New Control Strategy of Interconnected Micro grids for Enhancing Power Sharing Capability

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ABSTRACT

In this paper, Due to some operational barriers to existing power management systems the AC-DC connected grids are only involved in power sharing or power control but not in both, in order to overcome these problems this paper is proposed. This proposed autonomous power control system will look at the specific state of the DC grid loading before importing power from a interlinked AC micro grid. This strategy not only converts power to a DC micro grid but also reduces the number of active converters that will reduce energy transfer losses. The proposed system is completely self-contained as it adheres to the plug-n-play features of generators and tie-converters. The effectiveness of the proposed control system is guaranteed under various operating conditions. The results reveal the usefulness of the proposed system for managing DC micro grid power shortages efficiently autonomously, while maintaining better power control and voltage regulations over the DC Micro grid. Results are verified by MATLAB / SIMULINK environment.

Index Terms—Autonomous control, distributed control, droop control, hybrid micro grids, interlinked micro grids, power management.

I. INTRODUCTION

The advancement of renewable energy technologies plays an important role in the distribution of renewable energy and other energy technologies that have been widely acquired in various forms of network technology. In addition, they have been managed and directed using a variety of control strategies and structures. Their network approaches and control strategies are adapted primarily to maximize profits while meeting load requirements. Nowadays, renewable technology and other energy are heavily embedded in micro grids. As this new technology has several advantages such as better utilization of resources, improved energy quality and more reliable supply, these new technologies are still being distributed in the form of a small grid. Currently, advanced grid features are integrated with sin-based grid features. It was a big goal to take advantage of the great benefits of renewable energy sources and so on. For example, if we connect two or more small grids, it will result in saved sharing, support volume and volume, and ultimately strengthen the absolute reliability and flexibility of the connected small grids. Links between two or more small grids have been developed to meet the overall objectives of control and management strategies. Linking to small grids can be done directly or by syncing to turn the tie. Whenever two or more grids are connected with different operating modes and multipliers, compatible tie converters are widely used. If micro grids are to be connected with different control techniques and forces flowing between them, then also tire transformers are needed to control

Similarly, a small DC grid connection to a utility grid or other AC grid, as well as power flow control among other operations, tire converters are required. This was investigated under various circumstances. For connecting tie-converters for AC-DC micro grids, droop demand control has been suggested. On the basis of the standard terminal power and the mass of the controlled group connected between AC-DC grids, the power flow action is determined. This system will make the transfer of power between the connected grids more self-contained due to the relative load status. The connector converter will work continuously if the power flow decision is made with the associated load and thus can lead to inevitable loss of performance. The expansion of the same power-sharing system has been made possible by connecting micro grids to aid the storage system.This system will make the transfer of power between the connected grids more self-contained due to the relative load status. The connector converter will work continuously if the power flow decision is made with the associated load and thus can lead to inevitable loss of performance. The expansion of the same power-sharing system has been made possible by connecting micro grids to aid the storage system.

With automatic development monitoring in an existing scheme, the flow of power through connected converters can be reduced. This proposed automatic tracking system will help determine the way power is transmitted only when one small grid is heavily loaded, and another small grid is loaded. In the various operating conditions of the AC and DC small grid connected, this power sharing is investigated. This power management strategy is introduced by a system of three ports consisting of AC, DC and the storage network. Decisions regarding power sharing are made on the basis of loading conditions. To a lesser extent, published power-sharing systems for AC-DC-connected micro grids are performed entirely on the basis of droop or voltage regulation rules. Supported power sharing schemes will transfer power because equal load for all converters regardless of the power transfer requirement. Therefore the loss of unnecessary conversion performance is reduced. Typically, power control schemes only control the power of a DC micro grid by ignoring certain loading conditions of the generators, and do not even have a plug-n-play element for tie-converters. These shortcomings and challenges can be addressed in particular through the proposed management plan for this project

The proposed control scheme relies on the details of the final power of the tie converter to determine the overall loading status of the droop-controlled grid. The tie-converter automatically starts and transfers power to the micro DC grid during high loading demands or event status on a small DC grid on the basis of the set loading limit. DC power grid micro grid is controlled at a defined nominal level by the proposed hybrid control mode. In addition, the proposed system allows for the connection of more than one tie-converters, but was opposed to the existing system where all tie converters work simultaneously without the need for power transfer. The next tire converter only works once the original power transformer has been completed. The proposed system is completely independent of the enhanced features.

II. CONTROL STRATEGIES

The considered DC microgrid includes both non-dispatchable generator (solar-PV) and dispatchable generators (microturbine, fuel-cell) and loads, as shown in Fig. 1. The maximum power is extracted by the non-dispatchable -solar PV system at all the times since it is set to run in current control mode. The dispatchable generators are generally used for stabilizing the renewable capacity. These dispatchable generators are controlled through a centralized or decentralized control scheme.Because of its simplicity and reliability, a low-cost drag scheme is the most widely used and popular system. Therefore, the traditional droop system (P-V) has been used for generators sent to a DC microgrid (see Fig. 1), provided by

$$V_{\mathrm{dc,ref},i} = V_{\mathrm{dc,max}} - \partial_{\mathrm{dc},i} P_{\mathrm{dc},i}$$
$$\partial_{\mathrm{dc},i} = \frac{V_{\mathrm{dc,max}} - V_{\mathrm{dc,min}}}{P_{\mathrm{dc,max},i}} = \frac{\Delta V_{\mathrm{dc}}}{P_{\mathrm{dc,max},i}} \qquad (1)$$

where, $i$is the DC generator number (i= 1, 2, 3. . .); Vdc,ref,$I$is the reference voltage of ith generator; Pdc,is the output power of ith generator; Vdc,max and (V dc,min= Vdc,nom,TC1) are the defined maximum and minimum voltage; Pdc,max, *is the* maximum or rated power of ith generator; and ∂dc,$i$is the droop gain of ith generator. Based on (1), the voltage reference for the droop controlled generators 1 and 2 can be calculated by (2) and (3).As generators 1 and 2 share common DC bus voltage (i.e.,Vdc,ref,1 = Vdc,ref,2), (2) and (3) can be equated and rewritten by (4), which demonstrates that the power sharing of droop controlled generator will be proportional, according to their rated capacity.

The generator terminals is the same. Practically, all the generators are connected through feeders and cables of different lengths and hence the voltage at all the generator terminals is not equal. This voltage mismatch at the generator terminals needs to be compensated by using any of the appropriate compensation methods as it affects the power sharing. The droop equation with compensation of the feeder voltage drop can be rewritten by

$$V_{\mathrm{dc,ref},i} = V_{\mathrm{dc,max}} - \partial_{\mathrm{dc},i} P_{\mathrm{dc},i} + i_{\mathrm{dc},i} X_i. \qquad (5)$$

With the load change, the droop voltage controlled by theDC microgrid will change but the specified distance is allowed. For DC microgrid targeted, range of electrical powerwith the magnified integrated magnification shown in Fig. 1 (bottom left). For water-generating generators, power range i

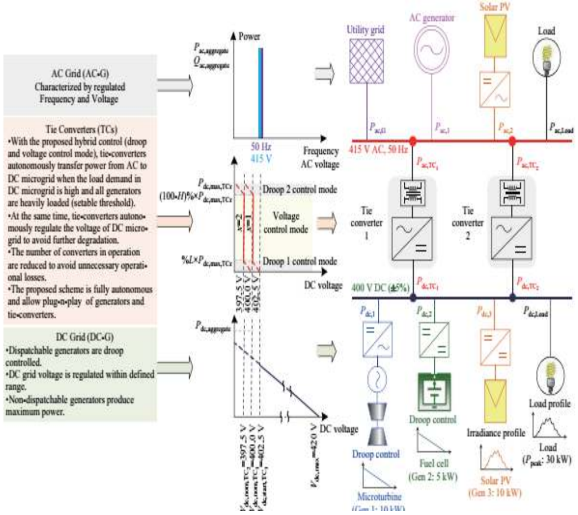

Fig. 2.1. Interlinked AC-DC microgrids and their control strategy.

is set between 395 V and 420 V, indicating that the generators will deliver power to 420 V and 100% power to 395 V. As soon as the DC generators are fully loaded (e.g., ≤ 402.5 V at80% loading generators), tie-converters will start importing power from the AC microgrid to meet the maximum load requirement in the DC system. Therefore, by using tire converters we can also control the power of the DC microgrid. For example the connected microgrids are shown in Fig. 1, the power and frequency of AC microgrid are considered to be stable. The AC microgrid can be controlled by notes with secondary voltage and frequency regulation, or operates in a grid-connected mode. 1 (e.g. 50 Hz and 415 V).

In addition, the AC microgrid has sufficient production capacity to meet its local demand and is also able to export residual energy to the DC microgrid which has been exposed by independent control of the tie-converters. Details of the control of tie-converters are provided in the section

III. PROPOSED HYBRID CONTROL OF TIE-CONVERTERS

The variability of a renewable source and loads on a micro grid will determine the amount of renewable energy or storage system to stabilize renewable capacity. Generators or high-capacity storage systems are needed for maximum recovery and loads, which may be a viable solution. Alternatively, a microgrid with insufficient production capacity can be linked to another microgrid grid or utility, directly or by synchronizing converters. A tire converter is the only way to connect a small DC grid to a small AC grid as shown in Fig. 1. In the proposed interlinked system, the AC microgrid is defined as a controlled voltage ,power and frequency system with sufficient power generation capacity, while the DC microgrid is defined as a notably controlled system of notes due to high variability of renewable and loads. In the event of high demand or low renewable energy output, power failure in the DC microgrid is treated by importing power from the AC microgrid. Ideally, with the proposed control of tire transformers, it can be achieved. In summary, the control system of tie-converters was developed based on the following objectives:

1) Transmission of power from AC to DC microgrid as there is any occurrence of DC microgrid or high demand requirement;

2) To reduce the loss of power transmission, by reducing the number of tie converters operating according to the need for power transmission, for example only during high demand flexible to use a tie converter.

3) Control of droop voltage controlled by DC microgrid;

4) Achieve completely independent and autonomous control over the communication network

5) Enable plug-n-play feature for tie converters and generators

Instead of the existing schemes for the interlinked AC-DC microgrids [18]–[22], a hybrid droop and voltage regulation mode control is proposed for the tie-converters and the mathematical form of the proposed control scheme is given by

$$V_{\mathrm{dc,ref,TC}x} = \begin{cases} \mathrm{Off}; \\ V_{\mathrm{dc,start,TC}x} - \delta_{\mathrm{L,TC}x} \times P_{\mathrm{dc,TC}x}; \\ V_{\mathrm{dc,nom,TC}x}; \\ V_{\mathrm{dc,nom,TC}x} - \delta_{\mathrm{H,TC}x}[P_{\mathrm{dc,TC}x} - (100-H)\% \times P_{\mathrm{dc,max,TC}x}]; \end{cases}$$

when TCx indicates the value of the tie-converter (x = 1, 2, 3 ..); Vdc is DC microgrid voltage; Vdc, Ref, TCx reference power xth tie-converter; Vdc, start, TCx is the voltage at the threshold start of xth tie-converter; Vdc, nom, TCxal power to be controlled by xth tie-converter; Pdc, TCx. DC power output of xth tie-converter; Pdc, max, TCx maximum power limit for xth tie-converter; L% and H% are the percentage of power measured by the tie-converer given in droop1 and 2 mode, respectively; Vdc, nom, TCx + 1 is a DC microgrid voltage where the xth tie-converter transmits high power; δL, TCx = (Vdc, start, TCx - Vdc, nom, TCx) / (L% × Pdc, max, TCx) is the droop 1 (low power) benefit of xthtieconverter; δH, TCx = (Vdc, nom, TCx - Vdc, nom, TCx + 1) / (H% × Pdc, max, TCx) is the droop 2 (high power) benefit of xthtieconverter. tie-converter 1 starts in droop 1 control mode when the voltage across the DC microgrid drops to a set Vdc set limit, start, TCx. When all generators are in a heavily loaded DC microgrid (e.g. over 80% loaded), the voltage drops to a set level. Start of binding converter in droop control mode with smooth transition to power control mode in default mode i.e., Pdc, TCx> L% × Pdc, max, TCx. The tie converter imports power from the AC micro grid to the micro DC grid to meet the high load requirement and also controls its power supply to be set at the lowest Vdc value, nom, TCx hence this is called power management mode. In addition, the work of the translators has been prioritized in contrast to the similar performance of tire transformers in existing systems. The first converter-tie starts only when all the generators in the DC microgrid are heavily loaded. As the initial capacity of the tire converter approaches the auxiliary to Pdc, TCx = (100 - H)% × Pdc, max, TCx, its control mode is switched to 2 control mode from power control mode and allows for minimal power outages. The next tie converter will start its operation using a small voltage drop caused by droop control 2. If the first tie-converter fails, the second tie-converter will start operating following a power outage due to high load requirement. Therefore, without the consent of the inherited inherited flexibility of the focus system, the proposed control strategy ensures reliable and reliable performance across all working conditions. The power allocation of tie-converter in the control mode of droop1 and droop 2 depends on the selected L% and H% value defined by the user, and the adjustment should be able to move the switch between different modes while considering voltage and power measurement tolerance or errors in the targeted microgrid. The efficiency of the DC microgrid voltage regulation can be improved, using the proposed power control mode. Especially during high demand,

$$\begin{gathered}V_{dc} > V_{dc,start,TCx}\\ 0 \le P_{dc,TCx} \le L\% \times P_{dc,max,TCx}\\ L\% \times P_{dc,max,TCx} < P_{dc,TCx} < (100-H)\% \times P_{dc,max,TCx}\\ (100-H)\% \times P_{dc,max,TCx} \le P_{dc,TCx} \le P_{dc,max,TCx}\end{gathered} \tag{6}$$

voltage of the DC micro grid is controlled at the nominal value, which is not done with the existing power management schemes for interlinked micro grids. The performance of the proposed scheme has been corroborated for different load operating scenarios, as described.

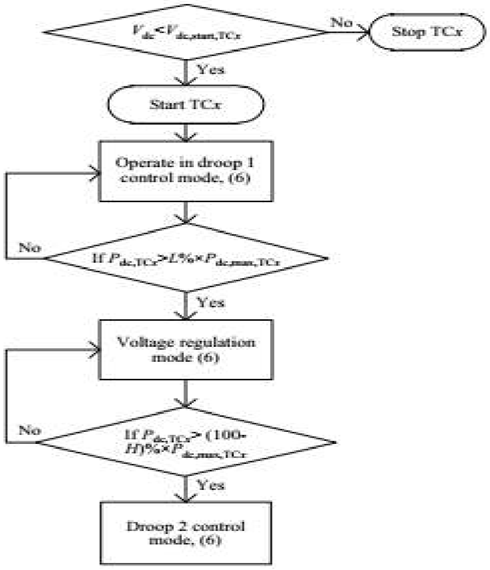

Fig.3. 3 Logic flow diagram showing mode transitions of tie-converter

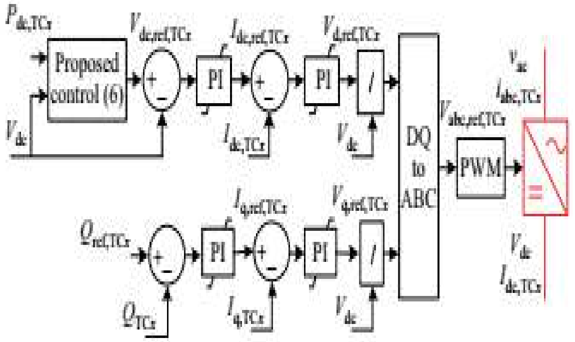

Fig. 3.4. Control block diagram of tie-converter.

IV DG interfacing System description:

The recommended test for island detection reading containing inverter-based DG, the same RLC load and the source-represented grid after impedance is shown in Fig. 4.1. DG mode of operation depends on the location of the circuit assistant whether it is off or not. Inverter based DG such as photovoltaic generation and wind power generation are usually set up with high power point tracking points. Because of the very short time to find islands, output power can be considered as a constant occurrence at the time of acquisition. As, DG is designed as a continuous power source, a permanent dc source is hired after the third phase of the inverter. Figure 5.6 represents the DG interface control block diagram. The three key components are the Phase Locked Loop (PLL), the external power control loop and the current internal control loop. operating independently according to the dual-controlled loop closure structure in the sync index dq..

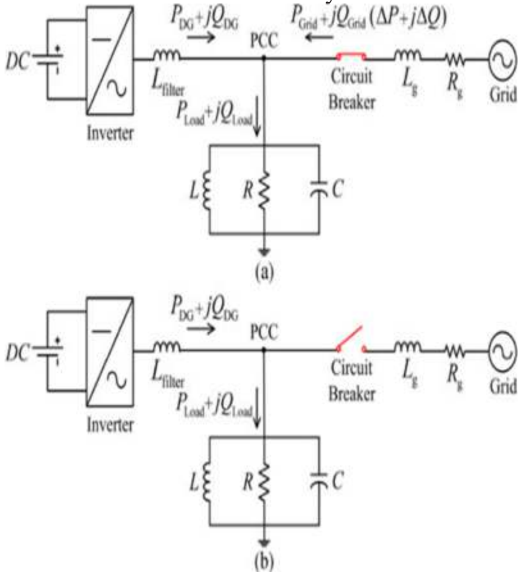

Fig. 4.1 Test system for islanding detection study
(a) Grid-connected operation mode
(b) Islanding operation mode.

Asshown,whentheDGisconnectedtotheutilitygrid,thefollowingequationsdescribethepowerflowsandtheactiveandreactivepowerconsumedbytheload:

$$P_{load} = P_{DG} + P_{Grid} = \frac{3v_{PCC}^2}{R} \qquad (1)$$

Qload = QDG +QGrid =3V_PCC^2 (1/2πfL-2πfC) (2)

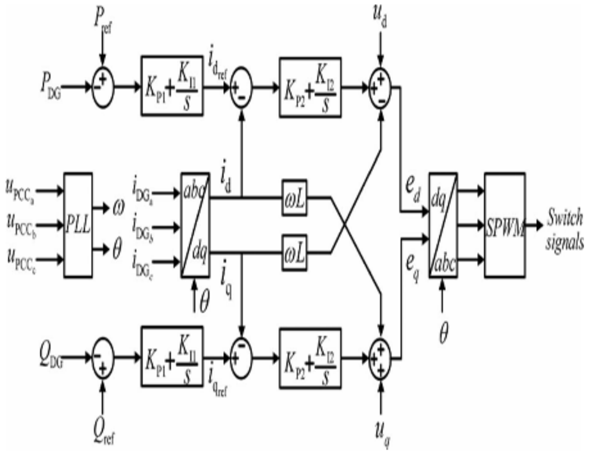

Fig.4.2. DG interface control for constant power operation.

V.MATLAB DESIGN AND RESULTS

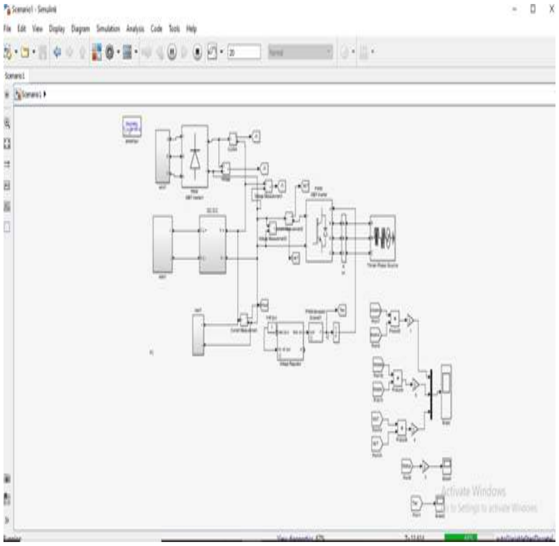

Fig.5.1: DC microgrid with microturbine, fuel cell and load.

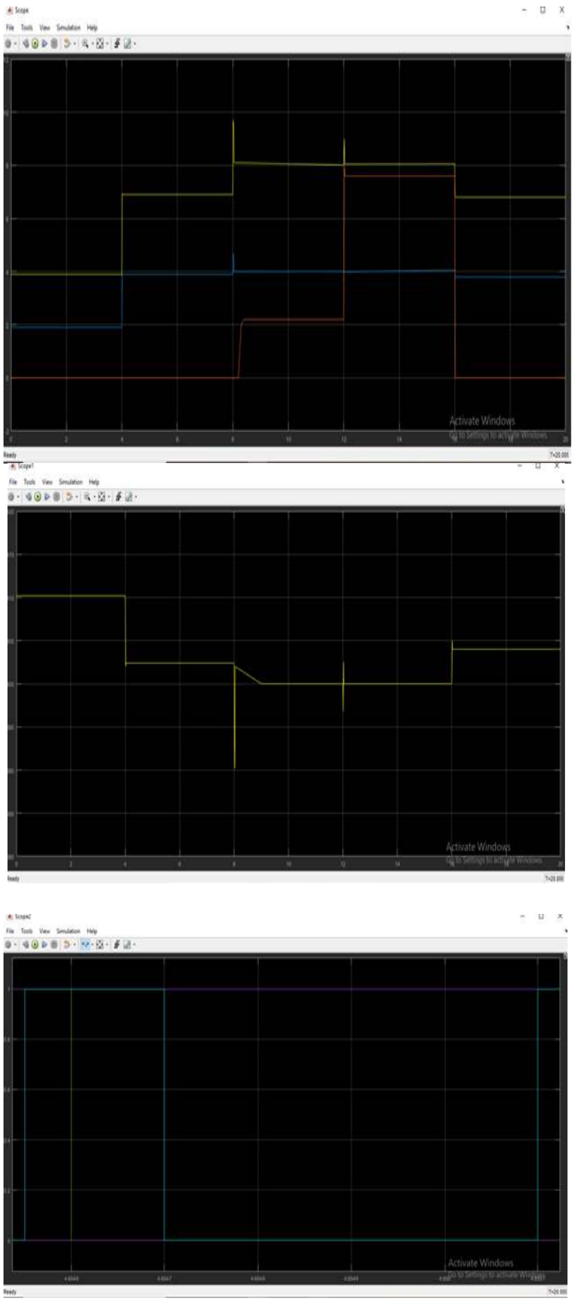

Fig. 5.2: Results showing (a) generators and tie-converter power, (b) DC microgrid voltage and (c) tie-converter control signals for four different load operating conditions.

DG INTERFACE SYSTEM:

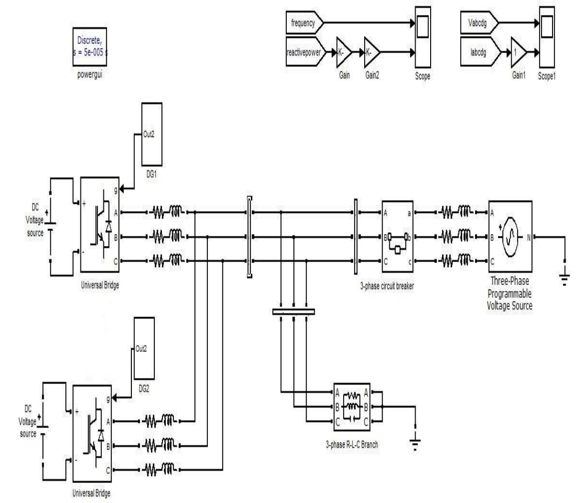

Fig. 5.3 Overall Configuration of the Islanding Detection Method

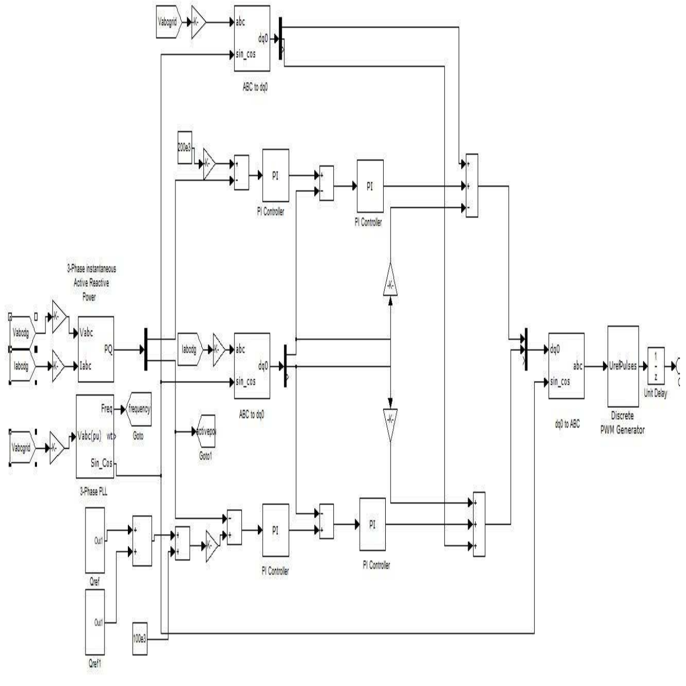

Fig 5.4 The block diagram of the DG interface control

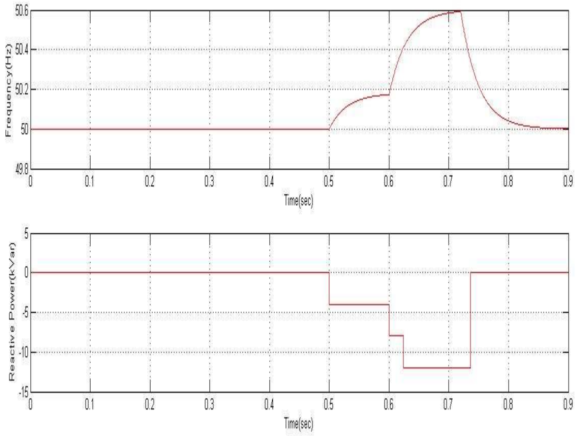

Fig 5.5 shows Reactive power and frequency vs time In sec

CONCLUSION

An autonomous power management scheme has been presented for interlinked AC-DC micro grids having different configurations. The proposed scheme manages the power deficit in the DC micro grid efficiently and autonomously. The number of tie-converters in operation has been reduced with the proposed prioritization to avoid unnecessary operational losses. A DG interfacing network and its control also to be simulated to analyzed the system stability .The scheme has demonstrated better voltage regulation in the DC micro grid. The performance and robustness of the proposed scheme have been validated for two different scenarios of the DC micro grid at variable load conditions.

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