

A Control Strategy of Multi-Terminal Grid-Forming Soft Open Point for Uninterrupted Power Supply Under Feeder Power Outages

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This paper proposes a control strategy of the multi-terminal grid-forming soft open point (MGSOP), aimed to ensure uninterrupted power supply during distribution feeder outages. Unlike existing approaches, the proposed control does not rely on an ideal DC voltage assumption, master-slave structure, or control mode switching. In the MGSOP, the AC-DC and DC-DC converters are used for multi-feeder interconnections and energy storage integration. The MGSOP control system comprises local and coordinating controllers, used to implement the proposed control strategy, which is made up of three sections: 1) Grid-forming AC voltage control implemented by local controllers, which ensures the independent construction of AC voltage and prevents control switching between grid-connected and standalone modes. 2) Hierarchical DC voltage control collaborated by both local and coordinating controllers. Based on the multi dynamic of DC voltage (ΔU_{dc} and dU_{dc}/dt), the control ensures dynamic DC power balance and DC voltage stability, avoiding system instability and restoration failures caused by the shutdown of the master converter under traditional master-slave control. 3) Coordinated control for the power regulation among multiple feeders, which reduces the consumption of energy storage during supply restorations. Finally, the effectiveness of the proposed control strategy is validated by simulations.