PROPOSED HIGH VOLTAGE POWER SUPPLY FOR THE ITER-RELEVANT LOWER HYBRID CURRENT DRIVE SYSTEM

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The ITER Lower Hybrid Current Drive system aims to generate 24 MW of RF power, of which 20 MW would be coupled to the plasmas. The present state of the art does not allow envisaging a unitary output of the klystrons exceeding 500kW and the project is based on 48 units leaving some margin when the transmission lines losses are taken into account. The major difficulty in expressing high voltage power supply (HVPS) specifications is coming from the fact that necessary sources for LH H&CD system, at 5 GHz, for ITER do not exist yet.

The power supply rating is evaluated based on minimum tube efficiency (~38%) for the worst phase of reflection coefficient. RF power of 600 kW (with some margins for the operation of the tube) at 38% efficiency leads to 1.6 MW of beam energy that can be managed with 75kV/22A or 80kV/20A HVPS. So the rating for an HVPS is proposed at 80kV/90A to combine and operate four klystrons using a single high voltage power supply system. Since single HVPS would be used to operate four klystrons in parallel configuration, the klystron supplier should ensure identical electrical requirements for all the klystrons, to avoid any imbalance in high voltage and hence in output RF power. Based on above considerations, it is proposed to design and develop twelve HVPS, based on (pulse step modulator) PSM technology, each rated at 80kV/90A. In this concept several (~80) individual power supplies (modular type, each rated at 1kV/90A) are stacked together and are connected in series through fast electronic switches, like insulated gate bipolar transistors (IGBT). Following ITER's power distribution layout, the high voltage electrical network includes 400 kV AC transformers, each one having two secondaries: one secondary delivers 66 kV while the other delivers 22 kV. The RF H&CD system will all be connected to the 22 kV lines. The 22 kV line is distributed to 12 feeder lines for 12 units of HVPS, each housing four klystrons. The feeders are protected by the vacuum circuit breaker (VCB) with over current relays, an earth fault relay, an under voltage relay and an over voltage relay. Multi-secondary transformer (22kV/1kV, 6.4MVA) is connected to each of the feeder lines, which powers the individual modular power supplies. All the modular power supplies are controlled and monitored using fiber optics ensuring fast control and noise immunity. It is proposed to accommodate all the twelve HVPS in Assembly Hall. High voltage cables would be used to connect the klystrons, placed in the LHCD source area in the same building.

This paper describes in details, the conceptual design proposed for ITER LHCD high voltage power supply (HVPS) system.