

ARTICLE TAG Servo Motors, Accuracy, Recommendations

IMPROVING ACCURACY WITH SERVOMOTORS AND HIGH SPEED NETWORK

SERVOMOTORS ARE IMPORTANT IN IMPROVING ACCURACY ACROSS OPERATIONS. BY **TAKESHI TANAKA**, YASKAWA ELECTRIC (SINGAPORE), AND **YUKI HONDA**, YASKAWA ELECTRIC CORPORATION



Most production machines are equipped with motors such as induction motors, stepping motors or servo motors. Servo motors are used when accurate positioning is required. Since the mechanism of the machine have been more complicated and required faster processes in recent years, the number of servo motors which have been used in such machines have increased. One example is that in semiconductor IC test machine, 35,000 to 40,000 CPH(Cycle Per Hour) is required. This means 11 IC chips need to be tested every one second and it takes only 90msec for one IC chip to be tested including motor positioning time. In such an IC tester machine, it uses 20 to 30 servo motors.

An explanation will be given on how servo products and its high-speed network achieve the demand, followed by an introduction of what type of motors are available in servo products and what measures are taken to maximise machine performance.

Servo Accuracy

Due to dealing with smaller products, shortening tact time and improving quality of processes, accurate control of servo drive systems has been required in a variety of applications. To satisfy such demands, we offer AC servo drives called Sigma7 series. The following explains its functions to improve accuracy of industrial machines.

- **24 bit motor encoder**

Positioning accuracy needs to be improved because of the size or parts being handled by servo motors are getting smaller. The inclusion of a 24 bit encoder enables highly-accurate positioning. The high-resolution encoder outputs 16,777,216 pulses per rotation. This is converted to 1.2nm resolution for 20mm lead ball screws.

- **Vibration suppression function**

Due to a low rigidity and several mass-spring elements in the mechanical structure, a machine experiences vibrations with different low-frequencies. The vibrations hinder accuracy of machines in such a structure since the load attached to the servomotor does not settle its position while the servomotor completely reached to its target position. A servo that can suppress two different low-frequencies simultaneously would be useful.

- **Motor ripple compensation**

When a servomotor rotates at a relatively low-speed such as around 10rpm, a fluctuation of the speed profile called speed ripples tend to be seen. Speed ripples affects machine performance when accurate and stable speed of motion is required. A servo that can reduce speed ripples would be beneficial in this case.

- **Less deviation control type**

Due to delay of position references, output trajectory is different from its position references such as the corner cut. A servo with a lineup specialised for trajectory tracking applications such as laser processing machines and dispensers is a useful addition. This types of servo provides built-in control with less deviation, which enables higher tracking performance.

- **Full closed loop control**

An encoder equipped with a servo motor cannot monitor a machine position when mechanical parts are attached on motor shafts such as a handling robot. A servo that can feedback the actual machine position

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directly with fully-closed control module and external encoders mounted on the machine is a great addition. This type of control scheme can achieve high-accuracy positioning.

Servo Accuracy By High Speed Network

For a long time, control command of a servo motor was sent by analogue voltage command or pulse train command from master controller. In this case there is a few disadvantages: 1) Limitation of speed like 1Mpps(Pulse Per Second) 2) Not strong enough for noise environment. 3) Cannot read/write Data inside of servo drive from master controller 4) Command cable and feedback cable is required for each servo drivers.

Recently Ethernet technology has become common even in the field of factory automation. Many Ethernet communication protocols for servo motor control are available in the market. MECHATROLINK is one of the IEC standard's for open network protocol. Advantages for this network are: 1) 100Mbps high speed Ethernet communication. 2) Maximum 62 slave nodes can connect to one network. 3) Real-time monitoring of servo drive can be possible 4) All technical documents are open and freely downloaded from the organisation's web site.

- **125usec high speed servo communication**
In order to improve the accuracy of servo control, a high speed network between a controller and servo drives plays an important role. In case of continuous path control, when the controller sends continues positioning data to servo drives

at a certain cyclic period. Receiving 125usec interpolation data cycle enables it to follow target trajectory accurately compared to 1msec cycle. Once servo driver received 125usec positioning data, it divides into shorter position control cycle like 62usec motor current control.

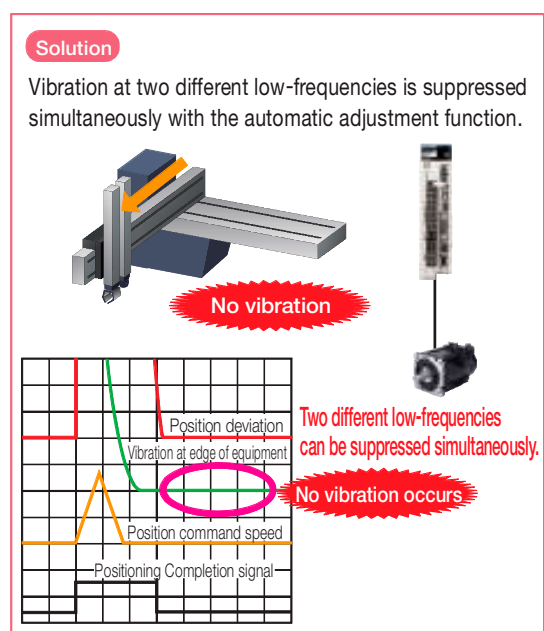
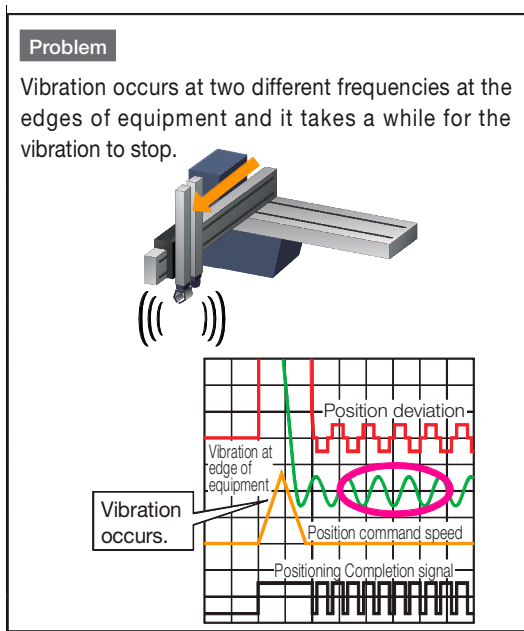
- **Real-Time Monitoring Of Servo Internal Data**

Once a controller connects servo drivers by a high speed network, the controller can monitor any information inside of servo drives. For example torque data can be monitored in real time being updated by every scan time. If the controller can monitor the torque data, it is able to detect illegal motor torque due to a mechanical problem. Then the controller can alert the operator that machine maintenance is necessary before it actually breaks down.

Variety Of Servomotors

Servomotors can be divided into three types below. Users can maximise their machine performance by selecting a suitable type of motor.

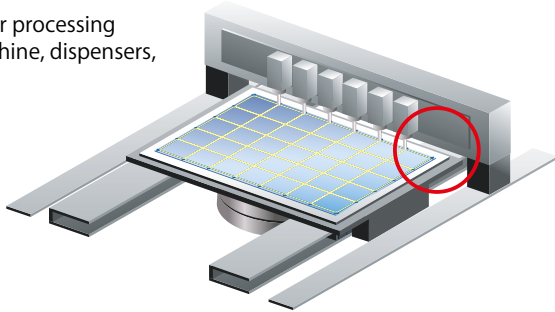
- **Rotary motor**
These types of servomotors are mostly used in a variety of applications. A different lineup of motor is suggested to different applications. For instance, low inertia and high speed type is suitable to chip mounters which require high response and shorter tact time.



Applications

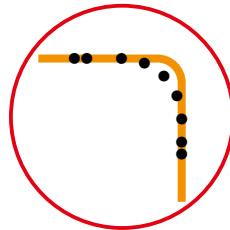
Ideal for applications that require reference tracking performance (high position accuracy) during movement

Laser processing machine, dispensers, etc.

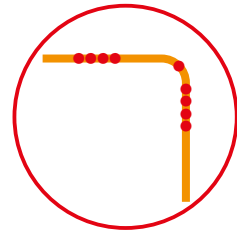


Less Deviation Control Type

Corner cut without precision with circular command.



Higher Tracking Performance!



- Direct drive motor**

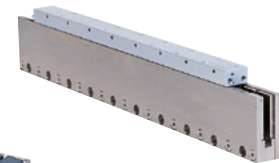
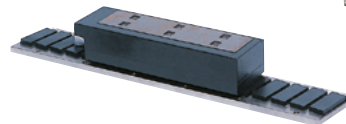
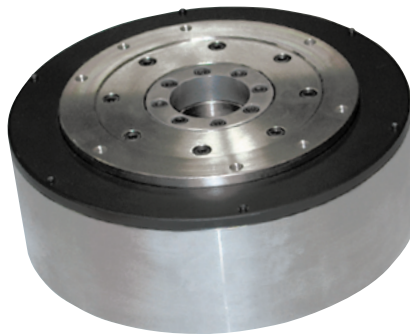
Compared to a rotary motor, a Direct Drive motor (DD motor) generates larger torque. The motor is designed to couple to a load without reduction gears or a belt mechanism. Therefore the machine with DD motor can achieve high rigidity leading to accurate positioning performance and process a large amount of work piece.

The type of DD motor can be largely divided into two types: Coreless type and type with iron core. Coreless type performs smooth running from low to high speed ranges due to less cogging torque. Type with iron core achieves higher torque and shorter tact time.

- Linear motor**

Linear motors are used for accurate linear motion such as machine tools and semiconductor exposure apparatuses. Likewise DD motor, linear motor has coreless type and type with iron core.

Linear motors have taken measures to improve accuracy by improving its motor structure. The latest linear motor of our products, Model SGLFW2, reduces cogging force 50 percent less compared



DD motor and Linear motor

to earlier models. It realises smoother speed profile and more accurate positioning. While some applications are very sensitive to changes of machine temperature because thermal expansion sometimes matters to ensure accuracy. We have provided water-cooled options to customers such as the semiconductor industry in an attempt to suppress raising temperature of their devices stemming from linear motors.

How To Realise Machine Accuracy

Improving machine accuracy can be realised by many related products and technologies. The following items are

important issues.

1. High speed and precise motion profile from master controller.
2. High speed and synchronised network from controller to servo drives.
3. Servo motor, DD motor and Linear motor to maximise machine performance.
4. Accurate and precise encoder feedback from actuator to servo drives.
5. Compensation for problems stemming from mechanical property by servo functions which deal with machine vibration, inertia change, resonance noise, ball screw harmonic vibration and so on.