Development and application of intelligent verification device for insulation (grounding) resistance meter

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Abstract. The intelligent insulation resistance meter realizes a verification device that can simultaneously verify the insulation resistance meter and ground resistance meter, which can provide the standard resistance value for the verification of insulation resistance meter and ground resistance meter. The automation of the verification device had been achieved by the intelligent insulation resistance meter. The resistance value could be automatically output after inputting the value of resistance by the keyboard, which reduces the time of manually adjusting the knob of resistance value. The original verification record and verification certificate will be generated automatically after verification. The application of wireless communication technology enables the wireless connection of computer, automatic resistance box and printer.

1. Introduction
With the rapid development of economy, energy demand has greatly increased. Thus, it’s important to improve the reliability of power grid. As an important testing technology, electrical test could find the problem, defect diagnosis and determine the running state of electrical equipment. At present, the electrical testing work is ineffective because the traditional test instruments could not meet the needs of intelligent development of electrical test[1-3].

Now, resistance boxes for insulation resistance meter and ground resistance meter are independent and huge, which are difficult to operate and store[4-8]. The traverse between resistance and voltage measuring knob need replace continually, which increase the burden of tester. Based on above reasons, an intelligent insulation resistance meter was researched.

2. Design of intelligent insulation resistance meter
The design of intelligent insulation resistance meter includes the development of automatic resistance box, control system and wireless communication technology.

2.1. Development of automatic resistance box
Considering the economy and accuracy, automatic resistance box needs three functions, that is, detection of insulating resistance, detection of grounding resistance and detection of voltage[9-11]. Based on above principles, making the high voltage resistance box and the high voltage digital voltmeter formed a automatic resistance box. The automatic resistance box could measure wiring without switching the voltage and resistance. The micro-control unit (MCU) was controlled through preparing the PC software, which controlled the stepping electric unit to drive the resistance limit switch to the specified position. The resistance box and PC could be synchronized in real time to
realize the resistance adjustment process without manual. The schematic diagram of automatic resistance box was shown in Figure 1.

Figure 1. Schematic diagram of automatic resistance box.

2.2. Development of software control system
Software control system based on MCU and PC, which were the information processing core of system[12]. MCU interacted with PC through wireless communication module. Based on C++ Builder 2010, upper computer software was developed under Windows XP or above operating system. Upper computer software realized the information interaction between the front-end graphical user interface program and the back-end database management system by connecting with the back-end Microsoft Access 2003 under ActiveX data objects. Thus, an insulation (ground) verification information management system was established, which including the resistance information acquisition, verification certificate generation and verification information management.

When checking pointer was balanced by the output standard resistance, the datum were recorded though the system automatically. The computer error calculation, the result judgment, the generation of verification original record and verification certificate were operated by the computer. The datum could also be stored and managed. The Figure 2 was composition diagram of software verification system module.
2.3. Development of wireless communication technology

Wireless communication module was established based on the chip of ESP8266, which included the integrated RF transceiver, baseband control management and LWIP protocol[13]. The link was not taken between the MCU and Wifi module for the communication, but directly took the form of asynchronous linkless (ACL). The whole communication process could be divided into six parts, which included Wifi initialization, LWIP protocol control setting, query, connection establishment, data communication and disconnection. Both the host and the slave adopted token-based communication protocols in the design. The flow diagram of data transmission was shown in Figure 3.
3. Benefit discussion
The remarkable economic and social benefits had been achieved for the intelligent insulation resistance meter. The time-consuming of verification for the intelligent insulation resistance meter decrease about 57.8% and 55.9% compare with traditional verification way, and about 1680 hours had been saved. Due to the decrease of workload, the cost of labor decreased about 139500 RMB and the cost of laboratory saved about 42000 RMB. In addition, the early defects of electrical equipment could be identified because of improving the verification accuracy of the intelligent insulation resistance meter. For instance, 4 grounding defects had been diagnosed, and the cost of upgrade for grounding

Figure 3. Flow diagram of (a) host data transmission and (b) slave data transmission.
grid saved about 1.48 million RMB. 9 insulating defects of electrical equipment had been verified, and the cost saved about 1.02 million RMB. The power outage time of user reduced about 150 hours, which increased the electricity sales by 3.3 million kWh and increased the electricity revenue by 1.815 million RMB.

The intelligent insulation resistance meter had enriched the technical supervision means and improved the reliability of equipment operation. For example, they had been applied in 9 companies, which could reduce the production cost and increase the electricity sold. At the same time, the application of the intelligent insulation resistance meter had promoted the technical progress and intelligent development trend of the electrical test specialty. It also reduced the probability of failure, and ensured the social security and stability of electricity use. It could reduce the emissions of gases and decomposers caused by equipment failure, avoid air pollution, protect the health of workers, and produce remarkable social benefits in safety and environmental protection.

4. Conclusion
The automatic resistance box could be controlled by using the application of microcontroller technology. The datum could be collected and managed by Access database management. Through XML data processing technology, the verification certificate was generated automatically in the verification device for the first time, and the Wifi technology was applied in the verification device for the first time to realize the wireless connection between the devices.

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