

## Research sucker on load-unload robot special for electric power metering device testing

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**Keyword:** Automatic testing; Loading-unloading; End-effector; Sucker

**Abstract.** Electricity metering equipment automatic testing detection pipeline has been widely used in most provincial company of the State Grid in the past two years. Sichuan electric power corporation metering center first developed a fully compatible pipelines, the compatibility of robot is one of the difficulties need to solve. According to the actual operation situation after the pipeline fully put into production, this paper analyzes the design and capacity of load-unloading robot special for electric energy metering equipment. Firstly, it introduces the current research status of the load-unload industrial robot, do a comparison between the existing robot execution ends in the electric power industry and the new design compatible sucker end-effector, and then introduces the structural design of robot, the design parameters of sucker, and the running process and the beats of robot. Through actual production operation, it is shown that the sucker robot special for the electric energy metering equipment can achieve precision several kinds equipments, which has a good application prospect.

### Introduction

Industry developed fast in recent years, electric power load increasing year by year, State Grid company promote the use of smart electricity meters and electric energy data acquire terminal vigorously, in order to meet the needs of the business and ensure the interests of the power generation companies, power grid companies and users. Following this trend, we must implement the centralized testing, centralized storage, unified distribution, unified supervision for measuring instruments and data acquire terminal, achieve to “integrated authorization, automatic detection, intelligent storage, logistics distribution”. Most company of State Grid had already finished construction of single phase meter, triphase meter automatic detection system, intelligent storage system and low voltage current transformer test system, also put into application. On the pipeline, except the testing device, pressure unit and some other special device unit, there is ABB robot for realizing up-down material function and sorting function, to accomplish the whole production process unattended.

As the task size increased, the pipeline with single function has many prominent problems such as: low efficiency, incompatible test program and interface, production waste, high operational and construction cost. Sichuan electric power corporation metering center has developed a new intelligent compatible (meters, collector, concentrator and data acquire terminal of special transformer) integration automatic detection and testing pipeline, the compatibility of the load-unload robot which as a key link has also been solved. Now we will analyze the design and ability of the sucker robot special use in electric energy metering industry.

### Industrial robot research status

Industrial robot research began in the 1960 s, with the development of this technology, load-unload robot began to be used on production line, especially in the developed countries such as Japan, Germany, the United States the research and application has reached a higher level. load-unload robot first appeared in Japan and Sweden, at the end of the 20th century 70 s Japan first used the robot technology for stacking work. In 1974, Sweden ABB developed IRB6 industrial robot, the first full electronic control robot in the whole word, which was mainly used in handling artifacts and carrying material. In Sweden, Germany, Japan and some other countries of the robot, the load-upload robot is commonly 4 to 6 degree of freedom, is mainly composed of fixed base, connecting

rod, link arm, arm, wrist, and end-effector. Highly developed robot industry makes load-unload robot widely used in all kinds of manufacturing industry, based on PC control platform, with designing different forms of intelligent end-effector, such as clamping, vacuum holding, forking and so on, realizing grabbing product in different types and size accurately, achieve transfer. Greatly improve the labor production efficiency, save manpower, reduce production cost, effectively improve the production environment. The construction of automatic testing and detective system in electric energy metering industry also adopted load-unload robot with different specification end-effector aim to smart meters, collector, concentrator and so on, significantly increased the actual capacity at a relatively low failure rate.

At present, in our country in the field of electric energy metering device testing, there are ABB grip jaw type robot and Shenyang Siasun robot, on the testing pipeline commonly used ABB grip jaw robot with six degree of freedom flexible system, which can accomplish precise orientation, device grab, transfer, device place and some others operation, the robot can do loading, unloading, sorting work independently. As shown in figure 1.



Figure1 Grip jaw load-unload robot

Using the single phase electricity meters as example, it can transfer 3 testing waiting meters once by loading robot. The line body clamp the carton with testing waiting meters in right location, the robot clamp the meters from carton to the pallet in online unit. When unloading, the robot clamp 3 meters once into the carton.

Because the single phase, triphase meter, collector and concentrator have different outlook dimensions, the grip jaw-robot with one kind end-effector just can apply in single function pipeline, according to testing object it configure grip jaw in different specification. The new generation intelligent fully compatible unity-automatic testing detection pipeline can support single phase meter, triphase meter, collector I, concentrator I, concentrator II and data acquire terminal of special transformer III testing at the same time, aim at the compatibility question that the load-unload robot can grab different device accurately. The testing pipeline adopted ABB robot with SCHMALZ vacuum sucker, this kind of grip jaw have no side jaw, use sponge sucker device, three sucker can choose flexible, in order to apply to metering and collecting device of different outlook dimensions, avoid the question of high investment and low efficiency caused by one pipeline must use several different single function robot.

## SUCKER ROBOT STRUCTURE DESIGN

Fully compatible automatic testing detection system's loading and unloading unit fixes two six degree of freedom robot with flexible system, which mainly composed by fixed base, connecting rod, link arm, arm, wrist and end-effector, use sucker grip jaw(include 3 sucker), it can pick and place single phase, triphase meter and data acquire terminal compatibility at the same time. Testing waiting meters are transferred to loading position by carton deliver module, then the RFID can identification the meter's sort and send the data to robot, to control robot's way of grab meters. Ac-

According to device's size ruled by the type specification for metering device, we classified single phase meter, collector I and concentrator II in one group, set the loading robot with "three meters one grab" mode to place meter in pallet; classified triphase meter, concentrator I and data acquire terminal of special transformer III in one group, set with "one meter one grab" mode, that is calling the middle sucker pick meters. The robot's structure as shown in figure 2 (a), the entity diagram as shown in figure 2 (b).

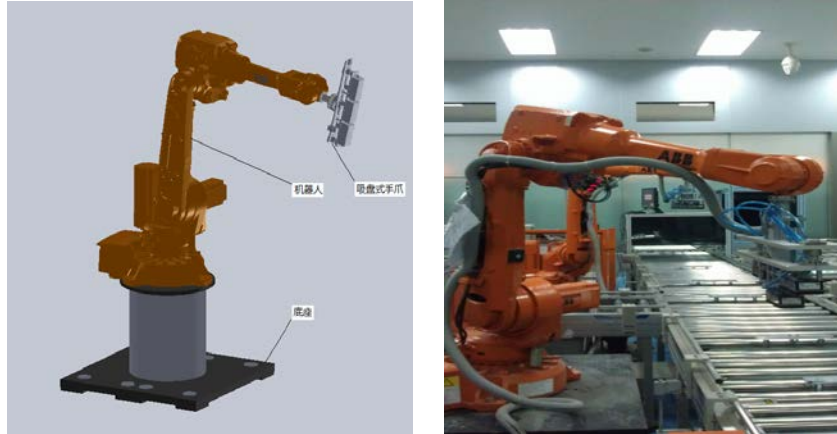


Figure 2 (a) Figure 2 (b)

After testing finished, it use RFID to identification the meters in pallet, then send the meters' sort and testing data to robot, the unloading robot pick out qualified meters from pallet and put in the carton, the unqualified metering device will be delivered in unqualified cache region, when the amount reach to one carton, they would be delivered to unloading position. If the meters' sort is different from the sort on binning, for example, unloading robot is pick out qualified single phase meters, and the amount is less than one carton, if the next device transferred on the pipeline are triphase meters, it can be distinguished by RFID, so the triphase meters will be delivered in the cache region directly, waiting for the single phase group in one carton and be transferred to unloading position.

## SUCKER END-EFFECTOR

The sucker smart end-effector studied in this paper is designed special for fully compatible testing line, the working principle and the description of the process are as follows: vacuum generator produce vacuum source, through the sponge suckers, pick out the meters had been transferred to the appointed position and then place on the pallet. The sucker grip jaw is designed as the principle below: 1. The structure is compact, safety in use, convenient maintenance, beautiful outlook; safe and reasonable drive, stable and reliable operation; 2. The selection of electrical components according to the design reliability, ensuring that the system has high stability, reliability and security; 3. Good compatibility, adjust and manipulate is convenient, give consideration to efficiency and security, aim to suitable for industry features.

Its design parameters, the type of the equipment selected is as follows: 1. The robot models: ABB IRB2600-20/1.65, repeat localization precision automatically 2. The robot load: 20KG, working radius  $R=1650$  mm; 3. The sucker type: FX-SW 120\*60 SCHMALZ, sucker weight: 1.2KG; 4. Vacuum switch models: VS-V-D PNP SCHMALZ; 5. Production rhythm: 20S.

## WORKING PROCESS

(1) Loading: According to the information of meters' class, the robot grab meters form the carton on the delivered line to the corresponding pallet on the testing pipeline.

When grabbing single phase meters, collector I, concentrator II: a) Carton full of meters is delivered to the loading table through roller line, clamp holding device clamp and position the carton. Time: 2S. b) Sucker fixture move to carton, six sucker grab three single phase at the same time, the

move to the pallet and put them in. The robot repeat the action till the pallet is full, finishing one beat rhythm. Time: 16S. c) Separating unit for pallet take back the cylinder and fall down, stops permit through. Time: 2S. Total ticks: 20S.

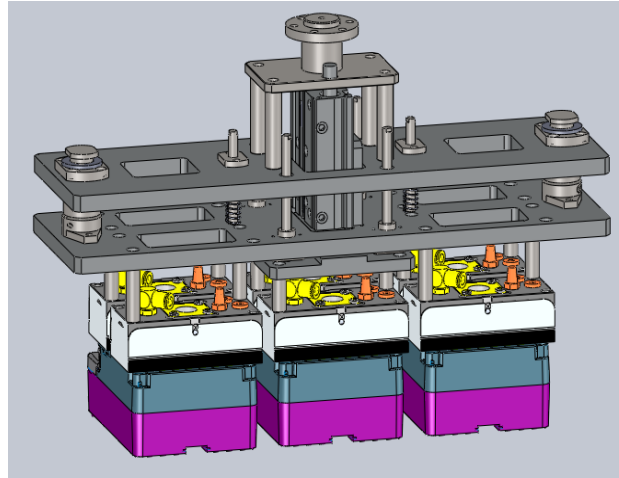


Figure 3 Sucker grab single phase meter

When grabbing triphase meters or terminals: Only the two middle sucker work, grabbing one meter, one pallet hold two meters, comparing with grabbing single phase meters, it needs one more step: Sucker fixture cylinder stretch out. Time: 2S. Total ticks: 22S.

(2) Unloading: According to the meters' class and testing data transferred, the robot pick up meters from pallet on the testing pipeline and then put into cartons on the roller line.

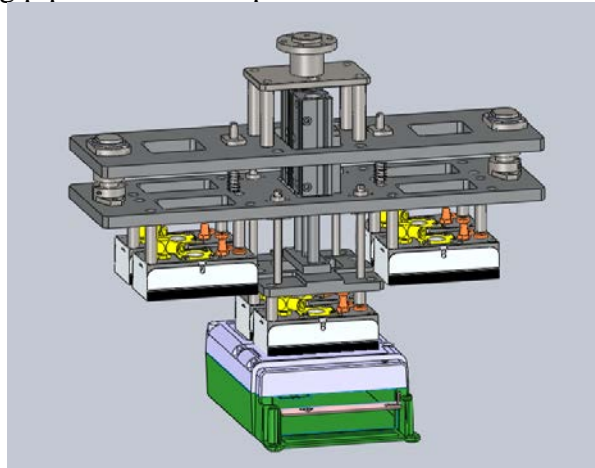


Figure 4 Sucker grab triphase meter

When grabbing single phase meters, collector I, concentrator II: a) Pallet full of meters is delivered to the unloading table through testing pipeline, clamp holding device clamp and position the pallet. Time: 2S. b) Sucker fixture move to pallet, six sucker grab three single phase at the same time, the move to the carton and put them in. The robot repeat the action till the carton is full, finishing one beat rhythm. Time: 32S. c) Separating unit for carton take back the cylinder and fall down, stops permit through. Time: 2S. Total ticks: 36S.

When grabbing triphase meters or terminals: Only the two middle sucker work, grabbing one meter, one pallet hold two meters, comparing with grabbing single phase meters, it needs one more step: Sucker fixture cylinder stretch out. Time: 2S. Total ticks: 38S. The beat above is set on the basis of the running speed of testing detection system, to ensure the robot and system be in best fit.

Chart 1 comparison in two kinds of end-effector

Item	Sucker	Grip jaw
compatibility	Can apply to several types of different size meters	One grip jaw only can be used in one kind of meter
stability	Higher	Lower
Mechanical structure	Simpleness,compact	More complicated
Energy saving	Smart vacuum generator has better energy-saving effect	Traditional energy dissipation
runnability	Alufer material is lighter, tough and tensile ,improve runnability	More heavier, lower runnability
economy	The sponge sucker can be replace rapidly if attrition, low cost	Metal replace need high time and expenses cost

## Conclusions

Take use of sponge sucker end-effector, that can apply successfully in fully compatible automatic testing detection system, solving the compatible problem that one robot can grab different kind of meters, which facilitate the fully compatible testing line be completed successfully and put in to production. Through the actual production run in Sichuan electric power corporation metering center, sucker robot is easy to manipulate, operating well in 24 hours, greatly promoted the production capacity of Sichuan metering center, one robot can complete different types of tasks, compared with traditional load-unload robot, this sucker robot has the advantages of simple, innovative structure and low cost, it can meet the needs of electric power metering device testing modern production, has a good application prospect.

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