

## Designing and implementation of batch testing equipment for RF electronic seal of smart meter

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**Abstract.** for electronic seal of smart meter with special appearance and light weight , a batch testing equipment is designed to write program into seal and test automatically , which will increase the testing efficiency of electronic seam installed in meter. The arrange part being consist of vibrating plate , sliding guide and blow pipe realize the auto arrangement of many seals. Then, the seal slide down and stop at the given position with the assistance of photoelectric sensors and breechblocks. The circuit board write data into seal and finish the testing. Finally ,the seal is put into slider and move into the appointed box according the testing result. The mechanical action are carried out by controller of equipment, such as start, stop, stick in and out, etc. the host computer send writing order to the circuit board. The working state of equipment can be shown on the liquid crystal screen installed on the device. The equipment can write data to 300 seals every hour automatically without participation of human. the use of this equipment can decrease the cost of test operator and increase the efficiency and accuracy of testing.

### Introduction

With the wide application of smart meter<sup>[1-2]</sup>, the technology of seal used in smart meter also changed from lead seal, threading plastic seal to RF electronic seal with the structure of snap joint . now this kind of electronic seal has become the mainstream seal because of simple, clean and security(the RF chip inside the seal can program and encrypt important data)<sup>[3]</sup>. it is also convenient to be installed on the smart meter on auto testing line established by SGCC(state grid corporation of China)<sup>[4-6]</sup>. before the installation , the key data should be written into the seal. If the writing and testing are done artificial ,the efficiency is lower. The traditional separation devices are suitable for the products with regular appearance . these devices with handler or chuck, produced by foreign manufacture ,are expensive and cannot catch the small and light accurately. To solve the problem, a new batch test equipment was designed to implement the writing and testing of electronic seal.

### The appearance of electronic seal

Electronic seal shape as shown in figure 1.

RF chip are embedded in the upper sealing cap。 The bottom using inverted buckle design, once in electric meter cannot pull out。 Only worn out seal cap can come into contact with the screw at the bottom of the open cover。 Once the RF chip in the cap was destroyed , the illegal operation can be found, the encrypt data was destroyed at the same time。

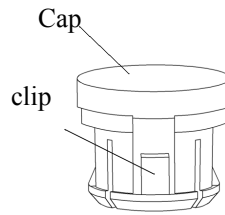


Fig. 1 shape of RF electronic seal

## The hardware structure and working principle of test equipment

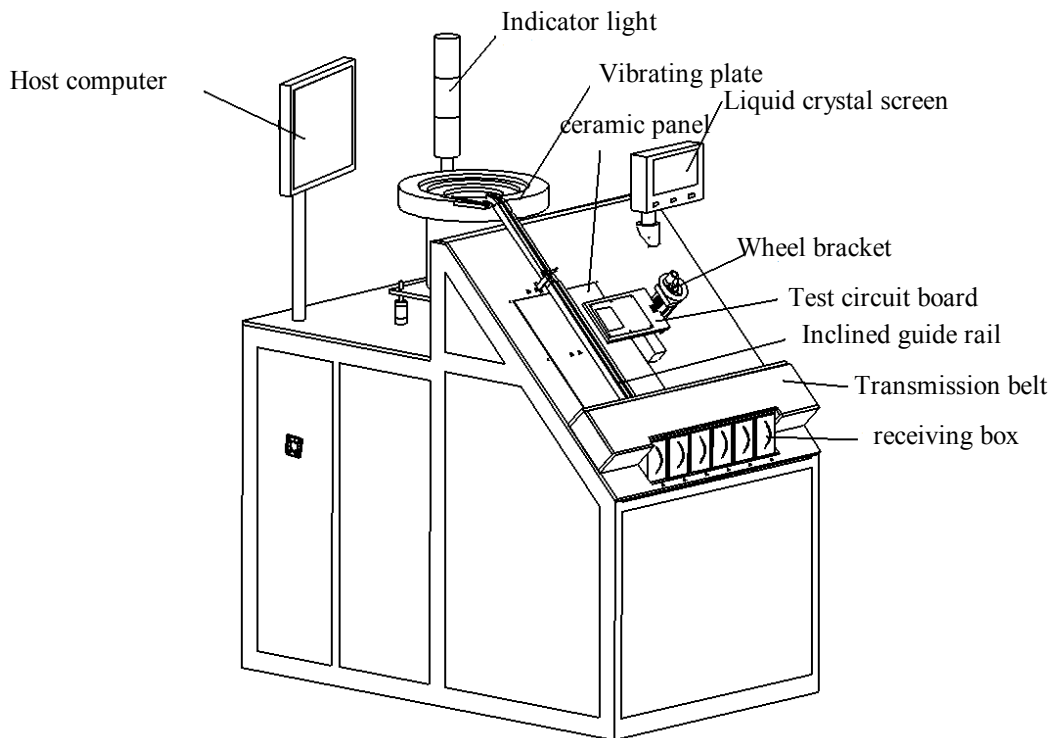


Fig. 2 hardware structure of the test equipment

As shown in figure 2, Hardware structure of the test equipment was designed according to the special structure of RF electronic seal. It is consist of automatic sorting part, discharge part, test part, separation part, positioning and control part, liquid crystal display, light ,air pump<sup>[7]</sup>and rack.

Considering environmental protection, electronic seal is light used with resin material, and packaed separately . before large number of seals are tested batchly, the first thing to be solved is sorting of the seals. automatic sorting part the equipment is composed of vibration plate and blow pipe. Seals were poured into the middle of the hopper of vibration plate , and moved forward along the u-shaped spiral from the bottom in the process of vibration. They will entered into the T spiral guide after passing by the end of the terraced hang seam . the seal enter into the guide rail with the cap upward under normal circumstances as shown in figure 3. But there are some seas leaning on the guide rail as shown in figure 4. These seals will be blown out by the blow pipe on both side of the rail and fall into the middle of the hopper ,then reorder from the bottom.

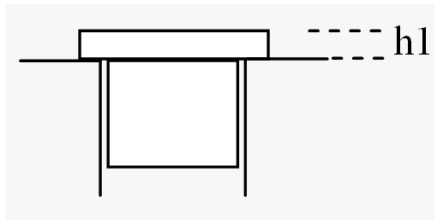


Fig. 3 seal on the guide rail correctly

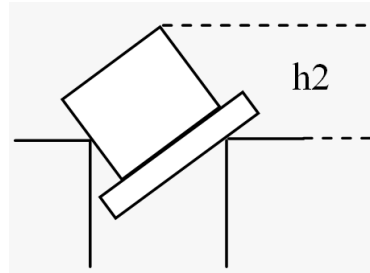


Fig. 4 seal on the guide rail incorrectly

Discharging part of the equipment is the T-shaped guide rail leaning parallel with the rack panel. It is two parts .the upper is on the step area. The bottom is on the testing area. The seals line up in order in the upper guide and slide down one by one. A small piece of soft pipe is installed on top of the second seal press it .there is a stop pole under the first seal. On both side of the first seal ,there is a pair of Photoelectric sensor . when it find the first seal up to the appoint location ,it order the stop pole to stretch out and stop the first seal , when the prior seal has been tested , the stop pole retract and the first seal slide down the test position .at the same time the soft pipe open and the second seal reach the position of the first seal .then the third seal reach the second seal's position and being pressed by the soft pipe. All these design helped the seal of the row move only one each time.in addition,there is a blow pipe on one side of the guide rail ,which help the seal slide quickly to the test point. Test part of the equipment include test circuit board, host computer, circuit lines and stop pole . the stop pole is located on the middle of the testing area, under the bottom guide rail. When the testing is running ,it stops the seal for a while. Circuit board is fixed parralle with the panel through the holder on one side .host computer transmit the data to circuit board .circuit board write data into seal through RF coil. The seal move to the seperation area. Separation part of the device is composed of belt, slider and the receiving box. When the device finished writing and testing ,the seal will be put into the slider and move to the receiving box through the belt.which box they will be put in is up to the result of testing .In addition, there is a liquid crystal screen on the controller which show the running state of the device and statistical result of the amount of quified seals and unquified seals.the tester also can press the button on the screen to stop the device When error occurs.indicate light is installed to show the different situation of the device ,normal or alarm.

### **Operating procedures and software design of the equipment**

The test work of the device is started by the controller, PC is responsible for the data by writing data to seal through test circuit board. The working process is shown in figure 5.

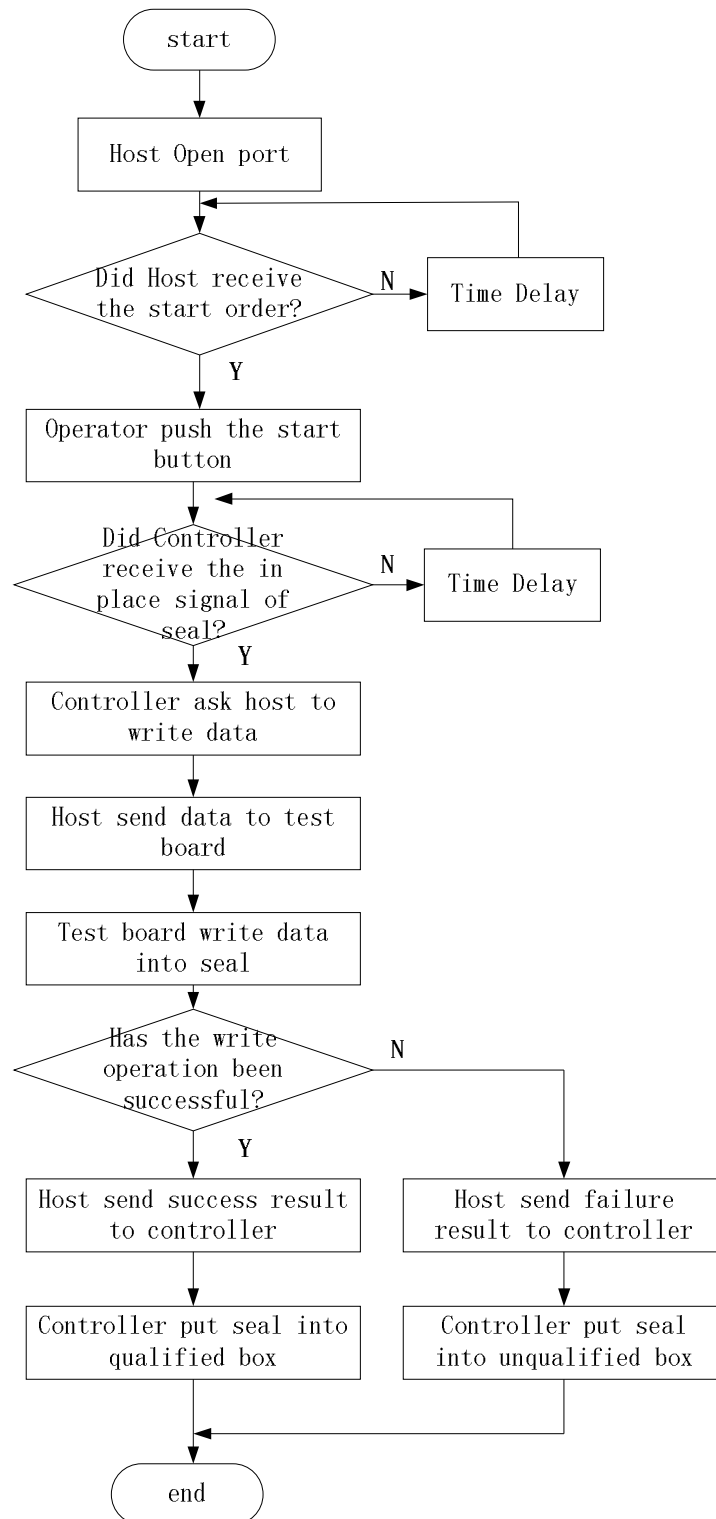


Fig. 5 working process of the device

- (1) start the program of host computer and open port.
- (2) press start button on liquid crystal screen of controller. the seal move to the test point . Photoelectric sensor send signal to controller , and controller tell host computer to begin testing.
- (3) host computer transmit data to circuit board , and circuit board write data into seal .
- (4) circuit board send the result to host computer ,and computer tell controller.
- (5) controller order device to send the seal to appoint receiving box.
- (6) controller will alarm if it cannot receive the feedback from host computer, the device reach the debug state and need tester intervention. Pressing stop button on the LCD screen can exit the test state.
- (7) when the test is end , controller send end signal to host computer . host computer close the port.

## The key technologies to implement test device and advantages

Several key technologies were used in the design of the device.

(1) automatic sorting. Because of the special shape, the first thing to solve is automatic sorting for multiple seals before testing. The blow pipe installed on vibration plate side cleverly uses the height difference between right and wrong sorting seals and blows out the wrong seal from the guide rail. The wrong seal falls into the middle of the hopper and restarts sorting from the beginning. The design can reduce human intervention, increase the efficiency of testing, and avoid artificial feeding product loss problems effectively.

(2) The intensity of the blow pipe can be adjusted according to the weight of the electronic seal, flexible, to adapt to the different weights of electronic seals.

(3) Several photoelectric sensors are installed in key positions and used to locate seals accurately and provide feedback information.

(4) A ceramic material panel is used below the guide rail in the test area, which prevents RF signal interference because of metal materials, and guarantees that the data are written into the seal successfully.

(5) The stop poles along the inclined guide rail can control only one seal to slide down and be operated.

(6) When the device stops working after an accident occurs, it can automatically record the number of qualified seals and unqualified seals. It can also save the last statistical data since the start of the next operation.

## Conclusions

RF electronic seals are becoming widely used in smart meters, and the demand for batch testing is increasing rapidly. This device, from start to stop, without human intervention, can automatically complete the sorting, testing, separating, and collecting functions. The design improves test efficiency greatly and reduces the error rate of manual testing. The cost is low and maintenance is easy too. Now the device has been widely used in testing departments of provincial electric power companies, and it also provides technical experience to the testing unit of seals in automation assembly lines.

## References

- [1] YUAN Yidong, Zhao Dongyan. The New Generation ID Card of Smart Meter[J]. *Electronic Engineering & Product World*. Vol.11(2014).
- [2] ZHU Ninghui, BAI Xiaomin, GAO Feng. Function Requirements and Structure Properties Analysis of Bi-directional Smart Meter[J]. *Power System Technology*. Vol. 35(2011).
- [3] ZHANG Liang. Design and implementation of security environmental protection digital measuring seal management system[D]. University of Electronic Science and Technology.(2013).
- [4] Zhang Mi, Zheng Angang, Zou Heping, Chen Hao, Liu Xingqi. Research on new type metering seal and automatic sealing technology[J]. *Electrical Measurement & Instrumentation*. Sci. Commun. Vol. 52 (2015).
- [5] ZHANG Yan, HUANG Jin-juan. Research and Application of Intelligent Verification Line System for Electric Energy Meter[J]. *Electrical Measurement & Instrumentation*. Vol.12 (2009).
- [6] LIN Naiyu, Lin Yueling, Tan Zhenhao. Application of Electric Energy Meter Automatic Sealing System in Metrological Verification Pipeline[J]. *Guangdong Electric Power*. Vol.26(2013).
- [7] CHEN Long, WEI Na, GUO Ke-jun. Design of the Control System of Automatic Seedling Tray Sorting Equipment[J]. *Forestry Machinery & Woodworking Equipment*. Vol.41(2013).