

Identification of Critical Parameters for AC Fault Response of Modular Multilevel Converters with Partially Black-Boxed Control

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Modular Multilevel Converter (MMC) High Voltage Direct Current (HVDC) systems are controlled through a plethora of control loops arranged in a complex hierarchy. Their response to AC-side short-circuit faults will be an interplay of multiple interacting control loops. The control loops must balance compliance to grid codes with impact on system protection, within the limits imposed by the power-electronic components. This paper uses global sensitivity based on elementary effects and Morris screening to identify the most critical parameters in a partially black-boxed MMC control model. Results show that fault current injection parameters and PLL gains have an impact on both internal and AC-side fault behavior, with nonlinear interaction observed between the PLL gain and droop of fault current injection. Results also show that total energy control has a significant impact on AC-side fault behavior and protection performance, which is usually overlooked by the existing literature. The impact of grid strength, pre-fault operation modes, and fault types is studied to generalize the results under different conditions. The application of global sensitivity analysis in MMC-HVDC systems offers transmission system operators a practical tool for identifying critical control parameters without requiring full model access.