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Evaluation and testing of advanced low-voltage power supplies

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Following a process of proof-of-concept on the requirements for radiation and magnetic filed tolerant low-voltage power supplies to be used to power silicon detectors in LHC experiments, a common procurement action was undertaken by the experiments and PH-ESS group.

The evaluation and testing of advanced COTS radiation and magnetic field tolerant low-voltage power supplies is described. An overview of the design principles of the power supplies is given together with the test methods used and results obtained.

Summary

Following a process of proof-of-concept on the requirements for radiation and magnetic field tolerant low-voltage power supplies to be used to power silicon detectors in LHC experiments, a common procurement action was undertaken by the experiments and PH-ESS group. Rather than making a custom design matching the electrical requirements and robust enough to work in their specific environments in term of magnetic field and radiations, it has been decided to select COTS devices following the electrical specifications, test them and adjust their design together with the manufacturer, to make them tolerant to magnetic field and radiations.

Based on the requirements of the all four LHC experiments for regulated low voltage DC power supplies, a market survey for COTS devices was thus launched. A common technical specification was established to fulfil all these requirements:
electrical, tolerance to magnetic field and radiations.

Following the market survey, two main manufacturers were selected and their equipments were evaluated.
First of all, electrical tests were performed to ensure their compliancy to the initial requirements. Several parameters were checked, such as static and dynamic regulation, ripple, efficiency, overcurrent and overvoltage protection and stability. To perform this, an in house test set up was implemented. Moreover, electromagnetic compatibility tests were performed in order to verify the harmonic rejection and the power factor.
The tolerance to magnetic field of these power supplies was then evaluated. The part of the power supply or converter intended to be magnetic field tolerant was subjected to a functional test whilst being exposed to a quoted magnetic field in a calibrated, large aperture electromagnet. The test was repeated in three axes in order to check the sensitive components in the worst condition.
Finally, CERN/PH/ESS group in collaboration with LHC experiments have organized radiation campaigns. Many tests were performed using low energy neutrons to analyze possible displacement damage (NIEL) of the control electronics and proton beam to study Single Event Effects (SEE).
If the equipments were matching most of the specifications (specifically in term of electrical parameters and tolerance to magnetic field), the tolerance to radiations was limited and required some parts of the power supplies to be redesigned in collaboration with the manufacturers.

The process of the evaluation and testing of these advanced COTS radiation and magnetic field tolerant low-voltage power supplies will be described. An overview of the design principles of the power supplies will be given together with the test methods used and results obtained.

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