A Remote Automatic Detection And Calibration Device for AC Watt-hour Meters

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Abstract. In this paper, a remote automatic detection method for AC electricity meter standard device based on cloud technology, wireless communication technology and automatic control technology is developed, to improve the work efficiency of large-scale AC electricity meter calibration. By optimizing the internal structure of the standard AC power meter, the grade of anti-shock and anti-vibration is improved. Through the integrated GPS positioning device, intelligent locking device and vibration label, the safety of the equipment itself and the traceability of the flow process are ensured. The cloud service system is further established to realize the remote automatic detection of the standard device of the electricity meter, which greatly saves the cost of manual calibration.

1. Introduction

The standard device of AC watt-hour meter widely used in AC electricity meter manufacturers and measurement institutions is an important measuring device for AC, which provides electric energy to the inspected watt-hour meter and determine the quality of AC electricity meter [1-3]. There are the following problems in the current testing of AC electricity meter standard devices [4, 5]: First, the testing is mainly based on the traditional manual on-site testing method, and there are inconsistencies in the testing scheme, testing operation and testing report, so it is difficult to effectively guarantee the testing quality, personnel and equipment safety. Second, according to the development of each measurement and testing institution, the time and cycle of the re-purchase of standard devices are different, in which the department of value transmission needs to invest a lot of time and manpower to test the standard devices of electricity meters, resulting in poor work efficiency and economy. Third, the detection data do not form a clear and reliable retrieval and preservation system, which does not meet the regulatory authorities' increasing management requirements for legally authorized testing institutions. There are data islands resulting in a waste of data resources.

In recent years, electric measurement technology towards the scale, systematization and the direction of automation development, and new information technology like bamboo shoots after a spring rain [6-10]. The large-scale application of civil 4G/5G high-speed wireless network, together with the establishment of special cloud service system, can realize real-time data sharing and push [11]. In order to avoid data waste and improve work efficiency, this paper will combine cloud system technology to establish remote automatic detection methods and devices for standard devices of AC electricity meters.
2. AC watt-hour meter standard device design

2.1. High resistance three-phase standard watt-hour meter
The core hardware structure of the high-resistance intelligent three-phase standard watt-hour meter is shown in the figure below. From analog signal to digital operation, it is mainly composed of PT compensable linear voltage transformer, CT compensable linear current transformer, T-board transformer control board, E-board electronic device board, Display board digital operation board, Power Supply auxiliary Power board, High speed I/O Board high-speed signal exchange Board, etc. The three phase components are completely independent and isolated to maximize the level of accuracy and minimize interphase current leakage in the measuring loop.

![Figure 1. Structure of the core components of a high-resistance intelligent three-phase standard power meter.](image)

2.2. Multi-function system design
The standard device types, functions and communication protocols of AC watt-hour meters produced by different manufacturers are different. Therefore, it is necessary to integrate the device data of various manufacturers to establish a set of optional and universal multifunctional controller for the standard device of AC watt-hour meters. Based on ARM Cortex M7, RS232 serial communication mode is used to interconnect with the device, and the multi-functional standard device controller is developed, which provides the hardware foundation for realizing the local control of the platform. Execute the client program on the master computer and send a signal to the server program in the controlled computer. Set up a special remote service that uses various remote control functions to send remote control commands. Control the operation of various applications in the standard table of the controlled end, read the corresponding data of the standard table and return to the control end. In addition, the system can monitor the verification process and collect verification data and fault information when working. By contrast with historical data, device problems can be detected in time.

2.3. Automatic detection software
The automatic detection software includes the control side calibration software system and the data analysis system. The verification software system has the characteristics of reproducibility, openness and loose coupling. In order to adapt to different controlled devices, different communication protocols and communication formats are integrated. The verification software system abstracts the
control instructions of all controlled devices, and writes the specific control programs of different models of controlled devices from different manufacturers into independent DLLs. When the verification software system is running, according to the manufacturer and model of the current controlled device, it dynamically loads the corresponding specific implementation program DLL of the controlled device through reflection technology, so as to realize the support for a variety of controlled devices. The data analysis system can realize the comprehensive processing of local data and carry out the comparative analysis of longitudinal data of the same equipment in different verification periods. The development trend of the equipment can be given according to the change of parameters such as equipment error. At the same time, the test results can be printed out according to different requirements of the test report or original record.

3. Remote automatic detection

3.1. Intelligent flow transport box

In order to monitor the positioning and security of the circulating standard table, GPS/LBS positioning module and 4G/5G Internet of Things communication module are built inside the standard equipment and the transport box. Intelligent special transport box is mainly composed of transport box body, control module, battery, electromagnetic lock, lock, standby mechanical lock, etc., and is equipped with cloud service system, which can obtain real-time status and unlock remotely through the Internet. Among them, the control module is the core module, which is responsible for the acquisition and execution of all states and data exchange with the cloud service system. It is mainly composed of built-in satellite positioning chip, vibration sensor, 2/3/4G/ NB-LOT communication module, relay, peripheral circuit and other key components. The electromagnetic lock is a high elastic electromagnetic lock, which can open the top cover of the heavy transport box when receiving the unlock signal. The electromagnetic lock has feedback signals, and the control module can obtain the current working state of the electromagnetic lock according to different feedback signals.

The internal control module of the transport box is powered by the battery, which automatically sends a positioning signal to the server of the Internet of Things, so that the background can confirm the real-time location of the standard table, judge whether there is any abnormality and make a comprehensive record. If the deviation from the planned transport path exceeds the set threshold, the 4G/5G communication module will send an abnormal alarm to the cloud server to remind the administrator for further processing. If the vibration sensor detects abnormal vibration, or even a violent impact, it will issue an abnormal alarm to the administrator, reminding the receiving unit of precision instrument not to start the machine immediately after acquiring the instrument; When the transport box arrives safely at the designated receiving unit, the staff of the receiving unit will make an application to the administrator, who will send instructions to the control module remotely through the cloud service system and the mobile Internet. After the command is received by the control module, the upper cover of the transport box will be opened. The control module gets the electromagnetic lock unlocking signal, and the staff of the receiving unit can take out the precision instrument for normal operation; When the precision instruments are used, the staff of the receiving unit shall put them into the transport box and cover the upper cover of the transport box. The electromagnetic lock body on QQ, the control module gets the electromagnetic lock closing signal, and the management personnel confirms that the new transport box is closed. The transport box can be returned by the receiving unit or sent to the next receiving unit as planned; The key of the standby mechanical lock is kept by the administrator, as a manual unlocking method when the battery is not charged for a long time, the battery power is exhausted, and the control module is offline, which makes it impossible to open the new transport box through the cloud service system.
3.2. Remote operating software system

To set up cloud service system based on 4G/5G mobile communication network technology, it is necessary to write a special database system, sharing system and remote control software according to the special requirements of metrological verification regulations in the industry. The remote cloud detection operating system and cloud database system are developed by using the automatic detection software of AC electricity meter standard device developed above. The remote detection operating system is the server-side program Server, which integrates the server-side program into the standard device. Through the remote control end, the multi-function remote control can be carried out, including obtaining the target standard representation value, executing error detection and recording, as well as obtaining the remote standard table and the state of the device under test. The cloud database system mainly stores the detection process and detection results in the cloud database automatically, so as to facilitate the use of the data analysis system. The automatic detection software system of AC watt-hour meter standard device can be stored in different computers separately from the data analysis system. It is not necessary to modify the original verification software system to add the new controlled device, but to incrementally develop a new DLL according to the communication protocol provided by the manufacturer of the new controlled device, and then update it to the existing system remotely, so as to realize the support for the new device, which is transparent to the system user and simple and efficient to the software developer.

4. Equipment testing

Using 0.1 on the Richter scale, field test device of the single-phase watt-hour meter standard established in accordance with the figure 4 complete remote testing system, according to the figure 5 subjects standard device power source Settings, such as selection of single-phase testing scheme, generate test tasks, test process on the basis of JJG597-2005 "ac watt-hour meter calibration device verification regulation of relevant steps required. After the completion of the test, the final test result can be saved and the complete information of the test result can be queried in the data processing interface, as shown in Figure 6.
According to JIG597-2005 "Verification Regulation of AC Watt-hour Meter Verification Device", JIG1085-2013 "Standard Watt-hour Meter", GB/T2423.5-1995 and other procedures and standards, the system can experience complex changes in the external environment can still maintain the 0.02 level of precision index. This system can obtain all the information of the standard device and control it completely. After connecting the 4G/5G network, it can realize the remote automatic verification operation completely.

Figure 4. Block diagram of the test system.

Figure 5. Power source configuration.

Figure 6. Test results of the power meter device.

5. Conclusion
The AC watt-hour meter standard unit remote automatic detection technology is proposed, in which the automatic and intelligent value traceability system and data analysis method are established and improved, to improve the quality of the ac watt-hour meter unit testing and realize effective control of
the equipment health status. Based on cloud technology, wireless communication technology and automatic control technology, the internal structure of the equipment is optimized under the condition of ensuring the accuracy of level 0.01, so as to ensure the reliable operation in the current violent environment of logistics and transportation. At the same time, the box is integrated with GPS positioning device, intelligent locking device and vibration label to ensure the safety and traceability of the equipment. A whole set of remote automatic detection scheme for the standard device of electricity meters is proposed, which realizes the remote automatic detection ensuring that the electric energy metering system is working well and the dissemination of accurate and reliable, and greatly saves labor cost and improves work efficiency.

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