# Application of Photoelectric Sensor Network in Substation Network Communication System

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**Abstract.** Photoelectric sensor refers to the sensor based on photoelectric effect. In recent years, with the continuous development and stability of photoelectric sensor, more attention has been paid to its wide application and practicability in substation. The substation communication control system will be affected by the communication system structure and communication mode, so it is necessary to make a comprehensive analysis and concrete judgment to find the best control system method and application. Because of its good insulation, strong anti-interference ability, small size and light weight, photoelectric sensors are widely used in substation communication systems. The application of photoelectric sensors in substation communication system has changed the substation communication system and structure. This paper analyzes the principle and technical characteristics of photoelectric sensor, and discusses its influence on structural communication of substation communication control system. As a new type of electronic transformer, the application of electric sensor will have a profound impact on substation automation system.

**Keywords:** Photoelectric Sensor; Network Communication; Transformer Substation.

## 1. Introduction

Photoelectric sensor is a sensor which takes photoelectric element as conversion element and can convert the measured non-electric quantity into electric quantity through the change of light quantity. Generally, photoelectric transducer consists of light source, optical element and photoelectric element [1]. It is a small electronic device, which can detect the change of the received light intensity. Photoelectric sensor is the key content of substation automation system. Different from traditional sensors, photoelectric sensors are not only very low in cost, but also light in weight and small in size, and have strong anti-interference time [2]. Compared with photoelectric sensors, traditional electromagnetic transformers are quite different. Photoelectric sensors have the advantages of very low step-making cost, light weight, small volume, no ferromagnetic and magnetic saturation, strong anti-interference ability, wide frequency band, large dynamic range, high insulation strength and so on [3]. The working principle of the photoelectric sensor is to sense the light source through the measuring head, which transmits the sensed light source to the optical system in the form of optical signal, and the optical system then transmits it to the photoelectric element [4]. This signal is converted by photoelectric elements and transmitted to electronic measuring waves in the form of optical parametric signals, and finally converted into usable signals by electronic measuring waves. Based on the characteristics of optical signal itself, photoelectric sensor has the characteristics of fast transmission and sensitivity to light.

Substation communication control system is an important part of substation automation system, and its technical level is directly related to the performance of substation automation system. With the rapid development of electronic technology and communication technology, substation communication system has also experienced centralized, functional distributed and decentralized stages [5]. Because of its good insulation, strong anti-interference ability, small size and light weight, photoelectric sensor replaces the traditional electromagnetic transformer in substation communication control system, and is widely used in substation communication control system [6]. The early photoelectric sensor used to detect the presence or absence of objects is a small metal cylindrical device. The transmitter is equipped with a calibration lens, which focuses the light to the receiver, and the receiver connects this device to a vacuum tube amplifier through a cable [7]. The

development and change of communication system always adapts to the development and change of substation measurement and control and protection devices. With the application of photoelectric sensor in substation, it will have a profound impact on substation communication control system and improve its automation application level. This paper analyzes the principle and technical characteristics of photoelectric sensor, and discusses its influence on structural communication of substation communication control system.

## 2. Overview of Photoelectric Sensors

### 2.1 The Meaning of Photoelectric Sensor

Photoelectric sensor is a kind of sensor at first, which tests whether an object exists and whether the surface state of the object changes with the help of various photoelectric induction characteristics. In principle, photoelectric sensor is a kind of sensor produced by its electric effect, which has flexible and diverse forms of expression. The wide application of photoelectric sensors in substation communication system makes the communication system structure of substation change qualitatively, greatly optimizes the communication system structure of substation, and lays a foundation for improving the automation level of substation. The basic principle of photoelectric sensor is shown in Figure 1.

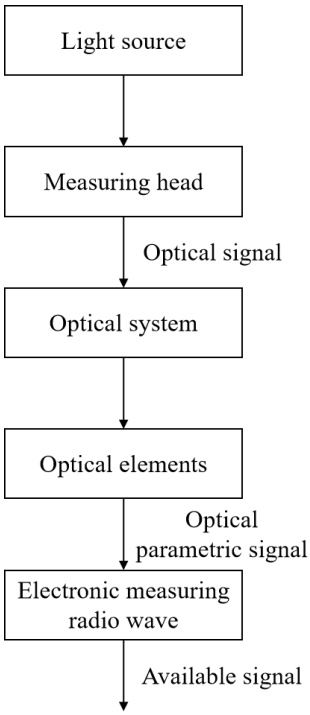


**Figure 1.** Basic principle of photoelectric sensor

From the principle of composition, the components of photoelectric sensor include the main light receiving part for receiving light and the light projecting part for emitting objects. Different detection objects and light-receiving surfaces will cover or reflect the projected light, and cause the light-receiving part of the light-emitting part to change indefinitely. After this change is detected by the independent detection of the light receiving part, it is converted into a corresponding electrical signal according to the intensity of the change, and this signal is output. The traditional substation communication system has only two layers, and the application of photoelectric sensors makes digital control switches, intelligent switchgear and other supporting electronic devices widely exist in the substation communication system. The structural transformation of substation communication system based on photoelectric sensor point-to-point transmission or point-to-multipoint transmission greatly

simplifies the complexity of wiring, and at the same time greatly improves the efficiency of subsequent work.

### 2.2 Performance Characteristics of Photoelectric Sensor

After the stability of the photoelectric sensor's technical performance meets the application requirements and is put into use, the restrictions on the detection of long-distance objects are greatly reduced. The excellent folding performance of photoelectric sensors comes from the fact that they are not affected by the reflection reaction and shading reaction caused by the detected object, which other proximity sensors cannot do. Their application will be limited by the properties of the detected object. The interface design of photoelectric sensor makes the use of substation communication system more convenient, promotes the standard of software and hardware in related systems to a higher level, and ensures the efficient and stable operation of substation communication system [8]. The photoelectric sensor has a high resolution, which can make the projected light beam continuously concentrate on the smallest spot through the highest design technology, or can realize a higher and stronger resolution and recognition rate by forming a relatively special light receiving system. With the continuous improvement of photoelectric sensor design technology, so far, it has been able to ensure that the light beam projected by photoelectric sensor has been stably concentrated on the tiny spot. In other words, the photoelectric sensor already has a special light receiving system, which ensures that its recognition rate and resolution are both accurate and powerful.

## 3. Automatic Operation of Photoelectric Sensor in Substation Network Communication System

### 3.1 Change Substation Communication System and its Structure

The photoelectric sensor can detect the longest distance, and the object to be detected is relatively less restricted, mainly because the shading reaction and reflection reaction caused by the object are the main corresponding detection principles. Substation automation communication system includes two parts: field communication within the system and communication between automation system and superior dispatching. Here, we mainly discuss the influence of the application of photoelectric sensor on the internal field-level communication system. Communication methods include parallel, serial, local area network and field bus. The photoelectric sensor's response time for relative inspection is short, and the speed of light itself can reach the highest speed. In addition, the circuit of the sensor is composed of various electronic parts and integrated circuits, so there is no so-called mechanical working time, which makes the response time between substations very short [9]. With the development of primary intelligent equipment, such as photoelectric transformer and intelligent switchgear, it provides a technical basis for resource integration and system integration to change the current separation state of monitoring, control, protection and metering devices and systems in substations. According to the relative reflectivity and relative absorptivity of different light formed by different detected objects, different differences are produced by combining the lengths of different projected light waves and the colors of the detected objects. Using this special property, we can identify the properties of different objects according to their different colors.

At present, the development of electric power systems in China is not balanced, and there is a greater difference between substation information systems and their automation operation levels. Advanced automation systems marked by a variety of decentralized components coexist with traditional old automation systems marked by centralized panel grouping. This unbalanced situation of substation information system level needs to be changed urgently. After the photoelectric sensor is applied to substation information system, it can not only adapt to the advanced decentralized automation system, but also be compatible with the traditional old automation system with centralized screen assembly, thus realizing the organic integration of automation information systems at different development stages.

### 3.2 Promote Automatic Operation of Substation Information System

In the traditional transformer communication system, the analog signal is mainly transmitted to the various compartments in the communication system, and this signal transmission is often accompanied by the problems such as the load of the negative inductor increasing and the complex repeated wiring. However, after the application of photoelectric sensor, the digital signal is transmitted in the system, which can carry out one-to-one and many-to-many efficient point propagation in the whole communication system, and can completely replace the original secondary cable [10]. The main transmission mode of substation is HVDC. In the substation of HVDC system, photoelectric sensors are mostly used to collect DC voltage and current in DC field. The photoelectric sensor can be applied in substation information system because it has strong data transmission function and corresponding intelligent electronic function. Because of the continuous development of photoelectric sensor and the continuous improvement and progress of network technology, it is a far-reaching and long-term comprehensive development prospect to combine photoelectric sensor with substation information system. The technical framework of cloud resource planning and scheduling of substation communication system is shown in Figure 2.

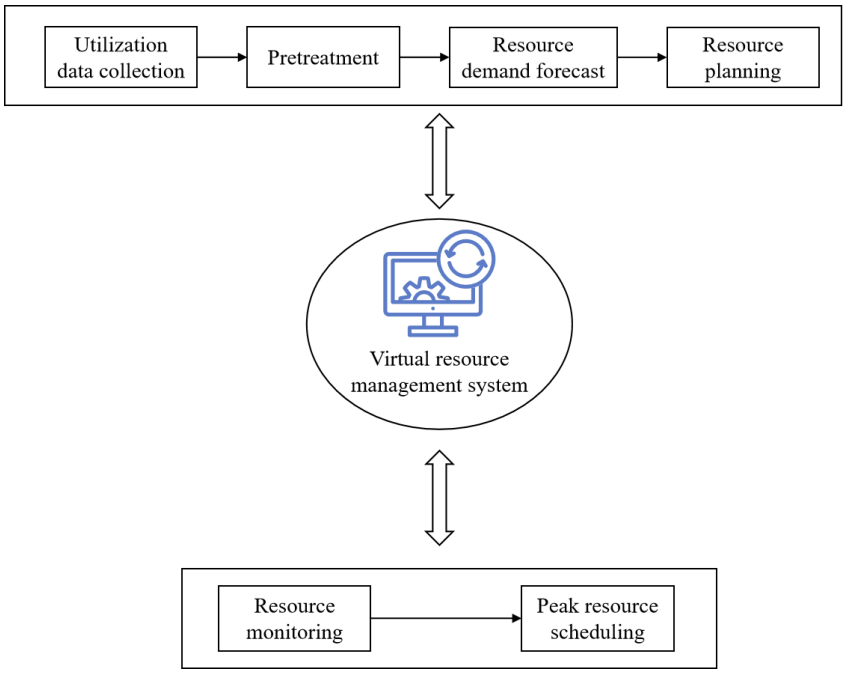


**Figure 2.** Technical framework of cloud resource planning and scheduling in substation communication system

After the photoelectric sensor is applied to the substation communication system, it has a fundamental impact on the substation communication system structure because of its superior characteristics. After the photoelectric sensor is applied to the substation communication system, its communication mode has changed correspondingly. At the same time, the corresponding electronic switching devices and intelligent electronic devices for digital circuit breaker operation control have been adopted in a large number, and the functions of the substation communication system have been greatly improved. With the wide use of photoelectric sensors in substations, there are many researches on substation faults. The research on photoelectric sensor faults shows that photoelectric sensor faults are the main form of substation faults. Therefore, only by enhancing the quality of photoelectric sensors and regular information maintenance can high-speed operation of substations be ensured. The interface design of photoelectric sensor greatly improves the convenience of the system. The simple characteristic of modular interface of electric sensor promotes the highest standardization of related software and hardware design in the system when facing the target, and ensures that the system can adapt to various transmission media, various communication protocols and various standards, and run

smoothly. Therefore, compared with the traditional photoelectric sensing system, the system has undergone qualitative changes in terms of openness, expansibility, flexibility and self-adaptability.

## 4. Conclusion

Due to the digital output characteristics of photoelectric sensor and the characteristics of intelligent electronic equipment, its application has a comprehensive and far-reaching impact on substation automation communication system. With the wide application of photoelectric sensor in substation information system and the full play of its superior performance, it can not only save a lot of manpower, material resources and financial resources, but also save energy to the maximum extent. The application of photoelectric sensor in substation communication system has the characteristics of intelligence and digital output. Although there are still some problems in the substation communication system in China that need to be corrected in time, the development of substation communication system can be promoted as long as advanced technology and technology can be actively used and adjusted according to the actual situation. Building a new type of substation automation system based on photoelectric sensors and other intelligent electronic devices, realizing seamless communication among all layers in the substation, and meeting the requirements of information sharing and system integration to the greatest extent, is the development direction of substation automation system in China. The mode of substation information system, which combines photoelectric sensor and network technology, will become the dominant mode in China power system, realizing seamless and systematic information, realizing the automation of substation information system and optimizing resource sharing.

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