Information Acquisition Function of Intelligent Meter Measurement and Control Unit in Electric Energy Information Acquisition and Monitoring System

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Abstract. The traditional smart meter is relatively solid in the hardware architecture design, and gradually can not meet the needs of energy measurement and control in the future. After the in-depth analysis of the metering function will be affected by various external factors, the paper designs a new hardware structure of "dual core-one expansion module" smart meter, through the actual scheme of separation of metering core and management core. The measurement and control chip with various parameters is integrated in the expansion module, which is processed and calculated by the management core, so as to realize the localization protection and alarm function of intelligent meters. Combined with the application status of energy Internet, this paper designs the position and function support scheme of the new smart meter in the energy network, and verifies the practical problems to be solved after adding a variety of measurement and control function modules. The research results have a good reference significance for the development of smart meters and meter master control in the future.

Keywords: Energy acquisition, Data acquisition, Smart meter.

1. Introduction
Smart meter is developed on the basis of traditional metering function meter, and it is also an important driving force for the development of smart grid. The accuracy of meter measurement results directly affects economic revenue of power system. At the beginning of the development stage, the traditional smart meter focused on how to realize the measurement and calculation of line load power. From the perspective of measurement function realization, it mainly studied how to select the process material of metering core body and the synchronization of metering clock. Therefore, the traditional smart meter function module is mainly composed of metering and MCU control units form. However, with the rapid development of science and technology, it is found that the accuracy of meter measurement data is not only related to the measurement principle and the process selection of metering chip, but also there are many uncertain influencing factors generated in the environment and operation process, which will affect the meter measurement results. Therefore, the structure and
function design of smart meters should carry out targeted technology improvement research and development according to the actual situation make [1].

2. Application requirements of intelligent meter with measurement and control capability

From the perspective of power system, the measurement process of traditional smart meters will be affected by many factors. In order to improve the accuracy of measurement data, it is necessary to comprehensively analyze the reasons affecting the measurement process, so as to design solutions accordingly; From the perspective of users, users hope that the convenience of electricity charge inquiry, payment, energy-saving and safe power consumption will be more convenient and efficient channels provide support. Combining the application requirements of the two levels, the internal reasons are deeply explored.

1. High-tech means to tamper with the measurement data: Although smart meters have made great improvements in safety and convenience compared with the first generation of electronic meters. For example, the way of direct stealing electricity is cut off by electronic seal and fully enclosed case, but the illegal elements also make use of the performance defects of the components in the meter that are sensitive to electromagnetic field, and use large magnets or high-power radio interference the metering core of the meter works intermittently, resulting in the loss of metering data. Therefore, the new meter should have the ability of monitoring and controlling electricity stealing behavior. When it detects the electricity stealing signal, it will send alarm information to the background.

2. The type and quantity of non-linear load and distributed new energy sources connected to the meter are gradually increasing. The line pollution caused by the interference of harmonic, noise and fault arc on the line directly affects the measurement data. When the power loss of the line is large, it is a direct economic loss to the user, and also has a serious impact on the power quality and service life of the power grid line. Therefore, the meter should have lines Harmonic and other interference monitoring functions, using harmonic suppression to solve the problem of excessive local harmonics on the line [2].

3. Bad phenomena in the operation environment of electric meters will also directly lead to meter stop measurement, such as lightning attack, fire, artificial damage to the shell and other behaviors. Therefore, real-time monitoring should be carried out for the operation environment of the meter, and the damage behavior and potential safety hazard will be recorded and alarmed at the first time.

4. The step price rule is introduced in the distributed new energy. The users can query the usage and transaction of electricity in real time. The meter should have the function of two-way interaction with large capacity, and the metering and statistical data of the master station can be pushed to the user side actively [3].

Based on the analysis of the application requirements of the above new smart meters, in addition to accurate metering chips, meters should also have multiple functions such as monitoring, edge calculation, control, etc. the main purpose is to improve the measurement accuracy by monitoring the environment and operation status; on the other hand, analyze the monitoring data, and realize the diversified energy demand of users.

3. Overall hardware architecture design of new smart meter

Through the above analysis, the smart meter should add a variety of measurement and control functions to meet the application needs of the industry and users in the future. On the basis of the measurement and management module, the new smart meter should enrich the functions, increase the expansion module of the measurement and control function, and use the isolation chip to hard isolate the function expansion and the metering module, so that the operation of the metering core is not affected by any control module and the failure of other module do not affect the normal operation of the metering core. Online software upgrade is not allowed for metering core. Metering core can provide legal data such as electric quantity and clock. Historical data such as positive and negative active power and positive and negative reactive power can be saved every minute for power tracing. The management core undertakes the management task of the whole meter, analyzes the data collected
by various monitoring chips integrated in the function expansion module in real time, mainly including charge control, display, external communication, event recording, data freezing, load control and other tasks, and supports online software upgrade. The power and clock of the management core are based on the metering core, and are synchronized in real time. The whole meter forms one main and one main A pair of "dual core-one expansion module" hardware structure [4, 5]. The specific structure is shown in the following figure:

**Figure 1.** Overall hardware architecture of new smart meter.

The new generation of smart meters introduces the design concept of "multi-core modular", which has dual chips of metering core and management core. The expanded function module can integrate monitoring, measuring and other types of chips to comprehensively monitor the meter function. The metering core is connected with the high-voltage line, and the management core and the expansion module are connected by low-voltage. In order to avoid the high-voltage side from penetrating the low-voltage side, the bidirectional/single-phase isolation chip is selected according to the types of signals transmitted between chips to realize the internal information security isolation, and can maintain the communication rate above 2Mbps. The function expansion module is not directly connected with the metering core, and the metering data is transmitted by the single-phase management core to calculate the error between the measurement data and the measurement data. The function expansion module is integrated in the form of chip slot. The data sampling and transmission between chips are independent. The operation of the chip does not affect the function of other chips. The form of the slot can be used with plug and convenient function expansion. In addition, the local alarm function is added to inform the operation and maintenance personnel of the safety risks existing on the site in the form of sound, light, infrared and other alarm forms. The debugging and upgrading module supports the real-time online software upgrade of MCU management core and extended monitoring module, which overcomes the problem of direct replacement of original meter failure. The overall effect of the new smart meter in the hardware structure design is multi-function, flexible and easy to use, in line with the new direction of hardware development platform [6].

**4. Design of measurement and control function of new type intelligent electric meter**

Based on the functions of traditional smart meters, the characteristic extended functions of measurement are added to monitor and measure the operating environment, line operation status and new energy grid connection parameters. The functional design of management core and expansion module is enriched. Different types of real-time characteristic chips in the extended function module realize the acquisition of meter parameters, which are coordinated by MCU management chip Calculation, analysis and decision-making, and the decision-making results are published to the localization alarm module and the remote master station system. The new function design of the new smart meter is shown in the following figure:
Figure 2. Design of measurement and control function of new type intelligent electric meter.

The metering function basically inherits the traditional metering technology, mainly for the MCU management module, expansion module and auxiliary module, the function is updated and added. The traditional management core only realizes the management of the metering task, and counts and displays the power data sampled by the metering chip on the LCD to ensure the consistency of the data on a line. In addition, all the data collected by the management core expansion module are processed in series and parallel, analyzed and decided according to certain rules. Therefore, the MCU management core adds the high-frequency aggregation collection and classification storage of monitoring data, and carries out the pre-processing process such as cleaning and edge of the stored data. Finally, according to the pre-set security threshold conditions of different monitoring parameters, whether the measurement function of the parameters is affected or not is judged. The extended function module is divided into three main functions: line detection, environmental monitoring and new energy monitoring. For example, the typical functions of load identification and power quality monitoring are designed as follows:

Load identification function, using the voltage and current data of the watt hour meter itself, through load feature extraction and pattern recognition, it can get the detailed electricity consumption list of household appliances, and realize the interaction of demand response, household energy efficiency analysis and other advanced applications. The load sensing module should have the online upgrade function of load sensing algorithm and load characteristic library, and have the upgrade record function.

The power quality detection function can realize the detection and storage of power quality data related to 2-41 harmonic amplitude value, 2-41 harmonic content, 2-41 harmonic active power, voltage total harmonic distortion rate, voltage deviation, frequency deviation, short-time flicker value, long-time flicker value, temporary overvoltage and instantaneous overvoltage.

In order to enhance the service level capability of smart meters, Bluetooth communication, online upgrade and localized alarm lights are also added:

1. Cancel the original 485, infrared and other local interfaces of the watt hour meter, and use low-power Bluetooth to undertake local communication services. It also supports the verification of measurement accuracy and clock accuracy by Bluetooth communication.

2. The management core and expansion module can be upgraded online. Support point-to-point upgrade or multicast upgrade to improve upgrade efficiency. Software upgrade supports the function of breakpoint continuous transmission, which can start the update process remotely or regularly. If the software upgrade fails, the version before the upgrade can be restored to ensure the normal operation of the watt hour meter [7, 8].
5. Analysis of typical application scenarios of new smart meter business in the future

Play the role of energy conversion hub and platform of power grid enterprises, connect the power grid (large grid, micro grid) and multiple customer side storage equipment, adopt ubiquitous power Internet of things thinking to build smart energy service system, and realize flexible access, data acquisition and real-time control of new energy facilities on the customer side such as electric vehicles, energy storage, distributed photovoltaic, etc. through the new generation of smart meters Gather smart devices and guide and regulate their power generation and consumption curves with the help of market-oriented means, establish a user-oriented intelligent energy management and service system, improve the ability of customers to deeply participate in power grid regulation, realize the integration with EMS and DMS, build a global energy management system of power grid, meet the demand of clean energy consumption, peak shaving and valley filling, voltage regulation and frequency regulation, etc. New mode of smart energy service.

Application 1: orderly charging management of electric vehicles

Combined with the edge calculation function of the management core, the optimization scheme of the power terminal integration system is realized. The new generation of electric energy meter increases the orderly charging and discharging function of electric vehicles in the form of modularization, guides its low power consumption and peak discharge, improves the utilization rate of grid equipment, and meets the diversified charging demand of home. The specific implementation method is as follows: the user app puts forward the charging and discharging business application and sends it to the master station or acquisition terminal. After receiving the orderly charging and discharging plan from the master station or acquisition terminal, the watt hour meter starts and stops the operation at the specified time point, or sends the flexible power control signal to the charging pile to accurately implement the orderly charging and discharging plan. The new generation of watt hour meter is no longer located in the end of the power grid, but as the key equipment of information interaction between energy controller and charging pile, to achieve benign interaction and ensure the smooth development of orderly charging and discharging business [9].

Application 2: distributed energy access management

According to the weather conditions and user's electricity consumption habits in the next few hours, the output guidance curve and user load curve of the distributed generation are predicted through the energy allocation optimization algorithm of the whole system or local distribution network. They sent to the acquisition and control system or user's mobile phone app in the area where the distributed microgrid is located together with the relevant control parameters. According to the output capacity and user load curve of the distributed microgrid issued by the master station, combined with the real-

Figure 3. Application scenarios of energy services.
time power and user load power of the distributed microgrid monitored by the master station, the
acquisition system makes reasonable arrangements for the user power consumption and the operation
strategy of the distributed microgrid through the local control strategy. The new generation of watt
hour meter can control the corresponding switch through the distributed microgrid operation strategy
acquired by the acquisition system, so as to realize the corresponding mode of user power
consumption and distributed microgrid operation [10].

6. Conclusion
In this paper, the design of new smart meters can greatly improve the perception ability of the end of
the grid. In addition to the measurement ontology function, it can also realize a variety of value-added
services, which can effectively serve the power grid, people's livelihood and the government, and
support the construction of ubiquitous power Internet of things. In terms of serving the power grid, it
can provide data support in the aspects of equipment and line fault warning and positioning, network
loss analysis, distribution network operation analysis, anti stealing, source network load collaborative
dispatching, load forecasting and equipment supplier evaluation; In terms of serving people's
livelihood, it can provide data support in the aspects of residents' power consumption judgment,
enterprise operation status evaluation, customer electricity behavior optimization, service oriented
push and enterprise product research In terms of serving the government. It can be applied in macro-
economic judgment, environmental protection supervision, local investment promotion effect
evaluation, housing vacancy rate identification and so on. It can be seen that more measurement and
control chips can be added to the extended function module of the new smart meter. In the future, the
development of the meter ontology will meet various application requirements from the aspects of
miniaturization, low power consumption and high integration.

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References
[1] Shen bin. Design and research of intelligent meter system [D]. Nanjing: Nanjing Forestry
University, 2013.
[2] Shen bin, Feng Weizhong, Shi Shanjing, Han Chenyan. Design and research of smart meter
based on ade7953 [J]. Instrument technology and sensor, 2012 (11): 44-49.
[3] Dai Yansheng, Sun Lingsheng. Design of a new intelligent instrument based on Embedded
Internet [J]. Electrical applications, 2005, (3): 83-87.
[4] Cai Zhoufeng. Research and design of smart watt hour meter [D]. Nanjing University of
technology, 2013.
[5] Kang Jiawen. Design of three-phase intelligent meter based on DSP technology [D]. Hebei
University of engineering, 2012.
[6] Zhao Jing. Design of smart meter with harmonic analysis function based on STM32 [D].
Shanghai Jiaotong University, 2012.
[7] Ma Xiaohua. Research on background harmonic voltage identification of power supply system
[D]. North China Electric Power University, 2007.
[8] Ge leijiao, Wang Yuqian, Qi Jiaxing, Wang Hui, Lin Qiang, Peng Ying. Connotation,
architecture and key technologies of electric power Internet of things for urban energy
Internet [J]. Electric power construction. 2019 (09): 1-9.
[9] Shao Guofeng. Research network of intelligent controller for small wind solar hybrid power
generation [D]. Hebei University of technology, 2011.
[10] Wang Chengshan, Wang Dan, Li Lisu, Jia Hongjie, Wang Weiliang. Key technology analysis of
Demand Side Smart Energy System [J]. Engineering Science. 2018 (03): 132-140.