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Evaluation of the Backup Signal-Processing System of the KSTAR Quench Detection System

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The KSTAR Quench Detection System (QDS) has been operated to protect the superconducting coil system of the KSTAR device in the last decade. The QDS discriminates a normal voltage of ~100 mV on NbTi or Nb₃Sn Cable-in-Conduit Conductors (CICCs) in the event of quench, while the Poloidal Field (PF) coils are applied with voltages of up to some kV by pulsed operation of the Magnet Power supply System (MPS). The high induced voltage is compensated by using analogue circuits with 10–15 kV class isolation and digital signal processors, which consist of 3 aged VME systems.

The QDS mainly consists of high voltage signal interfaces with 83 channels of voltage taps, 3 sets of the VME systems with a host computer, and 1 set of a logic solver. Spare parts of the QDS components have to be always prepared; however, these VME systems are difficult in replication due to particular tailor-made modules. Thus the VME systems are going to have a backup signal-processing system mostly using Commercial-Off-The-Shelf (COTS) devices. The backup signal-processing system may take over the total functions of the VME systems along with newly introducing optical repeaters to split digital communication signals and a superior logic solver at a nuclear safety grade. Both the VME systems and the backup signal-processing system simultaneously operate in normal operation, and interlock signals are voted by 1-out-of-2 (1oo2) logic.

A prototype of the backup system for the PF1-PF4 coils had been developed and integrated with the KSTAR QDS; and then, this prototype was being operated in the KSTAR campaign 2018. On the other hand a supplementary part, which is used for the PF5-PF7 coils and the Toroidal Field (TF) coils, of the backup signal-processing system was completed after the last campaign. This paper describes the development and experimental evaluation of the backup signal-processing system of the KSTAR QDS.

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