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Transformation and Application of Traditional Low Voltage Distribution Cabinet

Shilei Wang

Wenzhou Polytechnic, Wenzhou, 325035, China

Abstract

The main components of the traditional GGD low-voltage distribution cabinet are fixed products, the equipment runs in isolation, does not have the communication function, and is unable to carry out real-time on-line monitoring, life cycle management and so on. In order to make it have controllable, adjustable, measurable, excellent and other digital functions, the distribution cabinet is digitally upgraded. This paper mainly introduces the method and implementation steps of digital upgrade of core equipment frame circuit breaker, and adds edge control system to provide intelligent distribution integration method. The upgraded distribution cabinet has been in actual operation in many industrial applications, and the working condition is good.

Keywords

Low Voltage Distribution Cabinet; Edge Control; Fieldbus.

1. Introduction

Intelligent power distribution is to make full use of mobile Internet, artificial intelligence and other modern information technology and advanced communication technology to realize the Internet of everything and human-computer interaction in all aspects of the traditional distribution system. State awareness, efficient information processing, convenient and flexible distribution Internet of things system. The plates involved, such as intelligent manufacturing, lighthouse factories, smart cities, smart parks, 5G, new energy vehicle charging posts, data centers, rail transit, carbon peak, carbon neutralization and other sectors are all closely related to the intelligent power distribution industry. with the implementation of "new infrastructure" and "carbon neutralization", intelligent power distribution will grow rapidly in these areas.

Traditional low-voltage distribution cabinets have been used for a long time in China with a wide range of applications and a large number. Most of them do not have controllable, adjustable, measurable, excellent and other digital functions, so it is impossible to carry out real-time on-line monitoring, life cycle management and so on. Considering the practical needs and price of electrical upgrading, it is very meaningful to design an intelligent transformation scheme for this kind of traditional distribution cabinet and the actual operation of industry. In this paper, the GGD low voltage distribution cabinet is digitally upgraded and the edge control system is added to facilitate the integrated application of intelligent distribution system.

2. Network Architecture

The platform architecture includes three layers: perception layer, network layer and platform layer. The core of the whole system is platform layer. The application layer is the user interface of the system, which is located at the top of the architecture, and provides users with rich specific services through the analysis of the processed data. The application layer receives the information from the platform layer, processes and makes decisions on the information, and then unidirectionally sends the information through the platform layer and the network layer to control the device terminal of the perception layer. The application layer can access data in the form of Web browser (Paas) or APP, official account, Mini Program and other ways (Saas).

As shown in Figure 1. The main function of the perception layer is responsible for information collection and signal processing. Through perceptual recognition technology, things and things are connected through the network. In the transformation scheme, the intelligent electrical equipment is in the perception layer, and the new equipment is equipped with communication interface. The network layer accesses and transmits the information from the perception layer through the existing Internet, mobile communication network and other basic network facilities. In the system, the network layer connects the perception layer and the platform layer, which serves as a link between the preceding and the following.In the transformation scheme, the hardware of the equipment edge control system is the network layer, and the Ethernet communication is used between the devices. The platform layer is in the environment of server cluster or data center, in order to integrate the vast amount of information resources in the network into an interconnected large network through computing power, to solve the problems of data storage, retrieval, use, mining and security privacy protection.

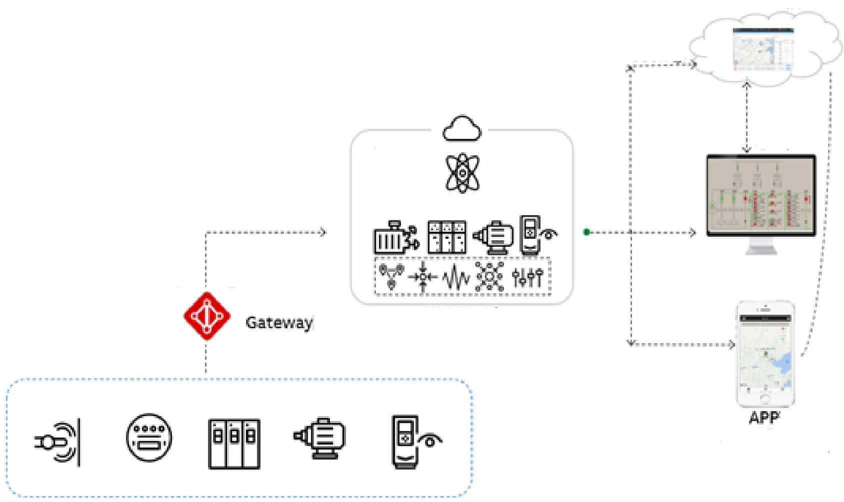

Figure 1. Three-tier architecture

3. Upgrade and Transformation Plan

3.1. Digital Upgrade Strategy of Frame Circuit Breaker

As shown in Figure 2, the Ekip UP of ABB is used as the digital upgrade unit of the circuit breaker. Ekip UP is a new generation of low-voltage digital upgrade unit that can be monitored, protected and controlled. By setting up its embedded industrial configuration tool, it can quickly go to the cloud. It is a multi-functional application digital device, which can quickly monitor, protect and control, and ensure the flexibility of plug and play. Ekip UP has good monitoring function. Can measure including current, voltage, phase sequence, frequency, power factor, peak factor and so on. System integration can be realized by the connectivity of up to eight fieldbus protocols, and special lines are provided for power automation applications that require advanced network security. Ability to evaluate power quality, such as hourly average voltage, short-term voltage interruption, voltage imbalance, harmonic analysis, etc.

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Figure 2. Ekip UP Digital upgrade unit

3.2. Installation of Digital Upgrade Unit Ekip UP

3.2.1. Ontology Installation

The installation mode of digital upgrade unit is divided into door installation and DIN rail installation. This scheme is installed on the embedded door, and the installation location is at the door of the frame circuit breaker of the GGD incoming cabinets. An installation hole of 282.4mm × 86.2mm is opened on the door panel, and the digital upgrade unit body is embedded in the cabinet door, and the self-locking clasp is used to fix it on the cabinet door. Then insert the accessory module and terminal piece into the corresponding installation position.

3.2.2. Installation of Current Sensor

The current sensor configured in the digital upgrade unit is based on Rogowski coil sensor technology to ensure high flexibility, wide range of linear and fast detection of current fluctuations and harmonic components. The sensor adopts open type, lightweight and flexible, does not need external power supply equipment, and can complete the installation task without shutting down the equipment under the condition of standard operation.

3.2.3. Modification of Other Control Loops of Digital Upgrade Unit

In the process of on-site transformation and upgrading, the frame circuit breaker fault tripping signal and the combined action signal are connected to the digital upgrade unit, and the passive dry contact signal is used for signal input. The output control signal is connected to the closing and opening control loop of the frame circuit breaker, and the remote local switching switch is used to realize the operation of two different modes. Through the use of current and voltage signals, combined with the internal logic algorithm, drive control signals to achieve a variety of protection function fault tripping.

The communication network control loop is divided into two parts. The cloud on the digital upgrade unit adopts Ethernet protocol and uploads the local test data to the cloud server in the form of network cable connection. In addition, the data acquisition on the local side adopts the standard Modbus communication protocol, which is connected with other intelligent electrical equipment by shielded twisted pair, and has been connected hand in hand to form a communication bus network.

Using the same method, use the Ekip UP unit to digitally upgrade the GGD feeder cabinet.

3.3. Installation of Edge Control System

The edge control system is an important part of the upgrade scheme. The marginal control system plays a central role. The main components are: edge controller, industrial server, switch, power module and so on. The installation location can generally be located under the traditional GGD incoming cabinets, see Figure 3,the existing energy metering devices need to be removed, holes are drilled to install C45 guides, and most of the components are installed with guide rails to save construction time. Through the edge control system, the feed cabinet and feeder cabinet form a complete set of intelligent distribution integrated equipment.

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Figure 3. Position of edge control system in the lower part of GGD cabinet

3.4. Network Configuration

The upgraded input cabinets and feeder cabinets need to be networked with intelligent interconnection cabinets, in which digital upgrade unit, intelligent electric meter, intelligent molded case circuit breaker and other components are equipped with Modbus communication protocol, and the interface is RS485, which is connected by shielded twisted pair, and finally the signal is connected to the edge controller communication module. In addition, the cloud module on the digital upgrade unit, the terminal display device in the intelligent interconnection cabinet, the server and the edge controller are networked through the network switch.

4. Communication Control of Intelligent Circuit Breaker

4.1. Communication Point Table and its Processing

The point table information mainly includes Modbus communication function code, communication address, description and conversion calculation formula of intelligent frame circuit breaker equipment. The equipment parameter information such as current, circuit breaker position, closing and opening signal and so on must be sorted out first. Table 1 shows the partial communication points of the circuit breaker.

Table 1. List of partial communication points of circuit breakers

Serial number	Variable name	Address	Bit
1	Emax2_Contact	20	
2	Emax2_Operation	21	
3	Emax2_Mopening	22	
4	Emax2_protection1	23	
5	Emax2_protection2	24	
6	Emax2_protection3	25	
7	Emax2_Closed	40	bit=0
8	Emax2_Ready	40	bit=4
9	Emax2_TripF	40	bit=7
10	Emax2_Local	40	bit=8
11	Emax2_Warning	40	bit=9
12	Emax2_Alarm	40	bit=10
13	Emax2_Trip	40	bit=12

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4.2. The Use of Intelligent Power Distribution Software AS

As shown in Figure 4, Take address 40 in Table 1 as an example to set up communication data. The function code is set to 04, that is, the FC4:Read input register read register is selected, the Start address read address is input 40, the number of read is 1, the read data name INT1 is named in Channel 1, and the data type is INT.

Similarly, complete other related data communication configuration according to the data of the address table in Table 1.

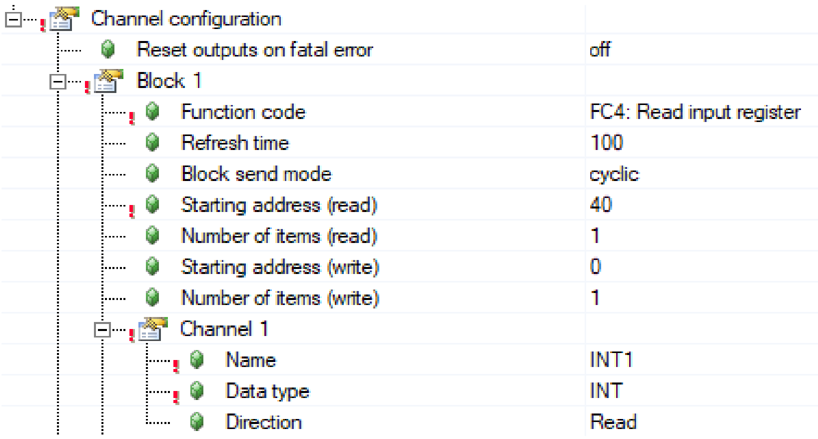

Figure 4. Communication data setting with address 40

Create an array of INT_ [1.. 12], WINT_ [1.. 2], REAL_ [1.. 2] variables to map to the communication data Imax O, where INT_ is an array, from 1.. 12 data type to INT. WINT_ is an array from 1.. 2 data type to INT,REAL_ to an array from 1.. 2 data type to REAL. After completion, the communication variable mapping is carried out. After the variables are mapped into the created array, the mapping variables also need to be parsed and processed. You need to create related variables to store parsed and processed variables.

Finally, the program is written according to the data processing mode of ST language. Figure 5 shows the circuit breaker closing and opening control program.

```
IF(Emax2_ON=1)THEN
    WINT_[1]:=8;
    IF  EDGEPOS (Emax2_Closed) THEN
        WINT_[1]:=0;
        Emax2_ON:=0;
    END_IF
END_IF
IF(Emax2_OFF=1)THEN
    WINT_[1]:=7;
    IF EDGENEG(Emax2_Closed)THEN
        WINT_[1]:=0;
        Emax2_OFF:=0;
    END_IF
END_IF
```

Figure 5. Closing and opening control program

5. On-site Debugging

5.1. Two or More

Ensure that the grounding and power supply of all kinds of equipment and systems are installed and meet the requirements, and the power switches and circuit breakers in all the plates, cabinets, stations and other equipment are all disconnected.

5.2. Check of Total Power Supply

The measured input voltage of the total circuit breaker, closing the total circuit breaker after passing the test, testing the output voltage of the total circuit breaker, and the input and output voltage of the total circuit breaker should meet the power supply requirements of the system and equipment. Power up the control cabinet, station and so on again. Close the circuit breaker one by one according to the relevant electrical control drawings, check whether the circuit breaker corresponds to the supplied equipment correctly, whether the disk counter is powered normally, and measure whether the power supply voltage meets the requirements, so as to avoid damage to the components.

5.3. Communication Network Test

According to the topology diagram of the project system, check the status of the network equipment in each layer of the network, check whether the communication parameters of each node in the network meet the requirements of the engineering design document, and whether the communication is normal. We also need to debug some functions of the system. Debug and confirm the function of the edge controller components, and if there is a redundant configuration, it should be debugged to confirm its redundant function. Debug and check whether the data transmission, upload and download functions of each layer of the network are normal. For redundant networks, we can judge whether they are normal by artificially cutting off a single network on any node. Then debug the man-machine interface (HMI). Check the user authorization settings and make sure that the user password and operation permissions are set correctly. Check and confirm the contents of the man-machine interface such as system interface diagram, alarm, historical trend record, report and so on with the user responsible personnel. According to the design requirements, the operation authority is switched on each computer to check whether the display and operation of the man-machine interface is normal or not when the operation authority is different. The debugging results of the man-machine interface should meet the design documents and user operation requirements.

5.4. Debugging of Electrical Instruments, Circuit Breakers, etc

Set the electrical instrument transformer ratio parameters, circuit breaker protection parameters and relay protection parameters according to the requirements of electrical design drawings. The communication parameters of electrical instrument, circuit breaker and relay protection device are set according to the system topology diagram. Debug the operation of the circuit breaker and relay protection device.

6. Conclusion

Through the transformation of the typical traditional low-voltage distribution cabinet, the traditional low-voltage electrical equipment has the intelligent ability to realize the "four remote" functions of telemetry, remote control, remote signal and remote adjustment. The intelligent frame circuit breaker is connected by RJ45 network cable and uses Modbus TCP communication protocol to realize data exchange with the edge controller. The edge controller uploads the data to the server through Ethernet and realizes the programming and control of the equipment based on the intelligent power distribution software Automation Studio. The reconstruction scheme is feasible, and it has been applied in many engineering applications in hospitals, data centers, unattended pumping stations and airport terminals, and the feedback from users is good.

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References

[1] Fang Jiawei, Zhu Herong, Chen Guiyou: Discussion About Application of Edge Intelligence Technology in Intelligent Distribution Networks, Electrical Automation, Vol.43 (2021) No.3, p.108-111.

[2] Shilei Wang: Research on the Construction of Enterprise case Resources in the course of principle and Application of Intelligent Electrical Appliances,International Core Journal of Engineering, Vol.5 (2019) No.7, p.173-177.

[3] Shilei Wang: Design and Application of "Fieldbus Technology" Engineering Practice Case under the Concept of OBE Education, Scientific Journal of Economics and Management Research, Vol.2 (2020) No. 5, p.147-152.

[4] PAN Zhixin, ZHAI Xuefeng, WANG Chengliang, et al. Research on Multi-source Data Processing and Fusion Technology of Smart DistributionGrid Based on Edge Computing. Electric Drive, Vol.51 (2021) No.22, p.74-80.

[5] Shilei Wang: Development and Application of Simulation Teaching Project of "Intelligent Electric apparatus principle and Application", Advances in Social Science, Education and Humanities Research. (Qingdao, December 29-30,2018). Vol. 1, p.51.

[6] Zou Ping, Shi Ruijie, Wu Xike, et al. Research and Simulation Verification of Integrated Access Technology for ElectricalEquipment Based on Edge Computing, Journal of System Simulation, Vol. 31 (2019)No.3,p.592-600.