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Fuzzy Based Grid Synchronization Scheme for Integration of Renewable Energy Sources

Irukula Abhilash[1], Vemula Krupa Rani[2] & Jisha Bhubesh[3]
[1]MTech scholar in Electrical and Electronics Engineering inCMR College of Engineering and Technology
[2,3]Assoiate professor in Electrical and Electronics Engineering in CMR College of Engineering and Technology

Abstract

Micro-grid is a promising area that might provide a solid solution for more and more stress on the utility supply and transmission line. Generally micro-grid comprises of renewable energy sources such as photovoltaic (PV), wind, fuel cell (FC) stack etc., as small-scale framework includes sustainable power sources which have a fundamentally extraordinary dynamic conduct, different creating limits and problematic impacts, for example, voltage plunges and changes, recurrence variety, and symphonies contortion are taken care of through brought together observing in conjunction with various levelled control. The unwavering quality and supportability of the subsequent complex small-scale framework synchronization is guaranteed through the proposed reconfigurable control and power system of the micro-grid, supported by a comprising fuzzy controller area network. The proposed design is fortified by an extra controller that backings long haul streamlining of small scale network task under typical conditions and oversees interim role assignments to control layers during crisis. Micro grids are increasing broad prevalence as they have all the fundamental properties to constitute a noteworthy building square of the imagined shrewd lattice. The unfavourable impacts of high infiltration of sustainable power sources (RES) like sun powered photovoltaic (PV), wind, and so on. On the stability of the existing grid network has been raising a major concern. This paper proposes a highly reliable controller i.e. FUZZY LOGIC CONTROLLER to reduce the source THD. Minimizing the time required for GS of the complete microgrid., simulation results related to this paper are presented.

Keywords

Microgrid(MG), Synchronization, Renewable Energy Sources, Fuzzy Logic Controller.

Introduction

Introduction to Micro grid: -A few years prior, micro grids turned into the most encouraging answer for the issues of the present power framework**.** Micro grids represent a vision for the future of power distribution in which islanding detection, control, dispatch strategies, grid integration and energy storage systems are major challenges. This study explores how to provide increased, cost-effective and environment friendly energy for local loads. Micro grids are power dissemination frameworks containing loads and dispersed vitality assets, (for example, appropriated generators, stockpiling gadgets, or controllable burdens) that can be worked in a controlled in with utility grid or while islanded.

Figure 0-1 Micro Grid Example

Micro grid Key Components: -Micro grids usually consist of distributed energy resources, power conversion equipment, communication system, controllers and energy management system to obtain flexible energy management. The customer is another key component for micro grid to be promoted and implemented involves distributed generator (DG) and distributed storage and provides energy to meet energy demand.

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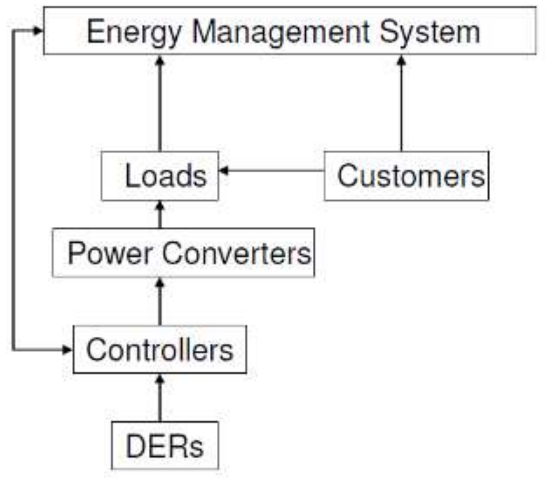

Figure 0-2 Micro grid key components

Synchronization: Parallelization of two synchronous frameworks requires coordinated activity with a specific end goal to limit surges and power oscillations. A smooth association is accomplished when the voltage sat the two transports to be associated are incidental in extent and phase. Also, recurrence must be minimal. If a flawless parallelization is come to, no power flow will be saw at the coupling electrical switch (CB) immediately after its activity (Fig. 1-3), which implies that the synchronization control is invalid. Then again, if the sync power is high, harm to the generators may happen. For example, the pole may be fissured or even break due to the unreasonable tensional exertion.

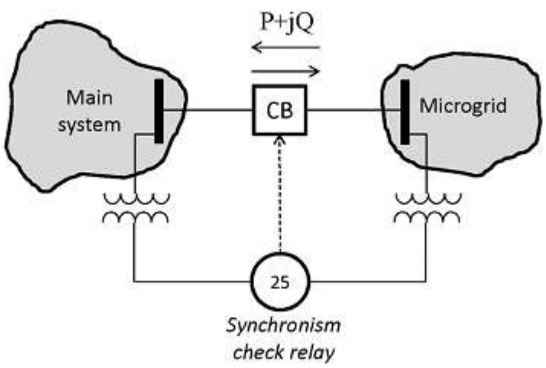

Figure 0-3 Parallelization of Two Systems

This paper proposes a straightforward, minimal effort, and solid GS technique in light of controller territory organize (CAN) correspondence. CAN is a hearty blame tolerant multiport serial communication arrange fit for giving 1 Mb/s information rate. The proposed conspire depends on CAN communication between the micro grid ace controller (MMC), neighbourhood controllers (LC), stack controller and network synchronization systems appeared in Fig.1-4. The figure demonstrates the piece chart portrayal of the laboratory model micro grid in view of MS like sun powered PV, proton trade film energy unit, wind turbine, and so on. The MMC is capable for the most part for the general supervisory framework observing and control.

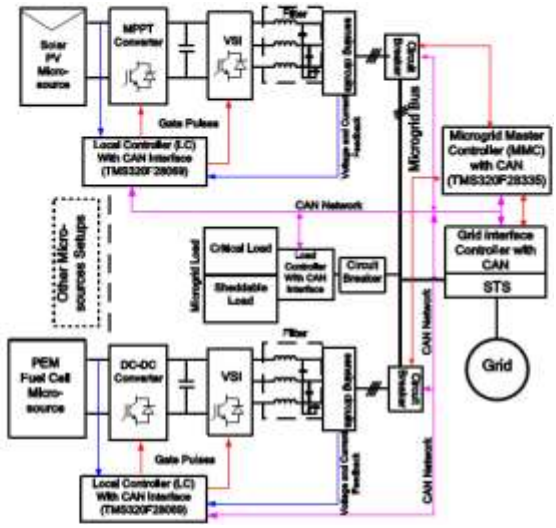

Figure 0-4 Micro Grid Configuration with CAN Communication Interface.

Grid Synchronization Technique: -

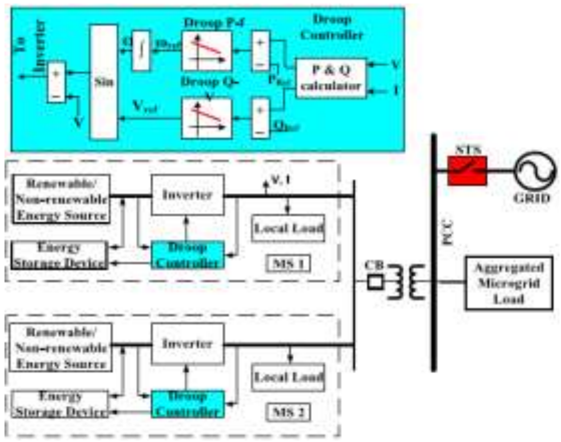

Figure 0-1 Droop Controller

Fig.2-1 demonstrates a case of a micro grid with two sources bolstered by a vitality stockpiling framework (ESS) for transient and unfaltering state go down. The controllers utilized for booths depend on hang control. The hang controller based on feedback of micro grid transport voltage and the

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current and the droop attributes, chooses the new working condition interns of the point ø (time fundamental of rakish frequency) and Vref which is then utilized for producing the beat width balance (PWM) control motion for inverter. This is the great hang control. The droop control despite the fact that straightforward for execution, it innately needs in giving precise control that having poor dynamic response because of poor bandwidth. In micro grids with brought together control upheld with appropriate correspondence engineering, the genuine and responsive power control amid the island method of activity is generally managed through the master– slave arrangement. In such micro grids which are all around outfitted with fast correspondence organize, the correspondence helped GS (CAGS) methods can be favoured.

Grid Synchronization Method:

As appeared in Fig.1-4, the LCs comparing to variorums, the MMC, the heap controller, and the framework synchronizer they are totally interconnected with each other by a CAN bus. CAN is a message communicate correspondence with non-destructive transport intervention. CAN give a hearty correspondence because of its multi method blunder identification highlight. In this paper, a disconnected CAN transport utilized for the micro grid control task is worked around CAN trans-recipient ISO1050.The CAN information is communicated to all hubs at the same time

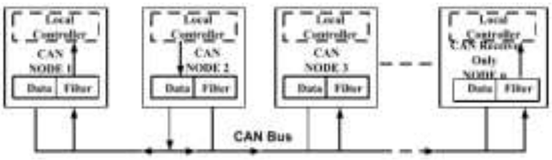

Figure 0-2 CAN Nodes Transmission and Reception of Data

Fig.2-2 shows the data broadcasting on a CAN node from the CAN bus. All CAN nodes receives the broadcasted messages and they can react or cannot react on those messages. This allows the grid synchronizer block to send the short messages to all the nodes. The nodes make their own decision whether to act on the message or not this is the big advantage of the CAN network of broadcasting the messages. The total block diagram of the proposed controller and the communication interface with the micro source fuel cell is shown in fig 2.3 the same applies to the remaining micro sources with interfaces each other. To synchronize total micro sources with each other to form the single bus bar to connect with the same main grid, it is compulsory that every micro source should receive the same grid voltages as fast as possible.

In the proposed scheme, the grid synchronizer block is designed to implement the synchronously rotating frame PLL(SRF-PLL) with capability to adopt unbalanced grid voltage and harmonic contamination. The instantaneous phase angle information of the grid voltage which is the output of theSRF-PLL and the voltage amplitude of the grid supply is communicated on the CAN network to all the LCs simultaneously.

In smaller networks, the network time delays are insignificant and can be neglected. Hence, each of the LC is in a position to generate the reference grid voltage template to drive the VSI to get grid synchronized voltage output. The outer voltage control loop implementation makes sure to maintain the operating voltage same for each of the MS. Thus, the voltage, frequency, and phase synchronized.

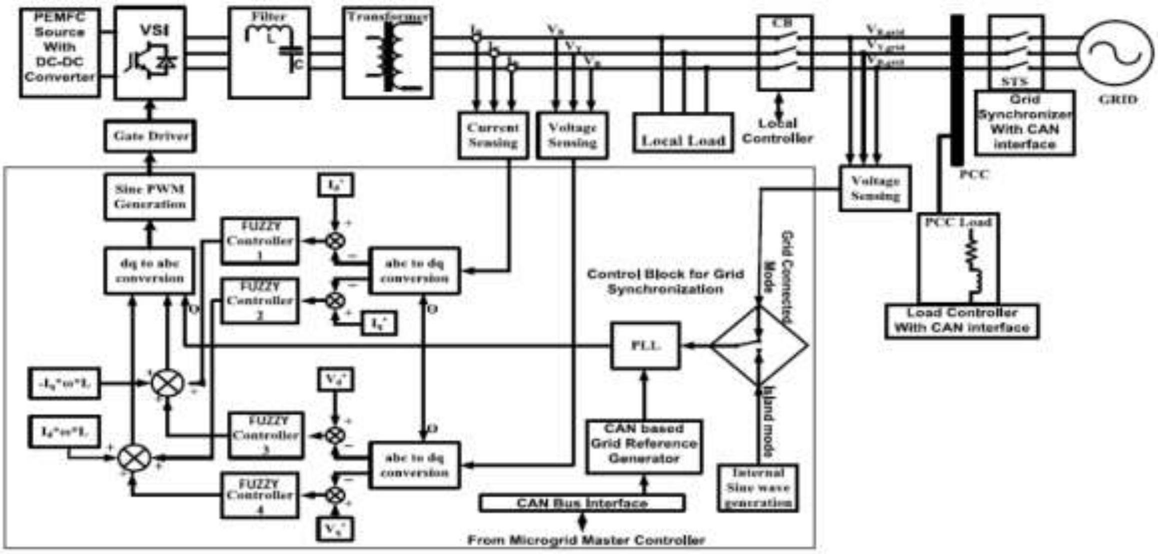

Figure 0-3 Detailed MPC Control for The Implementation with Power Devices and CAN Network

MS are ready to be connected with the grid. The grid synchronizer block continues data broadcasting on CAN bus during the synchronization process, thus enabling each of the sources to accurately track the grid voltage and phase changes. The communication interface designed with the CAN plays a vital role in switching the control between standalone and grid connected modes, allowing smooth synchronization as well as islanding of the micro grid.

After closing STS, on receiving confirmed message from the CAN interface, it is switched over to current control mode allowing export or import of the power to or from the main grid. This allows easy GS of all the MS, minimizing the time required for GS of the micro grid. To understand the proposed control scheme with SRF-PLL and its modelling, basic details are provided next. The proposed control scheme implementation allows the MS power to be modulated by VSI to regulate the micro grid bus voltage and frequency (v, f) during standalone mode of operation, which exists between the formation of the micro grid bus and its synchronization with the main grid. In the grid connected mode, the real and reactive power (P, Q) is controlled.

Fuzzy Logic Controller:

Fuzzy logic controller is used in local controller of the system for faster error compensation this results in faster response and helps in minimizing of the Total Harmonic Distortion(THD) levels in the source Voltage Source Inverter(VSI). Finally reducing the source current THD.

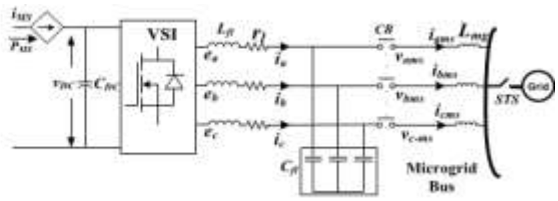

Figure 2-3 Equivalent circuit of power electronic system with LC filter

Fig.2-3 shows the equivalent circuit of a MS interconnected with the main grid through a power conditioning unit followed by an LC filter. Here the MS is represented as a controlled current source, I (ms) which supplies the real powerPmsinto thedc link capacitor at voltage V_{DC}. LC filter comprising L_{fl}-$C_{fl}$is used to filter out the high frequency switching components and micro grid line inductance (Lmg) is neglected being very small [30].

The local controller senses the VSI side and MG bus side parameters likei_{abc}, v_{abc}_MS, iabc-MS, V_{DC}, etc., to modulate the VSI to control the real power, reactive power or micro grid bus voltage and frequency depending on the operational mode. Synchronously rotating reference frame transformations used to realize the VSI control. Model of VSI can then be expressed as [30]

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$$L_{fl}\frac{d_{id}}{dt} = -r_l i_d + L_{fl}\omega i_q + e_d - v_d$$

$$L_{fl}\frac{d_{iq}}{dt} = -L_{fl}\omega i_d - r_l i_q + e_q - v_q$$

Where i_d, i_q, v_d, vq and ed, eq are the transformed variables of voltages and currents.

MATLAB AND SIMULINK MODEL:

MATLAB

MATLAB was first developed in the year 1970 for studying the straight polynomial mathematics. Then next it was further developed and create awareness about it by mathworks.com MATLAB is a software that performs all scientific researches and their related problems

MATLAB software is interfacing with programs that written in different languages, including C, C++, Java, Fortran and Python.

MATLAB is basically for numerical calculations by using a separate tool kit by using the MuPAD emblematic motor, creating access for figuring capacities. An extra software, Simulink software, which includes graphical reproduction and model-based plan for dynamic and inserted frameworks.

SIMULINK

Simulink also created by the mathworks.com it is additional software representing the graphical programming. simulation is done in multiple domain and it should have a graphical square along with it. Simulation flexibles very tight mixture by remaining content in the MATLAB conditions simulation is used for programming controls and multi domain and model-based designs.

Simulation software is simple and quick to learn and practicable. C codes can be created from Simulink software models for installing applications and fast prototyping of control systems.

MATLAB Simulation Diagrams

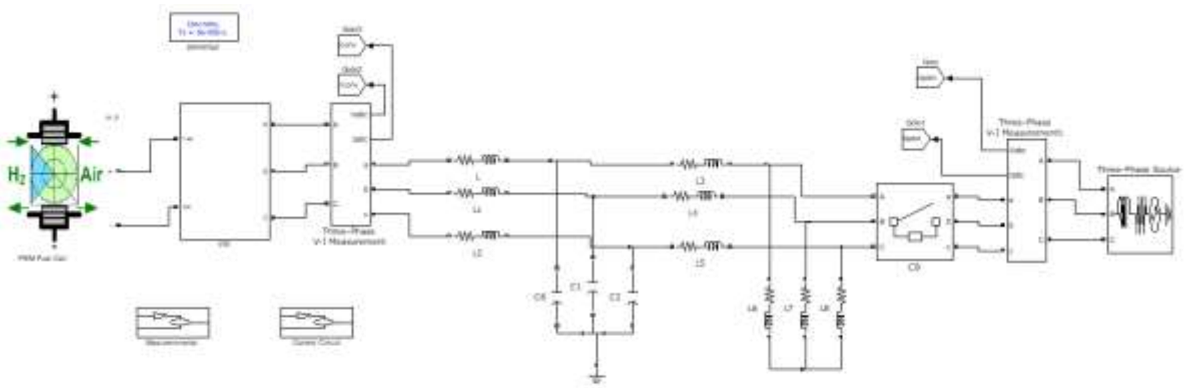

Figure 0-1 Simulation Model of The System

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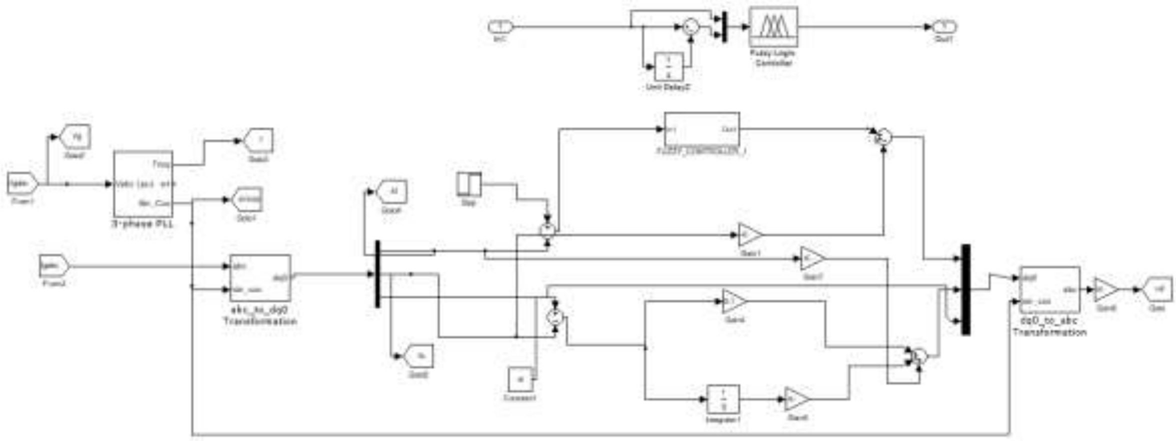

Figure 0-2 Sub System of The Controller

Simulation Results

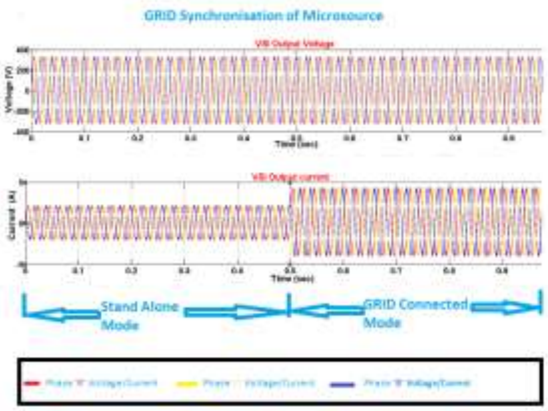

Figure 0-3 Voltage and current waveforms in standalone mode and grid connected mode

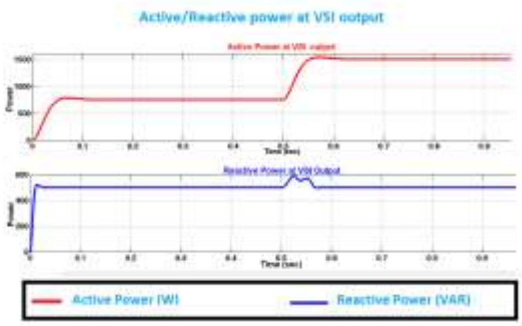

Figure 0-4 Active power and Reactive power at inverter

Figure 0-5 Active Power and Reactive Power at Grid

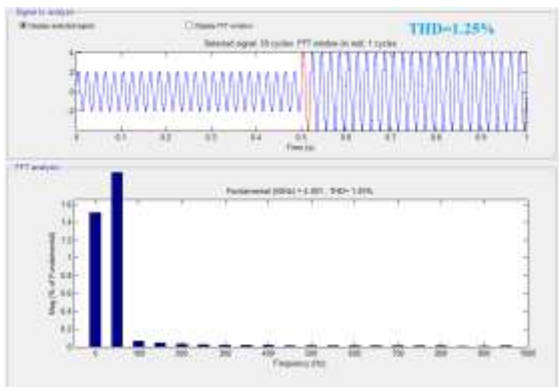

Figure 0-6 Active Power and Reactive Power at Grid

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1. CONCLUSION AND FUTURE SCOPE

The mode progress administration of a micro grid, dominated by RES is very unpredictable, particularly while changing from islanded mode to framework associated mode. The non-dispatch able nature of the majority of the RES makes the undertaking more troublesome. In order to limit the progress drifters, it is fundamental to synchronize all the MS all the while with the principle grid. This project demonstrates that its utilization can be stretched out further to provide strong GS conspire with no extra cost. The reproduction comes about affirm the change in the execution of the control unit. Using fuzzy controller, the yield current sounds are diminished and the controller execution is upgraded. Using fuzzy controller, the output current harmonics are reduced and the controller performance is enhanced and THD content is reduced. Along these lines, the controller execution is upgraded empowering it to be utilized for lattice synchronization of micro grid applications. General power quality in the framework is moved forward. New control scheme for power electronic interface of microgrid with grid system using artificial intelligence can be developed for utility interactive operation. In future Storage systems can be added along with the microgrid to store energy in absence of grid.

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