EPICS-BASED THOMSON SCATTERING DATA ACQUISITION SYSTEM USING FPGA SIGNAL MODULE

W.R. Lee[1], M.K. Park[1], S. Baek[1], T.G. Lee[1], J.H. Lee[1], H.K. Na[1], M. Kwon[1], H.S. Kim[2]

[1] *National Fusion Research Institute (NFRI), Gwahangno 113, Yuseong-Gu, Daejeon 305-333, Rep. of Korea*
[2] *Department of Computer Science and Engineering, Chungnam National University, Daejeon, Rep. of Korea*

Corresponding author: hyungshin@cnu.ac.kr

For the 2010 KSTAR experimental campaign, Thomson scattering (TS) diagnostic system has been newly developed to measure electron temperature and density. This diagnostic system using a conventional method is one of the most reliable system among the KSTAR diagnostics. A single Nd:YAG Laser system (2J, 10Hz, 1064nm, 10ns pulse width) fires a beam into the plasma via KSTAR port L. The scattered lights are transferred to polychromators and converted into electric signals. The electric signals are acquired by a charge to digital convertor (QDC) which needs gate inputs and must be synchronized to the laser pulse. For timing calibration of data acquisition system, a high resolution time-to-digital converter (TDC) and a delayed gate pulse generator are designed in a field programmable gate array (FPGA). There are many approaches to improve time resolution in time-of-flight (TOF) measurement technique but they are suffering from unpredictable internal delays of FPGA. After the survey and analysis of current on-going technology, we developed a moderate multi-function hardware module for our Thomson scattering data acquisition (TSDAQ) system. The FPGA-based signal control module of TSDAQ to have VME form-factor, has two ring oscillators with slightly different frequencies to measure an interval between laser beam injection and polychromator sensing time. The vernier method or tapped delay line is implemented for high precision digital delayed pulse generator to get synchronized QDC input gate pulse and beam injection time. The developed signal module is controlled by EPICS interface on a Power PC processor in FPGA and fully integrated into the KSTAR control system. All the functions such as electric signal conversion, switching and distribution, are implemented in the single FPGA signal module. It makes the laser beam injection timing to follow the KSTAR plasma experiment sequence. After initiating plasma experiment, the raw data from the acquisition system is converted to temperature and density values using lookup tables, and displayed in flow charts during the plasma shot and also transferred to MDSplus database simultaneously. Entire data processing and control logics clearly correspond to KSTAR standard control and management framework.
This paper focuses on the operation results of TSDAQ and calibration process with FPGA timing signal module which has an embedded EPICS I/O controller (IOC). We give full details of our basic control framework for diagnostic system which is composed of the EPICS standard, optional support code and tools for IOC. The implemented framework shows robust performance as a plasma diagnostic system controller.