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Test Results of a 7.5 kA Semi-Conductor Prototype Switch as Modular Switchgear in Energy Extraction Systems for the HL-LHC Magnet Test Bench Circuits

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The superconducting magnets, intended for use in the LHC High Luminosity (HL-LHC) project at CERN are based on Nb3Sn technology. Powering of prototypes of such magnets with up to tens of kilo-Amperes are required for detailed studies of the quench behavior, as well as an evaluation of the associated quench protection equipment. For this purpose an ultra-fast energy extraction system is needed to prevent any overheating of the magnet conductors during the quench process which is being analysed. No commercially available opening switch is capable of rupturing a DC current of 30 kA in a highly inductive circuit, within one millisecond and under development of up to 1 kV. This has been the incentive for undertaking the development of such a switch. The choice was to use high-current IGBT's as static switches. This paper presents the arguments for the different choices of topologies and component selections for the 7.5 kA basic module of which four units are composing the final switch. Specific features related to the design, the compensation techniques and the thermal considerations are highlighted. In particular, the paper offers a detailed presentation and analysis of all test results from type testing of the first module, including a comparison with the design-phase calculations and the simulation results.

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