Conceptual Design of the Power Supply system for the in-vessel saddle coils for MHD control in Asdex Upgrade

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In the frame of an ASDEX Upgrade enhancement, a system of active in-vessel coils and conducting wall for MagnetoHydroDynamic (MHD) stabilization is being designed and implemented; it is composed of 24 saddle coils arranged in three toroidal rows of eight coils each and supplied by as many ac Power Supplies (PS). The enhancement is implemented in several stages: a set of sixteen coils (the upper and lower ones, called B-coils), the remaining eight central coils (called A-coils), the first set of twelve fast ac power supplies, the conducting wall and the remaining 12 power supplies [1].
All the coils are rated for 1 kA dc current to produce static magnetic field for Edge Localised Modes suppression; the B-coils are also designed for ac currents up to $f = 1$ kHz for Resistive Wall Mode (RWM) feedback stabilization. The A-coils will allow up to $f = 3$ kHz to produce a rotating field to prevent mode-locking. The required coil voltage is derived from the calculations of the equivalent coil impedance versus frequency [2].
Intensive joint work is devoted to a careful identification of the complete set of PS specification parameters such to guarantee the required performance in terms of MHD control capability but also easy feasibility of the design, adoption of components widely used in the market and cost limitation. Besides the maximum values of current, voltage and frequency for each coil (A – B) and type of control, the additional requirements in terms of amplitude of the output current ripple, of total delay time, of modularity level are deeply discussed. A suitable set of reference waveforms is identified, as necessary for the PS technical specifications and relevant tests.
The conceptual design of the PS system is outlined on the basis of the requirements above described and extensive analysis is performed to verify that the basic schemes identified, based on a cascade topology with two IGBT (Isolated Gate Bipolar Transistor) H-bridges in series for the A units and one H-bridge for the B ones, were able to fulfill all the requirements, with the basic devices operating well within safety operating limits.
Additional studies are devoted to the overall PS scheme and the main features of the ac/dc input sections and dc links, to the evaluation of the best location of the ground connections in order to minimize the amplitude of the common mode currents and to the synthesis of the structure of a suitable common mode filter.
The paper summarizes the work which led to the definition of the PS requirements, describe the topologies of the selected basic units and of the overall scheme, discusses the design choices and report the results of the numerical simulations made to check the overall performance.

[1] W. Suttrop et al. “In-vessel saddle coils for MHD control in ASDEX Upgrade” Fusion Engineering and Design, Vol. 84, (2009), pp. 290-294
[2] M. Rott et al. “Electro-magnetic modeling of the planned active in-vessel coils at Asdex Upgrade”, Fusion Engineering and Design, *Volume 84, (2009)*, *Pages 1653-1657*

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