Overview on the Power Supply Systems for plasma MHD instabilities control

V. Toigo, E. Gaio, R. Piovan, M. Barp, M. Bigi, A. Ferro, C. Finotti, L. Novello, M. Recchia, A. Zamengo, L. Zanotto

Consorzio RFX – EURATOM – ENEA Association, C.so Stati Uniti 4, 35127 Padova (Italy)

Corresponding author: vanni.toigo@igi.cnr.it

The control of plasma MHD instabilities has been assuming a key role for achieving improved plasma performance and advanced scenarios both in Tokamak and RFP experimental machines.
The optimization of the overall plasma performance and the capability to avoid plasma disruption or to mitigate its consequences require, besides the axis-symmetric control of plasma position and shape, the implementation of a large variety of additional controls, such as the local control of non-axis-symmetric components of the magnetic field, the control of the Neoclassical Tearing Modes (NTM), the Resistive Wall Modes (RWM), the Edge Localised Modes (ELM) and even newest ones, which identification has been in progress in the last years.
The implementation of tools for MHD modes stabilization are increasing in the majority of the existing experimental devices also aimed at identifying the most viable solutions for ITER and DEMO. In general, they are based on heating (NBI, ECCD) and fueling (pellet injection) systems and/or active controls with external or in-vessel arrays of non-axis-symmetric coils. Typically, in the last case, the coils are independently fed by dedicated fast Power Supplies (PS) controlled in real-time by digital systems.
RFX, with its MHD control system, composed of 192 saddle coils fed by as many inverters controlled by an advanced real-time digital system, have performed a large variety of experimental campaigns on feedback control of MHD instabilities both in RFP and Tokamak configuration, achieving very significant progress in the understanding and improving of the MHD stability physics.
This paper is focused on the features of the Power Supplies for MHD modes control and deals with them on the basis of the experience gained by working on the design and operation of the RFX system and on the design of similar systems for other fusion experiments, like JET, Asdex Upgrade, JT-60SA.
First, the requirements in terms of power, dynamics, accuracy and delay for these types of PSs, relevant to the different MHD instabilities controls are analyzed.
Then, the paper describes the state-of-the-art technologies both in terms of semiconductors and suitable topologies, summarizing some guidelines for the design.
Finally, a review of the main features of the PSs of the active feedback control systems designed and implemented in the last years in the present fusion devices is presented and discussed.