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Renewable Energy Based Voltage Modulated Direct Power Control (DPC) for Grid Connected Voltage Source Inverter with Filter

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ABSTRACT

In this research, we propose a voltage modulated direct power control (VM-DPC) scheme for a three-phase voltage source inverter (VSI) coupled to a weak grid, where the PLL system may cause the system to become unstable if the traditional vector current control (VCC) method is used. The fundamental advantage of the proposed VM-DPC approach over the usual VCC method is the elimination of the PLL system. Furthermore, the VSI system must create some amount of reactive power in order to inject the rated real power into the weak grid. An eigenvalues-based analysis reveals that the suggested strategy allows the system to track its desired dynamics within a given operating range. It's worth noting that the SVR's needed power rating is quite low (say, 2.7 percent) when compared to the load demand when 5 percent voltage regulation is taken into account. The voltage regulator is attached at the mid-point of the grid in this work, although it might be linked at other locations to acquire the best rating. In MATLAB/SIMULINK, the proposed configuration is simulated. The theoretical expectations are closely met by both simulation and experimental data.

I INTRODUCTION

Voltage source converters (VSC) are widely utilized in smart grids, flexible AC drive systems, and renewable energy sources in current power networks (such as wind and solar). The grid linked voltage source inverter (VSI), which is normally managed as a current source injecting current into the grid, is one of the fundamental techniques in VSC. Traditional vector current control algorithms are commonly employed for network connected VSI to provide acceptable control performance. However, the network-related VSI, which employs a conventional vector current control method, is said to be unstable and perform poorly. Furthermore, as the penetration of renewable energy sources within modern power grids grows, the grid-connected VSI's capacity to maintain stability or high control excellence becomes increasingly critical. Course present control, which uses a phase protected loop (PLL) for network synchronization, is a widely used VSI control method. PLL has been shown to have a negative effect on the stability of tiny VSI signals in recent years. The PLL has been observed to diminish VSI stability by providing negative incremental confrontation at low incidences. The PLL-presented VSI frequency coupling dynamics have also been clearly displayed. The bandwidth of the PLL determines the incidence variation of negative resistance. As a result, a limited bandwidth PLL is commonly utilized to increase VSI stability, which severely degrades the system's dynamic performance. Furthermore, even though PLL is designed to have a very narrow bandwidth, maintaining stability in extremely weak network situations, such as when the network impedance is near to 1: 3 pu, is difficult with VSI. [2] [3] Wang recently discovered brief harmonic constancy in current power grids induced by grid-connected VSI, where small VSI signal dynamics tend to present negative checking, which can occur in a variety of frequency ranges depending on the two controls on the Inverter Device. Situations involving a converter or a power system. As a result, a PLL-free control technique is necessary to assure stable VSI functioning in poor network conditions. Direct Power Control (DPC) has been investigated as a control approach for network connected VSI to directly control prompt active and reactive power without utilizing an internal loop present regulator or PLL system. However, the flexible swapping frequency based on the switching state is the fundamental downside of these approaches, which might result in an unanticipated wideband harmonic spectrum, making it difficult to project a line filter effectively. Many DPC solutions have been developed in order to obtain a constant switching incidence. In each switching cycle, some of them use spatial vector inflection or calculate the needed converter voltage vector[4][19]. Furthermore, to ensure quick chasing presentation of active or sensitive power, slider mode control is applied to the DPC method, and passive DPC-based control is proposed, taking into consideration the system's inherent dissipation. However, unwanted swings in active or responsive power still occur. Model Predictive Control (MPC) -DPC, one of the best regulator algorithms, is developed intuitively with multivariate conditions, nonlinearity, and system restrictions in mind. MPCDPC picks a sequence of voltage vectors or computes duty cycle for each sampling period. MPC-DPC provides a constant conversion frequency as well. However, this can add to the computing workload. Gui et al. recently presented DPC network voltage modulation (GVM-DPC), which addresses the DPC technique's fundamental drawback, namely steady state presentation. [17] The distribution generator (DG) generates the linear invariant time system (LTI) based on the relevance of photovoltaic (PV) energy based on GVM-DP (PV) and its integration. The system is designed and analyzed by VSI. The issues that microgrid applications face will be discussed in this chapter. The topics of DG and micro grid will be thoroughly covered. The transition from a passive distribution network to an active technical state is examined using an adequate bibliographic survey. The present technological and economic benefits and challenges account for the gap in the literature. The identification of these modes has been addressed in the scope of current research since the microgrid can function in standalone interactive mode with the network. PV is mostly concerned with DG-based integration. The newest breakthroughs in PV (literature), PV integration via voltage source converters (VSC), and grid synchronization are all discussed here. The role of distributed PV-based generation in present and future Indian electricity scenarios is discussed in this article. Because the photovoltaic system's damping curve is minimal, the major goal is to increase the stability of the independent DG controller. [5] [6]

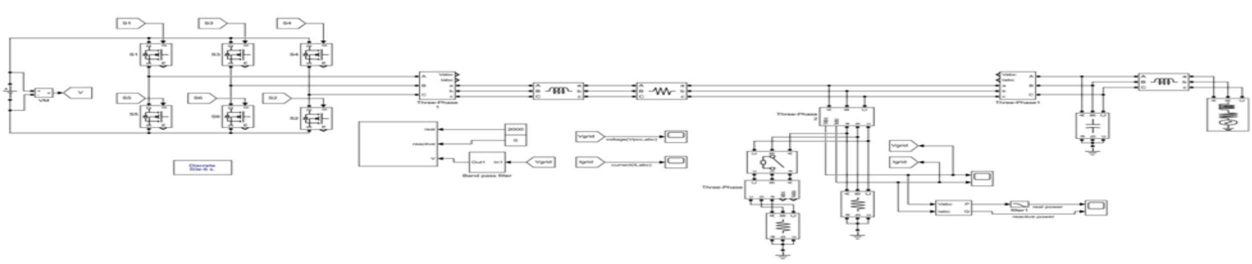
II RELATED WORK

The power to switch to renewable incomes is to switch dynamism manufacture to dispersed nodes, so Pulse Width Modulation (PWM) voltage source inverter (VSI) becomes a generally used border route among renewable resources or power grid .The extensive use of PWM inverters in control grid makes constancy examination of grid connected VSIs the main alarm of electrical engineers. Numerous educations have shown that constancy of the network connected VSI is influenced by controller or filter strictures .In addition to filters or control parameters, a weak power grid will also disturb constancy of the network connected VSI .Weak lattice is usually defined as a low short circuit (SCR) lattice, that is, high impedance or low inertia continuous (H), which is a typical feature of microgrids. As a outcome, power or frequency will be slanted in the weedy grid. Besides, if the power at common switching point (PCC) has harmonic components at natural frequencies of LCL filters. the network connected VSI may become unhinged. If voltage supply path is used to decrease reply time of closed circuit scheme, the situation will be more complicated.[10][11][13] Equally, connexion path in the control plane may cause the system to tend to be unstable in the lattice with current harmonics .Therefore, the constancy examination of the inverter in the weak current network is a complex difficult which requires a detailed dynamic model. Root locus state planetary or Nyquist impedance based techniques have been described for stability examination of grid connected VSI .Impedance-based techniques use bulky equivalent circuits, so it is not possible to simply investigate the effect of individual circuits and control parameters on system stability. [14][8] In the dynamic analysis of network connected VSI through the state space method, a abridged model is usually measured for system (circuit) or regulator. If you need to investigate the effects of simultaneous changes in circuits and control parameters, this vulgarization makes constancy the whole system is difficult to analyze.[9][10]

III PROPOSED SYSTEM

A typical stiff DC microgrid setup, where multiple power bases are coupled to bus 0 and the loads are associated to the outstanding buses. This scheme is widely used due to its easiness and cost efficiency [1]. Also, for this configuration, development of the load leg is easy. The change in the voltage of the loaded bus is main restraint, which was explained in the first part. The voltage of the buses away from the load (like buses 3 and 4 here) may drop below the specified limit due to loadOne of the key plans in VSC is the grid associated power source inverter (VSI), which is generally measured as a present foundation that injects present into grid. For network associated VSI, conventional vector current regulator strategies are generally used to deliver acceptable control presentation. Though, the network related VSI using standard vector current control strategy is described to be weak and to have stability and performance issues. The proposed scheme involves of two control modules to guarantee that the bus 3 voltage is inside the quantified limits under changed load situations. Block I controls the power flow or maintains a constant voltage at DAB output. Module II shows control of a full-bridge DC-DC converter that operates in power regulator mode. Voltage Control Figure 4 shows the control of a full-bridged DC-DC converter to regulate the output power of SVR (Vsvro). The line voltage drop (up to bus 3) has been used as a reference for the controller. The reference voltage is produced by following formula.

IV .SIMULATION RESULTS



The recommended SVR topology is shown in Figure 1. SVR consists of a DAB and a full-bridged DC-DC converter. The two jumpers (primary and secondary) on the DAB are used to produce high incidence square wave voltages at transformer terminals. The phase shift among the two rectangular waves can be attuned to regulator the control flow from V1 to V2 and vice versa. The energy flow always flows from bridge producing the main tetragonal wave to other bridge [20]. Please note that DAB works in power regulator mode. When output current (Iinb) and the input voltage (V1) change, the DAB output voltage (V2) always maintains its reference value. The DAB constant output voltage is associated to input of full-bridged DC-DC converter. The full bridge operates in power governor mode with unipolar inflection [21] to produce an adjustable DC voltage (Vsvro). Therefore, under stable and transient circumstances, obligatory amount of power by the proper divergence can be further in series with the DC network. In this planned configuration, the SVR controls voltage on bus 3 by adding a controlled series voltage with the proper divergence.

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V*svro= V*grid-V1

The error is shaped in among position and actual output voltage (i.e V*svro- Vsvro) which is fed to a PI controller.

The PI controller provides a control signal (i.e., Vc) to produce PWM signals for switches T9 through T12. The PI controller's gain selection should make the voltage circle bandwidth 10 times less than converting incidence

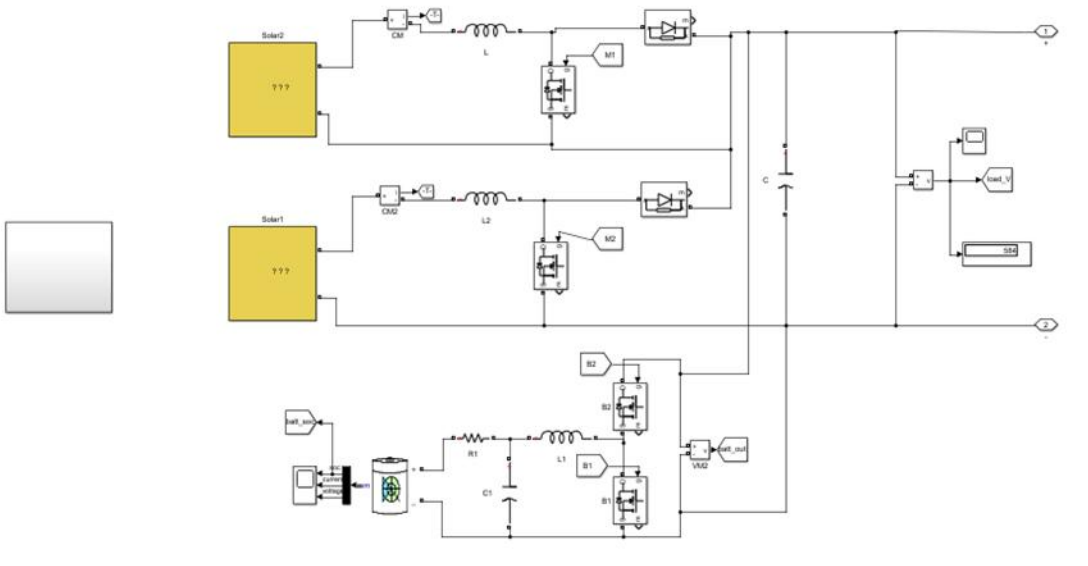


Fig. 4 Solar Sub System

Fig.5 PV Panel Sub System

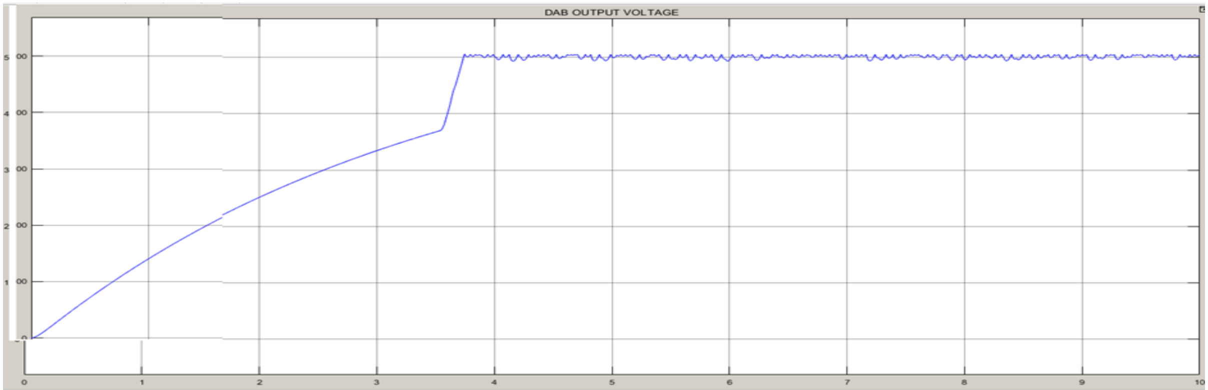


Fig 6 DAB Output Voltage

Therefore, it is possible to manage energy flows forward and backward during brownouts and brownouts, respectively. The condu ction of the switching device in the DAB occurs at zero power, which reduces the transferring loss of converter. SVR can dynamically adjust the DC microgrid bus voltage for various situations loading conditions. The answer time of the SVR during transients is determined by power controller (i.e. the second phase of control circuit) or capacitor associated through the SVR output. Here, the SVR adds the proper series power with the appropriate schism to compensate for voltage drop athwart the line resistor. Figure 9 (c) and (d) shows the SVR input and output voltage, respectively. Also pay attention to the DAB output voltage

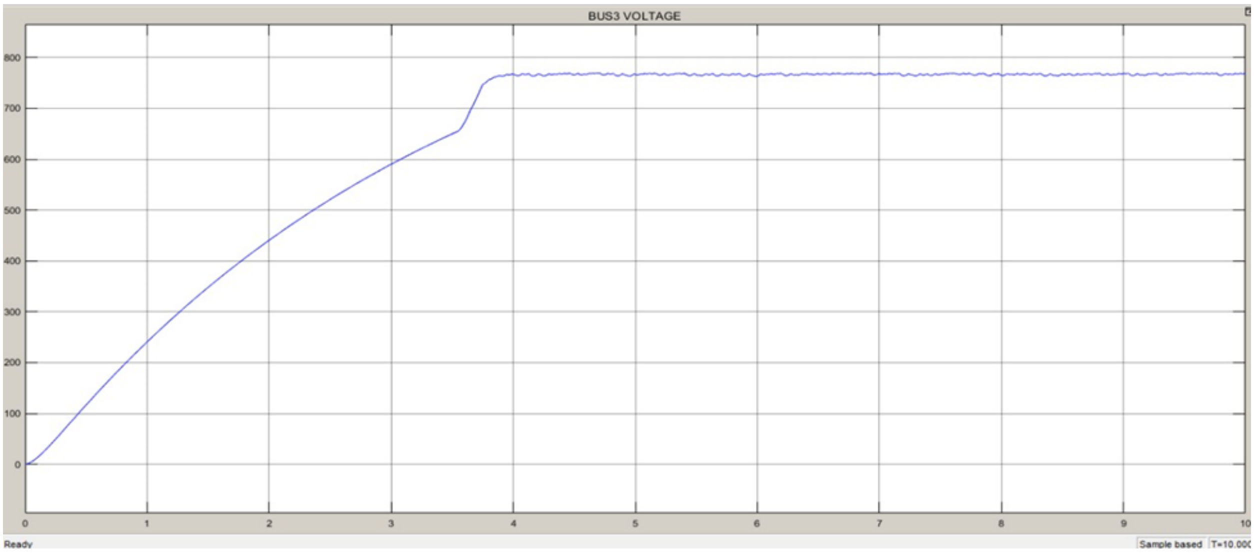


Fig 8 . Bus Voltage

The DC bus voltage is relative to maximum power of network input. What to look for: DC bus voltage is approximately ~ 1,414 x RMS line voltage. The total bypass admission of buses i and yiivi is the bypass current flowing from bus i to ground. Where VR is the reference voltage vector (n-1) × 1-dimensional that contains the relaxed bus voltage on each element.

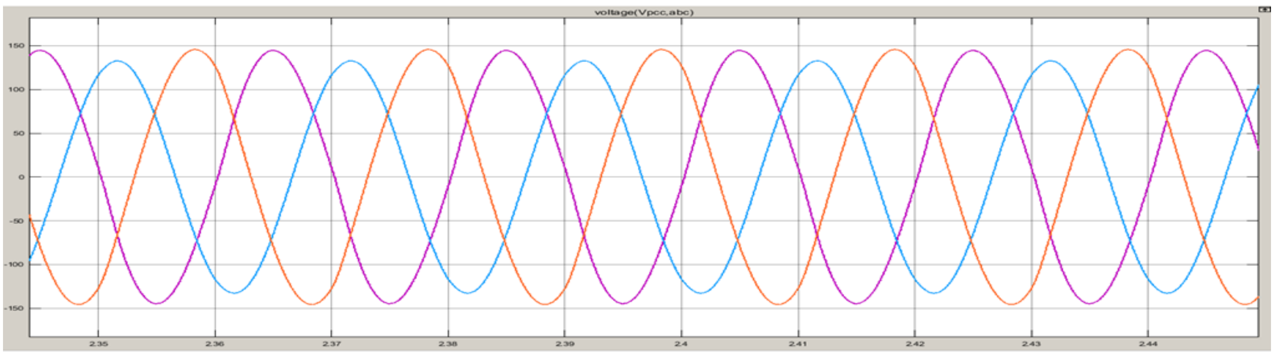


Fig 9 Constant Power

Figure 9 show the solar power output curve and daily load when a constant amount of energy is received from the public power system. The constant power circuit works by calculating the voltage across the load and the current drawn. The charging power limit curve representing the current and voltage amplitude of the charging current within a certain range, the charging circuit can be operated safely

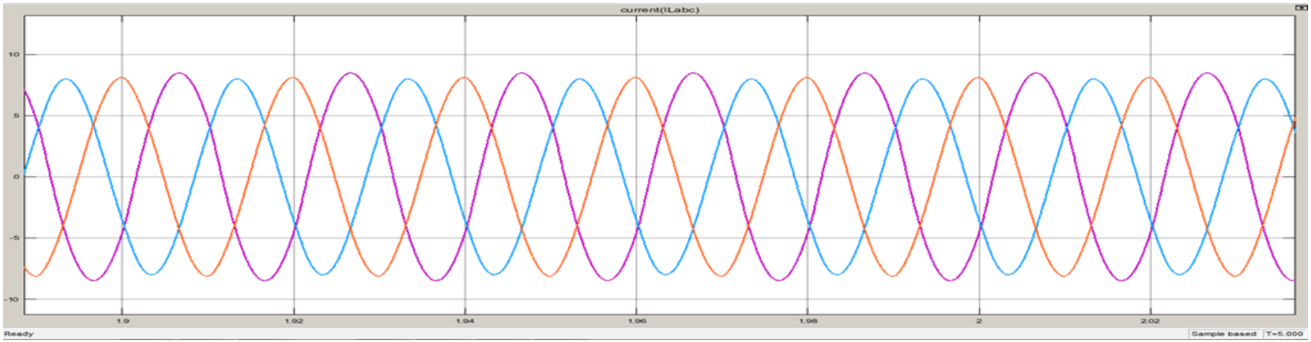
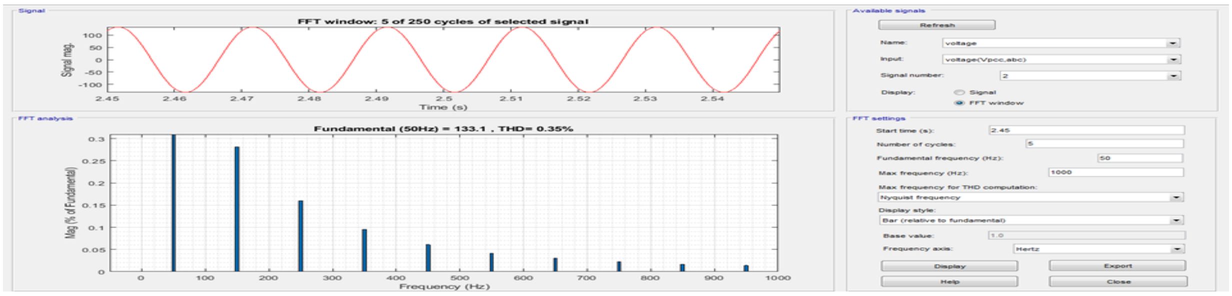


fig 10 Voltage (Vpcc, abc) Current (IL, abc)

V. STABILITY ANALYSIS

Stability Analysis In this section, we use proposed method to study the eigenvalues of the error dynamics. Based on these eigenvalues, we examine constancy of weak VSI associated to the network. First, let's define BPF transfer purpose used in this study as follows: Where is resonance bandwidth, is resonance frequency, and is damping ratio Furthermore, at 0.8 s, when the VSI regulates the active power of 3: 5 kW and the reactive power of 2: 0 kvar, the converter load connects to the PCC or consumes 1.0 kW of active power, as shown in Figure 13. When VSI adjusts the active power or responsive power to 0: 5 kW and 2: 0 kvar, individually, function of the proposed control methodWe also tested the effect of network frequency changes. the frequency changes from 48: 5 Hz to 50 Hz at 0: 8 s, or returns to 49: 5 Hz at 0:85 s. You can see in Figure 14 that VSI quickly syncs the new network frequency. Therefore, we can arrange that the planned control process is vigorous to changes in network incidence. In this case, we also use different BPF parameters (i.e. 0: 3). It can be seen that when network incidence changes, both active power or mercurial power change.



VI CONCLUSIONS

This article presents a VM-DPC stratagem for a three-phase VSI related to a weak network, where the PLL scheme can make scheme unbalanced. We use BPF to connect weak electrical network to the VSI system to apply GVM-DPC concept. Through an exhaustive analysis based on eigenvalues, the system remains stable within this working variety. Also, to inject nominal active power into the weak grid, the system must generate a convinced quantity of sensitive control to withstand the voltage in the PCC. Finally, the reproduction or new outcomes show that the proposed method works well on weak grids.. In proposed method, we tested with DC link we have to improvise into multiple output This system can be used in the application of renewable energy source solar, wind, fuel cell This system can also implemented in the single phase home applications . This article introduces the concept of a new series of DC microgrid regulators. Topologically, this is a cascade of a dual active bridge (DAB) or a full bridge DC / DC converter associated in serial input-parallel or output mode. The dc / dc converter can produce positive or negative voltages, so it can handle power flows back and forth during brownouts and brownouts, respectively. The conduction of the switching device in the DAB occurs at zero voltage, which condenses the substituting loss of converter.

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