Field data-based mathematical modeling by Bode equations and vector fitting algorithm for renewable energy applications

ABSTRACT

The power system always has several variations in its profile due to random load changes or environmental effects such as device switching effects when generating further transients. Thus, an accurate mathematical model is important because most system parameters vary with time. Curve modeling of power generation is a significant tool for evaluating system performance, monitoring and forecasting. Several numerical techniques compete to fit the curves of empirical data such as wind, solar, and demand power rates. This paper proposes a new modified methodology presented as a parametric technique to determine the system's modeling equations based on the Bode plot equations and the vector fitting (VF) algorithm by fitting the experimental data points. The modification is derived from the familiar VF algorithm as a robust numerical method. This development increases the application range of the VF algorithm for modeling not only in the frequency domain but also for all power curves. Four case studies are addressed and compared with several common methods. From the minimal RMSE, the results show clear improvements in data fitting over other methods. The most powerful features of this method is the ability to model irregular or randomly shaped data and to be applied to any algorithms that estimating models using frequency-domain data to provide state-space or transfer function for the model.

Keyword: Mathematical modelling; Bode equations vector; Renewable energy applications