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The implement of control and data acquisition system for the 100 T pulsed high magnetic field facility at WHMFC

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I Introduction

A facility, which will generate nondestructive pulsed high magnetic field above 100 T, is under development recently at WHMFC. There are three types of power supply system at WHMFC, which are the capacitor bank system (CBS), the flywheel generator/rectifier system (FGRS) and the lead-acid battery bank system (BBS). All the three power supply systems are used to drive a tri-coil magnet. The FGRS and the BBS are connected in serial to drive the outer coil of the magnet, eighteen 1 MJ capacitor modules and two 0.8 MJ capacitor modules in the CBS respectively drive the middle and inner coil of the magnet. A control and data acquisition system(CADAS) is developed to control these power supply systems to discharge coordinately and record experimental data.

II Design of global control system

1.structure and hardware of the CADAS

The CADAS is developed on the base of reformation of the existing control and monitor systems of three supply power systems, and involves two new part: a main control program and a global control block. The structure of the CADAS is shown in Fig.1. The main control program and the global control block are the core part of the CADAS, and developed based on the NI CompactRIO system, which adopts three-layer structure: LabVIEW host on computer, LabVIEW RT and FPGA, the latter two parts of which are on the CompactRIO hardware.

2. Design of Discharge Process Based on State Machine

The implementation of the discharge process is the key of the 100T system. Typical discharge process is shown in Fig.2. The control time accuracy is in milliseconds, so the discharge function is implemented by FPGA and programed with a state machine in the global control block, which is shown in Fig. 3

3.esign of data acquisition and status detection

Three fiber current measuring instruments are used to measure the discharge currents of the three coils respectively. In addition, some key output digit signals are also connected back and recorded. These data are written to the FIFO and received by LabVIEW RT program and then are transferred to the main control program to display and save.

4.Design of the main control program

The 100 T experiment operation can be performed by the main control program, the interface of which is shown in Fig. 4. The starting interface of the main control program is divided into the left side of the parameter setting area, the right side of the operation button area and the bottom side of the state display area, and it can also display various types of event recording and discharge waveforms during operation in other tab pages.

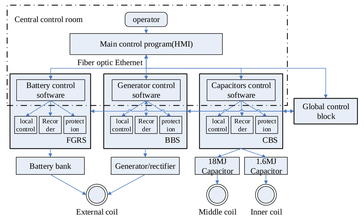

Fig.1. the CADAS structure

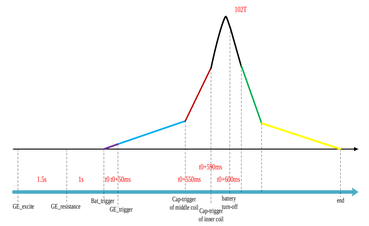

Fig.2. Time sequence of discharge

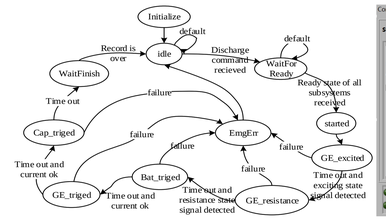

Fig.3. State machine diagram

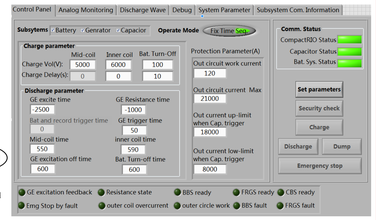

Fig.4. The interface of the main control program

III Results of experiment

The 100T facility and the CADAS have been put into test, a test three-coil magnet has been used to make experiment, and 67.6T magnetic field has been generated. In this experiment, the control system recorded the discharge current of the three coils and the triggering feedback signals of the three subsystems. The current peak value of outer, middle and inner coil are 12586A, 27028A and 14250A respectively. According analysis of the recorded data, the times of trigger feedback signals coincide with the setting on the HMI, which verifies the real-time and reliability of the CADAS.

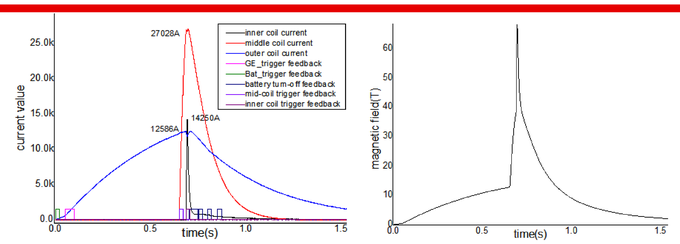

Fig.5. Discharge wave

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