

Application of Electronic Information Technology in Power Automation System

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Keywords: Electronic information technology, Power plant, Substation, Automation

Abstract: With the application of electronic information technology, the traditional power plant automation system has been continuously optimized. This paper discusses the application of electronic information technology in power plant electrical automation system and substation automation network communication network.

1. Introduction

Due to power plant electrical automation system adopts the traditional physical hard wiring and transducer board such as a large number of hardware devices, to monitor the power plant electrical equipment, and measuring the amount of the electric system, protection actions, setting, accident recall information such as the machine furnace thermal control system (DCS/FCS) cannot online real-time response, function and machine furnace thermal electrical equipment protection and control of contact depends on the backend system, once appear, problem or the system will lose protection measure and control function, protection measurement and control function in the system level to achieve risk is bigger. Modern electrical automation system of power plant adopted the advanced technology, reliable communication network, cancel the original hard wiring, transducer board and other traditional equipment, comprehensive information, digital, make the plant electrical equipment protection measure and control the local implementation of dispersion, backend systems through a communication network communication and on-site comprehensive protection measurement and control equipment, realize telemetry, remote communication, remote control, SOE, accident recall, and other functions, so protection of the protection of the measurement and control device control function is not dependent on the system, the greatest risk degree is reduced, equipment from abundant diagnostic information, improve the reliability of the power plant electrical system, It broadens and improves the monitoring scope and automation of DCS/FCS systems.

1.1 Three Level Architecture of Electric Automation System in Power Plant

The electrical automation system of power plant adopts a hierarchical and distributed structure, which is divided into three layers: monitoring layer, communication management layer and interval layer.

1.1.1 Monitoring Layer

The monitoring layer is the control center of the whole ECS system, which completes the data collection, processing, display and monitoring functions of the whole ECS system, and is authorized to control the corresponding equipment. The monitoring layer shall be equipped with background server, operator workstation, engineer station, web server (optional), five prevention workstation (optional, which can be configured separately or implemented in operator station), gateway (used for connecting with other systems) and satellite to satellite GPS (optional). (the above configuration quantity can be determined according to the system scale and requirements)

1.1.2 Communication Management

The communication management layer is composed of communication controller and related communication network equipment. The communication management layer is the key link of the whole system. It can complete the real-time information exchange between the monitoring layer and the Bay layer, and can directly communicate with the DPU of DCS system (thermal automation

system) through RS-485, and complete the access of various automation devices, so as to realize the conversion and connection functions of communication physical medium and communication protocol. The communication management layer supports fieldbus, Ethernet, RS-485 and other communication modes. The communication management layer can adopt dual network redundancy configuration to effectively ensure the reliability of network transmission.

1.1.3 Septum

The bay level equipment includes generator transformer unit protection and control device, excitation, synchronization, UPS, DC system measurement and control device, auxiliary power protection and control device and auxiliary power fast switching device. They protect, measure and control the relevant electrical equipment, and each bay unit is independent of each other.

1.2 Interface between Thermal Electric Monitoring System (Ecs) and Thermal Computer Monitoring System (Dcs / Fcs)

1.2.1 Requirements for Connection between Electrical and Thermal Computer Monitoring System

The main characteristics of power plant production process are high system complexity, high multi variable coupling, complex logic relationship, close relationship between switch control system and analog control system, high reliability requirements. For example, there are a large number of logic control relations such as interlock, protection, start and stop between the main and auxiliary machines of the power plant, between the auxiliary and auxiliary machines, between the DCS system of thermal monitoring and the ECS system of thermal power electrical monitoring. In the conventional control system of thermal power electrical system, the switch value is connected by the hard wire of empty contact and the analog value is connected by the hard wire of 4 ~ 20mA DC signal (transmitter output signal). These hard wires are connected to the thermal monitoring system DCS of turbine and boiler for data acquisition. The so-called hard wiring refers to the connection mode between DPU of DCS system and electrical control loop. Although the hardwired contact method has the advantages of fast transmission and high reliability, it needs a large number of transmitters, connecting cables, high construction cost, poor expansion performance of the system, and low overall automation level of the electrical system. In order to improve the overall automation level of the power plant, in view of the development of modern network communication technology, the ECS system based on network communication is adopted to replace the analog hard wiring with full digital communication mode, so as to realize the communication requirements between the electrical and thermal computer monitoring system.

1.2.2 Network Communication Mode between Electrical and Thermal Computer Monitoring System

The communication manager can be connected with the DPU of the corresponding unit DCS through the serial interface to exchange information and realize the digital communication between the electrical and thermal computer monitoring system. Generally, RS-485 interface between communication manager and DPU is relatively simple and easy, which provides a reliable way for electrical information to participate in process interlocking and for the realization of computer integrated automation in thermal power plants.

The whole communication mode is adopted between the electrical and thermal computer monitoring system. In this mode, there are two modes for the interface between the electrical monitoring system (ECS) of the power plant and the DCS of the thermal automation system of the turbine and boiler:

(1) The protection and measurement and control devices of the Bay layer are connected to the background of the monitoring layer through the communication controller, and communicate with the DCS Ethernet of the boiler thermal automation system through the communication gateway to realize the plant level communication;

(2) The bay level protection, measurement and control devices directly communicate with the

DPU of the thermal computer monitoring system DCS through the communication controller, and receive the control command of the DCS system. In the whole communication mode, the communication manager is configured according to the “process of the power plant”, and the communication manager participating in the process interlocking control communicates with the corresponding DPU one-to-one. Due to the small number of motor protection monitoring devices in each process, the real-time communication is high, which can fully meet the requirements of the process interlocking control of the power plant. In practical application, for electrical information that does not participate in process interlocking, it is connected to DCS through ECS monitoring layer communication gateway. For the protection monitoring device participating in process interlocking, the control information and non control information shall be separated, and the DPU and the communication gateway of ECS monitoring layer shall be connected to DCS through the independent communication interface of communication manager. In general, the real-time and reliability can meet the requirements of technical specifications.

At present, the voltage, current, power, electric quantity, protection action signal of the generator set and the control of the auxiliary power circuit and other information are connected to the corresponding DPU through the communication mode (while the connection of the switch value related to the process interlock and control is still reserved in some power plants), which has the following advantages:

(1) ECS eliminates a large number of transmitters, I/O CARDS, cabinets and connecting cables in data collection, thus reducing the cost.

(2) The information connected to DCS is comprehensive and rich. The amount of information has nothing to do with investment and the system has strong expansibility. The electric automation system of power plant involves many aspects, so it is impossible to directly upload the data and calculated parameters collected by all the bay level protection and monitoring equipment to the monitoring layer. Only by analyzing and processing the protection and measurement and control information of bay level equipment, can the efficiency and response speed be improved. In addition, in order to meet the requirements of process interlocking control in thermal power plant, the communication mode is adopted directly. Communication with corresponding DPU is no longer transmitted through ECS monitoring layer, DCS gateway and monitoring level layer by layer, which ensures necessary response speed requirements. Therefore, communication management layer is added in ECS system (see communication controller in unit 5 for the structure principle of communication management machine).

2. Communication Network Structure of Substation Automation Based on Iec 61850 Standard

Compared with the conventional substation secondary system, the substation integrated automation uses the microcomputer secondary equipment instead of the non computer equipment in terms of the secondary system device and function; uses the digital processing and logic operation instead of the analog operation and relay logic; uses the integrated function device instead of the screen cabinet composed of discrete components; adds the “Substation Microcomputer Monitoring System” and “communication control” System management “. In the integrated automation of substation, the secondary equipment of substation is divided into two layers, i.e. substation layer and bay layer, and the communication network is used to connect the secondary equipment of substation layer and bay layer, substation and dispatching control center, so that they can exchange data with each other and realize monitoring and management.

Compared with integrated automation substation, digital substation adds a layer of structure, that is, process layer. It reduces the digital processing to the process layer and completes the digital processing in the merge unit. In addition, the process bus between the process layer and the interval layer is added, which transmits the digitized data to the secondary equipment of the substation layer and the interval layer, and separates the digitization from the information processing and application, so as to truly realize the information sharing and information integration application.

In digital substation, unconventional transformer and merging unit are used to replace the protection, measurement and control, data acquisition and I / O part of other ired devices; Ethernet

network based on IEC61850 is used to replace the previous secondary connecting cable and loop; three-layer two bus is used to replace the two-layer one bus architecture of integrated automation substation. Due to the intellectualization of primary equipment and the networking of secondary equipment, the combination between primary equipment and secondary equipment of digital substation is closer, but the connection between all levels is clearer and simpler. The basic structure is analyzed below.

2.1 Process Layer

The process layer is the combination of primary equipment and secondary equipment, specifically the intelligent part of intelligent primary electrical equipment and its interface with secondary equipment. The main functions of the process layer are divided into three categories: ① real-time operation electric quantity data collection; ② operation state quantity collection; ③ operation control command execution. Compared with the integrated automation substation, the difference is that the traditional electromagnetic current and voltage transformer is replaced by the unconventional transformer, and the acquisition of traditional analog quantity is replaced by the direct acquisition of digital quantity, which is completed in the process layer rather than in the IED of the Bay layer. This method brings a series of advantages, such as good dynamic performance, good insulation and anti saturation characteristics, strong anti-interference performance, saving a large number of cables and substation floor space. The state parameter detection equipment for substation operation includes transformer, circuit breaker, disconnecter, bus, capacitor, reactor and DC power supply system. The online detection contents of these equipment include temperature, pressure, density, insulation, mechanical characteristics and working state data, which are collected at the process layer and transmitted from the process bus to the IED at the Bay layer.

2.2 Septum

The main functions of the Bay layer are: ① monitoring the real-time data of the Bay process layer; ② implementing the protection and control function for the primary equipment; ③ implementing the blocking function for the Bay operation; ④ implementing the simultaneous operation and other control functions; ⑤ implementing the communication and transmission function with the substation layer and the process layer and ensuring the reliability of the network communication.

2.3 Substation Level

The main functions of the substation layer are: ① collecting the real-time data information of the whole station, constantly refreshing the database, logging in the historical database on time; ② transmitting the relevant data information to the grid dispatching control center; ③ receiving the relevant control commands from the grid dispatching or control center and transmitting them to the Bay layer and process layer for execution; ④ having the online programmable operation locking control function of the whole station; ⑤ having It has local monitoring and man-machine contact functions, such as display, operation, printing, alarm and other functions, image, audio and other multimedia functions; ⑥ it has the functions of online maintenance, configuration and parameter modification of the equipment in the Bay layer and process layer.

2.4 Station Bus

The monitoring system at the substation level can communicate and exchange information with the protection and monitoring ied devices at the bay level through the station level bus Ethernet (or switching Ethernet). The station level bus is based on the mapping of ACSI to MMS and MMS to Ethernet, which are formulated in IEC 61850 standard, to realize information interaction. Station level network is a non real time network, which mainly provides message services based on MMS, such as protection setting service, fault event report service, control service of measurement and control device, etc.

2.5 Process Bus

Process bus provides three services: ① fast and reliable transmission of tripping command

between protection device and circuit breaker; ② transmission of transient data of unconventional transformer; ③ transmission of status data of all primary equipment. These three services put forward high requirements for process bus. Because the data flow between the process layer and the Bay layer is very large, and the requirements of real-time and reliability are very high, the mapping mode of MMS cannot be used, but the goose service mode of SCSM must be used.

Goose network is a kind of real-time network, which transmits SV message and goose message on goose network. These two kinds of messages have strong real-time performance, which are directly mapped to the data link layer of the network, avoiding the delay caused by multi-layer protocol processing messages, and meeting the requirements of real-time performance. However, due to the huge data flow (mainly SV message), power system failure will even occur network storm and block, so a series of measures must be taken to improve the reliability of the network. At present, most of the goose networks in digital substations adopt switching Ethernet, VLAN, priority and multicast technology to improve the real-time and reliability. These technical measures are essentially flow control and message filtering methods, which fundamentally improve the network environment and adapt to the needs of digital substation.

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