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Series Voltage Regulator for Radial DC – Microgrid

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Abstract - *For maintaining constant power supply it is important to regulate the voltage. Different techniques are used for maintaining constant power supply. Voltage regulator is used to regulate the voltage level. Here Series voltage regulator is used for constant voltage supply in radial DC microgrid. Series voltage regulator is the combination of Dual Active Bridge and Full Bridge DC-DC Converter. This circuit operates in two control modes they are power control mode and voltage control mode. Dual Active Bridge produce constant voltage and Full Bridge DC-DC Converter gives adjustable dc voltage. So, according to the requirement it gives output means voltage level at the different points becomes independent of the load variation. This configuration is simulated in MATLAB/SIMULINK. It is simulated in MATLAB/SIMULINK to check the dynamic performance of the system. With the help of them voltage fluctuation related problems overcome. DC distribution system is maintained regulated with the help of SVR.*

Key Words: **Series Voltage Regulator, Dual Active Bridge, DC-DC Converter**

1. INTRODUCTION

Microgrid is a group of interconnected loads and distributed energy resources such as fuel cells, photovoltaics (PV) etc. If the overall operation of the microgrid is managed perfectly it is beneficial for overall system performance.[1][2]DC distribution system is more beneficial than ac distribution system. DC distribution system offers higher energy efficiency, cost ,reliability and safety benefits than ac distribution system. A DC distribution system is the simple integration of renewable energy resources. For constant voltage regulation droop control technique is used but there are some voltage drop related problems arised.[3] In ac distribution system voltage regulation problem can be solved using dynamic voltage restorer. For the improvement of voltage quality DVR is used. In case of DC distribution system this problem is minimized by placing DG in the bus. In this paper SVR is the combination of DAB and full bridge dc – dc converter. From various dc-dc converters DAB is selected because it is having moderate power rating, high efficiency and provides isolation between input and output. In the second stage dc-dc converter change the polarity of the output voltage and regulate the voltage as per requirement. For maintaining fast and accurate control, stability dc-dc converters are used.

2. RELATED WORK

On this technique there has been more research is done. Many methods are modified for control purpose.

DBS System:

It is the method of scheduling the sources in the dc microgrid without the use of central controller. In this system each source and storage interface converter are made independently controlled by each other. Changes in the load and generation creates changes in voltage level. Then converter switch between constant voltage and constant power operation. Therefore dc bus acts as the communication link between sources.[4]

Hierarchical control of Microgrid:

This method is suited for both dc and ac microgrids. This method consist of three levels as follows:(i) Primary control is based on the droop method (ii) Secondary control allows restoring deviations produced by the primary control.(iii) Tertiary control manage power flow between the microgrid and the external electrical distribution system.[5]

Autonomous DC voltage control of a dc microgrid with slack terminals:

If there is variation in generation and load slack terminals respond to those changes and maintain the voltage. Here slack terminals are considered as VSC and energy storage systems. Under various operating conditions such as power variation, islanding and grid reconnection a prototype microgrid with two power and two slack terminals is established for excellent performance of the system.[6]

DC – Electric Springs

The DC electric springs can provide dynamic voltage regulation for DC bus. They are connected in series with the non critical loads and their operating modes have been analyzed and explained.[7]

SOC- Balancing control of a battery storage system based on a cascade PWM inverter:

Fluctuating electric power is produced by renewable energy sources such as wind turbine generators and photovoltaics. This fluctuating power can be compensated by installing an energy storage system. It describes battery energy storage system based on a cascade PWM converter with focus on a control method for state of charge balancing of battery units.[8]

3. METHODOLOGY

In this paper the concept of the series voltage regulator is explained. Input of the SVR is connected in parallel and output is connected in series mode. Here SVR consist of DAB and full bridge dc-dc converter. During voltage sag and swell dc-dc converter is capable of handling forward and reverse power. Switching devices in DAB are turned off at zero voltage so that, switching losses are minimized. Load current sharing and circulating current issues are solved by droop control method. But drawback of this method is that it is having poor current sharing and voltage drop problem. Droop index is introduced in order to improve the system performance. Using modified droop control technique this problem is solved.

4. SIMULATION MODEL FOR SVR

To implement and design a power system model MATLAB/SIMULINK is used. SIMULINK/Sim Power System has number of advantages over other systems. It is having number of advantages due to its powerful graphical structure, versatile analysis and graphic tools.

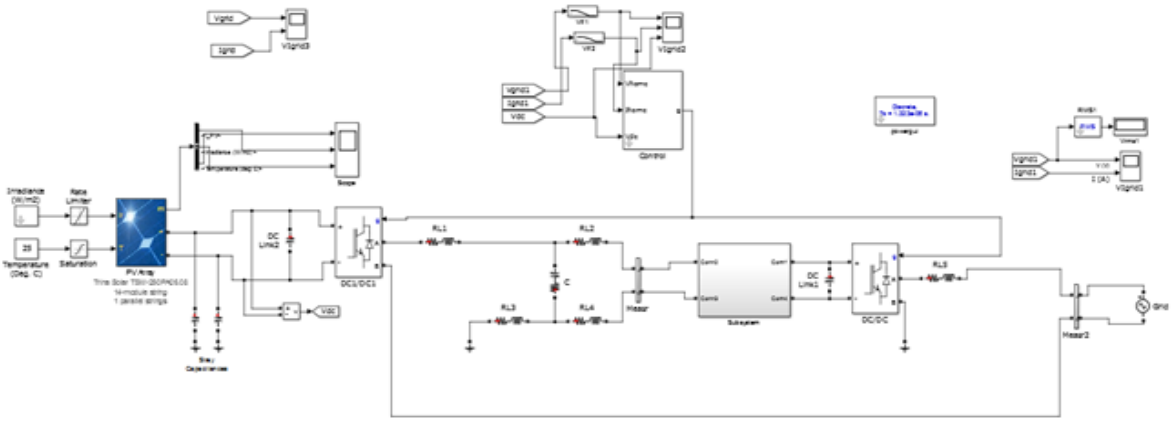

Fig1. Simulation of SVR

Above figure shows the simulation model of the series voltage regulator. It is the combination of DAB and full bridge dc-dc converter. SVR is placed before bus-3 because after that bus voltage drop is more. Output of the DAB is connected to the input of full bridge dc-dc converter.DAB operates in power control mode to maintain the required power flow through the SVR. That's why ouput becomes constant. Full bridge dc-dc converter produces adjustable output voltage. For simulation study a dc microgrid at 380V level is considered. Transmission line resistance is 0.35Ω. Parameters of SVR for simulation are P_o = 500W,V_1 = 380V, V_{svro} = 0-24V,C_1=500μF,C_2 = 1200μF,L_d =3.034mH,C_o=20μF,L_0= 2.2mH.

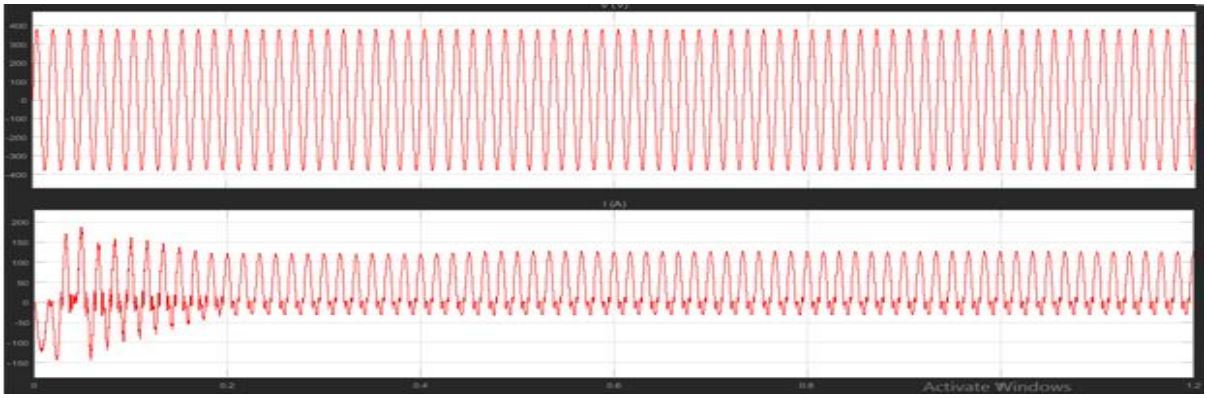

Fig 2. Graph for Grid-1

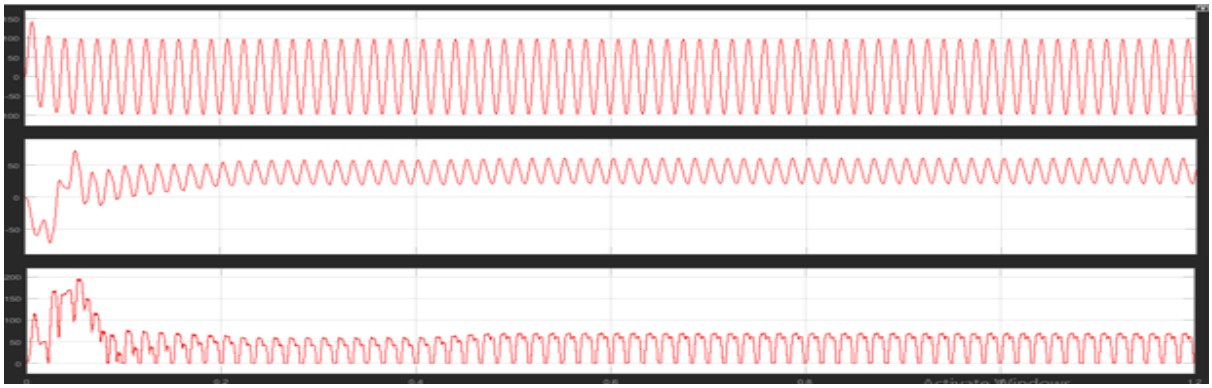

Fig 3. Graph for Grid-2

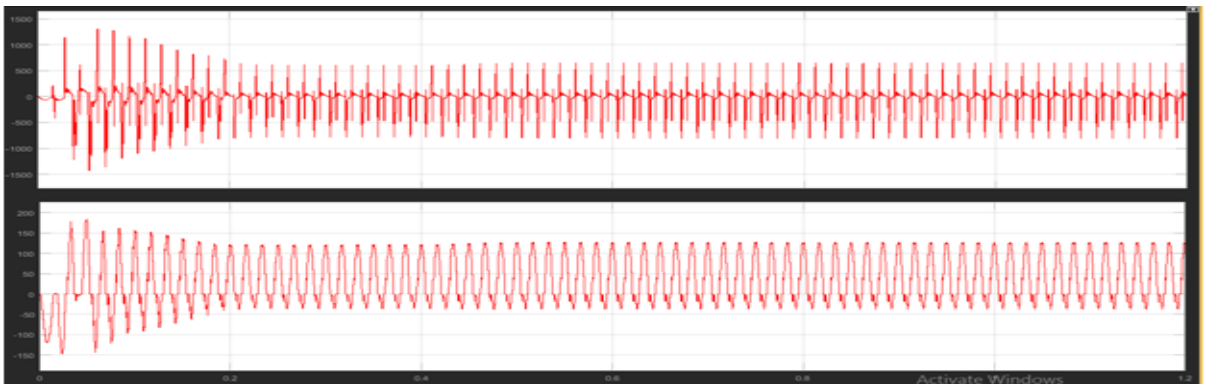

Fig 4. Graph for Grid-3

From above figures it is observed that output remains constant. Graphs are plotted between voltage and time..If we considered that the microgrid is running at light load condition then voltage of all the buses stays close to bus-o voltage. Now suddenly load of all the buses is changed from 30% to 100%.It is observed that the bus-3 voltage suddenly falls below desired value. It is observed that DAB output voltage is maintained at it's reference value under the variation of load.

5. CONCLUSION

In this paper series voltage regulator is used which regulates the output voltage and output voltage stays within limit. Here is the combination of two converters i.e Dual Active Bridge and Full Bridge dc-dc Converter. They are connected in input parallel and output series mode. The dc-dc converter is capable of handling forward and reverse power during voltage san and swell. DC distribution system is regulated by using SVR. Its performance is checked through simulation. This SVR removes voltage fluctuation related problems.

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