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Inverter Control Analysis in a Microgrid Community Based on Droop Control Strategy

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Abstract

Power-sharing in a microgrid community (MGC) requires mandatory strategies in order to stabilize the system by maintaining the rated frequency and voltage. The hierarchical control strategy is the most adopted control structure due to providing seamless operation in transient between islanded and grid-connected modes. Droop control strategy is discussed in this paper to control the voltage source inverter (VSI) in power exchange mode with other microgrids (MGs) or main utility grid. After analysing the average model of three-phase VSI, the voltage and current transfer functions are obtained according to the considered droop controller. The stability and seamless operation of the system are analysed, and the simulation results verify the control loops of the VSI can handle the power variation of the MG effectively.

This study is ordered as below (the colors correspond to the parts with the same color):

1) Steady-State Operation Based on Droop Control
Fig. 1 shows the microgrid community.
Fig. 2 represents a sample MG consists of PV, WT, and BAT.
Fig. 3 illustrates the droop control strategy.

2) Inverter Control (Fig. 4)
- Average model of inverter
- Voltage control loop (with/without Feed-Forward (FF)) (Fig. 5)
- Current control loop (Fig. 6)

3) Simulation Results

Fig. 1

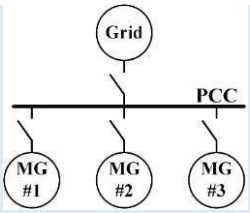


Fig. 2

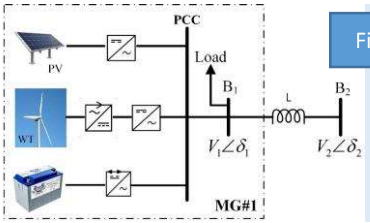


Fig. 3

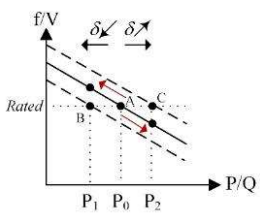


Fig. 4

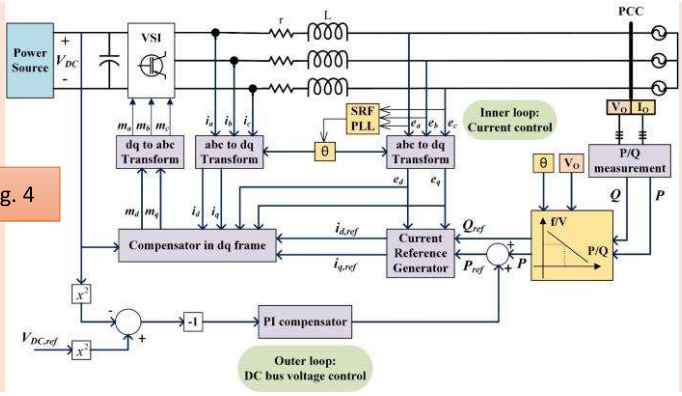


Fig. 5

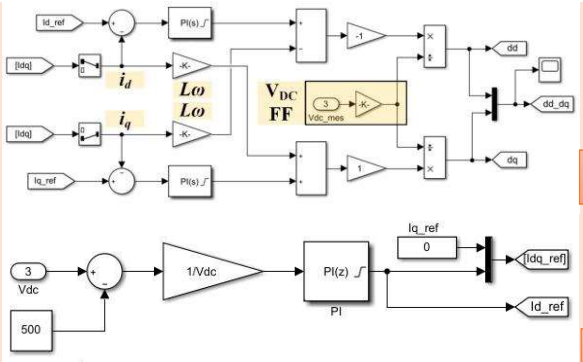
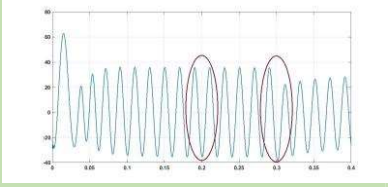
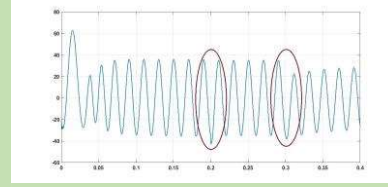


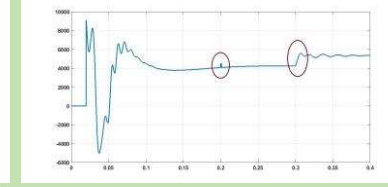
Fig. 6



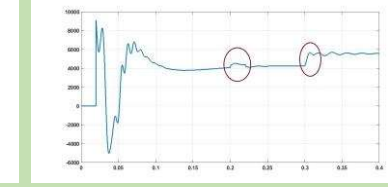
inverter current with FF



inverter current without FF



inverter power with FF



inverter power without FF

The main duty of voltage and current loops is stabilizing the inverter operation regarding the variation of reference values and input voltage V_{DC}.

Feed-Forward circuit can provide the following advantages in the design and control of inverter:

- Complete linear system is obtained,
- Plant is only dependent on the inductor value,
- Design the compensator is easier,
- Optimum design for the compensator can be obtained.

Conclusion

This paper investigates the droop control strategy in order to control the MG to maintain the frequency and voltage of the MG. Then, by considering the average model of a VSI, the inner and outer control loops with and without input voltage VDC Feed-Forward circuit are discussed. The control loops verify the stabilization of the inverter operation in case of changing the input voltage VDC reference, and active power reference of the control loops by droop controller. Eventually, the simulation in Matlab/Simulink shows that the designed voltage and current PI compensator make the VSI capable to handle the stability of the inverter based on the droop control strategy. The effect of VDC FF is also presented in the simulation results, and the smooth operation of the inverter in the case of using VDC FF can be observed. In future work, the theoretical considerations on system stability will be discussed