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## Ramping Injector Power Supply for Dipole Magnets

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For the upgrade of the booster of the European Synchrotron Radiation Facility in France, an IGBT based ramping current injection system for the dipole electromagnets has been developed, delivered and commissioned. The main function of the dipole power supply is to drive the necessary voltage for an accurate 4 Hz triangular current wave injection in the electromagnets with peak value of current 1600 A. The inductance of the dipole magnets is 180 mH and their ohmic part 0.56 Ohms. The maximum peak to peak voltage ripple at the specified 6.4 kHz ripple frequency is required lower than 40 V peak to peak which leads to extremely low current ripple. Special requirement for the 4 Hz ramped current injection system was the design for reliability of 90 million load cycles before maintenance. The dipole power supply has been realized by 2 synchronized identical water-cooled units in series connected. Each unit is realized by a 5-level neutral point clamped topology with a passive output filter and it is fed by a 12-pulse rectifier system. FPGA digital control is implemented for the controlled voltage source which results to precise high current injection in the dipole magnets. The synchronized operation of the two units offers in total 9-level output voltage which, in combination with the oversampled digital feedback control, leads to high dynamic performance. The ramping injector power supply also offers IGBT switching frequency 4 times lower than the ripple frequency in the magnets and proper thermal behavior in its nominal operation for high power cycling capability. Test results are available.

### Submitters Country

Netherlands

**Authors:** PAPATHANASIOU, Dimitrios (Ampulz); Mr SUSTRONK, Bart-Jan

**Co-author:** Mr VAN LIESHOUT, Lou

**Presenter:** PAPATHANASIOU, Dimitrios (Ampulz)

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