

# Application of semi-active RFID power meter in automatic verification pipeline and intelligent storage system

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**Abstract:** In this paper, the semi-active RFID watt-hour meter is applied to automatic test lines and intelligent warehouse management, from the transmission system, test system and auxiliary system, monitoring system, realize the scheduling of watt-hour meter, binding, control and data exchange, and other functions, make its more accurate positioning, high efficiency of management, update the data quickly, all the information at a glance. Effectively improve the quality, efficiency and automation of verification, and realize more efficient data management and warehouse management.

## 1. Introduction

RFID technology is a non-contact automatic identification technology for object tracking and information sharing, and has advantages of non-contact, long working distance, adaptability to severe environment and identification of moving objects, etc. Currently, RFID technology is widely applied in the warehousing field [2-4]. Automatic verification of the energy meter [5-7] is a new automatic instrument testing system which can automatically complete ex-warehouse, transport, verification, sorting and other functions through coordination on the production dispatching platform according to calibration tasks of the energy meter delivered by the marketing system. The semi-active RFID energy meter is the latest design plan where a special RFID chip is embedded into the energy meter. The energy meter possesses all RFID characteristics, and some key data of the energy meter can be stored into the RFID chip and read at any time so that all necessary data of the energy meter are obtained from production to use and the quality of supervision and management of all links is improved. Application of semi-active RFID energy meter in automatic verification pipeline and smart warehouse management can effectively improve verification quality, efficiency and automation degree and achieve more effective data management and warehouse management.

## 2 Semi-active RFID Energy Meter

The active RFID chip is implanted into the meter so as to energize the smart energy meter, achieve real-time data connection with the meter when energized and de-energized and upload data to the cloud service platform at various stages. The RFID anti-conflict mechanism can achieve simultaneous multi-channel and multi-label reading and writing as well as multi-parameter setting, rapid testing & calibration, local data copying and online fault diagnosis. Semi-active RFID is characterized by large data storage capacity, strong real-time processing capacity, certain-distance data transmission and receiving capacity.



RFID technology based smart energy meter can work at the ultra-high frequency band, support radio frequency reading and writing, identify particular objects based on radio signal, and possess data storage functions. The storage area of the chip is managed by blocks, supports separate locking, password protection, reading and control, low-power reading and writing, and is characterized by high storage safety and tamper-proofing. This helps the customer to achieve rapid and convenient management of the smart energy meter at all links, real-time acquisition, filtration, extraction, statistical analysis and statement inquiry, etc. of mass data of the smart energy meter. The RFID reading and writing equipment is used to keep mutual communication with the energy meter through radio communication, and read, write or store data. Starting from production of the energy meter, various information of the energy meter is recorded by RFID reading and writing equipment at any time. Unique identification of the RFID chip and RFID reading and writing equipment are used so as to more accurately position and more effectively manage the RFID energy meter of the smart warehouse management and automatic verification pipeline, rapidly update data and keep various information clear.

### **3 Verification of Energy Meter and Composition of Warehousing System**

The energy meter verification system as a cloud platform based full-automatic system is connected with the data server of the verification system by different control equipment, full-automatic verification equipment and server, and is also connected with the production dispatching platform of the smart upper-level warehousing system for completing a series of collaborative operations such as loading, voltage withstand, verification, sorting and unloading. Each unit is locally controlled by one independent control unit, and is connected to the main control cloud platform via network for uniform dispatching & control and automatic operation.

Once the system delivers a verification task of the energy meter, the smart warehousing system will transport the circulation box to the receiving position of the verification system. The verification system can automatically complete transport of circulation box, automatic loading/unloading, identification, withstand voltage test, appearance and electrical performance check, programable switch opening, function inspection and test, cost control test of cost-control energy meter, electricity presetting/ zero clearing/ encryption/ parameter setting of cost-control energy meter, accuracy test, sorting of qualified/disqualified smart three-phase energy meter, temporary storage of empty tray and other links. Due to the difference of the verification position, the energy meter can move back and forth at different work positions along with the tray. The key task of testing is to identify the corresponding relation among the energy meter, tray and feed box at different links.

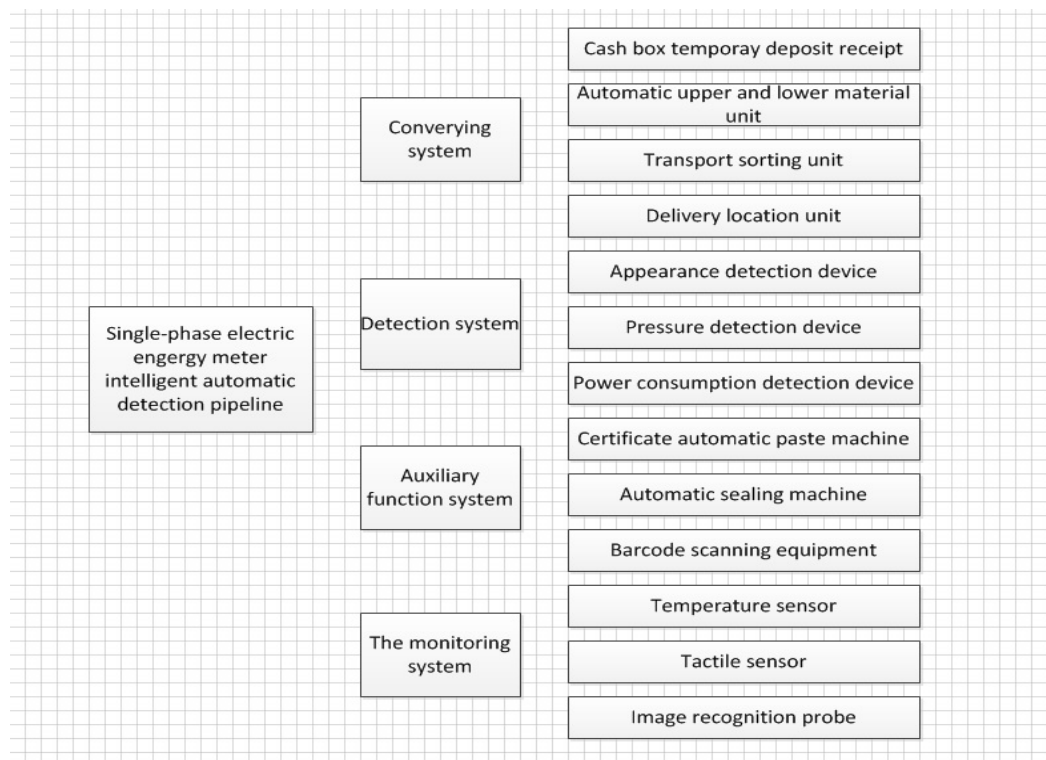


Figure 1. Single-phase electric energy meter intelligent automatic detection pipeline

#### 4 Application of RFID Energy Meter

According to characteristics of the verification pipeline of the RFID energy meter, more effective roles are played at the loading/unloading port, warehouse inlet/outlet, crossing, sorting area and temporary storage area, etc., as shown in the figure 2.

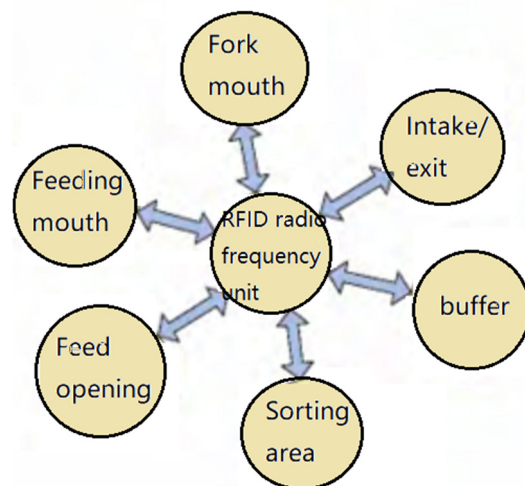


Figure 2. Application and Distribution of RFID Device in Line Body

The loading/unloading port is a position where the robot arms are loaded/unloaded. When the meter is tested, the robot arms grab the energy meter on the testing position for testing the performance and accuracy of the energy meter. After verification, the robot arms place the energy meter on the original position from the testing position or on other positions as required. The RFID energy meter possesses RFID functions, and is also provided with RFID labels at the bottom of the tooling tray which collects the energy meter. When the energy meter passes through the RFID reading

and writing area of the pipeline, the RFID device can read data from the energy meter and tray, integrate the mutual relationship, complete assets binding of the energy meter and tooling tray, store binding data in the system through software setting, index the corresponding energy meter number in the energy meter verification system according to the tray number and index the tray number according to the energy meter number, and achieve one-to-one correspondence between the energy meter and the tray.

#### Warehouse inlet/outlet

The RFID device is provided with a bar code reader on the profile frame located at the warehouse inlet. Before the energy meter enters into each verification unit, information of the energy meter is identified, and asset information of the energy meter is obtained. When the energy meter on the tray passes through the bar code reader, the PLC control system will trigger the bar code scanning gun of the bar code reader, and scan the bar code on the energy meter so as to read the energy meter and send bar code information to the data management system. The server can download the data of the energy meter in the data management system, process data, add processing results into the to-be-verified meter library, and complete assets entry of the energy meter in the pipeline system.

At the crossing, the energy meter can verify different flow directions in the line body according to different work positions. When the energy meter passes through the crossing of the RFID reader, the RFID reading/writing device can identify the number of RFID energy meter and tooling tray. The system can automatically complete asset binding of the energy meter and tray, automatically write the tray number and fill in the energy meter information on the meter number corresponding to the tray number. The system and RFID energy meter can also record whether the energy meter is warehoused. The system and RFID energy meter can not only index the corresponding energy meter number but also judge whether any energy meter on the line body is warehoused and test whether the meter is qualified so as to achieve correspondence between the energy meter and tray and data inquiry.

In the sorting area, the robot arm can sort qualified meters from disqualified ones after verification. The RFID equipment in the sorting area can identify the tray number, identify and verify the RFID energy meter, bind the RFID energy meter with corresponding verification device and meter position, effectively correspond the energy meter with the tooling tray, energy meter information and verification device, store data into the RFID chip and upload the server for data storage and inquiry, and obtain the flow direction of the energy meter according to inquiry data of the energy meter. Qualified energy meters are discharged to the next work position, and disqualified meters are separated and temporarily stored.

In the temporary storage area, disqualified meters are generally separated and temporarily stored during automatic verification. In the temporary storage area, an RFID device is provided so as to obtain temporarily stored data from the RFID chip of the energy meter, form one-to-one correspondence with the temporarily stored tooling tray, and bind assets through RFID device. Besides, the RFID device can identify testing and warehousing conditions of the energy meter before temporary storage and work position of the energy meter in the line body through tray number or RFID energy meter, thus effectively verifying information of the energy meter, allowing for convenient plug and play and playing a very important role in late information verification, positioning, sorting and tracking of the energy meter.

The software design process is shown in the figure, and process design is mainly divided into 7 steps.

1) Task starting. The task is started after the server delivers an order.

2) Information identification for binding of energy meter. An RFID reading and writing device is provided at the asset binding position of the energy meter for automatic information binding of the energy meter and tooling tray. When the energy meter passes through a reading and writing device, the reading and writing device can read the TID code from the RFID code of the energy meter and RFID electronic label code, achieve smart binding and correspondence between tray number and meter number. If no binding relationship between the tray and energy meter is formed, an alarm reminder is sent, and the task is completed.

3) Identification of empty and full trays. Some tooling trays collect energy meters on the line body, and some trays are empty. When passing through the RFID reading and writing device, if the tray collects an energy meter, the reader will identify the tray number as an index and find out relevant information of the energy meter, and the system will send an instruction for next operation. If the tray is empty, the system will send an alarm reminder, and the energy meter will be separated and temporarily stored.

4) Identification of flow direction of energy meter. After binding of the energy meter and tray, a party can be identified based on the other party's asset information. During circulation on the line body, RFID reading and writing devices are provided at the loading port and crossing of the line body, and corresponding identity information of the tray and energy meter can be found out based on the tray number so as to determine the flow direction.

5) Information identification at the meter testing position. An RFID reading and writing device is provided at the sorting position of the energy meter. The RFID reading and writing device can identify the tray number, index the energy meter based on the tray number and check information of the energy meter. If qualified, the energy meter will be discharged into the next work position; if disqualified, the energy meter will be separated and temporarily stored.

6) Information identification at unloading port. An RFID reading and writing device is also provided at the unloading port. According to the same method, asset information of the energy meter is indexed based on the tray number, and physical objects and information are packed together for new binding of asset information of energy meter, tray and box.

7) Task completion. Real-time communication between site data and cloud platform management system is established for uniform data management, and the task is completed.

#### 4 Conclusion

The semi-active RFID energy meter is applied in the energy meter verification pipeline system and smart warehouse management through RFID for automatic binding, reading, RFID label identification, rapid information check, information binding, positioning, sorting and tracking, etc. The verification line body is provided with multiple RFID reading and writing devices according to different demands for index and reverse index of information of the smart energy meter based on tray information. The energy meter is discharged into different work positions according to different demands so as to read asset information from the energy meter on the line body, and verification conditions and flow direction of the energy meter are determined according to asset information, with convenient use and complete functions after data inspection.

#### Acknowledgment

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