International Conference on Latest Research in Engineering Science

12 & 13 August 2017

www.ijrugc.org/Conference

A UNIFIED CONTROL STRATEGY THAT ENABLES BOTH ISLANDED AND GRID-TIED OPERATIONS OF THREE-PHASE INVERTER IN DISTRIBUTED GENERATION

MR. T. VENKATESHWARLU

Assistant Professor, Dept of EEE, Sri Sai Educational Society's Group of Institutions, Ramapuram, Kodad.

ABSTRACT

This paper presents a unified control strategy that enables both islanded and grid-tied operations of three-phase inverter in distributed generation, with no need for switching between two corresponding controllers or critical islanding detection. The proposed control strategy composes of an inner inductor current loop, and a novel voltage loop in the synchronous reference frame. The inverter is regulated as a current source just by the inner inductor current loop in grid-tied operation, and the voltage controller is automatically activated to regulate the load voltage upon the occurrence of islanding. Furthermore, the waveforms of the grid current in the grid-tied mode and the load voltage in the islanding mode are distorted under nonlinear local load with the conventional strategy. In extension we proposed optimized modulation patterns which offer controlled harmonic immunity between the ac and dc side. The application focuses on the conventional two-level converter when its dc-link voltage contains a mix of low-frequency harmonic components. Simulation results are presented to confirm the validity of the proposed switching patterns.

Index Terms: Distributed generation (DG), islanding, load current, seamless transfer, three-phase inverter, unified control.

I.INTRODUCTION

In contemporary world interconnection of distributed generations (DG) which operate in parallel with electrical power networks, is currently changing the paradigm we are used to live with. Distributed generation is gaining worldwide interest because of environmental issues and rising in energy prices and power plant construction costs. Distributed generations are relatively small and many of them make use of renewable energy such as fuel cells, gas turbines, micro-hydro, wind turbines and photovoltaic. Many DGs use power electronic inverters, instead of rotating generators. The inverters typically have fast current limiting functions for self-protection, and may not be damaged by out-of-phase reclosing. The operation of distributed generation will enhance the power quality in power system and this interconnection especially with reverse power flow may lead to some problems like voltage and frequency deviation, harmonics, reliability of the power system and islanding phenomenon. Islanding is one of the most technical concerns associated with the proliferation of distributed generation connected to utility networks. Islanding can be defined as a condition in which a portion of the utility system contains both load and distributed generation remains energized while being isolated from the remainder of the utility system. Islanding detection is a mandatory feature for grid-connected inverters as specified in international standards and guidelines. Inverters usually operate with current control and unity power factor and employ passive monitoring for islanding detection methods based on locally measured parameters. Under islanding conditions, the magnitude and frequency of the voltage at the point of common coupling (PCC) tend to drift from the rated grid values as a function of the power imbalance (ΔP and ΔQ). As it is known that distribution system does not have any active power generating source and does not receive power in case of a fault in transmission line.

However, with Distributed Generation this presumption is no longer valid. In current practice DG is required to disconnect the utilities from the grid in case of islanding. The main issues about islanding are:

1) Safety issues since a portion of the system remains energized while it is not expected.

2) Islanded system may be inadequately grounded by the DG interconnection.

3) Instantaneous reclosing could cause out of phase in the system.

4) Loss of control over voltage and frequency in the system.

5) Excessive transient stresses upon reconnection to the grid.

6) Uncoordinated protection.

The strategy of islanding detection is to monitor the DG output parameters for the system and based on the measurements decide whether an islanding situation has occurred from monitoring of these parameters. Islanding detection techniques can be divided into remote and local techniques.

1) Passive Methods

The idea of passive method is to measure system parameters such as variations in voltage, frequency, harmonic distortion etc. based upon the thresholds set for these parameters if these parameters has exceeds more that it is normal rate Islanding can be detected. This method is fast to detect the islanding. But it has large non detection zone and it need special care to set the thresholds for it is parameters. Passive method can classified into:

· Rate of change of output power
· Rate of change of frequency
· Rate of change of frequency over power
· Change of impedance
· Voltage unbalance
· Harmonic distortion

2) Active Methods

Active method tries to overcome the shortcomings of passive methods by introducing perturbations in the inverter output. Active method can detect the islanding even under the perfect match of generation and load, which is not possible in case of the passive detection schemes but it caused degradation of power quality. Active method can be classified into:

· Reactive power export error detection

· Impedance measurement method

· Phase (or frequency) shift methods

· Active Frequency Drift

· Active Frequency Drift with Positive Feedback Method

· Adaptive Logic Phase Shift

· Current injection with positive feedback

3) Hybrid Methods

Hybrid method based on implementing of two assortment of active and passive method. The active technique is implemented only when the islanding is suspected by the passive technique. It can be classified into:

· Technique based on voltage and reactive power shift

· Technique based on positive feedback and voltage imbalance

In general, once the main grid source supply is lost the DG has to take charge of the remaining network and the connected loads. Therefore, the loading condition of the DG is suddenly changed after islanding. Since the distribution networks generally include single-phase loads, it will be highly possible that the islanding changes the load balance of DG. Additionally, different loading conditions might result in different harmonic currents in the network since the amount and configuration of the load are changed. Therefore, this paper proposes hybrid detection techniques which use active and passive detection techniques. Active detection scheme disturbs the system and causes it to go out of it is boundaries by using Positive feedback and Continuous feedback signal injection based on DQ implementation.

Passive detection scheme, on the other hand, monitors parameters for detecting the islanding operations of DG: voltage unbalance, frequency, active and reactive power along with total harmonic distortion (THD). The proposed method utilizes not only two new monitoring parameters but also incorporates voltage magnitude in the conventional islanding detection techniques. The method monitors the changes in four parameters and diagnoses the operating conditions of DG by using different loading conditions, which are the combination of resistance, inductive and capacitive loads connected in parallel.

III. PRINICIPLE AND OPERATION OF THE SYSTEM

Islanding is a condition in which a micro-grid or a portion of the power grid, which contains both load and distributed generation (DG), is isolated from the remainder of the utility system and continues to operate. With the increasing competition among the power companies to secure more and more customers, the pressure to maintain a high degree of uninterrupted power service quality and reliability is felt by the utility companies.

Thus, in a deregulated market environment, current practices of disconnecting the DG following a disturbance will no longer be a practical or reliable solution. As a result, the IEEE Std. 1547-2003 states, as one of its tasks for future consideration, the implementation of intentional islanding of DGs. During the grid-connected operation, each DG system is usually operated to provide or inject preset power to the grid, which is the

International Conference on Latest Research in Engineering Science
12 & 13 August 2017
www.ijrugc.org/Conference

current control mode in stiff synchronization with the grid. When the micro-grid is cut off from the main grid (intentional-islanding operation), each DG system has to detect this islanding situation and has to be switched to a voltage control mode to provide constant voltage to the local sensitive Loads.

This paper describes a control strategy that is used to implement grid-connected and intentional-islanding operations of micro grids. The described method proposes two control algorithms, namely, one for grid-connected operations and the other for intentional-islanding operations.

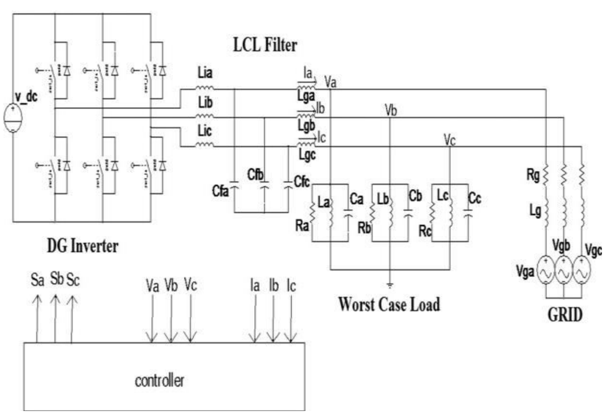


Fig 1. Schematic Diagram of the Grid-Connected Inverter System

III. CONTROLLER

Fig. shows the main circuit topology. This system consists of the micro source that is represented by the dc source, the conversion unit which performs the interface function between the dc bus and the three-phase ac world, and the LCL filter that transports and distributes the energy to the end use and the load. The controller presented provides a constant DG output and maintains the voltage at the point of common coupling (PCC) before and after the grid is disconnected.

Under normal operation, each DG system in the micro-grid usually works in a constant current control mode in order to provide a preset power to the main grid. When the micro-grid is cut off from the main grid, each DG inverter system must detect this islanding situation and must switch to a voltage control mode. In this mode, the micro-grid will provide a constant voltage to the local load.

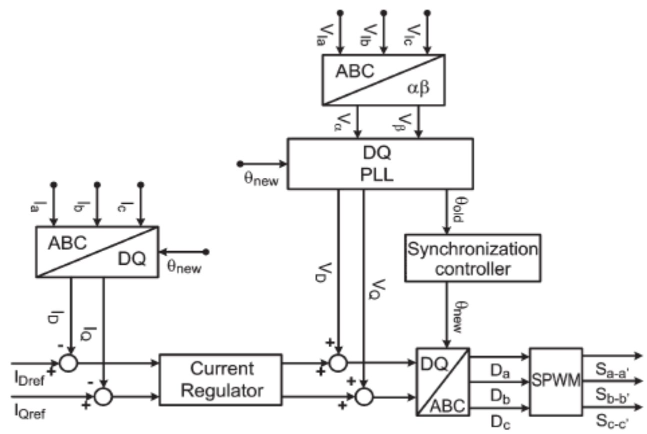


Fig.2. Block Diagram of the Current Controller

SIMULATION CIRCUITS AND WAVEFORMS

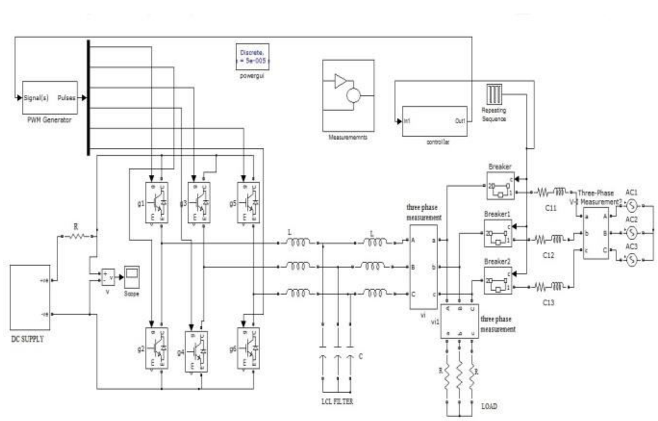


Fig. 3. Simulation Diagram of Voltage and Current Control Method

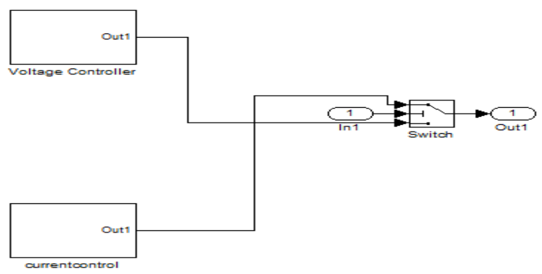


Fig.4. Inner Circuit of Controller

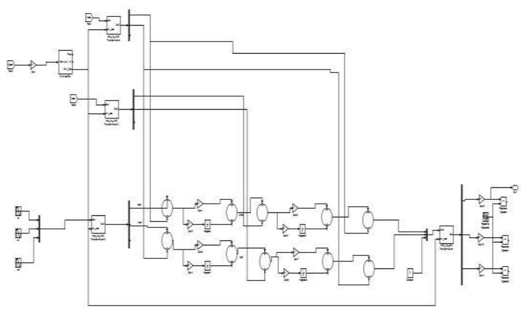


Fig.5 Simulation Circuit of Current Controller

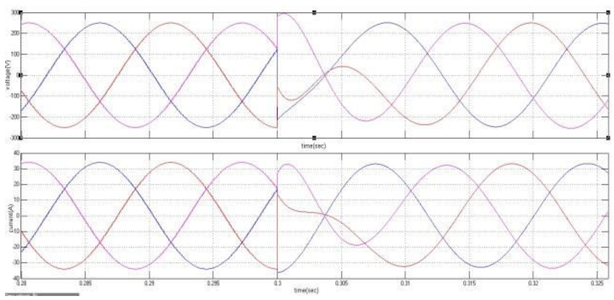


Fig.6 Simulation Waveforms of Voltage(top) and Currents(bottom) at PCC before and after Islanding

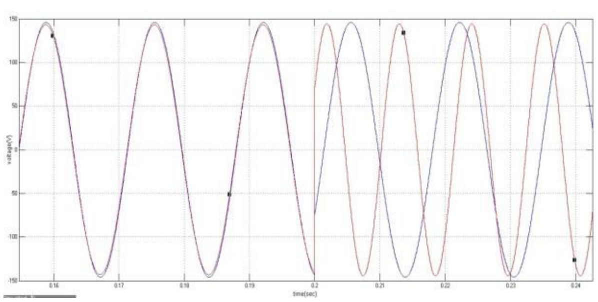


Fig.7 Simulation Waveforms of Grid Voltage and Inverter Voltage before and after Islanding

B) EXTENSION SIMULATION CIRCUITS

In the Extension system we proposed Wind generating system and all the controllers that can be implemented in a VSC-based HVDC transmission system based on SHE PWM have been discussed and analyzed. In the following, the system is simulated in MATLAB/Simulink will be presented. The implementation of the outer controllers will depend on the application and requirements, respectively..

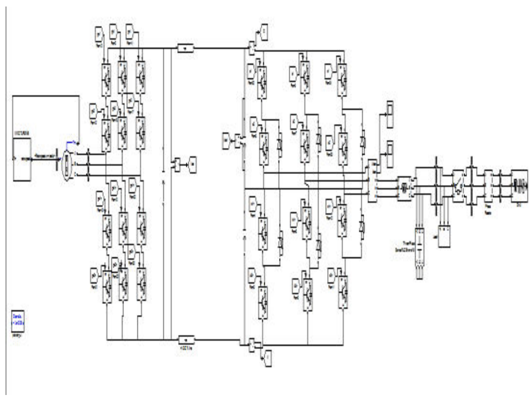


Fig 8. MATLAB/SIMULINK diagram of proposed system

The fig., shows PMSG voltage output it takes 0.12 (t_s=0.12) sec to settle, that is from t=0.12sec on wards it will comes to steady state.

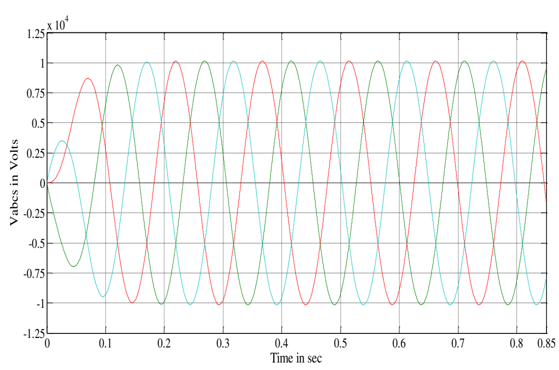


Fig 9. PMSG output voltage

Rectifier output voltage:

The fig.,shows rectifier output voltage across rectifier capacitor. The capacitor is used to filter out the rippleness in the DC wave.

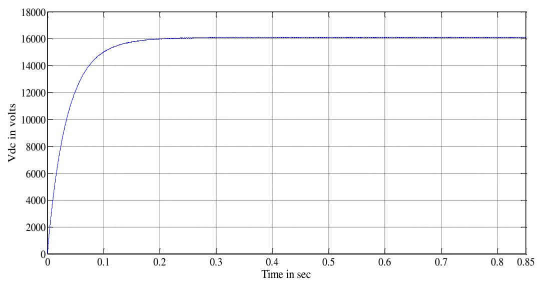


Fig10,Rectifier output voltage (output across rectifier side capacitor)Inverter side

Three level diode clamped converter is used as inverter, this converter have two capacitors in series.

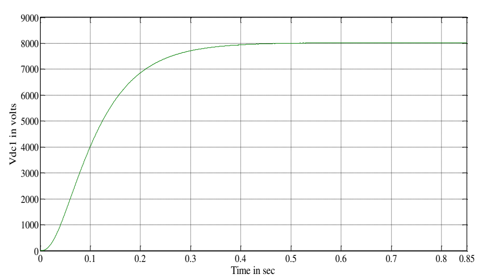


Fig 11.Voltage across terminal-I Inverter side capacitor-I

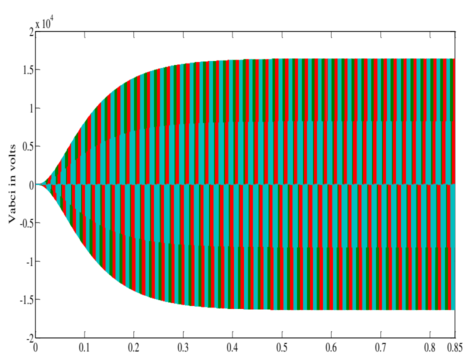
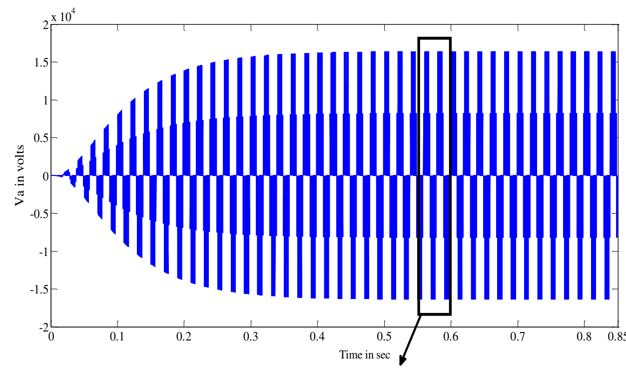
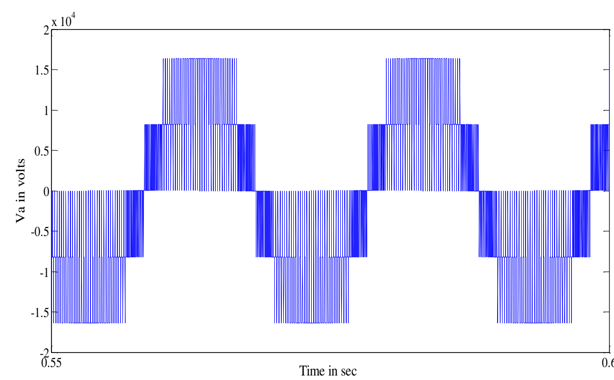


Fig 12. Inverter voltage before filtering

If the load placed at the voltage-source inverter output were be a perfect sinusoidal AC-current, i.e. current I_L would be sinusoidal although voltage V_L is not.

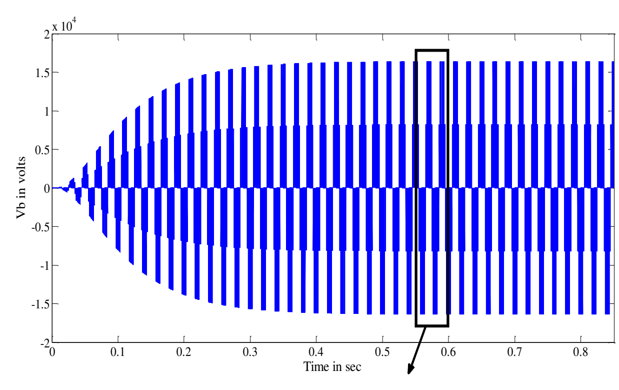


(a)

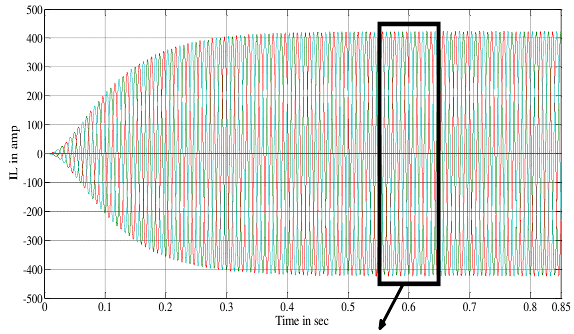


(b)

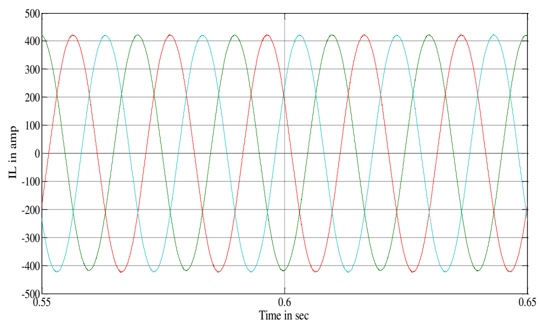
Fig 13. (a & b) shows Phase A Inverter voltage before filtering



(a)



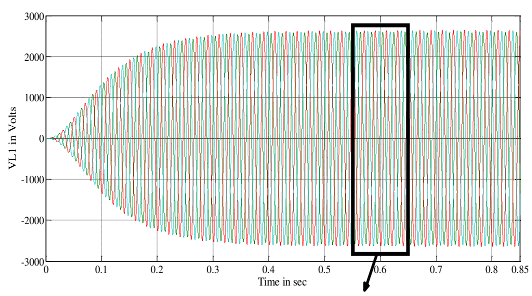
(a)



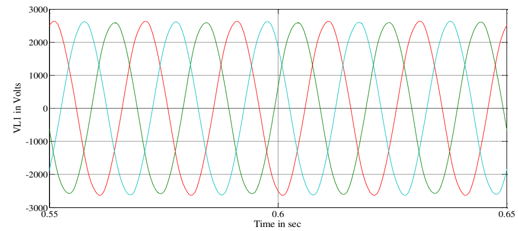
(b)Fig 14 (a and b) Load Current Without filtering Voltages and Currents after filtering

Terminal-I Voltage and Current:

To reduce rippleness in the voltage and current wave, Phase reactors and capacitive filters are used. The phase reactors are used to reduce ripple in current wave, the lesser value phase reactor is sufficient to filter the current wave.



(a)



(b)

Fig 15 (a & b) Terminal-I Voltage

CONCLUSION

A unified control strategy was proposed for three-phase inverter in DG to operate in both islanded and grid-tied modes, with no need for switching between two different control architectures or critical islanding detection. A novel voltage controller was presented. It is inactivated in the grid-tied mode, and the DG operates as a current source with fast dynamic performance. Upon the utility outage, the voltage controller can automatically be activated to regulate the load voltage. Moreover, a novel load current feed forward was proposed, and it can improve the waveform quality of both the grid current in the grid-tied mode and the load voltage in the islanded mode.

In extension we proposed the advances of the VSC-based HVDC technology based on SHE PWM are presented. It facilitates a number of key benefits, namely independent control of active and reactive power through the PWM control of the converter, fast dynamic response, and possibility to connect AC Island with no synchronous generation in the grid. ST HVDC system improves the fault ride through capability of the system and it offers verity of system operating conditions.

REFERENCES

[1]. I. J. Balaguer, Q. Lei, S. Yang, U. Supatti, and F. Z. Peng, "Control for grid-connected and intentional islanding operations of distributed power generation," IEEE Trans. Ind. Electron., vol. 58, no. 1, pp. 147–157, Jan.2011.

[2] R. H. Lasseter, "Microgrids and distributed generation,"J. Energy Eng., vol. 133, no. 3, pp. 144–149, Sep. 2007.

[3] C. Mozina, "Impact of green power distributed generation," IEEE Ind. Appl. Mag., vol. 16, no. 4, pp. 55–62, Jul./Aug. 2010.

[4] IEEE Recommended Practice for Utility Interface of Photovoltaic(PV) Systems, IEEE Standard 929-2000, 2000.

[5] IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems, IEEE Standard 1547-2003, 2003.

[6] J. Stevens, R. Bonn, J. Ginn, and S. Gonzalez,Development and Testing of an Approach to Anti-Islanding in Utility-Interconnected Photovoltaic Systems. Livermore, CA, USA: Sandia National Laboratories, 2000.