

# Integrated Research on Power Distribution Intelligent Switching Equipment

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## Abstract

### This

**This paper introduces the current technical situation of intelligent switch equipment for distribution, compares different intelligent switch schemes, analyzes the problems and causes of intelligent switch with low integration degree, puts forward the technical scheme of integrated design of intelligent switch equipment for distribution, and introduces the test implementation of intelligent switch. This paper studies the problems existing in the test and use of intelligent distribution switch, and analyzes the technical development trend of intelligent distribution switch.**

## Keywords

**Distribution intelligent switching devices; integrated design; IEC61850.**

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## 1. Introduction

By the end of 2012, state grid company distribution automation coverage rate: 10.5% (22,000 10kV lines in 26 provincial companies). And the automatic coverage rate of distribution network in France and Japan reached 90%.100%. In order to improve the distribution network automation level, since 2009, the state power grid companies within the scope of three batches of a total of 29 pilot distribution network automation construction and transformation. During this time, all participated in the pilot engineering construction and transformation of primary equipment and secondary equipment manufacturers, section research units, institutions and users work together to continuously explore and practice, make the definition of intelligent switching device gradually clear, for intelligent switching device step by step clarify the functional requirements.

With the continuous progress of economic and social development, users can supply power rely on sex put forward higher requirement. For this, want to reduce blackout accident as far as possible rate, shorten the outage time, on the one hand to optimize the distribution network structure, improve high power supply reliability. On the other hand to continue to improve the distribution network equipment product quality, intelligent configuration of the equipment, monitoring the running state of the equipment, equipment failure, increase equipment automatic control function, reduce equipment failure. And the occurrence of man-made accidents. Switch is the main equipment in the distribution network intelligent distribution network, an important part of automation.

With the microelectronics technology, sensing technology, optical fiber, computer technology and information technology are widely used in distribution network equipment, through one equipment and secondary equipment integration to realize perception, memory, self - diagnosis, self - repair and other intelligent operation functions with detection, monitoring, protection, communication and remote network monitoring. In order to improve the performance of switching equipment, it is necessary to realize the wisdom of switching equipment function of automation.

## **2. Intelligent distribution network for distribution intelligent switch equipment requirements**

Intelligent switch device is a high-voltage switch set with integrated smart components. The real-time monitoring and evaluation of the status of the switch is performed in real time, and the state of the device is reported according to the evaluation result or in a language recognizable by the smart grid related system. In addition to meeting the original functions of conventional equipment, the intelligent switch should also have the following functions: sensitive and accurate access to information sensing functions; processing capabilities for acquiring information; ability to judge the processing results; effective operation of judgment results Ability. The core function is to observe, control, and control various information such as equipment power, non-electricity, and health status, and provide support for the optimal operation of the power grid.

The smart switch device application target consists of two levels. The first is to increase the operator's ability to control the switch. Based on GOOSE, standardized operations that do not distinguish between manufacturers, devices, and output pulse width and power are not considered. Secondly, it increases the collection power of operators and managers on the operational status information of the equipment to provide reference for the status evaluation of switch and LCC management. This is the core content of the intelligent switch device to distinguish the traditional switch device, and it is also the charm of the smart switch device.

Substation equipment itself and automation systems are usually in secondary equipment. Switching equipment is one of the main causes of system failures in terms of interconnection, information acquisition, and sharing of secondary equipment interfaces. Based on the requirements of smart grid and intelligent substation and the problems of the equipment itself, the basic functional requirements of the intelligent switch are proposed, including the unified connection mode and interface (hardware/software) of the secondary equipment, communication function, perfect and reasonable equipment condition monitoring function, Information sharing and digitization, control functions (intelligent control), etc., and further derived more specific requirements, such as hardware interfaces such as RJ45/485, modern communication technology, IEC61850 protocol requirements, modern sensor technology monitoring technology and data processing, secondary Equipment integration and integration, first and second equipment integration, control method update, etc.

## **3. Analysis of the current status of power distribution intelligent switch**

Many domestic switch manufacturers are in intelligent switch. The field has been tried and many devices and applications have been developed. For example, the manufacturer provides independent temperature online monitoring, mechanical characteristics online monitoring, leakage current online monitoring intelligent components, etc., and developed electric grounding switches and controllers, electric chassis vehicles and controllers. The intelligent switch that has been developed so far can be divided into three types. The first type, non-integrated design multiple-device configuration and switch cabinet. Integrated intelligent switch device, that is, the way of building blocks. A variety of communication, control, measurement, and monitoring components are installed in the metal-enclosed switch to achieve certain intelligent functions. This stacked assembly method adds the function of the metal-enclosed switch, but due to the lack of an integrated design, some functional stacking reduces the electrical reliability and mechanical reliability of the metal-enclosed switch, and adds a large number of secondary wiring. For the IEC61850 control command receiving, execution, intelligent terminal unified host computer and background intelligent important functions, most of these intelligent switching devices are missing. This method is a common method adopted by intelligent switch.at present. One-time switch device combines intelligent components, intelligent terminals, and background systems to perform complete type test at the same time. This type of test is very important. As shown in Figure 1.

The main technology and technical economy of the first intelligent switching device problem:

(1) In addition to the sensor module, the system requires a number of independent intelligence, each unit requires a separate housing, power supply, processing unit, output and communication unit, etc.

(2) Position information, current information, control instruction signal, etc. Re-acquisition repeat processing. For example, switch factor position information is assisted.

Switch signal, proximity switch signal, open signal, main circuit voltage/repeated acquisition of current signals, etc.

(3) The information interaction between the sub-devices is completed by means of communication so that the whole machine has a variety of signals (e.g. multiple analog, digital a large flow of information, a variety of wiring in the transmission. Poor anti-jamming ability, poor product reliability, but also lead to finding difficulty and so on.

(4) The cost of intelligent switching equipment is high in relative to the integrated design a lot. The second is the integration of functional design with switch cabinet smart switching device. Using the integrated idea of integrated design, switch cabinets and intelligent components are effectively integrated into equipment manufacturing design at the beginning of the overall planning, to achieve a strong electrical equipment and two Second-weak device and sensor integration.

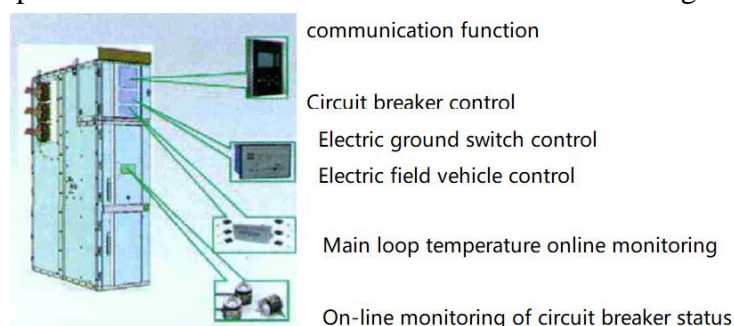


Fig. 1 Non-integrated design of multi-device structure and switch cabinet integrated intelligent switch equipment

Advantages of this:

(1) Be able to reasonably plan the smart switching equipment required by each intelligent functions and implementation methods, according to the functional requirements to determine the implementation of optimization solutions, such as removed metal closed switching equipment, require control and monitor circuit breaker scars, while fixed requires control and monitoring of isolated openings thermally monitored infrared for open products, while conductive suitable for multiple-compartment structures.

(2) select the sensor mounting position, solve the sensor effective monitoring and installation. For example, the temperature monitoring sensor in the most important monitoring of the temperature change of the position of the sliding electrical connection should be monitored in the center-removed device. But the installation of the product insulation performance and temperature-up cooling function can be hidden dangers.

(3) To achieve the optimal combination of intelligent functions, to achieve the letter stream sharing, reducing repeated acquisition, repeated display. The main difference between the communication problem and the way it is assembled. Such as Figure 2 shows.

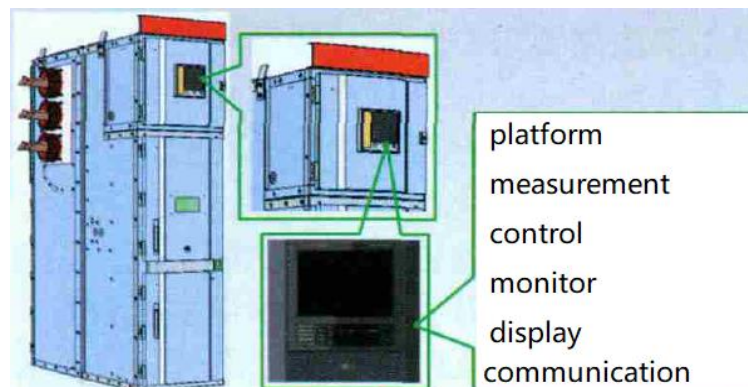


Fig. 2 Function integration design and switch cabinet integrated intelligent switch equipment

Thirdly, the integration of logic function, device structure and circuit breaker Intelligent switching devices with integrated design. In this way, the integrated design of circuit breakers and sensors, protection, measurement, control, intelligent monitoring components, communication and other functions integrated into the circuit breaker, and has a wealth of information display, thus simplifying, omitting the switch cabinet instrument room, simplifying the cabinet structure, and realizing the dual integration of functional integration and device integration.

This approach has a unified level (hardware/software), a measurement (power, position) function, functions, monitoring (features, temperature) functions, display and communication functions. Due to the high degree of integration, can significantly improve the stability and reliability level of intelligent switching equipment, because of the realization of higher technical requirements, there is only one manufacturer to study this technology, is still in the experimental stage. Inside the smart switching device, the linear displacement sensor is mounted on the insulating lever of the circuit breaker for measuring the movement of the insulated lever, the current transformer is mounted on the main circuit of the circuit breaker for measuring current, and the pressure sensor is mounted on the circuit breaker transmission chain to measure the contact pressure. The temperature sensor is mounted on the contact arm of the circuit breaker to measure the contact arm temperature, the power CT and the temperature emission module are installed in the middle position of the contact arm, and the circuit breaker panel is equipped with a touch-enabled LCD display, etc. See figure 3 for details.

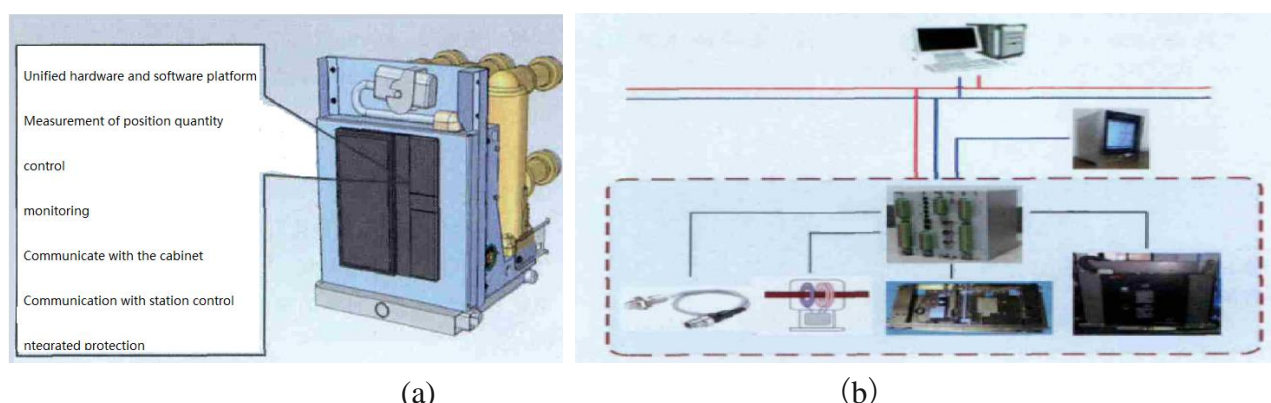


Fig. 3 12kV intelligent circuit breaker and its intelligent terminal function structure

At present, there are many domestic manufacturers have carried out 12kV smart switch Cabinet and 12kV intelligent ring net cabinet two types of research and development work, but the test assessment of the test verification of the manufacturers are very few, as of the end of 2013, only two manufacturers in Xi'an High-voltage Electrical Research Institute test station carried out a research test of intelligent switch cabinet Two other manufacturers of three products in the West High Court



test station and passed all intelligent type of test, respectively, the West High Court 12kV intelligent switch cabinet and ring net cabinet.

The main design features of the 12kV intelligent switch cabinet of the West High Court through intelligent type test are introduced: The contents of a single device are as follows:

- 1) Overall layout: using armor, center, front and rear layout; body width of 600mm, achieve miniaturization;
- 2) Insulation reliability design: the use of double shielding ring wall casing and a contact box with a shielded ring;
- 3) Flow and thermal design: cabinet body flow with natural ventilation hot,

The intelligent content is as follows:

- 1) Smart controller completes receiving IEC61850, GOOSE instruction optical/electric control signal, issue control instructions to the circuit breaker, realize the network function of switching equipment control operation;
- 2) Electric execution unit completion circuit breaker can move the component and ground the electric operation and condition detection of the switch, and the operation results and condition monitoring results of the equipment are uploaded to the communication components;
- 3) Temperature online monitoring using fiber-optic online monitoring, real-time monitoring changes in the temperature of the switch cabinet main circuit;
- 4) Circuit breaker status online monitoring, the circuit breaker movement status and the mechanical and operating current, time and mechanical characteristics of the process are monitored online;
- 5) Communication management machine completes the internal summary and Unified outreach



Fig. 4 Intelligent switchgear with test completed

The integrity test of the smart switching device (see Figure 4) is to ensure intelligence The inspection and verification work that the switching device must perform. Whether the electrical performance and protection function of the equipment body meet the relevant standards requirements, integrity testing must be carried out. All smart groups before the test all the sensors must be installed and working properly, and the insulation tests, high-capacity tests (see Figure 5), thermal tests and EMC tests required for switching equipment must be carried out one by one. Through this test method, the electrical equipment China Electric Industry Technology 2014 No. 6 verification "smart switch equipment" actual operating conditions, "smart switching equipment" control, monitoring, information display, communication and other intelligent functions item by item verification, and verify compliance with the requirements.



Fig. 5 Large capacity test method for intelligent switching equipment

#### 4. Recommendations for solving common technical problems

The first is the selection and design of sensor components. Some position sensors can use existing components, such as auxiliary switches, travel off. However, a large number of information collection requires special sensors, such as temperature, leakage current, force, motion current (unbuttoner, energy storage), displacement (straight line displacement, rotation angle), etc., and in reality, there is no sensor designed for switching equipment, so there are different degrees of deficiencies in use. Development for power distribution All kinds of sensors of the equipment, to achieve accurate, efficient, harmless, integrated, and so on, regulate the sensor interface, transmission, calibration, these are the need to solve urgent problems.

The second is the question of standards. IEC61850 is broad and does not with the manufacturer's understanding based on the differences, such as ICD file provides for the device IP location Address, manufacturer, equipment information, equipment functions, but did not specify the format, order, the manufacturers of equipment needs to be artificial understanding and change before docking. Status detection files can cause network congestion and missed the correct alert time due to the long time it takes to upload the file format. In the face of many standard implementation problems, IEC61850 has been revised, is expected to add more than 150 nodes.

The third is the ability to test. According to the requirements of the whole machine (one device and second equipment as a whole) for full-featured, whole process test verification, in addition to the laboratory to send control instructions for the operation function and ability verification of switching equipment, should also carry out the intelligent device upload information reception inspection and correctness verification, and the existing laboratory lacks this kind of verification and monitoring capability. It is gratifying to note that the West High Court test station is the construction of a new special laboratory for intelligent switching equipment to complete the test content of many tests.

In addition, the service life of electronic components, online monitoring functional stability issues, whether to increase monitoring-based non-battery protection, these will be intelligent switching equipment to overcome the technical difficulties.

#### 5. Conclusion

The intelligent distribution network is urgently needed for the intelligent distribution switching equipment There are many research work on developing intelligent power distribution switching equipment and improving product performance. At this stage, communication, temperature detection, feature monitoring, electric control is the basic configuration of universal intelligent way to achieve a variety of ways. The technical focus of this paper is to highlight functional integration and device integration, especially emphasize the integration of primary and secondary equipment integration technology, on the basis of ensuring the basic functions of switching equipment, strengthen information acquisition and information processing capacity, truly describe the product status, to provide users and managers with credible information is the basic requirement of power distribution

switch intelligence. The appearance of intelligent switching equipment weakens the boundary between first-time equipment and secondary equipment, strengthens the terminal assembly of switching equipment with first-time equipment as the main body, and puts forward intelligence and fusion from a new perspective.

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