



Prof. Quanrui Hao was born in China in 1984. He received the B.E. degree from Tianjin University in 2006, M.E. degree from Zhejiang University in 2008, and the Ph.D. degree from McGill University in 2013, respectively. He joined in Shandong University in 2014 and serves as full professor in Department of Electrical Engineering since 2020. He was selected as Future Young Scholar of Shandong University in 2019. He also serves as the executive member of IEEE PES DC protection and control technical committee and IEEE PES DC system planning and design technical committee. His research interests include flexible HVDC transmission, hybrid AC/DC grid, power system stability. He is the principle investigator of two national nature science foundation projects and two sub-projects of natural key research & development program of China. He has published more than forty papers and translated two books. The main circuit design software of multi-terminal UHVDC transmission designed by Prof. Hao has been applied for calculation of the real project.

TOPIC: Small-signal models and control of MMC and MMC-based flexible HVDC grid

Abstract: The future HVDC grid will develop to a complex grid composed of many modular multilevel converters (MMC) and various DC controllable devices. Inevitably, HVDC grid will be subjected to various disturbances such as the common single-phase grounding fault at ac side of MMC station. This kind of disturbance may cause the instability of MMC or even the entire HVDC grid. To accurately assess the stability of HVDC grid, this report will first introduce small-signal models (SSMs) of MMC and dc lines considering the frequency dependency of line parameters under unbalanced grid conditions. Next, the report will briefly introduce the modular approaches of small-signal modeling for large scale HVDC grid, including the modular construction of SSM

of the entire HVDC grid from SSMs of various devices, and the modular solution of steady-state values of state variables of the entire system. After that, a reduced-order models of MMC and HVDC grid based on Hankel singular values is proposed to improve the analysis efficiency for large scale HVDC grid. To guarantee the safe operation of MMC under ac disturbance, the allowable operating region of MMC under ac faults is depicted and analyzed. Based on that, the report will introduce a post-fault control strategy, which will automatically shrink the operating point of MMC to the boundary of post-fault operating region of MMC once its original operating point is beyond the post-fault operating region. The introduced post-fault control strategy allows MMC to transfer the maximum power meanwhile no constraint is violated. The designed controller in the modular structure makes it easy to extend and thus to include more constraints.