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Design of the Interlock System for MITICA

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MITICA is the prototype of the ITER full-size Heating Neutral Beam injector (HNB). It is being installed in the Neutral Beam Test Facility established at Consorzio RFX in Padova, Italy. The operation of MITICA requires the integrated collaboration of a large set of plant systems, including high-voltage power supply (-1MV / 60 A), radio frequency power supply (4 generators, 0.9 –1. 1 MHz / 200 kW), extraction grid (12 kV/ 140 A) and plasma grid filter (15V / 5 kA) power supply, vacuum pumping and gas injection, cooling system, and cryogenic plant. A dedicated Interlock System will be in charge of the integrated investment protection of the MITICA experiment during operation. It will implement cross-protection actions to avoid that faults generated in single plant systems could propagate to other plant systems and evolve into system-wide faults. Personnel and nuclear safety is taken care of in a dedicated safety system and, therefore, is not part of the MITICA interlock system.

The main requirements of the interlock system can be summarized as follows:

- Reaction to faults within predefined time constraints. Fast and slow protection actions will be implemented. Fast protection shall be capable to intervene in less than 10 us, from fault detection to commands of protection actions, whereas slow protection shall operate in less than 20 ms.
- Two-layer system architecture structured in central and plant system interlock System. Two plant systems interlock systems (PIS) will be implemented: the HNB PIS that is the prototype of the ITER HNB PIS and the MITICA PIS that will manage the protection of the MITICA-specific plant systems such as the cooling and the cryogenic systems.
- Fast prototyping to be ready for the upcoming MITICA power supply integrated commissioning that is expected in the first part of 2020.

The paper will initially present the fault analysis carried out on MITICA from which the Safety Instrumented Functions (SIF) are derived. The allocation of SIFs to the Safety Integrity Levels as per IEC 61508 technical standard is then presented

The hardware and software architecture will be then discussed in detail, with reference to a two-stage implementation approach, aiming the first one to realize a prototype for the power supply integrated commissioning, the second one to provide the entire system where the HNB PIS complies with the ITER requirements for plant interlock systems.

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