Comprehensive Calibration Platform Based on Instrument-shared Networks

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Abstract. In power test units at all levels, the calibration of equipment is one of the daily tasks. Various departments have repeatedly purchased many standard equipment, and some calibration tasks require moving the standard equipment to temporarily build a corresponding calibration system, which is expensive and unfavorable for the maintenance of the standard equipment. The paper proposes a comprehensive calibration platform based on the network sharing of instruments. The platform optimizes the standard equipment configuration of each department and automatically allocates the standard equipment on the platform according to the calibration task. Then it builds the calibration platform and completes the calibration task in accordance with the calibration process. The platform can perform multiple same or different calibration tasks at the same time and generate corresponding calibration certificates, which reduces the workload of calibration personnel and improves the reliability and utilization of standard equipment. The paper gives the model architecture and workflow of the platform. Experiments verify the effectiveness of the platform.

1. Introduction

The calibration of an instrument is a set of operations to determine the relationship between the indicated value of a measuring instrument or measuring system and the corresponding known value to be measured under specified conditions. The calibration of power equipment and instruments is mainly accomplished by the metrology and calibration departments of each power-saving company. At present, the calibration of each professional equipment and instrument is completed by each professional laboratory under the metrological calibration department. For this reason, measurement and calibration departments are equipped with a large number of standard equipment, and repeated purchase, leading to a large amount of capital investment. However, for a provincial company, there are not many professional metrological calibration businesses, resulting in the idleness of standard equipment. At the same time, the calibration instrument department's daily work, in the face of different calibration tasks need to be temporarily removed and set up corresponding calibration system, but all kinds of standard equipment is mainly stored in fixed laboratory environment [1-5], frequently to dismantle and set up calibration system will not only loss standard equipment but also not conducive to the maintenance of standard equipment. In addition, in order to ensure the performance of various calibration equipment in each laboratory, the quality and power consumption of the equipment are often large, and the on-site handling is difficult, with high power requirements [6-9]. Literature[10]developed a portable intelligent calibration device for comprehensive safety gauge test, aiming at the problems of traditional safety gauge calibration device with single function, large volume, manual calibration and low calibration efficiency. Cao Min [11] studied the automatic calibration and test system of instruments to realize automatic calibration and test process and automatic collection of calibration data, but they were not able to integrate a variety of different standard equipment.

Then, this paper puts forward a comprehensive calibration instrument network platform, the platform
will be the professional standard equipment on a large laboratory, the formation of a Shared network instrument, can according to the standard instruments calibration tasks automatically choose connection, build a platform of calibration, automatically by using the corresponding calibration process to complete the corresponding equipment and instrument calibration process. The platform can support many same or different calibration tasks at the same time.

2. Model Architecture Design of Comprehensive Calibration Platform Based on Instrument Network Sharing

2.1 Overall Architecture

The comprehensive calibration platform based on instrument network sharing is a comprehensive platform integrating control, acquisition, processing, storage, analysis, display and printing with the central laboratory as the control center, the comprehensive standard equipment resources as the support, and the interface adaptation technology as the bridge. The overall architecture of the platform is shown in Figure 1. The database is used to store all the data in the platform. Calibration software runs on the calibration terminal PC and manages the calibration of the whole platform. The standard equipment that can carry out modular common function is designed as the general module of measurement standard of calibration platform, while the standard equipment that cannot be Shared function is designed as the special module of measurement standard. The configuration calibration function is provided through the permutation and combination of calibration software. The calibration task interface allocates the network to receive the instruction from the calibration terminal, and assigns the corresponding measurement module for the corresponding calibration task according to different calibration tasks.

![Figure 1. Overall architecture](image-url)

Among them, the general module of measurement standards mainly includes signal generation module, precision voltage source module, etc., and the special module of measurement standards mainly has the special functional modules of various measurement standards. The specific classification of metering modules is shown in Figure 2.
Figure 2. Classification of special/general modules for integrated system of measurement standards

2.2 Functional Design
The functions of a comprehensive calibration platform based on instrument network sharing include two categories: information management and control management, as shown in Figure 3.
Information management includes user management, device management, data processing, certificate generation and data storage. The user management function is to provide users of the platform with the functions of logging in and out, modifying personal information, and distinguishing operation permissions by user level. The device management function is to provide independent number, register device information and record device status for standard devices of each access platform. The data processing function is to automatically process the calibration data returned by each equipment during the calibration process to judge the calibration progress and the final calibration result. The function of certificate generation is to automatically generate the corresponding calibration certificate according to the calibration result after data processing. Data storage function is to store user information, equipment information, calibration data and other relevant data in the platform. Control management includes interface allocation, device configuration, parameter input and system monitoring.

The interface assignment function is to assign the corresponding module to the calibration task through the calibration interface assignment network by analyzing the required module of the calibration task and combining the current usage status of the module.

The device invocation function is to initialize the corresponding module after the corresponding module is assigned to the calibration task.

The parameter input function is to pass the parameters corresponding to this calibration task to the corresponding module after initializing the module.

The system monitoring function includes the safety monitoring of all the system operations and the recording of the system operation log, the monitoring of the user's safe landing, the monitoring of the calibration software interface, the determination of the calibration progress, and the monitoring of the use of the instrument. At the same time, the instrument is judged to be in fault or idle state, alarm is issued to the system fault and alarm log is generated to improve the troubleshooting rate and record various operation data of the system.

3. Design of Interface Distribution Network Based on Instrument Sharing Network
The traditional interface distribution network only uses matrix switch, which is used to realize the
automatic connection between multiple calibration instruments and various simulated links of different units under test. Interface distribution network for different units under test each interface definition is completely different, each interface may be defined as a power supply, input signal, output signal, one of the external component terminals, and the signal amplitude is also different, a few millivolts low, a few hundred volts high. A large number of signal channels pose severe challenges to the design of the interface distribution network of the calibration platform [12].

In the comprehensive calibration platform, the function of the interface distribution network is mainly to automatically allocate power supply, signal source and other test excitation signals for the input port of the instrument to be calibrated through the switching matrix, and to automatically connect the output port of the instrument to the corresponding test module [13]. Interface allocation network can greatly reduce the workload in the execution of calibration tasks and reduce avoidable human errors in the test process, thus reducing the task execution time and realizing automation to a certain extent [14].

Interface distribution network is mainly composed of master control module, LAN network communication module, switch matrix, driver module and other auxiliary modules such as power supply, as shown in Figure 4.

![Figure 4](image)

**Figure 4.** Hardware system block diagram of interface distribution network module

1. **Main control module and auxiliary module**

The main control module USES THE ARM920T kernel based S3C2410 microprocessor to receive and process the operation instructions issued by the upper computer via LAN network communication module. The auxiliary module is directly connected with the main control module, including display module, status indicator module, power module, reset module and timely clock module.

2. **Switch matrix**

The designed switch matrix adopts 16 TQ2-3 relays arranged in a form of 4×4 matrix, which are connected to 4 row and column signal lines respectively. At the intersection of each row and column is a relay, whose conduction can be controlled by software, thus realizing channel switching. See Figure 5 for details.
(3) Driver module
After receiving the instruction sent by the upper computer, the master control module will perform output operation on the corresponding I/O port. Since the voltage required to drive the relay is higher than the output of the I/O port of the main control module, a drive circuit is needed to enhance the driving capability of the switch matrix. After the output of the I/O port of the main control module is amplified by the power of the drive module, the switch array can be driven on and off.

(4) LAN network communication module
LAN network communication module is used for communication between upper computer and master control module. DACVICOM’s 10/100ms /s adaptive Ethernet chip is adopted. The upper computer, through LAN network communication module, issues operation instructions to the main control module to establish analog link between measurement modules.

(5) Upper computer
After receiving the calibration task on the calibration platform, the upper computer will allocate the metering module resources for the corresponding calibration task, and automatically allocate the interface to the metering module on the network. The upper computer determines the connection of simulated links after each module is idle. The procedure flow is shown in Figure 6.
4. Workflow Design of Comprehensive Calibration Platform Based on Instrument Network Sharing

The work types of the calibration platform are divided into two categories: (1) it is only necessary to query and download the historical original calibration data. (2) Perform calibration tasks. The specific workflow of the platform is shown in Figure 7.

If the work type is (1) class, the experimenter simply logs in to the system, connects to the server database, directly queries and downloads the required certificates, and then exits the system.

If the type of work for (2) classes, the operator first input information for calibration of the instrument landing system and the calibration parameters, set up the calibration tasks, a calibration requirements of instructions, the system automatically for the prospective tasks required special measurement standard and measurement module, then query whether the assigned each module in the idle state, if module fault or busy at this time the school in the background task queue sequence automatically add the required module, when the module to remove occupy, the school must continue task execution, if the module is in the idle state, carry out calibration. When the modules required by the calibration task are allocated successfully, the system call calibration task interface allocates the network to connect the corresponding modules. After the successful connection, the corresponding modules are automatically initialized, the calibration parameters input by the experimenter are transferred to each module, and then the calibration begins. After calibration, each module will return calibration data to the system. The system automatically enters the data processing link. After the data processing is completed, the effect of the calibration will be judged and the calibration certificate will be generated. Finally, all the data of this calibration task will be stored in the database, which can be used to retrieve the calibration data and print the calibration certificate.

Figure 6. Upper computer program flow chart
5. Conclusion
According to the problems existing in the current power equipment calibration of State grid, a comprehensive calibration platform based on instrument network sharing is proposed in this paper.

The platform integrates a variety of metering and calibration devices in the same place, automatically selects the corresponding metering module according to the calibration task on the calibration platform software, and completes the calibration according to the corresponding calibration process. The comprehensive calibration platform can improve the utilization rate of power calibration equipment, improve the working efficiency of the calibration operator, to a certain extent, reduce the cost of calibration work to reduce the probability of error, to achieve standardization, generalization of the work of modern measurement calibration and intelligent goal to provide technical support and platform support.

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7. References
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