General Multi-Phase Element-Based Load Flow for AC–DC Power Systems

Shima Bagher Zade Homayie[1], Bala Venkatesh[1]

[1]Toronto Metropolitan University

Deep electrification of energy systems is expected in the future and distribution systems are pegged to grow several folds interconnecting numerous distributed energy resources such as wind, solar and storage. Accordingly, certain sections of the distribution systems will be meshed to provide a higher reliability due to their critical and enlarged role in energy systems. Furthermore, just like solar farms that internally use DC networks and interface with unbalanced multi-phase AC systems, it is expected that DC networks will continue to expand within AC distribution systems due to advancements in power electronic solutions. Therefore, a multi-phase AC–DC load flow that models both meshed and radial multi-phase topologies is an important analytical tool. Thus far, the literature reports a limited number of methods and restricted commercial grade solutions. To address this challenge, a novel multi-phase AC–DC load flow method is proposed. This method handles diverse multi-phase AC - DC network topologies and component types such as branches, transformers and controllable converters using an element-based modeling technique modeling self and mutually induced voltage drops as dependent voltage sources. Tested across various systems, this method has proven to be robust, computationally efficient, and faster than traditional node-based AC–DC load flow method, while maintaining the same level of accuracy and monotonic convergence.

979-8-3315-8138-1