Cautions on Safety

Make sure to read the manuals and pay careful attention to safety when designing a system. In practice, pay attention to the following contents and handle any products or demonstration units correctly.

Cautions on practice

DANGER

- Never touch any terminal while the power is supplied. If you touch a terminal, you may get an electrical shock.
- Turn off the power before connecting / disconnecting units, or opening any safety covers.
- Never insert your hand or any other object into a moving part.

CAUTION

- Never change the wiring or configuration of demonstration euipment without permission or if you are unsure of how to configure a system correctly. Such actions may cause fail ction, injury or fire.
- If a simulation unit (such as an X-Y table) generates an abnormal smell or sound, immediately turn off the power switch.
- If you detect any abnormality, immediately turn off the power and contact a qualified engineer.

Positioning Control

Manual number : JY992D89901
Manual revision : A
Date : July 2000

FAX BACK

Mitsubishi has a world wide reputation for its efforts in continually developing and pushing back the frontiers of industrial automation. What is sometimes overlooked by the user is the care and attention to detail that is taken with the documentation. However,to continue this process of improvement, the comments of the Mitsubishi users are always welcomed. This page has been designed for you,the reader,to fill in your comments and fax them back to us. We look for- ward to hearing from you.

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Thank you for taking the time to fill out this questionnaire. We hope you found both the product and this manual easy to use.

Introduction

This manual describes basic operation for those who learn positioning control for the first time, the aim being so that they can get training using demonstration units of Mitsubishi FA equipment.

The following relevant manuals are available and should be referred to

Manual Name	Number
FX-10GM/FX(E)-20GM Hardware and Programming manual	JY992D60401
FX-10GM Users Guide	JY992D68401
FX_{2N}-10GM/FX_{2N}-20GM Hardware and Programming manual	JY992D77801
FX2N-10GM Users Guide	JY992D77701
FX2N-20GM Users Guide	JY992D77601
FX-PCS-VPS Win-E Software Manual	JY992D86801
FX_{2N}-10GM/FX_{2N}-20GM Connection Manual	JY992D81601

1. The World of Positioning Control

1.1 Welcome to the new world!

The positioning controller, together with the programmable controller, personal computer and operator interface, is one of the four main units of FA (factory automation).

Among them, the positioning controller is important as the basis of FA, and regarded as the center of the mechatronics field in which many senior engineers have been playing active parts.

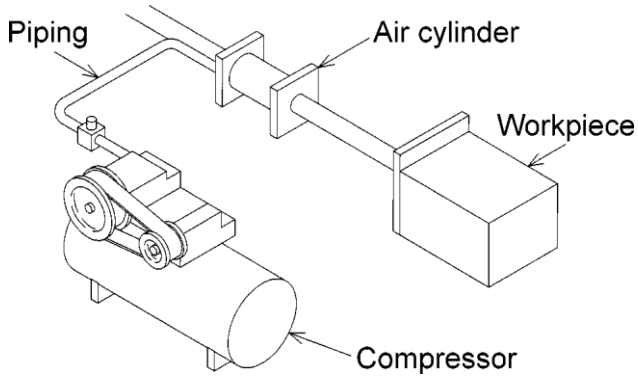
Positioning is all about motion, and motion often involves speed and precision. As speed can be related to productivity, it is an area of much development. But, when the machine speed increases, a problem with the stop precision is often generated. In order to solve this problem, diversified grades of position controllers have been required and developed.

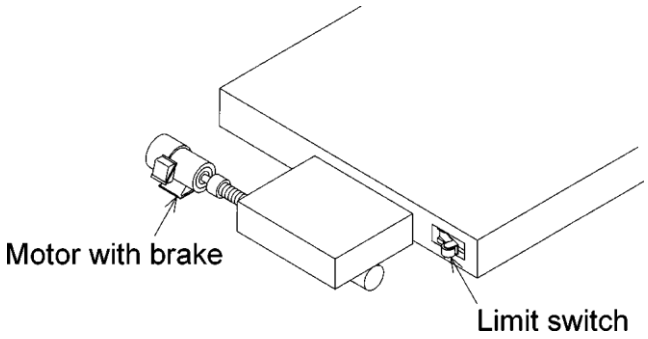
Improvement of the machine efficiency generates immeasurable added value, including reduction of labour and the machine floor area for the same quantity of production.

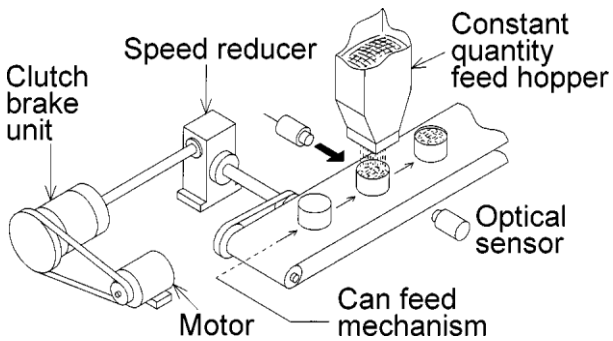
If there are no problems related to the positioning aspect of a machine, it may mean that the machine is not running most efficiently. Here is where the science of developing an optimum positioning control system comes in.

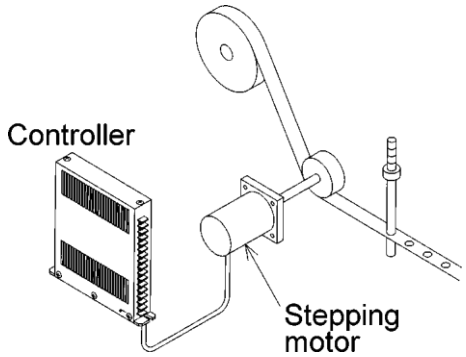
1.2 Diversified actuators

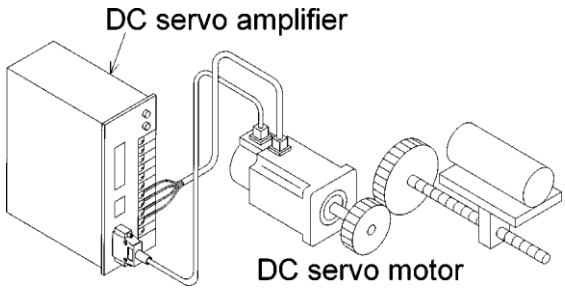
- A power source which moves an element in a system is called actuator. A unit which detects a position of a work piece or moving part is called sensor.
- Diversified actuators and sensors, from simple ones to enhanced ones, are used in positioning.
- This paragraph describes representative types, their features and weak points.

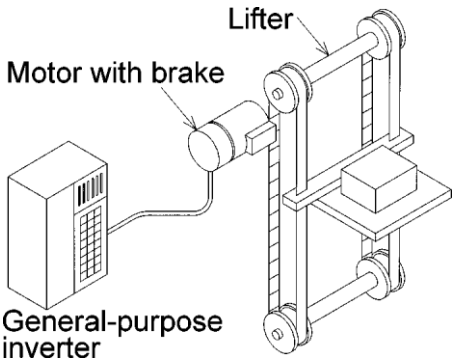
Pneumatic	
• Air source and high grade piping are required. • High torque is not available. • Multi-point positioning is complex and very difficult to achieve. • Change in positioning is difficult.	

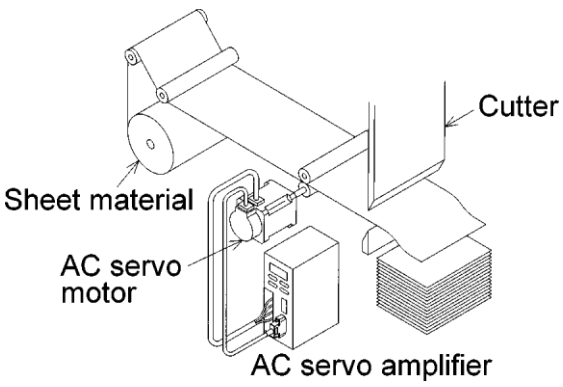
Brake motor	
• Positioning mechanism is simple. • Repeatability is poor. • Change in positioning is difficult. (When optical sensors or limit switches are used for stop)	

Clutch brake	
• Frequent positioning is available. • Life of friction plate is limited. • Change in positioning is difficult. (When optical sensors or limit switches are used for stop)	

Stepping motor	
• Positioning mechanism is simple. • If load is heavy, motor may step out and displacement can occur. • Motor capacity is small. • Precision is poor at high speed.	

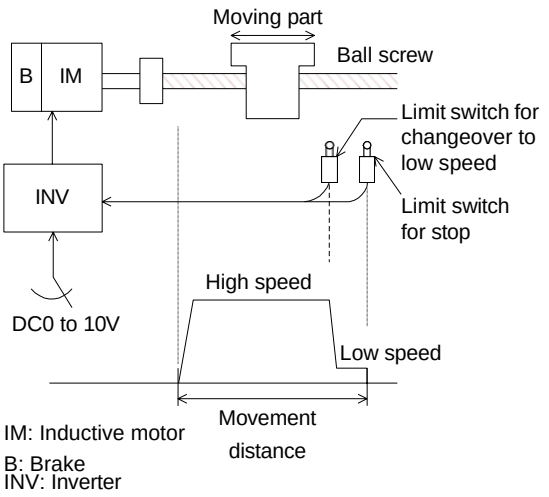
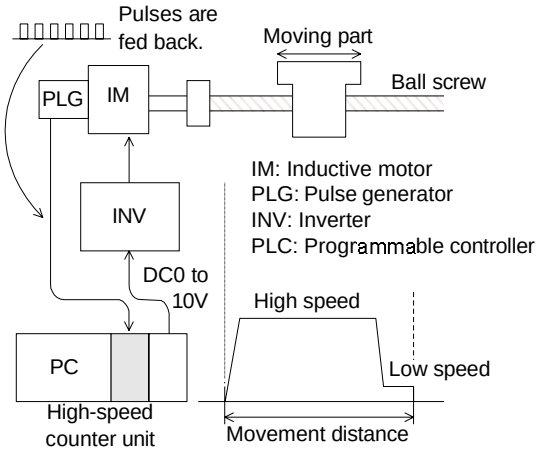
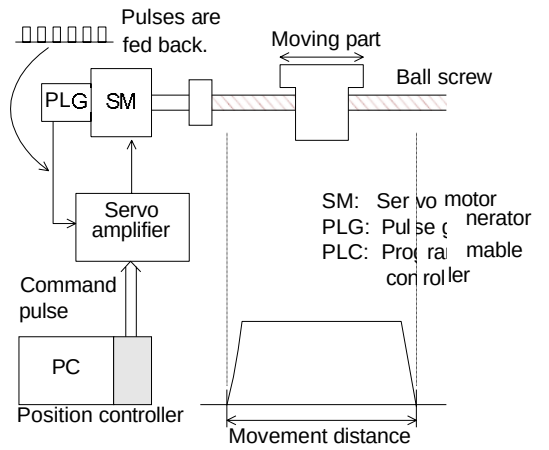
DC servo system	
• Positioning precision is good. • Maintenance is required for motor brushes. • It is not suitable for rotation at high speed.	

General purpose inverter and gener purpose motor	
• Multi-speed positioning is available using high-speed counter. • High precision positioning is not available. • Large torque is not available at start. (Specialized inverter is required)	

AC servo system	
• Precision is good. • Maintenance is not required. • Positioning address can be easily changed. • It is compact, and offers high power.	

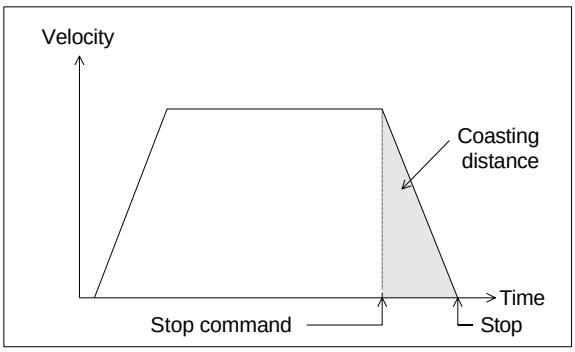
1.3 Positioning method type

1) There are three types of positioning method

Control method		Description	Schematic drawing
Speed control	**Limit switch method**	Two limit switches are provided in places where a systems moving part passes. At the first limit switch, the motor speed is reduced. At the second limit switch, the motor turns off and the brake turns on, to stop the moving part. In this method, because position controllers are not required, the system configuration can be realized at reasonable cost. (Guideline of stopping precision: Approximately ±1.0 to 5.0 mm)*	
	Pulse count method	A position detector (such as pulse encoder) is set up in a motor or rotation axis. The pulse number ge from the position detector is counted by a high-speed counter. When the pulse number reaches the preset value, the moving part stops. In this method, because limit switches are not used, the stop position can be easily changed.	
Position control	**Pulse command method**	An AC servo motor which rotates in proportion to the input pulse number is used as the drive motor. When the pulse number corresponding to the movement distance is input to the servo amplifier of the AC servo motor, positioning can be performed at high speed in proportion to the pulse frequency.	

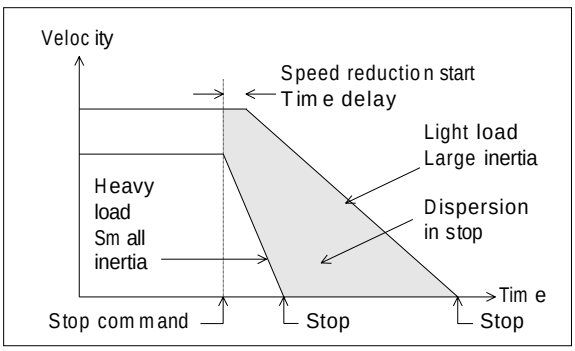
*1 The stop precision shows a value in a case where low speed is 10 to 100 mm/s.

2) Positioning method and stop precision

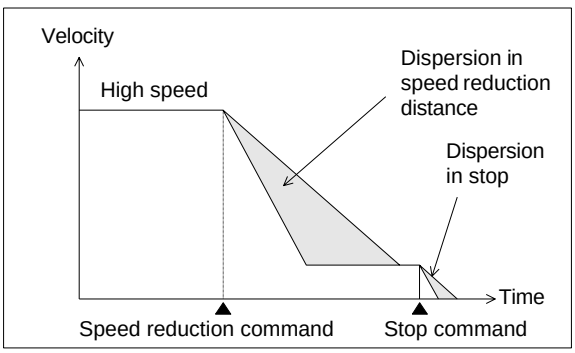


< Limit switch method >

- When automatically stopping a moving part driven by a motor, stop the motor by a position signal, detected by a limit switch (in general conditions, turn on the brake at the same time).
- The moving part continues by a coasting distance until it completely stops, after the stop command is given. The coasting distance is shaded in the figure.



- The stop precision is equivalent to the dispersion in the shaded area as shown in the figure on the left.
  The dispersion is affected by the speed when the stop command is given, the load size and the time delay since the stop command is given, until speed reduction actually starts.



- If the required stop precision is not satisfactory when stopping from the normal operation speed, the most effective method to improve the stop precision is to reduce the operation speed.
- However, if the operation speed is simply reduced, the machine efficiency may also be reduced. In actual operation, the motor speed can be reduced from high speed to low speed once, then the motor stopped.

< Pulse count method >

- When a pulse encoder is attached to a moving part, and the motor speed is controlled by a number steps while the pulse number is counted, the movement quantity per pulse is determined in accordance with the relationship between the pulse number generated by one rotation of the encoder, and the movement quantity of the moving part (workpiece) realized by one rotation of the motor. The movement quantity per pulse is regarded as the minimum unit for the stop command.
- However, the coasting distance at stop is not eliminated.

< Pulse command method >

- In this method using a servo system, the weak points described above are improved. A pulse encoder is attached to the servo motor, detecting the motor rotation quantity (workpiece movement distance), to continuously and directly control the speed from the high-speed operation to the target position, which allows the workpiece to stop with good precision.
- As the coasting distance at stop is eliminated, the positioning precision is improved.