

Analysis of Influence of Wiring Error on Electric Energy Metering Device and Preventive Measures

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Abstract: Electric energy metering device is the key to ensure the economic interests of power supply enterprises and users and the safety of electricity. Wiring errors are the main causes of electric energy metering distortion and power line failure. Five types of wiring errors of electric energy metering devices and their possible effects are described and sorted out, and the corresponding detection methods for software and hardware wiring errors are introduced. Based on the actual application of the electric energy metering device, the corresponding preventive measures are put forward, in order to provide some reference for solving the problem of wiring errors in the metering system of the electric energy metering device and ensuring the safety of electricity use.

Keywords: Electric Energy Metering; Wiring Error; Detection Method; Preventive Measures

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Introduction

As a kind of equipment that can measure and monitor electric energy data, electric energy metering device is the key^[1-3]to ensure the accuracy of electric energy metering and billing. However, the wiring error in the electric energy metering device is one of the main reasons for the inaccuracy of the electric energy metering data, which will

seriously affect the electricity billing of users and the income^[4-6] of power enterprises. Therefore, it is of great significance for both users and power enterprises to ensure the correctness of the wiring of the electric energy metering device and then improve the accuracy of the operation of the electric energy metering device. In the actual production and operation process, due to the negligence of installation personnel and the lack of standardized installation standards, the wiring errors of electric energy metering devices occur from time to time^[7-9]. Therefore, it is of great practical significance to study the wiring errors of electric energy metering devices and their effects for improving the wiring correctness of electric energy metering devices.

This paper mainly introduces the types, detection methods and preventive measures of wiring errors of electric energy metering devices, and analyzes and discusses the influence of wiring errors on electric energy metering, aiming to provide reference and help for the normal operation and management of electric energy metering devices.

1. Basic Principle and Structure of Electric Energy Metering Device

1.1 Definition and Significance of Electric Energy Metering

Electric energy measurement refers to the process of measuring, calculating and recording electric energy, which is one^[10,11] of the basic work of power system operation and management. Electric energy measurement is mainly to calculate the value of electric energy through the measurement of voltage, current, power factor and other parameters, and record and report the results.

The measurement of electric energy is of great significance^[12-14] to the safety, economy and environmental protection of the power system. First of all, electric energy metering can provide accurate electricity data, and provide basic data for the planning, construction and operation of the power system. Secondly, electric energy metering can control and manage the power load, and realize the rational dispatch and optimal operation of the power system. In addition, electric energy measurement is also the basis of economic accounting of electric power enterprises, which can provide necessary data support for electricity fee calculation and electricity trading. In practical

applications, electric energy metering devices are usually realized by electric energy meters, centralized metering systems and other forms. Watt-hour meter is a device used to measure and measure electric energy. It is usually installed at the user's electricity or different nodes of the power system to measure and record electric energy in real time. Centralized metering system refers to the establishment of special metering stations in the power system, through centralized metering and monitoring of electric energy in the power system, to achieve comprehensive management and control of electric energy. Ensuring the accuracy of electric energy measurement plays a vital role in ensuring the safety, economy and environmental protection of the power system. This is not only related to the economic benefits of electric power enterprises, but also related to the economic development of society and environmental protection.

1.2 Basic Composition of Electric Energy Metering Device

Electric energy metering device is a kind of equipment used to measure, calculate and record electric energy. It measures the current and voltage in the circuit according to the principle of electromagnetic induction, and then calculates the electric energy value. Electric energy metering device is composed of electric energy meter, centralized metering system, etc. Among them, the electric energy meter is the most commonly used electric energy metering device, which is usually composed of current components, voltage components, metering mechanisms and display devices.

A current element is a device used to measure the current in a circuit, usually a current transformer or a combination of current transformers. The current transformer is a device which uses the principle of electromagnetic induction to achieve current measurement. It is composed of two magnetic cores and multi-turn windings. When a current passes through the circuit, electromagnetic induction is immediately generated in the current transformer winding, and then a corresponding current signal is generated in the secondary winding, and the signal can be used for measuring the current after being amplified and processed to a certain extent.

A voltage element is a device used to measure the voltage in a circuit, usually a voltage

transformer or voltage divider. Voltage transformer is a device which uses the principle of electromagnetic induction to achieve voltage measurement. It is usually composed of a magnetic core and a multi-turn winding. When there is voltage in the circuit, electromagnetic induction will be generated in the winding of the voltage transformer, and then the corresponding voltage signal will be generated in the secondary winding. After certain amplification and processing, the signal can be used to measure the voltage.

Metering mechanism is a device used to calculate electric energy, which usually uses an electric energy meter chip or a special metering device. The metering mechanism usually calculates the instantaneous power according to the real-time value of current and voltage, and obtains the cumulative electric energy through integration. At the same time, the metering mechanism can also measure and record the power factor and demand according to the user's needs.

The display device is used to display the electric energy measurement results, usually in the form of mechanical pointer, digital or liquid crystal, etc., to present the measurement results to the user intuitively.

In a word, the electric energy metering device can provide necessary reference data and information for the operation and management of the power system through the measurement and calculation of current, voltage and other parameters, and provide accurate and reliable information such as power consumption and power quality for users. Its accuracy, reliability and stability are of great significance to both the safe operation of the power system and the social and economic operation.

2. Types of Wiring Errors of Electric Energy Metering Devices and Their Effects

In the process of installation and use of electric energy metering device, due to the negligence and improper operation of the installation personnel, the problem of wrong wiring often occurs. Wiring error refers to the cable connection error caused by the improper operation or negligence of the installation personnel in the wiring process of the electric energy metering device. Wiring error is one of the main causes of

measurement error of electric energy metering device.

2.1 Types of Wiring Errors

Common wiring errors are usually divided into five categories: phase sequence error, interphase reverse connection, single phase error, multi-line error and transformer error. Phase sequence error refers to the phase sequence wiring error of three-phase power supply, which is mainly caused by the incorrect connection sequence of L1, L2 and L3 three-phase power supply. When the phase sequence error occurs, the electric energy metering device will miscalculate the electric energy value, resulting in the mismatching between the metering result and the actual electric energy; on the contrary, it means that the two terminals of the voltage or current transformer are connected incorrectly, which will cause the electric energy metering device to be unable to accurately calculate the electrical energy value; Single-phase connection error refers to the connection error of phase line and zero line in single-phase power supply. When single-phase connection error occurs, the electric energy metering device cannot work normally. Multi-line connection error refers to the connection error of power supply, current transformer, electric energy metering device and other equipment. This error will not only affect the accuracy of measurement results, but also may lead to equipment damage; Transformer misconnection refers to the wrong wiring of current transformer and voltage transformer, which will lead to the mismatch between the calculated energy and the actual energy. Transformer misconnection is usually caused by the wrong polarity connection of transformer.

Wiring error is a very important problem in electric energy measurement. In order to ensure the accuracy of the measurement results, the correct wiring method should be paid attention to in the application process of the electric energy metering device. At the same time, when checking and maintaining the device, it is also necessary to carefully check the wiring to avoid the occurrence of wiring errors.

2.2 Influence of Wiring Error

Wiring error is one of the most common problems in energy metering devices, which

has a significant impact on the accuracy and reliability of energy metering. Wiring errors will lead to the error of current and voltage signals, which will cause the deviation of the electric energy measured by the electric energy metering device. The impact of wiring errors is mainly manifested in the following five aspects.

First, the accuracy of energy metering is reduced. Wiring errors can cause errors in the current and voltage signals, which can greatly affect the accuracy of energy metering. If the wiring error is serious, it may lead to a large difference between the measured value and the actual value of the electric energy measurement, which will have a serious impact on the accuracy and reliability of the electric energy measurement.

Second, energy billing is inaccurate. Energy billing is one of the important applications of electric energy metering. If there is a wiring error in the electric energy metering device, the measured electric energy value will be inaccurate when charging, thus affecting the user's electricity cost. This may bring huge economic losses to large factories and enterprises.

Third, there are potential safety hazards. Wiring errors may lead to problems such as short circuit or leakage of electricity, which may lead to potential safety hazards. For example, if the electrical parameters of the electric energy metering device are abnormal due to wiring errors, it may lead to problems such as circuit overload or electrical fire, endangering personal safety and property safety.

Fourth, signal interference. Wiring errors may cause the current and voltage signals of the energy metering device to be disturbed, thereby affecting the quality and stability of the signals. This will further reduce the accuracy and reliability of energy metering.

Fifth, the system stability is reduced. The stability of the electric energy metering device is of great significance to the normal operation of the power system. If the wiring error leads to the failure of the electric energy metering device, it will have an impact on the stability of the power system, and may even lead to system collapse.

To sum up, the influence of wiring errors on electric energy metering is very important and should be paid enough attention to. In order to ensure the accuracy and reliability

of electric energy measurement, it is necessary to effectively prevent and diagnose wiring errors.

3. Detection Method for Wiring Error of Electric Energy Metering Device

Wiring detection methods are generally divided into software methods and hardware methods. The software method is to use the internal software of the electric energy metering device to detect the wiring of the electric energy metering device. This method needs to add some logic detection programs inside the device to judge whether the wiring is correct by detecting the relationship between current, voltage, power factor and other parameters. For example, in a three-phase four-wire circuit, whether the wiring is correct can be judged by detecting whether the three-phase current is balanced, whether the neutral current is zero, and whether the A, B and C phase voltages are normal. The advantage of software method is that it does not need additional hardware equipment and has low cost, but its accuracy is affected by the accuracy of the device itself, and its detection ability is limited. Therefore, the software method can only detect some simple wiring errors.

The hardware method refers to the use of external hardware equipment to detect the wiring of the electric energy metering device. Commonly used hardware detection devices include: wiring boards, plug-in connectors, plugs and sockets, etc. The hardware method has the advantages of high accuracy and strong detection ability, which can detect more types of wiring errors, but its cost is high, it needs additional hardware equipment, and the detection process is more cumbersome.

In addition to software methods and hardware methods, there are also some wiring detection methods based on image recognition, machine learning and other technologies, which can automatically detect circuit wiring by shooting circuit board images and inputting image data into a computer for analysis. This method does not require professional equipment and can achieve fast and accurate detection, but it requires a large number of image samples and complex algorithm support.

In a word, wiring detection methods need to select appropriate methods according to

specific application scenarios and needs, and consider factors such as accuracy, efficiency, stability and security.

4. Preventive Measures for Wiring Errors of Electric Energy Metering Device

In the actual operation process, due to non-standard operation or other reasons, the electric energy metering device may have wiring errors, which will adversely affect the metering accuracy. In order to avoid this situation, we need to take a series of preventive measures.

First, maintain and overhaul the electric energy metering device regularly. After a long time of operation, the normal operation of the electric energy metering device may be damaged due to wear or failure. Therefore, it is necessary to maintain and overhaul the electric energy metering device regularly. Specific operations include, but are not limited to, cleaning the energy metering device, checking circuit connections, checking data collectors and transmission devices, calibrating current and voltage sensors, etc. Through regular maintenance and overhaul, the problems in the electric energy metering device can be found and eliminated in time to ensure its normal operation.

Secondly, standardize the use of electric energy metering devices. In order to avoid the influence of human factors on electric energy metering, it is necessary to standardize the use of electric energy metering devices. Specific measures include reasonable installation of electric energy metering devices, prevention of external interference, and avoidance of overload. In the process of using the electric energy metering device, it is necessary to abide by the relevant operation specifications and standards to avoid the occurrence of wiring errors caused by improper use.

Thirdly, strengthen the training and management of operators. In the process of using electric energy metering device, it is necessary to ensure the skill and knowledge level of operators. Therefore, it is necessary to strengthen training and management to ensure that operators are proficient in the use of electric energy metering devices, operating procedures and technical requirements, and to ensure that they operate in strict accordance with the operating procedures, so as to avoid wiring errors caused by

improper operation.

Then, the intelligent electric energy metering system is established and applied. Intelligent electric energy metering system is a new type of metering system which is widely used in power system. Compared with the previous electric energy metering system, the intelligent electric energy metering system has the advantages of high degree of automation, high measurement accuracy and reliable measurement data. During operation, the use of intelligent energy metering system can effectively avoid the impact of wiring errors on energy metering.

Finally, we need to establish a sound contingency plan. In case of emergencies, it is necessary to respond in time to ensure the normal operation of the electric energy metering device and the accuracy of the data. The contingency plan shall include but not limited to emergency handling procedures, emergency handling measures, emergency contacts, etc., to ensure that all kinds of problems can be dealt with quickly and effectively.

The accuracy and security of electric energy metering system is of great significance to the management of power production and consumption, so the importance of avoiding wiring errors to the accuracy and security of electric energy metering system can not be ignored. During the operation of the electric energy measuring device, the above measures can greatly reduce the frequency of wiring errors, thereby effectively improving the accuracy and reliability of the electric energy measuring device, and ensuring that the electric energy measurement can provide reliable basic data for energy management.

5. Conclusion

In this paper, the influence of wrong wiring of electric energy metering device on the accuracy of electric energy metering is studied and analyzed. Through the introduction of the types of wiring errors, the influence of five types of wiring errors on the accuracy of electric energy measurement, the possible consequences and the detection methods of software and hardware wiring are explained, including phase sequence error, phase

reverse connection, single phase error, multi-line error and transformer error. At the same time, during operation, it is recommended to take regular wiring detection and corrective measures to ensure the correct wiring of the electric energy metering device, so as to ensure the accuracy of electric energy metering. At the same time, in the design stage, wiring problems should be fully considered, reasonable layout of electric energy metering devices should be designed, and appropriate wiring instructions should be provided to prevent the occurrence of wiring errors.

The research results show that the wiring error of the electric energy metering device has a significant impact on the accuracy of electric energy metering, which will lead to the increase of the error of electric energy metering. Therefore, it is of great significance to strengthen the detection measures for the wiring of electric energy metering devices and take corresponding preventive measures during operation to ensure the accuracy of electric energy metering and the safety of electricity use.

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