

Isolation Technique Used in HIRFL Control System

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Abstract

HIRFL is a complex system containing a lot of distributed equipments. Most of them are high power and high precision devices in the noisy environment. So a high performance of the computer control system is required. Especially, as the continuous improvement of HIRFL operation performance, the requirement of control accuracy and reliability become more and more high. To satisfy the requirement of operation, isolation technique is one of the most important methods for control system in HIRFL. Its application is discussed in the paper.

1 The isolated transmission of control and data stream

There are mainly two kinds of isolated transmission for control system in HIRFL. One is pulse transformer isolation. The another is photoelectric isolated transfer.

1.1 Pulse transformer isolation transmission

The Bit serial transmission is often used. Generally, signals are transmitted with serial diphasic modulation and received with diphasic demodulation. The advantage of pulse transformer isolated transmission is that the transmitting distance is long, up to 100 meters, the transmitting rate is fast up from 500Kbits/s to 5M bits/s and the transmission have the function of parity check. Thus, this mode has high transmitting reliability and its cost is lower. Usually, it is used in CAMAC interface system.

1.1.1 CAMAC U-port modules(such as KSC-3936 and so on)

These modules are used in CAMAC serial loop to construct medium to large computer control system. As it has high anti-interference performance in transmission, the operation is rather reliable. No transmission error of serial loop(used KSC-3936) has ever happened in control system in HIRFL. The maximal transmitting rate of CAMAC serial loop is 5Mbits/s.

1.1.2 CAMAC module ER16VM

The module has 16 channels with pulse transformer. Every channel transmits serial isolated data to transmitter- receiver equipment of the field via LEMO connector and a twisted-pair shielding cable. All these are of master-slave communication structure. In injection/ejection system of SSC, there are 16 sets of DC power supplies, 10 sets of position regulating equipments and 113 sets of water cooling alarm. The control system have been performed reliable control and monitor only with 12 channels of the module. Distance of data communication is more than 100 meters. The transmission of the data is rather reliable. The maximal transmitting rate of ER16VM is 500Kbits/s.

1.2 Photoelectric isolated transmission

At present, photoelectric isolation technique is broadly used in data communication of computer automatic control and monitor system, such as RS-232 current loop communication board and RS-485 transmitter/receiver with photoisolator. The photoisolated communication is often used in multiplex system with bit serial transmission. On the one hand, it can improve the ability of anti-interference with the result that the reliability of system operation is increased. On the other hand, it can solve the problem of long distance reliable communication. For multiplex distributed system without very high speed, the photoelectric isolation communication is a simple and cheap solution. As the tendency of complex controlled equipment is characterized by intelligence, the transmitting mode has been used widely. Now we have started to develop the intelligent controller in HIRFL.

In the control system (designed in 1992) of SFC and ECR source beam line in HIRFL, the multiple-stage isolated parallel transmitting mode with our designed isolation controller has been used (see Fig.1and Fig.2). A few of CAMAC module and our designed control equipments accomplish the computer automatic control of decades DC stabilized current and DC high voltage power supplies. The control system has achieved reliable results.

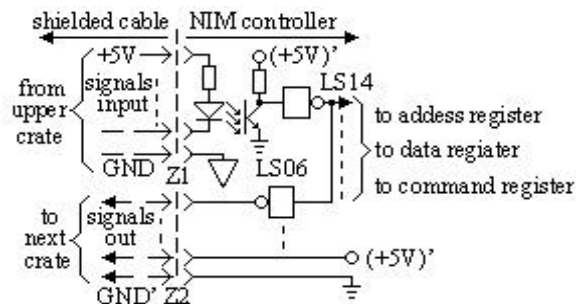


Fig. 1 Isolated transmission of control data stream

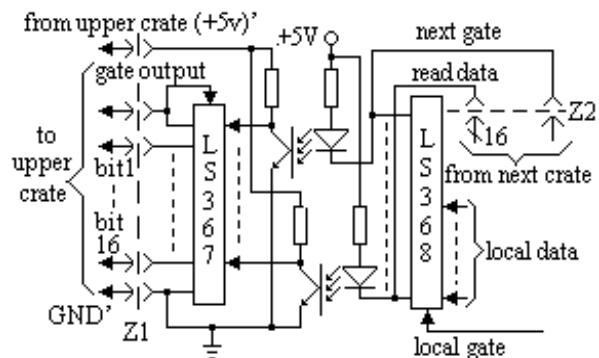


Fig. 2 Isolated transmission of read data and gating signal

2 Isolated transmission of digital signal

As the rational adoption of digital signal isolation can be efficiently realized, the electrical isolation between center control system and field controlled equipments, becomes very easy. The isolated transmission of digital signal has been widely used in the computer automatic monitor and control system at present. It can eliminate the mutual interference in running process and achieve more efficient and reliable data transmission comparing with HTL electrical level.

In HIRFL control system, the isolators used are common photoelectric couplers with 500-1000V isolated voltage. It has been proven in practice that the anti-interference ability and reliability of subsystem which use isolators is better.

In addition, to use the stand-alone relay contacts of equipments is also an efficient isolation method on the connection of status signal.

3 Analogous isolated transmission

In HIRFL control system, it is a long-term problem to measure the high precision analog signal exactly and reliably. The measurement of analog signal directly affects the further improvement of HIRFL operation performance. The most puzzling problem of high precision measurement of analog signal is of shielding from the affection of common-mode interference.

HIRFL contains a lot of high precision and powerful distributed power supplies which use floating ground output mode according to the need in work. It causes the continuous varying of potential between one equipment and another equipment or ground which leading to serious common-mode interference in signal measure. Generally, the most effective method for solving the problem is to use ADC

alone with which the digit signal is converted from analogous signal and transmitted through photoisolator. That control system needs much investment, and both the accuracy and the stability of measurement are not satisfactory as ripple voltage and affection from environment temperature to ADC. Another method is to use relay contact gating and removing far-end common-mode interference by isolated amplifier, then together with native power supplies to measure the signal(difference input) by multiplex ADC module KSC-3516. In order to eliminate the affection of ripple voltage, digital filter method in processing program has been adopted. The results are very satisfactory. The third method is that the analog signal is gated by relay contact and converted to digital signal by 7075 digital voltmeter. This method will be adopted in HIRFL control system. Of course, according to actual needs, isolated amplifier will be also adopted. Because of high input resistance of 7075 digital voltmeter which can eliminate the affection of general common-mode interference, the converting time of 100ms has been selected to overcome the affection of ripple voltage. It is important to use isolated amplifier for the measure and regulation of DC high voltage power supplies, if not, the control system can not work properly.

4 Conclusion

Because of the variety of control fields and the difference characters and requirement of control equipments, it is hard to reach a uniform work model. To built up a set of reliable and rational computer automatic control system and to reach the expected aim, technical staff must analysis and compare different schemes again and again with the rational processing method for digit and analog signals. However, using isolation technique is inevitable to assure the reliable work of control system.