A DAQ prototype for Front-end Waveform Digitization In Intensive Electromagnetic Field Circumstance

Zhou He[1,2], Lian Chen*[1,2], Feng Li[1,2], Weigang Yin[1,2], Ge Jin[1,2]

1.Anhui Key Laboratory of Physical Electronics, Modern Physics Department, University of Science and Technology of China

2.State Key Laboratory of Technologies of Particle Detection and Electronics, Hefei, Anhui, 230026

1. Introduction

Plasma confinement and the suppression of energy transport are fundamental to achieving the high-energy-density conditions necessary for fusion applications. Magnetizing the hot spot in an inertial confinement fusion (ICF) implosion can reduce conductive energy transport, thus increasing the ion temperature as well as the neutron yield. Due to the short duration of ICF experiment, we choose the pulsed magnetic field which is easy to generate compared with the steady-state magnetic field. The pulse magnetic field is created by discharging a high-voltage capacitor through a small wire-wound coil, and the Rogowski coil is used to measure the discharge current which can describe the corresponding magnetic field waveforms. Traditionally, the signal from the coil is transmitted to the oscilloscope through a long-distance coaxial cable because the intense electromagnetic radiation poses great threats to the nearby electronic systems.

Therefore, we designed a front-end DAQ prototype to replace the traditional measurement method. Accordingly, the Graphical User Interface (GUI) is written based on LabVIEW application platform, achieving the initialization and control of the DAQ prototype.

2. System Design

A. Hardware

The core of the prototype is based on a cyclone-Ⅲ FPGA, which is configured by a Serial Peripheral Interface (SPI) flash. Since the coil bandwidth is ~3MHz, according to Nyquist sampling theorem, we choose a high speed FADC which has a sample rates of up to 210MSPS. The ESD protection circuit based on TVS transient diode is designed to reduce transient strong electromagnetic interference in ICF experiment. Since signal amplitude generated by the Rogowski coil is large, a type attenuation network is used in order to ensure the signal amplitude within the dynamic range of ADC.

B. *Signal flow in FPGA*

The block diagram of the signal flow in the FPGA is shown in the middle of Fig. 1. The user-defined commands are sent from GUI and derived from the command decoder. At initialization, all the FIFOs and status registers are reset. Then a command for trigger waiting arrives. The system provides two trigger modes, external trigger mode for synchronization with the ICF experiment and internal trigger mode when the signal amplitude is known. The triple modular redundancy (TMR), which can reduce the impact of signal-event upset in strong magnetic field environment, is used in FPGA logic design. Since the electromagnetic interference will greatly affect the signal transmission, the wave signal is stored in the RAM and transmitted to the server after the implosion process.

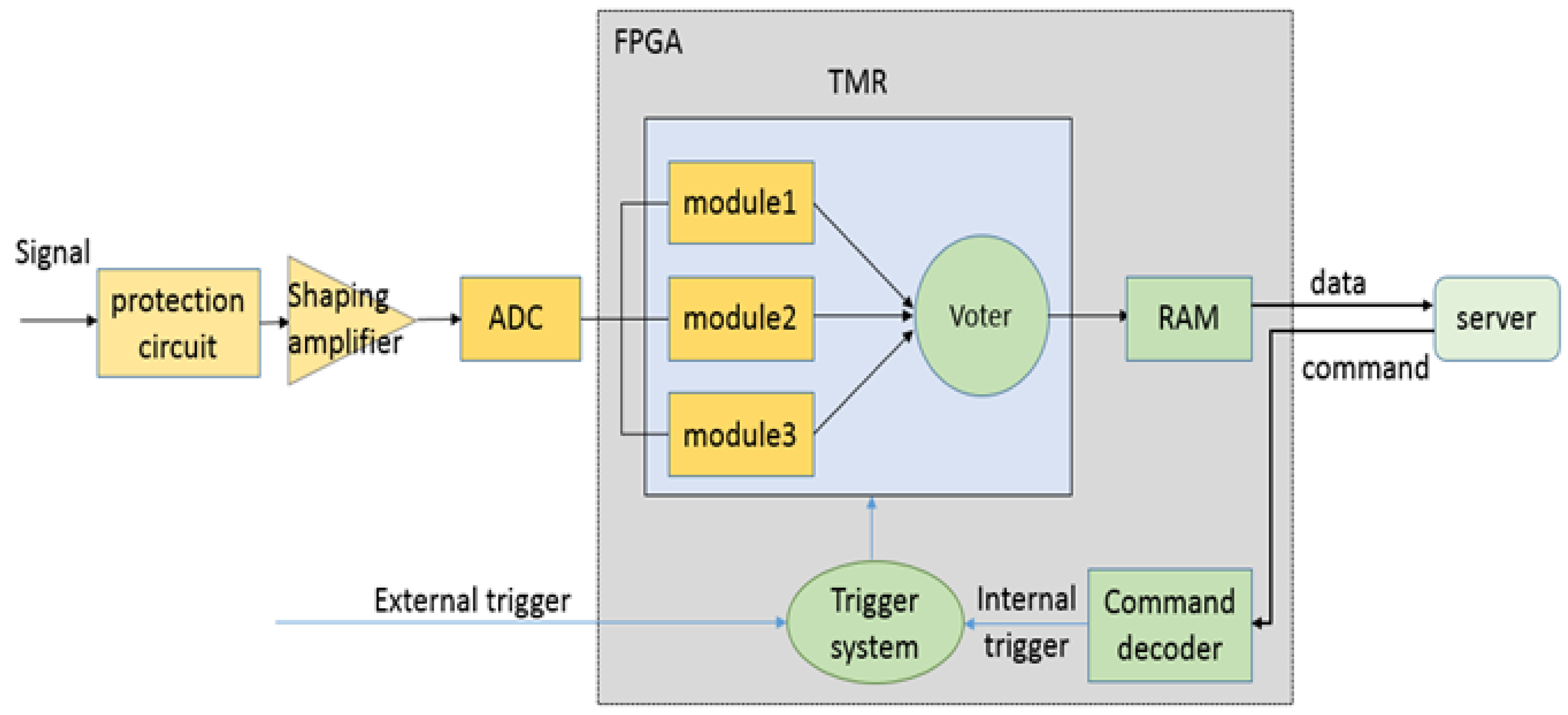

Fig. 1 Block diagram of the front-end signal digital acquisition system prototype

3. Experimental Results

Fig. 2 shows the waveform measured by the prototype. After setting the trigger mode and waveform length, we issue the command through the upper computer. The comparison between the waveform measured by prototype and oscilloscope is shown in Fig. 3. As can be seen from the figure, the prototype can still work normally under the strong magnetic field environment. By comparing the rising time, waveform amplitude, the waveform tested by prototype is consistent with the signal measured by oscilloscope.

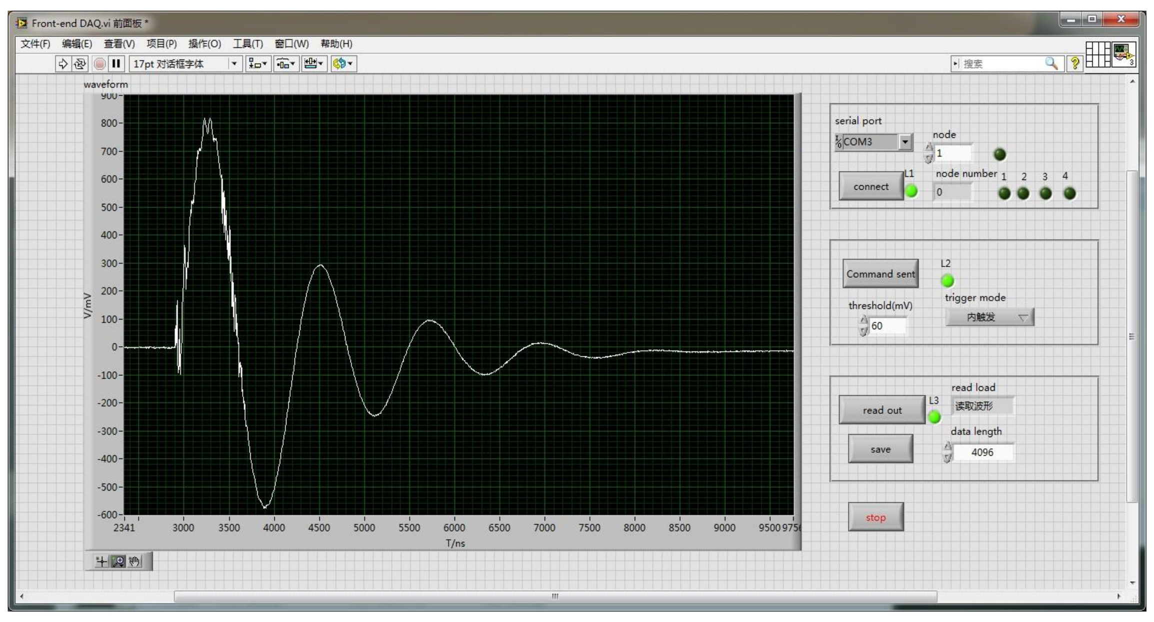

Fig. 2 the waveform from front-end DAQ

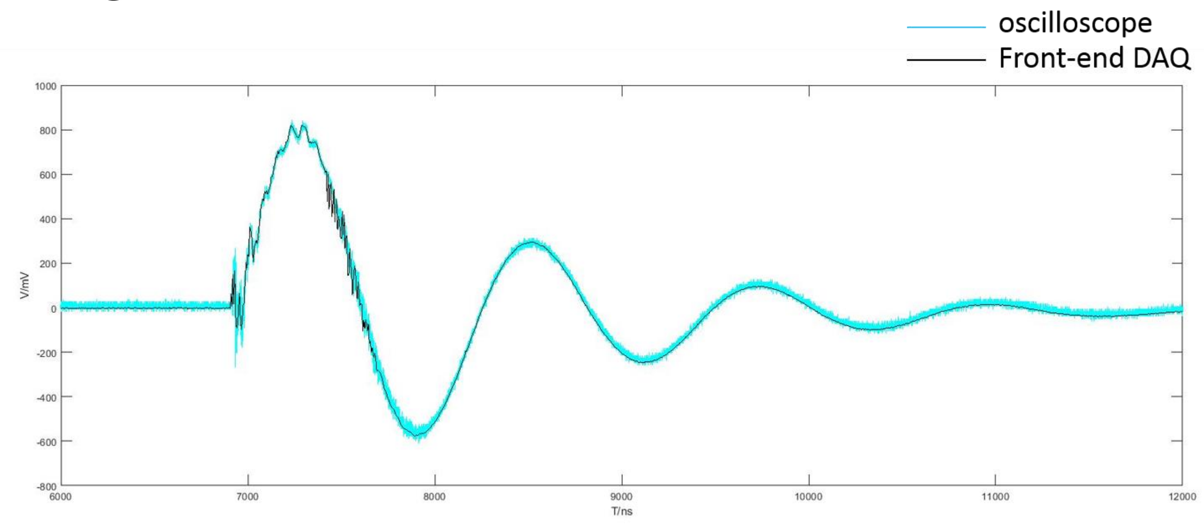

Fig.3 the waveform compared between oscilloscope and front-end DAQ

4.Conclusions

In this paper, we design a DAQ prototype for front-end waveform digitization in intensive electromagnetic field circumstance. It's proved through the outfield test that the prototype can replace the oscilloscope to read out the waveform in the intensive magnetic field environment.