A Zynq-based flexible ADC architecture combining real-time data streaming and transient recording

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Abstract:
The RFMx204 backplane fusion experiment is an upgrade of RFMx204, that was shutdown in 2016. Among the other improvements, the new architecture adds a Zynq-based FPGA to provide more information about plasma disruptions and to allow an improved real-time plasma control. The flexible ADC architecture allows both transient recording and real-time streaming. In the present version of RFMx204, transient recording provides still-based data acquisition by recording data in local memory and reading once the memory content after the plasma discharge. At the same time, the real-time data streaming function is enabled by a Zynq-based FPGA that can provide data to a software process in the central control computer.

Flexible ADC SoC implementation:
The RFMx204 improved controllability will require the design of a new ADC architecture able to provide both the transient recording and the streaming of data for the construction of the experiment.

Numerical integration of EM probes for RFMx204:
RFMx204 is a toroidal plasma machine with a diameter of 2.5 m, a major radius of 2 m, and a minor radius of 1.5 m. The experiment is currently being upgraded to RFMx204 [3]. A major concern is the improvement of the magnetic measurement system, which includes magnetic probes of various types and configurations.

EM feedback changes:
1. A new method inside the vacuum vessel to reduce plasma turbulence.
2. A change in the control of the plasma configuration.
3. A new method of using the plasma column for feedback.

The RFMx204 improvements will be presented in the paper.

Noise requirements in ADC stage for digital integration:
If we try to extend the acquisition over a 5 MHz bandwidth, the signal-to-noise ratio (SNR) requirements on the plasma signals become more stringent. The ADC architecture is designed to provide digital integration of the signals, which effectively reduces the noise level. The noise in the ADC stage is primarily due to the analog front-end and the digital backend components.

Working example for event triggered acquisition for NO1:
A new ADC architecture is designed to provide high-resolution data acquisition, which is essential for the study of plasma disruptions. The ADC architecture is optimized for high-speed data acquisition, allowing the capture of fast transient events with high fidelity.

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references:

https://github.com/andrea-rigoni/analieco