A System Identification-based Modeling Framework of Bidirectional DC-DC Converters for Power Grids

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***Abstract*—This paper proposes a system identification framework based on eigensystem realization to accurately model power electronic converters. The proposed framework affords an energy-based optimal reduction method to precisely identify the dynamics of power electronic converters from simulated or actual raw data measured at the converter's ports. This method does not require any prior knowledge of the topology or internal parameters of the converter to derive the system modal information. The accuracy and feasibility of the proposed method are exhaustively evaluated via simulations and practical tests on a software-simulated and hardware-implemented dual active bridge (DAB) converter under steady-state and transient conditions. After various comparisons with the Fourier series-based generalized average model, switching model, and experimental measurements, the proposed method attains a root mean square error (RMSE) of less than 1% with respect to the actual raw data. Moreover, the computational effort is reduced to 1/8.6 of the Fourier series-based model.**

***Index Terms*—Dual active bridge, eigensystem realization algorithm, generalized average model, power electronic converter, identification.**

I. Introduction

OVER the years, power systems with multiple power electronic converters have considerably evolved [1]-[3]. The modern power systems are characterized by an exceptional combination of power electronic converters enabling the interface with renewable energy resources, energy storage resources, microgrids, and DC loads, as depicted in Fig. 1. These controllable converters are capable of incorporating intelligence into the power system because they are equipped with communication capabilities and can make autonomous control decisions at the installation site. However, the interaction between power electronic converters and power systems creates complex dynamic behaviors in the entire grid [1]. Moreover, system-level designers and power system operators require robust tools to model and analyze the network and its elements. In particular, power electronic converters are spread over active distribution networks consisting of commercial off-the-shelf converters, which need to be modelled. Typically, manufacturers do not provide the behavioral model of converters; and consequently, the theoretical and simulation analyses for interconnection and control purposes are rendered infeasible. In power systems with a variety of converter brands, this problem can be more complex.

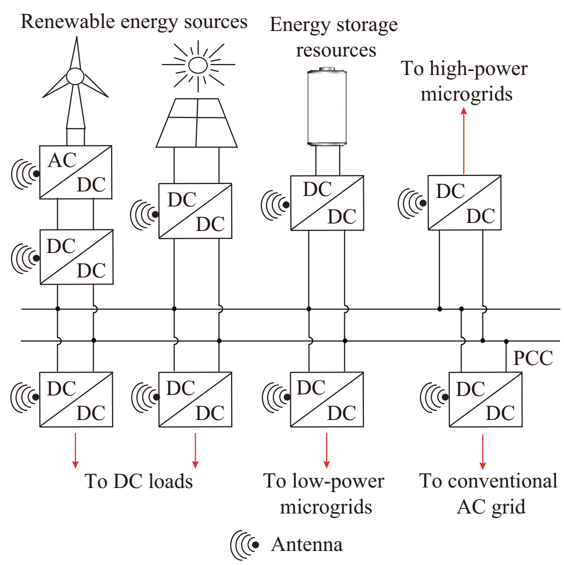

Fig. 1. DC grid scheme.

Although most of these converters can control the power flow among the elements, the high penetration of these devices can increase the probability of conflict between their

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