THE REALIZATION OF THE SYSTEM FOR RAPID DETECTION OF BEPC II MAGNET POWER SUPPLY

Chen Suying, Zhan Mingchuan, Zhang jingxi, Institute Of High Energy Physics, Chinese

Abstract

To quickly find the causes of the accelerator unstable or lost beam caused by magnet power supply in the Beijing Electron Positron Collider running, this set of rapid detection system for magnet power supply is developed. The stability of the system in 8 hours is about 0.005%,it can acquire over nearly 500 sets of magnet power supply current value most quickly in the 0.33ms time. All data is written to the MySQL database in real time，So as to be able to quickly troubleshoot magnet power supply problem through historical data analysis of database comparison.

INTRODUCTION

BEPC Ⅱ (Beijing Electron Positron Collider) nearly 500 sets of magnet power supply. To observe and quickly find lost beam or instability caused by the magnet power supply, we need a set of high-speed real-time online detection and analysis system. As the number of BEPCII power supply equipment is larger, equipment's location is also dispersed, therefore, rapid detection and diagnosis system adopts distributed structure, each local unit can be run independently, and also can be used as a mobile platform, for other systems or equipment test. In the accelerator running time, once the lost beam of unknown reason needs to be quickly detected by the magnet power supply current to capture the transient jump caused by the power supply, and all the data into the database, it is beneficial to the post analysis to confirm whether the magnet power supply has jump. This requires not only the rapid acquisition of equipment, but also a powerful data analysis functions.

SYSTEM STRUCTURE

Introduce of System Theory

BEPC Ⅱ magnet power supply control system undertake a heavy task to control those power switch machine, regulating and monitoring parameters change, the same is limited by the sampling rate, so that it can't catch the instantly jump of magnet power supply. A rapid detection system for BEPC Ⅱ magnet power online as the beam of synchrotron radiation and the pattern transformation projects to quickly find unstable factors of the magnet power supply. BEPC Ⅱ magnet power online rapid detection and diagnosis system structure as shown in Fig. 1: mainly includes a current sensor, isolating amplifier, signal conditioning module, data acquisition card, PXI system and other components, each PXI system can be used as a server to exchange data with client, system's software using LabVIEW and SQL language.

We select stability of 2ppm Hitec high precision sensor [2] according to the current output type sensor and magnet power supply, because the project magnet power supply stability is high. Compare the given signal on the sensor output voltage signal and the central control room send to the magnet power analysis to analysis the working condition of magnet power supply quickly through the data acquisition system, determine whether the magnet power supply caused by the beam loss. There are two important indicators: stability, accuracy.
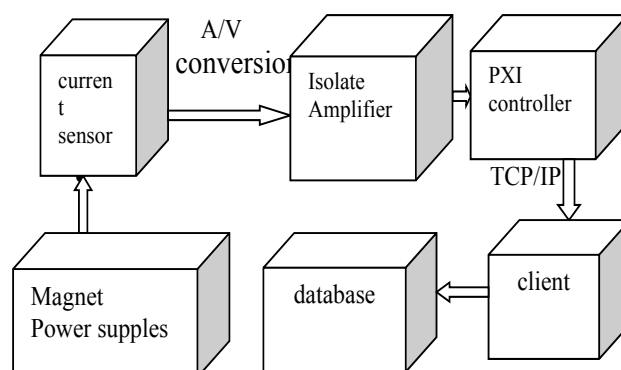

Figure 1: Structure diagram of the rapid detection system for magnet power supply.

The main technical index of online rapid detection and diagnosis system of magnet power supply system are:

- The minimum resolution system: 18bit
- The sampling rate of the system: 500 kHz
- Number of signal channel: 497
- System Stability for 8 hours: $\leq$ 0.005%
- System nonlinearity: $\leq$ 0.01%
- System sampling range: 10V

Because the magnet power supply's distribution is more dispersed, in order to reduce interference of long distance transmission, we use five set of PXI[3]system, then the system can most quickly in the 0.33ms time acquisition for all the magnet power supply current value and can quickly check the power supply problem.

PROGRAM DESIGN AND DATA PROCESSING SYSTEM STRUCTURE

Program Design

The total program flow chart shown in Fig. 2.

The acquisition would have been at a rate of 1Hz to monitor the stability of all magnet power supply, current stability formula: Is= (Imax-Imin) / (Imax+Imin). According to the status that stability and beam real-time display to determine whether a power supply problems,

then make fast acquisition of 30Hz on it, large amounts of data through the TCP/IP transmission to the database of central control room in the acquisition process, the TCP node is divided into three parts, as shown in Fig. 3.
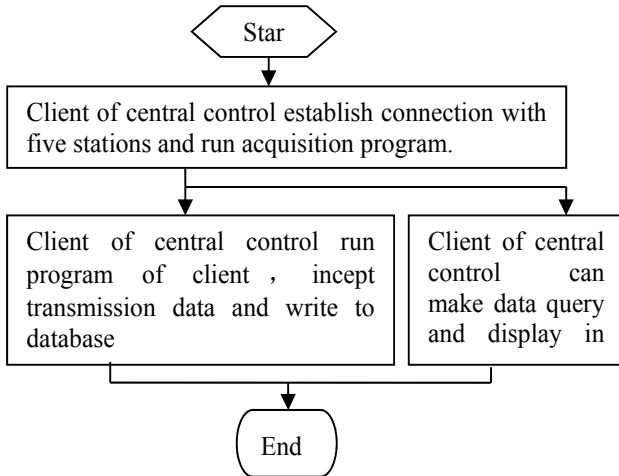

Figure 2: Total flow chart of the rapid detection system for magnet power supply.

Connection function: used to connect the communication between the client and server.

Transmission function: for the transmission of data between the client and server.

Conversion function: used to switch the computer IP address and the name of the computer.
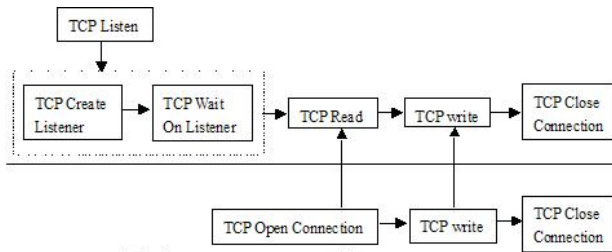

Figure 3: Working process of each part of the TCP node.

In the communication of central control room computer and five front PXI sub stations, PXI terminal be set for the server and central control room computer be set for the client. So the server terminal listens continuously when a client connect at running [4], and then send and receive data, the client continuously try to connect with server when it is running, if not connected will be repeated connect according to the procedure or report timeout, it will send and receive data processing when connect.

Optimization of Program Speed

In the program, direct data flow speed is the fastest, and the local variable or attribute nodes can be used to transfer the "controller" / "indicator" of numerical without connect to front panel controller / indicator direct. In fact, although they are similar from the transfer numerical characteristics, but there are many different places in essence, the essence of a local variable is the "controller" / "indicator" of data to be copied, so it use memory, it will occupy a lot of memory when build multiple local variables for the array. attribute node that operate behaviour is essentially read data or write data in the "controller" / "indicator" to query or placement and no memory, because parameters has created better allocation of memory. For the local variables direct operate memory, so the operation is very fast. With respect to the local variables in terms of attribute nodes efficiency is very low, or more CPU resource occupy.

Data Processing

MySQL is an open source small relational database management system [5], it has the advantages of small volume, high speed, support multi threading, make full use of CPU resources, support large database, and it can handle large databases with millions of records. MySQL can be used as a separate application in a client server network environment, can also be used as a library and embedded into other software.

The optimization of MySQL:

The Datatime is 8 bytes, and independent of the time zone, the default value is NULL, and the Timestamp is 4 bytes, and relate to the time zone, the default value is the current time. Because the specified value allowed as string format might be wrong, then use timestamp instead of integer data type to store time. For example, the value of'13:11:12'may look like the time value, because ":" is the delimiter, but if used on a date, the context will be as the year is interpreted as'2013-11-12','13:72:15'value is converted to'0000-00-00', because'72'is not a valid month.

The MySQL efficiency for the treatment of connection and connection release is very high. Therefore, if complex query is divided into a plurality of simple query, and connect these small query in the application layer, MySQL efficiency will be higher. Because of the complexity of the query will cause locking a relatively large area result in efficiency lower, but many of small query lock range is much smaller, time and resources consuming on connection can be basically ignored in MySQL.

The rapid detection system for magnet power supply acquire while using TCP/IP to transfer data to MySQL database of the central control room, the central control room can query the historical data at any time, query results show a chart of timeline for transverse, can be very intuitive to see the historical trend of the magnet power supply. As shown in Fig. 4.
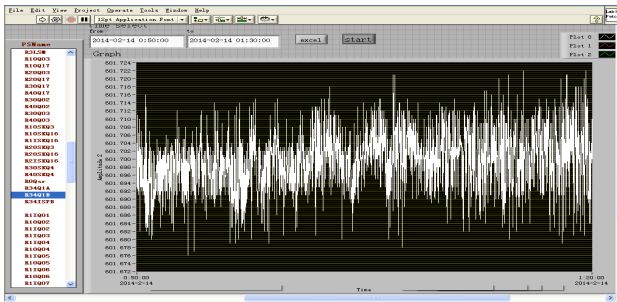
Figure 4: Interface of database in the central control room.

According to the current setting values are in agreement with the actual current value to judge the accuracy of the power supply, if the error is beyond a certain range to the correction coefficient.

THE TECHNICAL DIFFICULTIES AND THE SOLUTIONS

Problem of File Storage

System requirements speed of document storage reaches 30kB/s, excel file format is convenient but may not speed, using the TDMS file format, when the network does not access or data does not need to write the database, it can be stored in a local TDMS file. The actual speed of 372MB / s TDMS in a disk array high-speed streaming applications. At present, the use of computer disk average literacy rate is about 55MB / s, the speed of reading a single disk has been fully utilized. Although the speed of reading TDMS files very fast, very suitable for the storage of mass data, it is widely used in real-time systems, but only support simple data form, it can use the channel group and channel for hierarchical storage of data. Taking into account the long-running process system will produce a large amount of data, data acquisition software is designed to automatically save every day date for the file name of the file.

Measures for Anti-Interference

In order to accurately collect and process data, we must take into account the presence of various disturbances, anti-interference problem is an important content of system design, and take corresponding measures from the soft, hardware design to enhance the anti-interference ability of the system. Data acquisition system work site is bad, it with interference from various internal and external systems, when the measured signal is weak, will lead to large error of the data acquisition and processing.

Find the common mode interference greatly in power measurement, as shown in Fig. 5.

Through the analysis of testing data, data acquisition system was most likely introduced common mode interference from the ground, after the input signal cable shield connected with collection system terminal grounding piece, we achieved satisfactory results, the measured power stability is better than 100ppm. The test results as shown in Fig. 6.
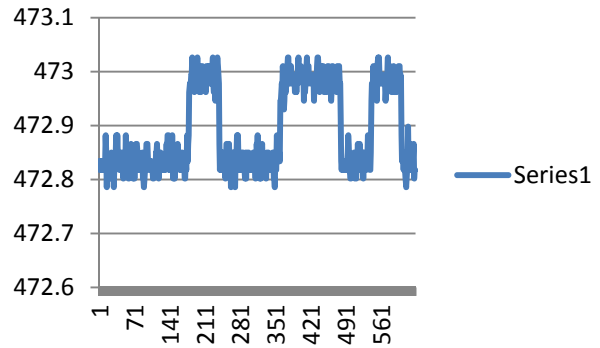

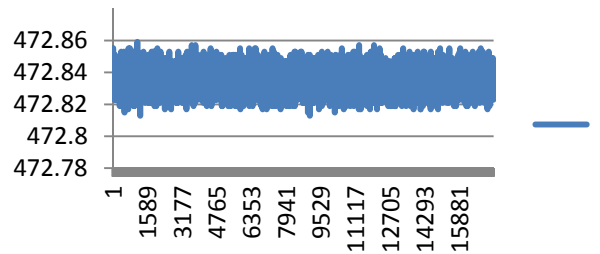Figure 5: Common mode interference exist in the output of magnet power supplym.

Figure 6: Output current of magnet power supply after eliminate interference.

CONCLUSION

Rapid detection system for magnet power supply designed in the thesis, it implementation of 500kHz system sampling rate, can quickly and accurately find the magnet power supply instantly jump, the system optimize the acquisition program and database, make rapid transmission and storage the amount of data, the development of database query interface is displayed in the time axis, comparison and the beam pattern can be very intuitive to judge whether the magnet power supply failure caused by beam instability or lost beam.

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