1st Asia-Pacific Conference on Plasma Physics, 18-23, 09.2017, Chengdu, China

Implementation of Drift-Free Integrator for Tokomaks

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In Tokamak operation, the magnetic diagnostic provides input to determine parameters for plasma control, plasma physics and machine protection. Magnetic sensors based on pickup coils and flux loops measure the time derivative of magnetic fluxes, and therefore, such signals have to be integrated in order to obtain flux signals. An analogue integrator is one of the method to achieve such measurements.

The op-amp based integrator is an ideal integrator. Because of inherent characteristics of an op-amp like input offset voltage and bias a drift voltage in output signal is produced. Thus design of a continuous drift-free real time integration system is really a challenge.

The basic blocks of integrator are double symmetrical analogue integrator, a differential amplifier at the output stage and an analogue compensation on each integrator. The analogue compensation uses sample and hold circuit to record and feedback the error offset at the input. The integrator operated automatically in compensation and integration mode, taking the reference of start of pulse. The drift voltage recorded after hundreds of lab experiment is only [1] 2.86 µV.s or 2.8mV for 1000sec.

A prototype of long pulse integrator for 1000 second pulse operation has been implemented, tested and validated in SST-1 Tokamak. The experimental results were compared with numerical integration in time and frequency domain to evaluate the performance of the implemented integrator. The integrators examined in this study are unconditionally stable for a long period. With this accuracy and preciseness, plasma control action for shape and position can be achieved. The same integrators are also tested during the Aditya coil calibration.

The poster will present the implementation, troubleshooting to get correct and clean data and error calculation and comparison with numerical model of rogowsky signal.

Reference

[1] Enhanced integrators for WEST magnetic diagnostics, Fusion Eng. Des. (2015).