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UNBALANCED VOLTAGE AND HARMONICS COMPENSATION IN AN ISLANDED AC MICROGRID BY USING FUZZY LOGIC CONTROLLER.

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ABSTRACT Power sharing problems are associated with DG reactive power, imbalance power and harmonic power. An enhanced droop control with fuzzy controller is proposed method through online virtual impedance adjustment is used to solve power sharing problems. DG reactive power, imbalance power, and harmonic power is added to the conventional real power frequency droop control. The transient real power variations caused by this are used to realize DG series virtual impedance tuning. With the regulation of DG virtual impedance at fundamental positive sequence, fundamental negative sequence, and harmonic frequencies, an accurate power sharing can be realized at the steady state. In order to activate the compensation scheme in multiple DG units in a synchronized manner, a low-bandwidth communication bus is adopted to send the compensation command from a micro-grid central controller to DG unit local controllers, without involving any information from DG unit local controllers. The feasibility of the proposed method is obtained by simulation results from a low-power three-phase micro grid with two parallel DG units with the same power rating.

Keywords: Virtual impedance, micro grid, Distributed generation, droop control, fuzzy controller islanding operation, renewable energy system, power sharing, voltage control.

1. INTRODUCTION

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper. In recent years, dispersed energy resources (DERs), such as wind turbines, photovoltaic systems and microturbines, have gain a great increasing interest since they are economic and environment friendly. In general, power electronic converters are used as interfaces between DERs and the grid [1], such that electrical power with good quality and high reliability can be delivered to the load or utility grid, as shown in Fig. 1. This paper focuses on islanded micro grids where the interfacing converters mainly operate as voltage sources to participate on the voltage and frequency regulation while sharing at the same time active and reactive power accurately by adjusting output voltage phase angles and amplitudes. However, it is also preferred that those converters could provide power quality management ability, in such a way that we can take full use of the converters

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available capacity. It is well known that power quality issues, especially voltage/current unbalances and voltage/current distortions have become more and more serious in modern power system. For instance, in islanded micro grids the voltage unbalance problem is a salient issue mainly produced by the use of single-phase generators/loads and it can lead to instability and power quality issues. In order to enhance the voltage waveform quality, several components to deal with the voltage unbalance compensation have been developed, such as static var compensator (STATCOM) [2], series active power filter [3] and shunt active power filter[4] However, all these compensation methods utilize additional power converters to inject negative sequence reactive power. Only a few works compensate the unbalanced voltage by utilizing the DG interfacing converters. In [5], the DG inverter is controlled to inject negative sequence current to balance the common bus voltage. However, a surplus converter capacity is needed to generate the negative sequence current and the injecting current might be too high under severe unbalance conditions. In the previous work [6], an unbalance compensation method is proposed by sending proper control signals to DGs local controllers. However, the negative sequence component of the common bus voltage is hard to suppress, since the microgrid central controller (MGCC) uses the voltage unbalance factor as a main control variable, which value is reduced by the positive sequence voltage.

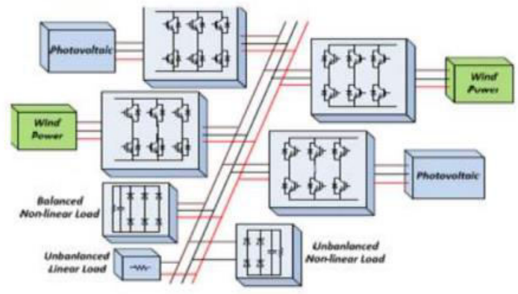

Fig. 1 General architecture of a micro grid

2. SYSTEM CONFIGURATION

As shown in Fig. 2, the error signals obtained by comparing the measured output voltage, the voltage drop generated by the selective virtual impedance loop, the power controllers, the selective harmonics compensation of PCC, the UHC block, and the reference value which are regulated by the proportional plus multi-resonant controllers (P+MRC) to generate references for the current loop. The reference current signals are then compared with the corresponding inverter currents, and are regulated by a proportional controller to produce voltage commands. Moreover, in order to activate the compensation strategy in multiple parallel-connected DG units synchronously, the LBC bus is used to send the compensation command from the MGCC to the local DG controller, including the secondary control and auxiliary control. The proposed hierarchical control strategies are presented as follow

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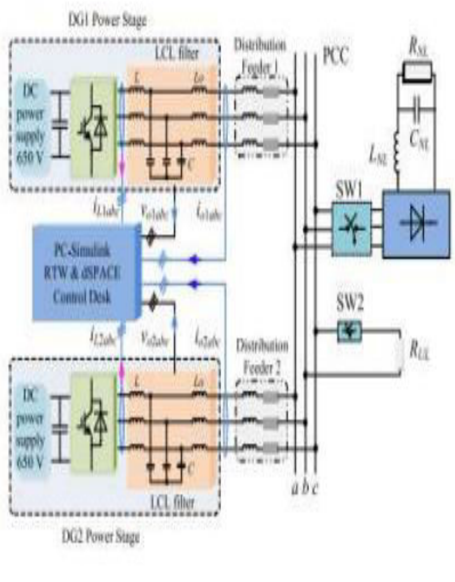

Fig. 2: Schematic of the test micro grid with two parallel-connected DG units

3. PROPOSED CONTROL STRATEGY

As shown in Fig. 3, the error signals obtained by comparing the measured output voltage, the voltage drop generated by the selective virtual impedance loop, the power controllers, the selective harmonics compensation of PCC, the UHC block, and the reference value which are regulated by the proportional plus multi-resonant controllers (P+MRC) to generate references for the current loop. The reference current signals are then compared with the corresponding inverter currents, and are regulated by a proportional controller to produce voltage commands. Moreover, in order to activate the compensation strategy in multiple parallel-connected DG units synchronously, the LBC bus is used to send the compensation command from the MGCC to the local DG controller, including the secondary control and auxiliary control. The proposed hierarchical control strategies are presented as follows.

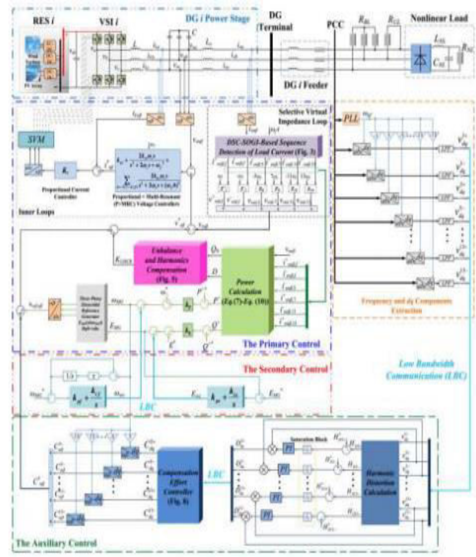

Fig. 3: Block diagram of the proposed hierarchical control strategy for the islanded micro grid

4. FUZZY LOGIC CONTROLLER

As of recent, the number and assortment of uses of fuzzy logic have expanded essentially. The applications go from consumer products, for example, cameras, camcorders, clothes washers, and microwave stoves to mechanical process control, restorative instrumentation, choice emotionally supportive networks, and portfolio choice. To comprehend why utilization of fuzzy logic has developed, you should first understand what is implied by fuzzy logic. Fuzzy logic has two unique implications. In a thin sense, fuzzy logic is an intelligent system, which is an augmentation of multivalve rationale. Be that as it may, in a more extensive sense fuzzy logic (FL) is practically synonymous with the hypothesis of fuzzy logic sets a hypothesis which identifies with classes of items with unshaped limits in which

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enrollment involves degree. In this viewpoint, fuzzy logic in its limited sense is a branch of fl. Indeed, even in its more tight definition, fuzzy logic varies both in idea and substance from conventional multivalve consistent systems. In fuzzy logic Toolbox programming, fuzzy logic ought to be translated as FL, that is, fuzzy logic in its wide sense. The fuzzy logic tool compartment is exceptionally great in all regards. It makes fuzzy logic a successful apparatus for the origination and plan of wise systems. The fuzzy logic tool stash is anything but difficult to ace and advantageous to utilize. Also, last, yet not minimum essential, it gives a peruse amicable and breakthrough prologue to philosophy of fuzzy logic and its far reaching applications.

4.1 What is fuzzy logic?

Fuzzy logic is about the relative significance of exactness: How essential is it to be precisely right when a rough answer will do? You can utilize Fuzzy Logic Toolbox programming with MATLAB specialized figuring programming as an apparatus for taking care of issues with fuzzy logics. Fuzzy logics is a captivating range of research since it benefits a vocation of exchanging off amongst hugeness and exactness-something that people have been overseeing for quite a while.

4.2 Why use fuzzy logic?

A fuzzy logic is a helpful approach to outline includes space to an outputs space. Mapping contribution to outputs is the beginning phase for everything. Consider the accompanying illustrations: With data about how great your administration was at an eatery, a fuzzy logic system can let you know what the tip ought to be. With your determination of how hot you need the water; a fuzzy logics system can alter the spigot valve to the right setting. With data about how far away the subject of your photo is, a fuzzy logic system can center the focal point for you

5. SIMULATION RESULTS

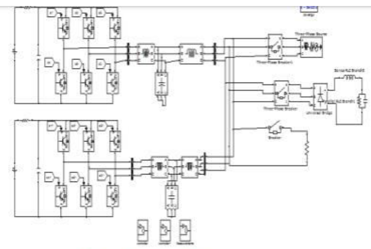

Fig. 4: Simulink model of proposed system

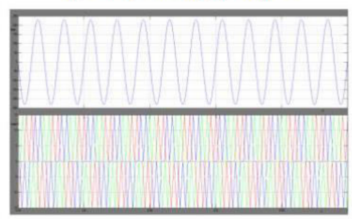

Fig. 5: Simulation waveforms of the conventional droop control in a micro grid with harmonic load dg1 voltage & current

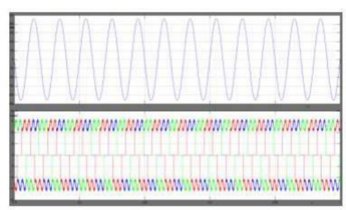

Fig. 6: Simulation waveforms of the conventional droop control in a micro grid with harmonic load dg2 voltage & current

Fig. 7: Performance of the proposed compensation

6.CONCLUSION

We proposed an enhanced power sharing scheme for voltage unbalance and harmonics compensation with fuzzy logic controller in an islanded micro grid. The proposed method utilizes the selective virtual impedance loop, the local voltage unbalance and harmonics compensation block, and the auxiliary selective compensation of PCC voltage characteristic harmonics in a micro grid to compensate the reactive, unbalance, and the harmonic power sharing errors. In the primary control, the selective virtual impedance at the fundamental positive sequence, fundamental negative sequence, and harmonic frequencies are adopted to enhance the power sharing of reactive, unbalance and harmonic power between the DG units. And the DSC-SOGI-based sequence decomposition method is utilized for individual harmonic component extraction,. The fundamental positivesequence real and reactive powers are used by the power controllers to generate the references of the DG output voltage amplitude and phase angle. The negative sequence and harmonic powers are applied for the generation of voltage unbalance and harmonics compensation reference signals. Moreover, the voltage amplitude and frequency restorations are achieved by the centralized secondary controller. The auxiliary harmonic compensation is realized by the selective compensation of the characteristic harmonics of the PCC voltage.

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