Research and Application of Transient Transparent Sensing Technology in Substations Using Internet of Things to Distributely Connect Non-contact New Broadband Sensor

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Abstract. When the equipment in the substation undergoes major disturbances (such as short-circuit failure, system oscillation, frequency collapse, voltage collapse, line lightning intrusion, etc.), electrical quantities (voltage, current, frequency, etc.) will undergo transient changes. This process is to correctly analyze the accident. The basis of cause can be used to evaluate the operating status of equipment, find fault points, and quickly deal with faults. However, the current domestic transient information perception in substations still needs to be developed: 1) The existing system data sources are PT and CT data, which are restricted by the bandwidth of PT and CT, and the high-frequency monitoring accuracy is not high; 2) the construction and maintenance of centralized screens are complicated. Using a large number of secondary cables; 3) the redundancy is small, and it is not easy to increase and upgrade. Therefore, it is urgent to develop a new type of distributed substation transient information sensing technology, to develop a system wide-frequency transient current sensing technology based on advanced magnetic field sensors to achieve non-contact measurement, and to develop a system broadband transient based on advanced optical electric field sensors to achieve non-contact measurement.

1. Introduction
Under the development of smart grid, China Southern Power Grid Corporation put forward the concept of transparent grid, which is to combine current information technology, computer technology, data communication technology, sensor technology, electronic control technology, automatic control theory, operations research, artificial intelligence, Internet technology, etc. The power grid is combined, and small and micro smart sensors are installed on the grid to display all aspects of the power system, including transparent power information, network information, market information, equipment status, operation status, transaction status, etc., forming "Transparent Grid".

Realize online security risk assessment of grid operation, optimize economic operation, intelligent decision-making and dispatch, and promote the safe, efficient, green and low-carbon development of energy and power. The purpose of this paper is to calculate and analyze the short circuit current, grounding fault, harmonic, voltage drop and other key problems in the design of medium voltage AC integrated power system, and provide the design method of power system [1].
2. Overview of Non-contact New Broadband Sensor
Advanced sensing technology is a hallmark feature of transparent power grids, and its core purpose is to provide real-time feedback and dynamic adjustment of power grid operating status. By building a large-scale distributed sensor network in the power grid, the state monitoring and management based on electromagnetic transformers is gradually transformed to the full-process monitoring and management of steady-state, transient and electromagnetic transient broadband operating conditions, and the full-time domain of substations is mastered. Full frequency domain operation overview; in the laboratory, simulations are carried out based on the overvoltage generation mechanism and actual circuit conditions. Currently in reality, the laboratory can simulate lightning impulse overvoltage and operating overvoltage. For a long time, this method has made a huge contribution. But this method also has its limitations. The actual situation is intricate, there are many influencing factors on overvoltage, and several overvoltage may be intertwined. Therefore, the laboratory simulation cannot completely simulate the field overvoltage[2].

The power grid is divided into five key links: power generation, transmission, distribution and transformation. Substation refers to the place in the power system that transforms voltage and current, receives and distributes power. It is the core node of the power grid architecture. Its safe and stable operation is related to power safety and society economic development. The main grid of electric energy distribution is at the intersection of substations. The substation is the gathering point of the entire network's operation information. Accurate acquisition of substation operation and fault data is the top priority of power grid safety management.

Due to the complex operating environment of the equipment in the substation, after experiencing major disturbances (such as short-circuit faults, system oscillations, frequency collapse, voltage collapse), electrical quantities (current, frequency, etc.) will undergo transient changes. This process is to correctly analyze the cause of the accident. Based on this, you can evaluate the operating status of the equipment, find the fault point, and quickly deal with the fault. However, the current domestic transient information perception in substations still needs to be developed:

1) The system data source is PT and CT data. Due to the bandwidth of PT and CT, the high frequency monitoring accuracy is not high. During data analysis, due to the lack of high-frequency signals of the monitoring data, fault location and identification cannot be achieved or the accuracy is not high.

2) The construction and maintenance of centralized screens are complicated, and a large number of secondary cables are used. Traditional substations use all kinds of cables to transmit signals. The number of cables is large, the routing is complicated, and the construction and maintenance are difficult, which is not conducive to unified management; although the smart substation has been optimized after the use of merged units and communication systems, there is still a construction and wiring process. Does not constitute a distributed monitoring system.

3) The redundancy is small, and it is not easy to increase or upgrade. With the existing design, it is difficult to increase the capacity and requires more power outages, and it is difficult to expand a single circuit, resulting in long power outages and large power outage losses.

3. Research on sensing technology for transparent sensing of transient information in substations
Carry out research on the design of substation transient signal sensing terminal based on distributed non-contact measurement. In the measurement technology, the current sensor based on the giant magnetoelectric effect is used for current measurement, and the electromagnetic compatibility and insulation protection of the sensor in the complex environment in the substation are analyzed and designed.

Magnetoresistance (MR) refers to a physical phenomenon in which the resistance of ferromagnetic metals and metal alloys such as iron, cobalt, and nickel changes under the action of a magnetic field. It is manifested in the fact that the resistivity of the magnetic field in the direction of parallel and perpendicular currents is different. equal. The resistivity parallel to the current direction is much greater than the resistivity perpendicular to the current direction, as shown in the Figure 1 below [3].
4. **Research on sensor networks for transparent sensing of transient information in substations**

Carry out research on IoT communication technology solutions suitable for distributed sensors for transparent sensing of transient information in substations. Research the performance requirements of multi-node distributed transient information transparent perception for data transmission bandwidth, speed, distance and security. After the sensor system monitors and collects information, it is necessary to transmit the data to the remote monitoring system in real time, study the supporting data transmission system, and build a transmission network with a large number of access nodes, high data security, and data transmission that takes into account broadband and multi-parameters.

Carry out the research on plug-and-play and networking technology of distributed sensors for the transparent sensing and transmission of transient information in substations, and propose a multi-sensor local networking transmission technology plan to quickly and real-time transmit sensor system monitoring data to the monitoring system.

Research on the data compression transmission and secure communication technology of the distributed sensor of the substation transient information transparent perception, and solve the problem of multiple terminal information collection and synchronization. In terms of information transmission, research is conducted on key technologies such as mobility management, nodes, security mechanisms, and information transmission performance optimization under different application environments and business needs to ensure that the transmission method can provide reliable and stable services in different environments. In terms of data synchronization, the time ruler is used to realize the time unity of each distributed node, which provides storage basis for data storage and basic support for data analysis [4].

Distributed connection non-contact substation transient information data meter completes the data receiving, storage and analysis functions of each distributed transient signal sensing terminal, and provides data external transmission channels.

Study the architecture design of the substation transient information transparent sensing system, determine the distributed measurement topology, the transient information data instrument will provide multi-channel distributed current/voltage transient information sensing terminal access, and its measurement topology is as follows. A single distributed connection non-contact substation transient information data instrument can support multiple node monitoring terminal data access.

Carry out transient information data instrument design, carry out functional design and protection design based on installation scenarios, and realize data storage and communication. The data meter needs to be deployed on the outdoor site and work for a long time, and it needs to be specially designed according to the environment. In terms of data storage, it is necessary to analyze the data volume and storage format, and complete the data storage in accordance with the specifications.

After the development of the prototype of this project is completed, it is planned to install the prototype on at least one main transformer side in the substation, and apply the research results of the pilot project. This project will rely on Nanning Power Supply Bureau or Qinzhou Power Supply Bureau to provide pilot application support.
The prototype developed by this project will be installed in the substation. After installation, the equipment assets will belong to the Guangxi Power Grid Corporation Electric Power Research Institute. The specific operation and maintenance work will be undertaken by the pilot power supply bureau. The Electric Power Research Institute of Guangxi Power Grid Corporation will provide operation and maintenance training and pilot prototype operation and maintenance management manuals to equipment operation and maintenance management units.

5. **Research on key technologies of distributed connection non-contact sensing terminals**

The pilot prototype is divided into a sensing terminal and a data meter. After the sensing terminal transmits the data to the data meter through wireless communication, the data is remotely transmitted through the integrated data network in the substation to the main equipment safety early warning and decision-making platform of the entire network of the Electric Power Research Institute of this project. The remote access and monitoring software module of the substation transient information. The installation plan and data transmission architecture of the pilot prototype are shown in Figure 6.

The remote access and monitoring software for the transient information of the substation will submit the network security evaluation report and the security evaluation report, and meet the security technical requirements when entering the network.

6. **Conclusion**

Research on voltage sensing technology, use new micro-sensing technology to develop distributed connection non-contact sensing terminals, develop remote access and monitoring software for substation transient information, and embed the main equipment safety early-warning decision-making platform of the entire network of the Electric Power Research Institute to build substation transients. The sensor network system with transparent information perception realizes passive and wireless communication design, realizes the transparent perception of incoming and outgoing transient information in the station, and is portable and easy to install. It provides solid data support for the acquisition and analysis of power grid transient information, and greatly improves the substation Transient information monitoring level improves the reliability of power grid operation.

**References**

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