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Modeling and sensitivity study of consensus algorithm-based distributed hierarchical control for DC microgrids

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Abstract— Distributed control methods based on consensus algorithms have become popular in recent years for microgrid (MG) systems. These kind of algorithms can be applied to share information in order to coordinate multiple distributed generators within a MG. However, stability analysis becomes a challenging issue when these kinds of algorithms are used, since the dynamics of the electrical and the communication systems interact with each other. Moreover, the transmission rate and topology of the communication network also affect the system dynamics. Due to discrete nature of the information exchange in the communication network, continuous-time methods can be inaccurate for this kind of dynamic study. Therefore, this paper aims at modeling a complete dc MG using a discrete-time approach in order to perform a sensitivity analysis taking into account the effects of the consensus algorithm. To this end, a generalized modeling method is proposed and the influence of key control parameters, the communication topology, and the communication speed are studied in detail. The theoretical results obtained with the proposed model are verified by comparing them with the results obtained with a detailed switching simulator developed in Simulink/Plecs.

Index Terms— Consensus algorithm, dc microgrids, dc/dc converters, discrete-time (DT) modeling, distributed hierarchical control.

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