Research on the hardware detection device of the IR46 intelligent IoT electric energy meter

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Abstract. Based on the characteristics and design concept of the IR46 intelligent IoT electric energy meter (hereinafter referred to as the IoT electric energy meter), from the perspective of verifying its design, practicability, and quality, a hardware detection device solution that satisfies the IoT electric energy meter is proposed. It satisfies its multi-core modular hardware detection requirements, can effectively guarantee the network access detection of IoT electric energy meters, improve detection efficiency, and reduce the difficulty of development of electric energy meter manufacturers. A reasonable hardware detection device solution is provided for the implementation of IR46 electric energy meters in China.

1. Introduction
IR46 is a standard system for standard design and production of electric energy meters issued by the International Organization for Legal Metrology (OIML). The current software and hardware design of electric energy meters in China is relatively solid, and cannot meet the standard requirements of software upgrades and modular design. When the application needs, it can only be solved by replacing the whole electric energy meter. In order to adapt to international standards and meet my country’s flexible market needs, the State Grid Corporation of China proposed a "dual-core" intelligent IoT electric energy meter architecture, which splits the software and hardware into two parts: the measurement core and the management core. This can solve the current problems and application requirements of intelligent IoT electric energy meters.

The new standard brings new demands, and the IoT electric energy meter will face more challenges in the design and production. At the same time, in order to effectively verify the product design, practicability, quality and other requirements, to ensure the reliability and stability of the product, the design of hardware detection device applied to verify the IoT electric energy meter plays an important role in the detection, and it directly affects the economic interests of power companies and customers. In summary, this paper designs and studies the hardware detection device of the IoT electric energy meter, analyzes its characteristics in depth, and provides guidance for the production and detection of the IoT electric energy meter, which can provide guidance for the production and detection of the IoT electric energy meter that meets international standards.

2. Technical Characteristics Of IoT Electric Energy Meter
The architecture design of the IOT electric energy meter includes: measurement module, management module, and expansion module. Each module is independent of each other. If the communication module is connected, not connected or replaced, the performance and operating parameters of the
electric energy meter will not be affected. The IoT electric energy meter has a communication module, which requires the support of two Bluetooth master-slave communication modes.

Among them, the metering module implements legal system-related functions, including power metering tasks, data storage, pulse indication, total loss of voltage, power supply abnormal event detection and other functions. In order to ensure that the metering reliability remains unchanged for a long time, software upgrades are not allowed. It also has a communication interface between the management module and the expansion module to realize data communication and provide external power, clock pulse output signals, metering raw data and carrier communication. The management module is used to manage the logical relationship between the metering module and the expansion module. It can run the embedded operating system and upgrade the software according to the market demand. It also has an expansion module interface for communication and active Reporting function, raw data sampling and other functions. The design block diagram is shown in Fig.1.

3. Design of Hardware Detection Device for IoT Electric Energy Meter

3.1. Hardware Detection Purpose
The hardware test is mainly to find the errors of the IOT electric energy meter, and prove whether the design is correct and reasonable. The hardware detection device designed for the IoT electric energy meter must first verify whether it meets the IR46 standard; secondly, it should verify the reliability of the product and whether it can achieve reliable upgrade requirements without affecting the core measurement of the meter. Finally, the testability and usability of the IoT electric energy meter should be tested to ensure that the product hardware can be used in practical application.

3.2. Hardware Detection Device Design
According to the multi-core modular architecture design of the above-mentioned IoT electric energy meter, it mainly includes a metering module, a management module, an expansion module, and a communication module as the underlying communication driving layer. Therefore, the hardware detection device for the IOT electric energy meter includes the hardware detection of the metering module, the hardware detection of the management module, the hardware detection of the expansion module, and the hardware detection of the communication module.

The hardware detection device is mainly composed of measurement module detection tooling, management module detection tooling, expansion module detection tooling, and Bluetooth module detection tooling. All hardware tools are connected to the electric energy meter. In addition, it is also equipped with a main control computer, a switch, a standard power source and a serial server. Each
epitope has a communication interface, an epitope controller, and an optical pulse collector, each of which occupies a serial server. The block diagram of the hardware detection device is shown in Fig.2.

The main control computer is used to realize the setting and control of the entire hardware environment, configure the parameters of the meter controller, record the fault information, analyze the cause of the fault, etc. The epitope controller is used to control the input and output of voltage and power. It mainly includes a voltage and current relay and epitope putter. The voltage and current relay realizes independent control of the voltage and current access and disconnection status of each meter, and epitope putter is used for pressure gauge operation.

When the hardware of the expansion module is detected, it is inserted into the interface of the expansion module of the IoT electric energy meter, and message interaction is realized through the pins in the interface, and the expansion module tooling is controlled by a custom command to simulate the tooling in-position signal. The other end of the tooling is connected to the serial server port, the detection system monitors the serial server port, and waits for the IOT electric energy meter to send a list of reading energy meter modules. After receiving the reading command, the slave device replies the electricity meter message, and finally the authentication between the energy meter and the Bluetooth slave device is realized. Through the above-mentioned method, a method for monitoring the interface of the electric energy meter expansion module is provided, and the handshake authentication test of the uplink module interface can be realized by using this method. The expansion module detection tool and the meter frame interface adopt a unified type, which is convenient for compatible expansion.

Each Bluetooth module communicates with the master via a network, and each epitope is equipped with a Bluetooth master module and a Bluetooth slave module. All Bluetooth modules are connected to the serial server through a serial port. Each Bluetooth tool has the function of changing the MAC address through a custom protocol to prevent MAC conflicts between different Bluetooth modules during testing.

3.3. Hardware detection process

At the beginning of the test, the control device is raised to the power source, the standard power source parameters are read to determine whether the source is raised successfully, if it is unsuccessful, it is repeated, and the test process is exited without success for more than three times. After the power source is successfully raised, the main control computer creates a detection thread for each epitope to achieve parallel testing of multiple epitopes and improve testing efficiency. After the detection thread is created, a detection experiment item is required to obtain each epitope, and each detection process is executed in turn. After the last detection item is completed, the detection is completed, and finally the detected fault information is recorded and analyzed. The detection process is shown in Fig.3.
4. Hardware Detection Function And Significance
In actual hardware detection, faults are inevitable. Through the use of reasonable detection technology, the recording and analysis of faults and minimizing the impact of faults are important meanings of hardware detection. The hardware detection of the new generation of IoT energy meters described in this paper first complies with the international IR46 standard and meets the multi-core modular design concept. The hardware detection devices of the metering module, management module, expansion module and communication module are designed. The hardware detection device is beneficial to verify the accuracy and efficiency of the metering module, the effectiveness and accuracy of the management module, the upgradeability and the expandability of the expansion module, and the communication function of the Bluetooth module. And to ensure the independent integrity of each functional module, when one of the modules fails, it does not affect the normal operation of other modules, and the failed module can be replaced separately. Finally, the fault information is recorded and the fault causes are analyzed to provide reliable basis for the design, practicability, quality of the IoT electric energy meter.

5. Conclusion
The development and implementation of the IoT energy meter is of great significance for China's power grid company from traditional mode to integrated energy service-oriented enterprises. In the process of advancing the IoT electric energy meter, the corresponding hardware detection device is designed and developed to effectively ensure the quality and practicability of the product. This paper analyzes the characteristics of the IoT electric energy meter, and designs a hardware detection device corresponding to its functional characteristics. It has instructive significance for the hardware detection technology of the IOT electric energy meter, but this paper only conducts research and review, and there is no specific detection realization. The related work needs further research.

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