Research on integrated measurement and control device and test technology in smart substation

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Abstract. According to the problems of low system integration, no redundant configuration and wide fault influence range of the measurement and control device, this paper research on the scheme of integrated measurement and control device in smart station, which can greatly reduce the number of measurement and control devices and effectively improve the reliability of integrated system. At the same time, the maintenance technology for integrated measurement and control device can improve the efficiency of maintenance for the whole station.

1. Introduction
As an important part of the secondary system in smart substation, the measurement and control device have some problems, such as low integration, no redundant configuration and wide fault influence range. According to these problems, through the research on the scheme of integrated measurement and control device, the number of measurement and control devices in the station is greatly reduced and the reliability of the integrated system is effectively improved. At the same time, the maintenance technology for integrated measurement and control device can improve the efficiency of maintenance for the whole station.

2. Research on technology of integrated measurement and control device
2.1. Application scheme of integrated measurement and control device
The smart substation is equipped with two sets of integrated measurement and control devices to realize the interval measurement and control functions, replacing the mode of configuring different measurement and control devices for different intervals.

The integrated measurement and control device adopt module plug-in structure. Different acquisition plug-ins use optical fiber interface to transmit the corresponding switch signal and analog signal to the integrated measurement and control device through HSR protocol. After the sampling plug-ins of different intervals collect the measurement and control information of all the intervals, the CPU plug-in of the device computer carries out the relevant sampling calculation and logic processing, so as to realize the measurement and control functions of the analog quantity module and switch equipment.
2.2. HSR protocol
The smart substation adopts HSR network protocol to transmit switching value and analog information. The switch local module and analog local module form a ring network structure, as shown in Fig 1. The ring network structure is transmitted to the integrated measurement and control device of the station through HSR network protocol. At the same time, the remote control and remote adjustment commands sent by the integrated measurement and control device are also transmitted to the corresponding switch value local module by HSR network protocol, so as to realize the measurement and control function of the integrated measurement and control device.

![Figure 1. Topology of HSR network](image)

2.3. Local module
The local module is the connection link between the integrated measurement and control device and the primary equipment such as switch and transformer. It sends the position of the primary switch equipment and the value of the transformer to the integrated measurement and control device through the HSR protocol message. At the same time, the trip command sent by the integrated measurement and control device is transmitted to the switch through the HSR protocol message, so as to realize the measurement and control function of the device.

3. Test technology principle of the integrated measurement and control device
This paper designs a kind of instrument which realize synchronous output analog voltage, current signal, switch position signal and HSR protocol message of multiple sets through GPS, and realize the overall maintenance test of switch equipment and integrated measurement and control device.

3.1. Overall test principle of integrated measurement and control device
The synchronous output of several single test instruments is realized through GPS, and each instrument can output enough channel switching signal, analog voltage and current signal, and conduct the overall
test of the primary switchgear control module, secondary protection control equipment and HSR network communication message between them.

3.1.1. Principle of remote signal and telemetry test. In order to realize the measurement and control function test, it needs to cover the single equipment of the measurement and control device and the local module.

In this paper, the principle of integrated measurement and control device system is designed as shown in the figure 2. Based on MMS protocol, the closed-loop test system is composed of test function part, local module, interval HSR network and integrated measurement and control device. It realizes the overall test of bay layer, station control layer and even Bay HSR network.

![Figure 2. Overall test principle of integrated measurement and control device](image)

Taking a substation as an example, the station is composed of three intervals. The switching module and local module of each interval form a HSR network. The HSR network is connected with the sampling board of corresponding interval of integrated measurement and control. Finally, the measurement and control of the primary switch and other equipment of the whole station bay by integrated measurement and control is realized.

In the test, there is a test instrument in each of the three intervals, which can simulate the output of switch signal and analog signal. The three instruments are synchronized by external clock signal. The software module in the test system controls the simultaneous output of switching signal and analog quantity of three instruments, and then transmits them to the collection ports of each interval of the
integrated measurement and control device through the HSR network of each interval, and then to the integrated measurement and control device of the whole station. The integrated measurement and control device transform the collected switch signal into remote signal and sends it to the monitoring background and local sampling display, and converts the analog voltage and current signal into telemetry signal, which is sent to the monitoring background and local sampling display.

The test system uses MMS message to collect the corresponding remote signaling and remote measurement values of the three intervals, and compares them with the switch position and analog voltage and current values output by the test instrument. If the two values are consistent, it indicates that the remote signaling and telemetry functions of the integrated measurement and control device are normal. This test scheme not only realize the maintenance test of integrated remote signaling and telemetry functions, but also indirectly verifies whether the functions of local modules with different intervals, HSR network and related communication links are normal.

3.1.2. Testing principle of remote control and remote adjustment. Remote control is essentially a kind of remote control. Based on the remote-control function and referring to the principle of remote signal and telemetry overall test, the integrated measurement and control test scheme can be designed, as shown in the figure 3.

![Overall remote-control function test scheme of integrated measurement and control device](image)

Figure 3. Overall remote-control function test scheme of integrated measurement and control device
The overall remote control function test scheme of integrated measurement and control device is completely consistent with the overall test structure of remote signaling and telemetry functions, and the data flow direction is opposite. The remote-control command is sent to the HSR network of the corresponding interval through the interval sampling plug-in of the measurement and control device, and transmitted to the corresponding switch value local module. The switch value local module of each bay is connected with the primary switch control output port, which is connected with the switch input port of the test instrument corresponding to the interval. The whole interval test is realized by subscribing the switch value status of the local analog output of the switch value.

Take remote control interval 1 as an example. First of all, the test system sends the remote-control switch opening and closing command of a switch device in interval 1 through the monitoring background. After receiving the remote-control command, the integrated measurement and control device sends it to the HSR network of bay 1 through the sending port of interval 1 sampling template. Secondly, the remote-control command is transmitted through the HSR ring network and finally sent to the switch value local module of bay 1. The switch value local module converts the HSR message opening and closing commands into the opening and closing hard contact exit and sends them to the primary switch equipment such as knife switch. Finally, the test instrument of interval 1 receives the corresponding switch value opening and closing command through the hard contact input port, and the hard outlet contact of the local module is opened and closed. When the hard outlet contact point of the received opening and closing command sent by the local module to the primary equipment is consistent with the remote switch opening and closing command issued by the monitoring background, it indicates that the remote-control function of integrated measurement and control device is tested normally.

4. Conclusion

This paper research on the technical scheme of integrated measurement and control device, which reduce the number of measurement and control devices and effectively improve the reliability of the integrated automation system. Combined with the application characteristics of integrated measurement and control device, the closed-loop and integrated measurement and control maintenance technology is used to achieve the goal of full interval integration test, which greatly improves the maintenance efficiency and further promotes the realization of smart operation and maintenance goal.

References

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