The Proton Synchrotron (PS), part of the LHC (Large Hadron Collider) injection chain, can be considered as the heart of CERN accelerator complex. In order to bend the trajectory of the particles to be delivered to the LHC, the PS makes use of some 100 dipole electromagnets connected in series. The typical acceleration cycle takes 2.4 seconds. During this cycle the active power at the magnet terminals varies from plus to minus 40 MW. As this large active power variation is not acceptable to the electrical network, energy storage is needed. The old solution, based on a 80t motor-generator set acting as a flywheel, has been recently replaced by a more efficient power system including capacitive storage (called “POPS”: POwer for the PS). The innovative electrical topology developed for such a system is patented.

A simplified schematic is presented in the picture, including:

- 2 step down insulation transformers from the medium voltage network
- 2 AD/DC chargers, each of them supplying a DC/DC converter,
- 6 DC/DC converters series connected, supplying the magnets,
- 6 banks of capacitors connected on the other side of DC/DC converters.

This electrical topology is interesting because it allows applying sufficient voltage on the series connected magnets with smaller voltage applied on the semiconductors, and the energy storage in the capacitors avoids high pulsed power on the public 50 Hz net.

Areas of expertise
Electrical power converters
Applications
This technology is competitive for pulsed electrical applications characterized by:
- High max active power (factor 4 btw average and peak power)
- High voltage and high current (up to ±10 kV / 6 kA)
- Short repetition time (cycling frequency ~1Hz)
- Long lifetime requirement (> 106 cycles, 15 years)

Advantages
- Possibility to make a global voltage exceeding the voltage ratings of components
- Improved reliability through a highly modular approach
- Possibility to make a high voltage without any high voltage transformer
- Reduced harmonics and Common Mode perturbations

Limitations
If none of the advantages is required, drawback of such a topology is to increase complexity, wiring cost and number of components.

Intellectual Property status

Related Publications