Design of Information Acquisition System for High Voltage Pulse Power Supply

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Abstract. Capacitor discharge is the main application form of pulse power technology, which is simple in principle and easy to implement. The design of pulse power supply system requires the information management of a large amount of experimental data. While the conventional acquisition system only pays attention to the display of the power waveform, and lacks the effective management of the intermediate state information and discharge waveform, which cannot meet the requirement of power supply. Aiming at this need, an integrated power supply information acquisition system based on Labview and Access database is designed. This system takes Labview as the software development platform and Access as the background database to realize the acquisition, storage and information management of power data. In the program design, the producer-consumer mode is adopted for data collection and processing, and the queue technology is used for circular communication to ensure the integrity and reliability of data processing. The actual operation shows that the acquisition process of the system is stable and reliable, and the information management of the power data is realized.

1. Introduction

The high voltage pulse capacitor is used as the energy storage unit and the high voltage thyristor anti-parallel diode is used as the switch unit in the high voltage pulse power supply [1]. The capacitor's total capacity is 39mF and the maximum energy storage is 500kJ. The charging voltage of the capacitor is adjusted according to the experimental requirements to obtain the expected discharge waveform. Labview is a graphical compilation environment developed by National Instruments (NI). It provides a concise and intuitive programming method for the realization of upper computer programming and data acquisition, which greatly shortens the development cycle of the entire system [2-4]. Therefore, it has been widely applied in industrial control, test measurement, motion control and other fields [5-6].

As an experimental platform of high voltage pulse power supply, there are lots of repetitive experiments need to do. Therefore, the acquisition and management of experimental data becomes particularly important. However, the general acquisition system is not strong in long-term data recording.
and management capabilities, which is not conducive to later research and development. In response to this need, a new type information acquisition system based on Labview and Access is designed. The Labview is used as the software development platform and the Access is used as the background database in the system. The output information of power supply is stored in the database for the convenience of real-time query, processing and later research.

2. System Overview
As shown in Figure 1, the main parts of the information acquisition system are power field sensors, photoelectric conversion box, intermediate signal processor and acquisition computer. The sensor is mainly composed of a voltage divider for measuring voltage and a Rocco coil for measuring current. Because of the strong electromagnetic interference caused by high current, the signal is transmitted by optical fiber. The collected digital signals are transmitted to the power controller for processing, and finally sent to the acquisition computer through RS232 serial port. The collected analog signals is amplified, maintained, A/D converted by multi-channel synchronous acquisition board, and finally sent to the acquisition computer through USB bus. The state information and waveform information of the power supply is displayed in the acquisition computer in real time, and simultaneously stored into the background Access database.

3. Hardware Design
3.1. Sensor design
Common pulse voltage measurement methods include resistance voltage divider, capacitance voltage divider, and Kerr effect method. The resistance voltage divider is widely used in pulse power voltage measurement because of its simple in structure and convenient to operate. Since the maximum voltage to be measured in the loop is 5kV, a resistance voltage divider with the rated value of 10kV and the voltage divider ratio of 1000:1 is designed. The schematic diagram of voltage divider is shown in Figure 2. In view of the high voltage pulse discharge system has fast response time and high peak current, CWT300 current sensor from PEM company is selected. CWT300 is based on the Rogowski coil, which has the characteristics of high linearity and wide measuring frequency range. The rated current of CWT300 is 60kA, the sensitivity is 0.1mv/A, which can meet the needs of current measurement in the loop.
3.2. Acquisition board selection
In the project of HT-6M magnet power supply, 15 channels of voltage and current signals shall be measured simultaneously. The requirements of the HT-6M project shall be taken into account in the selection of the acquisition board card. Therefore, the USB2891 acquisition card of Beijing Altai shall be selected. USB2891 acquisition card is based on USB bus, which can be directly connected to the USB interface of the compute. As is shown in Figure 3, USB2891 adopts synchronous parallel design, 16 channels and 16 chips work independently, each channel has 1Mps sampling rate. The triggering mode such as software internal trigger, digital trigger, analog trigger can be selected in each channel.

![Figure 3](image3.png)

4. Software Design
The software design based on Labview platform is divided into two parts: the man-machine interface design of the front panel and the background program design of the back panel. The front panel interface completes the function of man-machine interaction, while the background program completes the data collection, processing, storage, query and other functions.

4.1. Interface design
The man-machine interface of the information acquisition system is shown in Figure 4 and Figure 5. The interface is divided into real-time display of power information and historical query of power information by means of tabs. The real-time display of power information in Figure 4 includes power status display and discharge waveform display. In the power status display area, the status of the charger, capacitor and discharge cabinet can be checked in real time, and the fault information of the charger and discharge cabinet can be summarized and stored in the background database. When the power is discharged, the waveform information collected by the data acquisition card is uploaded to the computer. The waveform and the main information of the waveform are displayed in real time, and the relevant data are stored in the background database. Figure 5 is the picture of history query interface, which mainly include the link of the database, the processing and display of power information stored in the database. The power information of the database can be indexed according to the discharge number, date and fault state. After the information is found, the power information of the database can also be indexed by turning up or down to query the latest record.

![Figure 4](image4.png)
4.2. Program design

The process of background program mainly includes the acquisition, processing, storage and query of power information. These four processes are integrated into the parallel program design method of Labview. As shown in the Figure 6, there are mainly five parts: program initialization, producer cycle, consumer cycle, parameter button event and program termination. At first, each module of the program is initialized, and three loop structures are used to execute producer loop, consumer loop and parameter button event structure in parallel. At the end of the program, each module is terminated and corresponding program resources are released. In the program, producer cycle is used for data information collection, and consumer cycle is used for processing and storage of information. The producer-consumer mode is adopted to improve the efficiency of data collection. Event structure is adopted in the historical data query and other operations, which does not affect the process of data collection and storage.

4.2.1. Program initialization: It is mainly the initialization of modules involved in background program. Firstly, VISA serial port is initialized with baud rate of 9600 bps, 8-bit data bit and 1-bit parity bit. Secondly, the triggering mode of acquisition card is set as analog trigger. At the same time, the queue index is opened to prepare for the producer-consumer cycle. Finally, Access database index is opened to prepare for the storage of data.

4.2.2. Producer cycle: It mainly includes the collection, verification, real-time display and queueing of power information. As show in the Figure 7, after the data is uploaded to the computer, it is decoded according to the set format, then CRC check (Cyclic Redundancy Check) is carried out on the body part of the data. Finally, the valid data is displayed in the front panel and synchronously queued.
4.2.3. **Consumer cycle**: It mainly includes data exit queue, data processing, real-time display and data into database. As show in the Figure 8, after the data is taken out of the queue, the packet decoding is carried out, and the power state information and waveform information are comprehensively analyzed to make fault judgment. With the discharge number as the key word, the power supply information is stored as a record in Access database.

4.2.4. **Parameter button event**: It mainly includes the query, processing and display of power information in the database. Through the event structure, the functions of querying by shot number, date, fault shot and turning up and down of data records are realized. In order to prevent SQL injection in the process of query, all SQL statements are programmed by parameterized query mode.

4.2.5. **Procedure termination**: It mainly completes the release of VISA serial port resources, queue resources and database index resource. After the release of index resource, the producer cycle, consumer cycle and parameter event cycle is exited successively, and finally the whole program is exited.

5. **Experimental Test**

5.1. **Experimental platform**

The physical diagram of the power supply test bench is shown in Figure 9. On the left of the picture is the main part of the power supply, mainly including the thyristor discharge switch, the damping for protecting the capacitor and the high-voltage capacitor for storing energy. On the right of the picture is the charger and control devices, mainly including capacitor charger, power controller and the Rogowski coil.
5.2. Test result
The charging voltage of capacitor is set at 5kV, the charge and discharge experiments were carried out on the capacitor for many times. The collected power information is shown in Figure 10 and Figure 11. Figure 10 is the result of real-time display of the power information, and Figure 11 is the result of query on record No.21 in the database. Through the information acquisition system, every experimental record stored in the database can be indexed. At same time, the power information and fault information have been sorted out and summarized.

Figure 9 The physical picture of the experimental platform

Figure 10 Test results graph of real-time display interface

Figure 11 Test results graph of history query interface
Acknowledgment
In order to realize the information management of experimental data for pulse power supply, a new information acquisition system is designed. This system relies on the graphical programming platform of Labview and takes Access as the background database. The functions as data acquisition, data storage, real-time display and historical information query is realized in the system. The experimental result shows that the system is flexible and convenient to operate, which improves the intellectualization of the data acquisition system. At present, the information acquisition system of power supply is still being tested and perfected.

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