FA_Equipment_for_Beginners(Servos)_ENG

MITSUBISHI ELECTRIC
Changes for the Better

FA Equipment for Beginners (Servos)

This is a quick overview of Servos for beginners.

Introduction Purpose of the Course

This is an introductory course designed to provide beginners, who are new to Servos, an opportunity to learn the basics of Servos.

Introduction Course Structure

Chapters of this course are made up as follows.
We recommend that you start from Chapter 1.

Chapter 1 - What are Servos?

Learn about the of basics of Servos includings: role, practical applications, principles and structure.

Chapter 2 - Differences between Inverters and Servos

Learn about differences of usage and specifications, comparison of basic structures, and replacement Inverters with Servos.

Final Test

Passing grade: 60% or higher.

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Introduction How to use this e-Learning Tool

Go to the next page	▶❘	Go to the next page.
Back to the previous page	❘◀	Back to the previous page.
Move to the desired page	TOC	"Table of Contents" will be displayed, enabling you to navigate to the desired page.
Exit the learning	✕	Exit the learning. Window such as "Contents" screen and the learning will be closed.

Introduction Precautions for Use

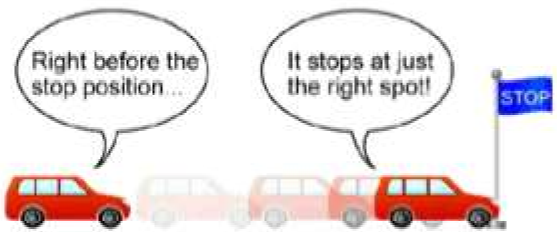
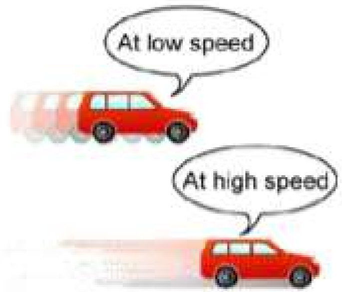
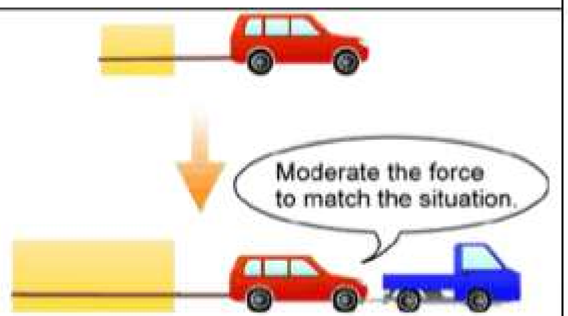
Safety Precautions

Before using the physical hardware, please read the Safety Precautions in the corresponding manuals and follow the relevant safety information contained therein.

Chapter 1 What is a servo?

1.1 The Role of a Servo

The word "servo" are used for the situation that objects move to the target position or follow a moving objective.
The word "servo" comes from the Latin word, servos, which means slave, and a "servomechanism"("servo" for short).
Servo is a control system that control machine as issued commands.
Servo mechanism enables the position, speed, torque control or combinations of these controls.

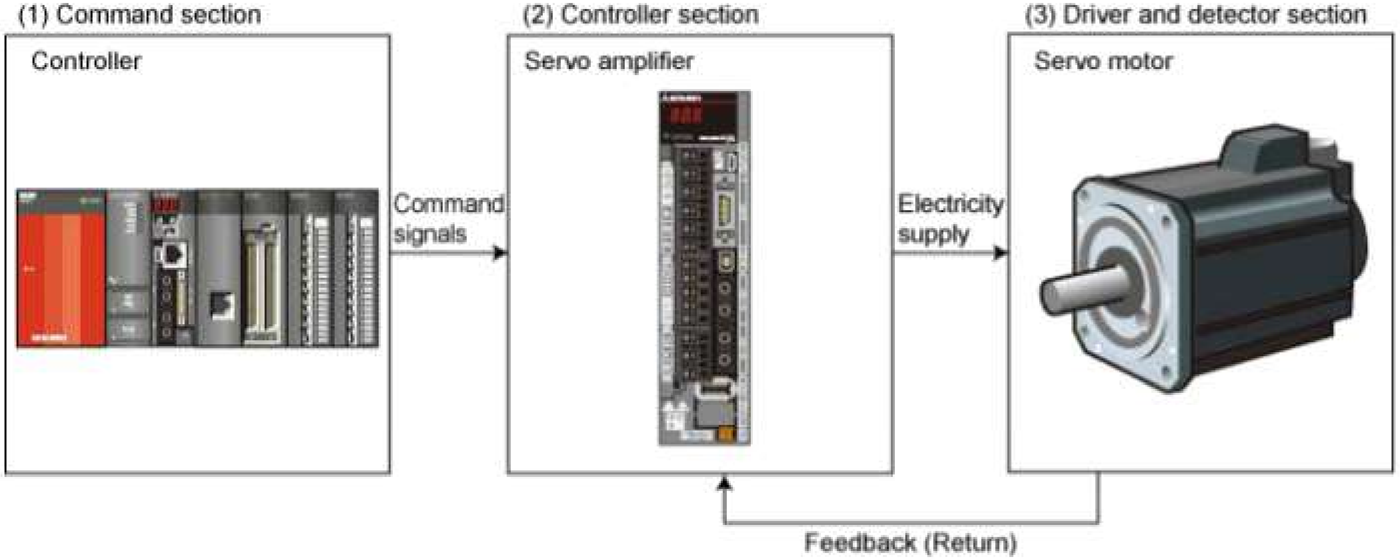
Position control	Speed control	Torque control
Servos accurately move objects or stop them at a set position. Servos can even positioning objects at submicron precision (µm = 1/1000 mm), and repeatedly start/stop objects.	Servos highly response to the target speed even when the speed changes. Servos can also minimize the speed difference from the target speed when the load changes. Continuous operation is possible at wide range of speed.	Servos accurately control the torque even when the load changes. *Torque is the force that produces rotation.
		

1.1 The Role of a Servo

For high-speed and high-precision operation, servomechanisms feed back, verifying its operation all times to follow the instruction correctly.
It is important how accurately control and minimize the difference between the command signal and the feedback signal.
Definition of "servomechanism" by the Japanese Industrial Standard (JIS):
A control system to control objects as following the target changes using a target position, orientation, posture, and other factors.
Servomechanisms are structured mainly by the systems and sections listed below.

Command section	This section outputs operation command signals.
Controller section	This section moves the motor and other parts in accordance with the commands.
Driver and detector section	This section drives the controlled target and detects the status of the target.

Most mechanisms use hydraulic or pneumatic systems. However recently electrical systems have been widely used due to their high-level maintainability. AC servo is most commonly used electric motor for FA control requiring accuracy.
Servo motors have encoders that detects angle of rotation, speed, and direction. The motors send those detected information to the servo amplifier (control section) as feedback.



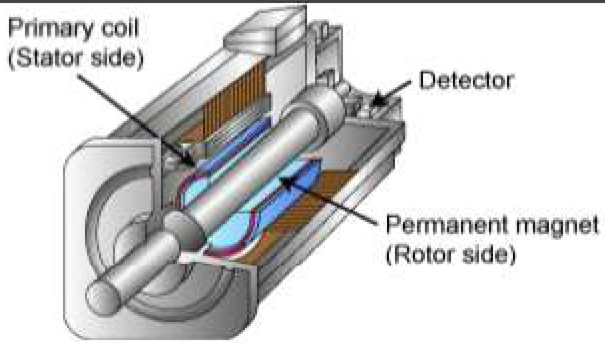
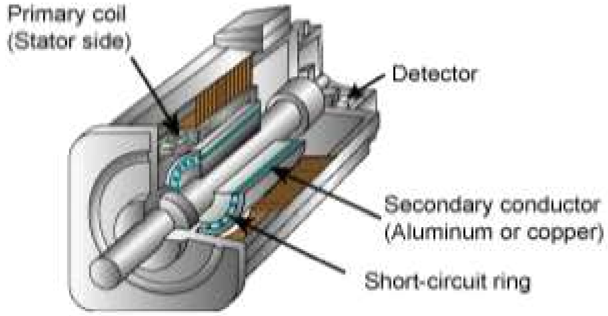
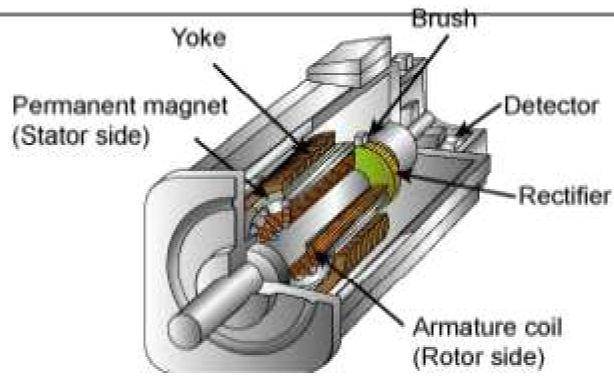
1.1 The Role of a Servo

Types of servo motors

There are three types of servo motors in general: SM (synchronous) series AC servo motors, IM (induction) series AC servo motors, and DC servo motors. For FA devices and systems, SM series AC servo is most commonly used in low or medium-sized capacities.

Maintenance-free	DC servo motors require rectifier brush inspections and maintenance.
Environment resistance	DC servo motors cannot be used in applications requiring clean environments as they generate brush abrasion dust.
Power generation during blackouts	IM series AC servo motors cannot be used during blackouts as they do not have permanent magnets.

1.1 The Role of a Servo

Types	Structure	Features	
		Advantages	Disadvantages
SM (Synchronous) series AC servo motor		Maintenance-free. Excellent environment resistance. High torque. Power generation control during blackouts. Compact and lightweight. High power rate.	Little more complicated control by servo amplifier than those for DC servo motors. 1:1 response is required between the motor and servo amplifier. Demagnetization might occur.
IM (Induction) series AC servo motor		Maintenance-free. Excellent environment resistance. High speed and high torque. High efficiency at high capacity. Robust structure.	Low in efficiency at low capacity. More complicated control by servo amplifier than those for DC servo motors. No power generation control during blackouts. Change characteristic depending on temperature.
DC servo motor		Simpler control by servo amplifier. Power generation during blackouts. Low price at low capacity. High power rate.	Require maintenance and periodic inspection on parts around the rectifier. Not used in applications requiring clean environments as they generate brush abrasion dust. Not used at high torque due to their brushes. Demagnetization might occur.

1.1 The Role of a Servo

[Encoder types]

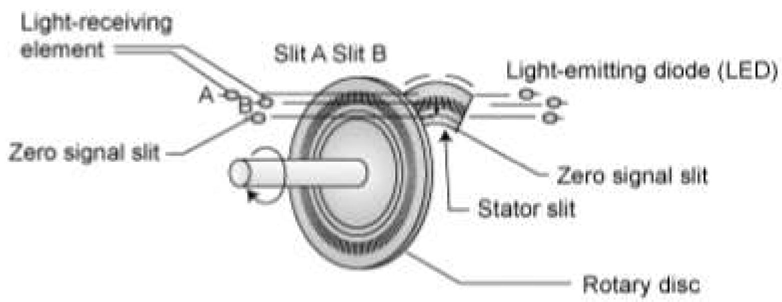
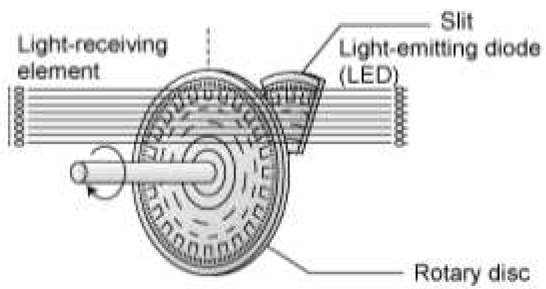
<Incremental encoders and absolute encoders>

Servo motor has increasingly adopted absolute encoders which require no return-to-origin operation after a blackout.
Absolute encoders have an absolute position detector to detect position in a rotation and a multi-revolution detector that counts the number of rotations.
The multi-revolution detector data is backed up with a battery to prevent the data delete when a blackout occurs.

In general, optical encoders are used when compactness and high resolution is required. However, magnetic encoders can be used instead when environmental resistance is particularly required. (high resistance to stains and the similar).
The principles of an optical encoder is shown in the diagram below.
Some encoder achieve the high resolution (1 million pulses/rotation), improving the detection method.

1.1 The Role of a Servo

Comparison of encoders (General)

Item	Incremental encoder	Absolute encoder
Output	Incremental value output. A pulse is output corresponding to changes in the rotation angle.	Absolute values output. The absolute value of the rotation angle is output.
Response during blackouts	Require a return-to-origin operation at power up.	Not require a return-to-origin operation at power up.
Price	At low price as their structures are relatively simple.	At high price as their structures are relatively complex.
Structure		
Supplementary information	Incremental encoders, with multiple optical slits on a rotating disc, convert slit position data into electrical signals by detecting the light passing through fixed slits with a photodiode.	Absolute encoder constantly detect the position of the motor axis (an absolute encoder is attached to the motor axis). The encoder does not require a return-to-origin operation at power up as they do not require a pulse count.

1.2 Examples of servo applications

Servomechanisms are used in an extremely wide range of application in a variety fields due to its flexibility.

Servos are applied to things in our daily life, such as computer DVD drives and hard disc drives, paper feed mechanisms in copy machines, and tape feed mechanisms in digital video cameras. Servos are also used in industrial applications, such as in aviation control mechanisms and driving for astronomy telescopes.

Some examples of applications of AC servos used in FA fields will be illustrated below.

AC servos in the 1980s takes the leading roles in variable-speed drives for FA devices by their use in numerical control (NC) and robotics fields.
In the 1990s, they start to be used in a greater range of applications due to the market expansion, shifting from the use of hydraulic systems to electrical ones.
In recent years, with advancements in information technology (IT) including cellular communications, the servo applications have increased dramatically to related fields such as semiconductor fabrication, electronic component assembly, and liquid crystal display (LCD) applications.

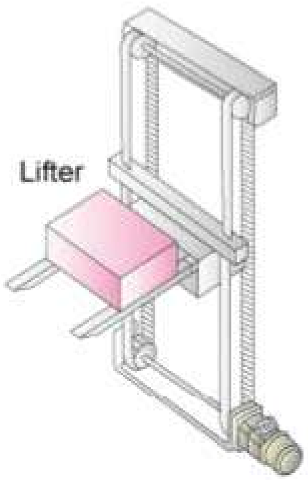
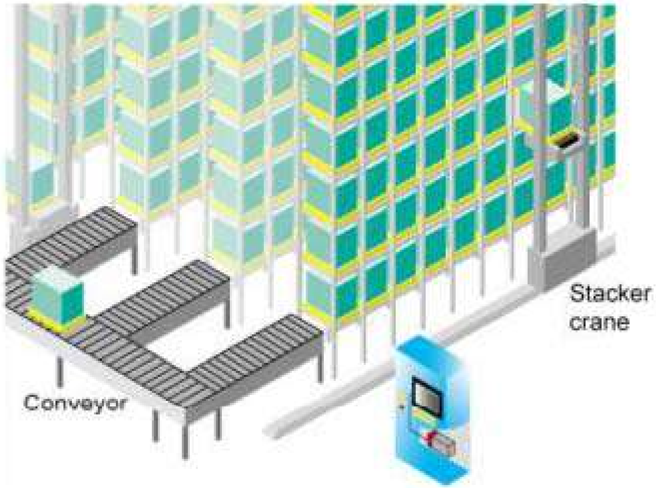
1. Transport applications
2. Winding machinery applications
3. Food product applications
4. Semiconductor applications
5. Injection molding applications
6. Electronic component assembly applications

1.2 Examples of servo applications

Transport control

Transport devices are indispensable elements in many fields currently as industries become more sophisticated and automated.

Some examples that use servos in this field are shown below.

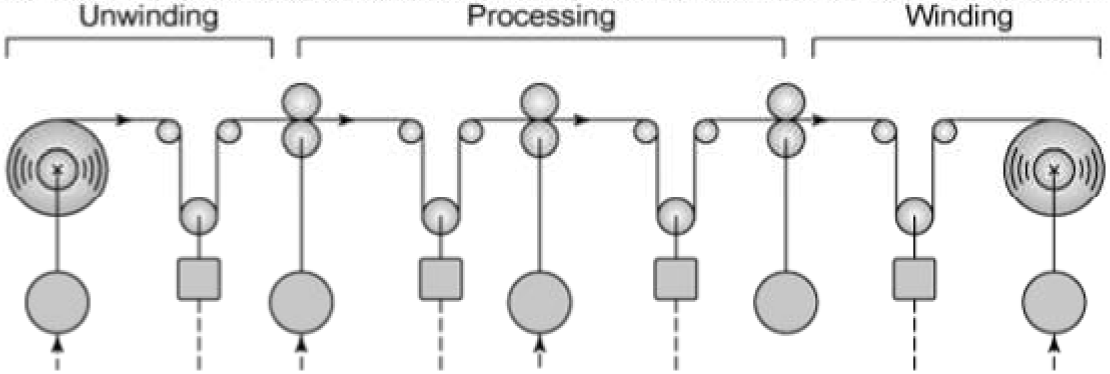
Transport machine (Vertical)	Automated warehouse picking systems
Servos increase machine speed and improve production efficiency. Objects accurately stop at the set position. A servo motor that has a magnetic braking system is used to prevent objects on the machine from dropping during blackouts.	AC servos have been used more commonly for picking and traveling units to meet the need for high speed in automated warehouses with automated warehouse picking systems. The use of AC servo motors enables smoother speeds and adjustable speeds with high-speed operation. Logistical inventory management efficiency is increased dramatically over the entire process from procurement of raw materials to delivery of end products using automated warehouse picking systems used with supplier-chain management (SCM).
	

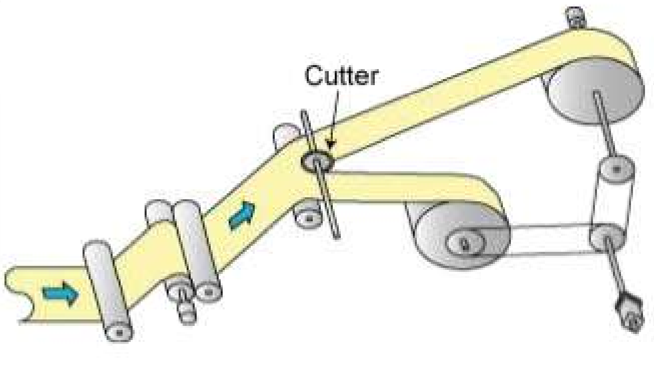
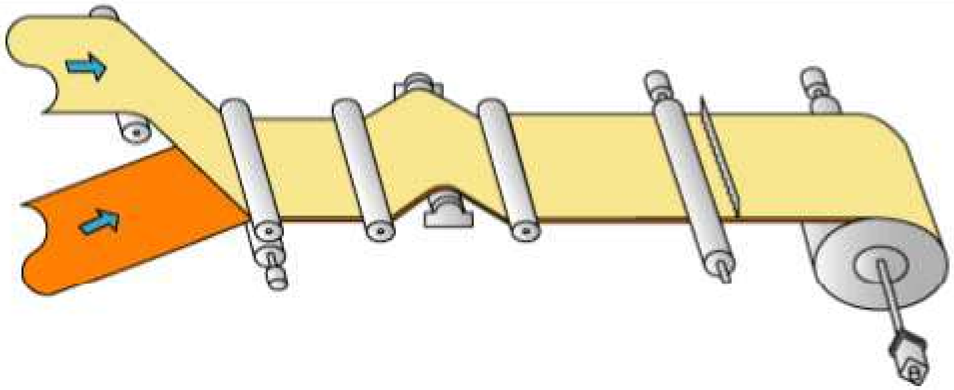
1.2 Examples of servo applications

Winding machinery applications

A winding machine handles a long pieces of material such as paper or film. It is also called "web".
Winding operations has mainly three steps: unwinding material, processing material, and winding material onto a roll.
The processing method may change depending on the application (slitter, laminator, printer), but the overall structure is same.

Diagram of a Typical Mechanism:

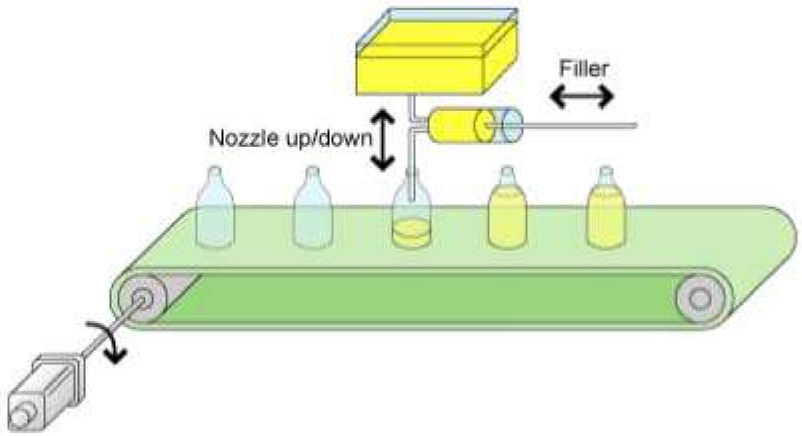
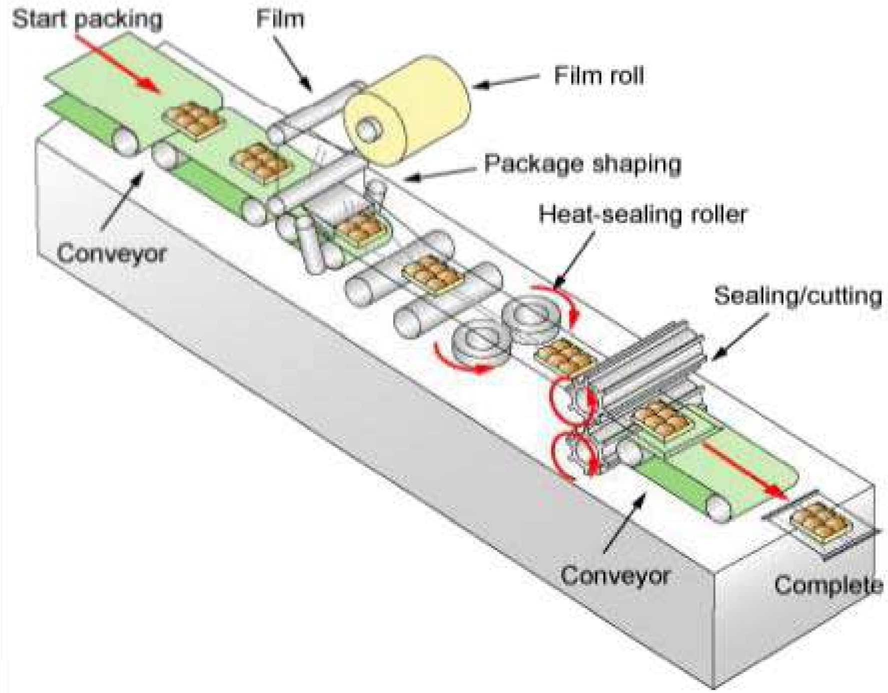


Slitter	Laminator
A slitter is a machine that inserts slits into workpieces at the winding roll, the final process. Tension is controlled so that the cutter inserts slits correctly.	A laminator is a device that fits and seals the layers of film together. Tension is controlled properly so that the right amount of pressure is applied to the films. Coating machines, printers, and other types of equipment have similar mechanisms.
	

1.2 Examples of servo applications

Food product applications

The Higher quality and safer food processing have been required increasingly , therefore servo is often used as a solution for many fields, even for food process.

Filling machine line	Packing machine line
	
The filling machine fills bottles in different shapes and sizes with different types of liquids at high speed. The filling process is controlled so that bottles are filled with the right amounts for their size at high speed without any bubbles forming.	Servomechanisms ensures that food products are sealed and packed accurately and in a sanitary manner. It is important that the proper amount of film is cut off from the roll according to the size of each food product.

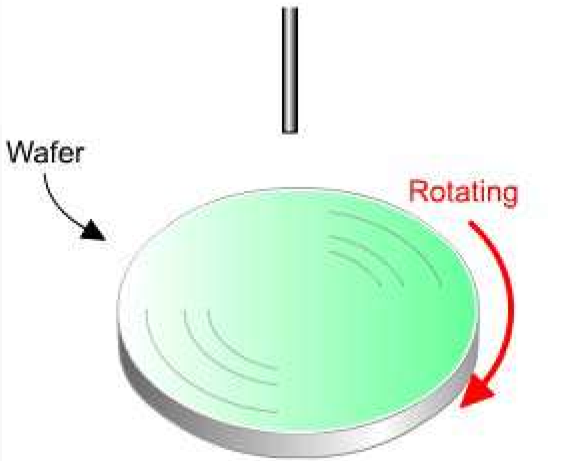
1.2 Examples of servo applications

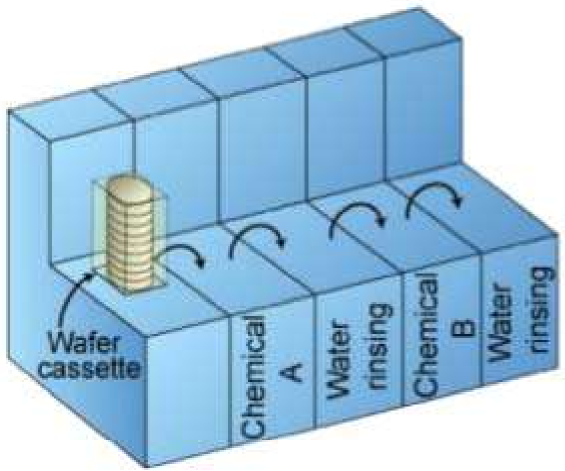
Semiconductor applications

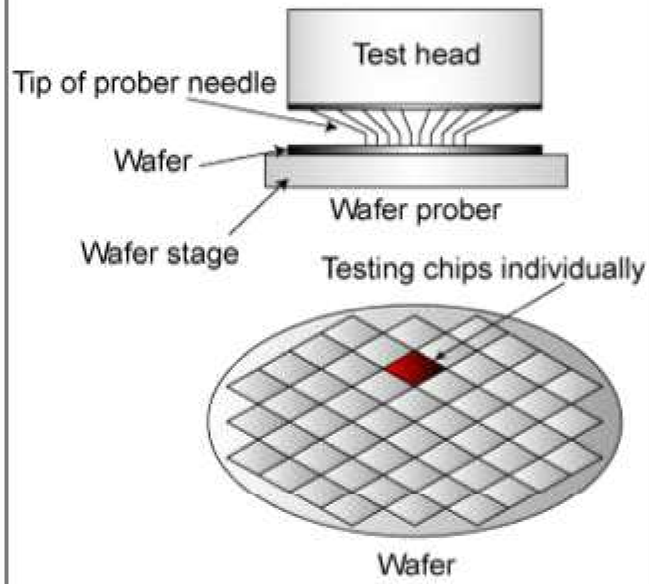
Semiconductor fabrication processes are usually conducted at the submicron level.
For this reason, they require extremely high processing precision and clean environments.
Servo systems are commonly used as they can satisfy these conditions.
Semiconductor technology is constantly advancing, creating an even greater need for higher level servo technology.

1.2 Examples of servo applications

Spin coating	Wafer cleaning	Wafer prober
Fabrication of semiconductor circuits uses the photographic principles. Spin coaters apply a photo resist to a semiconductor wafer. The spin coaters use the principle of centrifugal force to drip a resist solution onto the wafer as to spread thinly and evenly over the entire surface. If the wafer spins too fast, the resist may fly off the wafer. Conversely, if the wafer spins too slowly, the resist may not spread over the surface evenly.	Semiconductor fabrication processes use photographic principles and require completion of several cleaning steps throughout the fabrication process. Wafers are immersed in chemical solutions and water (pure water) to dissolve, neutralize, and wash away impurities and then dried. There is batch processing in which several wafers are processed together in a cassette and single-wafer processing in which wafers are processed individually.	A large number of LSI chips are produced from a single wafer, and each chip is tested using a wafer prober and tester before assembly. As a needle is placed directly on the surface of a chip, the positioning must be accurate. This step must be processed at high speed.





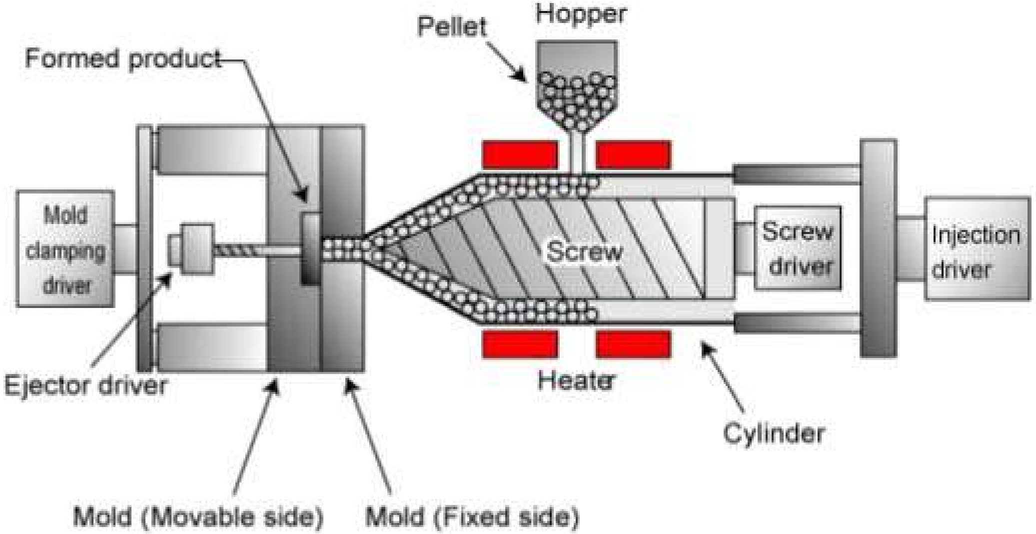


1.2 Examples of servo applications

Injection molding applications

Injection molder is the device that fabricates the plastic parts.
Plastic material is heated and melted down, and then injected into a mold to fabricate parts.
The conventional molders mainly use hydraulic control, but more and more molders currently have adopted AC servo systems to conserve electricity.

Injection molder

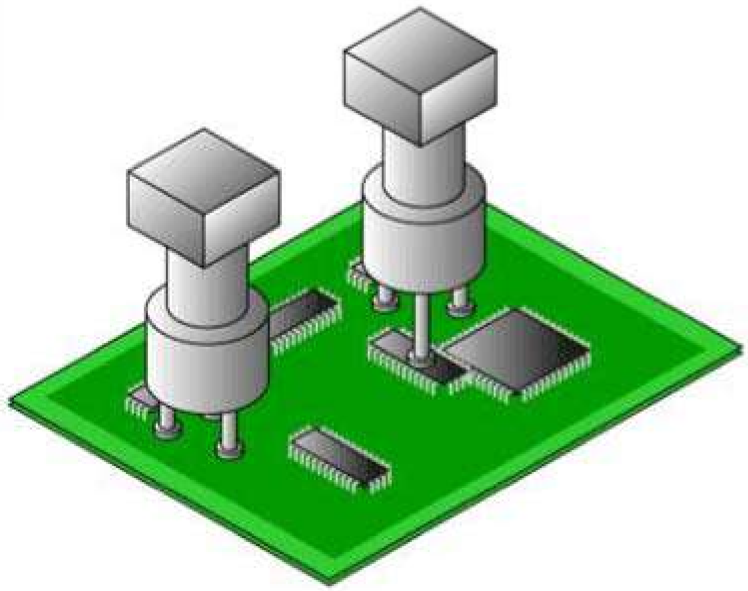
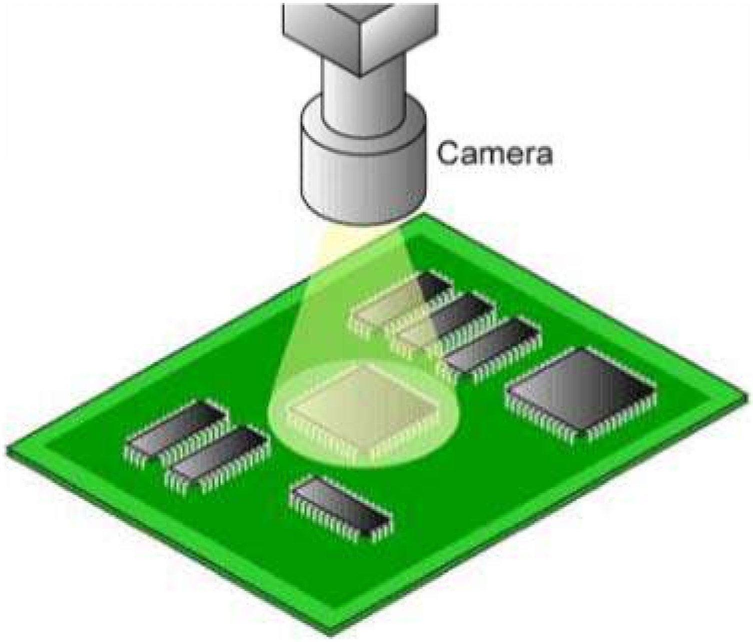


The plastic materials and pellets are melted by heater near cylinder-screw axis assembly and inject into the mold.
The molded part is pushed to extract from the mold by an ejector pin, after the material has hardened.
The mold clamping force is extremely high. Some forces for large-part applications even exceed 3000 tons.

1.2 Examples of servo applications

Electronic component assembly applications

Mounters is the device that mounts electronic components such as LSI chips onto circuit boards, so high speed and high precision are required.
In particular, the advanced mounting technology recently has been needed for flip-flops (semiconductor chips mounted directly onto a circuit board), chip stacking, and related technologies.
Detector units have also become necessary for high-speed circuit board assemblies, automated to improve productivity.
AC servos satisfy these requirements.

Mounter	Basic testing
	

Electronic components (LSI chips, resistors, capacitors, etc.) are mounted onto a printed circuit board (PCB). This process requires accurate positioning and high speed.

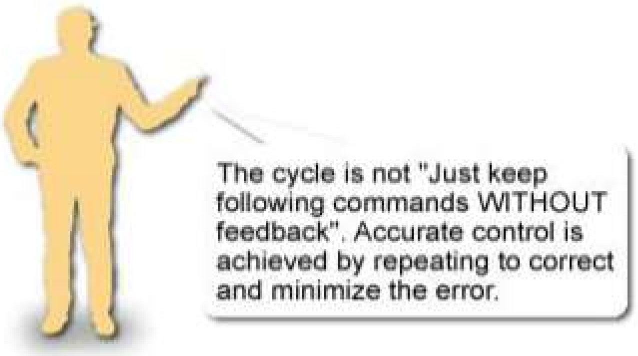
Electronic components (ICs, resistors, capacitors, etc.) have been tested whether correctly mounted onto a PCB. PCB itself may be tested in some cases.

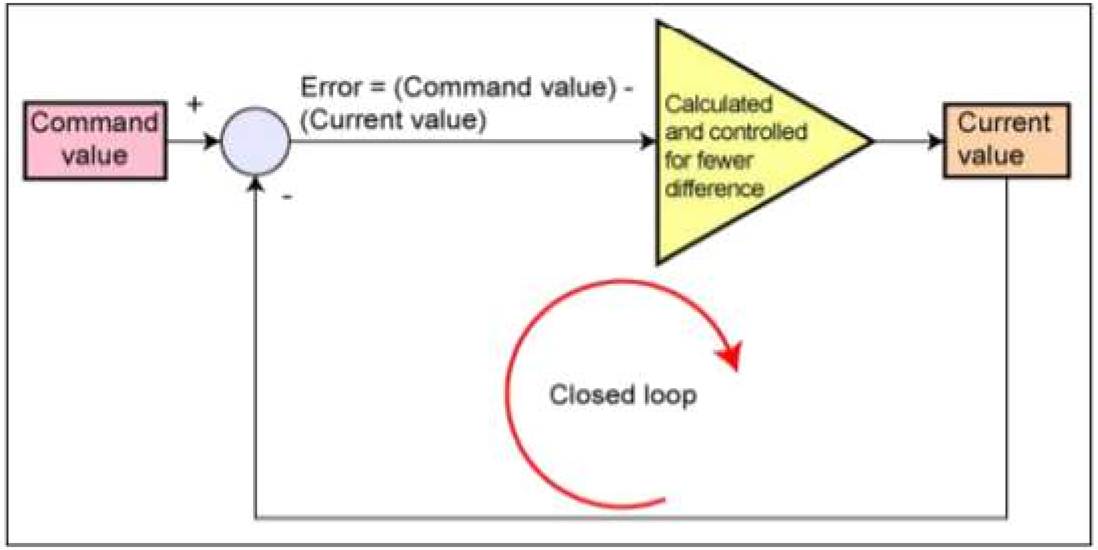
1.3 Servo principles and structures

The main feature of a servo system is that it compares the command value and the current value and works to minimize the difference between the two using feedback control.

Feedback control is repeated for the (controlled) machine to follow the command as accurately as possible. If the deviation occurs, the control method will be changed and the feedback will be repeated.

The loop that cycles through " error → current value → error " is referred to as a closed loop because it closes.
Conversely, a system that does not use any feedback is referred to as an open loop.





1.3 Servo principles and structures

There are three different command modes in servo systems as listed below. The mode is decided depending on what the command values are.

(1) Position control mode (2) Speed control mode (3) Torque control mode

Some servo products allow you to switch the modes even during operation.

Ex.:

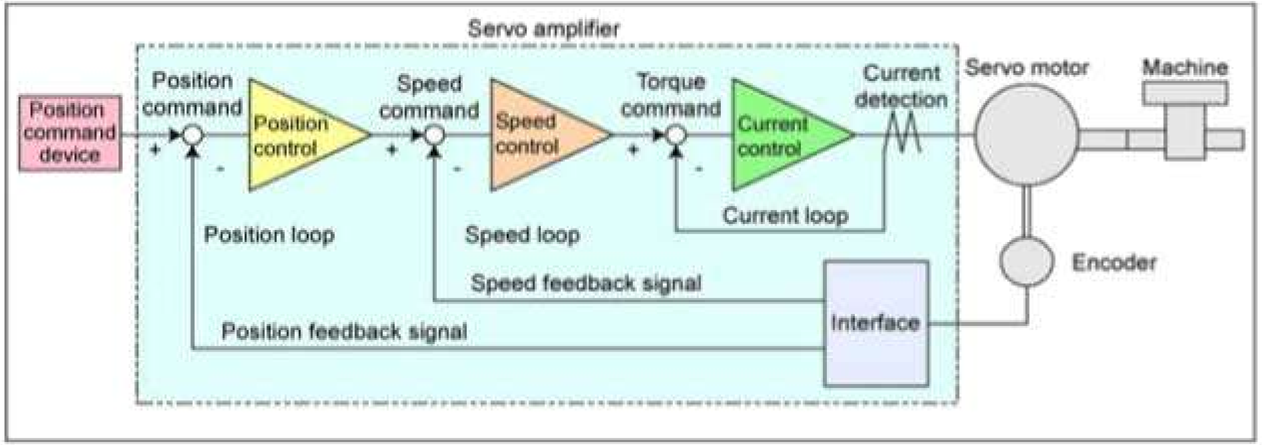
Switching from speed control mode to torque control mode	The machine runs at constant speed (speed control mode) when the material starts to be wound onto the winding roll. It later switches to torque control mode to ensure that the material is wound at constant tension.

In recent years, Motion control has become more commonly used. This control is suitable when a controller is used to control multiple axes simultaneously.

1.3 Servo principles and structures

Servo control loop

Focus on the flow of signals in servo. The servo structure is as follows.



In AC servo systems, encoder mounted onto the servo motor detects pulse signals and motor current. The feedback is sent to the servo amplifier to control machines so that they follow issued commands.
The three different loops listed below are in this feedback.

Position loop	This is a loop which controls position by using position feedback signals generated from encoder pulses.
Speed loop	This is a loop which controls speed by using speed feedback signals generated from encoder pulses.
Current loop	This is a loop which controls torque by using current feedback signals generated from detection of the servo amplifier current.

1.3 Servo principles and structures

In each loop, the signals are controlled so that the difference between a command signal and a feedback signal is zero.
The response speeds for the loops are given below in order of slower to faster.

(Position loop) < (Speed loop) < (Current loop)

The type of loop used in each control mode is listed below.

Control mood	Loop
Position control mode	Position loop, speed loop, current loop
Speed control mode	Speed loop, current loop
Torque control mode	Current loop (However, speed control required under no-load conditions)

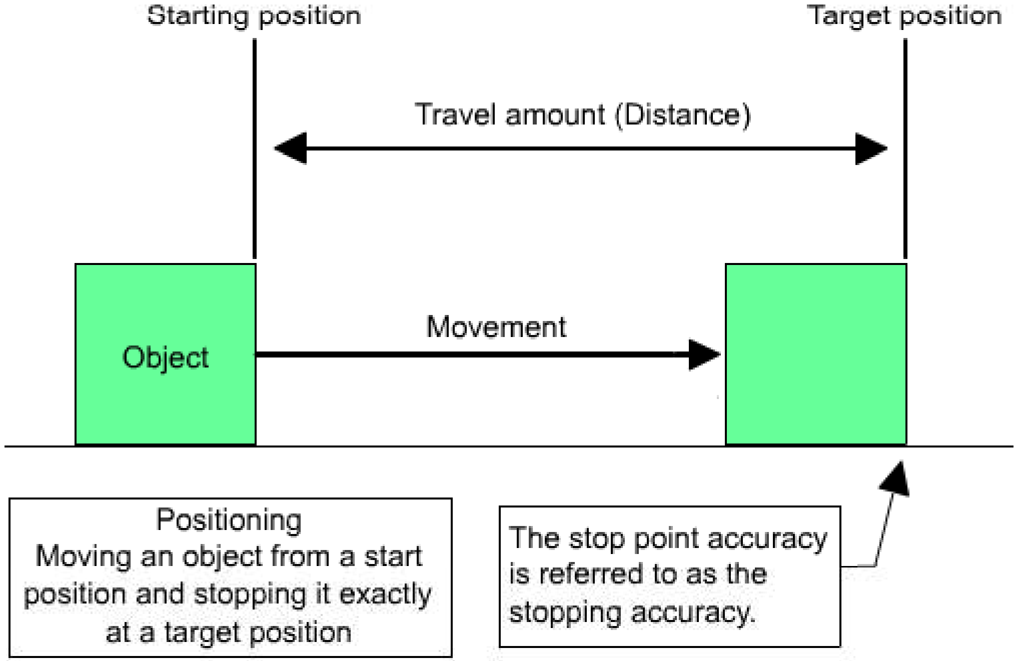
1.3 Servo principles and structures

[Position control mode]

(a) Target position for positioning control

In FA systems, the "positioning process" involves moving objects such as processing work pieces or tools (drills, cutters) at optimal speed and stopping them at a set position with high precision. This type of control is referred to as position control. Most servo systems may be used for this positioning control.

Start (Press this button)



In positioning control, the motor requires the accurate monitoring of motor speed condition at all times, therefore an encoder that detects the motor speed condition is used.
In addition, in order to follow up the commands at high speeds, servo motors use the specialized encoders designed to increase generated torque, part of motor power performance, and decrease the inertia of the motor itself.

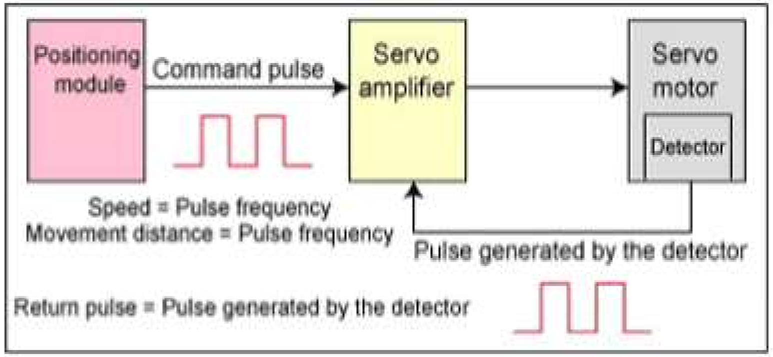
1.3 Servo principles and structures

[Position control mode]

(b) Basics of position control

Basic position control in servo systems involves the items below.

- The machine travel amount is proportional to the total command pulse number.
- The machine speed is proportional to the command pulse sequence speed (pulse frequency).
- Positioning completes within the final plus/minus one pulse range, and the position is maintained as long as there are no updated position commands.
  (Servo locking function)



Therefore, a position precision for the servo system is determined with the following.

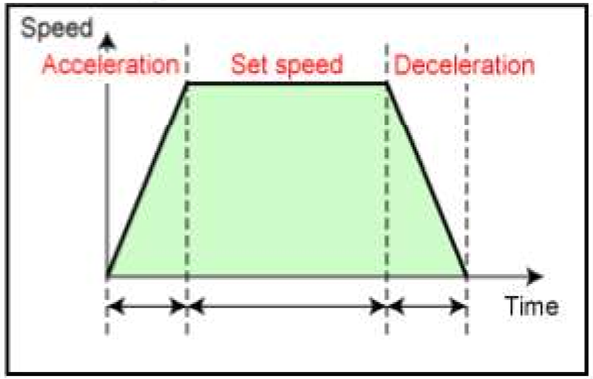
- Travel amount of a mechanical system per servo motor rotation
- Number of output pulses of the encoder per servo motor rotation
- Errors such as backlash of a mechanical system

1.3 Servo principles and structures

[Speed control mode]

A feature of speed control in servo systems is that machines are able to run at a detailed and wide range of speeds with little variation.

(a) Soft start/stop functions



The accelerated speed (rate of change in speed) at rising/falling edge can be adjusted to prevent shocks to the machine during acceleration/deceleration.

(b) Wide speed control range

Speed can be controlled over a wide range from extremely low speed to high.
(Around 1:1000 to 1:5000) The rated torque characteristic is within the speed control range.

(c) Low rate of change in speed

Machines can run with less change in speed when there is a change in load.

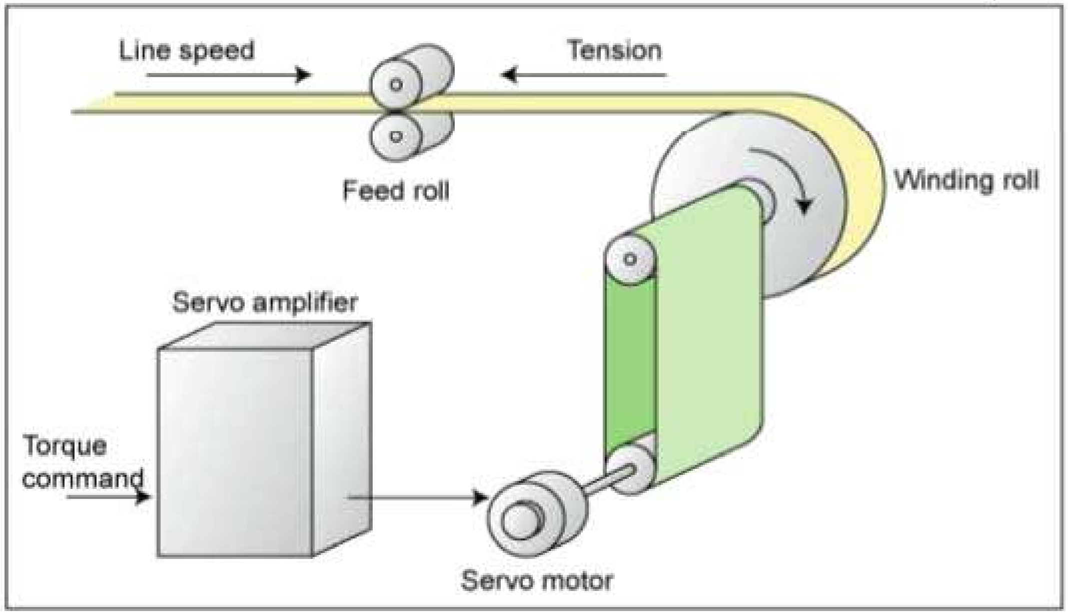
1.3 Servo principles and structures

[Torque control mode]

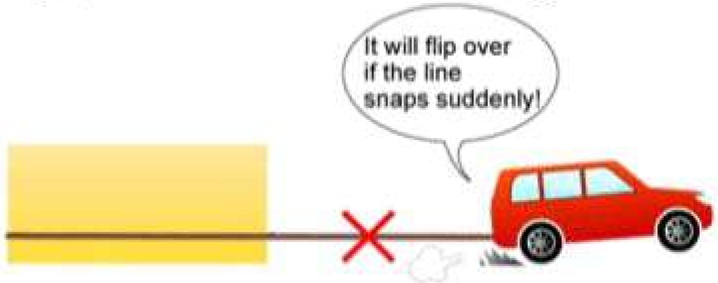
Outputs a target torque by controlling the current of the servo motor in torque control.

<Winding examples>

(a) Because the load torque increases as the radius of the winding roll increases, the torque output from the servo motor is controlled as suitable in order to control tension to keep it constant.



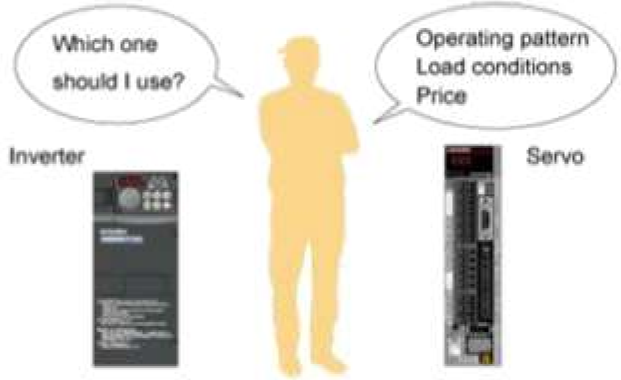
(b) Make sure to set a speed limit value because the motor with a light load will rotate at very high speed, for example, when the material is accidentally cut in the middle of operation.



Chapter 2 What are the differences between inverters and servos?

2.1 Differences in applications and specifications

General-purpose inverters and general-purpose servos differ fundamentally in terms of objectives and functions.
The choice depends on factors such as operating pattern, load conditions, and price.



2.1 Differences in applications and specifications

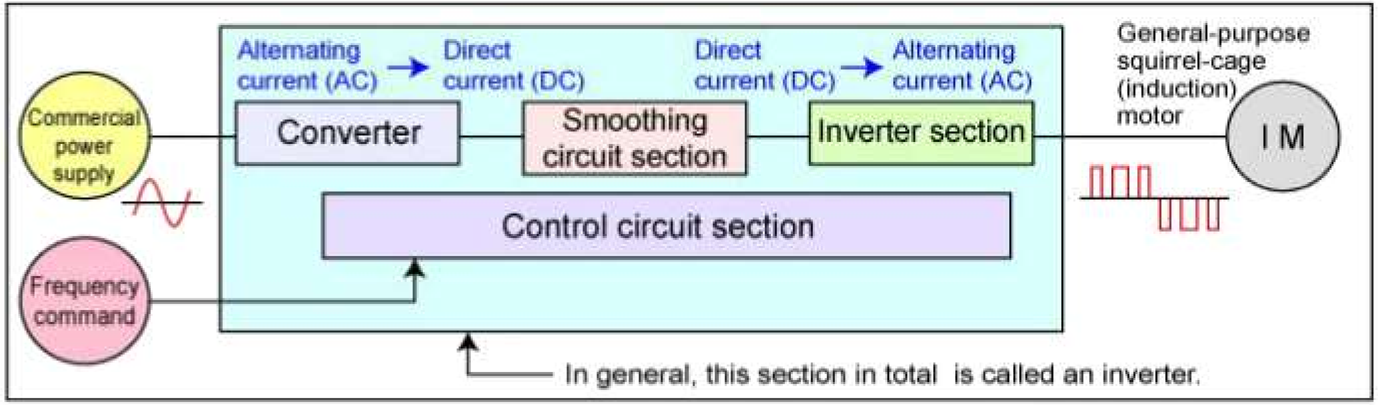
Comparison	(General-purpose) Inverter	(General-purpose) Servo
Control applications	Used to control relatively mild normal conditions.	Used in applications requiring high-speed and high-precision control temporarily.
Control mode	Used basically for the speed control modes.	Used for the position control, speed control, and torque control modes.
Motor	A general-purpose (induction) motor is used.	Specified/limited by the combination of the servo amplifier.
Operation with multiple motors	Multiple motors can be driven using a single inverter.	Fundamentally, one servo amplifier is used to drive one motor only.
Price	(Relatively) Low-priced	(Relatively) High-priced
Responsiveness (The higher the better)	Low responsiveness. Around 100 rad/s.	High responsiveness. Around 200 rad/s to 15000 rad/s.
Stopping precision	Up to around 100 µm.	Up to around 1 µm available.
Frequency of start/stop (Number of times machine can be started/stopped)	Around 20 rpm or below.	Around 20 rpm to 600 rpm.
Rate of change in speed	High rate of change. Easily affected by changes in load and other factors as there is no speed feedback available.	Low rate. Enables changes in load and other factors to be cancelled out as there is speed feedback available.
Continuous operating range (Continuous operation at 100% load)	Narrow range. Around 1:10 rad/s.	Wide range. Around 1:1000 rad/s to 1:5000 rad/s.
Maximum torque (Rated torque ratio)	Around 150%.	Around 300%.
Output	Around 100 W to 300 kW.	Around 10 W to 60 kW.

2.2 Comparison of basic structures

The basic structure is broadly divided into two parts: a main circuit that converts electricity. A control circuit that issues commands to determine how the electricity is converted.

Main circuit	Structurally, inverters and servos are almost same. One difference between servos and inverters is that servos have a section referred to as a dynamic brake. The dynamic brake unit absorbs inertial energy built up in the servo motor and apply a brake on the servo motor.
Control circuit	Compared to inverters, servos have a rather complicated structure. This is because servomechanisms require functions for complicated feedback, control mode switching, limits (on current, speed, torque), and other operations.

(1) Basic inverter structure

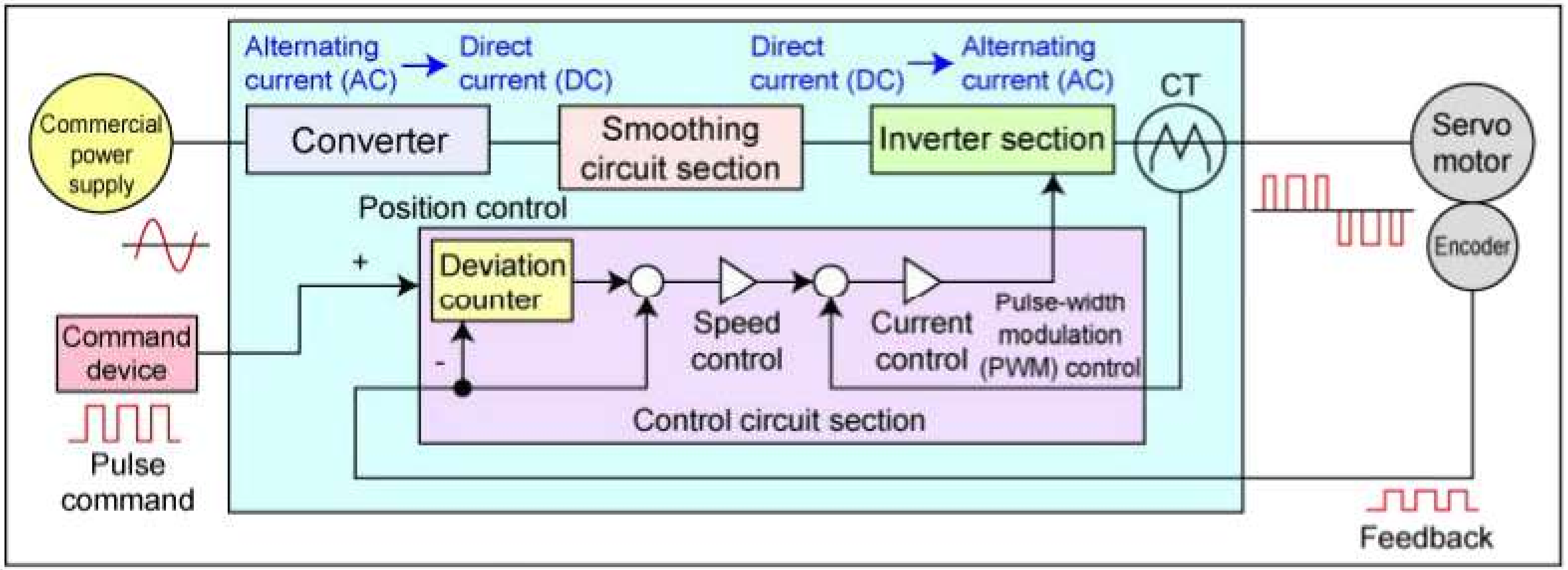


Each section function as below:

- Converter section : Works to convert an AC voltage from a commercial power supply into a DC voltage.
- Smoothing circuit section : Works to smooth out variations in a direct current wave.
- Inverter section : Works to convert a DC voltage into an AC voltage with a variable frequency.
- Control circuit section : Works mainly to control the inverter section.

2.2 Comparison of basic structures

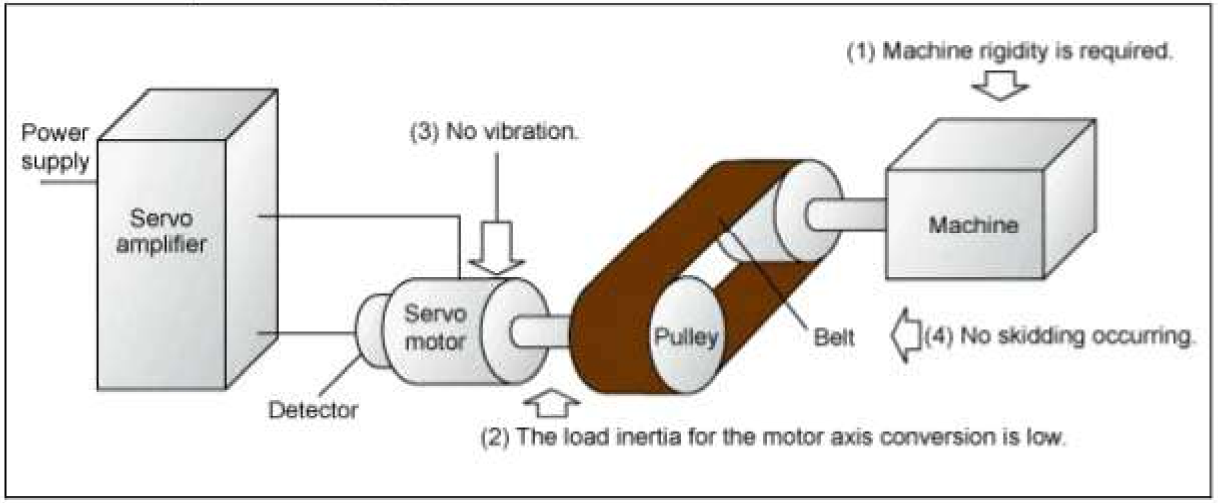
(2) In the basic servo structure, each section function as below:



- Converter section : Works to convert an AC voltage from a commercial power supply into a DC voltage.(Same as for the inverter)
- Smoothing circuit section : Works to smooth out variations in a direct current wave. (Same as for the inverter)
- Inverter section : Works to convert a DC voltage into an AC voltage with a variable frequency. One difference between servos and inverters is that servos have a section referred to as a dynamic brake.
- Control circuit section : Works mainly to control the inverter section. Servos have a rather complicated structure compared to inverters due to the fact that they require functions for feedback, control mode switching, limits (on current, speed, torque), and other operations.

2.3 Changes from inverters to servos

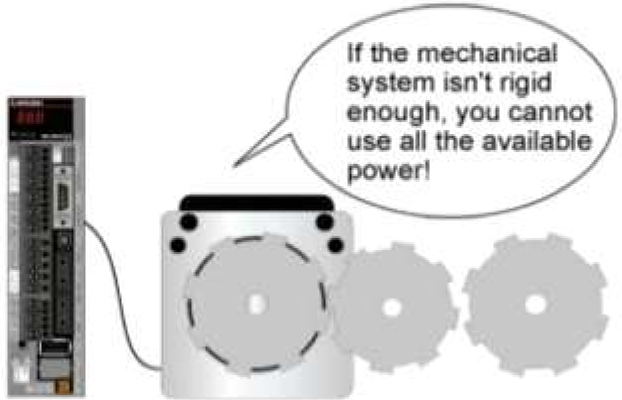
Generally speaking, servos offer better performance than inverters.
For this reason, it is believed that changing from inverters to servos does not cause any problems for operation.
However, keep the following in mind.



(1) Rigidity on the machine side

Servo has twice stronger torque than inverter.
If the machine structure is weak, vibration may occur during acceleration/deceleration (Hunting phenomenon) because the servo receives feedback signals from the detector for control.

In such cases, countermeasures must be implemented such as strengthening the structure of the machine itself or lowering the gain (control sensitivity) for the servo system.
The Mitsubishi servo amplifier has filter function within the control loop.
The filter function automatically adjust and lower servo system gain to suppress vibration at the frequencies where vibration occurs easily in mechanical systems (resonant frequencies).



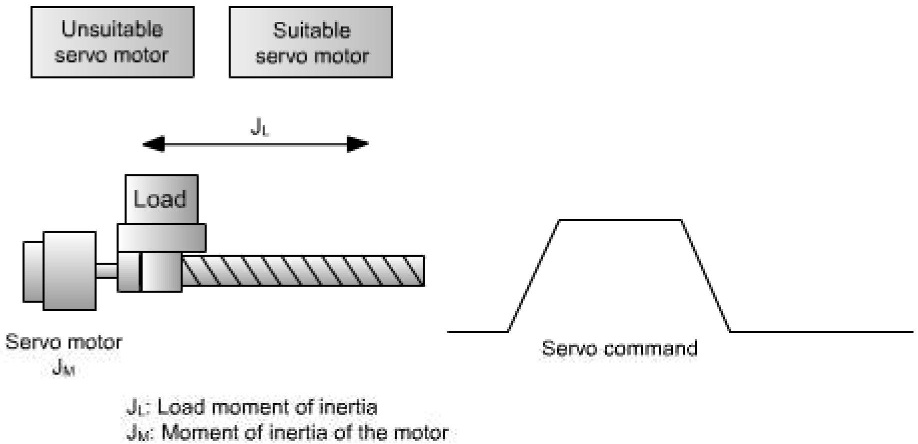
2.3 Changes from inverters to servos

(2) Size of the load inertia for motor axis conversion

In general, servos are more influenced by the size of moment of inertia of load than inverters.
If moment of inertia of load is too large compared to moment of inertia of motor, the motor axis will become easily affected by the load, and control will become unstable.
It is important to select appropriate servo capacities for the load of the mechanical system.

For stability, it is desirable that the magnification of moment of inertia of load (motor axis conversion) to moment of inertia of motor be lower than the recommended load to motor inertia ratio.

↓ Press the below button. ↓



(3) Vibration to the motor axis

If a mechanical vibration is applied to the section where the motor is attached, the affect on the rotating motor shaft may be a problem.
Servo motors with built-in detectors require measures to reduce vibration.

(4) Skidding of the speed reducer mechanism

For V belt speed reducer mechanisms, countermeasures such as a timing belt become necessary to prevent from skidding that occurring in the belt section.

FA_Equipment_for_Beginners(Servos)_ENG

Test | Final Test

Now that you have completed all of the lessons of the FA Equipment for Beginners (Servos) Course, you are ready to take the final test. If you are unclear on any of the topics covered, please take this opportunity to review those topics.
There are a total of 10 questions (27 items) in this Final Test.
You can take the final test as many times as you like.

How to score the test

After selecting the answer, make sure to click the **Score** button. Failure to do so will not score the test. (Regarded as unanswered questions.)

Score results

The number of correct answers, the number of questions, the percentage of correct answers, and the pass/fail result will appear on the score page.

Correct answers : 3

Total questions : 10

Parcentage : 30%

To pass the test, **60%** of correct answers is required.

Proceed Review Retry

- Click the **Proceed** button to exit the test.
- Click the **Review** button to review the test. (Correct answer check)
- Click the **Retry** button to retry the test multiple times.

FA_Equipment_for_Beginners(Servos)_ENG

Test Final Test 1

A servo is a control mechanism designed to operate by issued commands and verify own operating conditions at all times and feed back to ensure that there are no error from the issued commands.

Select the correct statement about control features.

- Feedback signals are controlled so as to be minimized.
- The difference between the command signals and feedback signals is controlled so as to be minimized.
- The command signals are controlled so as to be minimized.

Score Back

FA_Equipment_for_Beginners(Servos)_ENG

Test | Final Test 2

Select the type of servo motor used most commonly in FA devices.

- ○ Synchronous (SM) series servo motor
- ○ Induction (IM) series servo motor
- ○ DC servo motor

Score | Back

FA_Equipment_for_Beginners(Servos)_ENG

Test Final Test 3

Absolute (absolute position detection) encoder

Fill in the blanks in the explanation for absolute encoders.

Absolute encoders, which require no --Select-- after a blackout, have become more commonly adopted in servo motors in recent years.

Absolute encoders have --Select-- used to detect position in rotation and multi-revolution detector that --Select-- the number of rotations.

The multi-turn detector data is backed up with a --Select-- so as not to be lost.

Score Back

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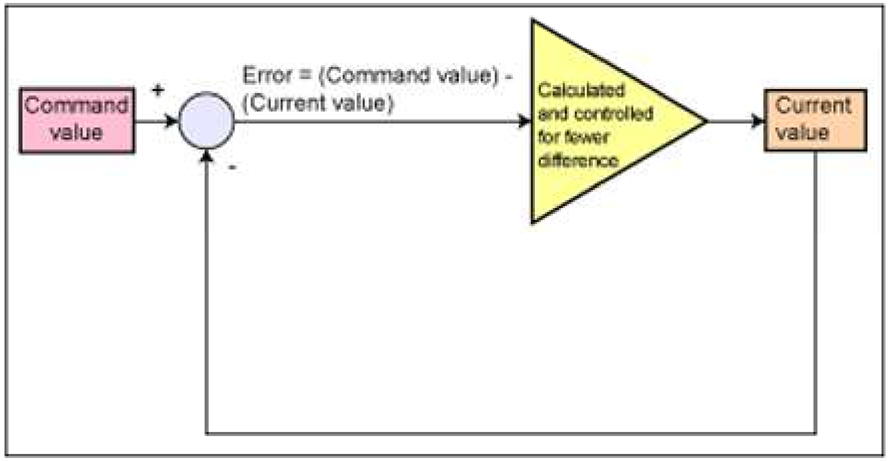
Test | Final Test 4

Servo control principles

Fill in the blanks in the explanation for servo control principles.

The main feature of a servo system is that it compares the command value and the --Select-- ,
and to --Select-- the difference between the two using --Select-- .
Based on the flow of control signals, the loop that cycles through "error → current value → error" is referred to as --Select-- bacause it --Select--



Score | Back

FA_Equipment_for_Beginners(Servos)_ENG

Test | Final Test 5

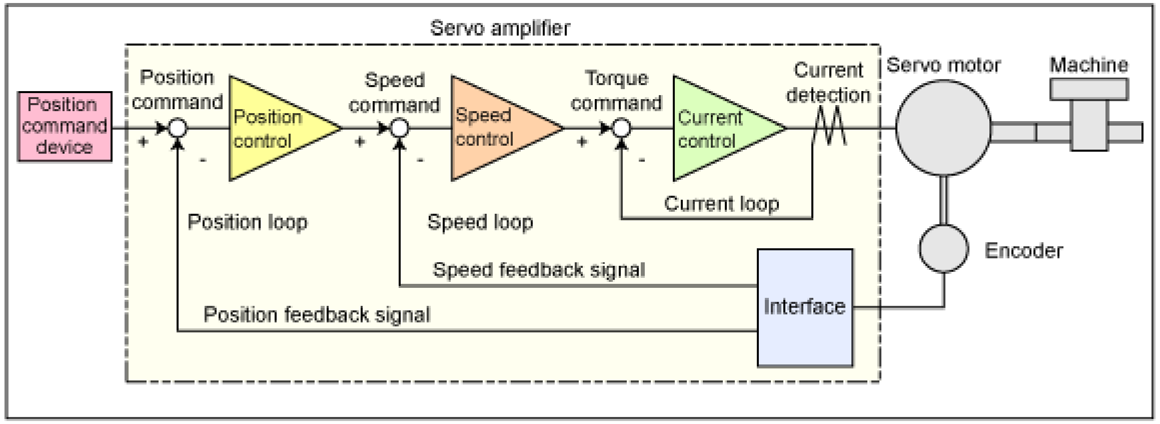
Types of servo control loops

Select the servo control loop that corresponds to the explanation listed below.

--Select-- A control loop that uses position feedback signals generated from encoder pulses.

--Select-- A control loop that uses speed feedback signals generated from encoder pulses.

--Select-- A control loop that uses current feedback signals generated through detection of servo amplifier output current.



Score Back

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Test Final Test 6

Position control principles

In servo position control, the servo operates to make the command pulse and the feedback pulse from the encoder become equivalent to each other.
Fill in the blanks in the explanations below with the appropriate terms.

The machine travel amount is proportional to the --Select-- .

The machine speed is proportional to the --Select-- .

Positioning will complete if the difference between the command pulse and feedback pulse is within --Select-- range, and --Select-- is maintained as long as there are no updated position commands issued.

Score Back

Test Final Test 7

Features of Servo Speed Control

Select the correct statement about control.(Multiple answers are possible.)

- [ ] Wide speed control range.
- [ ] Narrow speed control range.
- [ ] Low rate of change in speed.
- [ ] High rate of change in speed.

Score Back

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Test Final Test 8

Servo torque Control

Select the correct statement about torque control.

- ○ Torque control is used to control the servo motor current.
- ○ Torque control is used to control the servo motor voltage.
- ○ Torque control is used to control the servo amplifier input current.

Score Back

FA_Equipment_for_Beginners(Servos)_ENG

Test Final Test 9

Precautions for change from an inverter to a servo. (mechanical rigidity)

Fill in the blanks in the explanation below.

Servo has --Select-- ▼ stronger torque than inverter.

For this reason, with weak machine structures (machines width low rigidity), ▼ occurs rather easily during acceleration.

In such cases, the system is used in area where vibration dose not occur by strengthening the machine construction or --Select-- ▼ the servo gain.

Score Back

FA_Equipment_for_Beginners(Servos)_ENG

Test Final Test 10

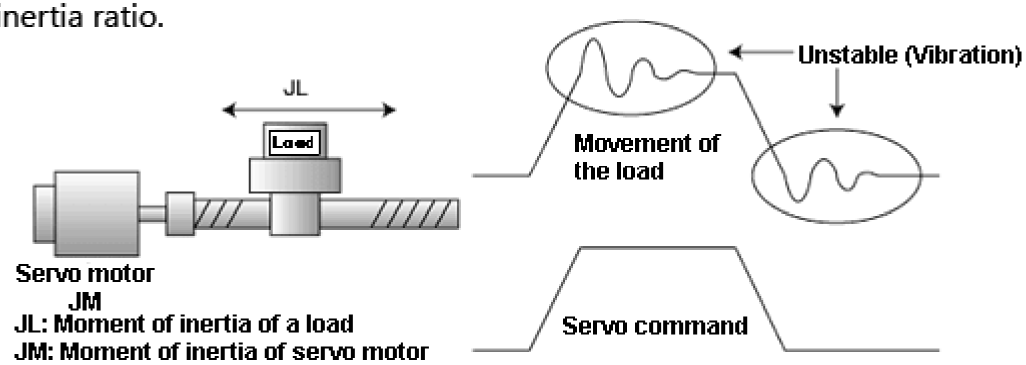
Precautions when changing from an inverter to a servo. (load inertia)

Fill in the blanks in the explanation below.

In general, servos are influenced by --Select-- of inertia of the load than inverters.

With servo motors, if moment of inertia of --Select-- is too large compared to moment of inertia of motor the motor axis will become easily affected by the load and control will become --Select-- .

As a general guideline for stability, it is desirable that the magnification of moment of inertia of load (motor axis conversion) to moment of inertia of --Select-- be lower than the suggested be lower than the recommended load to motor inertia ratio.



Score Back

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Test | Test Score

You have completed the Final Test. You results area as follows.
To end the Final Test, proceed to the next page.

Correct answers : 0

Total questions : 10

Percentage : 0%

Proceed Review Retry

You failed the test.

FA_Equipment_for_Beginners(Servos)_ENG

You have completed the FA Equipment for Beginners (Servos) Course.

Thank you for taking this course.

We hope you enjoyed the lessons and the information you acquired in this course is useful for configuring systems in the future.

You can review the course as many times as you want.

Review

Close