Heating and Current Drive Power Systems for Steady-State MFE Devices*

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Steady-state magnetic fusion devices require many megawatts of heating and current drive (H&CD). The ITER design has 20 MW each of electron cyclotron (EC) and ion cyclotron (IC) H&CD, and possibly 20 MW of lower hybrid (LH) H&CD, with potential upgrades to 40 MW. The ITER EC system has twenty-four 170 GHz gyrotrons plus three startup gyrotrons. The IC system has eight tetrode rf sources. The planned LH system has 24 klystrons. The proposed configurations for the ITER EC and LH power supplies are similar, with 12 rf sources connected in pairs to a main high voltage (HV) power supply. The IC system has a power supply per source. Although the EC and LH power systems reduce cost by connecting multiple rf sources to a single main HV power supply, problems can arise when the sources, such as the ITER gyrotrons, are not designed to operate at the same voltage.

Each H&CD system has several requirements to fulfill in support of MFE device operations. For example, EC systems are used for plasma heating, current drive, and to control MHD instabilities. The configuration of their power systems must have the versatility to meet these requirements, as well as operate one or more rf sources off-line for troubleshooting etc. If possible, one would like to have a common architecture for the various H&CD power systems to maximize commonality and to avoid the expense of developing several designs.

A power system architecture is proposed that can be readily adapted to a variety of heating and current drive systems. It consists of unregulated main HV power supplies with multiple rf sources connected to each as in the ITER EC and LH H&CD systems. A HV power supply would produce a voltage appropriate for the class of rf sources (klystrons, gyrotrons, or tetrodes) to be connected to it. A separate solid-state IGBT-based pulse-width-modulated regulator is used for each rf source. By providing completely independent control of the voltage applied to each rf source, a very versatile power system is obtained that maximizes the support of device operations by being able to run any source in any of its possible modes of operation, while at the same time providing the capability to troubleshoot any source off-line.

TOPIC: HC: Heating and Current Drive

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