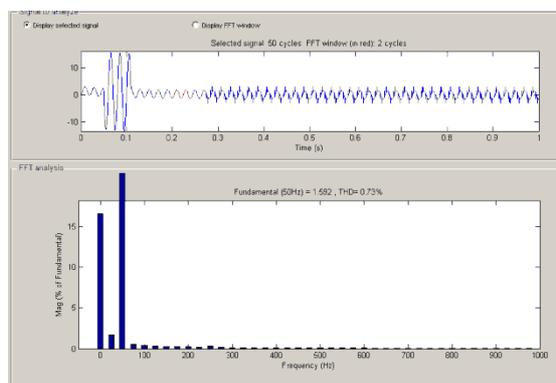


Fig. 13 Proposed THD Value

V. CONCLUSION

A 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 experimental studies. As compared to a single inverter with multifunctional capabilities, a DVSI 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 DVSI scheme is a suitable interfacing option for microgrid supplying sensitive loads. The shunt devices proposed here, while reducing the distortions in currents, improved the power factor thus reducing the reactive power demand from the wind generator and the load at point of common coupling. Thus, the integration of FACTS devices maintains the desired power quality requirements. The operation of STATCOM and the TSC and their control strategies are simulated in MATLAB/SIMULINK. The use of STATCOM, as a shunt controller, gives better results than by TSC.

In this project the power from the grid which the power quality is improved by using DVSI and reduce the harmonics and eliminate the losses in the line. The voltage is developed in the system by using PWM technique. The developed voltage is nonlinear or unbalance in the three phase line so this nonlinear condition is balanced or controlled by using any other techniques.

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ISSN(Online) : 2319-8753
ISSN (Print) : 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

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