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## Driving and protecting superconducting hybrid magnets

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The 45 T hybrid magnet project is developed by High Magnetic Field Laboratory in Nijmegen, Netherlands from an existing 22 MW power supply for its resistive magnet and a new 20 kA current source for the outer superconducting magnet. With 10 V load voltage it requires half an hour to charge to full current. The current source is fed from the 400 V mains and consists of a 12-pulse topology (4x3 pulse) with passive filtering. This will be further detailed in the paper. The new current source will feed the magnet through safety devices that will mostly prevent the superconducting magnet from quenching. These devices will contain redundant DC circuit-breakers opening the current path from the current source and transferring the load current into the parallel connected dump resistor. Further parallel connected with the load is a series connection of dump resistor, DC circuit breakers and semiconductor make switch: the slow dump circuit. Various abnormal and fault scenarios can be dealt with. Coordination in the control of the switches at certain fault levels in one of the power supplies and its protective action will therefore be mandatory to avoid the risk of a possible quench to be minimized. At a positively detected quench or such cases the load current will be transferred within 8 ms into the fast dump resistor at 2.5 kV maximum avoiding any possible damage to the part of the superconductive cable that became normal conductive. A slow dump facility is connected parallel to the load to more slowly reduce the current to zero at 50 V reverse avoiding quenching. Closing the thyristor make switch while opening the fast dump breakers will initiate the load current transfer to the slow dump resistor. In the paper several above mentioned scenarios will be explained.

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