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MicroTCA.4 based data acquisition system for KSTAR Tokamak

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The Korea Superconducting Tokamak Advanced Research (KSTAR) control system comprises various heterogeneous hardware platforms. This diversity of platforms raises a maintenance issue. In addition, limited data throughput rate and the need for higher quality data drives us to find the next generation control platform. Investigation shows that many leading experiments in the field of high energy physics are seriously pursuing the modern high performance open architecture based modular design. An extension of Micro Telecommunications Computing Architecture (MTCA) initiated by the Physics community, MTCA.4, provides modular structure of high-speed links and allows flexible reconfiguration of system functionality. For the systematic standardization of the real time control at KSTAR, we developed a new functional digital controller based on the MTCA.4 Standard. The KSTAR Multifunction Control Unit (KMCU, K-Z35) is realized using Xilinx System-On-Chip SOC architecture. The KMCU development is the result of a successful international collaboration. The KMCU features a Xilinx ZYNQ7000 SOC with ARM processor, FPGA fabric with multi-gigabit transceivers, 1GB DDR-3 memory, as well as a single VITA-57 FMC site reserved for future functional expansion. KMCU is matched with a dedicated Rear Transition Module (RTM) with sites for two FMC-like analog Data Acquisition (DAQ) modules. The RTM pinout is compatible with the DESY standard Zone-3 interface, D1.0.

The first DAQ system to be implemented is the Motional Stark Effect (MSE) diagnostic. The MSE DAQ system uses two analog modules each with 16 channel simultaneous ADC sampling at 2MSPS with programmable gain. By using a single RTM with many compatible high performance analog modules, the programmable and reconfigurable KMCU takes advantage of the modular design concept. An internal EPICS IOC easily manages the selected hardware configuration.

Another novel function of KMCU is simultaneous two point streaming data transmission. Some parts of the Plasma Control System (PCS) at KSTAR demand data from diagnostics for 3D reconstruction or specific data processing. KMCU duplicates input data from a rear module and simultaneously transmits it to the CPU and external host system through the MTCA backplane and front SFP+ interface. We are now developing a new functionally optimized KMCU series.

The paper presents the complete data acquisition system and commissioning results of the MSE diagnostics based on the MTCA.4 Standard. We also introduce a conceptual design for real time processing node for plasma control system based on the KMCU.

Author: Dr LEE, Woong-ryol (National Fusion Research Institute)

Co-authors: Dr KWON, Giil (NFRI); Mr HONG, Jaesic (NFRI); Mr KIM, Kihyun (SeedCore Ltd.); Mr MILNE, Peter (D-TACQ Ltd.); Mr LEE, Taegu (NFRI)

Presenter: Dr LEE, Woong-ryol (National Fusion Research Institute)

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