

Development of Quench Detection Units for W7-X (P1-E-35)

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The Quench Detection System of W7-X will consist of nearly 400 Quench Detection Units (QDU) for the fast and reliable supervision of the 70 superconducting coils and the 120 superconducting bus bar sections.

There will be five control racks with about 80 QDU, a data acquisition unit, an AC-DC power supply with integrated DC-UPS unit in each of the racks and a PC based data management system as an overlay structure.

Each QDU will have a special analogue input circuit realised as a programmable half bridge front end with different polarity-sensing and limiting functions for suppressing high dynamic voltages. Special filter design is included for noise-suppression and over voltage protection. A reconfigurable control/arithmetic unit offers possibilities of future expansions (e.g. all digital evaluation).

The QDU acquires and checks the differential voltages of the superconductors permanently. In case of a quench it triggers the fast discharge of the coils and the storage of the voltage signals on the memory unit. The quench signals are in the millivolt range and have to be clearly identified within a noisy and a high-voltage background within a few milliseconds.

Each QDU transfers the stored signal dates via a high-speed RS-485 serial interface with 20KV optical isolation barrier to the data acquisition unit, an industrial system. A second optically isolated RS-485-network enables interconnection of each QDU in the control rack (Compound-Mode of QDU).

The QDU are designed with an internal failsafe, programmable self test and redundancy feature, broken wire check of the quench detection cables and connectors inside and outside of the cryostat of W7-X.

All QDU will be fed via an UPS supported 24V DC bus through a high voltage isolated DC-DC transformer on each unit.

The design of the QDU allows operation under high voltage levels of up to 8kV and under magnetic stray field levels up to 30mT. The front end is very well isolated and the outputs of the QDU are strictly separated by optical isolating transformers. The differential inputs are equipped with 500V short-time over voltage protection.

The presentation will give an overview of the design of the first prototype.