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User's Manual

Positioning Modules (with Pulse Output)

IM 34M6H56-02E

Applicable Modules:

Model Code	Model Name
F3NC32-0N	Positioning Module (with Pulse Output)
F3NC34-0N	Positioning Module (with Pulse Output)

YOKOGAWA
Yokogawa Electric Corporation

IM 34M6H56-02E
2nd Edition

Applicable Product:

- **Range-free Multi-controller FA-M3**

  - Model code : F3NC32-0N, F3NC34-0N
  - Name : Positioning Module (with pulse output)

The document number and document model code for this manual are given below.

Refer to the document number in all communications; also refer to the document number or the document model code when purchasing additional copies of this manual.

- Document No. : IM 34M6H56-02E
- Document Model Code : DOCIM

Media No. IM 34M6H56-02E (YK) 2nd Edition : Jul., 2007 (AR)
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Important

■ About This Manual

- This Manual should be passed on to the end user.
- Before using the controller, read this manual thoroughly to have a clear understanding of the controller.
- This manual explains the functions of this product, but there is no guarantee that they will suit the particular purpose of the user.
- Under absolutely no circumstances may the contents of this manual be transcribed or copied, in part or in whole, without permission.
- The contents of this manual are subject to change without prior notice.
- Every effort has been made to ensure accuracy in the preparation of this manual. However, should any errors or omissions come to the attention of the user, please contact the nearest Yokogawa Electric representative or sales office.

■ Safety Precautions when Using/Maintaining the Product

- The following safety symbols are used on the product as well as in this manual.

Danger. This symbol on the product indicates that the operator must follow the instructions laid out in this instruction manual to avoid the risk of personnel injuries, fatalities, or damage to the instrument. Where indicated by this symbol, the manual describes what special care the operator must exercise to prevent electrical shock or other dangers that may result in injury or the loss of life.

Protective Ground Terminal. Before using the instrument, be sure to ground this terminal.

Function Ground Terminal. Before using the instrument, be sure to ground this terminal.

Alternating current. Indicates alternating current.

Direct current. Indicates direct current.

The following symbols are used only in the instruction manual.

WARNING

Indicates a “Warning”.

Draws attention to information essential to prevent hardware damage, software damage or system failure.

CAUTION

Indicates a “Caution”

Draws attention to information essential to the understanding of operation and functions.

TIP

Indicates a “TIP”

Gives information that complements the present topic.

SEE ALSO

Indicates a “SEE ALSO” reference.

Identifies a source to which to refer.

- For the protection and safe use of the product and the system controlled by it, be sure to follow the instructions and precautions on safety stated in this manual whenever handling the product. Take special note that if you handle the product in a manner other than prescribed in these instructions, the protection feature of the product may be damaged or impaired. In such cases, Yokogawa cannot guarantee the quality, performance, function and safety of the product.
- When installing protection and/or safety circuits such as lightning protection devices and equipment for the product and control system as well as designing or installing separate protection and/or safety circuits for fool-proof design and fail-safe design of processes and lines using the product and the system controlled by it, the user should implement it using devices and equipment, additional to this product.
- If component parts or consumable are to be replaced, be sure to use parts specified by the company.
- This product is not designed or manufactured to be used in critical applications which directly affect or threaten human lives and safety — such as nuclear power equipment, devices using radioactivity, railway facilities, aviation equipment, air navigation facilities, aviation facilities or medical equipment. If so used, it is the user’s responsibility to include in the system additional equipment and devices that ensure personnel safety.
- Do not attempt to modify the product.

■ Exemption from Responsibility

- Yokogawa Electric Corporation (hereinafter simply referred to as Yokogawa Electric) makes no warranties regarding the product except those stated in the WARRANTY that is provided separately.
- Yokogawa Electric assumes no liability to any party for any loss or damage, direct or indirect, caused by the use or any unpredictable defect of the product.

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■ General Requirements for Using the FA-M3 Controller

- **Avoid installing the FA-M3 controller in the following locations:**
  - Where the instrument will be exposed to direct sunlight, or where the operating temperature exceeds the range 0°C to 55°C.
  - Where the relative humidity is outside the range 10 to 90%, or where sudden temperature changes may occur and cause condensation.
  - Where corrosive or flammable gases are present.
  - Where the instrument will be exposed to direct mechanical vibration or shock.
  - Where the instrument may be exposed to extreme levels of radioactivity.

- **Use the correct types of wire for external wiring:**
  - Use copper wire with temperature ratings greater than 75°C.

- **Securely tighten screws:**
  - Securely tighten module mounting screws and terminal screws to avoid problems such as faulty operation.
  - Tighten terminal block screws with the correct tightening torque as given in this manual.

- **Securely lock connecting cables:**
  - Securely lock the connectors of cables, and check them thoroughly before turning on the power.

- **Interlock with emergency-stop circuitry using external relays:**
  - Equipment incorporating the FA-M3 controller must be furnished with emergency-stop circuitry that uses external relays. This circuitry should be set up to interlock correctly with controller status (stop/run).

- **Low impedance grounding:**
  - For safety reasons, connect the [FG] grounding terminal to a Japanese Industrial Standards (JIS) Class D Ground[*1] (Japanese Industrial Standards (JIS) Class 3 Ground). For compliance to CE Marking, use braided or other wires that can ensure low impedance even at high frequencies for grounding.

    *1 Japanese Industrial Standard (JIS) Class D Ground means grounding resistance of 100Ω max.

- **Configure and route cables with noise control considerations:**
  - Perform installation and wiring that segregates system parts that may likely become noise sources and system parts that are susceptible to noise. Segregation can be achieved by measures such as segregating by distance, installing a filter or segregating the grounding system.

- **Configure for CE Marking Conformance:**
  - For compliance to CE Marking, perform installation and cable routing according to the description on compliance to CE Marking in the “Hardware Manual” (IM34M6C11-01E).

■ Waste Electrical and Electronic Equipment

Waste Electrical and Electronic Equipment (WEEE), Directive 2002/96/EC

(This directive is only valid in the EU.)

This product complies with the WEEE Directive (2002/96/EC) marking requirement.

The following marking indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category

With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a “Monitoring and Control instrumentation” product.

Do not dispose in domestic household waste.

When disposing products in the EU, contact your local Yokogawa Europe B. V. office.

Introduction

■ Overview of the Manual

This manual describes the specifications and functions of the positioning modules (model F3NC32-0N and F3NC34-0N) to be installed in an I/O slot of the FA-M3, as well as information required for operating these modules.

■ Setup Tool for Positioning Modules

A setup tool is available for configuring the positioning modules. It allows a user to easily perform parameter setup, action testing and monitoring of the positioning modules using a windows interface.
For details on the setup tool, read ToolBox for Positioning Modules User's Manual (IM34M6Q31-01E)

■ Related Instruction Manuals

The manuals to be read depend on the CPU module to be used.
You should read the latest versions of the following instructions manuals, as required.

- **F3SP28, F3SP38, F3SP53, F3SP58, F3SP59**

  For information on sequence CPU functions, refer to:

  - Sequence CPU Instruction Manual - Functions (for F3SP28-3N/3S, F3SP38-6N/6S, F3SP53-4H/4S, F3SP58-6H/6S and F3SP59-7S) (IM34M6P13-01E)

  For information on sequence CPU instructions, refer to:

  - Sequence CPU Instruction Manual - Instructions (IM34M6P12-03E)

  For information on creating ladder programs, refer to:

  - FA-M3 Programming Tool WideField2 (IM34M6Q15-01E)

- **F3SP21, F3SP25, F3SP35, F3SP05, F3SP08**

  For information on sequence CPU functions, refer to:

  - Sequence CPU Instruction Manual - Functions (for F3SP21, F3SP25 and F3SP35) (IM34M6P12-02E)

  For information on sequence CPU instructions, refer to:

  - Sequence CPU Instruction Manual - Instructions (IM34M6P12-03E)

  For information on creating ladder programs, refer to:

  - FA-M3 Programming Tool WideField2 (IM34M6Q15-01E)

- **F3BP20, F3BP30**

  BASIC CPU Modules and YM-BASIC/FA Programming Language (IM34M6Q22-01E)

- **For specifications, functions and operation procedure of the ToolBox for Positioning Modules software:**

  - FA-M3 ToolBox Manual (IM34M6Q30-01E)
  - FA-M3 ToolBox for Positioning Modules (IM34M6Q31-01E)

- **For the FA-M3 specifications and configurations*[1], installation and wiring, test run, maintenance, and module installation restrictions for the whole system:**

  *1: Refer to the relevant product manuals for specifications except for power supply modules, base modules, input/output modules, cables and terminal units.

  - Hardware Manual (IM 34M6C11-01E)

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FA-M3

Positioning Module (with pulse output)

IM 34M6H56-02E 2nd Edition

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Revision Information i

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1. Overview

The F3NC32-0N and F3NC34-0N positioning modules are advanced I/O modules to be mounted onto the base module of an FA-M3 range-free controller. It generates a position control path according to commands from the CPU module and outputs position reference as pulse trains.

It comes in two models: F3NC32-0N and F3NC34-0N, which can simultaneously control up to two and four axes respectively.

With position reference pulse output, the module is suitable for driving servomotors or drivers, as well as stepper motors or drivers in position control applications.

1.1 Features

The module has the following features:

- **Fast and accurate positioning control**
  - High speed position reference pulse output at 5 Mpps max. for servomotors and 1 Mpps max. for stepper motors provides comfortable margin for driving linear, DD and other high speed, high precision motors.
  - Short startup time of 0.15 ms for one axis, and 0.5 ms for either four axes under linear interpolation or two axes under circular interpolation allows synchronization with high-speed peripheral devices.

- **Rich positioning control functions**
  - A full range of positioning control functions enable easy implementation of any positioning control application. Available positioning control modes include: position control (PTP, CP and indexing), speed control, speed control to position control switchover, and position control to speed control switchover. Interpolation systems include linear, circular and helical.
  - Two operation modes are provided: pattern operation and direct operation. Pattern operation uses preset action patterns for easier operation. Direct operation uses a ladder program to set up target position and target speed for each positioning action.

- **Pulse counter and general purpose I/O contacts**
  - A 5-Mpps pulse counter (supporting absolute encoders) is provided for each axis. As the pulse counter can serve as motor position feedback, the module can check the current position, detect position shift, and by itself implement closed-loop position control for increased positioning accuracy.
  - Six general-purpose inputs and three general-purpose outputs are provided for each control axis. When connected to a motor/driver, these I/O contacts can serve as various control signals: driver alarm, positioning completed, servomotor on, driver reset, etc.

- **Parameter setup, action monitoring and action testing using setup tool for positioning modules**
  - A setup tool known as “ToolBox for Positioning Modules (SF662-ECW)” is available for easier module configuration and debugging. It can be used to set up registered parameters, action patterns and position data, as well as perform action monitoring and testing.

1.2 Concept of Position Control

This positioning module generates a position control path according to commands (with specified target position, speed, acceleration/deceleration time, etc.) from the CPU module and outputs position reference values as pulse trains. The number of output pulses determines the angle through which a motor rotates and the frequency of output pulses determines the speed at which a motor rotates.

The module supplies control pulses to a servo motor/driver so that an axis is driven by a motor to a target position at a target speed in closed-loop control using the control pulses as reference and the encoder pulses as feedback.

In closed-loop control, the difference in pulse count between reference pulses and feedback pulses controls the behavior of a motor, that is, when the difference reduces, the motor slows down, and when the difference becomes zero, the motor stops.

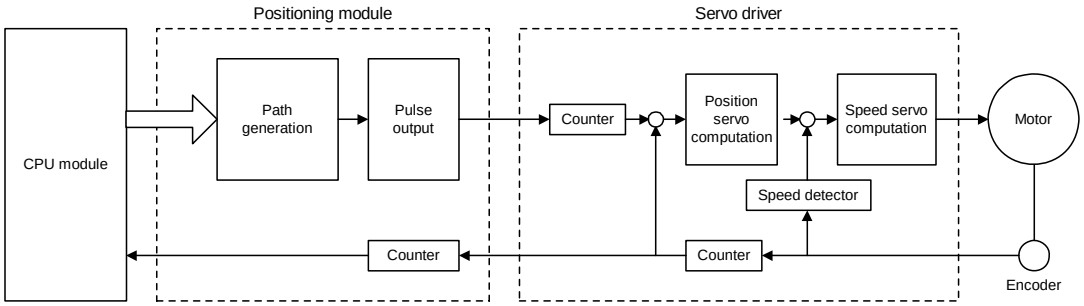


Figure 1.1 Operating Principle of Positioning Module

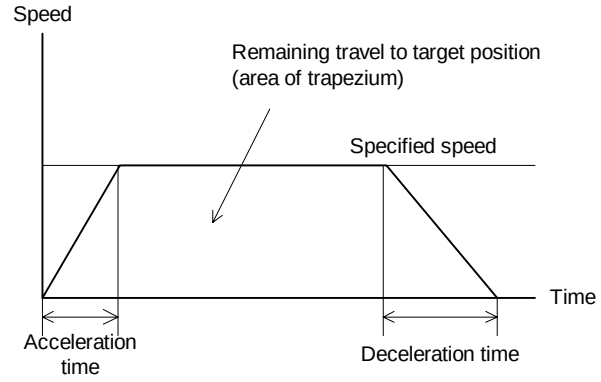


Figure 1.2 Path Generation

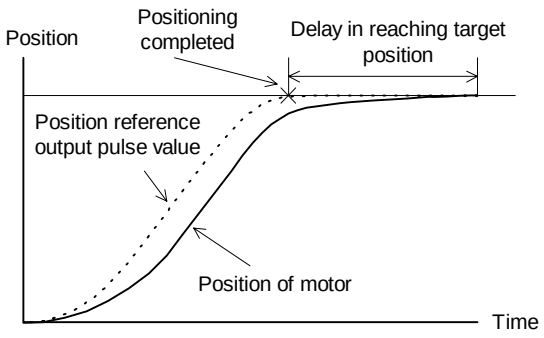


Figure 1.3 Position Reference Output Pulses and Servomotor Movement

DANGER

An external emergency stop circuit should be built in, according to the motor manufacturer's recommendations, for turning off the power supply and stopping the motor immediately if it operates in an unexpected manner due to machine fault or misoperation.

CAUTION

- When connecting a servomotor to the positioning module, choose a position-control servo driver. Speed-control or torque-control servo drivers cannot be used with the positioning module.
- The maximum pulse output rate is 1 Mpps for stepper motors. If the Maximum Speed Selection parameter is set to 5 Mpps for stepper motors, operation cannot be guaranteed.
- The module does not allow the startup speed to be specified when performing interpolated positioning. Therefore, interpolated positioning is not allowed for stepper motors that require startup speed to be specified.

1.3 Operation Mode

The positioning module provides two modes of operation: direct operation and pattern operation.

■ Direct Operation

In direct operation, the module dynamically controls the position, speed and acceleration/deceleration of axes according to real-time commands from the CPU module.

Direct operation is suitable for dynamic control applications where target position and speed are specified just in time based on external information (correction data from an image processing device, etc.), or target position and speed differ for each positioning action.

In direct operation mode, positioning actions can be coded using a program, thus enabling sophisticated operations such as change in target position or speed during positioning.

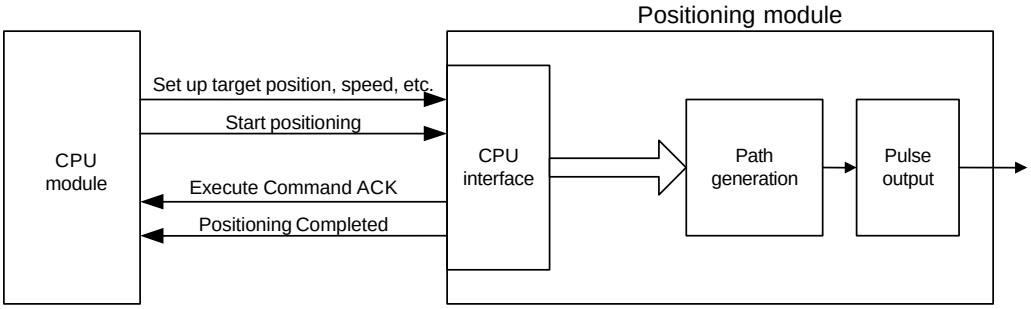


Figure 1.4 Direct Operation

■ Pattern Operation

In pattern operation, the module performs positioning according to pre-stored action patterns and position data. You can use a setup tool, ToolBox for Positioning Modules (SF662-ECW), to store the action patterns and position data in the module. In this type of operation mode, positioning can be initiated simply by specifying an action pattern number from the CPU module. Up to four action patterns can be executed concurrently.

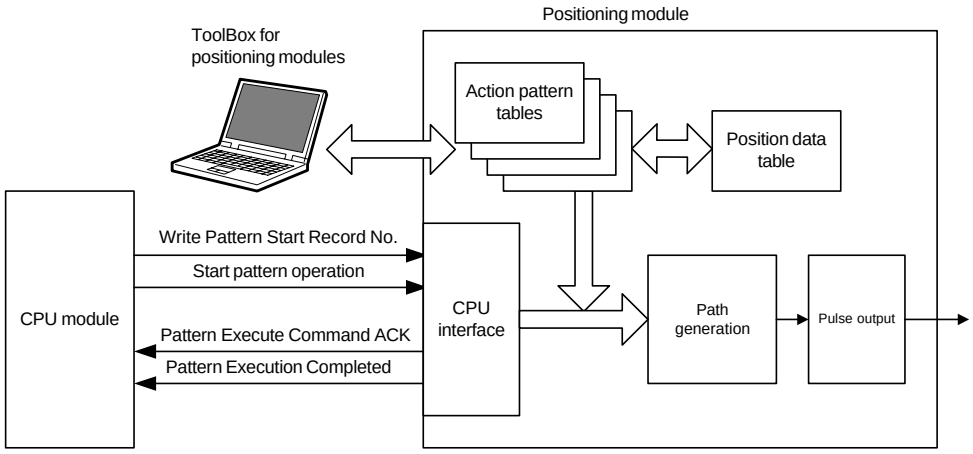


Figure 1.5 Pattern Operation

1.4 Control Mode

Three control modes are provided: position control mode, speed control mode and manual pulse generator mode. Available movements and functions differ in each mode so you should switch between these modes as required during operation.

Position control mode supports normal control and index control, which can be configured using axis registered parameters.

The following figure shows the control modes and available functions of the modules.

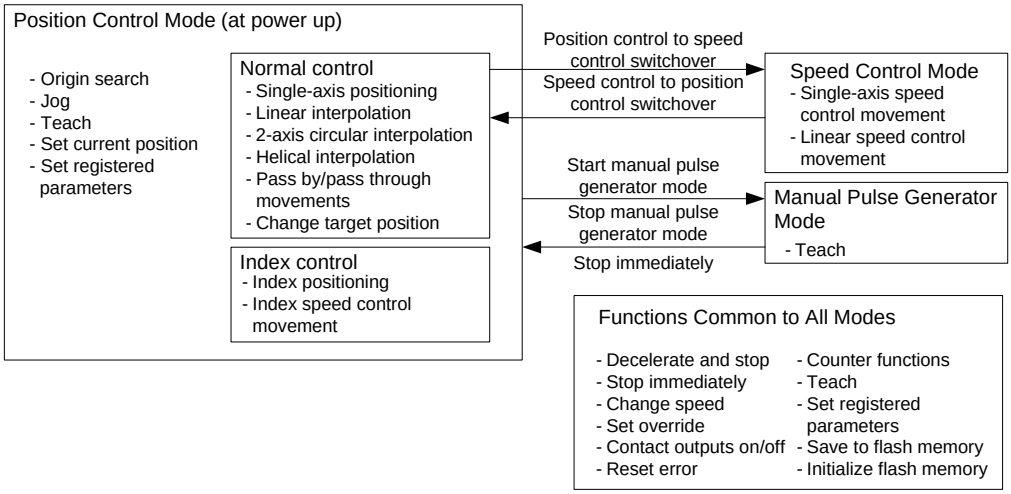


Figure 1.6 Control Modes and Available Functions

■ Position Control Mode

Position control moves individual axis or axes to a specified target position according to specified speed, acceleration time and deceleration. The module also supports continuous path movement (linear interpolation, circular interpolation, helical interpolation) whereby multiple axes move in tandem along an interpolated path, pass-by and pass-through movements whereby the axes continue to the next target position, passing by or passing through but without stopping at the original target position, as well as change in target position during positioning. In addition, the module can be configured to perform index positioning within a specified index range (e.g. 0 to 360°) taking the shortest path. All axes default to position control mode when the module is powered on.

■ Speed Control Mode

Speed control moves a set of axes in the same direction according to a specified speed, acceleration time or deceleration time. The specified speed can be changed during speed control movement, if required.

You can use the Position Control to Speed Control command and the Speed Control to Position Control command to switch between position control mode and speed control mode.

You can switch from speed control to position control even during speed control movement to bring a set of axes to a specified target position.

■ Manual Pulse Generator (MPG) Mode

A manual pulse generator can be connected to the module to manually operate a motor in manual pulse generator mode.

You can switch from position control mode to MPG mode using a Start Manual Pulse Generator Mode command, and then switch back to position control mode using a Stop Manual Pulse Generator Mode command or a Stop Immediately action.

1.5 ToolBox for Positioning Modules (SF662-ECW)

ToolBox for Positioning Modules (SF662-ECW) is a Windows software tool for configuring positioning modules. After connecting the FA-M3 and a PC using RS-232-C, Ethernet or FL-net, you can use the ToolBox software to set up registered parameters, action patterns and position data for a positioning module, run action tests, perform action monitoring and perform tuning. The ToolBox software can be run concurrently with the FA-M3 Programming Tool WideField2 software (SF620-ECW).

For details on the specifications, function and usage of the ToolBox for Positioning Modules (SF662-ECW) software, see the “FA-M3 ToolBox Manual” (IM34M6Q30-01E) and “FA-M3 ToolBox for Positioning Modules User’s Manual” (IM34M6Q31-01E).

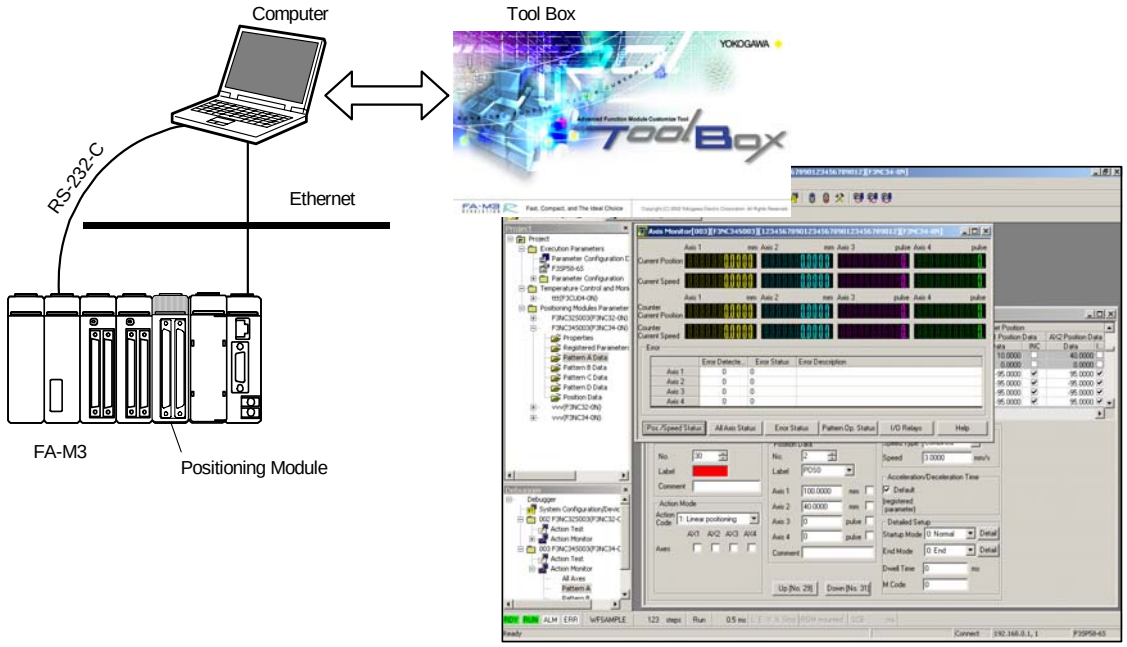


Figure 1.7 ToolBox for Positioning Modules (SF662-ECW)

CAUTION

The ToolBox for Positioning Modules (SF662-ECW) software is intended for short-term monitoring and operation of positioning modules for the purpose of tuning. It should not be used and is not guaranteed to work properly as an operation control panel for extended operation in a production environment.

2. Specification

2.1 Models and Suffix Codes

Table 2.1 Models and Suffix Codes

Model	Suffix Code	Style Code	Option code	Description
F3NC32	-0N	–	–	2-axis control, 5 Mpps (for driving servo motor)/1 Mpps (for driving stepper motor) pulse rate, 2 counters for input from encoder (including absolute encoder), PTP and CP (linear and circular interpolation), direct and pattern operation
F3NC34	-0N	–	–	4-axis control, 5 Mpps (for driving servo motor)/1 Mpps (for driving stepper motor) pulse rate, 4 counters for input from encoder (including absolute encoder), PTP and CP (linear, circular, and helical interpolation), direct and pattern operation

2.2 Compatible CPU Modules

The modules are compatible with the following CPU modules.

Table 2.2 Compatible CPU Modules

CPU Modules	Style Code and ROM Rev
F3SP28-3N F3SP38-6N F3SP53-4H F3SP58-6H	Rev.7 or higher
Other CPU modules	Any

2.3 General Specifications

Table 2.3 General Specifications

Item		Specifications	
		F3NC32-0N	F3NC34-0N
Control	Number of controlled axes	2	4
	Control method	Open-loop control using position reference pulse output	
	Output pulse type	RS-422A compliant differential line driver (AM26C31 or equivalent); Pulse type selectable for each axis: CW/CCW pulse, travel/direction pulse, and phase A/phase B pulse	
	Output pulse rates	- Using servo motor / - Using stepper motor CW/CCW: 5,000,000 (pulse/s) / 1,000,000 (pulse/s) Travel/direction : 5,000,000 (pulse/s) / 1,000,000 (pulse/s) Phase A/B (x4) : 5,000,000 (pulse/s) / 1,000,000 (pulse/s) Phase A/B (x2) : 2,500,000 (pulse/s) / 500,000 (pulse/s) Phase A/B (x1) : 1,250,000 (pulse/s) / 250,000 (pulse/s)	
Counter	Number of channels	2	4
	Input pulse type	- Incremental encoder (phase A/B) - Absolute encoder (See Section 2.4, "Compatible Absolute Encoders" for details)	
	Input pulse rate	Phase A/B (x 4) : 5,000,000 (pulse/s) Phase A/B (x 2) : 2,500,000 (pulse/s) Phase A/B (x 1) : 1,250,000 (pulse/s)	
External contact input		6 inputs per axis (origin input, forward limit input, reverse limit input, driver alarm input, external trigger input, and general-purpose input 6); 1 emergency stop input	
External contact output		3 outputs per axis (deviation pulse clear signal, general output 2 and general output 3), and 1 SEN signal per axis	
Positioning functions	Units of measurement	mm, degrees and pulses	
	Control modes	Position control (PTP, CP and index); Speed control, position control to speed control switchover, and speed control to position control switchover	
	Interpolation modes	Single axis movement; 2-axis linear interpolation; 2-axis circular interpolation	Single axis movement; 2-, 3-, and 4-axis linear interpolation; 2-axis circular interpolation, 3- and 4-axis helical interpolation
	Operation modes	Pattern operation and direct operation	
	Pattern operation	PTP movement, CP normal movement, CP pass-by movement, and CP pass-through movement; Number of action pattern records: 2000 max. (500 actions each for 4 patterns) Number of position data records: 2000 max per axis	
	Position reference	Absolute/incremental position reference -2,147,483,648 to 2,147,483,647 (pulses) -214,748.3648 to 214,748.3647 (mm) -21,474.83648 to 21,474.83647 (degrees)	
	Speed reference	1 to 5,000,000 (pulses/s) 0.0001 to 214,748.3647 (mm/s) 0.00001 to 21,474.83647 (degree/s)	
	Acceleration/deceleration curve	Automatic trapezoidal acceleration/deceleration (configurable startup speed); Automatic S-shape acceleration/deceleration (startup speed not configurable)	
	Acceleration/deceleration time	0 to 32,767 (configurable independently for acceleration and deceleration)	
	Others	Change in target position during movement Change in target speed during movement	
Origin search		Two types of automatic origin search; Manual origin search (any combination of external contact inputs may be used)	
Manual operation		Jog operation and manual pulse generator mode	
Other functions		Electronic gear, teaching, current position setup; M code output, override, software limit switch; Counter coincidence or zone coincidence detection	
Data backup		Flash ROM (100,000 times rewritable)	
Startup time*1		0.15 ms for single axis positioning 0.16 ms for 2-axis linear interpolation 0.41 ms for 2-axis circular interpolation	0.15 ms for single axis positioning 0.17 ms for 4-axis linear interpolation 0.41 ms for 2-axis circular interpolation
Current consumption (at 5 V DC)		450 mA	540 mA
External power supply (24 V DC)		80 mA	120 mA
External wiring		One 48-pin connector	Two 48-pin connectors
External dimensions		28.9 (W) x 100 (H) x 83.2 (D) mm*2	
Weight		160 g	180g

*1: Up to 1 ms delay may be added if another axis is in motion.

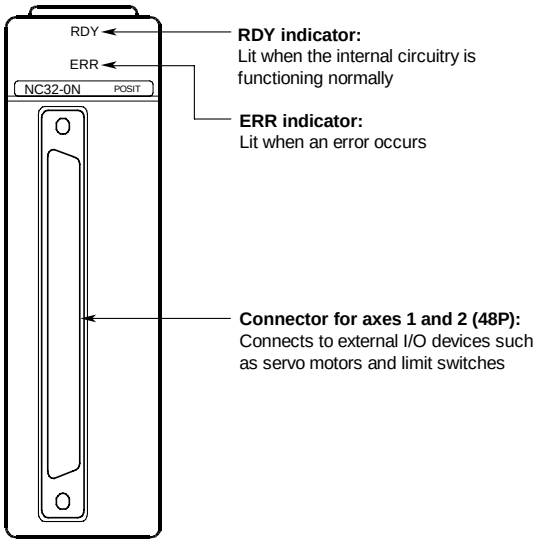
*2: Not including protrusions (see the external dimension diagram for details)

2.4 Compatible Absolute Encoders

- **Absolute encoders from Yaskawa Electric or equivalent:**
  - Yaskawa Electric's Σ-III and Σ-II series for AC servo motor drive
- **Absolute encoders (1 Mbps, Manchester coding) from SANYO Electric or equivalent:**
  - SANYO Electric's ABS-E and ABS-RII absolute sensors (installed with RA062M) for use with the Q-series and P-series AC servo systems

2.5 Components and Their Functions

- **F3NC32-0N (with 2 axes)**



- **F3NC34-0N (with 4 axes)**

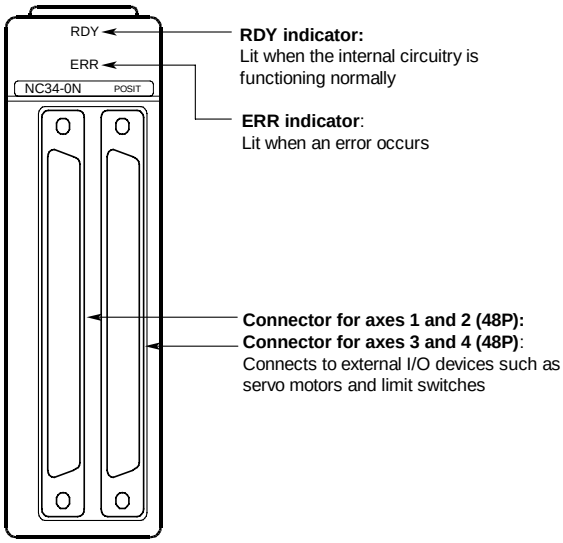


Figure 2.1 Front View of F3NC32-0N and F3NC34-0N Modules

2.6 External Dimensions

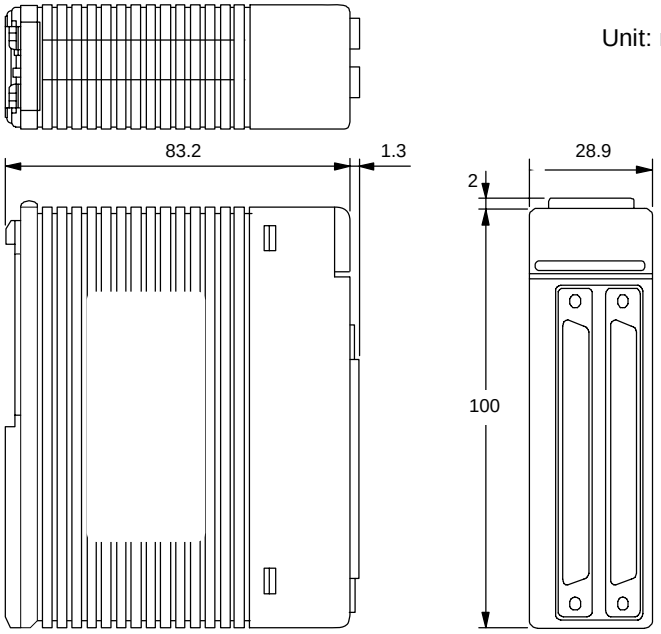


Figure 2.2 External Dimensions Diagram

2.7 Compatible External Interface Connectors

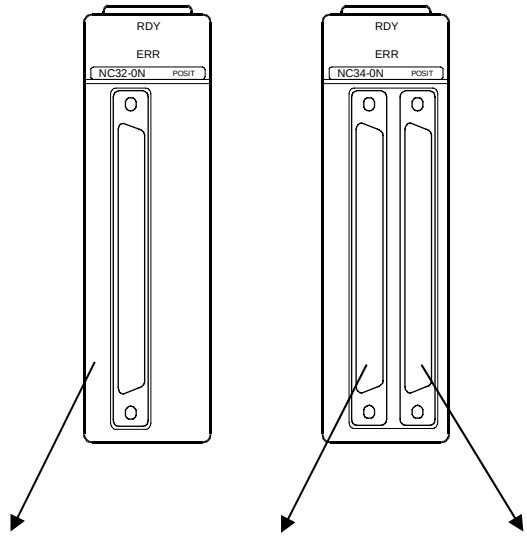
Table 2.4 Compatible External Interface Connectors

Connection	Compatible Connector	Remarks
Soldered	FCN-361J048-AU connector, and FCN-360C048-B connector cover from Fujitsu Limited	To be purchased separately.
Crimp-on	FCN-363J048 housing, FCN-363J-AU contacts, and FCN-360C048-B connector cover from Fujitsu Limited	
Pressure-welded	FCN-367J048-AU/F from Fujitsu Limited	

2.8 External Connection Diagram

The external connection diagram is shown below. For details on external connection signals, see Chapter 11, "Connections and Wiring".

Table 2.5 External Connection Diagram



24b	Axis 2 counter Phase B Input (-)	24a	Axis 1 counter Phase B Input (-)
23b	Axis 2 counter Phase B Input (+)	23a	Axis 1 counter Phase B Input (+)
22b	Axis 2 counter Phase A Input (-)	22a	Axis 1 counter Phase A Input (-)
21b	Axis 2 counter Phase A Input (+)	21a	Axis 1 counter Phase A Input (+)
20b	Axis 2 encoder Z-phase input (-)	20a	Axis 1 encoder Z-phase input (-)
19b	Axis 2 encoder Z-phase input (+)	19a	Axis 1 encoder Z-phase input (+)
18b	Axis 2 SEN signal output	18a	Axis 1 SEN signal output
17b	Axis 2 SEN signal output (GND)*1	17a	Axis 1 SEN signal output (GND)*1
16b	Axis 2 general output 3*4	16a	Axis 1 general output 3*4
15b	Axis 2 general output 2*4	15a	Axis 1 general output 2*4
14b	Axis 2 deviation pulse clear output *4	14a	Axis 1 deviation pulse clear output *4
13b	Contact input COM*2	13a	Contact input COM*2
12b	Axis 2 general input 6*4	12a	Axis 1 general input 6*4
11b	Axis 2 external trigger input *4	11a	Axis 1 external trigger input *4
10b	Axis 2 driver alarm input *4	10a	Axis 1 driver alarm input *4
9b	Axis 2 reverse limit input *4	9a	Axis 1 reverse limit input *4
8b	Axis 2 forward limit input *4	8a	Axis 1 forward limit input *4
7b	Axis 2 origin input *4	7a	Axis 1 origin input *4
6b	Axis 2 pulse output B (-) (CCW/direction/phase B)	6a	Axis 1 pulse output B (-) (CCW/direction/phase B)
5b	Axis 2 pulse output B (+) (CCW/direction/phase B)	5a	Axis 1 pulse output B (+) (CCW/direction/phase B)
4b	Axis 2 pulse output A (-) (CW/travel/phase A)	4a	Axis 1 pulse output A (-) (CW/travel/phase A)
3b	Axis 2 pulse output A (+) (CW/travel/phase A)	3a	Axis 1 pulse output A (+) (CW/travel/phase A)
2b	Emergency stop input (GND)*3	2a	Emergency stop input *3
1b	24-V external power supply input (GND)*3	1a	24-V external power supply input *3

24b	Axis 4 counter Phase B Input (-)	24a	Axis 3 counter Phase B Input (-)
23b	Axis 4 counter Phase B Input (+)	23a	Axis 3 counter Phase B Input (+)
22b	Axis 4 counter Phase A Input (-)	22a	Axis 3 counter Phase A Input (-)
21b	Axis 4 counter Phase A Input (+)	21a	Axis 3 counter Phase A Input (+)
20b	Axis 4 encoder Z-phase input (-)	20a	Axis 3 encoder Z-phase input (-)
19b	Axis 4 encoder Z-phase input (+)	19a	Axis 3 encoder Z-phase input (+)
18b	Axis 4 SEN signal output	18a	Axis 3 SEN signal output
17b	Axis 4 SEN signal output (GND)*1	17a	Axis 3 SEN signal output (GND)*1
16b	Axis 4 general output 3*4	16a	Axis 3 general output 3*4
15b	Axis 4 general output 2*4	15a	Axis 3 general output 2*4
14b	Axis 4 deviation pulse clear output *4	14a	Axis 3 deviation pulse clear output *4
13b	Contact input COM*2	13a	Contact input COM*2
12b	Axis 4 general input 6*4	12a	Axis 3 general input 6*4
11b	Axis 4 external trigger input *4	11a	Axis 3 external trigger input *4
10b	Axis 4 driver alarm input *4	10a	Axis 3 driver alarm input *4
9b	Axis 4 reverse limit input *4	9a	Axis 3 reverse limit input *4
8b	Axis 4 forward limit input *4	8a	Axis 3 forward limit input *4
7b	Axis 4 origin input *4	7a	Axis 3 origin input *4
6b	Axis 4 pulse output B (-) (CCW/direction/phase B)	6a	Axis 3 pulse output B (-) (CCW/direction/phase B)
5b	Axis 4 pulse output B (+) (CCW/direction/phase B)	5a	Axis 3 pulse output B (+) (CCW/direction/phase B)
4b	Axis 4 pulse output A (-) (CW/travel/phase A)	4a	Axis 3 pulse output A (-) (CW/travel/phase A)
3b	Axis 4 pulse output A (+) (CW/travel/phase A)	3a	Axis 3 pulse output A (+) (CW/travel/phase A)
2b	*5	2a	*5
1b	24-V external power supply input (GND)*3	1a	24-V external power supply input*3

*1: SEN signal output (GND) pins for all axes are connected internally. They may be used as the GND pin for pulse outputs.

*2: Contact input COM pins for all axes are connected internally (even across different connectors).

*3: The single emergency stop input and 24-V external power supply input are used for all axes. The 24-V external power supply input pins are connected together internally across different connectors.

*4: I/O contacts can be configured as normally-open (NO contact) or normally-closed (NC contact) using registered parameters for each axis.

Origin input, forward limit input, reverse limit input, driver alarm input, and external trigger input may be configured as general inputs, while deviation pulse clear output may be configured as a general output using registered parameters for each axis. There are some restrictions on the specifications of contact inputs. Be sure to check contact inputs against the CAUTION given in Chapter 11 (Subsection 11.2.4, “External Contact Inputs”) before use.

*5: Absolutely do not wire these pins.

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3. Function Overview

This chapter provides an overview of the main functions of the positioning modules. Tables 3.1 lists the main functions.

Table 3.1 List of Main Functions

● Position Control

Function	Description	See Also
Single-axis positioning	Performs single-axis positioning in normal position control mode.	3-2
Interpolated positioning	Performs linear interpolation, circular interpolation and helical interpolation.	3-3
Pass-by and pass-through movements	Executes the next positioning action without stopping movement, passing by or passing through the current target position.	3-5
Changing target position during positioning	Changes target position during positioning.	3-6
Changing speed during positioning	Changes speed during positioning.	3-6
Index control	Performs positioning within an index range. Shortest path control is available.	3-7

● Speed Control

Function	Description	See Also
Speed control movement	Executes movement in speed control mode, moving in the same direction.	3-8
Changing speed during speed control movement	Changes speed during speed control movement.	3-8
Speed control to position control switchover	Switches from speed control mode to position control mode to move to a target position.	3-9
Position control to speed control switchover	Switches from position control mode to speed control mode.	3-9

● Origin Search

Function	Description	See Also
Automatic origin search	Performs automatic origin search using external contact inputs according to preset values of axis registered parameters.	3-10
Manual origin search	Performs customized origin search using external contact inputs according to a program.	3-12

● Manual Control

Function	Description	See Also
Jog	Operates a motor manually. This function is useful when performing teaching.	3-13
Manual pulse generator mode	Operates a motor manually using a manual pulse generator.	3-14

● Counter Functions

Function	Description	See Also
Read encoder feedback	Reads encoder feedback when the encoder of a servomotor or driver is connected to a counter input.	3-15
Counter/zone coincidence detection	Detects an event when the current position of a counter coincides with a preset counter value or falls within a preset range.	3-16

● Other Functions

Function	Description	See Also
External contact input/output	Inputs external contact signals such as emergency stop input, limit switch input and origin input, or outputs deviation pulse clear signal.	3-17
Electronic gear function	The electronic gear function can be used to convert current position, target position and specified speed data into actual mechanical travel or speed.	3-18
M code function	The M code function can be used to suspend a pattern execution, which can then be resumed by an instruction from the CPU module after an external machine has completed its processing.	3-19
Teach function	Writes current position, counter current position or entered numerical data to a position data table.	3-19
Set override	Changes the override value, which is used to scale specified speed data of positioning actions by 1 to 500 (%).	3-20
Set current position	Changes the current position or counter current position of an axis at rest.	3-20
Saving & initializing parameters	Saves parameter values to flash memory or initializes flash memory	3-21

3.1 Position Control

3.1.1 Single-axis Positioning

Single-axis positioning moves an axis to a specified target position using specified speed and acceleration time and deceleration time.

A target position may be specified as an absolute value or an incremental value.

The acceleration/deceleration curve for an axis may be specified as automatic trapezoidal or S-shaped. Acceleration time and deceleration time may be set independently. With automatic trapezoidal acceleration and deceleration, you can also specify a startup speed.

Axis movement may be configured to start immediately after command execution or wait to be triggered by an external event.

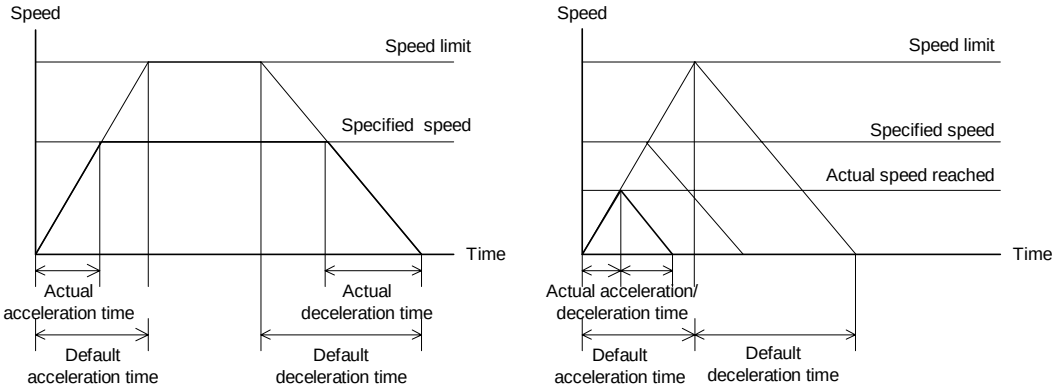


Figure 3.1 Positioning Movement Using Automatic Trapezoidal Acceleration and Deceleration

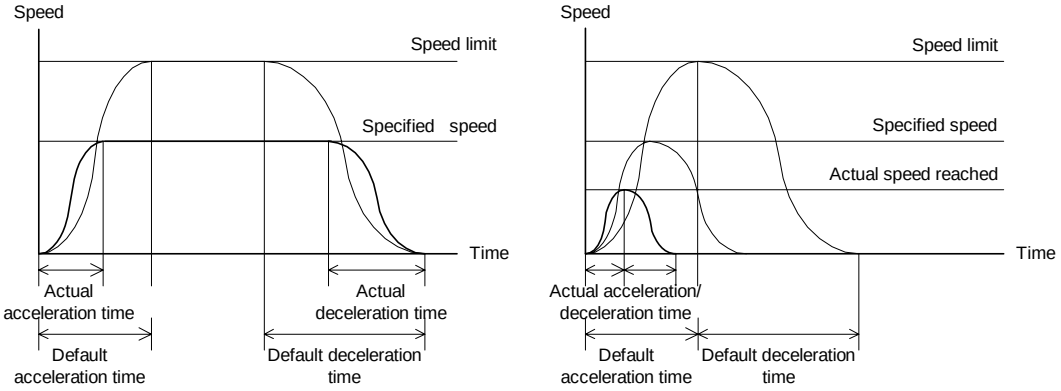


Figure 3.2 Positioning Movement Using Automatic S-shape Acceleration and Deceleration

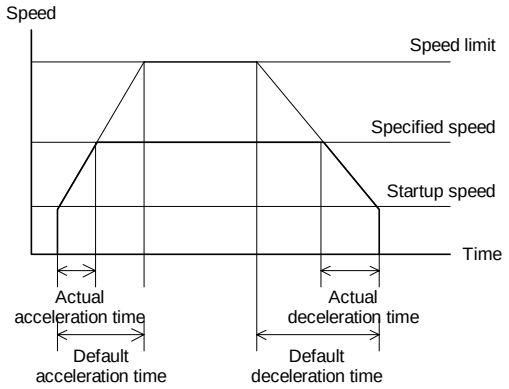


Figure 3.3 Positioning Movement When a Startup Speed is Specified

3.1.2 Interpolated Positioning

Interpolated positioning moves multiple axes in tandem to reach a target position by following a path obtained using interpolation. The module supports 2-, 3-, and 4-axis linear interpolation, 2-axis circular interpolation, as well as 3- and 4-axis helical interpolation.

A target position may be specified as an absolute value or an incremental value.

The speed of the interpolation movement can be specified using combined speed or axis speed. Combined speed in 2-axis circular or helical interpolation is measured along the tangential line of the circular or helical path.

The acceleration/deceleration curve for an axis may be specified as automatic trapezoidal or S-shaped. Acceleration time and deceleration time may be set independently.

Axis movement may be configured to start immediately after command execution or wait to be triggered by an external event.

Interpolation movement cannot be specified with a non-zero startup speed. Any specified startup speed will be ignored.

- **Linear Interpolation Using 2, 3 or 4 Axes**

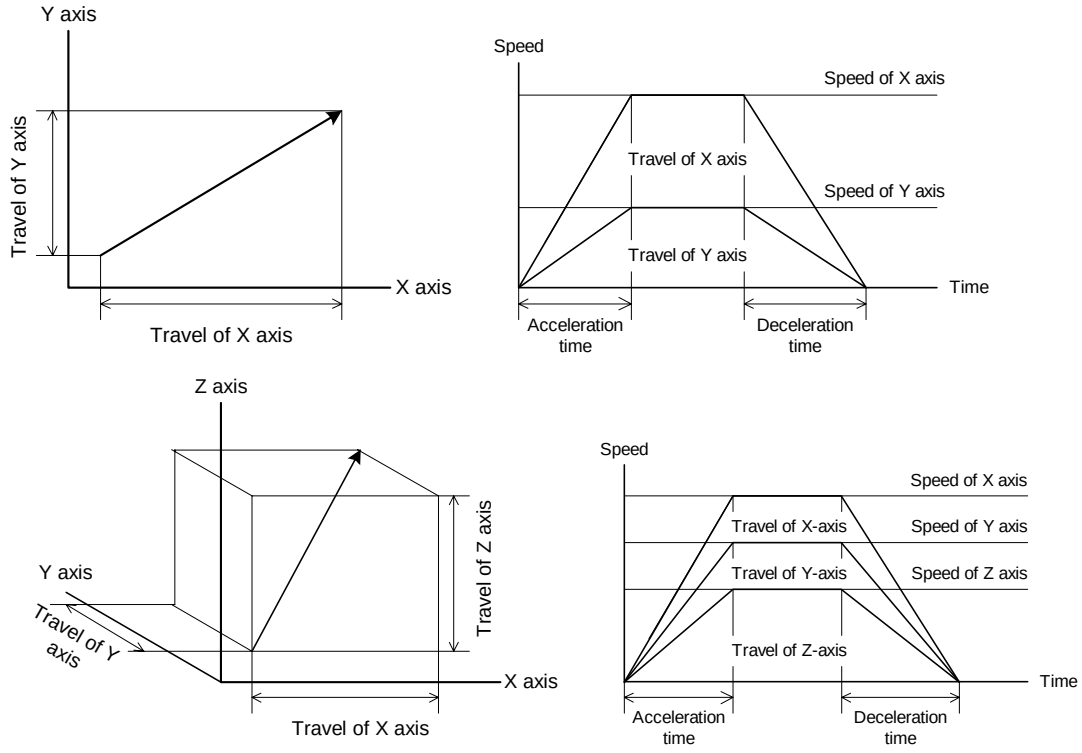


Figure 3.4 Examples of 2-axis and 3-axis Linear Interpolation

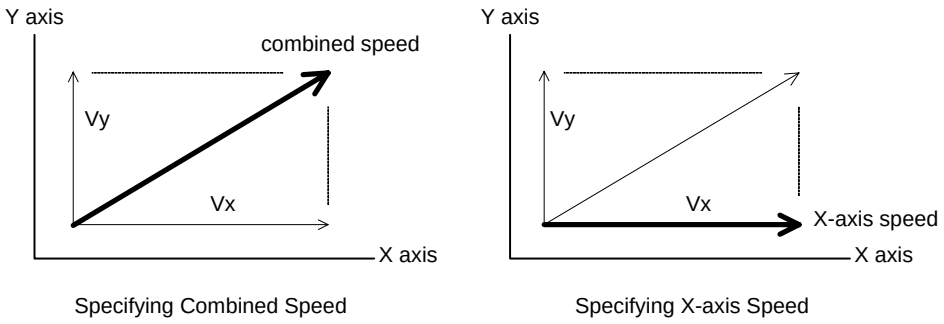


Figure 3.5 Examples of 2-axis Linear Interpolation with Specified Speed

2-axis Circular Interpolation (using sub point, CW using center, CCW using center)

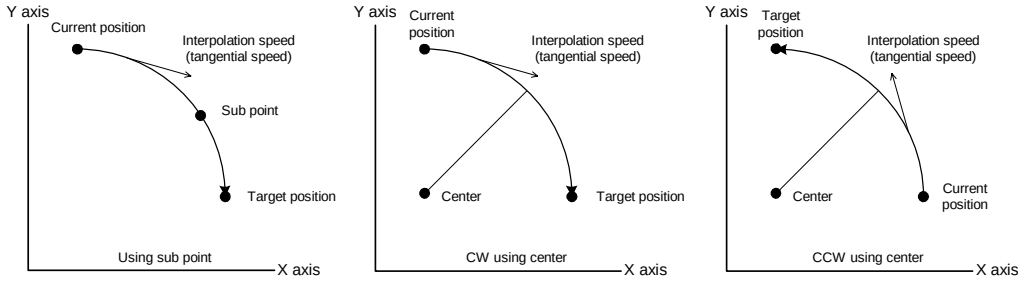


Figure 3.6 Circular Interpolation (using sub point, CW using center, CCW using center)

3-axis or 4-axis Helical Interpolation (CW using center, CCW using center)

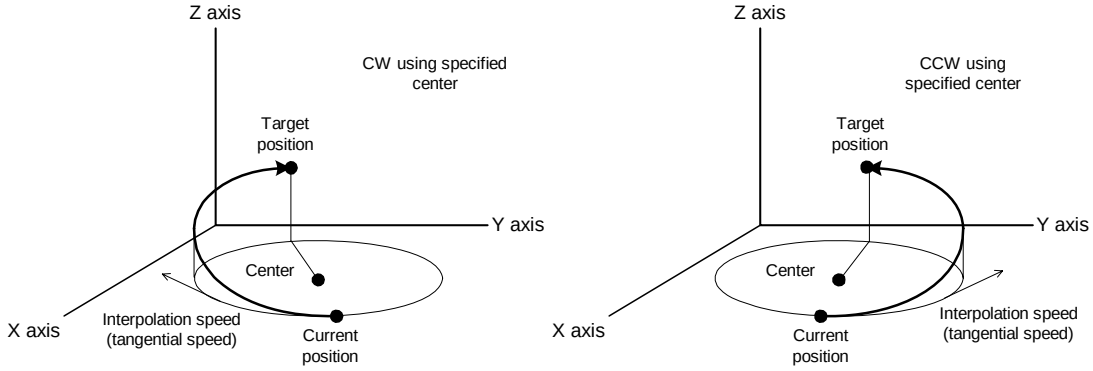


Figure 3.7 Helical Interpolation (CW using center, CCW using center)

3.1.3 Pass-by and Pass-through Movements

In pattern operation, two successive positioning actions may be combined so that axes do not stop between actions but moves continuously, passing by or passing through the first target position. Pass-by and pass-through movements are useful for collision prevention or tack time reduction. The actions to be combined may be in different directions.

Pass-by and pass-through movements are only allowed in pattern operation but not in direct operation.

In direct operation, pass-by movement can be implemented by changing the target position during positioning (see Section 3.1.4).

- **Normal Movement**

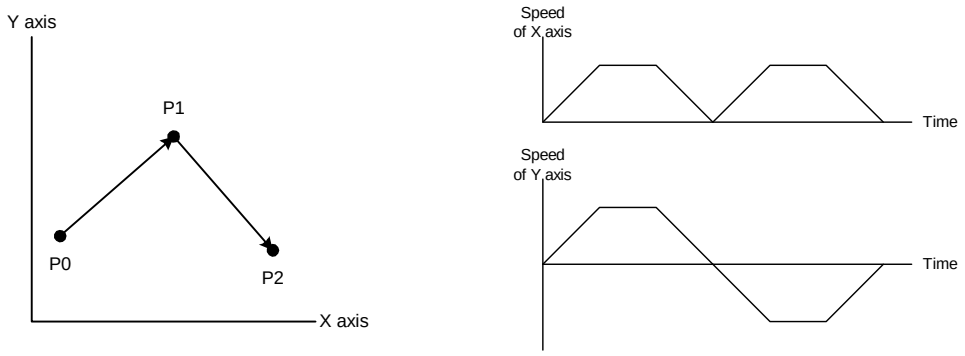


Figure 3.8 Path and Speed for Normal Movement

- **Pass-by Movement**

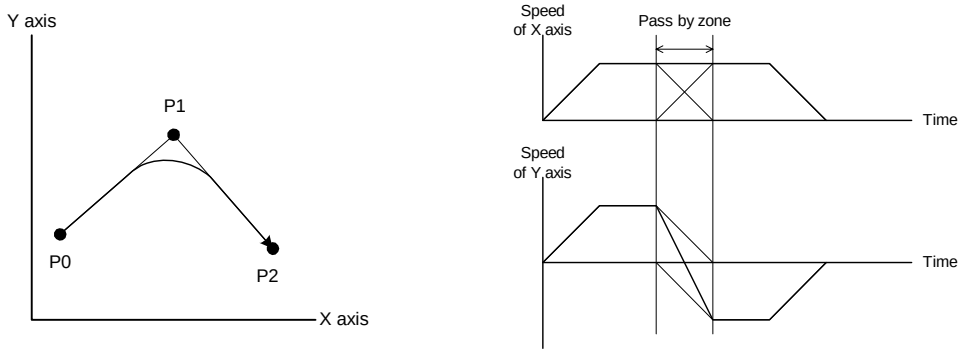


Figure 3.9 Path and Speed for Pass-by Movement

- **Pass-through Movement**

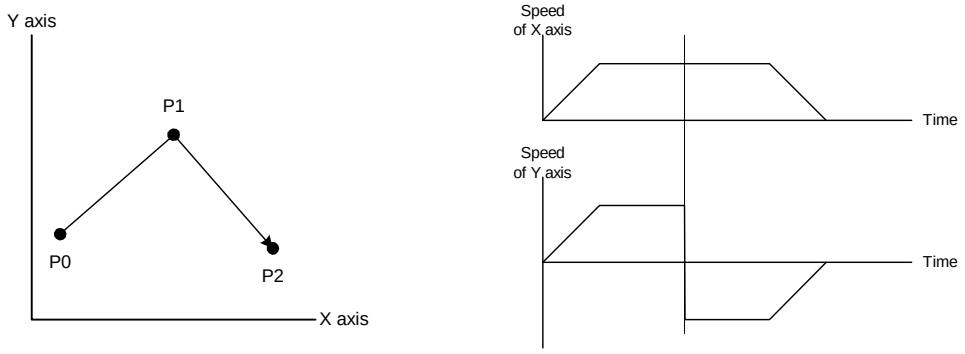


Figure 3.10 Path and Speed for Pass-through Movement

3.1.4 Changing Target Position during Positioning

In direct operation, the target position, as well as the specified speed, acceleration time and deceleration time, may be changed during positioning. The change in target position can be in a different direction.

Changing target position during positioning is only allowed in direct operation.

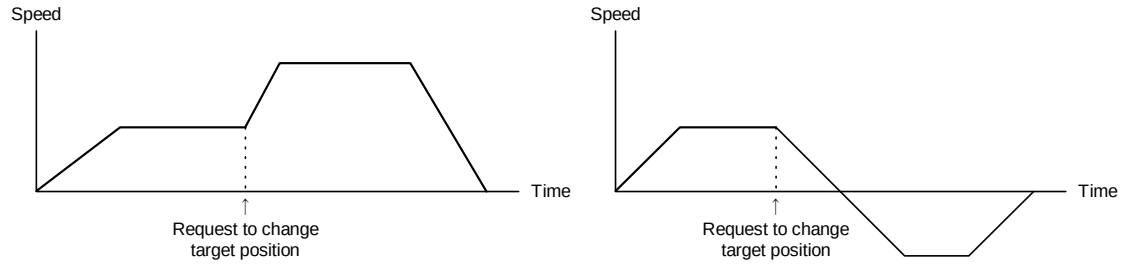


Figure 3.11 Speed When Target Position Is Changed during Positioning (using single-axis positioning as example)

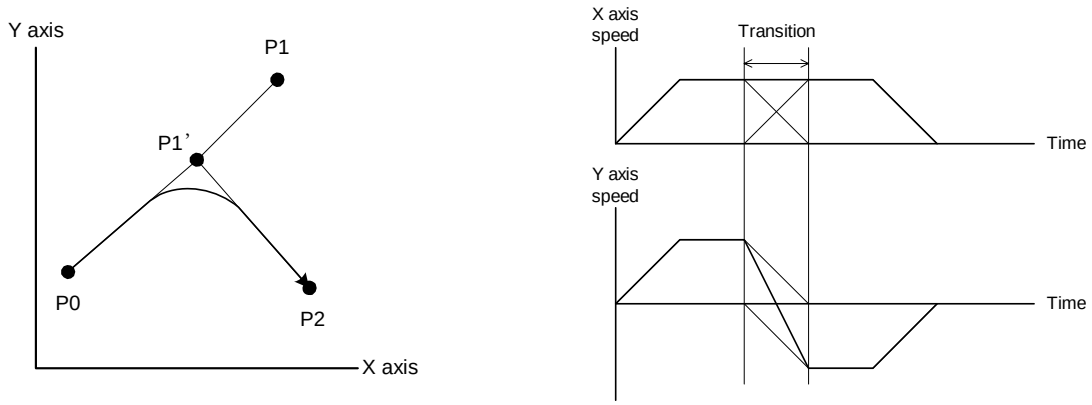


Figure 3.12 Path and Speed When Target Position Is Changed during Positioning (using 2-axis linear interpolation as example)

3.1.5 Changing Speed during Positioning

In direct operation, the specified speed, as well as the acceleration time and deceleration may be changed during positioning.

Changing specified speed during positioning is only allowed in direct operation.

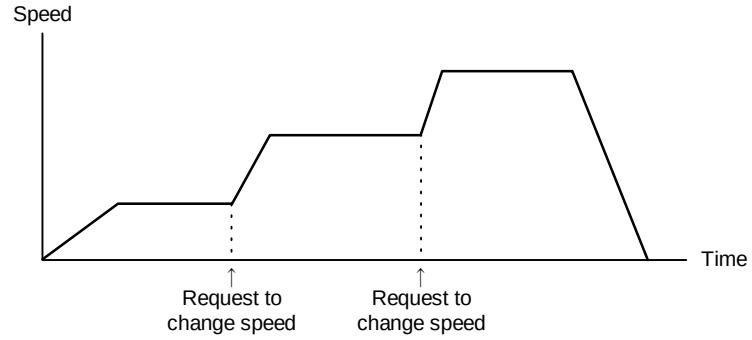


Figure 3.13 Changing Speed during Positioning

3.1.6 Index Control

In index control, current and target positions are handled as ring data that assumes values from zero to a specified index range (0-360° in the example shown below).

An axis must be configured for index control with a preset index range using axis registered parameters.

A target position may be specified as an absolute value or an incremental value. If an absolute target position is specified, an axis rotates in either CW or CCW direction to reach the target position taking the shorter path (shortest path control). An axis can be made to rotate beyond one revolution by specifying multiple increment target positions.

Index positioning can also be initiated during index speed control movement of an axis started with only a specified speed to move the axis to a specified target position.

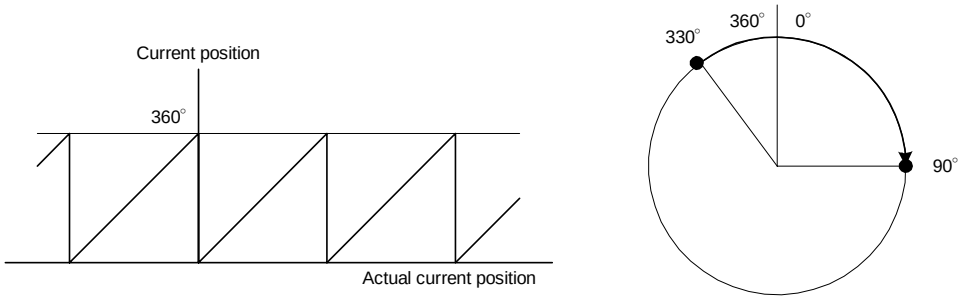


Figure 3.14 Index Control Movement (example with index range of 0 to 360°)

3.2 Speed Control

3.2.1 Speed Control Movement

Speed control moves a set of axes in the same direction according to a specified speed, acceleration time or deceleration time.

Before performing speed control movements, the axes must first be switched from position control to speed control. The acceleration/deceleration curve for an axis may be specified as automatic trapezoidal or S-shaped. Acceleration time and deceleration time may be set independently.

Axis movement may be configured to start immediately after command execution or wait to be triggered by an external event.

3.2.2 Changing Speed during Speed Control Movement

The specified speed, as well as acceleration time and deceleration time, may be changed during speed control movement. The change in speed, however, cannot be in a different direction.

To change the direction of movement, first stop the axes and then start speed control movement with a new specified speed in another direction.

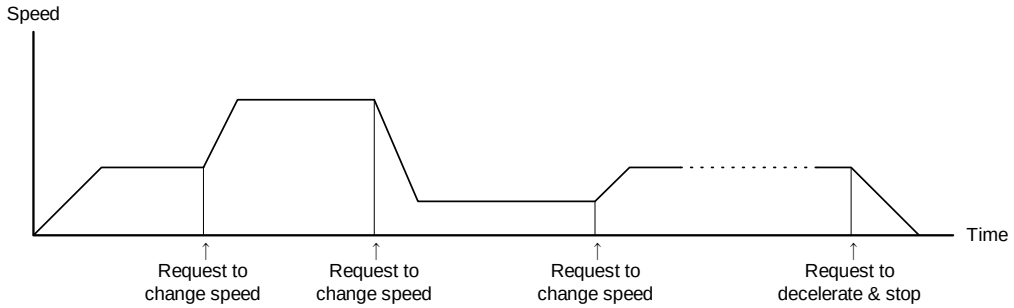


Figure 3.15 Speed Control Movement with Changes in Specified Speed

3.2.3 Speed Control to Position Control Switchover

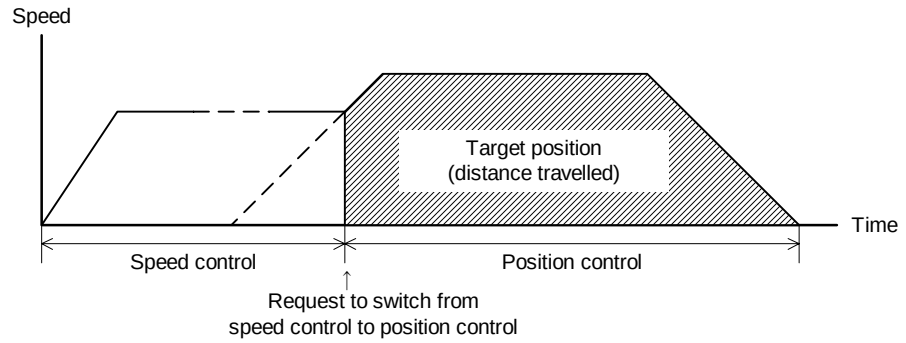
During speed control movement, axes can be switched from speed control mode to position control mode to be moved to a new target position.

The target position may be specified as an absolute value or an incremental value. You can choose to reset the current position to zero at the time of control switchover or continue with the current position values.

The acceleration/deceleration curve for an axis may be specified as automatic trapezoidal or S-shaped. Acceleration time and deceleration time may be set independently.

Control switchover may be configured to take place immediately after command execution, or wait to be triggered by an external event, such as external trigger input, external trigger input and Z-phase input, counter coincidence detection, or zone coincidence detection. When the Encoder Z-phase input is used as a trigger, you can specify the Z-phase edge and Z-phase search count.

- **When Z-phase Input is Not Used**



- **When Z-phase Input is Used (Z-phase rising edge is to be detected twice)**

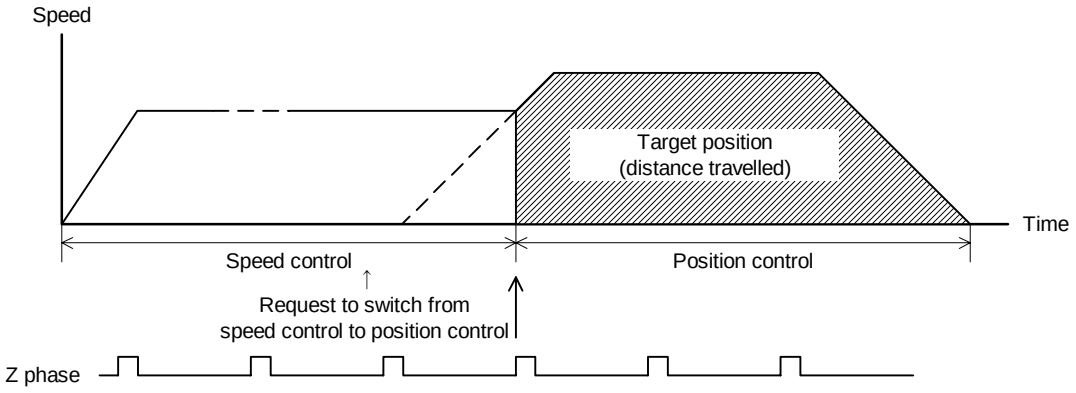


Figure 3.16 Speed Control to Position Control Switchover

3.2.4 Position Control to Speed Control Switchover

This command switches from position control mode to speed control mode to prepare for execution of speed control movements.

3.3 Origin Search

There are two ways to perform origin search: automatic and manual. In automatic origin search, the origin search behavior is defined by axis registered parameters. In manual origin search, the origin search behavior is arbitrarily defined by an application program.

3.3.1 Automatic Origin Search

Before performing automatic origin search, you need to first set up registered parameters associated with automatic origin search (AOS).

The module searches for the origin automatically using the external switches according to these registered parameters values, and then enters Z-phase search.

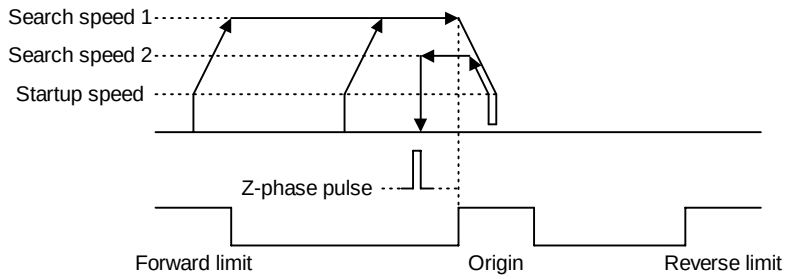
In Z-phase search, the module counts the number of Z-phase pulses defined by the AOS Z-phase Search Count parameter, and then stops the axis immediately. The stop position, after adjustment by the AOS Offset parameter, is taken as the origin. The module then outputs a deviation pulse clear signal for a duration defined by the AOS Deviation Pulse Clear Time parameter.

Automatic origin search may be configured using the AOS Mode axis registered parameter to use or to not use the origin switch, in addition to using the forward and reverse limit switches.

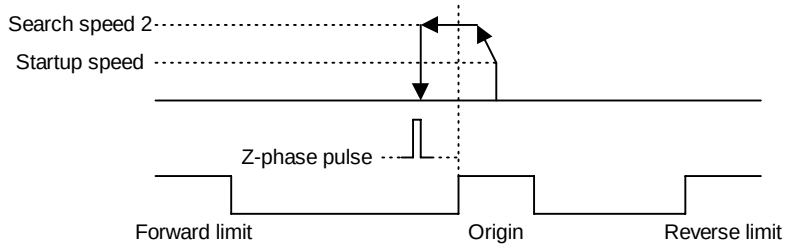
For details on automatic origin search, see Section 6.7.1, "Automatic Origin Search".

- **Automatic Origin Search (AOS mode 0: using origin switch)**

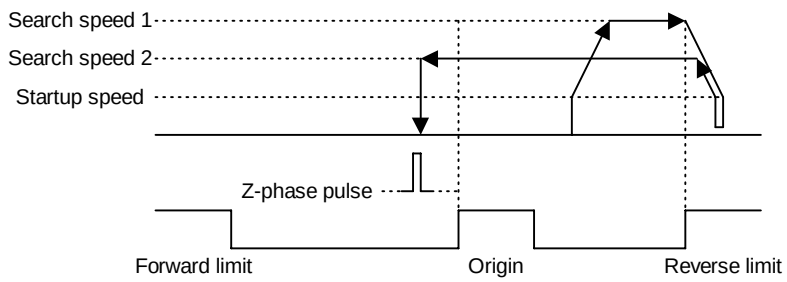
  - Starting with axis in the forward direction of Origin Input



  - Starting with Origin Input turned on



  - Starting with axis between Origin Input and Reverse Limit Input



- Starting with Reverse Limit Input turned on

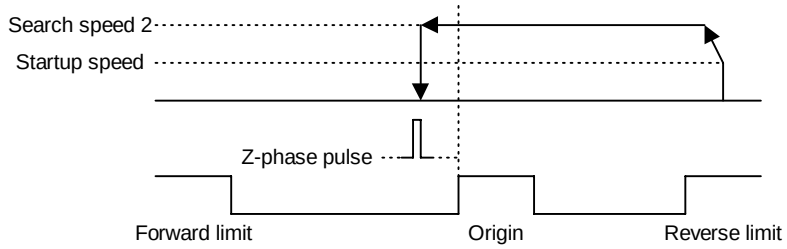
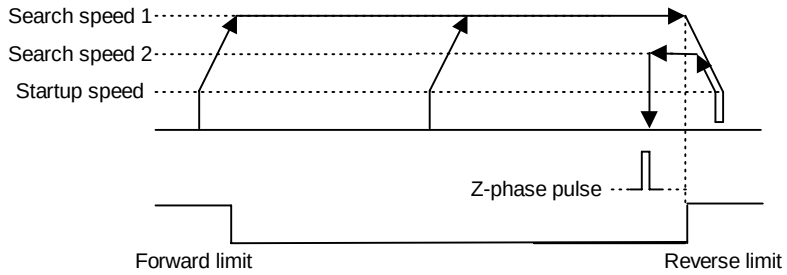


Figure 3.17 Automatic Origin Search Movement (reverse direction search with AOS mode=0)

● Automatic Origin Search (AOS mode 1: not using origin switch)

- Starting with Reverse Limit Input turned off



- Starting with Reverse Limit Input turned on

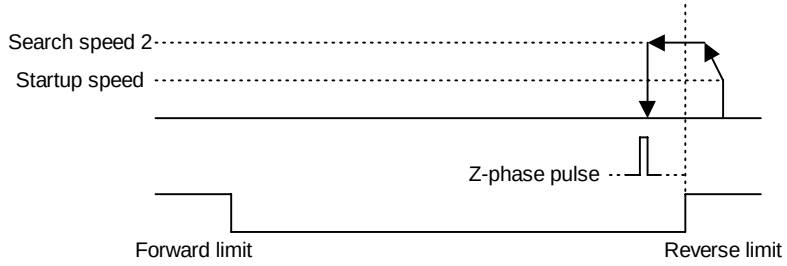


Figure 3.18 Automatic Origin Search Movement (reverse direction search with AOS mode=1)

3.3.2 Manual Origin Search

In manual origin search, the module searches for the origin according to the axis command parameter values as it detects changes in external contact inputs. When the required change is detected, it either stops or shifts to Z-phase search.

If configured to perform Z-phase search, the module counts the number of Z-phase pulses defined by the Z-phase Search Count parameter, and then stops the axis immediately. The stop position is taken as the origin. The module then outputs a deviation pulse clear signal for a duration defined by the Deviation Pulse Clear Time parameter. It does not output a deviation pulse clear signal if Z-phase Search Count is set to zero.

If origin search must be carried out at different speeds or in different directions depending on the status of the external contact inputs, it may be divided into two or more phases, each executed by a Manual Origin Search command using different sets of parameters. Such customization allows the origin search to be carried out in any preferred way.

For details on manual origin search, see Section 6.7.2, "Manual Origin Search".

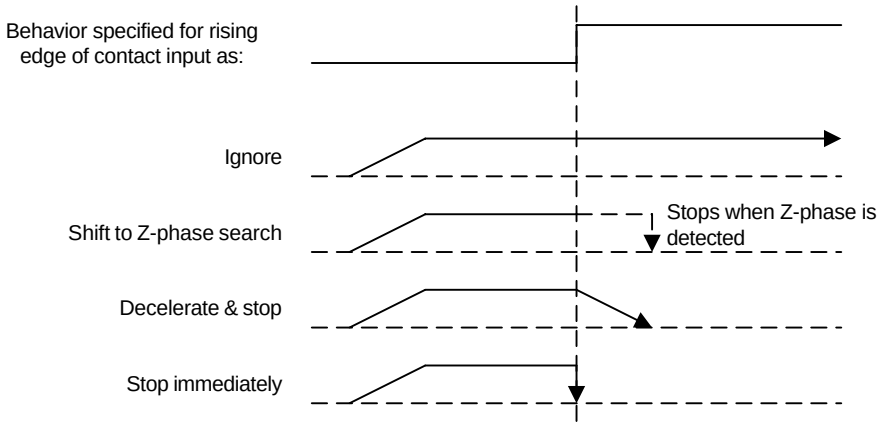


Figure 3.19 Manual Origin Search Movement

3.4 Manual Control

3.4.1 Jog

You can use the jog operation to move a motor manually.

You can specify the speed, acceleration time and deceleration time before jogging, or even change the speed during jogging.

Forward limit errors and reverse limit errors, if any, are ignored during jogging. A pulse overflow error, however, will be generated if movement exceeds the movement range of the positioning module (except when under index control).

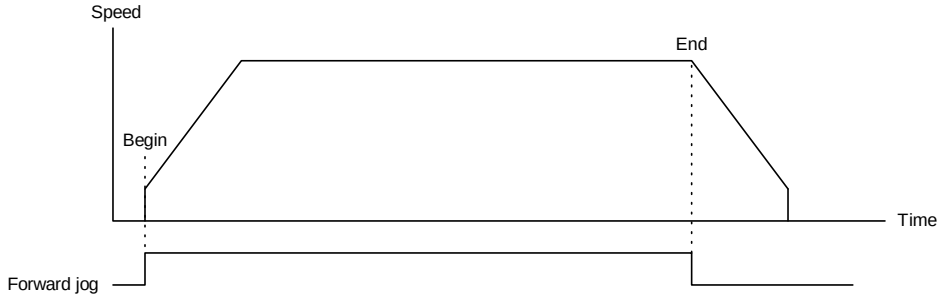


Figure 3.20 Jog Movement (forward jog using automatic trapezoidal acceleration/deceleration curve)

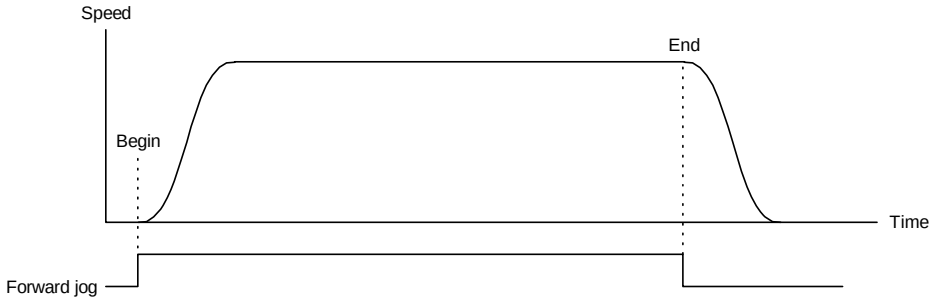


Figure 3.21 Jog Movement (forward jog using S-shape acceleration/deceleration curve)

3.4.2 Manual Pulse Generator (MPG) Mode

You can manually operate a motor for testing or other purposes by connecting a manual pulse generator to any of the counter inputs (2 channels for F3NC32-0N and 4 channels for F3NC34-0N) and using the Start Manual Pulse Generator Mode command.

The mapping between a pulse count from a manual pulse generator and the travel of an axis can be specified using the MPG Mode Multiplication and MPG Decimal Point parameters within a range of 1/10,000 to 32,767 times.

As MPG mode is configured independently for each axis, you can manually operate two axes at the same time using two manual pulse generator inputs, or operate multiple axes using a single manual pulse generator input.

Movement speed is limited by the Specified Speed parameter in MPG mode. Any input pulses exceeding the specified speed are stored and output when the speed falls below the specified speed.

Forward limit errors and reverse limit errors, if any, are ignored during jogging. A pulse overflow error, however, will be generated if movement exceeds the movement range of the positioning module (except when under index control).

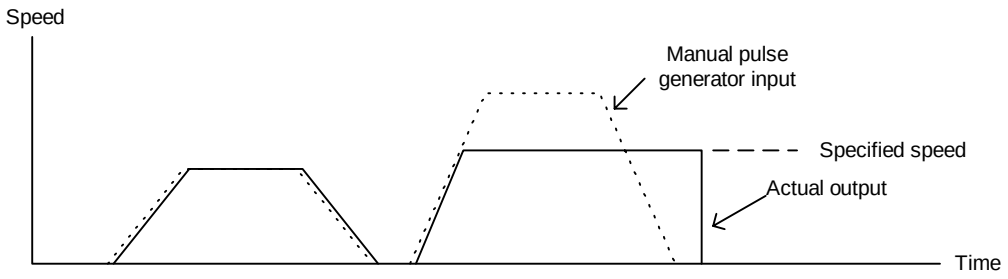


Figure 3.22 Manual Pulse Generator (MPG) Mode

CAUTION

Do not switch to MPG mode if the encoder feedback of a servomotor is connected to a counter input, or the motor may not operate as expected.

3.5 Counter Functions

3.5.1 Read Encoder Feedback

The positioning module contains two (for F3NC32-0N) or four (for F3NC34-0N) counter inputs for absolute encoders, which are capable of counting pulses at 5 Mpps max. By connecting a servo motor encoder to a counter input, you can read feedback pulses from the encoder.

The following encoders may be connected to these counters:

- General-purpose incremental encoder (Phase A/B output)
- Absolute encoder from Yaskawa Electric, or equivalent
- Absolute encoder with 1-Mpps Manchester encoding from Sanyo Electric, or equivalent.

By reading encoder feedback pulses through the counters, the module can be used to perform semi-closed-loop position control with added capabilities such as current position checking, positioning detection, absolute position correction and offline teaching. If you use an absolute encoder to provide feedback pulses, you can implement a positioning system requiring no origin search.

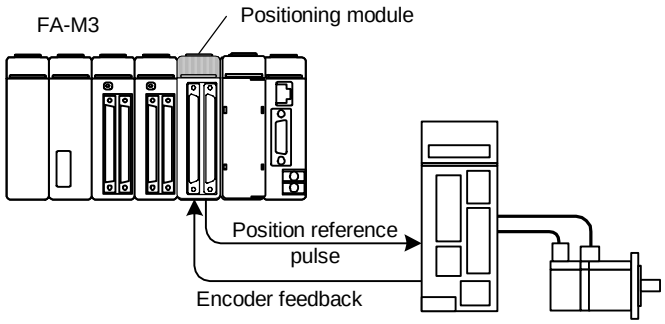


Figure 3.23 Reading Encoder Feedback Pulses

3.5.2 Counter/Zone Coincidence Detection

A counter can be configured to generate an event when the counter current position coincides with a preset value or falls within a preset range. The event can be used to trigger a positioning action waiting to start or raise an interrupt signal to the CPU module.

The counter usage (counter coincidence or zone coincidence), coincidence value, upper and lower limits can be preset using axis registered parameters, and be changed subsequently using the Counter Setup command.

The Counter/Zone Coincidence Detected input relay turns on when the specified counter condition is true. Turning on the Reset Counter Coincidence output relay clears the input relay.

Counter input of the positioning module is implemented by software, and a maximum delay of 1 ms may occur.

● Counter Coincidence Detection

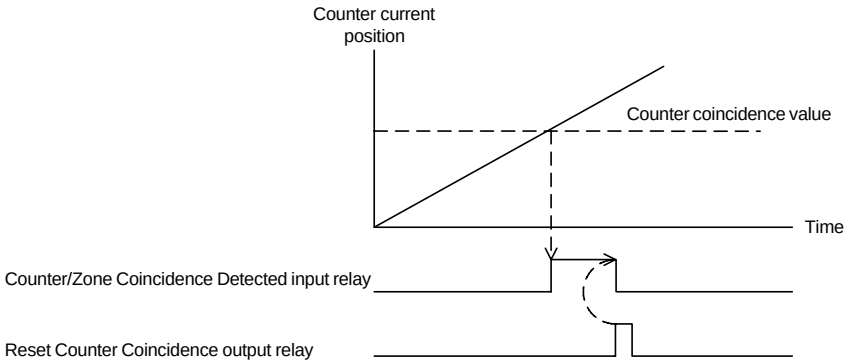


Figure 3.24 Counter Coincidence Detection Function

● Zone Coincidence Detection

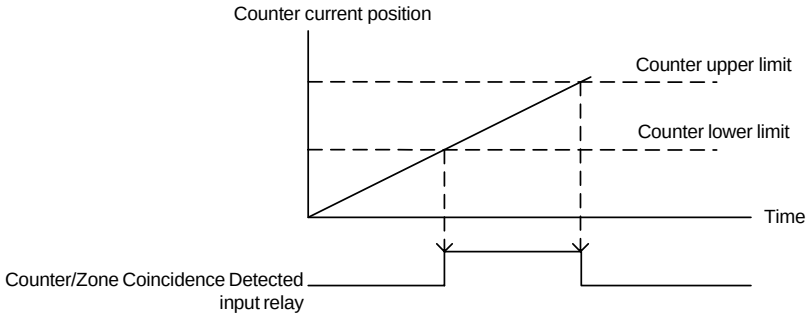


Figure 3.25 Zone Coincidence Detection Function

3.6 Other Functions

3.6.1 External Contact Input/Output

The module has one emergency stop input contact as well as six input contacts, three output contacts, and one SEN signal output contact for each axis. All I/O contacts can be individually configured as normally-open (NO) or normally-closed (NC) contact using axis registered parameters.

I/O contacts that are allocated for specific functions by default can be reconfigured as general-purpose contacts using axis registered parameters. By connecting external equipment to the general-purpose I/O contacts, you can use the CPU module to monitor the equipment by reading the input contacts, as well as control the equipment by turning on or turning off the output contacts.

- **Emergency Stop Input**

  All axes share a common Emergency Stop input, which is a normally-closed contact that must be wired when using the positioning module. The positioning module cannot be used if the Emergency Stop input is in open state.

- **Contact Input and Contact Output**

Table 3.2 External Contact I/O and Their Functions

Contact Input	Function
Origin Input (General Input 1)	Connects to origin switch for use in origin search.
Forward Limit Input (General Input 2)	Connects to forward limit switch. An axis generates an error and stops positioning if the Forward Limit Input turns on during forward movement.
Reverse Limit Input (General Input 3)	Connects to reverse limit switch. An axis generates an error and stops positioning if the Reverse Limit Input turns on during reverse movement.
Driver Alarm Input (General Input 4)	Connects to the output signal for error notification by a servo driver. An axis generates an error and stops positioning if the Driver Alarm Input turns on.
External Trigger Input (General Input 5)	Connects to external equipment. It can be used to trigger the execution of a positioning action.
General Input 6	Its on/off state can be read from a CPU module.

Contact Output	Function
Deviation Pulse Clear Output (General Output 1)	Connects to the input signal of a servo driver for clearing deviation pulses. It is used to output a signal to a servo driver for clearing deviation pulses when origin search is completed.
General Output 2	It can be turned on or off using CPU module instructions or turned on when positioning is completed.
General Output 3	It can be turned on or off using CPU module instructions or turned on when positioning is completed.

- **SEN Signal Output**

  This signal output is used when using a Yaskawa Electric or equivalent absolute encoder. It cannot be used for other purposes. Leave it unconnected when using other servo drivers.

DANGER

An external emergency stop circuit should be built in, according to the motor manufacturer's recommendations, for turning off the power supply and stopping the motor immediately if it operates in an unexpected manner due to machine fault or misoperation.

3.6.2 Electronic Gear Function

The electronic gear function can be used to convert current position, target position and specified speed data into actual mechanical travel or speed values.

The unit of measurement and electronic gear can be predefined using axis registered parameters (Display Unit, Electronic Gear M Value, Electronic Gear N Value).

The unit of measurement can be specified as pulse, mm or degree. The table below shows the data range and implicit decimal point position for position data and speed data for each display unit option.

The electronic gear function cannot be used if display unit is specified as pulse.

Table 3.3 Data Read and Written Using Ladder Program

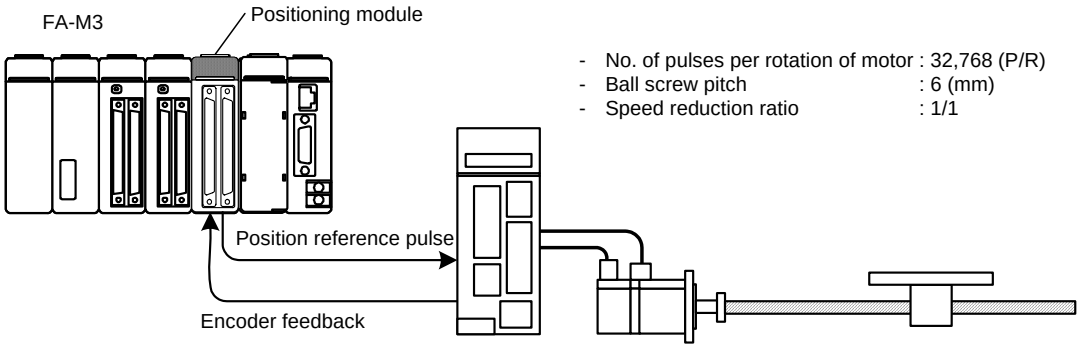
Display Unit	Position Data	Speed Data
pulse	-2,147,483,648 to 2,147,483,647 (pulse)	1 to 5,000,000 (pulse/s)
mm	-2,147,483,648 to 2,147,483,647 (x 10^{-4} mm)	1 to 2,147,483,647 (x 10^{-4} mm/s)
degree	-2,147,483,648 to 2,147,483,647 (x 10^{-5} degree)	1 to 2,147,483,647 (x 10^{-5} degree/s)

Table 3.4 Data Read and Written Using ToolBox for Positioning Modules (SF662-ECW) software

Display Unit	Position Data	Speed Data
pulse	-2,147,483,648 to 2,147,483,647 (pulse)	1 to 5,000,000 (pulse/s)
mm	-214,748.3648 to 214,748.3647 (mm)	0.0001 to 214,748.3647 (mm/s)
degree	-21,474.83648 to 21,474.83647 (degree)	0.00001 to 21,474.83647 (degree/s)

The electronic gear function is useful in the following two applications.

- **Example: ball screw**



- **Example: Index table**

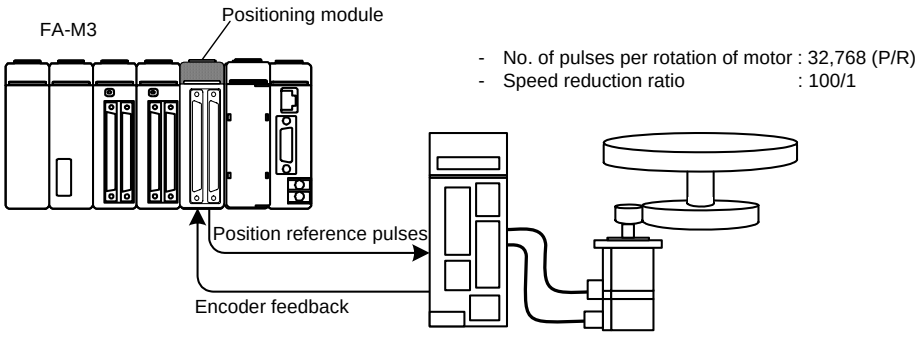


Figure 3.26 Examples for Electronic Gear Setup

3.6.3 M Code Function

The M code function can be used to suspend a pattern execution, which can then be resumed by an instruction from the CPU module after an external equipment has completed its processing, thus synchronizing operations of the positioning module and related external equipment.

If an M Code (1 to 32,767) is specified for an action pattern in pattern operation, the positioning module stores this value to the M Code Status of pattern operation statuses, and turns on the Pattern M Code Detected input relay at the end of the positioning action.

The CPU module checks the Pattern M Code Detected input relay, reads the value of the M Code Status, and initiates execution of the corresponding external equipment.

After the external equipment completes execution, the CPU module turns on the Pattern Reset M Code output relay to begin execution of the next action pattern.

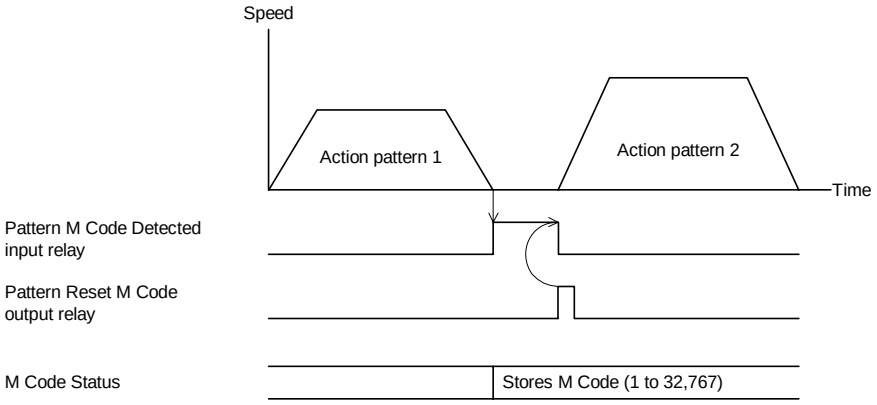


Figure 3.27 Operation of M Code Function

3.6.4 Teach Function

The Teach function can be used to store current position data, counter current position data and entered numerical data into the position data table as you manually move an axis using the jog function or manual pulse generator mode.

The Teach function allows saving of absolute or incremental position data, as well as concurrent saving of data for two or more axes concurrently.

Position data stored via teaching are lost when power is turned off. To save the data permanently, execute a command to save it to flash memory.

3.6.5 Set Override

The Set Override function can be used to scale specified speed data of positioning actions by 1 to 500 (%).

In direct operation, the module executes a speed change immediately after the override value is changed.

In pattern operation, the new override value is not applied to the current action of an executing pattern but to subsequent pattern actions.

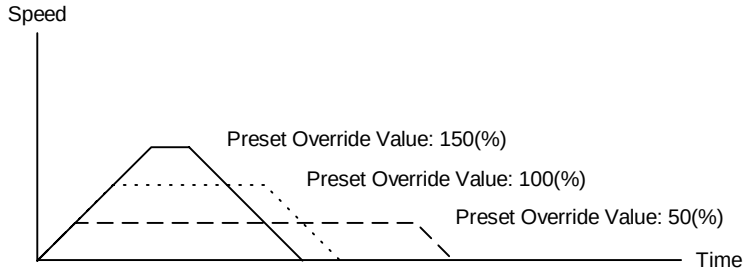


Figure 3.28 Override (using single-axis positioning as example)

3.6.6 Set Current Position

You can change the current position value and/or the counter current position of an axis in Positioning Completed state.

You can also set the current position and the counter current position to the same value.

3.6.7 Saving and Initializing Parameters

You can save all registered parameters (axis registered parameters, pattern registered parameters, action pattern data table, position data table) to the flash memory in the module when all axes are at rest. Parameters must be set with the Set Axis Registered Parameters command or Set Pattern Registered Parameters command before they can be saved to the flash memory. The command for saving to flash memory can be executed only for axis 1 but all parameters will be saved to flash memory.

At power up or system reset, parameter data stored in the flash memory is copied into the parameter area within the CPU interface and the work area. (The positioning module operates according to the parameter data in the work area.)

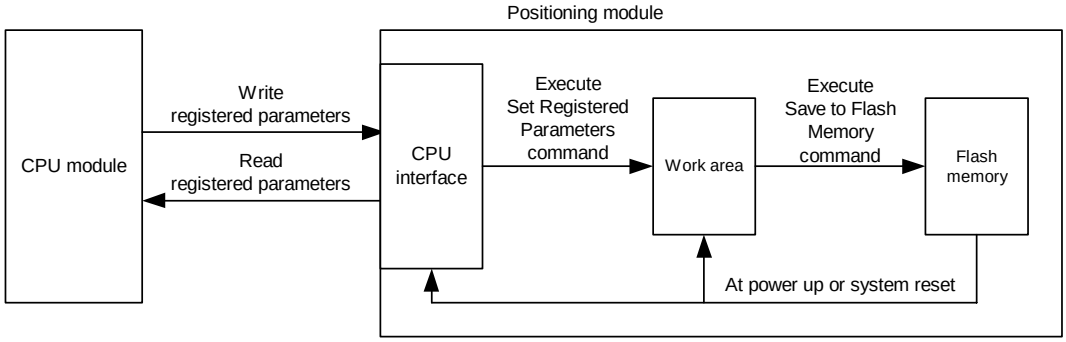


Figure 3.29 Setting and Saving Parameters

To initialize the content of the flash memory to the factory defaults, set the required command code to axis 1 from the CPU module and turn on the AX1 Execute Command output relay. The parameters will be initialized to their factory defaults.

CAUTION

- Data saved in the flash memory will be lost if power is interrupted during parameter data saving.
- Do not save parameter data to the flash memory unnecessarily as there is a limit to the number of write operations to the flash memory (100,000 times).

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4. Preparing for Operation

Figure 4.1 shows the procedure flowchart for operation preparation. For details on the task in each box, refer to the table on the next page.

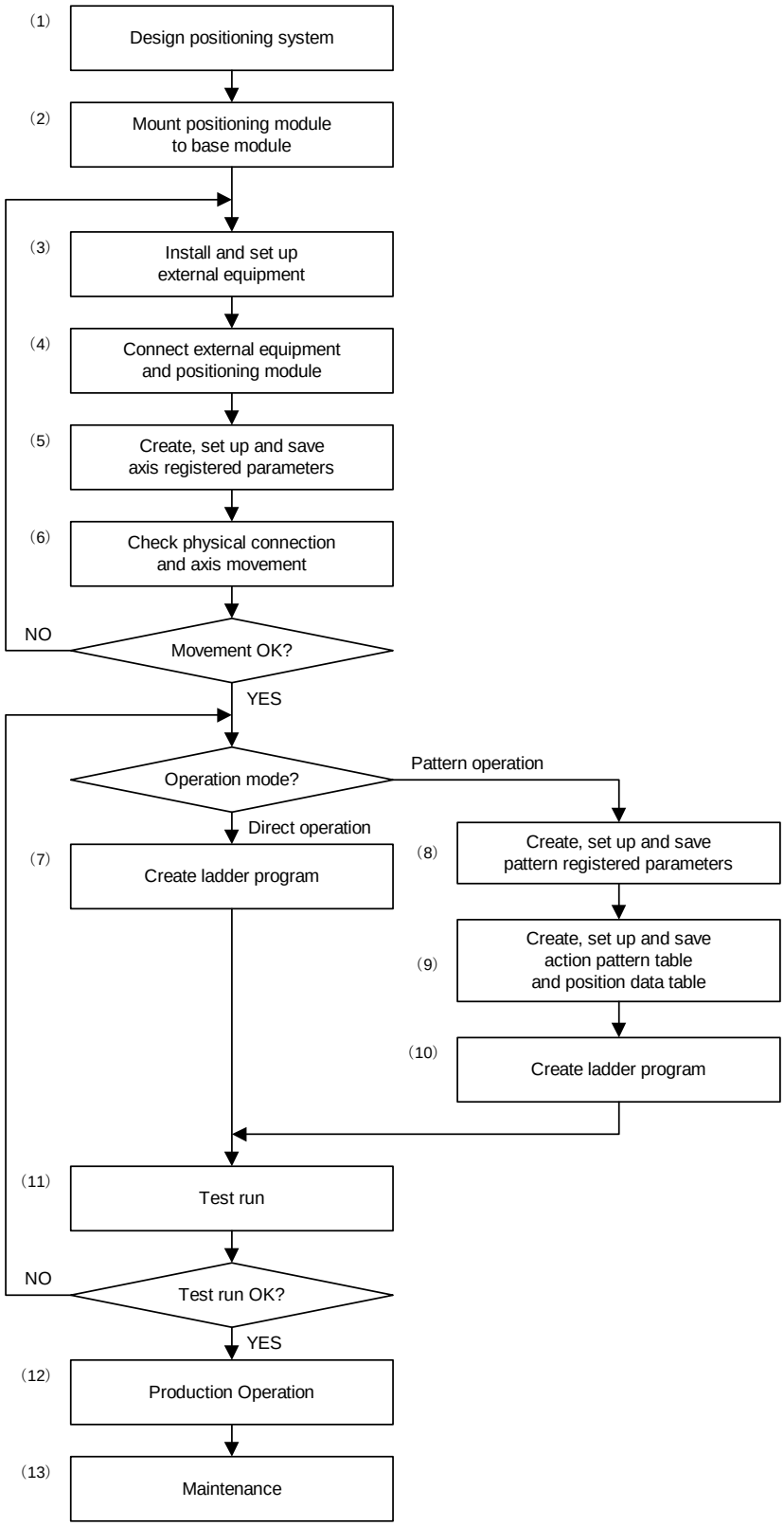


Figure 4.1 Flowchart for Operation Preparation

Table 4.1 Description and Reference for Each Task

Task	Description	See Also
(1)	Design the system after understanding the functions and usage of the positioning module and external equipment.	- 1. Overview - 2. Specification - 3. Function Overview
(2)	Mount the positioning module to the base module.	- 11.1 Attaching and Detaching Modules
(3)	Install and set up external equipment such as motors/drivers and various limit switches by referring to their respective instruction manuals.	- User's manuals for external equipment
(4)	Connect the positioning module to external equipment such as motors/drivers and other limit switches. Connect I/O modules to external equipment as required.	- 11.2. Signal Specifications - 11.3 Examples of Connections to Third-party Motors/Drivers - User's manuals for external equipment
(5)	Create axis registered parameter data, set up data in the positioning module, and save data to the flash memory using the ToolBox for Positioning Modules software or using a ladder program.	- 5. Input/Output Relays, Parameters and Statuses - 6. Direct Operation Programming - FA-M3 ToolBox for Positioning Modules User's Manual (IM34M6Q31-01E) - FA-M3 Programming Tool WideField2 User's Manual (IM34M6Q15-01E) - User's manuals for external equipment
(6)	Using the ToolBox for Positioning Modules software or using a ladder program, check physical connections to external equipment, and check operation using jog operations.	- 5. Input/Output Relays, Parameters and Statuses - 6. Direct Operation Programming - 11.2. Signal Specifications - 11.3 Examples of Connections to Third-party Motors/Drivers - FA-M3 ToolBox for Positioning Modules User's Manual (IM34M6Q31-01E) - FA-M3 Programming Tool WideField2 User's Manual (IM34M6Q15-01E) - User's manuals for external equipment
(7)	Create a ladder program to perform positioning in direct operation by setting up position, speed and acceleration/deceleration time data and executing positioning commands.	- 5. Input/Output Relays, Parameters and Statuses - 6. Direct Operation Programming - FA-M3 Programming Tool WideField2 User's Manual (IM34M6Q15-01E)
(8)	Create pattern registered parameter data, set up data in the positioning module, and save data to the flash memory using the ToolBox for Positioning Modules software or using a ladder program.	- 5. Input/Output Relays, Parameters and Statuses - 7. Pattern Operation Programming - FA-M3 ToolBox for Positioning Modules User's Manual (IM34M6Q31-01E) - FA-M3 Programming Tool WideField2 User's Manual (IM34M6Q15-01E)
(9)	Create action pattern table and position data table required for pattern operation, set up data in the positioning module, and save data to the flash memory using the ToolBox for Positioning Modules software or using a ladder program.	- 5. Input/Output Relays, Parameters and Statuses - 6. Direct Operation Programming - 7. Pattern Operation Programming - 8. Pattern Operation Action Pattern Data - FA-M3 ToolBox for Positioning Modules User's Manual (IM34M6Q31-01E)
(10)	Create a ladder program to perform positioning using pattern operation by specifying a record number in the pre-registered action pattern table.	- 5. Input/Output Relays, Parameters and Statuses - 7. Pattern Operation Programming - FA-M3 Programming Tool WideField2 User's Manual (IM34M6Q15-01E)
(11)	Debug ladder program, and adjust positioning movement.	- FA-M3 ToolBox for Positioning Modules User's Manual (IM34M6Q31-01E) - FA-M3 Programming Tool WideField2 User's Manual (IM34M6Q15-01E)
(12)	Start real operation. Monitor positioning movement as required.	- 5. Input/Output Relays, Parameters and Statuses - FA-M3 ToolBox for Positioning Modules User's Manual (IM34M6Q31-01E) - FA-M3 Programming Tool WideField2 User's Manual (IM34M6Q15-01E)
(13)	When an error or warning is encountered, determine the cause of the error or warning by referring to the error codes, and troubleshoot according.	- 10. Errors and Troubleshooting - FA-M3 ToolBox for Positioning Modules User's Manual (IM34M6Q31-01E) - FA-M3 Programming Tool WideField2 User's Manual (IM34M6Q15-01E)

5. Input/Output Relays, Parameters and Statuses

5.1 List of Input/Output Relays

This module provides 32 input relays and 32 output relays for interfacing with the CPU module of the FA–M3.

5.1.1 Input Relays

Table 5.1 lists the input relays available in the positioning module.

The module can be made to raise an interrupt to the CPU module when an input relay changes from OFF to ON. In the table, □□□ denotes the slot number of the FA–M3 where the positioning module is installed.

Table 5.1 List of Input Relays

Input Relay No.	Signal Name	Description	Relationship with Other Relays
X□□□01	AX1 Execute Command ACK	Turns on when execution of direct command for axis 1 is successfully completed.	Turning off Y□□□33 turns off this relay.
X□□□02	AX2 Execute Command ACK	Turns on when execution of direct command for axis 2 is successfully completed.	Turning off Y□□□34 turns off this relay.
X□□□03	AX3 Execute Command ACK	Turns on when execution of direct command for axis 3 is successfully completed.	Turning off Y□□□35 turns off this relay.
X□□□04	AX4 Execute Command ACK	Turns on when execution of direct command for axis 4 is successfully completed.	Turning off Y□□□36 turns off this relay.
X□□□05	AX1 Positioning Completed	Turns on when axis 1 is in positioning completed state.	
X□□□06	AX2 Positioning Completed	Turns on when axis 2 is in positioning completed state.	
X□□□07	AX3 Positioning Completed	Turns on when axis 3 is in positioning completed state.	
X□□□08	AX4 Positioning Completed	Turns on when axis 4 is in positioning completed state.	
X□□□09	AX1 Error Detected	Turns on when error is encountered on axis 1.	
X□□□10	AX2 Error Detected	Turns on when error is encountered on axis 2.	
X□□□11	AX3 Error Detected	Turns on when error is encountered on axis 3.	
X□□□12	AX4 Error Detected	Turns on when error is encountered on axis 4.	
X□□□13	Pattern A Execute Command ACK	Turns on when execution of pattern command of pattern A is successfully completed.	Turning off Y□□□49 turns off this relay.
X□□□14	Pattern B Execute Command ACK	Turns on when execution of pattern command of pattern B is successfully completed.	Turning off Y□□□50 turns off this relay.
X□□□15	Pattern C Execute Command ACK	Turns on when execution of pattern command of pattern C is successfully completed.	Turning off Y□□□51 turns off this relay.
X□□□16	Pattern D Execute Command ACK	Turns on when execution of pattern command of pattern D is successfully completed.	Turning off Y□□□52 turns off this relay.
X□□□17	Pattern A Execution Completed	Turns on when execution of pattern A is successfully completed.	
X□□□18	Pattern B Execution Completed	Turns on when execution of pattern B is successfully completed.	
X□□□19	Pattern C Execution Completed	Turns on when execution of pattern C is successfully completed.	
X□□□20	Pattern D Execution Completed	Turns on when execution of pattern D is successfully completed.	
X□□□21	Pattern A Error Detected	Turns on when error is encountered during pattern A execution.	
X□□□22	Pattern B Error Detected	Turns on when error is encountered during pattern B execution.	
X□□□23	Pattern C Error Detected	Turns on when error is encountered during pattern C execution.	
X□□□24	Pattern D Error Detected	Turns on when error is encountered during pattern D execution.	
X□□□25	Pattern A M Code Detected	Turns on during M Code output of pattern A.	Turning onY□□□57 turns off this relay.

X□□□26	Pattern B M Code Detected	Turns on during M Code output of pattern B.	Turning on Y□□□58 turns off this relay.
X□□□27	Pattern C M Code Detected	Turns on during M Code output of pattern C.	Turning on Y□□□59 turns off this relay.
X□□□28	Pattern D M Code Detected	Turns on during M Code output of pattern D.	Turning on Y□□□60 turns off this relay.
X□□□29	AX1 Counter/Zone Coincidence Detected	Turns on when counter coincidence or zone coincidence is detected on axis 1.	Turning on Y□□□61 when counter coincidence is detected turns off this relay
X□□□30	AX2 Counter/Zone Coincidence Detected	Turns on when counter coincidence or zone coincidence is detected on axis 2.	Turning on Y□□□62 when counter coincidence is detected turns off this relay
X□□□31	AX3 Counter/Zone Coincidence Detected	Turns on when counter coincidence or zone coincidence is detected on axis 3.	Turning on Y□□□63 when counter coincidence is detected turns off this relay
X□□□32	AX4 Counter/Zone Coincidence Detected	Turns on when counter coincidence or zone coincidence is detected on axis 4.	Turning on Y□□□64 when counter coincidence is detected turns off this relay

5.1.2 Output Relays

Table 5.2 lists the output relays available in the positioning module.

In the table, □□□ denotes the slot number of the FA–M3 where the positioning module is installed.

Table 5.2 List of Output Relays

Output Relay No.	Signal Name	Description	Relationship with Other Relays
Y□□□33	AX1 Execute Command	Request to execute direct command for axis 1.	Turn this relay off after confirming that X□□□01 has turned on.
Y□□□34	AX2 Execute Command	Request to execute direct command for axis 2.	Turn this relay off after confirming that X□□□02 has turned on.
Y□□□35	AX3 Execute Command	Request to execute direct command for axis 3.	Turn this relay off after confirming that X□□□03 has turned on.
Y□□□36	AX4 Execute Command	Request to execute direct command for axis 4.	Turn this relay off after confirming that X□□□04 has turned on.
Y□□□37	AX1 Stop Immediately	Request to stop axis 1 immediately.	
Y□□□38	AX2 Stop Immediately	Request to stop axis 2 immediately.	
Y□□□39	AX3 Stop Immediately	Request to stop axis 3 immediately.	
Y□□□40	AX4 Stop Immediately	Request to stop axis 4 immediately.	
Y□□□41	AX1 Forward Jog	Request to jog axis 1 forward.	
Y□□□42	AX2 Forward Jog	Request to jog axis 2 forward.	
Y□□□43	AX3 Forward Jog	Request to jog axis 3 forward.	
Y□□□44	AX4 Forward Jog	Request to jog axis 4 forward.	
Y□□□45	AX1 Reverse Jog	Request to jog axis 1 backward.	
Y□□□46	AX2 Reverse Jog	Request to jog axis 2 backward.	
Y□□□47	AX3 Reverse Jog	Request to jog axis 3 backward.	
Y□□□48	AX4 Reverse Jog	Request to jog axis 4 backward.	
Y□□□49	Pattern A Execute Command	Request to execute pattern command of pattern A.	Turn this relay off after confirming that X□□□13 has turned on.
Y□□□50	Pattern B Execute Command	Request to execute pattern command of pattern B.	Turn this relay off after confirming that X□□□14 has turned on.
Y□□□51	Pattern C Execute Command	Request to execute pattern command of pattern C.	Turn this relay off after confirming that X□□□15 has turned on.
Y□□□52	Pattern D Execute Command	Request to execute pattern command of pattern D.	Turn this relay off after confirming that X□□□16 has turned on.
Y□□□53	Pattern A Stop Immediately	Request to stop pattern A operation immediately.	
Y□□□54	Pattern B Stop Immediately	Request to stop pattern B operation immediately.	
Y□□□55	Pattern C Stop Immediately	Request to stop pattern C operation immediately.	
Y□□□56	Pattern D Stop Immediately	Request to stop pattern D operation immediately.	
Y□□□57	Pattern A Reset M Code	Request to reset M Code Detected relay for pattern A.	Turn this relay off after confirming that X□□□25 has turned off.
Y□□□58	Pattern B Reset M Code	Request to reset M Code Detected relay for pattern B.	Turn this relay off after confirming that X□□□26 has turned off.
Y□□□59	Pattern C Reset M Code	Request to reset M Code Detected relay for pattern C.	Turn this relay off after confirming that X□□□27 has turned off.

Y□□□60	Pattern D Reset M Code	Request to reset M Code Detected relay for pattern D.	Turn this relay off after confirming that X□□□28 has turned off.
Y□□□61	AX1 Reset Counter Coincidence	Request to reset Counter Coincidence Detected relay for axis 1.	Turn this relay off after confirming that X□□□29 has turned off.
Y□□□62	AX2 Reset Counter Coincidence	Request to reset Counter Coincidence Detected relay for axis 2.	Turn this relay off after confirming that X□□□30 has turned off.
Y□□□63	AX3 Reset Counter Coincidence	Request to reset Counter Coincidence Detected relay for axis 3.	Turn this relay off after confirming that X□□□31 has turned off.
Y□□□64	AX4 Reset Counter Coincidence	Request to reset Counter Coincidence Detected relay for axis 4.	Turn this relay off after confirming that X□□□32 has turned off.

CAUTION

- Never set output relays associated with axis 3, axis 4, pattern C or pattern D on a F3NC32–0N module. Input relays associated with axis 3, axis 4, pattern C or pattern D should be ignored on a F3NC32–0N module.
- In a multi–CPU system, no more than one CPU module should be configured to use a positioning module. For details on configuration setup, see "FA–M3 Programming Tool WideField2 User Manual" (IM34M6Q15–01E).

5.1.3 Operation of I/O Relays

■ Input Relays

- **Execute Command ACK relays (X□□□01 to X□□□04)**

  The Execute Command ACK relay for an axis turns on upon successful completion of the execution of a direct command initiated by a rising edge of the Execute Command relay (Y□□□33 to Y□□□36) for the axis.

  Turning off an Execute Command relay (Y□□□33 to Y□□□36) turns off its corresponding Execute Command ACK relay.

  If an error is encountered during execution of a direct command, the corresponding Execute Command ACK input relay does not turn on. Instead, the Error Detected relay (X□□□09 to X□□□12) turns on. If a warning is encountered, a warning code is stored in Warning Status of axis statuses.

- **Positioning Completed relays (X□□□05 to X□□□08)**

  The Positioning Completed relay for an axis turns on when the axis is in positioning completed state (motor is at rest). The relay is off when the motor is moving, such as during execution of a positioning command or during a jog operation.

- **Error Detected relays (X□□□09 to X□□□12)**

  The Error Detected relay for an axis turns on when an error related to direct operation is encountered, or when an error is encountered during positioning.

  You can obtain detailed error information by reading Error Status of axis statuses.

  Executing a Reset Error command turns off the Error Detected relay.

  The Reset Error command, however, cannot be used to turn off an error generated by execution of a Set Axis Registered Parameters command (error code = 1□□). To reset such an error, you need to re-execute a Set Axis Registered Parameters command with valid data.

- **Pattern Execute Command ACK relays (X□□□13 to X□□□16)**

  The Pattern Execute Command ACK relay for a pattern turns on upon successful completion of the execution of a pattern command initiated by a rising edge of the Pattern Execute Command relay (Y□□□49 to Y□□□52) for the pattern.

  Turning off a Pattern Execute Command relay (Y□□□49 to Y□□□52) turns off its

corresponding Pattern Execute Command ACK relay.

If an error is encountered during execution of a pattern command, the corresponding Pattern Execute Command ACK input relay does not turn on. Instead, the Pattern Error Detected relay (X□□□21 to X□□□24) turns on. If a warning is encountered, a warning code is stored in the Pattern Warning Status of pattern operation statuses.

- **Pattern Execution Completed relays (X□□□17 to X□□□20)**

  The Pattern Execution Completed relay turns on when pattern operation is in Execution Completed state. The relay is off during pattern execution.

- **Pattern Error Detected relays (X□□□21 to X□□□24)**

  The Pattern Error Detected relay for a pattern turns on when an error related to pattern operation is encountered.

  You can obtain detailed error information by reading Pattern Error Status of pattern operation statuses.

  Executing a Reset Pattern Error command turns off the Pattern Error Detected relay. The Reset Pattern Error Command, however, cannot be used to turn off an error caused by execution of a Set Pattern Registered Parameters command (error code = 130□). To reset such an error, you need to re-execute a Set Pattern Registered Parameters command with valid data.

- **Pattern M Code Detected relays (X□□□25 to X□□□28)**

  The Pattern M Code Detected relay for a pattern turns on upon completion of a positioning movement specified with an M Code parameter. Pattern operation is suspended at the same time.

  Turning on the corresponding Pattern Reset M Code relay (Y□□□57 to Y□□□60) turns off the Pattern M Code Detected relay, and restarts pattern operation.

- **Counter/Zone Coincidence Detected relays (X□□□29 to X□□□32)**

  The Counter/Zone Coincidence relay for an axis turns on when the current position of the pulse counter coincides with a preset Counter Coincidence Value or falls within a preset range.

  The Counter Setup command can be used to set or modify the values of counter-related axis registered parameters, namely, Counter Usage Selection (counter coincidence or zone coincidence), Counter Coincidence Value, Counter Upper Limit and Counter Lower Limit.

  Turning on the Reset Counter Coincidence relay (Y□□□61 to Y□□□64) for an axis turns off its corresponding Counter/Zone Coincidence Detected relay.

  If zone coincidence is detected, the Counter/Zone Coincidence Detected relay turns off when the current position of the pulse counter moves out of the preset range.

■ Output Relays

● Execute Command relays (Y□□□33 to Y□□□36)

Turning on the Execute Command relay for an axis executes the command designated by Direct Command Code of axis command parameters.

Upon successful completion of the execution of the direct command, the corresponding Execute Command ACK relay (X□□□01 to X□□□04) turns on.

Turning off the Execute Command relay at this point turns off the Execute Command ACK relay (X□□□01 to X□□□04).

● Stop Immediately relays (Y□□□37 to Y□□□40)

Turning on the Stop Immediately relay for an axis stops the motor for the axis immediately without deceleration.

If multiple axes are moving in interpolated movement (linear interpolation, circular interpolation or helical interpolation), all moving axes will be stopped immediately.

● Forward Jog relays (Y□□□41 to Y□□□44)

Turning on the Forward Jog relay for an axis moves the motor for the axis in the forward direction.

● Reverse Jog relays (Y□□□45 to Y□□□48)

Turning on the Reverse Jog relay for an axis moves the motor for the axis in the reverse direction.

● Pattern Execute Command relays (Y□□□49 to Y□□□52)

Turning on the Pattern Execute Command relay for a pattern executes the command designated by Pattern Operation Command Code of pattern command parameters.

Upon successful completion of the execution of the pattern command, the corresponding Pattern Execute Command ACK relay (X□□□13 to X□□□16) turns on.

Turning off the Pattern Execute Command relay at this point turns off the Pattern Execute Command ACK relay (X□□□13 to X□□□16).

● Pattern Stop Immediately relays (Y□□□53 to Y□□□56)

Turning on the Pattern Stop Immediately relay for a pattern causes an executing pattern operation to be stopped immediately. The moving motor is also stopped immediately without deceleration.

● Pattern Reset M Code relays (Y□□□57 to Y□□□60)

Turning on the Pattern Reset M Code relay for a pattern turns off the corresponding Pattern M Code Detected relay (X□□□25 to X□□□28) if it is on. The suspended pattern operation is resumed at the same time.

● Reset Counter Coincidence relays (Y□□□61 to Y□□□64)

Turning on the Reset Counter Coincidence relay for an axis turns off the corresponding Counter/Zone Coincidence Detected relay (X□□□29 to X□□□32) if it is on.

This output relay is effective only when Counter Usage Selection is set to counter coincidence. If Counter Usage Selection is set to zone coincidence, the Counter/Zone Coincidence Detected relay (X□□□29 to X□□□32) turns off when the current position of the pulse counter moves out of the preset range.

5.2 List of Parameters and Statuses

Table 5.3 shows the layout of the registered parameter area, command parameter area and status area of the positioning module. For details, see Subsection 5.2.1 to 5.2.7.

Table 5.3 Layout of Parameter and Status Areas

Data Position No.	Description
0001 to 0100	Axis Common Statuses
0101 to 0200	Axis 1 Registered Parameters
0201 to 0300	Axis 1 Command Parameters
0301 to 0400	Axis 1 Statuses
0401 to 0500	Axis 2 Registered Parameters
0501 to 0600	Axis 2 Command Parameters
0601 to 0700	Axis 2 Statuses
0701 to 0800	Axis 3 Registered Parameters
0801 to 0900	Axis 3 Command Parameters
0901 to 1000	Axis 3 Statuses
1001 to 1100	Axis 4 Registered Parameters
1101 to 1200	Axis 4 Command Parameters
1201 to 1300	Axis 4 Statuses
1301 to 1330	Pattern A Registered Parameters
1331 to 1350	Pattern A Command Parameters
1351 to 1400	Pattern A Statuses
1401 to 1430	Pattern B Registered Parameters
1431 to 1450	Pattern B Command Parameters
1451 to 1500	Pattern B Statuses
1501 to 1530	Pattern C Registered Parameters
1531 to 1550	Pattern C Command Parameters
1551 to 1600	Pattern C Statuses
1601 to 1630	Pattern D Registered Parameters
1631 to 1650	Pattern D Command Parameters
1651 to 1700	Pattern D Statuses
1701 onwards	(System reserved)

■ Position Reference Unit and Speed Reference Unit

Some parameters and statuses of the positioning module are handled in position reference unit, speed reference unit, counter position reference unit or counter speed reference unit.

Tables 5.4 and 5.5 show how these units are determined by the Display Unit and Counter Display Unit axis registered parameter values.

Table 5.4 Position Reference Unit and Speed Reference Unit

Display Unit	Position Reference Unit	Speed Reference Unit
pulse	pulse	pulse/s
mm	$\times 10^{-4}$ mm	$\times 10^{-4}$ mm/s
degree	$\times 10^{-5}$ degree	$\times 10^{-5}$ degree/s

Table 5.5 Counter Position Reference Unit and Counter Speed Reference Unit

Counter Display Unit	Counter Position Reference Unit	Counter Speed Reference Unit
pulse	pulse	pulse/s
mm	$\times 10^{-4}$ mm	$\times 10^{-4}$ mm/s
degree	$\times 10^{-5}$ degree	$\times 10^{-5}$ degree/s

For instance,

- If the Display Unit is specified as 'mm', then 1.0 [mm] should be handled as 10,000 [$\times 10^{-4}$ mm] in ladder programs.
- If the Display Unit is specified as 'degree', then 1.0 [degree] should be handled as 100,000 [$\times 10^{-5}$ degree] in ladder programs.

■ Handling of Fractional Values

Some statuses in Table 5.3 store data in position reference unit, speed reference unit, counter position reference unit or counter speed reference unit.

Within the module, these statuses may store fractional values defined as follows:

- Value less than 1 [pulse] if the Display Unit is specified as 'pulse';
- Value less than 0.0001 [mm] if the Display Unit is specified as 'mm';
- Value less than 0.00001 [degree] if the Display Unit is specified as 'degree';

Fractional values stored internally within the module are discarded (or rounded down for negative values) before display by the CPU and ToolBox for Positioning Module (SF662–ECW) software, which is a setup tool for positioning modules.

On the contrary, fractional values are rounded before pulse output, resulting in a possible position deviation of ±1 [pulse].

■ Reading and Writing Two–word Data

Parameters and statuses listed with two data position numbers are 2–word data. The smaller data position number contains the low order word, and the larger data position number contains the high order word.

Each data position number corresponds to a word. Always use the word–based WRITE instruction and READ instruction to access the module from a sequence program. Using a long–word–based instruction will result in incorrect access. Similarly, always use word–based instructions for access from a BASIC program.

CAUTION

When the CPU module reads 2–word status data from the positioning module, concurrency of the high–order word and low–order word of 2–word data is not assured due to conflicts between the timing of reading from the CPU module and the data update period of the positioning module.

To ensure that the high–order word and low–order word of 2–word data are concurrent when reading from a sequence CPU, use the READ command to read the data twice consecutively and verify that the data read are the same in both instances. If the HRD command is used, data concurrency is not assured even if you confirm that the data are the same.

Data concurrency cannot be assured when reading from a BASIC CPU.

For details on how to ensure data concurrency by executing the READ command twice from a sequence CPU, see Section 9.3, "Precautions on Reading Two–word Data".

5.2.1 Axis Common Statuses

This section lists and describes statuses common to all axes.

Do not write to axis common statuses as it will overwrite existing data.

■ Axis Common Statuses

Table 5.6 Axis Common Statuses

Data Position No.	Parameter Name	Data Range and Description	See Also
0001	Module Information	"F3"	5–8
0002	Module Information	"NC"	5–8
0003	Module Information	"32" or "34"	5–8
0004	Module Information	"0N"	5–8
0005	Module Information	" "	5–8
0006	Module Information	" "	5–8
0007	Module Information	"RV"	5–8
0008	Module Information	"□□" ("□□" denotes the revision number)	5–8
0009	(System reserved)		–
0010	(System reserved)		–
0011 / 0012	No. of Write Operations to Flash Memory	non–negative integer	5–8
0013	No. of Pattern Data Records Used	1 to 500	5–8
0014	No. of Position Data Records Used	1 to 2000	5–9
0015 to 0100	(System reserved)		–

■ Description of Axis Common Statuses

● Module Information

Data Position No.: 0001 to 0008
Data Range and Description: Module Model Code: "F3NC320N" or "F3NC340N".
Revision: "RV□□"

Module Information stores module information such as model code and revision.

● No. of Write Operations to Flash Memory

Data Position No. 0011 to 0012
Data Range and Description: non–negative integer

No. of Write Operations to Flash Memory stores the total number of previous write operations to the flash memory.

Do not save parameter data to the flash memory beyond the maximum allowable limit of 100,000 times. Otherwise, data integrity is not guaranteed.

● No. of Pattern Data Records Used

Data Position No. 0013
Data Range and Description 1 to 500

No. of Pattern Data Records Used stores the number of action pattern records to be used for each pattern in pattern operation.

Its value is common to all action pattern tables, and can be modified using the ToolBox for Positioning Modules software (SF662–ECW). The valid data range is 1 to 500, and the default value is 100.

For details on how to change the number of pattern data records used, see "FA–M3 ToolBox for Positioning Modules User's Manual" (IM34M6Q31–01E).

- **No. of Position Data Records Used**

  Data Position No.: 0014
  Data Range and Description: 1 to 2,000
  No. of Position Data Records Used stores the number of position data records to be used in pattern operation.

  Its value can be modified using the ToolBox for Positioning Modules software (SF662–ECW). The valid data range is 1 to 2000, and the default value is 400.

  For details on how to change the number of position data records used, see "FA–M3 ToolBox for Positioning Modules User's Manual" (IM34M6Q31–01E).

5.2.2 Axis Registered Parameters

This section lists and describes the axis registered parameters.

■ List of Axis Registered Parameters

Table 5.7 List of Axis Registered Parameters (Basic Parameters)

Data Position No.				Parameter Name	Data Range and Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0101	0401	0701	1001	Maximum Speed Selection	0: Standard mode; 1: High–speed mode (Factory setting: 0)	5-13
0102	0402	0702	1002	Pulse Output Mode	0: CW/CCW pulse 1: Travel/direction 2: Phase A/B (x4) 3: Phase A/B (x2) 4: Phase A/B (x1) (Factory setting: 0)	5-13
0103	0403	0703	1003	Motor Direction Selection	0: Forward movement produces CW pulse output 1: Reverse movement produces CW pulse output (Factory setting: 0)	5-14
0104	0404	0704	1004	Contact Usage Selection	$0000 to $011F (bit data) (Factory setting: $0000)	5-14
0105	0405	0705	1005	Contact I/O Polarity	$0000 to $073F (bit data) (Factory setting: $0000)	5-15
0106 to 0108	0406 to 0408	0706 to 0708	1006 to 1008	(System reserved)		–
0109	0409	0709	1009	Display Unit	0: pulse; 1: mm; 2: degree (Factory setting: 0)	5-15
0110	0410	0710	1010	(System reserved)		–
0111 / 0112	0411 / 0412	0711 / 0712	1011 / 1012	Electronic Gear M Value	1 to 2,147,483,647 (Factory setting: 1)	5-16
0113 / 0114	0413 / 0414	0113 / 0714	1013 / 1014	Electronic Gear N Value	1 to 2,147,483,647 (M/N<100) (Factory setting: 1)	5-16
0115	0415	0715	1015	(System reserved)		–
0116	0416	0716	1016	Index Control	0: No index control 1: Index control (Factory setting: 0)	5-17
0117 / 0118	0417 / 0418	0717 / 0718	1017 / 1018	Index Range	4 to 2,147,483,647 (position reference unit) (Factory setting: 4)	5-18
0119 to 0120	0419 to 0420	0719 to 0720	1019 to 1020	(System reserved)		–
0121 / 0122	0421 / 0422	0721 / 0722	1021 / 1022	Forward Limit	–2,147,483,648 to 2,147,483,647 (position reference unit) (Factory setting: 2,147,483,647)	5-18
0123 / 0124	0423 / 0424	0723 / 0724	1023 / 1024	Reverse Limit	–2,147,483,648 to (Forward Limit – 1) (position reference unit) (Factory setting: –2,147,483,648)	5-18
0125 / 0126	0425 / 0426	0725 / 0726	1025 / 1026	Speed Limit	1 to 5,000,000 (pulse/s) 1 to 2,147,483,647 (x 10^{-4}mm/s) 1 to 2,147,483,647 (x 10^{-5}degree/s) (Valid data range depends on Display Unit) (Factory setting: 1,000,000)	5-19
0127	0427	0727	1027	(System reserved)		
0128	0428	0728	1028	Acceleration/ deceleration Curve	0: Automatic trapezoidal acceleration/deceleration 1: S–shape acceleration/deceleration (Factory setting: 0)	5-19
0129 / 0130	0429 / 0430	0729 / 0730	1029 / 1030	Startup Speed	0 to Speed Limit (speed reference unit) (Factory setting: 0)	5-20
0131	0431	0731	1031	Default Acceleration Time	0 to 32,767 (ms) (Default Acceleration Time specified for Speed Limit) (Factory setting: 1,000)	5-21
0132	0432	0732	1032	Default Deceleration Time	0 to 32,767 (ms) (Default Deceleration Time specified for Speed Limit) (Factory setting: 1,000)	5-21
0133 to 0134	0433 to 0434	0733 to 0734	1033 to 1034	(System reserved)		
0135 / 0136	0435 / 0436	0735 / 0736	1035 / 1036	CI Error Tolerance	0 to 2,147,483,647 (x 10^{-4}mm/s) (Factory setting: 1,000)	5-21
0137 to 0149	0437 to 0449	0737 to 0749	1037 to 1049	(System reserved)		–

Table 5.8 List of Axis Registered Parameters (Automatic Origin Search)

Data Position No.				Parameter Name	Data Range and Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0150	0450	0750	1050	AOS Mode	$0000 to $0003 (bit data) (Factory setting: $0000)	5-21
0151	0451	0751	1051	AOS Direction	0: Reverse; 1: Forward (Factory setting: 0)	5-22
0152	0452	0752	1052	AOS Dwell Time	0 to 32,767 (ms) (Factory setting: 10)	5-22
0153 / 0154	0453 / 0454	0753 / 0754	1053 / 1054	AOS Speed 1	1 to Speed Limit (speed reference unit) (Factory setting: 10,000)	5-22
0155 / 0156	0455 / 0456	0755 / 0756	1055 / 1056	AOS Speed 2	1 to AOS Speed 1 (speed reference unit) (Factory setting: 1,000)	5-22
0157	0457	0757	1057	AOS Acceleration Time	0 to 32,767 (ms) (Factory setting: 1,000)	5-22
0158	0458	0758	1058	AOS Deceleration Time	0 to 32,767 (ms) (Factory setting: 1,000)	5-23
0159	0459	0759	1059	AOS Z–phase Edge Selection	0: Rising edge; 1: Falling edge (Factory setting: 0)	5-23
0160	0460	0760	1060	AOS Z–phase Search Count	0 to 32,767 (pulses) (Factory setting: 0)	5-23
0161 / 0162	0461 / 0462	0761 / 0762	1061 / 1062	AOS Z–phase Search Range	0 to 2,147,483,647 or 0 to AOS Z–phase Search Count (position reference unit) (Factory setting: 2,147,483,647)	5-23
0163	0463	0763	1063	AOS Deviation Pulse Clear Time	0 to 32,767 (ms) (Factory setting: 10)	5-23
0164	0464	0764	1064	(System reserved)		–
0165 / 0166	0465 / 0466	0765 / 0766	1065 / 1066	AOS Offset	–2,147,483,648 to 2,147,483,647 (position reference unit) (Factory setting: 0)	5-24
0167 to 0171	0467 to 0471	0767 to 0771	1067 to 1071	(System reserved)		–

Table 5.9 List of Axis Registered Parameters (Counter/Encoder)

Data Position No.				Parameter Name	Data Range and Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0172	0472	0772	1072	Counter Type Selection	0: General–purpose incremental 1: Sanyo Denki's Manchester Coding 2: Yaskawa Electric's Serial (Factory setting: 0)	5-24
0173	0473	0773	1073	Counter Direction Selection	0: Forward pulse input denotes forward movement 1: Reverse pulse input denotes forward movement (Factory setting: 0)	5-25
0174	0474	0774	1074	Counter Multiplication	1: x1; 2: x2; 4: x4 (Factory setting: 4)	5-25
0175	0475	0775	1075	Counter Display Unit	0: pulse; 1: mm; 2: degree (Factory setting: 0)	5-26
0176	0476	0776	1076	(System reserved)		–
0177 / 0178	0477 / 0478	0777 / 0778	1077 / 1078	Counter Electronic Gear M Value	1 to 2,147,483,647 (Factory setting: 1)	5-26
0179 / 0180	0479 / 0480	0779 / 0780	1079 / 1080	Counter Electronic Gear N Value	1 to 2,147,483,647 (M/N<100) (Factory setting: 1)	5-26
0181	0481	0781	1081	(System reserved)		–
0182	0482	0782	1082	Counter Index Control	0: No index control 1: Index control (Factory setting: 1)	5-27
0183 / 0184	0483 / 0484	0783 / 0784	1083 / 1084	Counter Index Range	0 to 2,147,483,647 (counter position reference unit) (Factory setting: 0)	5-27
0185 / 0186	0485 / 0486	0785 / 0786	1085 / 1086	ABS Encoder Offset	0 to 2,147,483,647 (counter position reference unit) (Factory setting: 0)	5-27
0187 / 0188	0487 / 0488	0787 / 0788	1087 / 1088	ABS Encoder Pulses Per Rev.	–2,147,483,648 to 2,147,483,647 (pulse) (Factory setting: 32,768)	5-28
0189	0489	0789	1089	ABS Encoder Bit Length	17 to 28 (bits) (Factory setting: 28)	5-28
0190	0490	0790	1090	Counter Usage Selection	0: Counter coincidence 1: Zone coincidence (Factory setting: 0)	5-29
0191 / 0192	0491 / 0492	0791 / 0792	1091 / 1092	Counter Coincidence Value	–2,147,483,648 to 2,147,483,647 (counter position reference unit) (Factory setting: 0)	5-29
0193 / 0194	0493 / 0494	0793 / 0794	1093 / 1094	Counter Upper Limit	–2,147,483,648 to 2,147,483,647 (counter position reference unit) (Factory setting: 2,147,483,647)	5-30
0195 / 0196	0495 / 0496	0795 / 0796	1095 / 1096	Counter Lower Limit	–2,147,483,648 to Counter Upper Limit (counter position reference unit) (Factory setting: –2,147,483,648)	5-30

■ Description of Axis Registered Parameters

● Maximum Speed Selection

[Data Range] **0: Standard mode**
1: High–speed mode
[Factory Setting] **0: Standard mode**
[Data Position No.] **Axis 1: 0101; Axis 2: 0401; Axis 3: 0701; Axis 4: 1001**
Maximum Speed Selection specifies the maximum limit for output pulses.

Table 5.10 shows the maximum speed of output pulses for each combination of Maximum Speed Selection and Pulse Output Mode parameter values.

Select '0: Standard mode' for Maximum Speed Selection when using a stepper motor. If the Maximum Speed Selection parameter is set to '1: High–speed mode' for stepper motors, operation cannot be assured. Even when using a servomotor, select '0: Standard mode' if the maximum speed is below the values (pps) shown in the table below.

Table 5.10 Maximum Speed of Output Pulses

Maximum Speed Selection	Pulse Output Mode	Maximum Speed (pps)
0: Standard mode	0: CW/CCW pulse	1,000,000
	1: Travel/direction	1,000,000
	2: Phase A/B (x4)	1,000,000
	3: Phase A/B (x2)	500,000
	4: Phase A/B (x1)	250,000
1: High–speed mode	0: CW/CCW pulse	5,000,000
	1: Travel/direction	5,000,000
	2: Phase A/B (x4)	5,000,000
	3: Phase A/B (x2)	2,500,000
	4: Phase A/B (x1)	1,250,000

● Pulse Output Mode

[Data Range] **0: CW/CCW pulse**
1: Travel/direction
2: Phase A/B (x4)
3: Phase A/B (x2)
4: Phase A/B (x1)
[Factory Setting] **0: CW/CCW pulse**
[Data Position No.] **Axis 1: 0102; Axis 2: 0402; Axis 3: 0702; Axis 4: 1002**
Pulse Output Mode specifies the mode for output pulses.

The table below shows the actual output pulses for each Pulse Output Mode option.

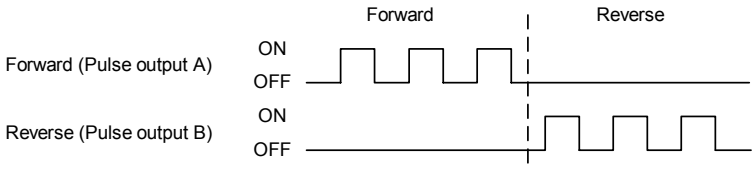
Table 5.11 Pulse Output Mode and Actual Output

Pulse Output Mode	Pulse Output A	Pulse Output B
CW/CCW pulse	CW pulses	CCW pulses
Travel/direction	Travel	Direction
Phase A/B	Phase A	Phase B

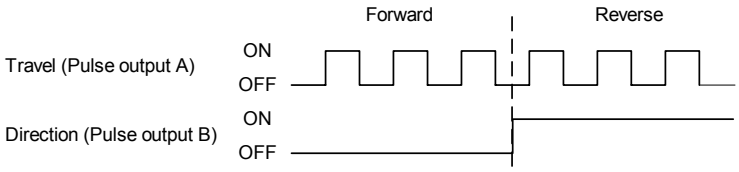
Table 5.12 State of Signal Output When A Pulse Is On or Off

Signal	When pulse is OFF	When pulse is ON
+ Signal	Positive logic OFF (high level)	Negative logic ON (low level)
– Signal	Negative logic OFF (low level)	Positive logic ON (high level)

- CW/CCW pulse



- Travel/direction



- Phase A/B

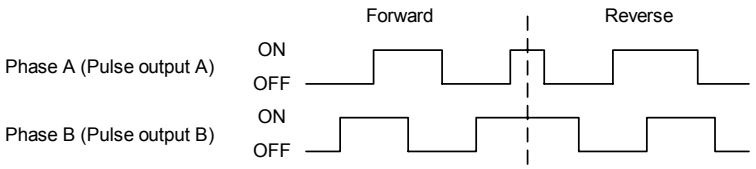


Figure 5.1 Pulse Output Mode and Output Pulses

● Motor Direction Selection

[Data Range] **0: Forward movement produces CW pulse output**
1: Reverse movement produces CW pulse output
[Factory Setting] **0: Forward movement produces CW pulse output**
[Data Position No.] **Axis 1: 0103; Axis 2: 0403; Axis 3: 0703; Axis 4: 1003**

Motor Direction Selection maps the sign of position data set from the CPU module to the direction of pulse output for motor rotation.

Forward and reverse movement map to positive and negative position data from the CPU module respectively.

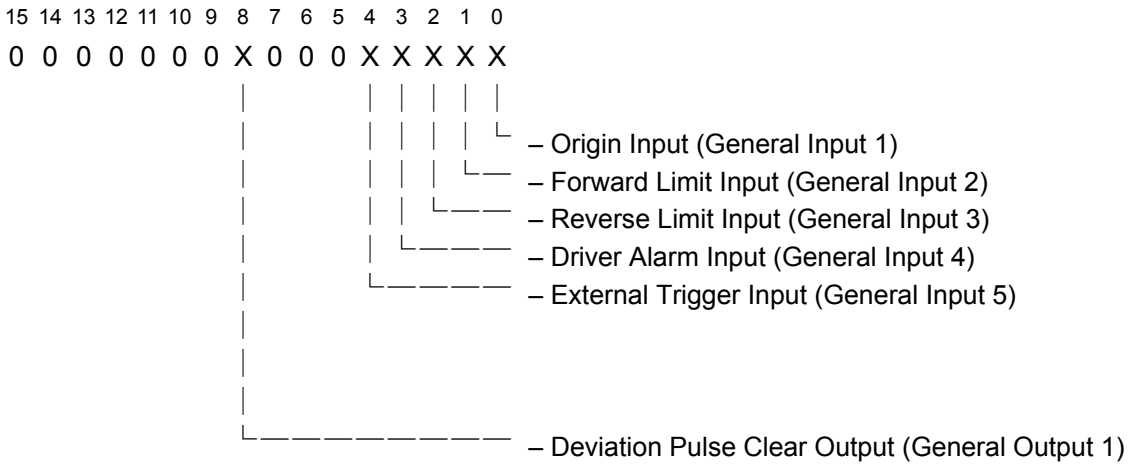
● Contact Usage Selection

[Data Range] **$0000 to $011F (bit data)**
[Factory Setting] **$0000**
[Data Position No.] **Axis 1: 0104; Axis 2: 0404; Axis 3: 0704; Axis 4: 1004**

Contact Usage Selection stores bit data, which defines how external I/O contacts are used.

0: Used as inherent function

1: Used as general input/output



Contact I/O Polarity

[Data Range] **$0000 to $073F (bit data)**
[Factory Setting] **$0000**
[Data Position No.] **Axis 1: 0105; Axis 2: 0405; Axis 3: 0705; Axis 4: 1005**

Contact I/O Polarity defines the logic of external I/O contacts using bit data.

0: NO (normally open) contact

1: NC (normally closed) contact

An NO contact is true when there is signal input, while an NC contact is true when there is no signal input. For instance, a limit is detected for an NC limit input when there is no signal input, and not detected when there is a signal input.

In the case of contact output, turning on an NO contact output turns on its transistor output, while turning off its output turns off its translator output.

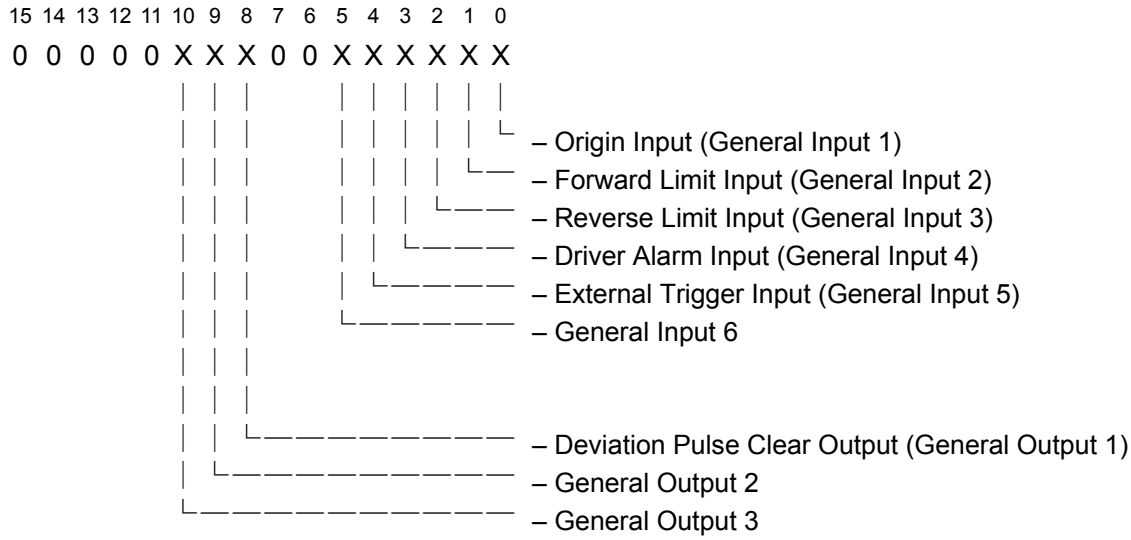


Table 5.13 Normally Open (NO) Contact Versus Normally Closed (NC) Contact

Input/Output Status	NO Contact	NC Contact
Input is ON	ON voltage/ON current at input terminal	No ON voltage/ON current at input terminal
Input is OFF	No ON voltage/ON current at input terminal	ON voltage/ON current at input terminal
Output is ON	Output transistor is ON	Output transistor is OFF
Output is OFF	Output transistor is OFF	Output transistor is ON

Display Unit

[Data Range] **0: pulse**
1: mm
2: degree
[Factory Setting] **0: pulse**
[Data Position No.] **Axis 1: 0109; Axis 2: 0409; Axis 3: 0709; Axis 4: 1009**

Display Unit defines the measurement unit for position data and speed data used in positioning.

When specifying combined speeds for linear interpolation, circular interpolation and helical interpolation, the display unit of all interpolation axes should be set to '1: mm'.

The table below shows the data range and implicit decimal point position for position data and speed data for each display unit option.

When display unit is set to '0: pulse', electronic gear function cannot be used, and both Electronic Gear M Value and Electronic Gear N Value must be set to 1.

Table 5.14 Data Read and Written Using Ladder Program

Display Unit	Position Data (position reference unit)	Speed Data (speed reference unit)
Pulse	–2,147,483,648 to 2,147,483,647 (pulse)	1 to 5,000,000 (pulse/s)
mm	–2,147,483,648 to 2,147,483,647 (x 10^{-4} mm/s)	1 to 2,147,483,647 (x 10^{-4} mm/s)
degree	–2,147,483,648 to 2,147,483,647 (x 10^{-5} degree)	1 to 2,147,483,647 (x 10^{-5}degree/s)

Table 5.15 Data Read and Written Using ToolBox for Positioning Modules (SF662–ECW) software

Display Unit	Position Data (unit)	Speed Data (unit)
pulse	–2,147,483,648 to 2,147,483,647 (pulse)	1 to 5,000,000 (pulse/s)
mm	–214,748.3648 to 214,748.3647 (mm)	0.0001 to 214,748.3647 (mm/s)
degree	–21,474.83648 to 21,474.83647 (degree)	0.00001 to 21,474.83647 (degree/s)

● Electronic Gear M Value

[Data Range] 1 to 2,147,483,647
[Factory Setting] 1
[Data Position No.] Axis 1: 0111/0112; Axis 2: 0411/0412
Axis 3: 0711/0712; Axis 4: 1011/1012

Electronic Gear M Value specifies the numerator (M) of the electronic gear ratio.

● Electronic Gear N Value

[Data Range] 1 to 2,147,483,647 (M/N<100)
[Factory Setting] 1
[Data Position No.] Axis 1: 0113/0114; Axis 2: 0413/0414
Axis 3: 0713/0714; Axis 4: 1013/1014

Electronic Gear N Value specifies the denominator (N) of the electronic gear ratio.

The actual number of output pulses is calculated from the electronic gear ratio (Electronic Gear M Value and Electronic Gear N Value) as follows:

$$\text{Number of output pulses} = \text{travel} \times \frac{\text{Electronic Gear M Value}}{\text{Electronic Gear N Value}}$$

Some examples are shown below to explain the Electronic Gear M Value and Electronic Gear N Value.

When display unit is set to '0: pulse', electronic gear function cannot be used, and both Electronic Gear M Value and Electronic Gear N Value must be set to 1.

- Example: ball screw

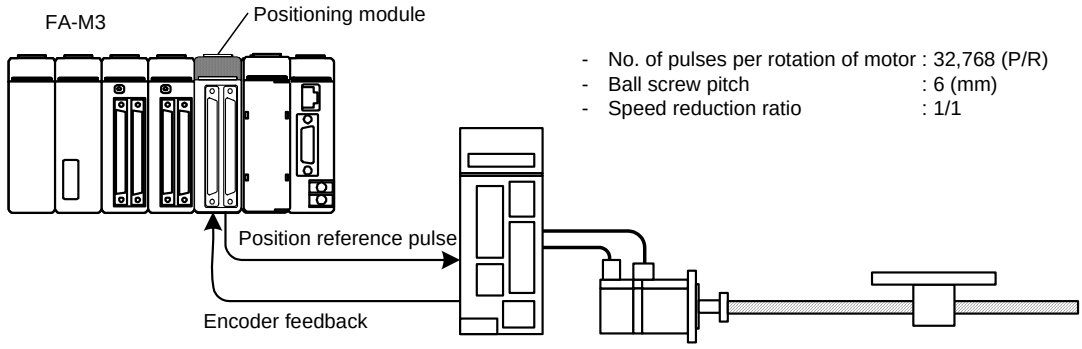


Figure 5.2 Example of Electronic Gear Setup for A Ball Screw

If Display Unit is set to '1: mm', and 1 motor rotation (32,768 pulses) produces 60,000 (x 10^{-4} mm) units of movement, then

$$32,768 = 60,000 \times \frac{\text{Electronic Gear M Value}}{\text{Electronic Gear N Value}}$$

Therefore,

$$\frac{\text{Electronic Gear M Value}}{\text{Electronic Gear N Value}} = \frac{32,768}{60,000} = \frac{1,024}{1,875}$$

Hence, Electronic Gear M Value and Electronic Gear N Value should be set to 1,024 and 1,875 respectively.

- Example: Index table

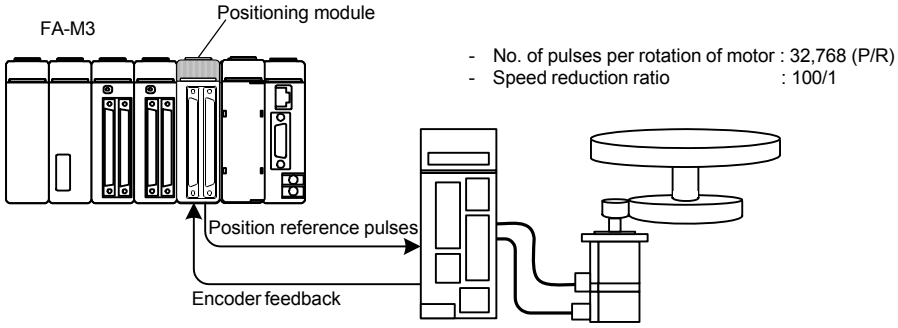


Figure 5.3 Example of Electronic Gear Setup for An Index Table

If Display Unit is set to '2: degree', and 100 motor rotations (3,276,800 pulses) produces 36,000,000 (x 10^{-5} mm) units of movement, then

$$3,276,800 = 36,000,000 \times \frac{\text{Electronic Gear M Value}}{\text{Electronic Gear N Value}}$$

Therefore,

$$\frac{\text{Electronic Gear M Value}}{\text{Electronic Gear N Value}} = \frac{3,276,800}{36,000,000} = \frac{512}{5,625}$$

Hence, Electronic Gear M Value and Electronic Gear N Value should be set to 512 and 5,625 respectively.

● Index Control

[Data Range] **0: No index control**
1: Index control
[Factory Setting] **0: No index control**
[Data Position No.] **Axis 1: 0116; Axis 2: 0416; Axis 3: 0716; Axis 4: 1016**

Index Control specifies whether to use index control.

Index control can be used when Display Unit is set to '0: pulse' or '1: mm'.

Soft limits (forward limit and reverse limit values) are ignored when index control is used.

Hard limits (forward limit Input and reverse limit Input) are also ignored when index control is used. (These inputs, however, can function as input switches during origin search)

Index Range

[Data Range] **4 to 2,147,483,647 (position reference unit)**
[Factory Setting] **4**
[Data Position No.] **Axis 1: 0117/0118; Axis 2: 0417/0418**
Axis 3: 0717/0718; Axis 4: 1017/1018

Index Range specifies the range of the index when using index control.

Under index control, Absolute target position data specified must be between 0 and (Index Range – 1) (position reference unit).

Index Range should be set to a value such that the corresponding number of pulses after electronic gear conversion is an integer. Any fractional value may result in a deviation beyond one rotation.

Index Range need not be specified if Index Control is set to '0: No index control'.

In the following example, Display Unit is set to '2: degree' and Index Range is set to '36,000,000 (x 10^{-5} degree)'

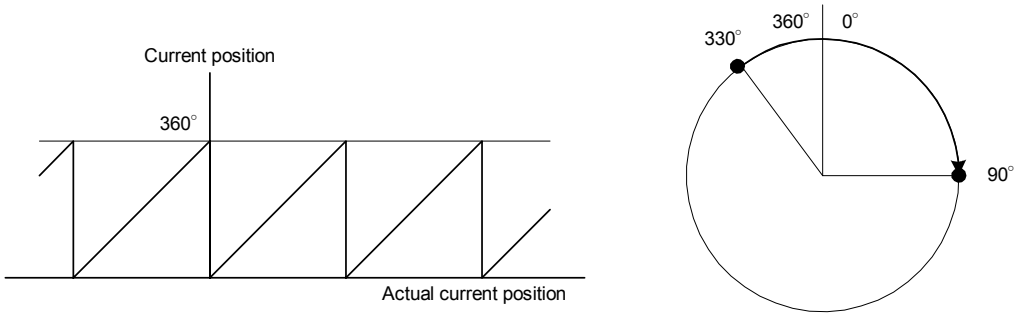


Figure 5.4 Example for Index Range Setup

Forward Limit

[Data Range] **–2,147,483,648 to 2,147,483,647 (position reference unit)**
[Factory Setting] **2,147,483,647**
[Data Position No.] **Axis 1: 0121/0122; Axis 2: 0421/0422**
Axis 3: 0721/0722; Axis 4: 1021/1022

Forward Limit specifies the movement limit in the forward direction as a value from the origin.

If a command is issued with a target position exceeding this limit, an error will be generated and the motor does not move. If the limit is exceeded during interpolation or a change target position movement, an error is generated, and the motor stops immediately.

If origin search is not performed, the position at power up is taken as the origin.

This limit is ignored during speed control, origin search, jogging, manual pulse generator mode and index control. (no error will be generated).

This parameter need not be specified under index control.

Reverse Limit

[Data Range] **–2,147,483,648 to (Forward Limit – 1)**
(position reference unit)
[Factory Setting] **–2,147,483,648**
[Data Position No.] **Axis 1: 0123/0124; Axis 2: 0423/0424**
Axis 3: 0723/0724; Axis 4: 1023/1024

Reverse Limit specifies the movement limit in the reverse direction as a value from the origin.

If a command is issued with a target position exceeding this limit, an error will be generated and the motor does not move. If the limit is exceeded during interpolation or a change target position movement, an error is generated, and the motor stops immediately.

If origin search is not performed, the position at power up is taken as the origin.

This limit is ignored during speed control, origin search, jogging, manual pulse generator mode and index control. (no error will be generated).

This parameter need not be specified under index control.

● Speed Limit

[Data Range] **1 to 5,000,000 (pulse/s)**
1 to 2,147,483,647 (x 10^{-4} mm/s)
1 to 2,147,483,647 (x 10^{-5} degree/s)
(Valid data range depends on Display Unit)
[Factory Setting] **1,000,000**
[Data Position No.] **Axis 1: 0125/0126; Axis 2: 0425/0426**
Axis 3: 0725/0726; Axis 4: 1025/1026

Speed Limit specifies the limit for specified speed values.

If a command is issued with a specified speed exceeding this value, an error will be generated and the motor does not move. If the limit is exceeded during interpolation or a change target position movement, an error is generated, and the motor stops immediately.

Table 5.10 shows the maximum speed of output pulses for each combination of Maximum Speed Selection and Pulse Output Mode parameter values.

You should set the Maximum Speed Limit such that its value after electronic gear conversion using Electronic Gear M Value and Electronic Gear N Value does not exceed the value given in Table 5.10.

● Acceleration/deceleration Curve

[Data Range] **0: Automatic trapezoidal acceleration/deceleration**
(Startup Speed can be specified)
1: S–shape acceleration/deceleration
(Startup Speed cannot be specified)
[Factory Setting] **0: Automatic trapezoidal acceleration/deceleration**
(Startup Speed can be specified)
[Data Position No.] **Axis 1: 0128; Axis 2: 0428; Axis 3: 0728; Axis 4: 1028**

Acceleration/deceleration Curve specifies the acceleration/deceleration curve to be used.

When using stepper motors, selecting an S–shape acceleration/deceleration curve may cause the motor to be out of phase.

- Automatic Trapezoidal Acceleration/Deceleration

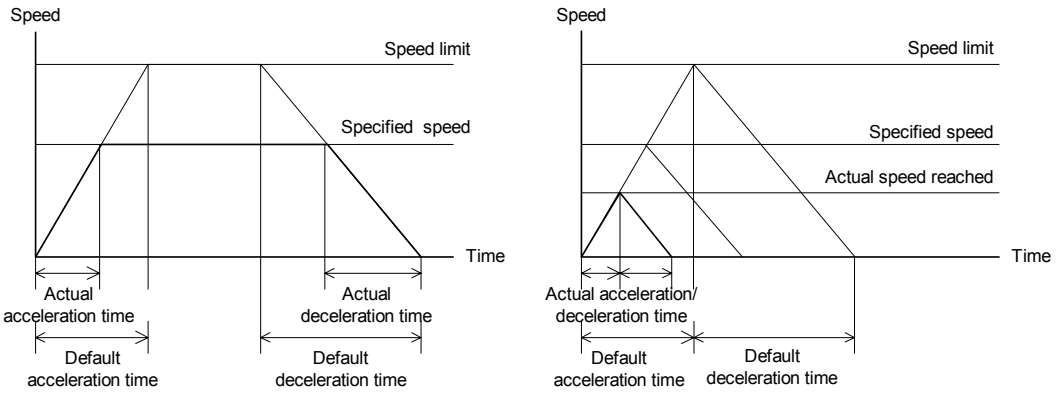


Figure 5.5 Positioning Movement Using Automatic Trapezoidal Acceleration/Deceleration

- S–shape Acceleration/Deceleration

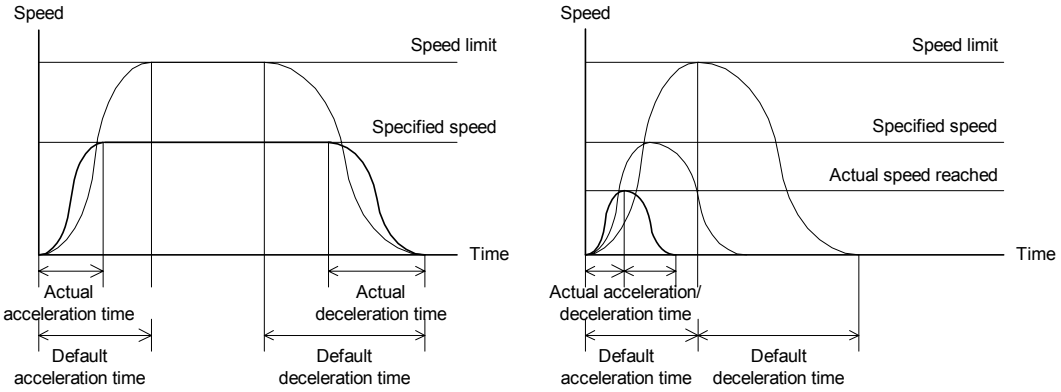


Figure 5.6 Positioning Movement Using Automatic S–shape Acceleration/Deceleration

Startup Speed

[Data Range] **0 to Speed Limit (speed reference unit)**
[Factory Setting] **0**
[Data Position No.] **Axis 1: 0129/0130; Axis 2: 0429/0430**
Axis 3: 0729/0730; Axis 4: 1029/1030

Startup Speed specifies the speed at the beginning of positioning and immediately before stopping at the end of positioning.

Set Startup Speed to 0 if Acceleration/deceleration Curve is set to '1: Automatic S–shape acceleration/deceleration'. Startup Speed is only used for single–axis movements, and is ignored for interpolation.

When using a stepper motor, if Startup Speed is set to 0, the motor may resonate and become out of phase in the early stage of acceleration (or in the late stage of deceleration). To avoid this, set the Startup Speed above the resonance frequency. On the other hand, if the Startup Speed is set too high, the motor is subject to mechanical shock and may become out of phase at starting or stopping. Furthermore, if the travel of a positioning movement is extremely short with respect to the Startup Speed, the motor may move at a speed below the Startup Speed.

When using a servomotor, Startup Speed is normally set to 0.

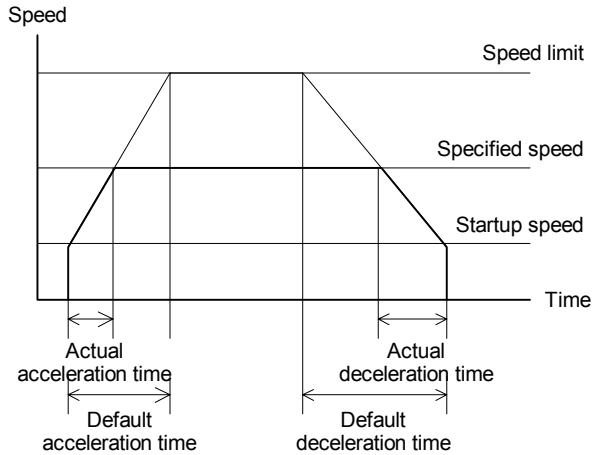


Figure 5.7 Positioning Movement with a Non–Zero Startup Speed

- **Default Acceleration Time**

[Data Range] **0 to 32,767 (ms)**
[Factory Setting] **1,000**
[Data Position No.] **Axis 1: 0131; Axis 2: 0431; Axis 3: 0731; Axis 4: 1031**
Default Acceleration Time specifies the rate of acceleration as the time taken to accelerate from the Startup Speed to the Speed Limit.

A positioning movement may use this acceleration time as default, or be specified with a different acceleration time.

- **Default Deceleration Time**

[Data Range] **0 to 32,767 (ms)**
[Factory Setting] **1,000**
[Data Position No.] **Axis 1: 0132; Axis 2: 0432; Axis 3: 0732; Axis 4: 1032**
Default Deceleration Time specifies the rate of deceleration as the time taken to decelerate from the Speed Limit to the Startup Speed.

A positioning movement may use this deceleration time as default, or be specified with a different deceleration time.

- **CI Error Tolerance**

[Data Range] **0 to 2,147,483,647 (x 10^{-4}mm/s)**
[Factory Setting] **1,000**
[Data Position No.] **Axis 1: 0135/0136; Axis 2: 0435/0436**
Axis 3: 0735/0736; Axis 4: 1035/1036
When performing circular interpolation using a specified center point, depending on the center position and the target position, a deviation may arise between the circular path and the target position. CI Error Tolerance specifies the maximum deviation allowed.

If a command is issued with a target position such that the tolerance limit is exceeded, an error is generated and the motor does not move. If the deviation falls within the error tolerance, circular interpolation follows a whorl–like path.

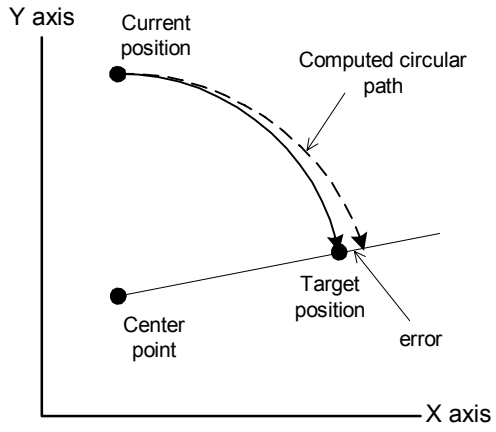


Figure 5.8 CI Error Tolerance Setup

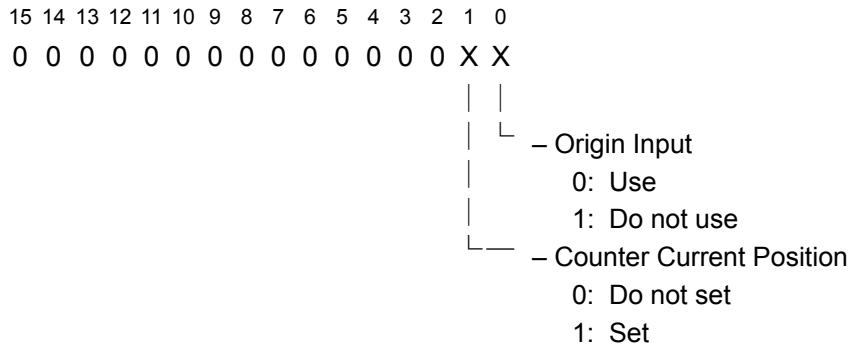
- **AOS Mode**

[Data Range] **$0000 to $0003 (bit data)**
[Factory Setting] **$0000**
[Data Position No.] **Axis 1: 0150; Axis 2: 0450; Axis 3: 0750; Axis 4: 1050**
AOS Mode can be used to specify whether to use the Origin Input during automatic origin search.

AOS Mode can also be used to specify whether to set the origin position found (after applying origin offset) to the counter current position upon successful completion of the automatic origin search operation.

The counter current position cannot be set if Counter Type Selection is set to '1: Sanyo Denki's Manchester Coding'.

For details on automatic origin search, see Section 6.7.1, "Automatic Origin Search".



- **AOS Direction**

[Data Range] **0: Reverse**
1: Forward
[Factory Setting] **0: Reverse**
[Data Position No.] **Axis 1: 0151; Axis 2: 0451; Axis 3: 0751; Axis 4: 1051**
AOS Direction specifies the direction of rotation for moving at AOS Speed 1 during automatic origin search.

- **AOS Dwell Time**

[Data Range] **0 to 32,767 (ms)**
[Factory Setting] **10**
[Data Position No.] **Axis 1: 0152; Axis 2: 0452; Axis 3: 0752; Axis 4: 1052**
AOS Dwell Time specifies the dwell time for automatic origin search.

- **AOS Speed 1**

[Data Range] **1 to Speed Limit (speed reference unit)**
[Factory Setting] **10,000**
[Data Position No.] **Axis 1: 0153/0154; Axis 2: 0453/0454**
Axis 3: 0753/0754; Axis 4: 1053/1054
AOS Speed 1 specifies the high speed for automatic origin search.

Its value must be equal or greater than Startup Speed if Startup Speed is non–zero.

- **AOS Speed 2**

[Data Range] **1 to AOS Speed 1 (speed reference unit)**
[Factory Setting] **1,000**
[Data Position No.] **Axis 1: 0155/0156; Axis 2: 0455/0456**
Axis 3: 0755/0756; Axis 4: 1055/1056
AOS Speed 2 specifies the low speed for automatic origin search.

Its value must be equal or greater than Startup Speed if Startup Speed is non–zero.

- **AOS Acceleration Time**

[Data Range] **0 to 32,767 (ms)**
[Factory Setting] **1,000**
[Data Position No.] **Axis 1: 0157; Axis 2: 0457; Axis 3: 0757; Axis 4: 1057**
AOS Acceleration Time specifies the time taken to accelerate from Startup Speed to AOS Speed 1 in automatic origin search.

- **AOS Deceleration Time**

  [Data Range] **0 to 32,767 (ms)**
  [Factory Setting] **1,000**
  [Data Position No.] **Axis 1: 0158; Axis 2: 0458; Axis 3: 0758; Axis 4: 1058**
  AOS Deceleration Time specifies the time taken to decelerate from AOS Speed 1 to zero in automatic origin search.

- **AOS Z–phase Edge Selection**

  [Data Range] **0: Rising edge**
  1: Falling edge
  [Factory Setting] **0: Rising edge**
  [Data Position No.] **Axis 1: 0159; Axis 2: 0459; Axis 3: 0759; Axis 4: 1059**
  AOS Z–phase Edge Selection selects the Z–phase edge when Z–phase detection is used in automatic origin search.

- **AOS Z–phase Search Count**

  [Data Range] **0 to 32,767 (pulses)**
  [Factory Setting] **0**
  [Data Position No.] **Axis 1: 0160; Axis 2: 0460; Axis 3: 0760; Axis 4: 1060**
  AOS Z–phase Search Count specifies the number of Z–phase pulses to be counted during Z–phase detection in automatic origin search before an origin can be established.

  If this parameter is set to 0, no Z–phase search is performed, and the position where the Origin Input or Forward Limit Input/Reverse Limit Input turns off is taken as the origin.

- **AOS Z–phase Search Range**

  [Data Range] **0 to 2,147,483,647 or 0 to AOS Z–phase Search Count (position reference unit)**
  [Factory Setting] **2,147,483,647**
  [Data Position No.] **Axis 1: 0161/0162; Axis 2: 0461/0462**
  Axis 3: 0761/0762; Axis 4: 1061/1062
  An error will be generated during automatic origin search if Z–phase detection is still not successful after starting Z–phase search, and moving beyond AOS Z–phase Search Range.

  This parameter is used to terminate a search operation when a Z–phase cannot be detected because of a Z–phase signal disconnection or some other reason. It is usually set to a value close to the period of the Z–phase.

  This parameter need not be specified if AOS Z–phase Search Count is set to 0.

- **AOS Deviation Pulse Clear Time**

  [Data Range] **0 to 32,767 (ms)**
  [Factory Setting] **10**
  [Data Position No.] **Axis 1: 0163; Axis 2: 0463; Axis 3: 0763; Axis 4: 1063**
  AOS Deviation Pulse Clear Time specifies the duration for deviation pulse clear signal output after Z–phase search at the end of automatic origin search. This parameter need not be specified if AOS Z–phase Search Count is set to 0 as no deviation pulse clear signal will be output.

If the Deviation Pulse Clear Output is configured to be used as a General Output, there will be no deviation pulse clear signal output.

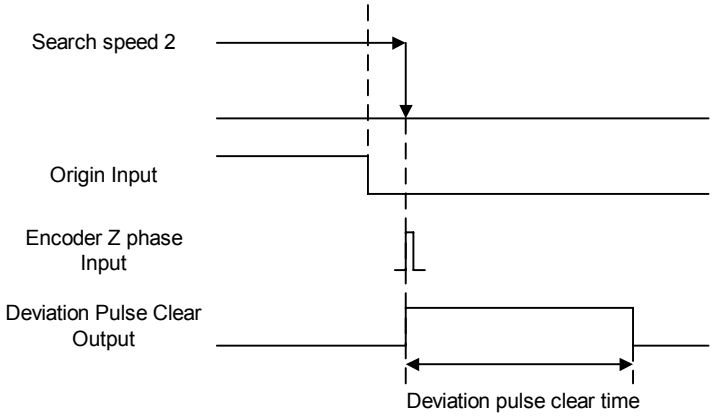


Figure 5.9 Deviation Pulse Clear Signal Output

- ## AOS Offset

[Data Range] **–2,147,483,648 to 2,147,483,647 (position reference unit)**
[Factory Setting] **0**
[Data Position No.] **Axis 1: 0165/0166; Axis 2: 0465/0466**
Axis 3: 0765/0766; Axis 4: 1065/1066

AOS Offset specifies an offset to be applied at the end of automatic origin search to obtain the origin.

AOS Offset is used when there is a mechanical offset between the real origin and the origin position detected at the end of automatic origin search.

If the AOS Mode specifies to set the counter current position, the origin obtained after applying offset is written to the counter current position.

If Index Control is specified, this parameter value must be between 0 and (Index Range – 1); if Counter Index Control is specified and AOS Mode specifies to also set the counter current position, this parameter value must be between 0 and (Counter Index Range – 1).

- ## Counter Type Selection

[Data Range] **0: General–purpose incremental**
1: Sanyo Denki's Manchester Coding
2: Yaskawa Electric's Serial
[Factory Setting] **0: General–purpose incremental**
[Data Position No.] **Axis 1: 0172; Axis 2: 0472; Axis 3: 0772; Axis 4: 1072**

Counter Type Selection specifies the encoder input mode of the encoder to be connected to the counter input.

Select '0: General purpose incremental' for connecting a normal 2–phase (Phase A/Phase B) encoder.

Select '1: Sanyo Denki's Manchester Coding' for connecting an absolute encoder using Manchester Coding Synchronization manufactured by Sanyo Denki Corporation or its equivalent.

Select '2: Yaskawa Electric's Serial' for connecting an absolute encoder manufactured by Yaskawa Electric Corporation or its equivalent.

If '1: Sanyo Denki's Manchester Coding' or '2: Yaskawa Electric's Serial' is specified, absolute data from the absolute encoder is transmitted using serial communication, and read from the Counter Phase A Input.

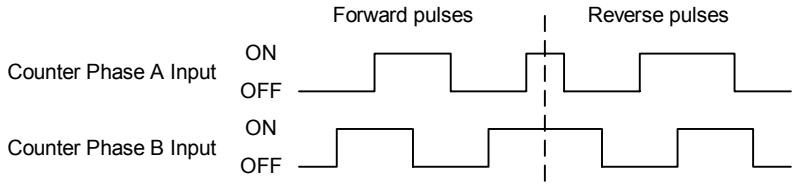
If the counter input is used in a manual pulse generator, this parameter must be set to '0: General–purpose incremental'.

Counter Direction Selection

[Data Range] **0: Forward pulse input denotes forward movement**
1: Reverse pulse input denotes forward movement
[Factory Setting] **0: Forward pulse input denotes forward movement**
[Data Position No.] **Axis 1: 0173; Axis 2: 0473; Axis 3: 0773; Axis 4: 1073**

Counter Direction Selection maps the sign of counter current position data read from the CPU module to the direction of counter input.

Forward and reverse movements represent positive and negative counter current position data read from the CPU module respectively.



Counter Multiplication

[Data Range] **1: x1**
2: x2
4: x4
[Factory Setting] **4: x4**
[Data Position No.] **Axis 1: 0174; Axis 2: 0474; Axis 3: 0774; Axis 4: 1074**

Counter Multiplication specifies the multiplication of the counter when Counter Type Selection is specified as '0: General–purpose incremental' or '2: Yaskawa Electric's Serial'.

The table below shows the maximum speed of input pulses for each counter multiplication option.

Table 5.16 Maximum Speed of Input Pulses

Counter Multiplication	Maximum Speed (pps)
1: x1	1,250,000
2: x2	2,500,000
3: x4	5,000,000

Counter Multiplication is normally set to '4: x4'. If the counter current position exceeds the movement range when Counter Multiplication is set to '4: x4", set it to '2: x2' or '1: x1' instead. This will reduce the counter current position to half or a quarter of its previous value respectively.

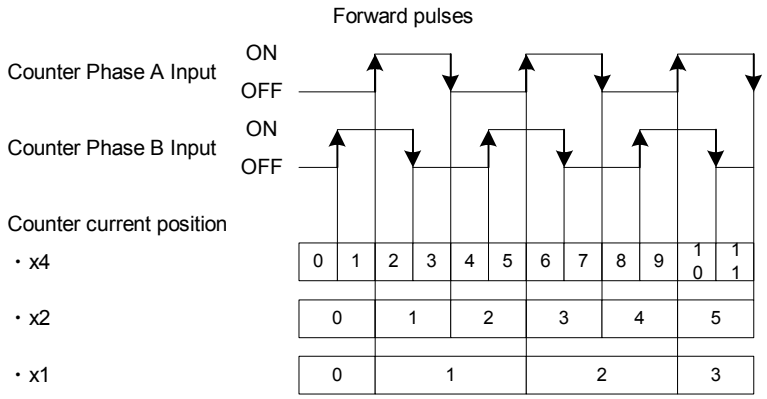


Figure 5.10 Counter Multiplication

Counter Display Unit

[Data Range] **0: pulse**
1: mm
2: degree
[Factory Setting] **0: pulse**
[Data Position No.] **Axis 1: 0175; Axis 2: 0475; Axis 3: 0775; Axis 4: 1075**

Counter Display Unit specifies the unit for position data and speed data used in counter input.

Similar to position data and speed data used in positioning, Counter Display Unit specifies the unit and inherent decimal point position of position data and speed data of counter input as shown in the table below.

When Counter Display Unit is set to '0: pulse', electronic gear function cannot be used, and both Electronic Gear M Value and Electronic Gear N Value must be set to 1.

Table 5.17 Data Read Using Ladder Program

Counter Display Unit	Position Data (position reference unit)	Speed Data (speed reference unit)
Pulse	–2,147,483,648 to 2,147,483,647 (pulse)	1 to 5,000,000 (pulse/s)
mm	–2,147,483,648 to 2,147,483,647 (x 10^{-4} mm/s)	1 to 2,147,483,647 (x 10^{-4} mm/s)
Degree	–2,147,483,648 to 2,147,483,647 (x 10^{-5} degree)	1 to 2,147,483,647 (x 10^{-5} degree/s)

Table 5.18 Data Read Using ToolBox for Positioning Modules (SF662–ECW) software

Counter Display Unit	Position Data (unit)	Speed Data (unit)
Pulse	–2,147,483,648 to 2,147,483,647 (pulse)	1 to 5,000,000 (pulse/s)
mm	–214,748.3648 to 214,748.3647 (mm)	0.0001 to 214,748.3647 (mm/s)
Degree	–21,474.83648 to 21,474.83647 (degree)	0.00001 to 21,474.83647 (degree/s)

Counter Electronic Gear M Value

[Data Range] **1 to 2,147,483,647**
[Factory Setting] **1**
[Data Position No.] **Axis 1: 0177/0178; Axis 2: 0477/0478**
Axis 3: 0777/0778; Axis 4: 1077/1078

Counter Electronic Gear M Value specifies the numerator (M) of the electronic gear ratio for counter input.

Counter Electronic Gear N Value

[Data Range] **1 to 2,147,483,647 (M/N<100)**
[Factory Setting] **1**
[Data Position No.] **Axis 1: 0179/0180; Axis 2: 0479/0480**
Axis 3: 0779/0780; Axis 4: 1079/1080

Counter Electronic Gear N Value specifies the denominator (N) of the electronic gear ratio for counter input.

$$\text{Number of output pulses} = \text{travel} \times \frac{\text{Counter Electronic Gear M Value}}{\text{Counter Electronic Gear N Value}}$$

The actual number of input pulses is calculated from the electronic gear (Electronic Gear M Value and Electronic Gear N Value) as follows:

When Counter Display Unit is set to '0: pulse', the electronic gear function cannot be used, and both Counter Electronic Gear M Value and Counter Electronic Gear N Value must be set to 1.

For an example on how to set up the Counter Electronic Gear M Value and Counter Electronic Gear N Value, see the description for Electronic Gear M Value and Electronic Gear N Value.

- **Counter Index Control**

[Data Range] **0: No index control**
1: Index control
[Factory Setting] **1: Index control**
[Data Position No.] **Axis 1: 0182; Axis 2: 0482; Axis 3: 0782; Axis 4: 1082**

Counter Index Control specifies whether index control is used in counter input.

Index control can be used when Counter Display Unit is set to '0: pulse' or '1: mm'.

If a counter is not subject to index control, a counter overflow error is generated if an attempt is made to bring the current position of the counter beyond the maximum value that can be represented by 32 bits.

- **Counter Index Range**

[Data Range] **0; 4 to 2,147,483,647 (counter position reference unit)**
[Factory Setting] **0**
[Data Position No.] **Axis 1: 0183/0184; Axis 2: 0483/0484**
Axis 3: 0783/0784; Axis 4: 1083/1084

Counter Index Range specifies the range of the index when using index control.

If Counter Index Range is set to 0, the counter operates as a 32-bit ring counter.

Counter Index Range should be set to a value such that the corresponding number of pulses after electronic gear conversion is an integer. Any fractional value may result in a deviation beyond one rotation.

If Counter Index Range is non–zero, counter position data specified under index control must be between 0 and (Counter Index Range – 1) (position reference unit).

Counter Index Range need not be specified if Counter Index Control is set to '0: No index control'.

For an example on how to set the Counter Index Range, see the description for Index Range.

- **ABS Encoder Offset**

[Data Range] **–2,147,483,648 to 2,147,483,647**
(counter position reference unit)
[Factory Setting] **0**
[Data Position No.] **Axis 1: 0185/0186; Axis 2: 0485/0486**
Axis 3: 0785/0786; Axis 4: 1085/1086

ABS Encoder Offset specifies the difference between the output value from the absolute encoder and the counter current position read by the CPU module from the positioning module when Counter Type Selection is set to '1: Sanyo Denki's Manchester Coding' or '2: Yaskawa Electric's Serial'.

If the output value of the absolute encoder is zero, the counter current position assumes the value of this parameter.

This parameter need not be specified if Counter Type Selection is set to '0: General–purpose Incremental'.

- **ABS Encoder Pulses Per Rev.**

  [Data Range] **0 to 2,147,483,647 (pulse)**
  [Factory Setting] **32,768**
  [Data Position No.] **Axis 1: 0187/0188; Axis 2: 0487/0488**
  Axis 3: 0787/0788; Axis 4: 1087/1088

  ABS Encoder Pulses Per Rev. specifies the number of pulses per revolution of the motor when Counter Type Selection is set to '2: Yaskawa Electric's Serial'.

  Counter Multiplication should be considered when setting this parameter. For instance, if an absolute encoder with 1024 (pulses) per rotation is used with 4x multiplication, the ABS Encoder Pulses Per Rev. should be set to 4,096.

  This parameter need not be specified if Counter Type Selection is not set to '2: Yaskawa Electric's Serial'.

- **ABS Encoder Bit Length**

  [Data Range] **17 to 28 (bits)**
  [Factory Setting] **28**
  [Data Position No.] **Axis 1: 0189; Axis 2: 0489; Axis 3: 0789; Axis 4: 1089**

  ABS Encoder Bit Length specifies the resolution of an encoder in terms of the number of bits used to encode a position when Counter Type Selection is set to '1: Sanyo Denki's Manchester Coding'.

  For more details, read the instruction manual of the encoder or servo driver used.

  This parameter need not be specified if Counter Type Selection is not set to '1: Sanyo Denki's Manchester Coding'.

Counter Usage Selection

[Data Range] **0: Counter coincidence**
1: Zone coincidence
[Factory Setting] **0: Counter coincidence**
[Data Position No.] **Axis 1: 0190; Axis 2: 0490; Axis 3: 0790; Axis 4: 1090**

Counter Usage Selection specifies the counter usage mode for counter input.

This function allows an interrupt signal to be raised to the CPU module to trigger execution of A counter can be configured to generate an event when the counter current position coincides with a preset value or falls within a preset range. The event can be used to trigger a positioning action waiting to start or raise an interrupt signal to the CPU module.

- Counter Coincidence Detection

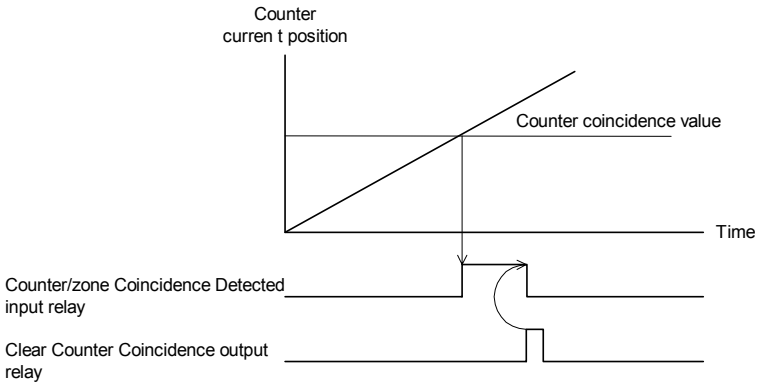


Figure 5.11 Counter Coincidence Detection Function

- Zone Coincidence Detection

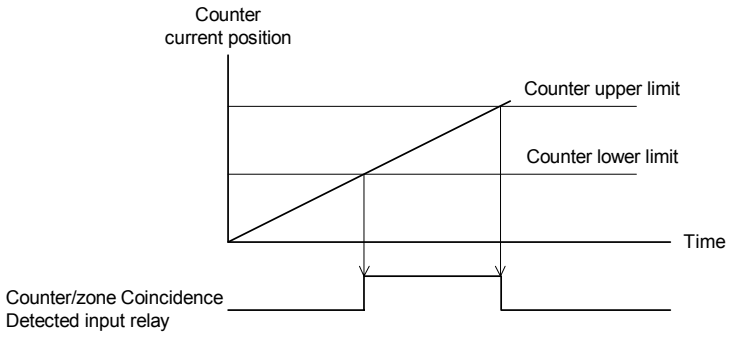


Figure 5.12 Zone Coincidence Detection Function

Counter Coincidence Value

[Data Range] **–2,147,483,648 to 2,147,483,647**
(counter position reference unit)
[Factory Setting] **0**
[Data Position No.] **Axis 1: 0191/0192; Axis 2: 0491/0492**
Axis 3: 0791/0792; Axis 4: 1091/1092

Counter Coincidence Value specifies the preset value for counter coincidence detection when Counter Usage Selection is set to '0: Counter coincidence'.

This value can also be changed by executing a Counter Setup command.

This parameter need not be specified if Counter Usage Selection is set to '1: Zone coincidence'.

- **Counter Upper Limit**

  [Data Range] **–2,147,483,648 to 2,147,483,647 (counter position reference unit)**
  [Factory Setting] **2,147,483,647**
  [Data Position No.] **Axis 1: 0193/0194; Axis 2: 0493/0494 Axis 3: 0793/0794; Axis 4: 1093/1094**

  Counter Upper Limit specifies the upper limit for zone coincidence detection when Counter Usage Selection is set to '1: Zone coincidence'.

  This value can be changed by executing a Counter Setup command.

  This parameter need not be specified if Counter Usage Selection is set to '0: Counter coincidence'.

- **Counter Lower Limit**

  [Data Range] **–2,147,483,648 to Counter Upper Limit (counter position reference unit)**
  [Factory Setting] **–2,147,483,648**
  [Data Position No.] **Axis 1: 0195/0196; Axis 2: 0495/0496 Axis 3: 0795/0796; Axis 4: 1095/1096**

  Counter Lower Limit specifies the lower limit for zone coincidence detection when Counter Usage Selection is set to '1: Zone coincidence'.

  This value can be changed by executing a Counter Setup command.

  This parameter need not be specified if Counter Usage Selection is set to '0: Counter coincidence'.

5.2.3 Axis Command Parameters

This section lists and describes axis command parameters.

■ List of Axis Command Parameters

Table 5.19 List of Axis Command Parameters

Data Position No.				Parameter Name	Data Range and Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0201	0501	0801	1101	Direct Command Code	0 to 32,767	5–32
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	5–32
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non–zero: Startup condition code	5–32
0204	0504	0804	1104	End Condition	0: Normal end; Non–zero: End condition code	5–35
0205	0505	0805	1105	(System reserved)		–
0206	0506	0806	1106	Target Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	5–35
0207 / 0208	0507 / 0508	0807 / 0808	1107 / 1108	Target Position	–2,147,483,648 to 2,147,483,647 (position reference unit) or position data no. (1 to No. of Position Data Records Used)	5–35
0209 to 0210	0509 to 0510	0809 to 0810	1109 to 1110	(System reserved)		–
0211 / 0212	0511 / 0512	0811 / 0812	1111 / 1112	Specified Speed	1 to Speed Limit (speed reference unit) or –(Speed Limit) to (Speed Limit) (speed reference unit)	5–36
0213	0513	0813	1113	Acceleration Time	–1: Default acceleration; 0 to 32,767 (ms)	5–36
0214	0514	0814	1114	Deceleration Time	–1: Default deceleration; 0 to 32,767 (ms)	5–36
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	5–37
0216	0516	0816	1116	Preset Override Value	1 to 500 (%)	5–37
0217 to 0218	0517 to 0518	0817 to 0818	1117 to 1118	(System reserved)		–
0219	0519	0819	1119	CI Turns	0 to 32,767 (turns)	5–38
0220	0520	0820	1120	CI Sub Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	5–38
0221 / 0222	0521 / 0522	0821 / 0822	1121 / 1122	CI Sub Position	–2,147,483,648 to 2,147,483,647 (position reference unit) Or, position data no. (1 to 2,000)	5–38
0223	0523	0823	1123	Contact Output Setting	$0000 to $0707 (bit data)	5–38
0224	0524	0824	1124	MPG Mode Multiplication	–32,768 to 32,767	5–39
0225	0525	0825	1125	MPG Mode Decimal Point	0: x 1; 1: x 1/10; 2: x 1/100; 3: x 1/1,000; 4: x 1/10,000	5–39
0226 to 0227	0526 to 0527	0826 to 0827	1126 to 1127	(System reserved)		–
0228	0528	0828	1128	Origin Search Direction	0: Reverse; 1: Forward	5–39
0229	0529	0829	1129	Z–phase Edge Selection	0: Rising edge; 1: Falling edge	5–40
0230	0530	0830	1130	Z–phase Search Count	0 to 32,767 (pulses)	5–40
0231 / 0232	0531 / 0532	0831 / 0832	1131 / 1132	Z–phase Search Range	0 to 2,147,483,647 or 0 to Z–phase Search Count (position reference unit)	5–40
0233	0533	0833	1133	Deviation Pulse Clear Time	0 to 32,767 (ms)	5–40
0234	0534	0834	1134	(System reserved)		–
0235 / 0236	0535 / 0536	0835 / 0836	1135 / 1136	Counter Coincidence Value	–2,147,483,648 to 2,147,483,647 (counter position reference unit)	5–41
0237 / 0238	0537 / 0538	0837 / 0838	1137 / 1138	Counter Upper Limit	–2,147,483,648 to 2,147,483,647 (counter position reference unit)	5–41
0239 / 0240	0539 / 0540	0839 / 0840	1139 / 1140	Counter Lower Limit	–2,147,483,648 to Counter Upper Limit (counter position reference unit)	5–41
0241 to 0300	0541 to 0600	0841 to 0900	1141 to 1200	(System reserved)		–

■ Description of Axis Command Parameters

● Direct Command Code

[Data Range] **0 to 32,767**
[Data Position No.] **Axis 1: 0201; Axis 2: 0501; Axis 3: 0801; Axis 4: 1101**
Direct Command Code specifies the code of a direct command to be executed.

Table 5.20 List of Direct Command Codes

Command Code	Command Name	Function	See Also
0	Single–axis Positioning	Performs positioning using one axis.	6–50
1	Linear Interpolation	Performs positioning of 2, 3 or 4 axes using linear interpolation.	6–56
2	Circular Interpolation Using Sub Point	Performs circular interpolation movement of 2 axes using a specified sub point.	6–62
3	CW Circular Interpolation Using Center	Performs clockwise circular interpolation movement of 2 axes using a specified center point.	6–62
4	CCW Circular Interpolation Using Center	Performs counter–clockwise circular interpolation movement of 2 axes using a specified center point.	6–62
5	CW Helical Interpolation	Performs clockwise helical interpolation movement of 3 of 4 axes using a specified center point.	6–69
6	CCW Helical Interpolation	Performs counter–clockwise helical interpolation movement of 3 of 4 axes using a specified center point.	6–69
10	Position Control to Speed Control	Switches from position control mode to speed control mode.	6–83
11	Speed Control to Position Control	Switches from speed control mode to position control mode.	6–86
12	Single–axis Speed Control Movement	Performs single–axis speed control movement.	6–92
13	Linear Speed Control Movement	Performs linear interpolated speed control movement using 2, 3 or 4 axes.	6–97
15	Index Positioning	Performs single–axis positioning under index control.	6–103
16	Index Speed Control Movement	Performs single–axis speed control movement under index control.	6–109
20	Decelerate and Stop	Decelerates and stops a positioning movement.	6–120
21	Change Speed	Adjusts movement using a new specified speed during movement.	6–114
22	Set Override	Changes override value.	6–128
23	Contact Outputs On/Off	Sets output of selected external contacts to ON or OFF.	6–150
30	Set Axis Registered Parameters	Sets up registered parameters of individual axes.	6–9
32	Save to Flash Memory	Saves all parameters to flash memory. (This command can only be executed from axis 1.)	6–153
33	Initialize Flash Memory	Initializes the flash memory. (This command can only be executed from axis 1.)	6–157
40	Set current position	Changes the current position.	6–45
41	Teach (Write Current Position)	Writes the current position value to the position data table.	6–133
42	Teach (Write Current Counter Position)	Writes the counter current position value to the position data table.	6–133
43	Teach (Write Numeric Data)	Writes numeric data to the position data table.	6–133
44	Start Manual Pulse Generator Mode	Switches from position control mode to manual pulse generator (MPG) mode.	6–23
45	Stop Manual Pulse Generator Mode	Switches from manual pulse generator mode to position control mode.	6–29
50	Reset Error	Clears error status of positioning module.	6–15
60	Automatic Origin Search	Performs automatic origin search according to the axis registered parameter values.	6–32
61	Manual Origin Search	Performs customized manual origin search.	6–39
70	Set Counter Current Position	Changes the counter current position.	6–138
71	Counter Setup	Sets the Counter Type Selection and other counter–related parameters.	6–142
72	Read Yaskawa Encoder Data	Reads absolute data from absolute encoder manufactured by Yaskawa Electric.	6–147

● Command Options

[Data Range] **$0000 to $FFFF**
[Data Position No.] **Axis 1: 0202; Axis 2: 0502; Axis 3: 0802; Axis 4: 1102**
Command Options specifies various options for a direct command.

Its data varies with individual commands. For more details, refer to the detailed description for individual commands.

Startup Condition

[Data Range] **0: Normal startup; Non–zero: Startup condition code**
[Data Position No.] **Axis 1: 0203; Axis 2: 0503; Axis 3: 0803; Axis 4: 1103**

Startup Condition specifies startup condition for a direct command.

If Startup Condition is set to '0: Normal startup', the direct command is executed on the rising edge of the Execute Command output relay.

If set to a non–zero value, execution is delayed until a trigger condition (e.g. external trigger input, external trigger to encoder Z–phase input, or counter/zone coincidence) becomes true. The trigger condition can be specified not only for the command axis from which the command is executed, but also for the contact input of another axis.

To cancel a command waiting for a trigger, turn on the Stop Immediately output relay or execute a Decelerate and Stop command for the axis where the command was previously issued.

No timeout processing for trigger waiting is performed internally. Thus, programs should be written to handle the situation where the trigger condition never becomes true.

Table 5.21 Startup Conditions

Startup Condition	Trigger Condition
0	Normal startup
1	External trigger input (of command execution axis)
2	External trigger input & encoder Z–phase input (of command execution axis)
3	Counter/zone coincidence (of command execution axis)
11	External trigger input of axis 1
12	External trigger input of axis 2
13	External trigger input of axis 3
14	External trigger input of axis 4
21	External trigger input & encoder Z–phase input of axis 1
22	External trigger input & encoder Z–phase input of axis 2
23	External trigger input & encoder Z–phase input of axis 3
24	External trigger input & encoder Z–phase input of axis 4
31	Counter/zone coincidence of axis 1
32	Counter/zone coincidence of axis 2
33	Counter/zone coincidence of axis 3
34	Counter/zone coincidence of axis 4

- **Normal startup**
  With normal startup, a command is executed immediately on the rising edge of the Execute Command output relay.

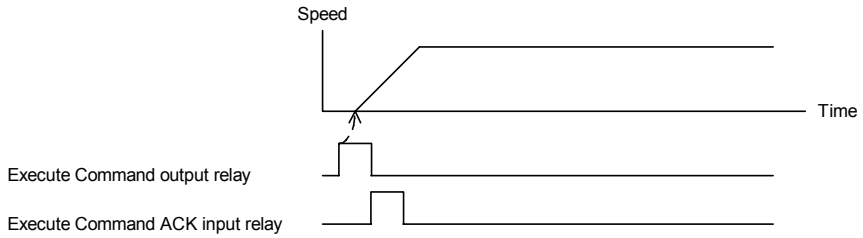


Figure 5.13 Positioning Movement Started Using Normal Startup

- **External Trigger Input**
  With external trigger input startup, a command is executed when the External Trigger Input turns on
  The command is executed immediately if the External Trigger Input is on when the command is issued.
  The External Trigger Input is ignored if it is configured to be used as a General Input.

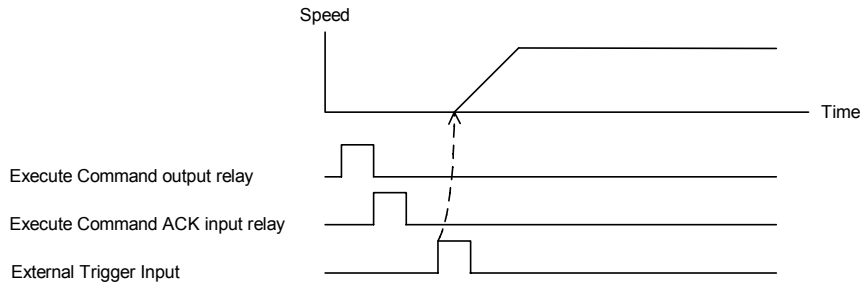


Figure 5.14 Positioning Movement Started Using External Trigger Input

- **External Trigger Input & Encoder Z–phase Input**
  With 'External trigger input & encoder Z–phase input' startup, edge detection of the Encoder Z–phase Input is performed when the External Trigger Input turns on.
  The module shifts to edge detection of the Encoder Z–phase Input immediately if the External Trigger Input is on when the command is issued.
  The External Trigger Input is ignored if it is configured to be used as a General Input.
  Beware that the movement may never be started if the motor associated with the startup condition is at rest.

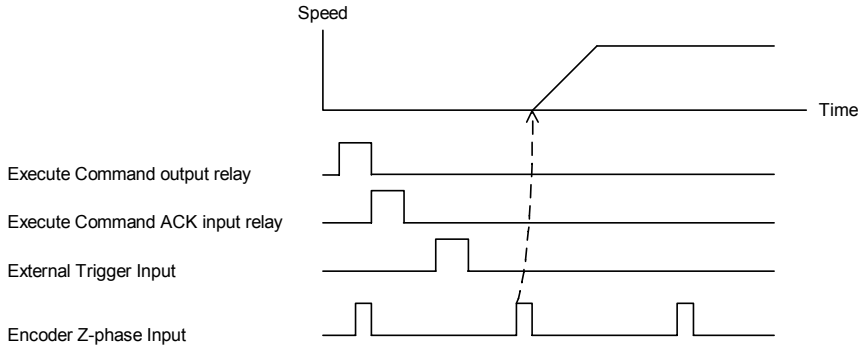


Figure 5.15 Positioning Movement Started Using External Trigger Input & Encoder Z–phase Input

- **Counter/zone coincidence**
  With counter/zone coincidence startup, the command is executed when the Counter/Zone Coincidence Detected input relay is on.
  The command is executed immediately if the Counter/Zone Coincidence Detected relay is on when the command is issued.
  The behavior of the Counter/Zone Coincidence Detected input relay can be configured using axis registered parameters and changed using the Counter Setup command.

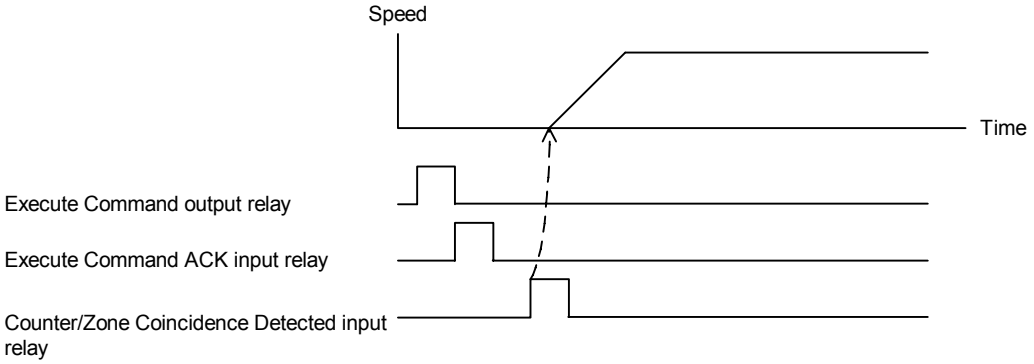


Figure 5.16 Positioning Movement Started Using Counter/Zone Coincidence

End Condition

[Data Range] **0: Normal end; Non–zero: End condition code**
[Data Position No.] **Axis 1: 0204; Axis 2: 0504; Axis 3: 0804; Axis 4: 1104**

End Condition specifies zero or more external contact output to be turned on when positioning completes (the Positioning Completed input relay turns on) using bit data. This parameter can only be used to turn on external contact outputs set to '1: Used As General Output' by Contact Usage Selection of axis registered parameters. An error is generated if Contact Usage Selection specifies to use Deviation Pulse Clear Output.

The specified contact outputs are not turned on if the positioning movement did not complete successfully due to occurrence of an error, execution of a Decelerate and Stop command or any other reason.

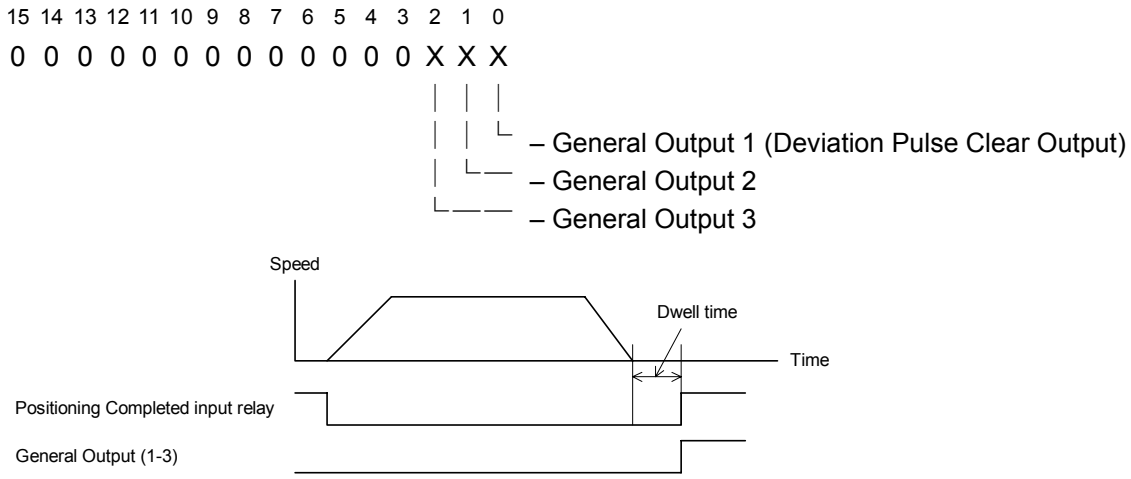


Figure 5.17 State of Contact Output at Completion of Positioning

Target Position Mode

[Data Range] **0: Using ABS position**
1: Using INC position
2: Using position data no.
[Data Position No.] **Axis 1: 0206; Axis 2: 0506; Axis 3: 0806; Axis 4: 1106**

Target Position Mode defines how a target position is specified.

If Target Position Mode is set to '0: Using ABS position', a specified target position is accepted as is, regardless of the startup position.

If Target Position Mode is set to '1: Using INC position', a specified target position is interpreted as an increment relative to the stop position if an axis is at rest or relative to the last specified target position if a target position is changed during movement.

If Target Position Mode is set to '2: Using position data no.', a specified target position refers to position data pre–stored in the position data table as an absolute position or incremental position.

Target Position

[Data Range] **–2,147,483,648 to 2,147,483,647 (position reference unit)**
or position data no. (1 to No. of Position Data Records Used)
[Data Position No.] **Axis 1: 0207/0208; Axis 2: 0507/0508**
Axis 3: 0807/0808; Axis 4: 1107/1108

Target Position specifies the target position of a positioning command or the new current position of a Set Current Position command.

This parameter should be set to a position data number if Target Position Mode is set to '2: Using position data no.".

The final target position computed from the values of the Target Position and Target Position Mode must be between the Forward Limit and Reverse Limit of axis registered parameters.

- **Specified Speed**

[Data Range] **1 to Speed Limit (speed reference unit)**
or, –(Speed Limit) to (Speed Limit) (speed reference unit)
[Data Position No.] **Axis 1: 0211/0212; Axis 2: 0511/0512**
Axis 3: 0811/0812; Axis 4: 1111/1112

Specified Speed specifies the movement speed for a positioning command, speed control movement command or a jog operation.

Specified Speed is normally positive. However, for speed control movement commands and index speed control movement commands, its sign indicates the direction of rotation.

Specified Speed should be smaller than the Speed Limit axis registered parameter. It should be above Startup Speed if Startup Speed is non–zero.

If an override is specified, the speed at 100% override, as well as the speed after override adjustment at command issuance must be between Startup Speed and Speed Limit.

Specified Speed should not be set to zero.

- **Acceleration Time**

[Data Range] **–1: value of Default Acceleration Time axis registered parameter**
0 to 32,767 (ms)
[Data Position No.] **Axis 1: 0213; Axis 2: 0513; Axis 3: 0813; Axis 4: 1113**

Acceleration Time specifies the time to be taken to accelerate from Startup Speed to Specified Speed.

If Acceleration Time is set to –1, the value of the Default Acceleration Time axis registered parameter is used.

If there is no need to change the acceleration time for individual positioning actions, set Acceleration Time to –1.

- **Deceleration Time**

[Data Range] **–1: value of Default Deceleration Time axis registered parameter**
0 to 32,767 (ms)
[Data Position No.] **Axis 1: 0214; Axis 2: 0514; Axis 3: 0814; Axis 4: 1114**

Deceleration Time specifies the time to be taken to decelerate from Specified Speed to Startup Speed.

If Deceleration Time is set to –1, the value of the Default Deceleration Time axis registered parameter is used.

If there is no need to change the deceleration time for individual positioning actions, set Deceleration Time to –1.

- **Using Default Acceleration Time and Default Deceleration Time of axis registered parameters**

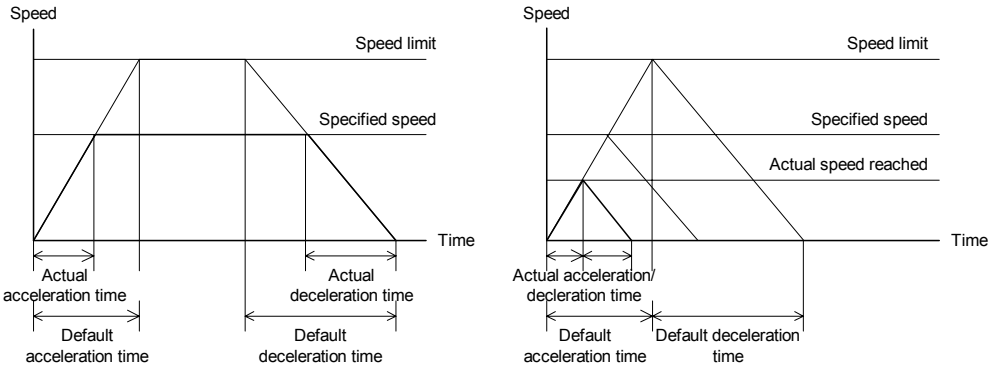


Figure 5.18 Positioning Movement Using Default Acceleration and Deceleration Time

- **Specifying Acceleration Time and Deceleration Time**

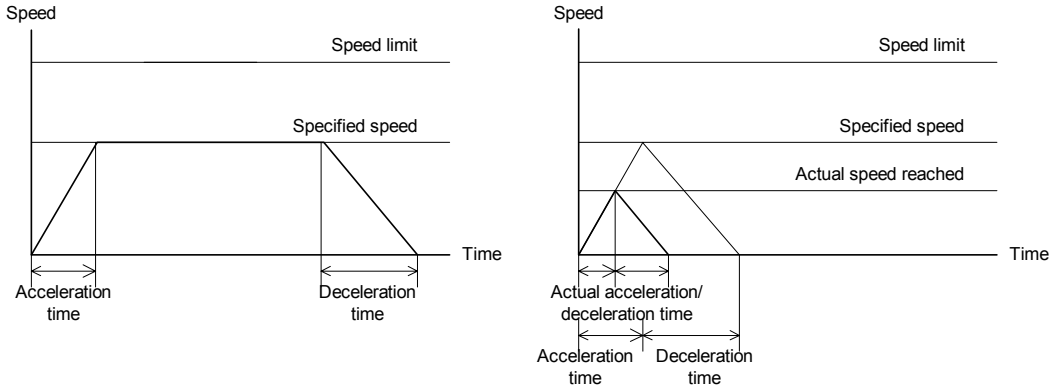


Figure 5.19 Positioning Movement Using Specified Acceleration Time and Deceleration Time

● Dwell Time

[Data Range] 0 to 32,767 (ms)
[Data Position No.] Axis 1: 0215; Axis 2: 0515; Axis 3: 0815; Axis 4: 1115
Dwell Time specifies the delay for turning on the Positioning Completed input relay after a positioning movement initiated by a positioning command completes execution.

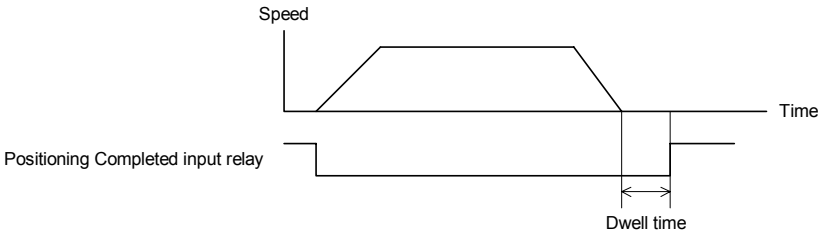


Figure 5.20 Setting Dwell Time

● Preset Override Value

[Data Range] 1 to 500 (%)
[Data Position No.] Axis 1: 0216; Axis 2: 0516; Axis 3: 0816; Axis 4: 1116
Preset Override Value specifies a new override value for a Set Override command to be used for scaling Specified Speed by 1 to 500%.

Executing a Set Override command during movement performs a change speed action.

The Preset Override Value must be such that (Specified Speed x Preset Override Value (%)) is smaller than the Speed Limit axis registered parameter. If Startup Speed is non–zero, the computed value must also be above the Startup Speed.

Current Speed Status of axis statuses stores the value of the actual speed after override adjustment.

- **CI Turns**

  [Data Range] **0 to 32,767 (turns)**
  [Data Position No.] **Axis 1: 0219; Axis 2: 0519; Axis 3: 0819; Axis 4: 1119**
  CI Turns specifies the number of turns for circular interpolation commands and helical interpolation commands.

  Setting CI Turns to zero moves directly to the target position without making any turns.

  Setting CI Turns to a non–zero integer produces the specified number of revolutions from the starting position before movement to the target position.

- **CI Sub Position Mode**

  [Data Range] **0: Using ABS position**
  1: Using INC position
  2: Using position data no.
  [Data Position No.] **Axis 1: 0220; Axis 2: 0520; Axis 3: 0820; Axis 4: 1120**
  CI Sub Position Mode specifies how the sub position or center position is specified for circular interpolation commands and helical interpolation commands.

  If CI Sub Position Mode is set to "0: Using ABS position', CI Sub Position is accepted as is, regardless of the startup position.

  If CI Sub Position Mode is set to '1: Using INC position', CI Sub Position is interpreted as an increment relative to the stop position if an axis is at rest or relative to the last specified target position if a target position is changed during movement.

  If CI Sub Position Mode is set to '2: Using position data no.', CI Sub Position refers to position data pre–stored in the position data table as an absolute position or incremental position.

- **CI Sub Position**

  [Data Range] **–2,147,483,648 to 2,147,483,647 (position reference unit)**
  or, position data no. (1 to 2,000)
  [Data Position No.] **Axis 1: 0221/0222; Axis 2: 0521/0522**
  Axis 3: 0821/0822; Axis 4: 1121/1122
  CI Sub Position specifies the circular interpolation sub position for circular interpolation commands and helical interpolation commands.

  This parameter should be set to a position data number if CI Sub Position Mode is set to '2: Using position data no.".

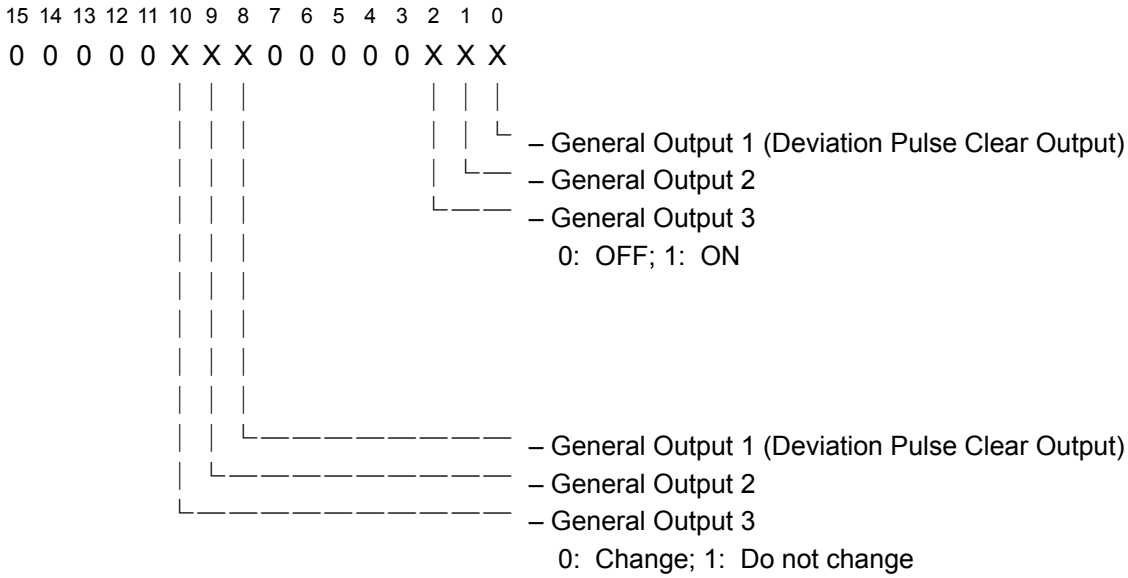
  The final circular interpolation sub position computed from the values of CI Sub Position and CI Sub Position Mode must be between the Forward Limit and Reverse Limit of axis registered parameters.

- **Contact Output Setting**

  [Data Range] **$0000 to $0707 (bit data)**
  [Data Position No.] **Axis 1: 0223; Axis 2: 0523; Axis 3: 0823; Axis 4: 1123**
  Contact Output Setting uses bit data to specify which external contact outputs are to be turned off or turned on by a Contact Outputs On/Off command.

  This parameter can only be used to turn on external contact outputs set to '1: Used As General Output' by Contact Usage Selection of axis registered parameters. An error is generated if Contact Usage Selection specifies to use Deviation Pulse Clear Output.

  One part of the bit data contains mask bits that indicate which general outputs are to be changed, while another part of the bit data indicates whether each bit to be changed is to be turned on or turned off.



- **MPG Mode Multiplication**

  [Data Range] –32,768 to 32,767
  [Data Position No.] Axis 1: 0224; Axis 2: 0524; Axis 3: 0824; Axis 4: 1124
  MPG Mode Multiplication specifies the multiplication to be applied to the counter input in MPG mode when a manual pulse generator is connected to manually operate a motor.

  MPG Mode Multiplication is normally positive; setting a negative value, however, allows output of pulses in the opposite direction for the counter input.

  If MPG Mode Multiplication is set to 0, no movement can be produced.

- **MPG Mode Decimal Point**

  [Data Range] 0: x 1
  1: x 1/10
  2: x 1/100
  3: x 1/1,000
  4: x 1/10,000
  [Data Position No.] Axis 1: 0225; Axis 2: 0525; Axis 3: 0825; Axis 4: 1125
  MPG Mode Decimal Point specifies the decimal point position of the counter input in MPG mode when a manual pulse generator is connected to manually operate a motor.

  The actual angular rotation of the motor is computed from MPG Mode Multiplication and MPG Mode Decimal Point using the following formula.

  Motor Rotation (position reference unit)
  = Counter Input (counter position reference unit) x Multiplication x Decimal Point

  When combined, these two parameters allow the number of input pulses to be scaled by 1/10,000 to 32,767.

- **Origin Search Direction**

  [Data Range] 0: Reverse
  1: Forward
  [Data Position No.] Axis 1: 0228; Axis 2: 0528; Axis 3: 0828; Axis 4: 1128
  Origin Search Direction specifies the movement direction for origin search for a Manual Origin Search command.

  For details on manual origin search, see Section 6.7.2, "Manual Origin Search".

- **Z–phase Edge Selection**

[Data Range] **0: Rising edge**
1: Falling edge
[Factory Setting] **0: Rising edge**
[Data Position No.] **Axis 1: 0229; Axis 2: 0529; Axis 3: 0829; Axis 4: 1129**
Z–phase Edge Selection specifies whether to detect the rising edge or falling edge of Z–phase for a manual origin search command or a startup condition for a positioning movement.

- **Z–phase Search Count**

[Data Range] **0 to 32,767 (pulses)**
[Data Position No.] **Axis 1: 0230; Axis 2: 0530; Axis 3: 0830; Axis 4: 1130**
Z–phase Search Count specifies the number of Z–phase input edges to be counted during Z–phase detection for a Manual Origin Search command or a startup condition for a positioning movement.

Specify a value equal or greater than 1 for detection of Z–phase edges in a startup condition.

- **Z–phase Search Range**

[Data Range] **0 to 2,147,486,647 or 0 to Z–phase Search Count (position reference unit)**
[Data Position No.] **Axis 1: 0231/0232; Axis 2: 0531/0532**
Axis 3: 0831/0832; Axis 4: 1131/1132
An error occurs if Z–phases cannot be detected after starting Z–phase search, and moving beyond the Z–phase Search Range during manual origin search.

This parameter is used to terminate a search operation when a Z–phase cannot be detected because of a Z–phase signal disconnection or some other reason. It is usually set to a value close to the period of the Z–phase.

- **Deviation Pulse Clear Time**

[Data Range] **0 to 32,767 (ms)**
[Factory Setting] **10**
[Data Position No.] **Axis 1: 0233; Axis 2: 0533; Axis 3: 0833; Axis 4: 1133**
Deviation Pulse Clear Time specifies the duration for outputting the deviation pulse clear signal at the end of origin search after Z–phase detection for a Manual Origin Search command.

The module does not output a deviation pulse clear signal if Z–phase Search Count is set to zero.

If the Deviation Pulse Clear Output is configured to be used as a General Output, there will be no deviation pulse clear signal output even if Deviation Pulse Clear Time is set to a non–zero value.

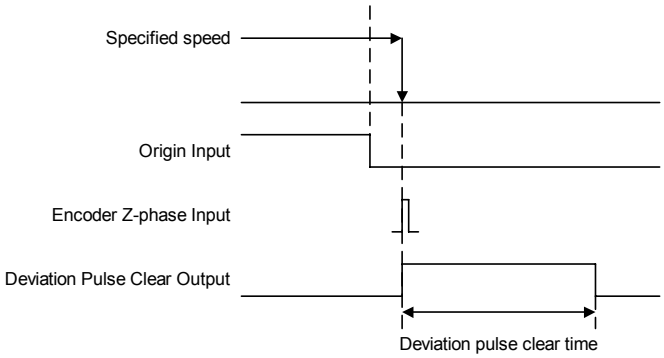


Figure 5.21 Deviation Pulse Clear Signal Output

Counter Coincidence Value

[Data Range] **–2,147,483,648 to 2,147,483,647 (counter position reference unit)**

[Data Position No.] **Axis 1: 0235/0236; Axis 2: 0535/0536 Axis 3: 0835/0836; Axis 4: 1135/1136**

Counter Coincidence Value specifies the value for counter coincidence detection for a Counter Setup command.

This value can also be preset using axis registered parameters.

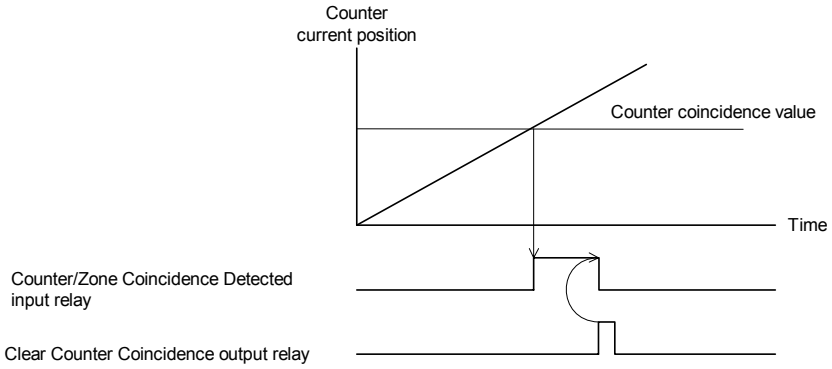


Figure 5.22 Counter Coincidence Detection Function

Counter Upper Limit

[Data Range] **–2,147,483,648 to 2,147,483,647 (counter position reference unit)**

[Data Position No.] **Axis 1: 0237/0238; Axis 2: 0537/0538 Axis 3: 0837/0838; Axis 4: 1137/1138**

Counter Upper Limit specifies the upper limit for zone coincidence detection for a Counter Setup command.

This value can also be preset using axis registered parameters.

Counter Lower Limit

[Data Range] **–2,147,483,648 to Counter Upper Limit (counter position reference unit)**

[Data Position No.] **Axis 1: 0239/0240; Axis 2: 0539/0540 Axis 3: 0839/0840; Axis 4: 1139/1140**

Counter Lower Limit specifies the lower limit for zone coincidence detection for a Counter Setup command.

This value can also be preset using axis registered parameters.

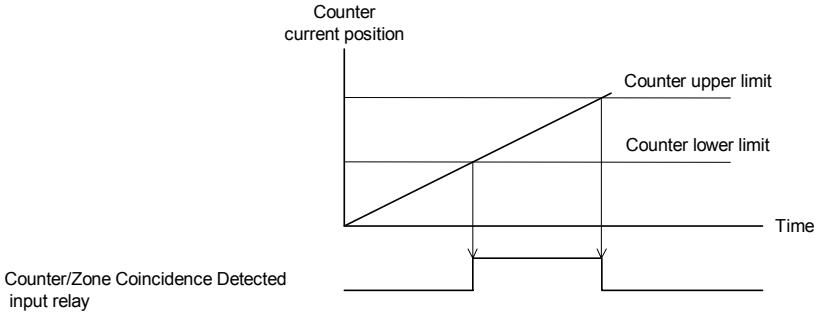


Figure 5.23 Zone Coincidence Detection Function

5.2.4 Axis Statuses

This section lists and describes axis statuses.

■ List of Axis Statuses

Table 5.22 List of Axis Statuses

Data Position No.				Status Name	Data Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0301	0601	0901	1201	Error Status	Error code when error occurs	5–42
0302	0602	0902	1202	Warning Status	Warning code when warning occurs	5–43
0303	0603	0903	1203	Extended Status 1	Action information such as axis or pattern where action was initiated	5–43
0304	0604	0904	1204	Extended Status 2	Movement information such as whether axis is accelerating, decelerating or changing speed.	5–44
0305	0605	0905	1205	Origin Search Status	Status related to origin search	5–44
0306	0606	0906	1206	(System reserved)		–
0307	0607	0907	1207	Contact Input Status	State of contact inputs (bit data)	5–44
0308	0608	0908	1208	Contact Output Status	State of contact outputs (bit data)	5–45
0309	0609	0909	1209	(System reserved)		–
0310	0610	0910	1210	Remaining DCC Time Status	–1: Accelerating or moving at constant speed 0: At rest 1 to 32,767: Remaining deceleration time (ms)	5–45
0311 / 0312	0611 / 0612	0911 / 0912	1211 / 1212	Remaining Travel Status	Remaining travel to target position 0 to 2,147,483,647 (position reference unit)	5–45
0313	0613	0913	1213	Current Override Value Status	1 to 500 (%)	5–46
0314	0614	0914	1214	(System reserved)		–
0315 / 0316	0615 / 0616	0915 / 0916	1215 / 1216	Current Position Status	–2,147,483,648 to 2,147,483,647 (position reference unit)	5–46
0317 / 0318	0617 / 0618	0917 / 0918	1217 / 1218	Target Position Status	–2,147,483,648 to 2,147,483,647 (position reference unit)	5–46
0319 / 0320	0619 / 0620	0919 / 0920	1219 / 1220	Current Speed Status	–5,000,000 to 5,000,000 (pulse/s) –2,147,483,648 to 2,147,483,647 (x 10^{-4}mm/s) –2,147,483,648 to 2,147,483,647 (x 10^{-5}degree/s) (Data range depends on Display Unit)	5–46
0321 / 0322	0621 / 0622	0921 / 0922	1221 / 1222	Counter Current Position Status	–2,147,483,648 to 2,147,483,647 (Counter position reference unit)	5–46
0323 / 0324	0623 / 0624	0923 / 0924	1223 / 1224	Counter Current Speed Status	–5,000,000 to 5,000,000 (pulse/s) –2,147,483,648 to 2,147,483,647 (x 10^{-4}mm/s) –2,147,483,648 to 2,147,483,647 (x 10^{-5}degree/s) (Data range depends on Display Unit)	5–47
0325 / 0326	0625 / 0626	0925 / 0926	1225 / 1226	Counter Latched Position Status	–2,147,483,648 to 2,147,483,647 (Counter position reference unit)	5–47
0327 / 0328	0627 / 0628	0927 / 0928	1227 / 1228	Counter Absolute Data Status	Received raw absolute data (when Counter Type Selection is Sanyo Denki's Manchester Coding) Absolute position status (when Counter Type Selection is Yaskawa Electric's Serial)	5–47
0329 to 0400	0629 to 0700	0929 to 1000	1229 to 1300	(System reserved)		–

■ Description of Axis Statuses

● Error Status

[Data Position No.] Axis 1: 0301; Axis 2: 0601; Axis 3: 0901; Axis 4: 1201
[Data Range] 0 to 32,767

Error Status stores the error code when an error is detected.

Its value has no meaning when the Error Detected input relay is off. For details on error codes, see Section 10.3, "List of Axis Error and Warning Codes".

Warning Status

[Data Position No.] **Axis 1: 0302; Axis 2: 0602; Axis 3: 0902; Axis 4: 1202**
[Data Range] **0 to 32,767**

Warning Status stores the warning code when a warning is detected.

It stores the value zero when no warning is detected.

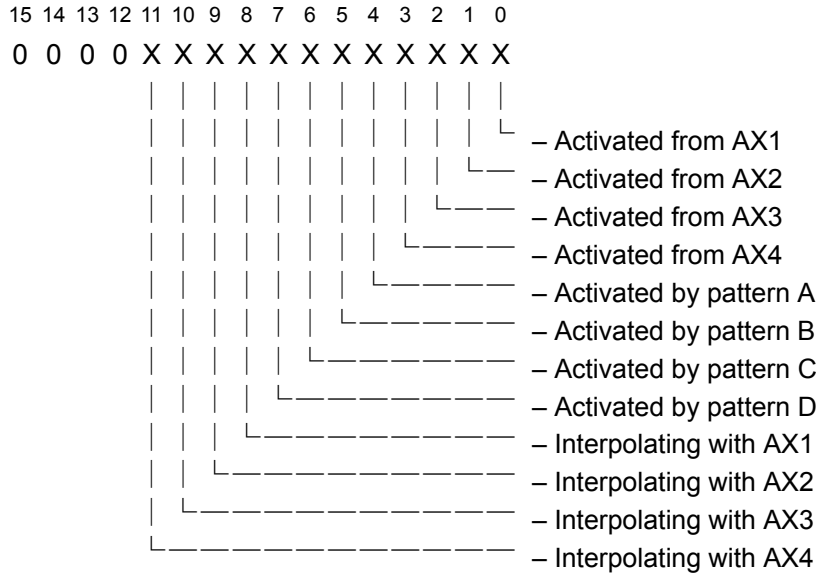
Unlike errors, there is no associated relay to indicate presence of a warning. Read the Warning Status before starting a positioning movement to verify that execution can proceed normally. For details on warning codes, see Section 10.3, "List of Axis Error and Warning Codes".

Extended Status 1

[Data Position No.] **Axis 1: 0303; Axis 2: 0603; Axis 3: 0903; Axis 4: 1203**
[Data Range] **$0000 to $0FFF (bit data)**

Extended Status 1 stores bit data that indicates whether an axis is moving and if so, from which axis or which pattern was the movement initiated.

A bit is 1 if it is true.

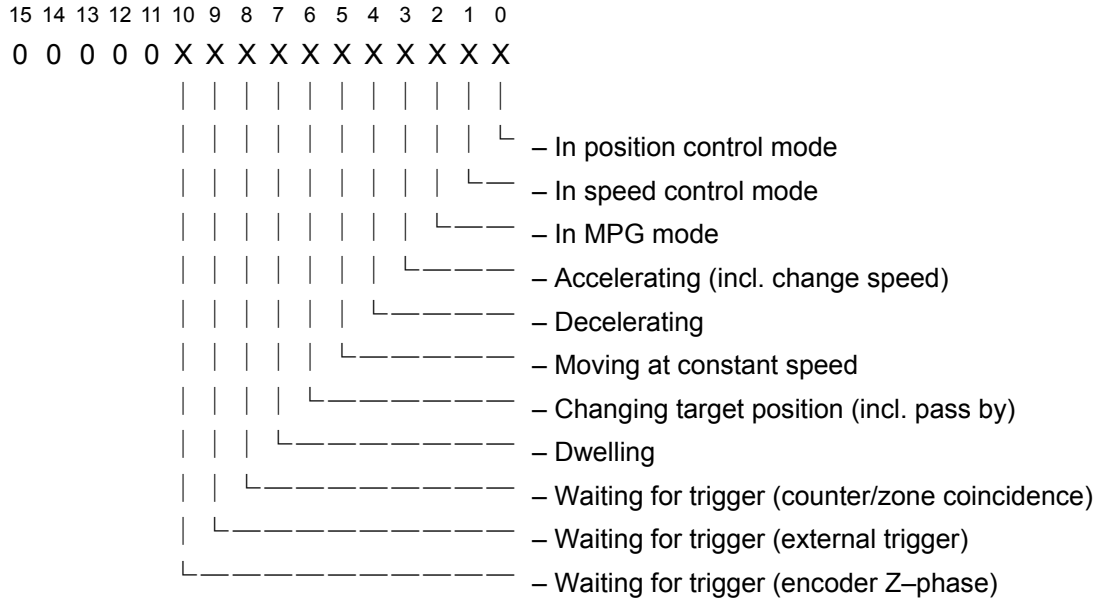


- **Extended Status 2**

[Data Position No.] **Axis 1: 0304; Axis 2: 0604; Axis 3: 0904; Axis 4: 1204**
[Data Range] **$0000 to $07FF (bit data)**
Extended Status 2 stores bit data that indicates the status of axis movement.

A bit is 1 if it is true.

This status is not updated during origin search. Status of movement during origin search is stored in Origin Search Status instead.



In the case of a command waiting for a trigger with startup condition specified as 'External trigger input & Z–phase search', both bits 9 and 10 are on before the external trigger input is detected. After the external trigger input is detected, and the module shifts to Z–phase search, only bit 10 stays on.

- **Origin Search Status**

[Data Position No.] **Axis 1: 0305; Axis 2: 0605; Axis 3: 0905; Axis 4: 1205**
[Data Range] **0 to 5**
Origin Search Status stores the status during or at the end of origin search.

0: Powered on or normal completion of origin search.

1: Stopped by Stop Immediately or Decelerate & Stop Input edge. (applies only to manual origin search)

2: Stopped by Stop Immediately relay or Decelerate & Stop command

3: Stopped by error

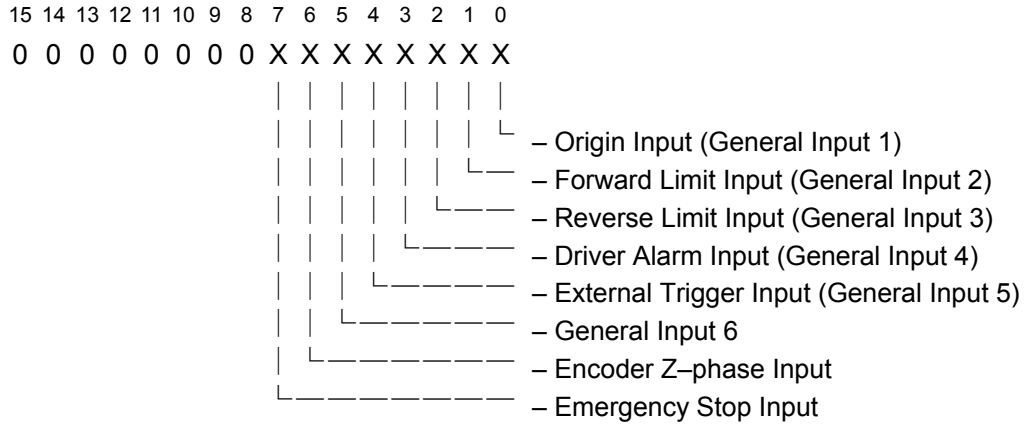
4: Searching for Z–phase

5: Before Z–phase search

- **Contact Input Status**

[Data Position No.] **Axis 1: 0307; Axis 2: 0607; Axis 3: 0907; Axis 4: 1207**
[Data Range] **$0000 to $00FF (bit data)**
Contact Input Status stores the states of external contact inputs, Encoder Z–phase Input and Emergency Stop Input.

Each bit is 0 or 1 when the state of the corresponding contact is off or on respectively. If the contact corresponding to a bit is specified as an NO (normally open) contact, the bit is 1 when the contact is closed; if the contact corresponding to a bit is specified as an NC (normally closed) contact, the bit is 1 when the contact is open.

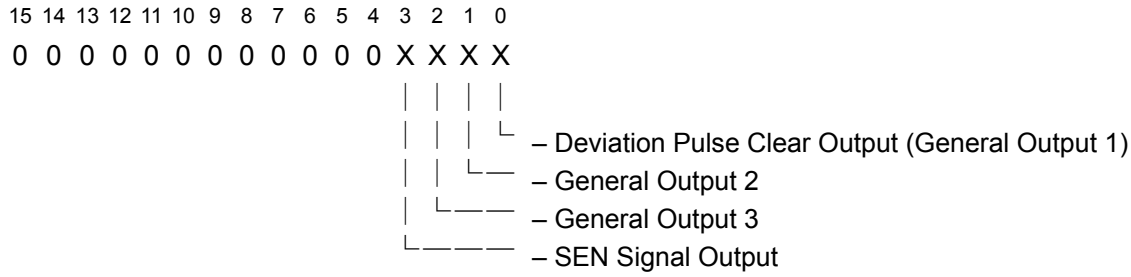


- **Contact Output Status**

[Data Position No.] **Axis 1: 0308; Axis 2: 0608; Axis 3: 0908; Axis 4: 1208**
[Data Range] **$0000 to $000F (bit data)**

Contact Output Status stores the states of external contact outputs.

Each bit is 0 or 1 when the state of the corresponding contact is off or on respectively.



- **Remaining DCC Time Status**

[Data Position No.] **Axis 1: 0310; Axis 2: 0610; Axis 3: 0910; Axis 4: 1210**
[Data Range] **–1, 0 to 32,767 (ms)**

Remaining DCC Time Status stores the remaining time to completion of path generation after a decelerate & stop action is started during positioning to stop at the target position.

This status does not store any meaningful value if a Decelerate & Stop action is initiated for a movement without an associated target position (e.g. speed control movement or jogging).

This status can be used to determine the time for starting a Change Target Position (pass by) action.

If a dwell time is specified, the dwell time is not included in the Remaining DCC Time Status. After Remaining DCC Time Status becomes 0, the Positioning Completed input relay turns on after a delay designated by Dwell Time.

–1 : Accelerating or moving at constant speed
0 : At rest
1 to 32,767 : Remaining deceleration time (ms)

- **Remaining Travel Status**

[Data Position No.] **Axis 1: 0311/0312; Axis 2: 0611/0612**
Axis 3: 0911/0912; Axis 4: 1211/1212
[Data Range] **0 to 2,147,483,647 (position reference unit)**

Remaining Travel Status stores the remaining travel to the target position during positioning movement.

This status stores a value zero during movements without an associated target position (e.g. speed control movement or jogging).

This status can be used to determine the time for starting a Change Target Position (pass by) action.

As the remaining travel is calculated simply from the difference between the current position and the target position, it may deviate from the actual travel distance during circular interpolation.

During pass by movement, this status stores the travel to the target position during the Decelerate and Stop movement. (It stores the remaining travel to the new target position after passing through the transition zone.)

During a target position change movement or speed control to position control switchover in single–axis positioning where an axis is to be stopped momentarily to allow a change in travel direction, the status stores the remaining travel to the momentary stop.

- **Current Override Value Status**

[Data Position No.] **Axis 1: 0313; Axis 2: 0613; Axis 3: 0913; Axis 4: 1213**
[Data Range] **1 to 500 (%)**
Current Override Value Status stores the current override value.

The preset override value can be changed using the Set Override command.

At power up, the module operates at 100% override.

- **Current Position Status**

[Data Position No.] **Axis 1: 0315/0316; Axis 2: 0615/0616**
Axis 3: 0915/0916; Axis 4: 1215/1216
[Data Range] **–2,147,483,648 to 2,147,483,647 (position reference unit)**
Current Position Status stores the current position.

This status stores the current position based on output pulses of the positioning module, and its value may differ from the actual position when a servomotor is used.

- **Target Position Status**

[Data Position No.] **Axis 1: 0317/0318; Axis 2: 0617/0618**
Axis 3: 0917/0918; Axis 4: 1217/1218
[Data Range] **–2,147,483,648 to 2,147,483,647 (position reference unit)**
Target Position Status stores the target position during positioning movement.

It stores the target position for the movement, which is computed from the Target Position Mode and Target Position specified when positioning is initiated.

- **Current Speed Status**

[Data Position No.] **Axis 1: 0319/0320; Axis 2: 0619/0620**
Axis 3: 0919/0920; Axis 4: 1219/1220
[Data Range] **–5,000,000 to 5,000,000 (pulse/s)**
–2,147,483,648 to 2,147,483,647 (x 10^{-4} mm/s)
–2,147,483,648 to 2,147,483,647 (x 10^{-5} degree/s)
(Data range depends on Display Unit)
Current Speed Status stores the current speed.

It stores the current position based on output pulses of the positioning module, and its value may differ from the actual position when a servomotor is used. Current Speed Status may be positive or negative, depending on the direction of the motor's rotation.

- **Counter Current Position Status**

[Data Position No.] **Axis 1: 0321/0322; Axis 2: 0621/0622**
Axis 3: 0921/0922; Axis 4: 1221/1222
[Data Range] **–2,147,483,648 to 2,147,483,647**
(counter position reference unit)
Counter Current Position Status stores the current position of the counter.

Counter Current Speed Status

[Data Position No.] **Axis 1: 0323/0324; Axis 2: 0623/0624**
Axis 3: 0923/0924; Axis 4: 1223/1224

[Data Range] **–5,000,000 to 5,000,000 (pulse/s)**
–2,147,483,648 to 2,147,483,647 (x 10^{-4} mm/s)
–2,147,483,648 to 2,147,483,647 (x 10^{-5} degree/s)
(Data range depends on Display Unit)

Counter Current Speed Status stores the current speed of the counter.

Its value may be positive or negative, depending on the direction of rotation of input pulses.

Counter Current Speed Status is computed according to the internal counter sampling period (approximately 100 us to 1 ms). Hence, under low speed or certain conditions, its value may be significantly different from the actual speed. Counter Current Speed Status can be used for monitoring purposes but should not be used as feedback for control purposes.

Counter Latched Position Status

[Data Position No.] **Axis 1: 0325/0326; Axis 2: 0625/0626**
Axis 3: 0925/0926; Axis 4: 1225/1226

[Data Range] **–2,147,483,648 to 2,147,483,647**
(counter position reference unit)

Counter Latched Position Status stores the latched position of the counter.

This status latches the current position of the counter at the point when the Encoder Z–phase Input is detected during execution of origin search or movements that use the Encoder Z–phase Input as a trigger for startup.

Counter Absolute Data Status

[Data Position No.] **Axis 1: 0327/0328; Axis 2: 0627/0628**
Axis 3: 0927/0928; Axis 4: 1227/1228

[Data Range] **–2,147,483,648 to 2,147,483,647**

Counter Absolute Data Status stores absolute data of the counter.

When Counter Type Selection is set to '1: Sanyo Denki's Manchester Coding', this status monitors 30 bits of raw received data.

Table 5.23 An Example of Received Data

	MSB															LSB
Low Word	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
High Word	0	0	AW1	AW0	0	0	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16

– D0 to D25: Absolute data (26 bits) – AW0, AW1: Alarm code

When Counter Type Selection is set to '2: Yaskawa Electric's Serial', this status monitors absolute position data read from the encoder. Its value is normally the same as the Counter Current Position Status, but would differ if an electronic gear ratio is defined or after execution of a Write Counter Current Position command.

When Counter Type Selection is set to '0: General–purpose Incremental', the data of this status has no meaning.

5.2.5 Pattern Registered Parameters

This section lists and describes the pattern registered parameters.

■ List of Pattern Registered Parameters

Table 5.24 List of Pattern Registered Parameters

Data Position No.				Parameter Name	Data Range and Description	See Also
Pattern A	Pattern B	Pattern C	Pattern D			
1301 / 1302	1401 / 1402	1501 / 1502	1601 / 1602	Pattern Combined–speed Limit	1 to 2,147,483,647 (x 10^{-4}mm/s) (Factory setting: 1,000,000)	5–48
1303	1403	1503	1603	Pattern Combined–speed ACC Time	0 to 32,767 (ms) (Default acceleration time specified for Pattern Combined–speed Limit) (Factory setting: 1,000)	5–48
1304	1404	1504	1604	Pattern Combined–speed DCC Time	0 to 32,767 (ms) (Default deceleration time specified for Pattern Combined–speed Limit) (Factory setting: 1,000)	5–49
1305 to 1330	1405 to 1430	1505 to 1530	1605 to 1630	(System reserved)		–

■ Description of Pattern Registered Parameters

● Pattern Combined–speed Limit

[Data Range] 1 to 2,147,483,647 (x 10^{-4} mm/s)
[Factory Setting] 1,000,000
[Data Position No.] Pattern A: 1301/1302; Pattern B: 1401/1402
Pattern C: 1501/1502; Pattern D: 1601/1602

Pattern Combined–speed Limit specifies the maximum combined speed that can be specified for pattern actions.

If a pattern operation is started with a specified combined speed exceeding this value, an error will be generated and the motor does not move. If this limit is exceeded during interpolation or other movement, an error is generated, and the motor stops immediately.

If a specified combined speed causes the speed limit of an axis to be exceeded during interpolation, an error is also generated, and the motor stops immediately.

If a Pattern Preset Override Value is specified, and the speed after override adjustment exceeds the Pattern Combined–speed Limit, an error is generated.

● Pattern Combined–speed ACC Time

[Data Range] 0 to 32,767 (ms)
[Factory Setting] 1,000
[Data Position No.] Pattern A: 1303; Pattern B: 1403
Pattern C: 1503; Pattern D: 1603

Pattern Combined–speed ACC Time specifies the default rate of acceleration for pattern actions specified with a combined speed as the time taken to accelerate from zero to Pattern Combined–speed Limit.

A positioning movement may use this acceleration time as default, or be specified with a different acceleration time.

Pattern Combined–speed DCC Time

[Data Range] **0 to 32,767 (ms)**
[Factory Setting] **1,000**
[Data Position No.] **Pattern A: 1304; Pattern B: 1404**
Pattern C: 1504; Pattern D: 1604

Pattern Combined–speed DCC Time specifies the default rate of deceleration as the time taken to decelerate from Pattern Combined–speed Limit to zero for pattern actions specified with a combined speed.

A positioning movement may use this deceleration time as default, or be specified with a different deceleration time.

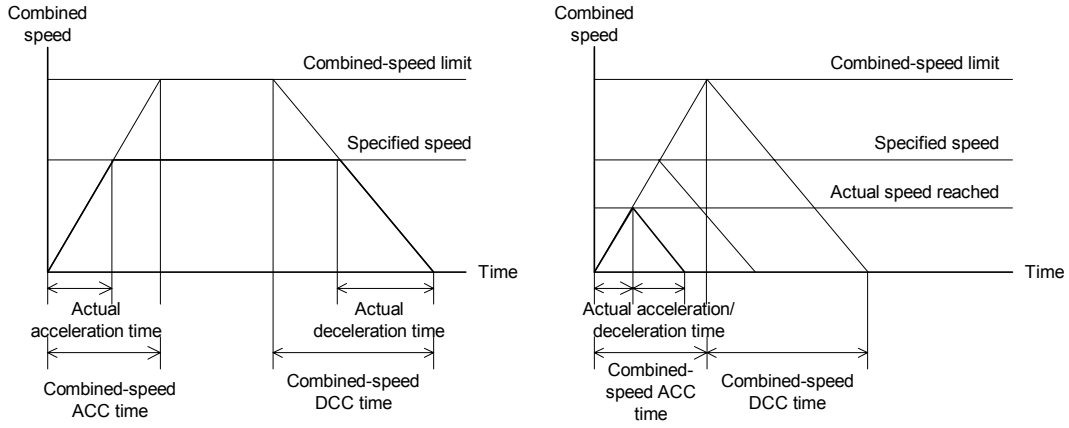


Figure 5.24 Pattern Combined–speed Limit, Acceleration Time and Deceleration Time

5.2.6 Pattern Command Parameters

This section lists and describes pattern command parameters.

■ List of Pattern Command Parameters

Table 5.25 List of Pattern Command Parameters

Data Position No.				Parameter Name	Data Range and Description	See Also
Pattern A	Pattern B	Pattern C	Pattern D			
1331	1431	1531	1631	Pattern Command Code	0 to 32,767	5–50
1332	1432	1532	1632	(System reserved)	Do not write any non–zero value.	—
1333	1433	1533	1633	Pattern Preset Override Value	1 to 500 (%)	5–50
1334	1434	1534	1634	Pattern Start Record No.	1 to No. of Pattern Data Records Used	5–51
1335 to 1338	1435 to 1438	1535 to 1538	1635 to 1638	(System reserved)		—
1339	1439	1539	1639	Pattern End Record No.	1 to No. of Pattern Data Records Used	5–51
1340 to 1350	1440 to 1450	1540 to 1550	1640 to 1650	(System reserved)		—

■ Description of Pattern Command Parameters

● Pattern Command Code

[Data Range] 0 to 32,767
[Data Position No.] Pattern A: 1331; Pattern B: 1431
Pattern C: 1531; Pattern D: 1631

Pattern Command Code specifies the code of a pattern command to be executed in pattern operation.

Table 5.26 List of Pattern Command Codes

Command Code	Command Name	Function	See Also
0	Start pattern operation	Executes pattern.	7–11
1	Restart pattern operation	Restarts a pattern operation that was stopped by a Decelerate & Stop command.	7–15
2	Decelerate and Stop Pattern Operation	Decelerates and stops pattern operation.	7–24
3	Pattern Operation Test	Executes pattern action records between a specified Pattern Start Record No and a specified Pattern End Record No.	7–19
4	Reset Pattern Error	Clears error status of pattern operation.	7–8
5	Set Pattern Registered Parameters	Sets pattern registered parameters.	7–4
6	Set Pattern Override	Changes override value for pattern operation.	7–30

● Pattern Preset Override Value

[Data Range] 1 to 500 (%)
[Data Position No.] Pattern A: 1333; Pattern B: 1433
Pattern C: 1533; Pattern D: 1633

Pattern Preset Override Value specifies a new override value for scaling Specified Speed by 1 to 500% for a Set Pattern Override command.

For positioning movements initiated in pattern operation, the Pattern Preset Override Value applies instead of the Preset Override Value of the axis.

If a Set Pattern Override command is executed during pattern operation, the new override value is applied to subsequent action patterns.

The Pattern Preset Override Value must be such that (Specified Speed in pattern operation x Pattern Preset Override Value (%)) is smaller than the Speed Limit axis registered parameter or the Pattern Combined–speed Limit pattern registered parameter.

Furthermore, in single–axis movement with a non–zero Startup Speed, the speed after override adjustment must be equal to or greater than the Startup Speed.

Current Speed Status of axis statuses stores the value of the actual speed after override adjustment.

- **Pattern Start Record No.**

  [Data Range] 1 to No. of Pattern Data Records Used
  [Data Position No.] Pattern A: 1334; Pattern B: 1434
  Pattern C: 1534; Pattern D: 1634

  Pattern Start Record No. specifies the record number for starting pattern operation for Start Pattern Operation commands and Pattern Operation Test commands.

- **Pattern End Record No.**

  [Data Range] 1 to No. of Pattern Data Records Used
  [Data Position No.] Pattern A: 1339; Pattern B: 1439
  Pattern C: 1539; Pattern D: 1639

  Pattern End Record No. specifies the record number for stopping pattern operation for Pattern Operation Test commands.

  Pattern Operation Test commands can be used to execute a specified range of action patterns between Pattern Start Record No. and Pattern End Record No.

5.2.7 Pattern Operation Statuses

This section lists and describes pattern operation statuses.

■ List of Pattern Operation Statuses

Table 5.27 List of Pattern Operation Statuses

Data Position No.				Status Name	Data Range and Description	See Also
Pattern A	Pattern B	Pattern C	Pattern D			
1351	1451	1551	1651	M Code Status	0 to 32,767	5–52
1352	1452	1552	1652	Pattern Error Status	Error code when error occurs	5–52
1353	1453	1553	1653	Pattern Warning Status	Warning code when warning occurs	5–52
1354	1454	1554	1654	Pattern Error Code 1	Detailed error code 1 when error occurs	5–53
1355	1455	1555	1655	Pattern Error Code 2	Detailed error code 2 when error occurs	5–53
1356	1456	1556	1656	Pattern Action Status	Movement information for pattern operation	5–53
1357	1457	1557	1657	Pattern Action Record No.	1 to 500	5–53
1358	1458	1558	1658	Pattern Current Override Value	1 to 500 (%)	5–54
1359 to 1362	1459 to 1462	1559 to 1562	1659 to 1662	Pattern Action Record Label	Label corresponding to Pattern Action Record No.	5–54
1363 to 1400	1463 to 1500	1563 to 1600	1663 to 1700	(System reserved)		–

■ Description of Pattern Operation Statuses

- **M Code Status**

  [Data Position No.] Pattern A: 1351; Pattern B: 1451
  Pattern C: 1551; Pattern D: 1651
  [Data Range] 0 to 32,767
  If an action pattern is specified with an M code, M Code Status stores the M code when execution of the action pattern ends.

- **Pattern Error Status**

  [Data Position No.] Pattern A: 1352; Pattern B: 1452
  Pattern C: 1552; Pattern D: 1652
  [Data Range] 0 to 32,767
  Pattern Error Status stores the error code when an error occurs in pattern operation.

  Its value has no meaning when the Pattern Error Detected input relay is off. For details on error codes, see Section 10.4, "List of Pattern Error and Warning Codes".

- **Pattern Warning Status**

  [Data Position No.] Pattern A: 1353; Pattern B: 1453
  Pattern C: 1553; Pattern D: 1653
  [Data Range] 0 to 32,767
  Pattern Warning Status stores the warning code when a warning is detected in pattern operation.

  It stores the value zero when no warning is detected.

  Unlike errors, there is no associated relay to indicate presence of a warning. Read the Pattern Warning Status before starting a pattern operation to verify that execution can proceed normally. For details on warning codes, see Section 10.4, "List of Pattern Error and Warning Codes".

- **Pattern Error Code 1**

  [Data Position No.] **Pattern A: 1354; Pattern B: 1454**
  Pattern C: 1554; Pattern D: 1654
  [Data Range] **1 to 500**
  Pattern Error Code 1 stores a detailed error code 1 when an error occurs in pattern operation.

  Its value has no meaning when the Pattern Error Detected input relay is off. For details on error codes, see Section 10.4, " List of Pattern Error and Warning Codes ".

- **Pattern Error Code 2**

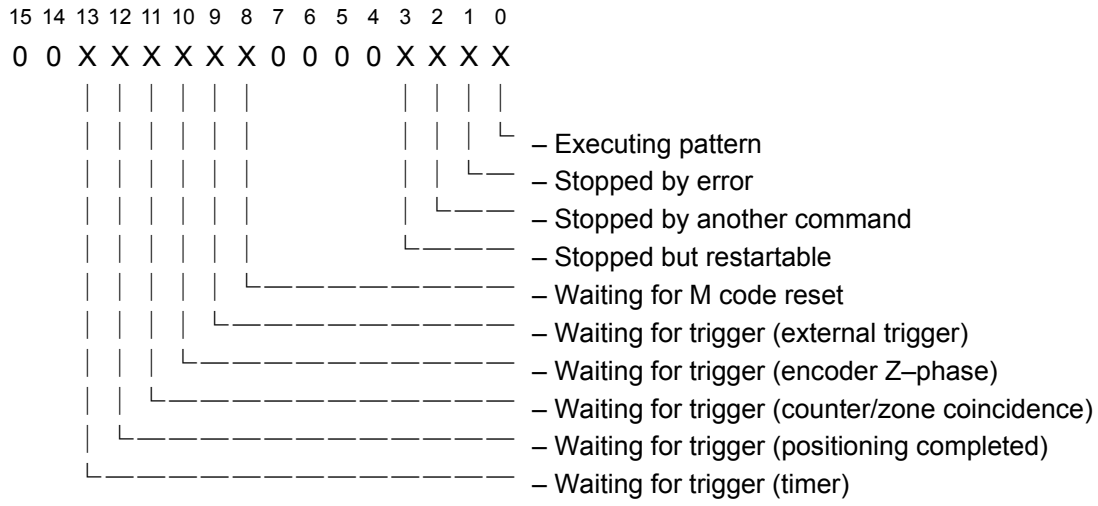
  [Data Position No.] **Pattern A: 1355; Pattern B: 1455**
  Pattern C: 1555; Pattern D: 1655
  [Data Range] **0 to 32,767**
  Pattern Error Code 2 stores a detailed error code 2 when an error occurs in pattern operation.

  Its value has no meaning when the Pattern Error Detected input relay is off. For details on error codes, see Section 10.4, " List of Pattern Error and Warning Codes ".

- **Pattern Action Status**

  [Data Position No.] **Pattern A: 1356; Pattern B: 1456**
  Pattern C: 1556; Pattern D: 1656
  [Data Range] **$0000 to $3F0F (bit data)**
  Pattern Action Status stores bit data that indicates the action status during pattern operation.

  A bit is 1 if it is true.



- **Pattern Action Record No.**

  [Data Position No.] **Pattern A: 1357; Pattern B: 1457**
  Pattern C: 1557; Pattern D: 1657
  [Data Range] **1 to 500**
  Pattern Action Record No. stores the record number of the action pattern being executed when a pattern operation is executing or the record number of the last action pattern executed when a pattern operation is not executing.

- **Pattern Current Override Value**

  [Data Position No.] **Pattern A: 1358; Pattern B: 1458**
  Pattern C: 1558; Pattern D: 1658
  [Data Range] **1 to 500 (%)**
  Pattern Current Override Value stores the current Pattern Preset Override Value.

  The override value can be changed using the Set Pattern Override command.

- **Pattern Action Record Label**

  [Data Position No.] **Pattern A: 1359 to 1362; Pattern B: 1459 to 1462**
  Pattern C: 1559 to 1552; Pattern D: 1659 to 1662
  [Data Range] **Label corresponding to Pattern Action Record No.**
  Pattern Action Record Label stores the record label of the action pattern being executed when a pattern operation is executing or the record label of the last action pattern executed when a pattern operation is not executing.

6 Direct Operation Programming

In direct operation, the module dynamically controls the position, speed and acceleration/deceleration of axes according to real-time commands from the CPU module.

Direct operation is suitable for dynamic control applications where target position and speed are specified just in time based on external information (correction data from an image processing device, etc.), or target position and speed differ for each positioning action.

In this type of operation control mode, positioning actions can be coded using a program, thus enabling sophisticated operations such as change in target position or speed during positioning.

This chapter describes commands available in direct operation, abbreviated as direct commands — their functions, how to execute these commands, relevant precautions and sample programs.

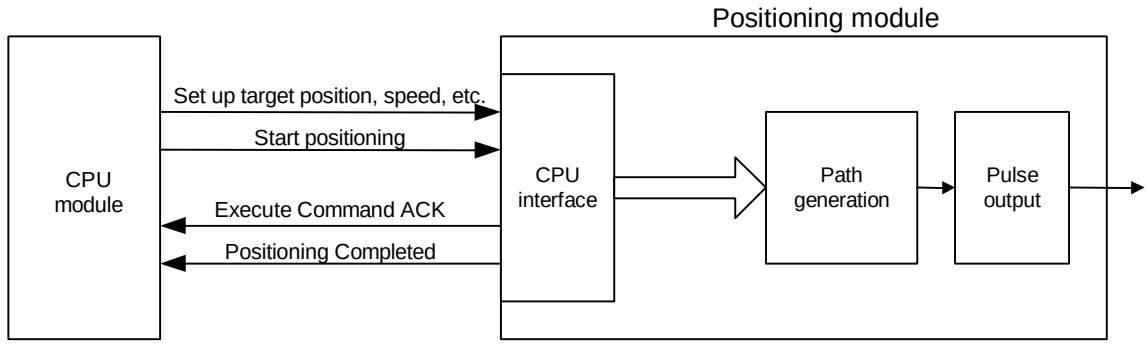


Figure 6.1 Direct Operation

6.1 Operation Procedure

Figure 6.2 shows an operation procedure flowchart in direct operation mode.

For details on individual commands in direct operation mode, see Sections 6.2 to 6.20.

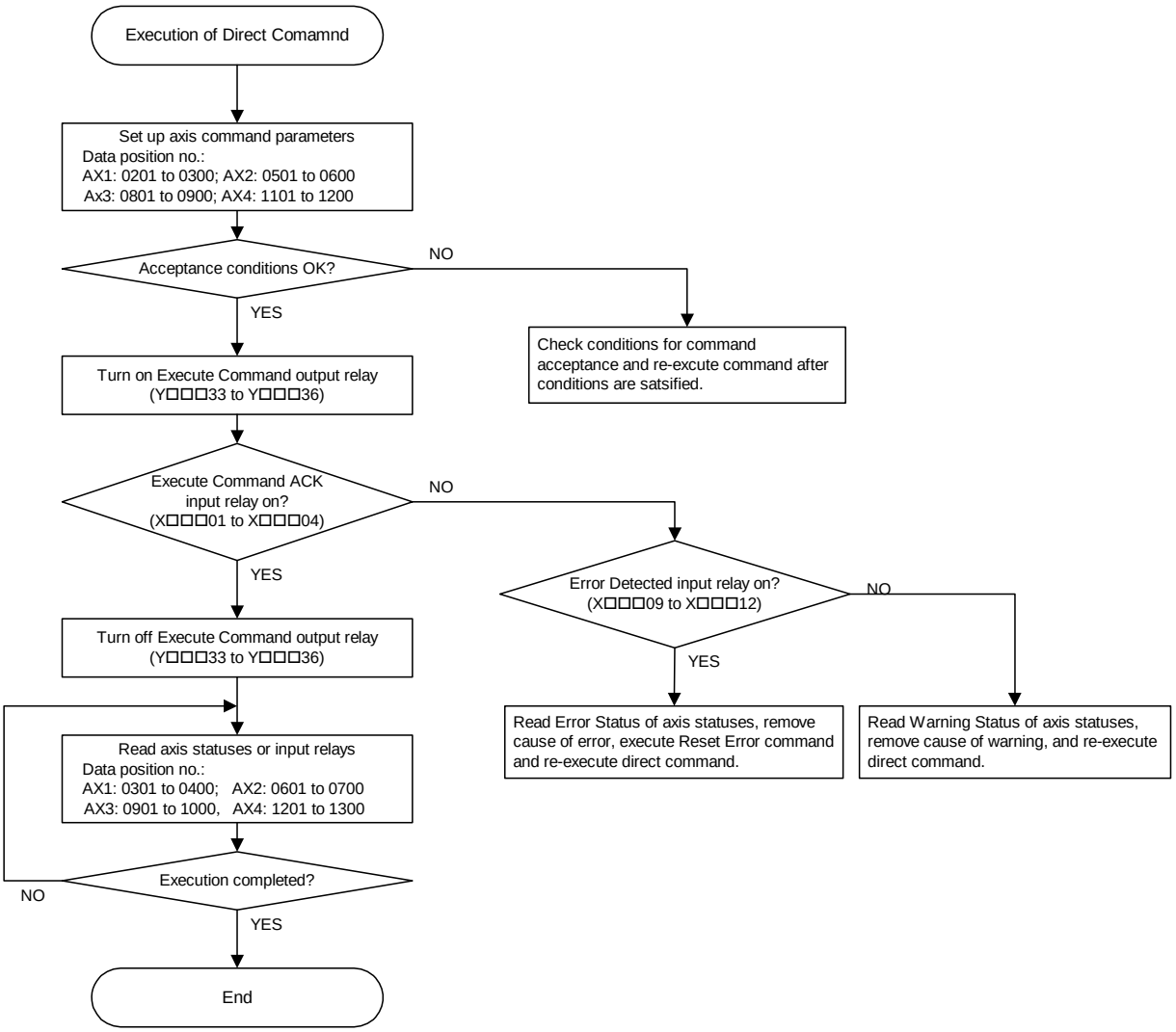


Figure 6.2 Operation Flow in Direct Operation

6.2 Direct Commands

6.2.1 List of Direct Commands

Table 6.1 shows a list of direct commands. For details of individual commands, see Section 6.3 to 6.20.

Table 6.1 List of Direct Commands

Command Code	Command Name	Function	See
—	Read Parameters/Statuses	Reads parameters and statuses of the module.	6-7
30	Set Axis Registered Parameters	Sets up registered parameters of individual axes.	6-9
50	Reset Error	Clears error status of positioning module.	6-15
—	Jog	Operates the motor manually using jog operations.	6-18
44	Start Manual Pulse Generator Mode	Switches the operation mode from position control mode to manual pulse generator mode.	6-23
45	Stop Manual Pulse Generator Mode	Switches the operation mode from manual pulse generator mode to position control mode.	6-29
60	Automatic Origin Search	Performs automatic origin search according to the axis registered parameter values.	6-32
61	Manual Origin Search	Performs customized manual origin search.	6-39
40	Set Current Position	Changes the current position.	6-45
0	Single-axis Positioning	Performs positioning using one axis.	6-50
1	Linear Interpolation	Performs positioning of 2, 3 or 4 axes using linear interpolation.	6-56
2	Circular Interpolation Using Sub Point	Performs circular interpolation movement of 2 axes using a specified sub point.	6-62
3	CW Circular Interpolation Using Center	Performs clockwise circular interpolation movement of 2 axes using a specified center point.	6-62
4	CCW Circular Interpolation Using Center	Performs counter-clockwise circular interpolation movement of 2 axes using a specified center point.	6-62
5	CW Helical Interpolation	Performs clockwise helical interpolation movement of 3 of 4 axes using a specified center point.	6-69
6	CCW Helical Interpolation	Performs counter-clockwise helical interpolation movement of 3 of 4 axes using a specified center point.	6-69
—	Change Target Position	Adjusts movement to a new specified target position during positioning.	6-77
10	Position Control to Speed Control	Switches from position control mode to speed control mode.	6-83
11	Speed Control to Position Control	Switches from speed control mode to position control mode.	6-86
12	Single-axis Speed Control Movement	Performs speed control movement using one axis.	6-92
13	Linear Speed Control Movement	Performs linear interpolated speed control movement using 2, 3 or 4 axes.	6-97
15	Index Positioning	Performs single-axis positioning under index control.	6-103
16	Index Speed Control Movement	Performs single-axis speed control movement using index control.	6-109
21	Change Speed	Adjusts movement using a new specified speed during movement.	6-114
20	Decelerate and Stop	Decelerates and stops a positioning movement.	6-120
—	Stop Immediately	Stops a positioning movement immediately.	6-125
22	Set Override	Changes override value.	6-128
41	Teach (Write Current Position)	Writes the current position value to the position data table.	6-133
42	Teach (Write Current Counter Position)	Writes the counter current position value to the position data table.	6-133
43	Teach (Write Numeric Data)	Writes numeric data to the position data table.	6-133
70	Set Counter Current Position	Changes the counter current position.	6-138
71	Counter Setup	Sets the Counter Type Selection and other counter-related parameters.	6-142
72	Read Yaskawa ABS Encoder	Reads absolute data from absolute encoder manufactured by Yaskawa Electric.	6-147
23	Contact Outputs On/Off	Sets output of selected external contacts to ON or OFF.	6-150
32	Save to Flash Memory	Saves all parameters to flash memory. (This command can only be executed from axis 1.)	6-153
33	Initialize Flash Memory	Initializes the flash memory. (This command can only be executed from axis 1.)	6-157

6.2.2 Required Parameters of Direct Commands

Before executing a direct command from the CPU module, you need to first set up required axis command parameters.

Table 6.2 shows the required parameters for each direct command.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Empty: Non-required parameters (parameter values are ignored)

Table 6.2 Required Parameters of Direct Commands (1/3)

Parameter Name				Manual Control			Origin Search		
	Read Parameters/Statuses	Set Axis Registered Parameters	Reset Error	Jog	Start Manual Pulse Generator Mode	Stop Manual Pulse Generator Mode	Automatic Origin Search	Manual Origin Search	Set Current Position
Direct Command Code		30*3	50		44	45	60	61	40
Command Options					○			○	○
Startup Condition									
End Condition									
(System reserved)									
Target Position Mode									
Target Position									△
(System reserved)									
Specified Speed				○	○			○	
Acceleration Time				△				△	
Deceleration Time				△				△	
Dwell Time				△				△	
Preset Override Value									
(System reserved)									
CI Turns									
CI Sub Position Mode									
CI Sub Position									
Contact Output Setting									
MPG Mode Multiplication					○				
MPG Mode Decimal Point					○				
(system reserved)									
Origin Search Direction								○	
Z-phase Edge Selection								○	
Z-phase Search Count								○	
Z-phase Search Range								○	
Deviation Pulse Clear Time								○	
(system reserved)									
Counter Coincidence Value									
Counter Upper Limit									
Counter Lower Limit									
(system reserved)									

*1: If Target Position Mode is set to "2: Using Position Data No.", setup is not required for parameters of interpolation axes involved in the movement.

*2: Setup is required for parameters of all movement axes only when changing speed during linear speed control movement.

*3: Parameters are to be set in the axis registered parameter area.

Table 6.3 Required Parameters of Direct Commands (2/3)

Parameter Name	Position Control							Speed Control					Index Control	
	Single-axis Positioning	Linear Interpolation	Circular Interpolation Using Sub Point	CW Circular Interpolation Using Center	CCW Circular Interpolation Using Center	CW Helical Interpolation	CCW Helical Interpolation	Position Control to Speed Control	Speed Control to Position Control (during motion)	Speed Control to Position Control (at rest)	Single-axis Speed Control Movement	Linear Speed Control Movement	Index Positioning	Index Speed Control Movement
Direct Command Code	0	1	2	3	4	5	6	10	11	11	12	13	15	16
Command Options		○	○	○	○	○	○		○	○		○		
Startup Condition	△	△	△	△	△	△	△		△		△	△	△	△
End Condition	△	△	△	△	△	△	△		△				△	
(System reserved)														
Target Position Mode	○	◎*1	◎*1	◎*1	◎*1	◎*1	◎*1		○				○	
Target Position	○	◎*1	◎*1	◎*1	◎*1	◎*1	◎*1		○				○	
(System reserved)														
Specified Speed	○	○	○	○	○	○	○		○		○	◎	○	○
Acceleration Time	△	△	△	△	△	△	△		△		△	△	△	△
Deceleration Time	△	△	△	△	△	△	△		△		△	△	△	△
Dwell Time	△	△	△	△	△	△	△		△		△	△	△	△
Preset Override Value														
(System reserved)														
CI Turns			○	○	○	○	○							
CI Sub Position Mode			◎*1	◎*1	◎*1	◎*1	◎*1							
CI Sub Position			◎*1	◎*1	◎*1	◎*1	◎*1							
Contact Output Setting														
MPG Mode Multiplication														
MPG Mode Decimal Point														
(system reserved)														
Origin Search Direction														
Z-phase Edge Selection	▲	▲	▲	▲	▲	▲	▲		▲		▲	▲	▲	▲
Z-phase Search Count	▲	▲	▲	▲	▲	▲	▲		▲		▲	▲	▲	▲
Z-phase Search Range														
Deviation Pulse Clear Time														
(system reserved)														
Counter Coincidence Value														
Counter Upper Limit														
Counter Lower Limit														
(system reserved)														

*1: If Target Position Mode is set to "2: Using Position Data No.", setup is not required for parameters of interpolation axes involved in the movement.

*2: Setup is required for parameters of all movement axes only when changing speed during linear speed control movement.

*3: Parameters must be set in the axis registered parameter area.

Table 6.4 Required Parameters of Direct Commands (3/3)

Parameter Name					Teaching			Counter Function					
	Change Speed	Decelerate and Stop	Stop Immediately	Set Override	Teach (Write Current Position)	Teach (Write Counter Current Position)	Teach (Write Numeric Data)	Set Counter Current Position	Counter Setup	Read Yaskawa ABS Encoder	Contact Outputs On/Off	Save to Flash Memory	Initialize Flash Memory
Direct Command Code	21	20		22	41	42	43	70	71	72	23	32	33
Command Options					○	○	○	○	○				
Startup Condition	△												
End Condition													
(System reserved)													
Target Position Mode					◎	◎	○						
Target Position					◎	◎	○	△					
(System reserved)													
Specified Speed	◎*2												
Acceleration Time	△												
Deceleration Time	△												
Dwell Time													
Preset Override Value				○									
(System reserved)													
CI Turns													
CI Sub Position Mode							◎						
CI Sub Position							◎						
Contact Output Setting											○		
MPG Mode Multiplication													
MPG Mode Decimal Point													
(system reserved)													
Origin Search Direction													
Z-phase Edge Selection	▲												
Z-phase Search Count	▲												
Z-phase Search Range													
Deviation Pulse Clear Time													
(system reserved)													
Counter Coincidence Value									△				
Counter Upper Limit									△				
Counter Lower Limit									△				
(system reserved)													

*1: If Target Position Mode is set to "2: Using Position Data No.", setup is not required for parameters of interpolation axes involved in the movement.

*2: Setup is required for parameters of all movement axes only when changing speed during linear speed control movement.

*3: Parameters must be set in the axis registered parameter area.

6.3 Read Parameters/Statuses

■ Function

Reads parameters and statuses of the positioning module.

■ Usage

● Command Parameters Used

No command parameters need to be set.

● Command Acceptance Conditions

This command is always accepted.

● Procedure

(1) Reads parameters and statuses of the module from the CPU module. For details on how to access the module from the CPU, see Chapter 9, "Accessing the Module".

■ Precautions

- Parameters and statuses listed with two data position numbers are 2-word data. The smaller data position number contains the low order word, and the larger data position number contains the high order word.
- Each data position number corresponds to a word. Always use the word-based WRITE instruction and READ instruction to access the module from a sequence program. Using a long-word-based instruction will result in incorrect access. Similarly, always use word-based instructions for access from a BASIC program.

CAUTION

When the CPU module reads 2-word status data from the positioning module, concurrency of the high-order word and low-order word of 2-word data is not assured due to conflicts between the timing of reading from the CPU module and the data update period of the positioning module.

To ensure that the high-order word and low-order word of 2-word data are concurrent when reading from a sequence CPU, use the READ command to read the data twice consecutively and verify that the data read are the same in both instances. If the HRD command is used, data concurrency is not assured even if you confirm that the data are the same.

Data concurrency cannot be assured when reading from a BASIC CPU.

For details on how to ensure data concurrency by executing the READ command twice from a sequence CPU, see Section 9.3, "Precautions for Reading Two-word Data".

■ Sample Program

● Description

This sample program reads all axis statuses of a module installed in slot 3.

● List of Devices

Table 6.5 shows the list of devices used.

Table 6.5 List of Devices Used by Sample Program for Reading Parameters/Statuses

Device	Name	Data Description
D00301 to D00400	AX1 Statuses	See Section 5.2.4, "Axis Statuses"
D00601 to D00700	AX2 Statuses	See Section 5.2.4, "Axis Statuses"
D00901 to D01000	AX3 Statuses	See Section 5.2.4, "Axis Statuses"
D01201 to D01300	AX4 Statuses	See Section 5.2.4, "Axis Statuses"

● Program Code

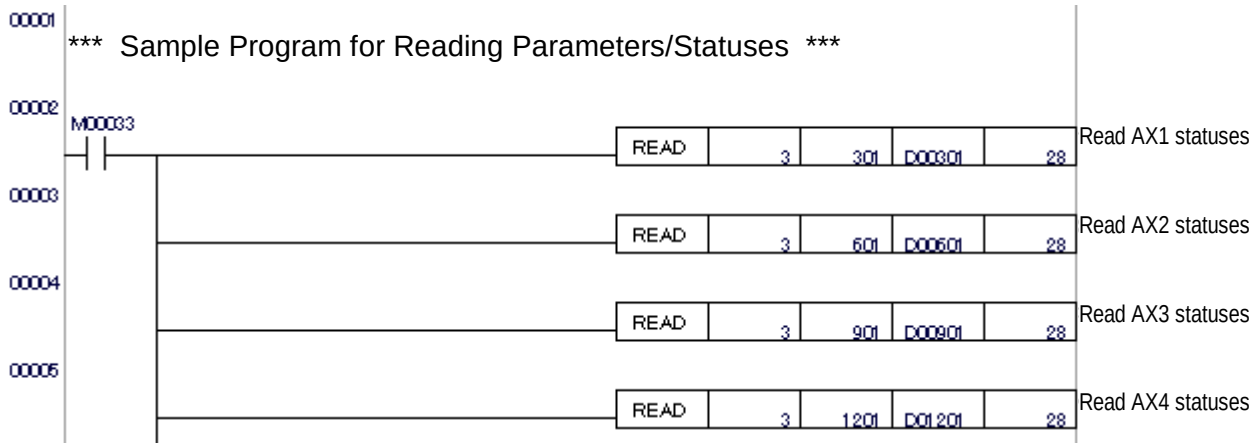


Figure 6.3 Sample Program for Reading Parameters/Statuses

6.4 Set Axis Registered Parameters

■ Function

Sets axis registered parameters.

You can also set axis registered parameters using the Toolbox for Positioning Modules software (SF662-ECW).

■ Usage

● Command Parameters Used

Table 6.6 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.6 Required Parameters of Set Axis Registered Parameters Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	30: Set Axis Registered Parameters	○
101 to 200	401 to 500	701 to 800	1001 to 1100	Axis Registered Parameters	See Section 5.2.2, "Axis Registered Parameters" on how to set these parameters.	○

● Command Acceptance Conditions

Table 6.7 lists the pre-conditions for command execution.

Table 6.7 Command Acceptance Conditions for Set Registered Parameters Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis registered parameters are valid.	○	
No axis error has been detected (excluding registered parameters setup error).		○
In Positioning Completed state		○
Not waiting for trigger		○
ToolBox is not performing an action test		○

● Procedure

(1) Set up axis registered parameters, and write Direct Command Code value '30: set axis registered parameters' to axis command parameter area of the command axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- Axis registered parameter data set using the Set Axis Registered Parameters command are cleared at power off. Execute the Save to Flash Memory command to save parameter data if required.
- Axis registered parameters can be used even if they are not saved to the flash memory but they would have to be setup using the Set Axis Registered Parameters command each time the module is powered on.
- The Reset Error command cannot be used to clear an axis registered parameter setup error encountered during execution of a Set Axis Registered Parameters command. To clear such an error, re-execute the Set Axis Registered Parameters command with valid parameter data.

■ Sample Program

● Description

This sample program sets up axis registered parameters of axis 1 for a positioning module installed in slot 3.

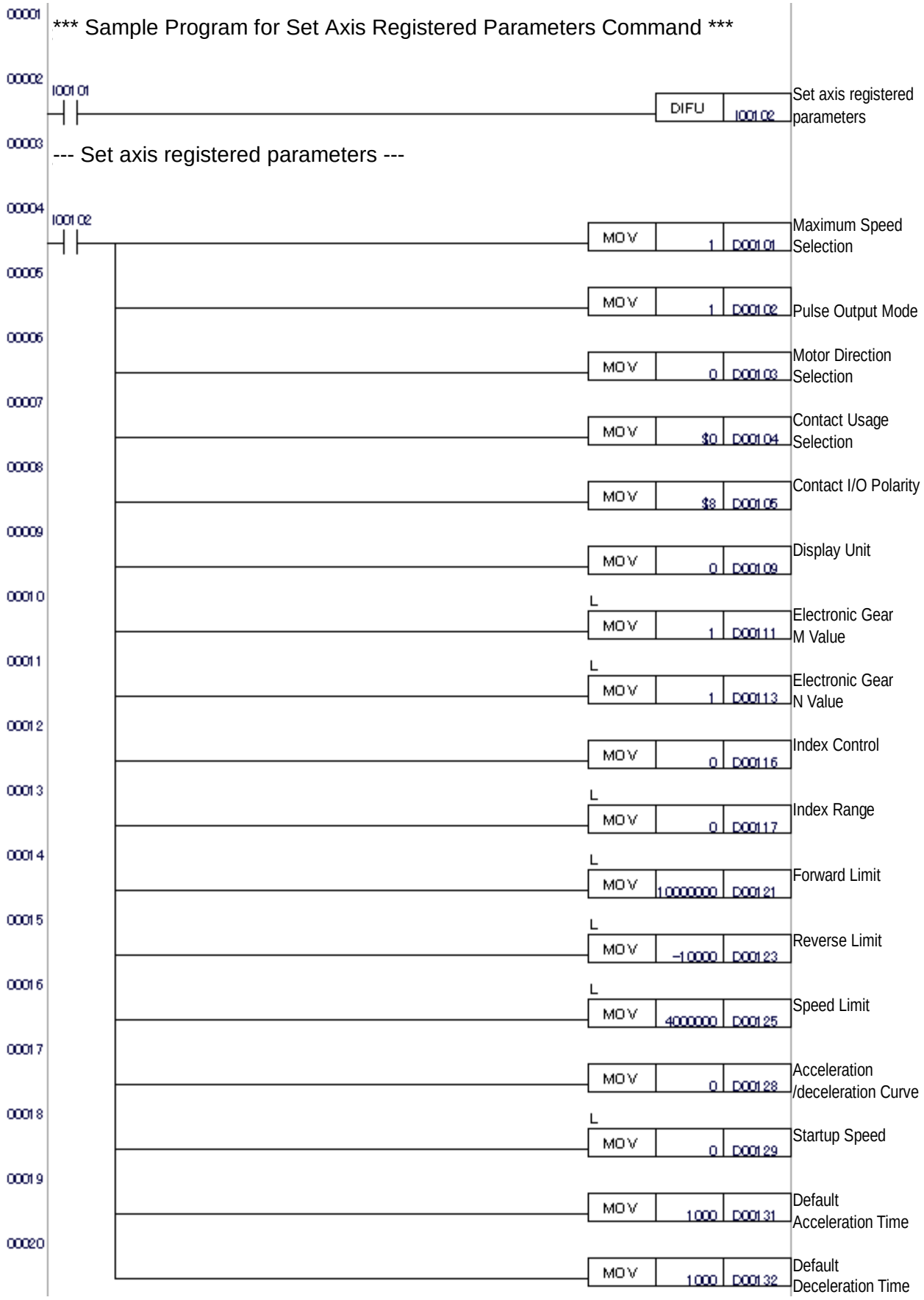
● List of Devices

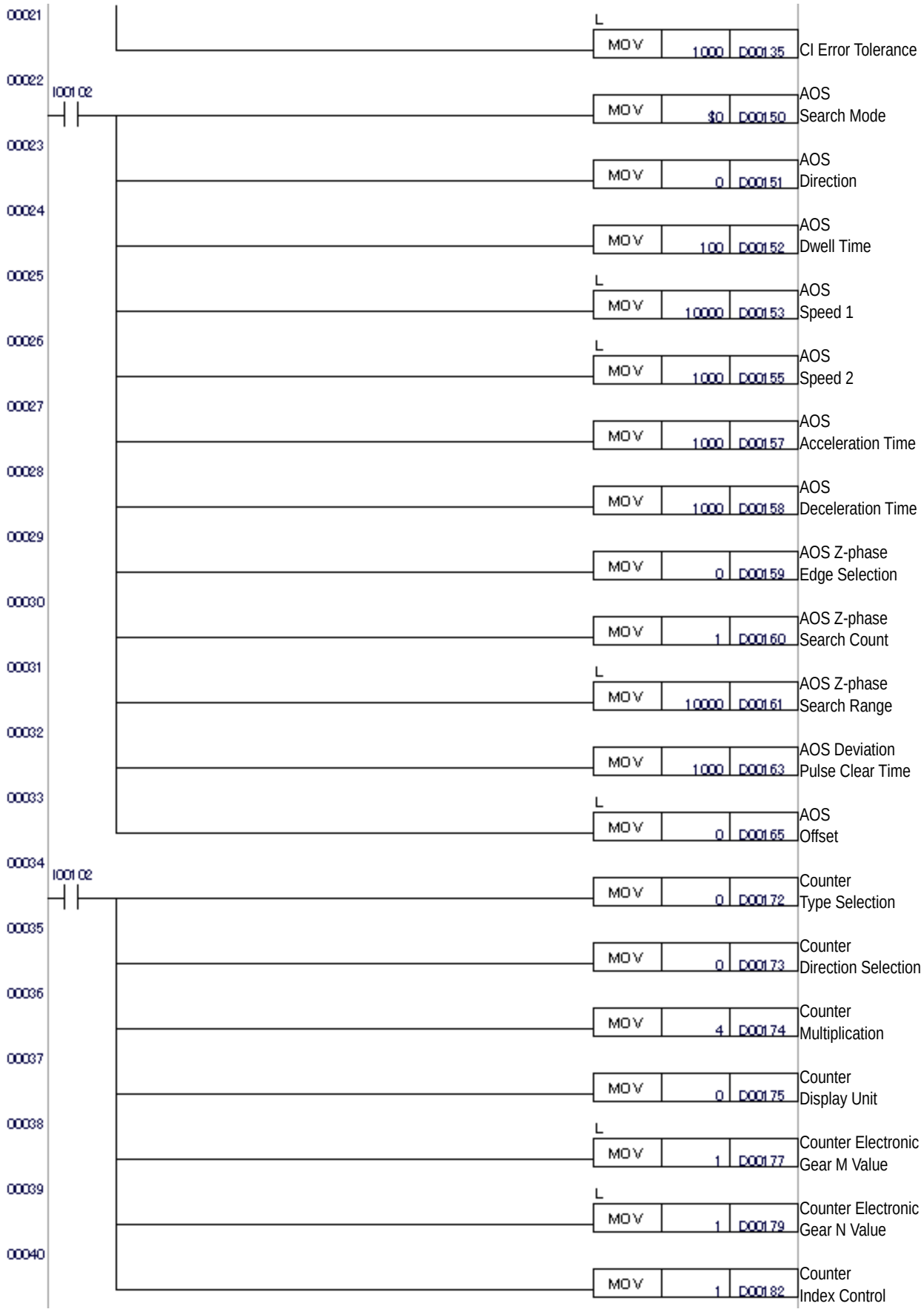
Table 6.8 lists the devices used.

Table 6.8 List of Devices Used in Sample Program for Set Axis Registered Parameters Command

Device	Name	Data
D00101 to D00200	Axis Registered Parameters	Set up data in this area before executing the Set Axis Registered Parameters command.
D00201	AX1 Direct Command Code	30: Set Axis Registered Parameters
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
I00099	Command execution disable (to be set elsewhere)	
I00101	Set axis registered parameters	
I00102	Set axis registered parameters (differential up)	
I00103	Waiting for execute command ACK	
I00104	Command executing	

- **Sample Program**




00021
L
MOV 1000 D00135
CI Error Tolerance
00022
I001 02
MOV $0 D00150
AOS Search Mode
00023
MOV 0 D00151
AOS Direction
00024
MOV 100 D00152
AOS Dwell Time
00025
L
MOV 10000 D00153
AOS Speed 1
00026
L
MOV 1000 D00155
AOS Speed 2
00027
MOV 1000 D00157
AOS Acceleration Time
00028
MOV 1000 D00158
AOS Deceleration Time
00029
MOV 0 D00159
AOS Z-phase Edge Selection
00030
MOV 1 D00160
AOS Z-phase Search Count
00031
L
MOV 10000 D00161
AOS Z-phase Search Range
00032
MOV 1000 D00163
AOS Deviation Pulse Clear Time
00033
L
MOV 0 D00165
AOS Offset
00034
I001 02
MOV 0 D00172
Counter Type Selection
00035
MOV 0 D00173
Counter Direction Selection
00036
MOV 4 D00174
Counter Multiplication
00037
MOV 0 D00175
Counter Display Unit
00038
L
MOV 1 D00177
Counter Electronic Gear M Value
00039
L
MOV 1 D00179
Counter Electronic Gear N Value
00040
MOV 1 D00182
Counter Index Control

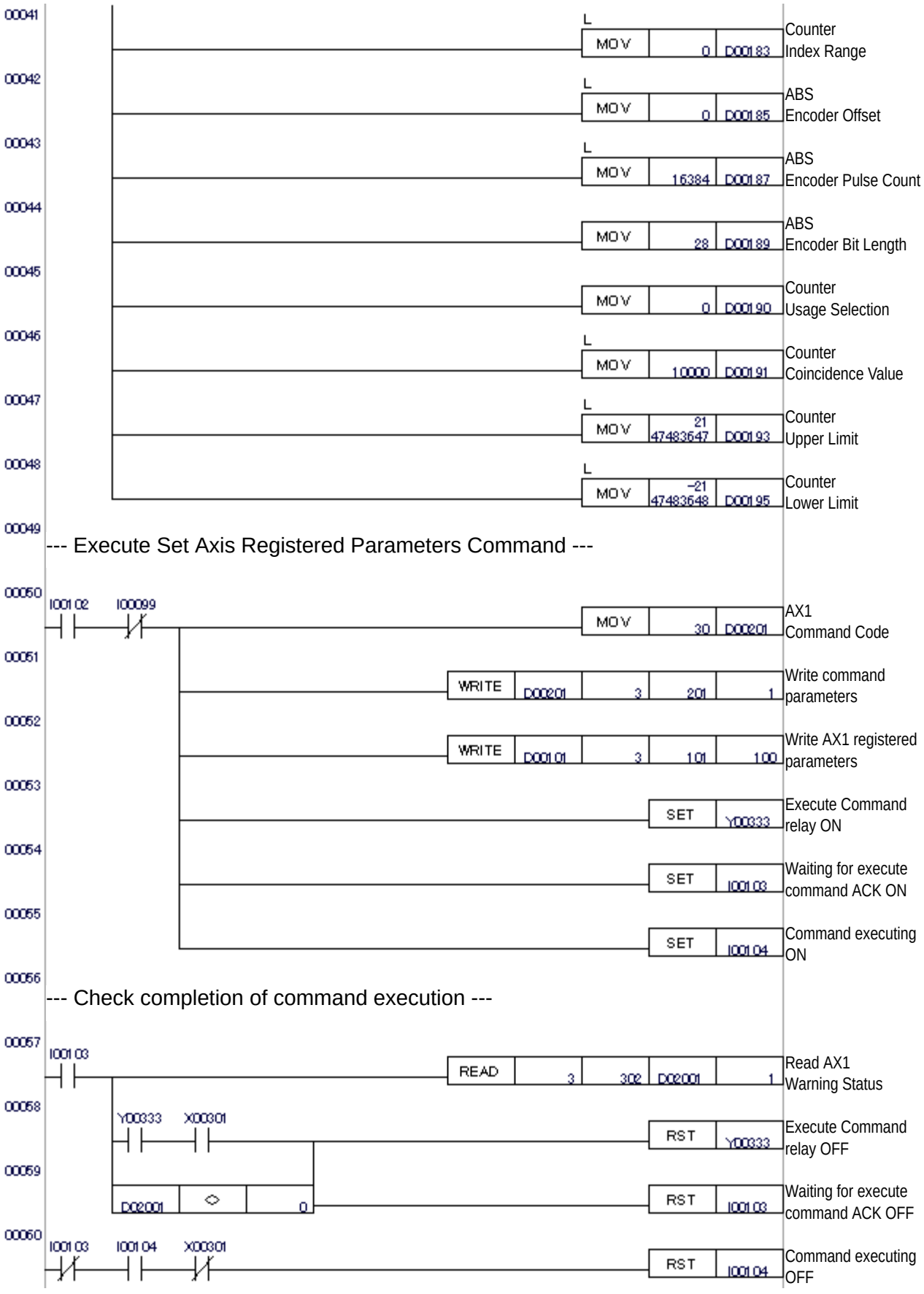


Figure 6.4 Set Axis Registered Parameters Program

Timing Chart

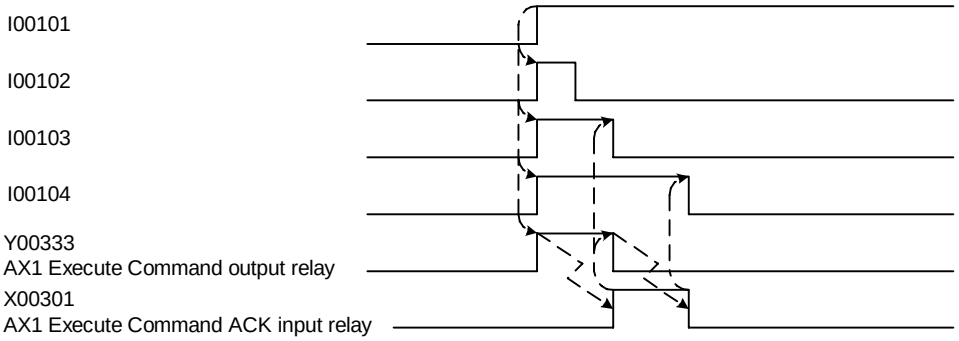


Figure 6.5 Timing Chart for Set Axis Registered Parameters Program

6.5 Reset Error

■ Function

This command clears the error status (state where Error Detected relay is on) of an axis. However, it cannot be used to clear a registered parameter setup error.

■ Execution Procedure

● Command Parameters Used

Table 6.9 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.9 Required Parameters of Reset Error Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	50: Reset Error	○

● Command Acceptance Conditions

Table 6.10 lists the pre-conditions for command execution.

Table 6.10 Command Acceptance Conditions for Reset Error Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
An axis error has been detected (excluding axis registered parameters setup error).		○

● Procedure

(1) Write Direct Command Code '50: reset error' to axis command parameter area of the command axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- Only two commands can be executed when an axis is in error state (Error Detected input relay is on), namely, Reset Error command and Set Axis Registered Parameters command. You should use the Reset Error command to clear the axis error and resume normal operation.
- The Reset Error command cannot be used to clear an axis registered parameter setup error encountered during execution of a Set Axis Registered Parameters command. To clear such an error, re-execute the Set Axis Registered Parameters command with valid parameter data.

■ Sample Program

● Description

This sample program clears the error on axis 1 of a positioning module installed in slot 3.

● List of Devices

Table 6.11 lists the devices used.

Table 6.11 List of Devices Used in Sample Program for Reset Error Command

Device	Name	Data
D00201	AX1 Direct Command Code	50: Reset Error
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
I00099	Command execution disable (to be set elsewhere)	
I00201	Reset error	
I00202	Reset error (differential up)	
I00203	Waiting for execute command ACK	
I00204	Command executing	

- **Sample Program**

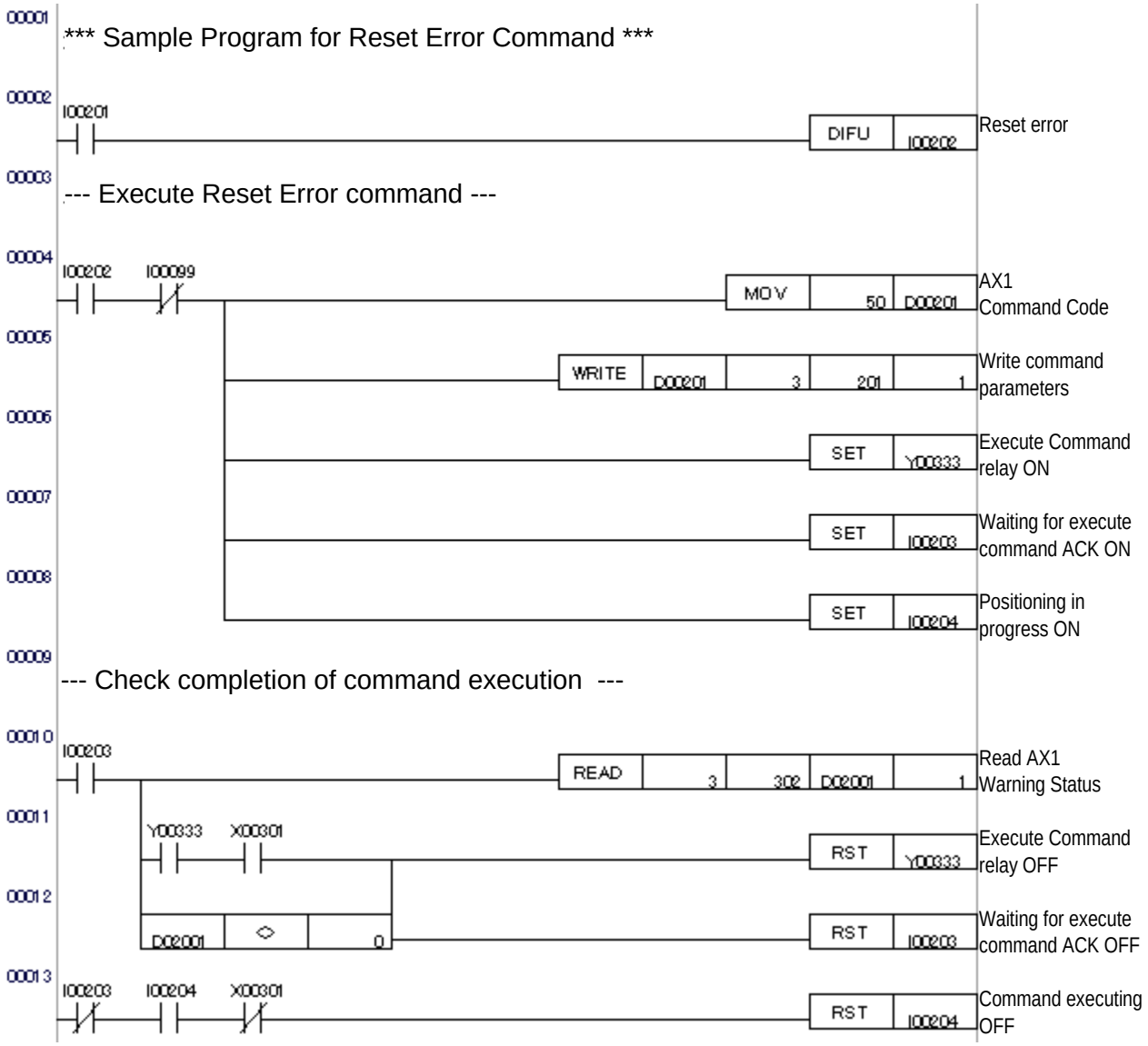


Figure 6.6 Reset Error Program

- **Timing Chart**

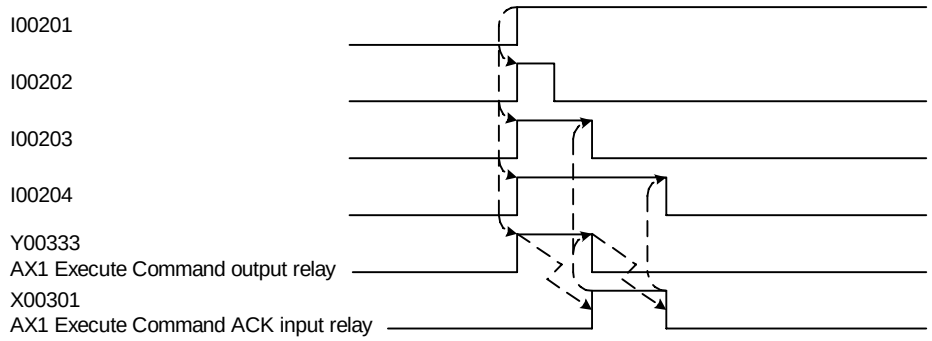


Figure 6.7 Timing Chart for Reset Error Program

6.6 Manual Control

You can operate the motor manually using jog operations or a manual pulse generator.

This section describes jog commands, as well as commands for starting and stopping manual pulse generator mode.

6.6.1 Jog

■ Function

The motor rotates in the forward direction and the reverse direction respectively while the Forward Jog output relay and the Reverse Jog output relay is on.

Jogging continues until the Forward Jog output relay or the Reverse Jog output relay is turned off, or the Stop Immediately output relay is turned on.

You can execute a Change Speed command during jogging to change the speed of movement.

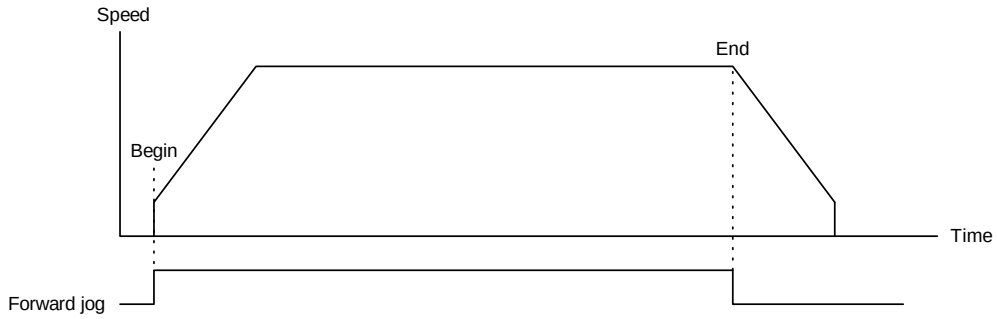


Figure 6.8 Forward Jog Using Automatic Trapezoidal Acceleration and Deceleration

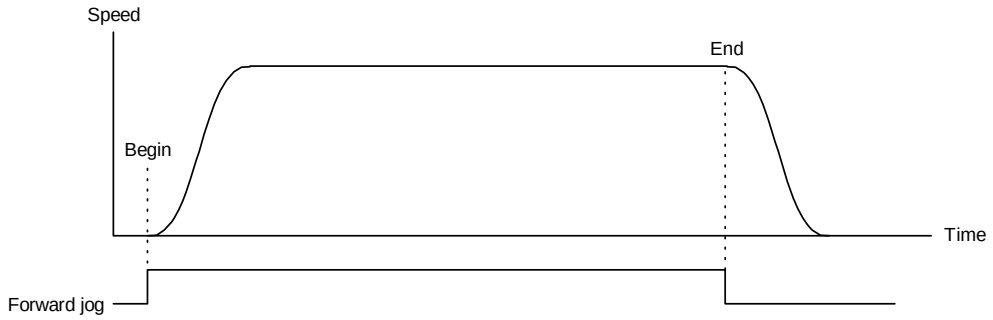


Figure 6.9 Forward Jog Using S-shape Acceleration and Deceleration

■ Execution Procedure

● Command Parameters Used

Table 6.12 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.12 Required Parameters of Jog Commands

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	Startup Speed to Speed Limit (speed reference unit)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△

● Command Acceptance Conditions

Table 6.13 lists the pre-conditions for jogging.

Table 6.13 Command Acceptance Conditions for Jogging

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In position control mode		○
In Positioning Completed state		○
Not waiting for trigger		○

● Procedure

(1) Write required parameters to axis command parameter area of the command axis.

(2) Turn on the Forward Jog output relay or Reverse Jog output relay, and the motor begins jog movements in the forward or reverse direction respectively.

- If any parameter data is invalid, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Forward (Reverse) Jog output relay clears the warning code.

(4) The Positioning Completed input relay turns off when jogging begins. Turning off the Forward (Reverse) Jog output relay stops jog operations, and the Positioning Completed input relay turns on.

■ Precautions

- Executing a Decelerate and Stop command during jogging is not allowed and will generate a warning. To stop jogging, turn off the Forward (Reverse) Jog output relay, or turn on the Stop Immediately output relay.
- Forward limit and reverse limit defined by axis registered parameters are ignored during jogging. Nevertheless, a pulse overflow error will be generated if jogging causes an axis to move beyond the movement range of the positioning module.

■ Sample Program

● Description

This sample program jogs axis 1 of a positioning module installed in slot 3 in the forward direction.

● List of Devices

Table 6.14 lists the devices used.

Table 6.14 List of Devices Used in Sample Program for Jogging

Device	Name	Data
D00211/D00212	AX1 Specified Speed	100,000 (x 10-4mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D02001	AX1 Warning Status	
Y00341	AX1 Forward Jog output relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I00301	Start/stop forward jog operation	
I00302	Start forward jog operation (differential up)	
I00303	Stop forward jog operation (differential down)	
I00304	Forward jogging in progress	

- **Sample Program**

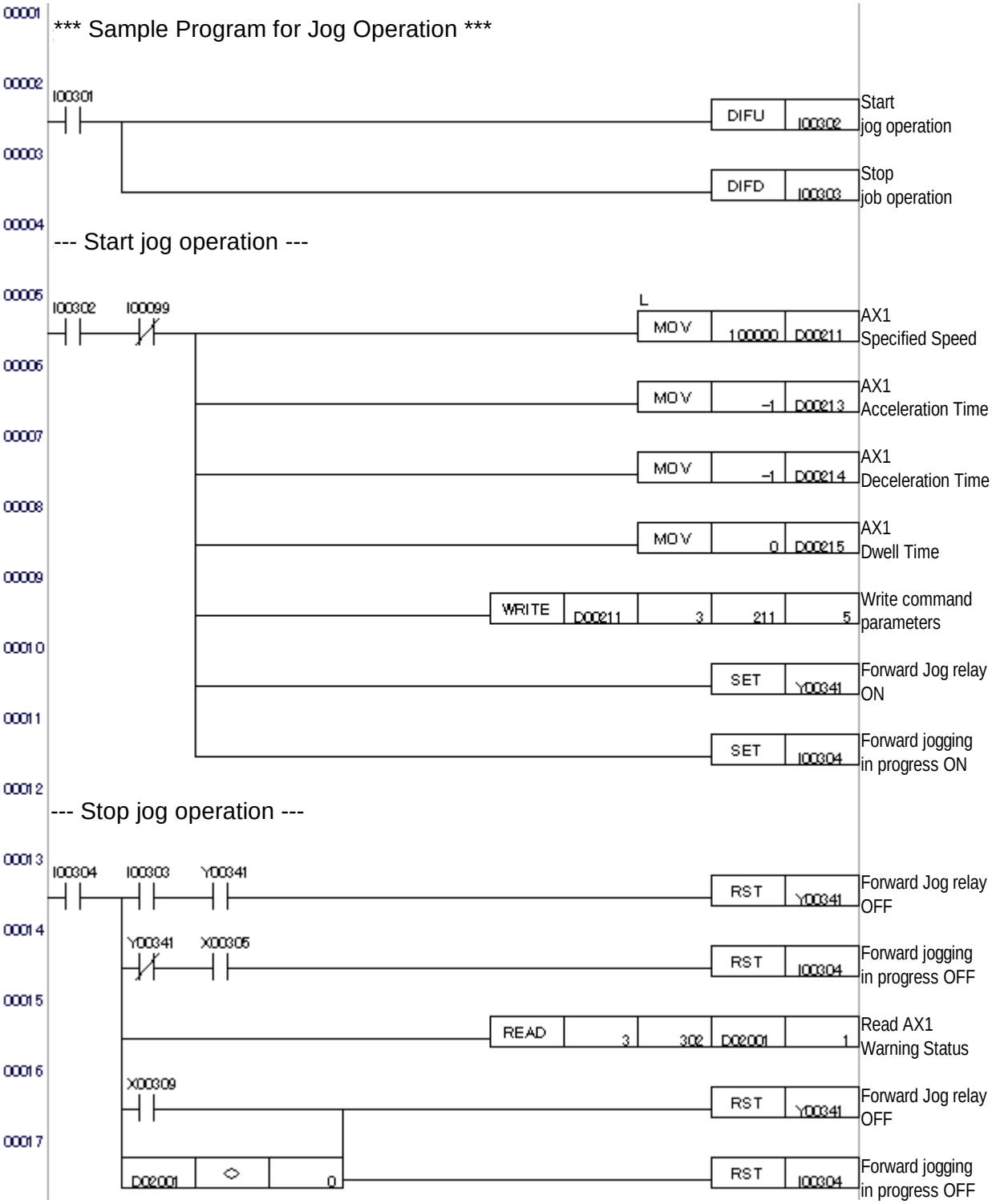


Figure 6.10 Jog Program

Timing Chart

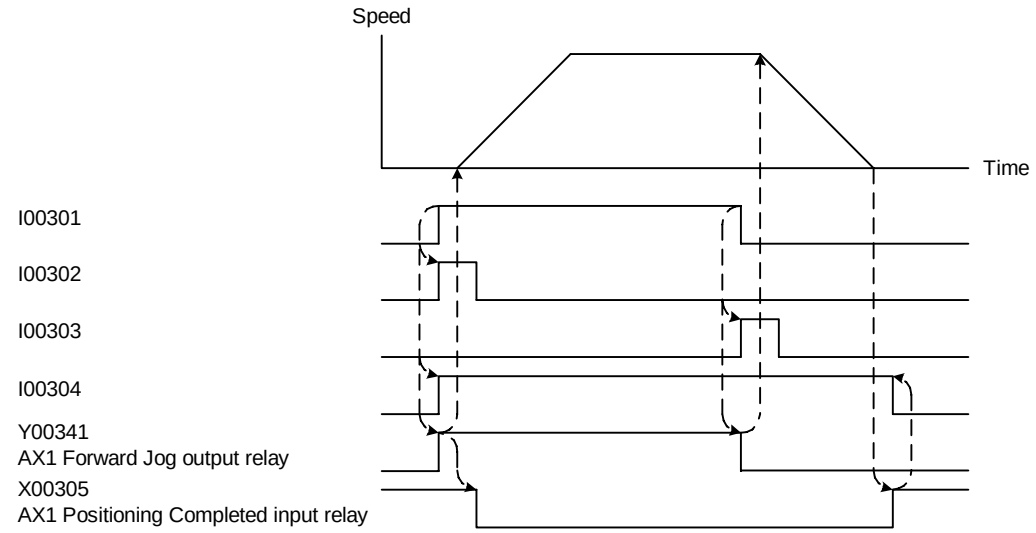


Figure 6.11 Timing Chart for Jog Program

6.6.2 Start Manual Pulse Generator Mode

■ Function

This command switches an axis from position control mode to manual pulse generator (MPG) mode.

You can operate a motor manually using a manual pulse generator after executing a Start Manual Pulse Generator command.

Manual pulse generator mode continues until a Stop Manual Pulse Generator Mode command is executed, or the Stop Immediately output relay is turned from off to on.

- Movement speed is limited by the Specified Speed parameter in MPG mode. Any input pulses exceeding the specified speed are stored and output when the speed falls below the specified speed.
- The ratio of a pulse count from a manual pulse generator and the angular travel of a motor can be specified using MPG Mode Multiplication and MPG Decimal Point of axis command parameters.

  Any change in the values of these parameters during MPG mode will be effected when the Start Manual Pulse Generator command is next executed.
- You can connect a manual pulse generator input to any of the counter inputs (two channels for F3NC32-0N and four channels for F3NC34-0N).
- As MPG mode is configured independently for each axis, you can manually operate two axes at the same time using two manual pulse generator inputs, or operate multiple axes using a single manual pulse generator input.
- To use a counter as manual pulse generator input for an axis, you must set the Counter Type Selection axis registered parameter to '0: General-purpose incremental'.

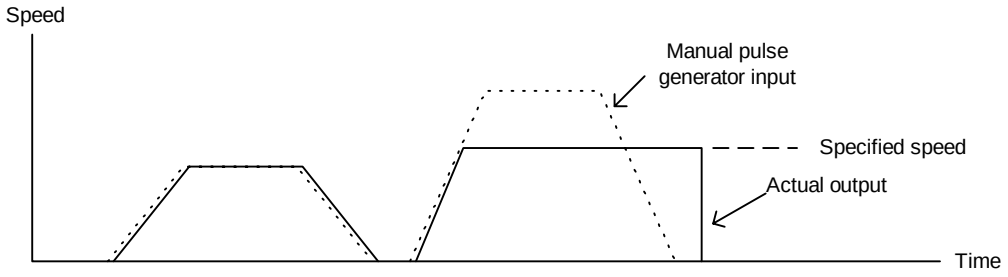


Figure 6.12 Manual pulse Generator Mode

CAUTION

Do not switch to MPG mode if the encoder feedback of a servomotor is connected to a counter input, or the motor may not operate as expected.

■ Execution Procedure

● Command Parameters Used

Table 6.15 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

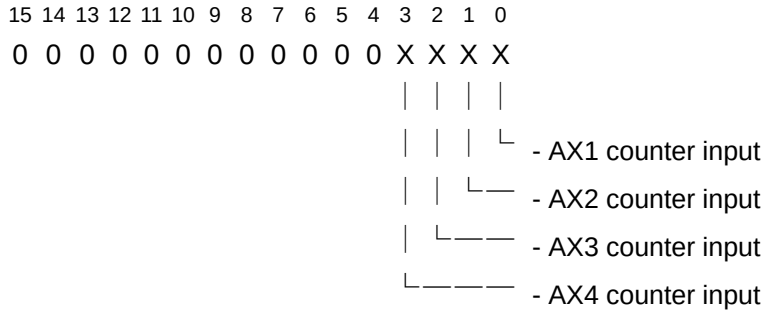
▲: Parameters that may require setup depending on other parameter values

Table 6.15 Required Parameters of Start Manual Pulse Generator Mode Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	44: Start Manual Pulse Generator Mode	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	1 to Speed Limit (speed reference unit)	○
0224	0524	0824	1124	MPG Mode Multiplication	-32,768 to 32,767	○
0225	0525	0825	1125	MPG Mode Decimal Point	0: x 1; 1: x 1/10; 2: x 1/100 3: x 1/1,000; 4: x 1/10,000	○

● Command Options

Bit data stored in the Command Options parameter is used to specify the counter inputs to be used as manual pulse generator inputs. If a bit is set to '0' in Command Options, the counter input of the corresponding command execution axis is used as a manual pulse generator input.



● Command Acceptance Conditions

Table 6.16 lists the pre-conditions for command execution.

Table 6.16 Command Acceptance Conditions for Start Manual Pulse Generator Mode Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In position control mode (except when executed in manual pulse generator mode)		○
In Positioning Completed state (except when executed in manual pulse generator mode)		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '44: start manual pulse generator mode' and required parameters to axis command parameter area of the command axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed relay turns off when the axis switches from position control to manual pulse generator mode.

■ Precautions

- The Positioning Completed input relays remains off during MPG mode.
- Operating the motor from the CPU module is not allowed during MPG mode.
- If an error is encountered during MPG mode, the axis will be switched from MPG mode to position control mode.
- Acceleration time and deceleration time cannot be set in MPG mode. The Start Manual Pulse Generator Mode command should be executed when there is no pulse input.
- Forward limit and reverse limit defined by axis registered parameters are ignored in MPG mode. Nevertheless, a pulse overflow error will be generated if movement exceeds the movement range of the positioning module.
- If the counter input used is not under index control, an overflow error may occur. To avoid overflow, set Counter Index Control of axis registered parameters to '1: Index control'.

■ Sample Program

● Description

This sample program switches axis 1 of a positioning module installed in slot 3 from position control mode to manual pulse generator mode.

● List of Devices

Table 6.17 lists the devices used.

Table 6.17 List of Devices Used in Sample Program for Start Manual Pulse Generator Mode

Device	Name	Data
D00201	AX1 Direct Command Code	44: Start Manual Pulse Generator Mode
D00202	AX1 Command Options	$0001
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4}mm/s)
D00224	AX1 MPG Mode Multiplication	1
D00225	AX1 MPG Mode Decimal Point	0:×1
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I00401	Start manual pulse generator mode	
I00402	Start manual pulse generator mode (differential up)	
I00403	Waiting for execute command ACK	
I00404	Command executing	

- **Sample Program**

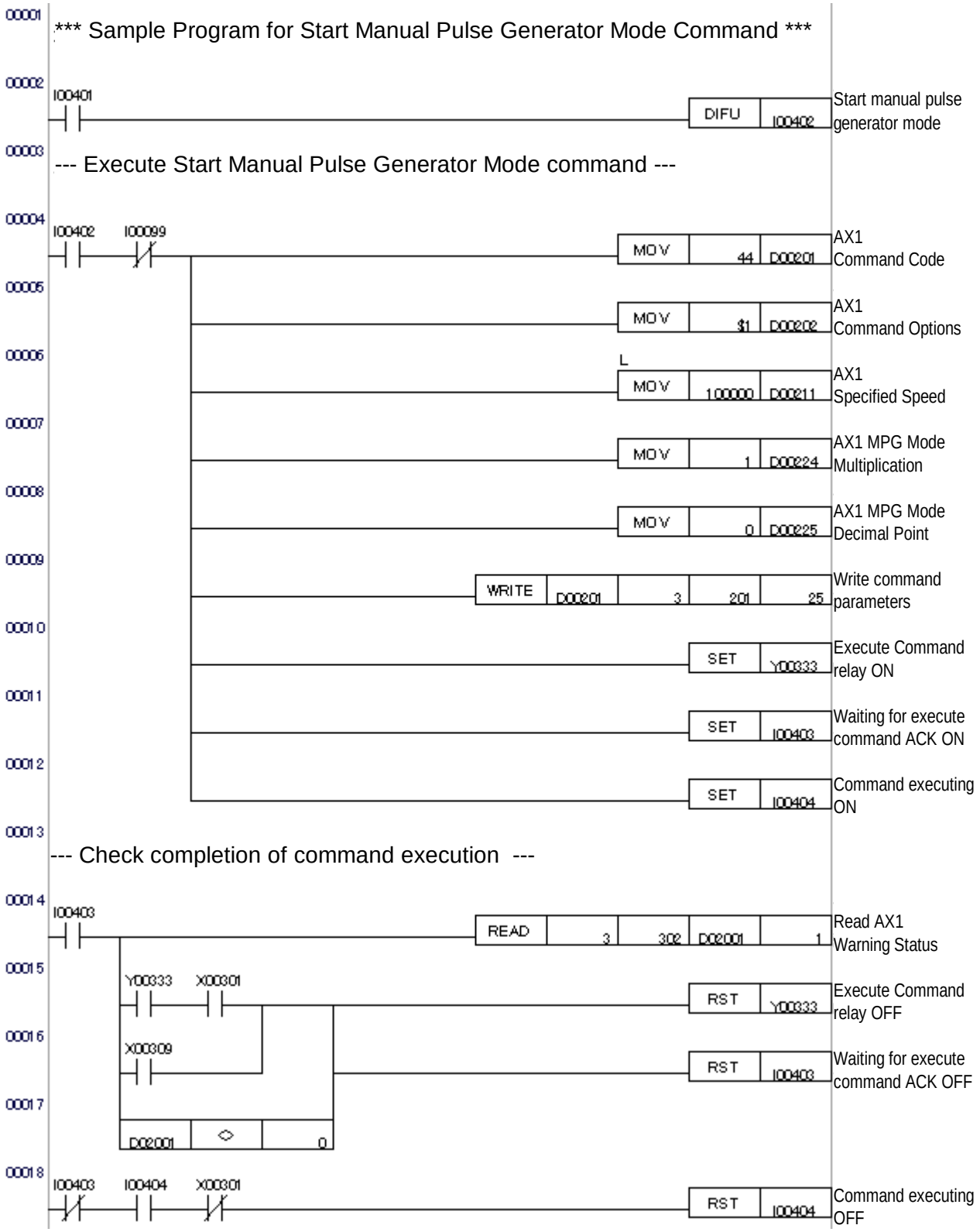


Figure 6.13 Start Manual Pulse Generator Mode Program

Timing Chart

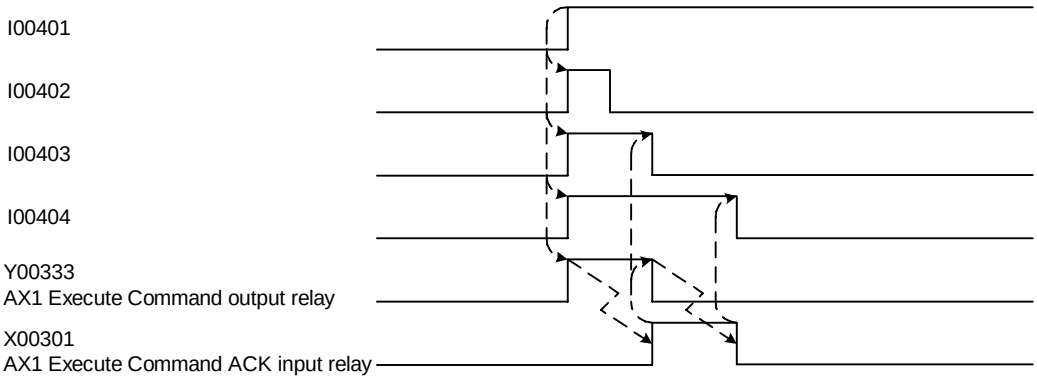


Figure 6.14 Time Chart for Start Manual Pulse Generator Mode Program

6.6.3 Stop Manual Pulse Generator Mode

■ Function

This command switches an axis from manual pulse generator mode to position control mode.

■ Execution Procedure

● Command Parameters Used

Table 6.18 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.18 Required Parameters of Stop Manual Pulse Generator Mode Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	45: Stop Manual Pulse Generator Mode	○

● Command Acceptance Conditions

Table 6.19 lists the pre-conditions for command execution.

Table 6.19 Command Acceptance Conditions for Stop Manual Pulse Generator Mode Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
No axis error has been detected.		○
In manual pulse generator mode		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '45: stop manual pulse generator mode' to axis command parameter area of the command axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns on when the axis switches from manual pulse generator mode to position control.

■ Precautions

- Executing the Stop Manual Pulse Generator Mode command while a motor is moving in MPG mode stops the motor immediately without deceleration.
- Pulses stored earlier in MPG mode because the Specified Speed was exceeded are cleared when the Stop Manual Pulse Generator Mode command is executed.

■ Sample Program

● Description

This sample program switches axis 1 of a positioning module installed in slot 3 from manual pulse generator mode to position control.

● List of Devices

Table 6.20 lists the devices used.

Table 6.20 List of Devices Used in Sample Program for Stop Manual Pulse Generator Mode

Device	Name	Data
D00201	AX1 Direct Command Code	45: Stop Manual Pulse Generator Mode
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I00501	Stop manual pulse generator mode	
I00502	Stop manual pulse generator mode (differential up)	
I00503	Waiting for execute command ACK	
I00504	Command executing	

- **Sample Program**

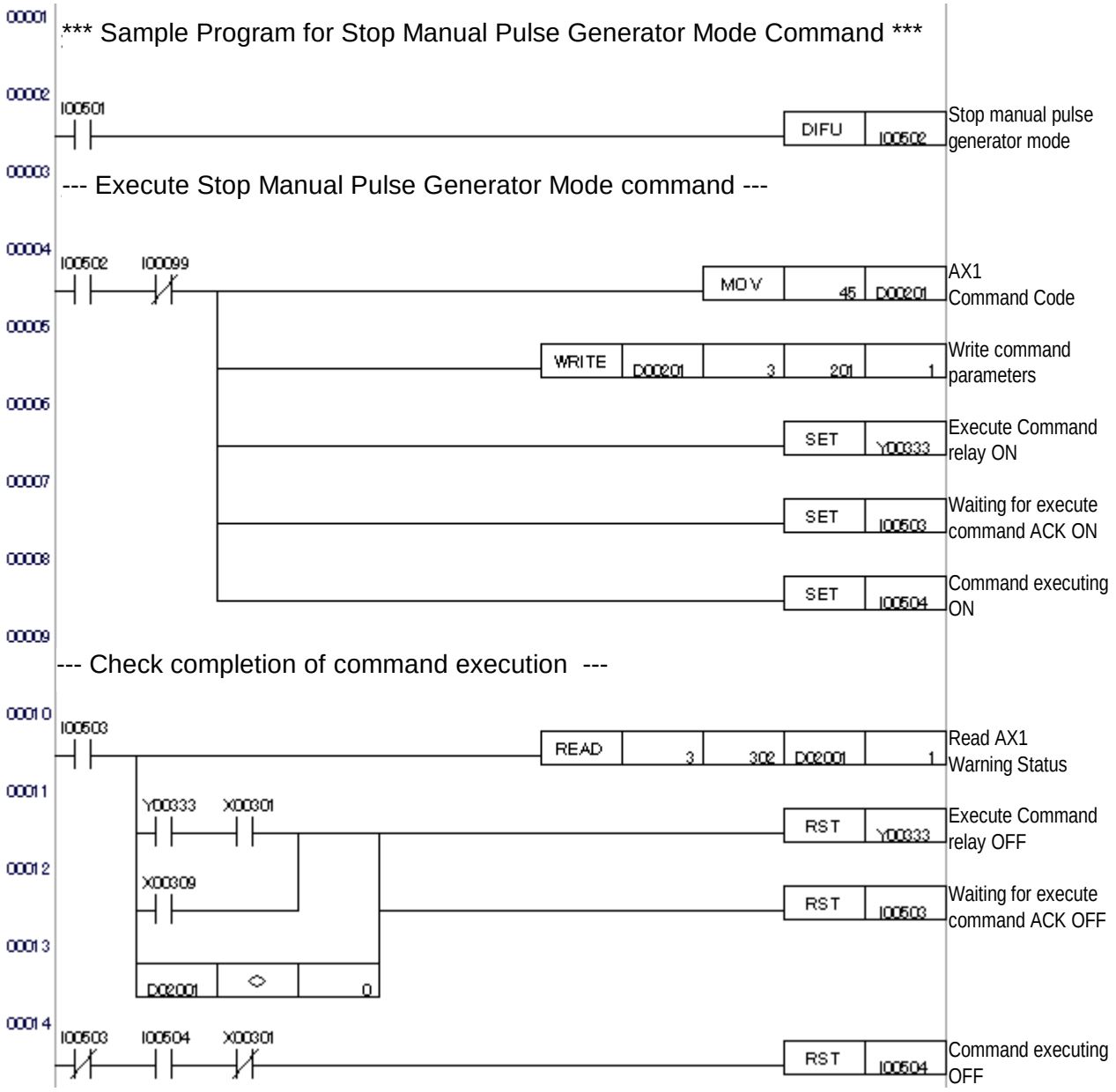


Figure 6.15 Stop Manual Pulse Generator Mode Program

- **Timing Chart**

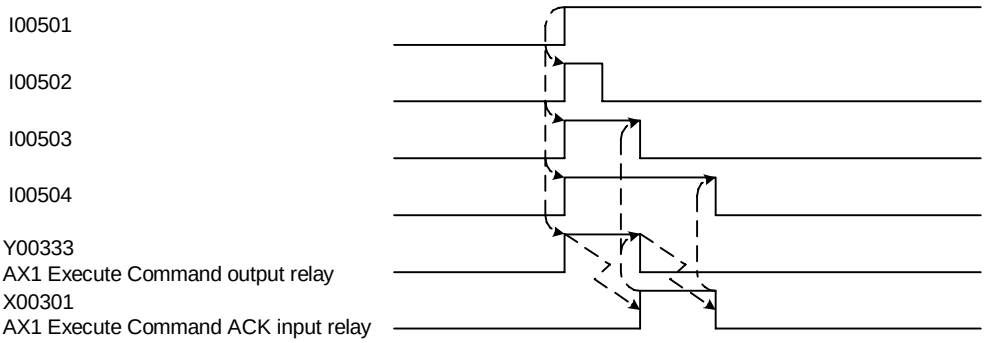


Figure 6.16 Timing Chart for Stop Manual Pulse Generator Mode Program

6.7 Origin Search

There are two ways to perform origin search: automatic and manual. In automatic origin search, the origin search behavior is defined by axis registered parameters. In manual origin search, the origin search behavior is arbitrarily defined by an application program.

This section describes the Automatic Origin Search command and the Manual Origin Search command.

6.7.1 Automatic Origin Search

■ Function

This command performs automatic origin search according to the axis registered parameter values.

- Automatic origin search may be defined using the AOS Mode axis registered parameter to use or to not use the origin switch, in addition to using the forward and reverse limit switches.

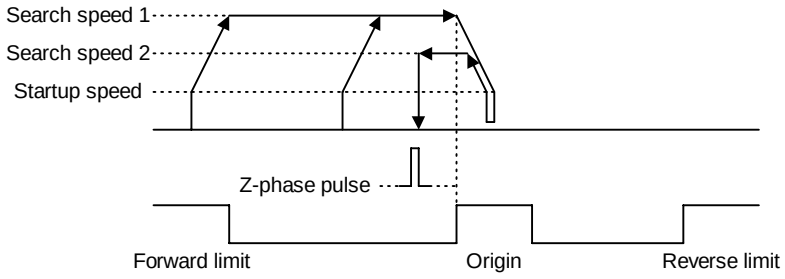
  The AOS Mode can also be used to specify whether to set the origin position found to the counter current position upon successful completion of the automatic origin search operation.
- In Z-phase search, the axis stops immediately after counting the number of Z-phase pulses defined by the Z-phase Search Count parameter. The stop position, after adjustment by the AOS Offset parameter, is taken as the origin.
- After arriving at the origin, the module outputs a deviation pulse clear signal for the duration defined by the AOS Deviation Pulse Clear Time parameter.

■ Description of Automatic Origin Search (AOS Mode=’0: use origin switch’)

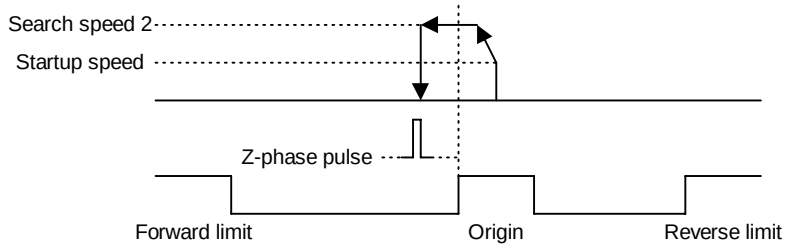
Figure 6.17 illustrates the automatic origin search movement initiated at different positions whereby AOS Mode is set to ' 0: Use origin switch', and AOS Direction is set to '0: Reverse'. If AOS Direction is set to '1: Forward', swap the forward limits and reverse limits shown in Figure 6.17.

1. If the Origin Input or the Reverse Limit input is off at the beginning of automatic origin search, the axis moves in the reverse direction at the speed defined by the AOS Speed 1 parameter. If the Origin Input or the Reverse Limit Input is on at the beginning of automatic origin search, automatic origin search begins with step 3 below.
2. The axis decelerates and stops when it detects a rising edge of the Origin Input or Reverse Limit Input.
3. The axis then restarts in the forward direction at the speed defined by the AOS Speed 2 parameter.
4. The axis shifts to Z-phase search operation after it detects a falling edge of the Origin Input.

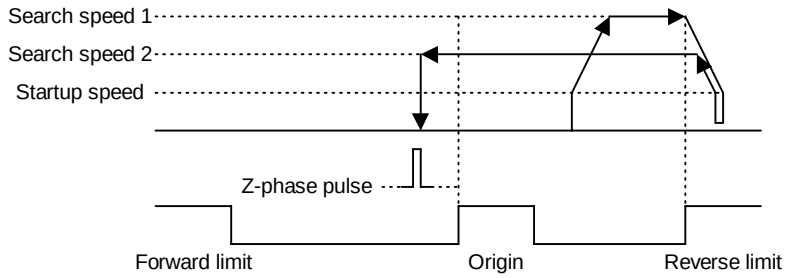
● Starting with axis in the forward direction of Origin Input



- **Starting with Origin Input turned on**



- **Starting with axis between Origin Input and Reverse Limit Input**



- **Starting with Reverse Limit Input turned on**

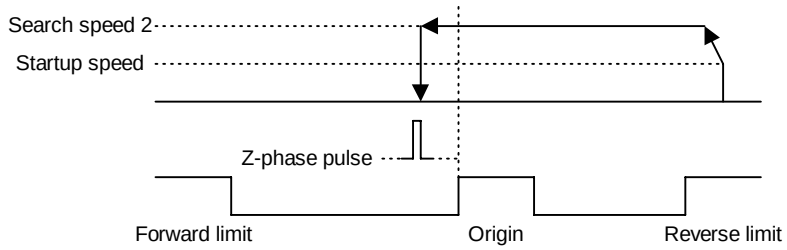


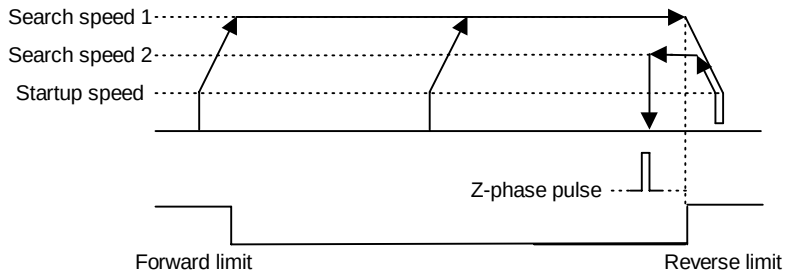
Figure 6.17 Automatic Origin Search Movement (reverse direction search with AOS Mode=0)

■ Description of Automatic Origin Search (AOS Mode='1: Do not use origin switch')

Figure 6.18 illustrates the automatic origin search movement initiated at different positions when AOS Mode is set to ' 1: Do not use origin switch', and AOS Direction is set to '0: Reverse'. If AOS Direction is set to '1: Forward', swap the forward limits and reverse limits shown in Figure 6.18.

1. If the Reverse Limit input is off at the beginning of automatic origin search, the axis moves in the reverse direction at the speed defined by the AOS Speed 1 parameter. If the Reverse Limit Input is on at the beginning of automatic origin search, automatic origin search begins with step 3 below.
2. The axis decelerates and stops when it detects a rising edge of the Reverse Limit Input.
3. The axis then restarts in the forward direction at the speed defined by the AOS Speed 2 parameter.
4. The axis shifts to Z-phase search operation after it detects a falling edge of the Reverse Limit Input.

● Starting with Reverse Limit Input turned off



● Starting with Reverse Limit Input turned on

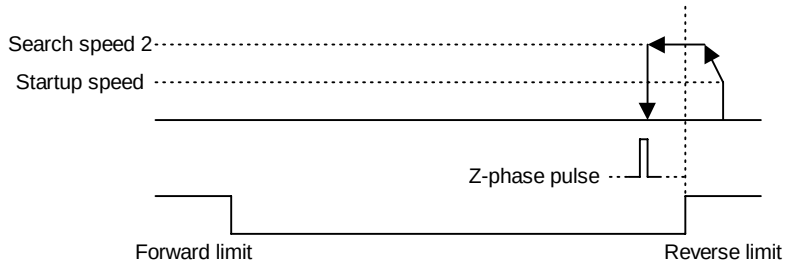


Figure 6.18 Automatic Origin Search Movement (reverse direction search with AOS Mode=1)

■ Execution Procedure

● Command Parameters Used

Table 6.21 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.21 Required Parameters of Automatic Origin Search Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	60: Automatic Origin Search	○

● Command Acceptance Conditions

Table 6.22 lists the pre-conditions for command execution.

Table 6.22 Command Acceptance Conditions for Automatic Origin Search Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
No axis error has been detected.		○
In position control mode		○
In Positioning Completed state		○
Not waiting for trigger		○

● Procedure

(1) Use the Set Axis Registered Parameters command as described in Section 6.4 to set up parameters to be used in automatic origin search.

(2) Write Direct Command Code '60: automatic origin search' to axis command parameter area of the command axis.

(3) Turn on the Execute Command output relay for the command axis.

(4) The Execute Command ACK input relay turns on and automatic origin search begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(5) In Z-phase search, the axis stops immediately after counting the number of Z-phase pulses defined by the AOS Z-phase Search Count parameter. The stop position, after adjustment by the AOS Offset parameter, is taken as the origin. If Z-phase Search Count is set to zero, the module skips Z-phase search. After the deviation pulse clear signal is output for a duration defined by the AOS Deviation Pulse Clear Time parameter, the Positioning Completed input relay turns on.

(6) Check the cause of completion for the automatic origin search operation by reading Origin Search Status of axis statuses. If the Origin Search Status is zero, it means the origin search has ended after completion of Z-phase search.

■ Precautions

- Automatic Origin Search will be aborted with error in the following situations:
  - The module detects a rising edge in the limit input for the direction opposite to the AOS Direction while moving in the direction opposite to the AOS Direction at AOS speed 2.
  - The module fails to detect Z-phase pulses within the AOS Z-phase Search Range after shifting to Z-phase search.
- Forward limit and reverse limit defined by axis registered parameters are ignored during automatic origin search. Nevertheless, a pulse overflow error will be generated if movement exceeds the movement range of the positioning module.
- You should specify use of each of the external contact inputs (Origin Input, Forward Limit Input and Reverse Limit Input) required for automatic origin search by setting the relevant bit of the Contact Usage Selection axis registered parameter to 0. Any external contact input set to '1: Used as General Input' will be ignored during automatic origin search.
- To output a deviation pulse clear signal, you should specify use of the Deviation Pulse Clear output contact by setting the relevant bit of the Contact Usage Selection axis registered parameter to 0. If you set the contact output to '1: Used as General Output', no deviation pulse clear output will be performed.
- Forward Limit Input and Reverse Limit Input are normally ignored if Index Control of axis registered parameters is set to '1: Index Control' but in origin search, they can still function as input switches.

■ Sample Program

● Description

This sample program performs automatic origin search using axis 1 of a positioning module installed in slot 3.

● List of Devices

Table 6.23 lists the devices used.

Table 6.23 List of Devices Used in Sample Program for Automatic Origin Search Command

Device	Name	Data
D00201	AX1 Direct Command Code	60: Automatic Origin Search
D02001	AX1 Warning Status	
D00305	AX1 Origin Search Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I00601	Automatic origin search	
I00602	Automatic origin search (differential up)	
I00603	Waiting for execute command ACK	
I00604	AOS in progress	

- **Sample Program**

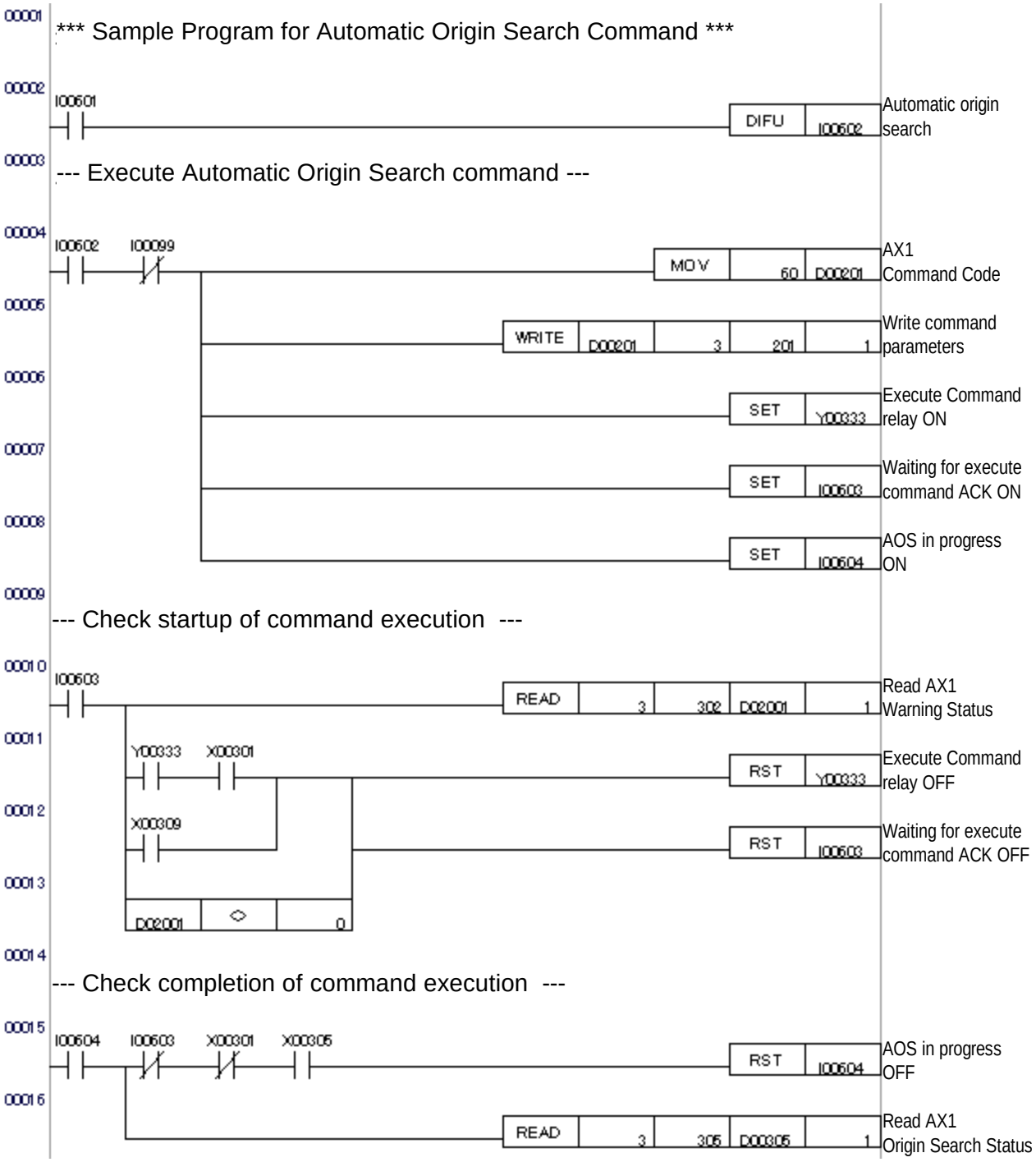


Figure 6.19 Automatic Origin Search Program

Timing Chart

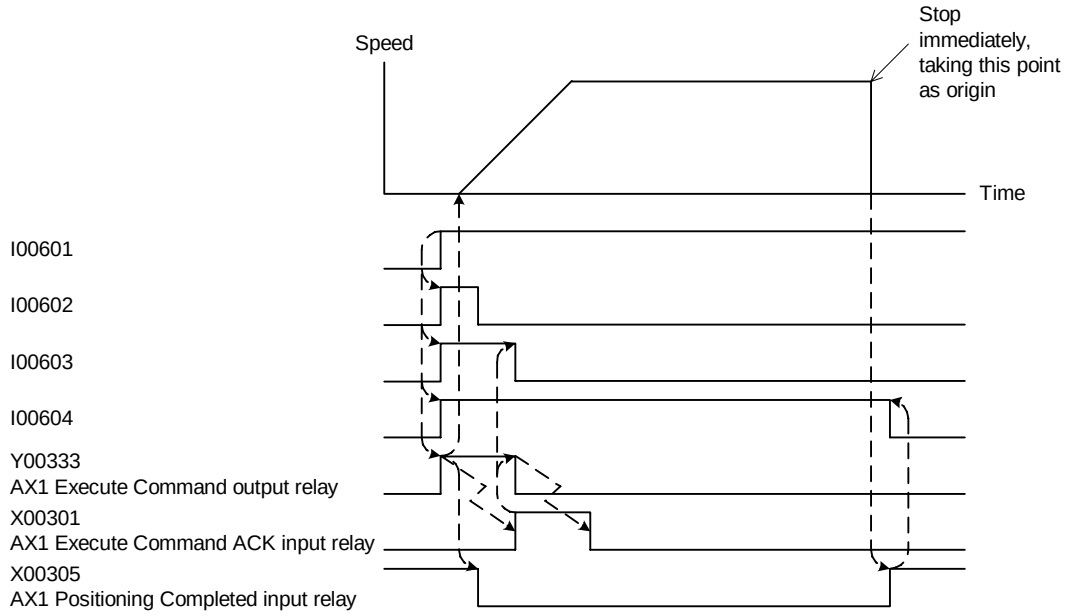


Figure 6.20 Timing Chart for Automatic Origin Search Program

6.7.2 Manual Origin Search

■ Function

This function performs manual origin search according to the Specified Speed, Origin Search Direction and Z-phase Edge Selection parameter values, as well as the origin search mode (Command Options parameter), which defines the behaviors of the module when an external contact input is detected.

If origin search must be carried out at different speeds or in different directions depending on the status of the external contact inputs, it may be divided into two or more phases, each executed by a Manual Origin Search command using different sets of parameters. This allows flexible customization of the origin search process.

- Three external contact inputs can be used in manual origin search: Origin Input, Forward Limit Input and Reverse Limit Input. The origin search mode uses bit data to specify the operation (stop immediately, decelerate & stop, shift to Z-phase or ignore) when a rising or falling edge of each of the above three inputs is detected using bit combinations.
- In Z-phase search, the axis stops immediately after counting the number of Z-phase pulses defined by the Z-phase Search Count parameter. The stop position is taken as the origin.
- After arriving at the origin, the module outputs a deviation pulse clear signal for the duration defined by the Deviation Pulse Clear Time parameter.

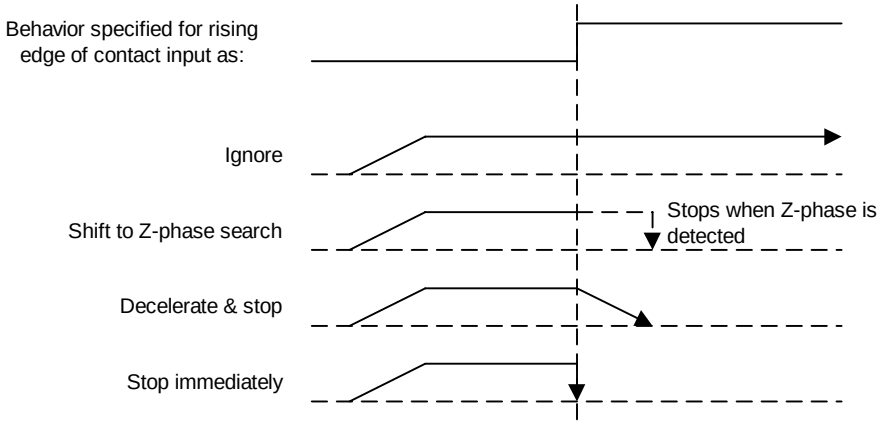


Figure 6.21 Manual Origin Search

■ Execution Procedure

● Command Parameters Used

Table 6.24 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

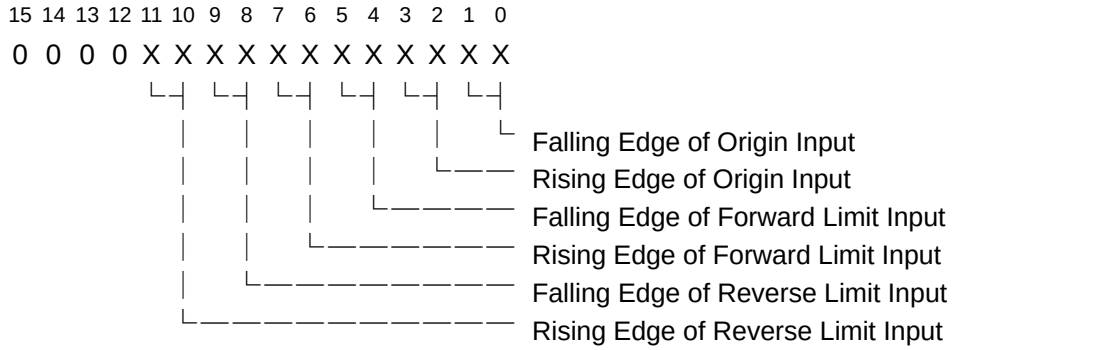
Table 6.24 Required Parameters of Manual Origin Search Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	61: Manual Origin Search	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	Startup Speed to Speed Limit (speed reference unit)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0228	0528	0828	1128	Origin Search Direction	0: Reverse; 1: Forward	○
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	○
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	○
0231 /0232	0531 /0532	0831 /0832	1131 /1132	Z-phase Search Range	0 to 2,147,483,647 or 0 to Z-phase Search Count (position reference unit)	○
0233	0533	0833	1133	Deviation Pulse Clear Time	0 to 32,767 (ms)	○

● Command Options

Bit data of the Command Options parameter specifies the behavior of the axis when a rising or falling edge is detected for of each of the three external output inputs related to manual origin search.

One out of four 2-bit combinations can be selected for each rising or falling edge of an external contact input. If all bits are set to 0, the axis shifts to Z-phase search immediately after manual origin search begins.



00: Ignore (Stops with error if rising edge of limit input in the direction of movement is encountered)

01: Shift to Z-phase Search

10: Decelerate & Stop

11: Stop Immediately

● Command Acceptance Conditions

Table 6.25 lists the pre-conditions for command execution.

Table 6.25 Command Acceptance Conditions for Manual Origin Search Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In position control mode		○
In Positioning Completed state		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '61: manual origin search' and required parameters to axis command parameter area of the command axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and origin search begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) In Z-phase search, the axis stops immediately after counting the number of Z-phase pulses defined by the Z-phase Search Count parameter. The stop position, after adjustment by the AOS Offset parameter, is taken as the origin. If Z-phase Search Count is set to zero, the module skips Z-phase search. After a deviation pulse clear signal is output for a duration defined by the Deviation Pulse Clear Time parameter, the Positioning Completed input relay turns on.

(5) Confirm the cause of completion for the origin search operation by reading Origin Search Status of axis statuses. If the Origin Search Status is zero, it means the origin search has ended after completion of Z-phase search.

■ Precautions

- Manual origin search ends when the axis comes to reset after detecting the specified external contact inputs. To continue manual origin search in a different direction or at a different speed after the axis has stopped, change the direction and speed parameters, and then again execute a Manual Origin Search command.
- Manual origin search will be aborted with error in the following situations:
  - A limit input is detected in the origin search direction but the Origin Search Mode parameter is set to '00: ignore' to ignore both the rising and falling edges of the limit input.
  - The module fails to detect the limit input in the origin search direction after shifting to Z-phase search. (This is not a setup error.)
  - The module fails to detect Z-phase pulses within the Z-phase Search Range after shifting to Z-phase search.
- To set up the manual origin search parameters based on the states of the external contact inputs before origin search, read Contact Input Status of axis statuses before executing the Manual Origin Search command.
- After shifting to Z-phase search, axis continues with Z-phase search even if it detects an edge of an external contact input if the input is configured for '11: Stop

immediately' or '10: Decelerate & stop' by the Origin Search Mode parameter.

- Forward limit and reverse limit defined by axis registered parameters are ignored during origin search.
- You should specify to use each of the external contact inputs (Origin Input, Forward Limit Input and Reverse Limit Input) required for manual origin search by setting the relevant bit of the Contact Usage Selection axis registered parameter to 0. Any external contact input set to '1: Used as General Input' will be ignored during manual origin search.
- To output a deviation pulse clear signal, you should specify to use the Deviation Pulse Clear output contact by setting the relevant bit of the Contact Usage Selection axis registered parameter to 0. If you set the contact output to '1: Used as General Output', no deviation pulse clear output will be performed.
- Forward limit and reverse limit defined by axis registered parameters are ignored during origin search. Nevertheless, a pulse overflow error will be generated if movement exceeds the movement range of the positioning module.
- Forward Limit Input and Reverse Limit Input are normally ignored if Index Control of axis registered parameters is set to '1: Index Control' but during origin search, they can still function as input switches.

■ Sample Program

● Description

This sample program performs manual origin search using axis 1 of a positioning module installed in slot 3.

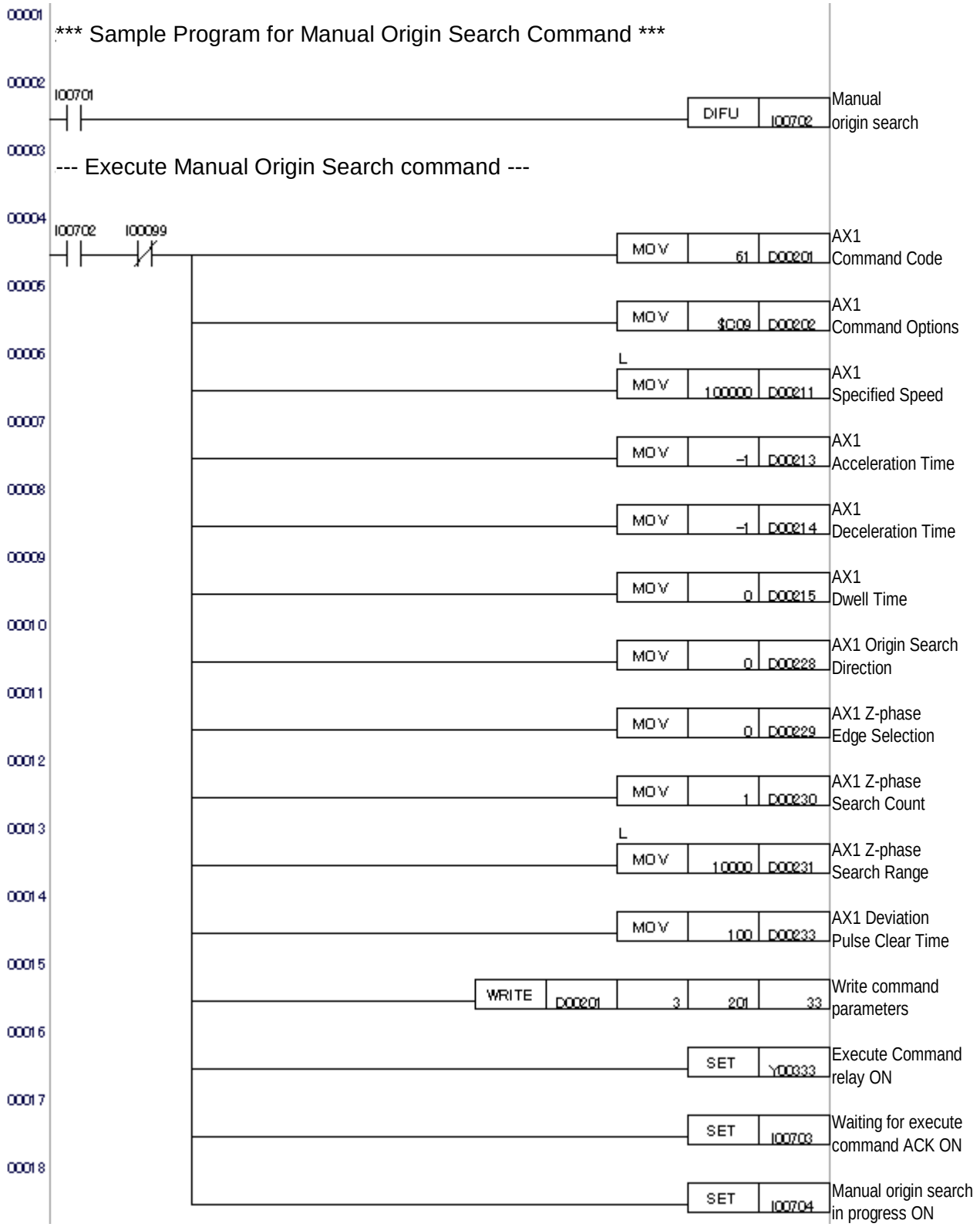
● List of Devices

Table 6.26 lists the devices used.

Table 6.26 List of Devices Used in Sample Program for Manual Origin Search Command

Device	Name	Data
D00201	AX1 Direct Command Code	61: Manual Origin Search
D00202	AX1 Command Options	$0C09
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4}mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D00228	AX1 Origin Search Direction	0: Reverse
D00229	AX1 Z-phase Edge Selection	0: Rising edge
D00230	AX1 Z-phase Search Count	1 (pulse)
D00231/D00232	AX1 Z-phase Search Range	10,000 (x 10^{-4}mm/s)
D00233	AX1 Deviation Pulse Clear Time	100 (ms)
D02001	AX1 Warning Status	
D00305	AX1 Origin Search Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I00701	Manual origin search	
I00702	Manual origin search (differential up)	
I00703	Waiting for execute command ACK	
I00704	Manual origin search in progress	

- **Sample Program**



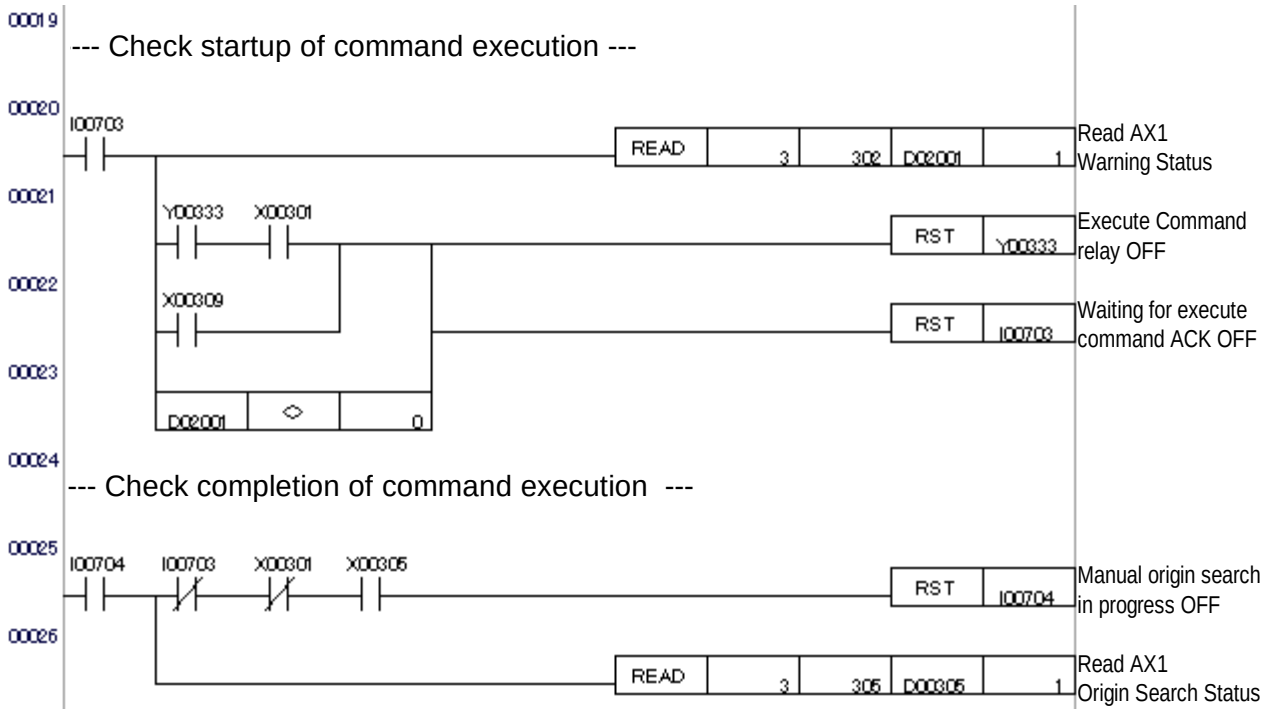


Figure 6 Manual Origin Search Program

- **Timing Chart**

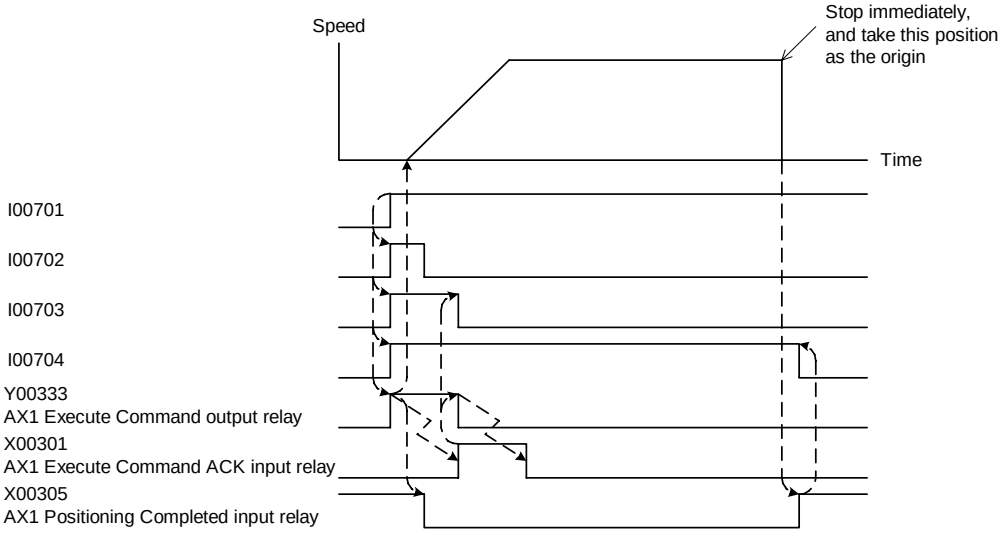


Figure 6.23 Timing Chart for Manual Origin Search Program

6.8 Set Current Position

■ Function

This command changes the current position.

- The Set Current Position command can also be used to change the counter current position at the same time.

■ Execution Procedure

● Command Parameters Used

Table 6.27 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

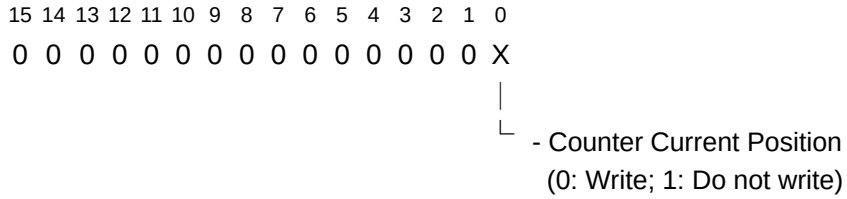
▲: Parameters that may require setup depending on other parameter values

Table 6.27 Required Parameters of Set Current Position Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	40: Set Current Position	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	△
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	Reverse Limit to Forward Limit (position reference unit)	○

● Command Options

Bit data stored in the Command Options parameter can be used to specify whether to also change the counter current position at the same time.



● Command Acceptance Conditions

Table 6.28 lists the pre-conditions for command execution.

Table 6.28 Command Acceptance Conditions for Set Current Position Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
Not in speed control mode		○
In Positioning Completed state		○
Counter is not used as manual pulse generator. (when specified to also write counter current position)		○
Counter is not used as Sanyo's Absolute encoder. (when specified to also write counter current position)		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '40: set current position' and required parameters to axis command parameter area of the command axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- Executing Set Current Position command discards fractional pulse counts to the right of the decimal point that are stored in the positioning module. As a result, an error of less than one pulse may occur.
- If Index Control axis registered parameter is set to "1: Index control", the specified current position value to be set should be between 0 (inclusive) and the Index Range (position reference unit).
- If specified to also write the counter current position when Counter Type Selection of axis registered parameters is set to '1: Sanyo Denki’s Manchester Coding', a warning will be generated when the Set Current Position command is executed and the counter current position will remain unchanged.
- If specified to also write the counter current position and Counter Index Control of axis registered parameters is set to '1: Index control', the specified current position value to be set should be between 0 (inclusive) and the Counter Index Range (position reference unit).

■ Sample Program

● Description

This sample program changes the current position of axis 1 to 2,000,000 ($\times 10^{-4}$ mm) for a positioning module installed in slot 3.

● List of Devices

Table 6.29 lists the devices used.

Table 6.29 List of Devices Used in Sample Program for Set Current Position Command

Device	Name	Data
D00201	AX1 Direct Command Code	40: Set Current Position
D00202	AX1 Command Options	$0000 (do not write counter current position)
D00207/D00208	AX1 Target Position	2,000,000 (x 10^{-4} mm/s)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I00801	Set current position	
I00802	Set current position (differential up)	
I00803	Waiting for execute command ACK	
I00804	Command executing	

- **Sample Program**

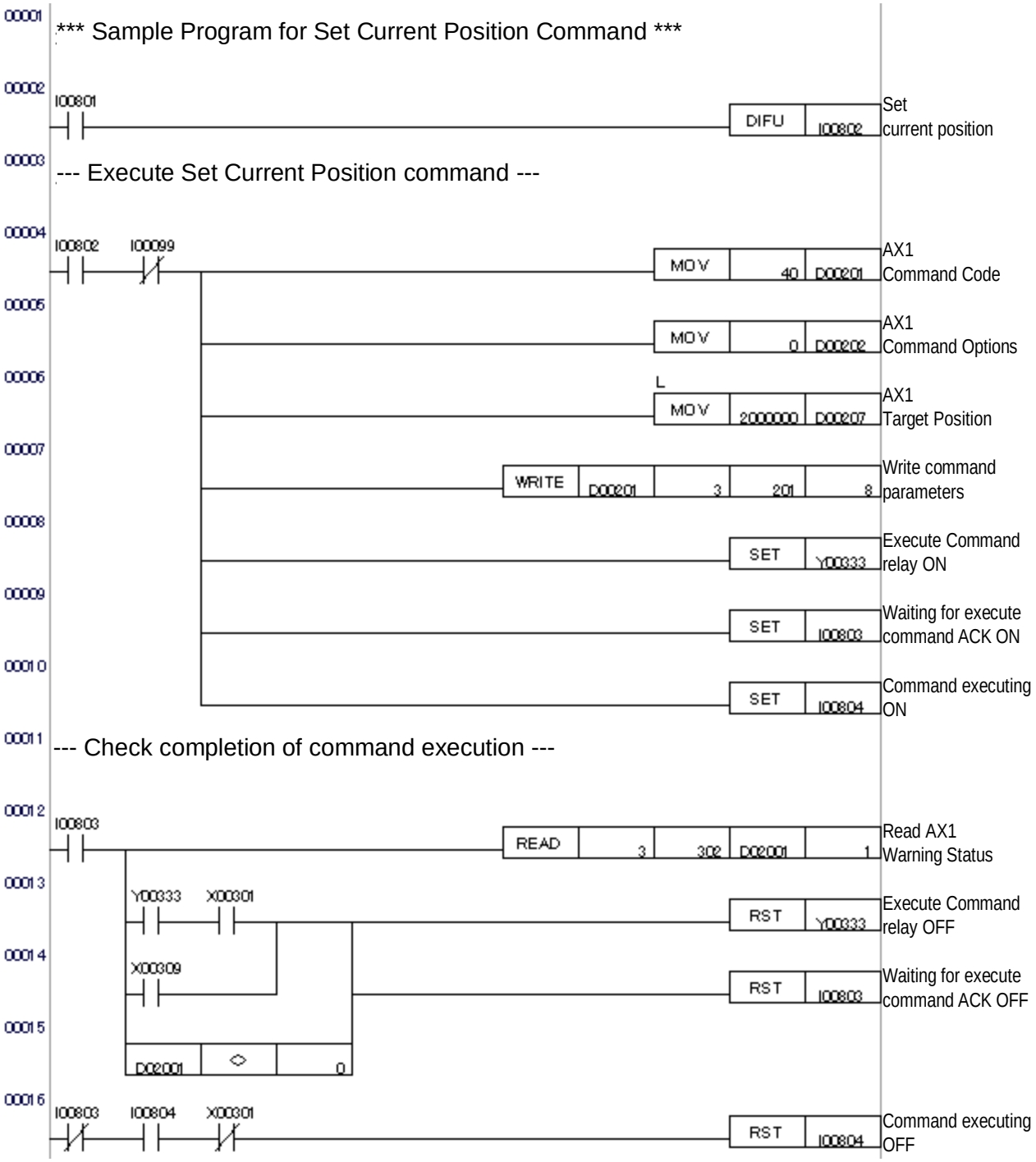


Figure 6.24 Set Current Position Program

Timing Chart

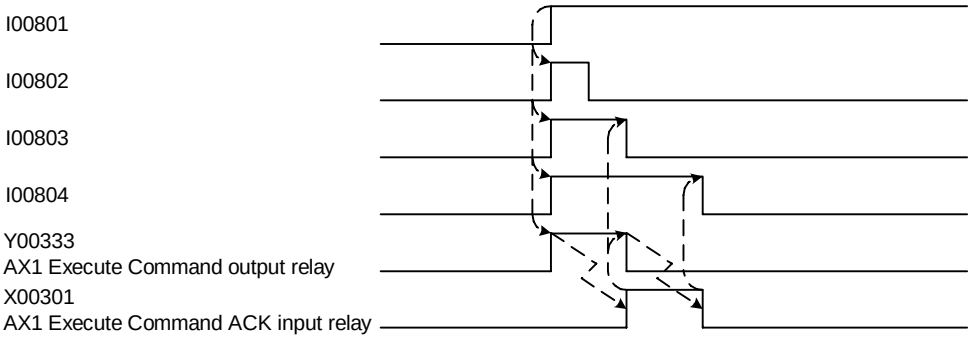


Figure 6.25 Timing Chart for Set Current Position Program

6.9 Position Control

This section describes position control commands.

6.9.1 Single-axis Positioning

■ Function

This command performs positioning of one axis according to the specified target position, specified speed, acceleration time and deceleration time.

Executing this command during positioning movement changes the target position immediately, and the axis continues movement to the new target position.

- The target position can be specified using an absolute position, an incremental position or a position data number.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual command execution.
- A startup speed can be specified using an axis registered parameter.
- A dwell time at the end of positioning can be specified.
- Instead of starting positioning immediately after command execution, a startup condition can be specified to delay positioning until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- An end condition can be specified to turn on an external contact output when positioning completes.

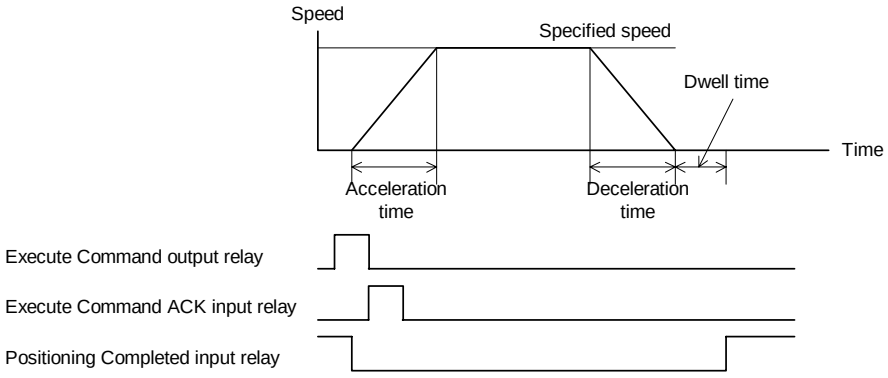


Figure 6.26 Single-axis Positioning

■ Execution Procedure

● Command Parameters Used

Table 6.30 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.30 Required Parameters of Single-axis Positioning Command

Data Position Number				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	0: Single-axis Positioning	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	△
0204	0504	0804	1104	End Condition	0: Normal end; Non-zero: End condition code	△
0206	0506	0806	1106	Target Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	○
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	-2,147,483,648 to 2,147,483,647 (position reference unit) or position data no. (1 to No. of Position Data Records Used)	○
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	Startup Speed to Speed Limit (reference speed unit)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

● Command Acceptance Conditions

Table 6.31 lists the pre-conditions for command execution.

Table 6.31 Command Acceptance Conditions for Single-axis Positioning Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In position control mode		○
Not under index control		○
Not jogging		○
No origin search is in progress		○
No change target position action is in progress		○
No change in set of interpolation axes during movement.		○
Not waiting for trigger		○
No change in command execution axis		○

● Procedure

(1) Write Direct Command Code '0: Single-axis positioning' and required parameters to axis command parameter area of command axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and movement begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns off when positioning begins. The Positioning Completed input relay turns on when the positioning movement the target position.

■ Precautions

- Setting new parameter values and executing a Single-axis Positioning command during single-axis positioning movement initiates a change target position movement. If the new Target Position Mode parameter is set to '1: Using INC Position', the new target position is computed as an incremental position from the previous target position.

■ Sample Program

● Description

This sample program performs single-axis positioning of axis 1 of a positioning module installed in slot 3.

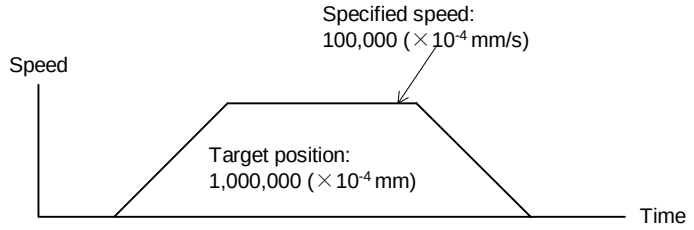


Figure 6.27 An Example of Single-axis Positioning Command Operation

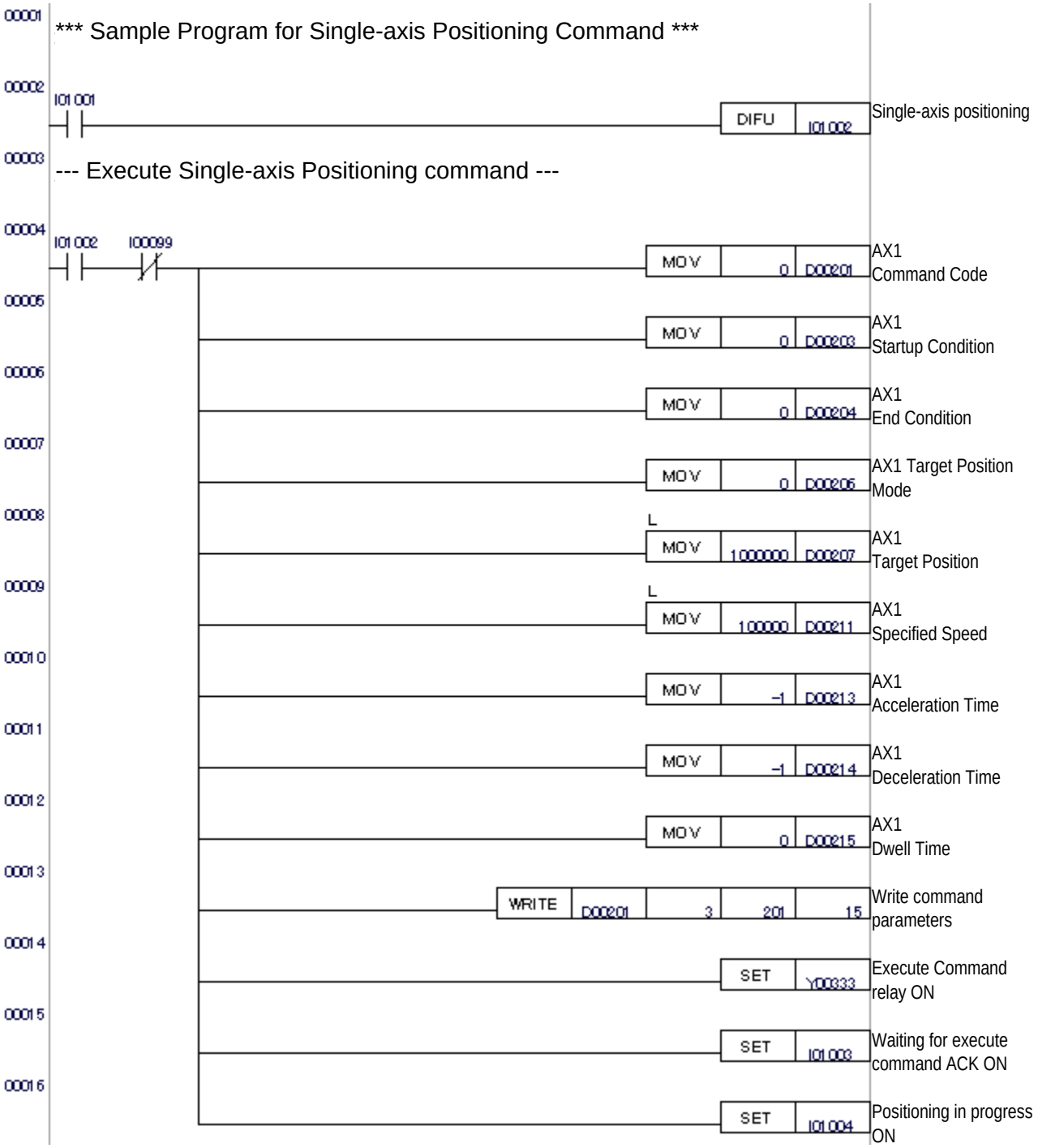
● List of Devices

Table 6.32 lists the devices used.

Table 6.32 List of Devices Used in Sample Program for Single-axis Positioning Command

Device	Name	Data
D00201	AX1 Direct Command Code	0: Single-axis Positioning
D00203	AX1 Startup Condition	0: Normal startup
D00204	AX1 End Condition	0: Normal end
D00206	AX1 Target Position Mode	0: Using ABS position
D00207/D00208	AX1 Target Position	1,000,000 (x 10^{-4} mm)
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4} mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I01001	Single-axis positioning	
I01002	Single-axis positioning (differential up)	
I01003	Waiting for execute command ACK	
I01004	Positioning in progress	

- **Sample Program**



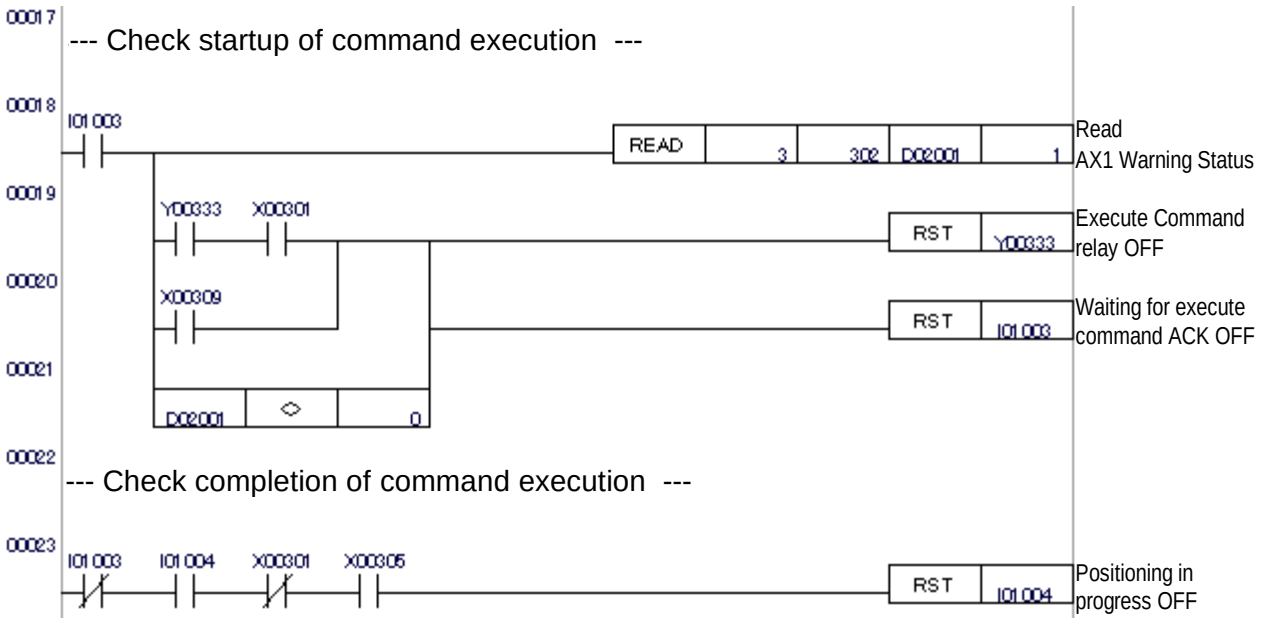


Figure 6.28 Single-axis Positioning Program

- **Timing Chart**

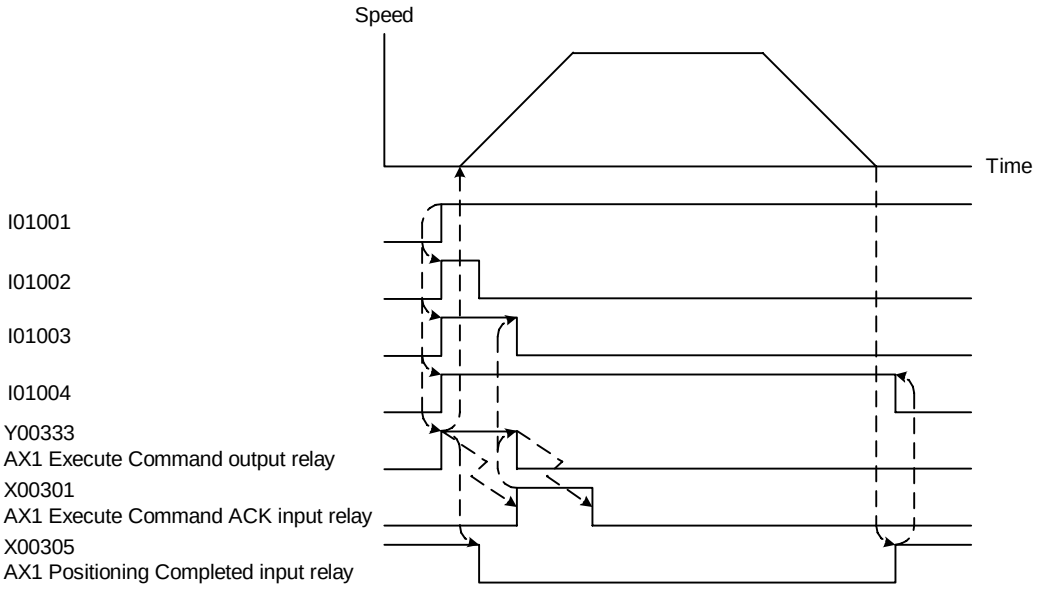


Figure 6.29 Timing Chart for Single-axis Positioning Program

6.9.2 Linear Interpolation

■ Function

This command performs linear interpolated positioning of 2, 3 or 4 axes according to the specified target position, specified speed, acceleration time and deceleration time. Executing this command during positioning movement changes the target position immediately, and the axes continue movement to the new target position.

- The target position can be specified using an absolute position, an incremental position or a position data number.
- The speed of the interpolation movement can be specified as the combined-speed, or the speed of the command execution axis.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual command execution.
- A dwell time at the end of positioning can be specified.
- Instead of starting positioning immediately after command execution, a startup condition can be specified to delay positioning until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- An end condition can be specified to turn on an external contact output when positioning completes.

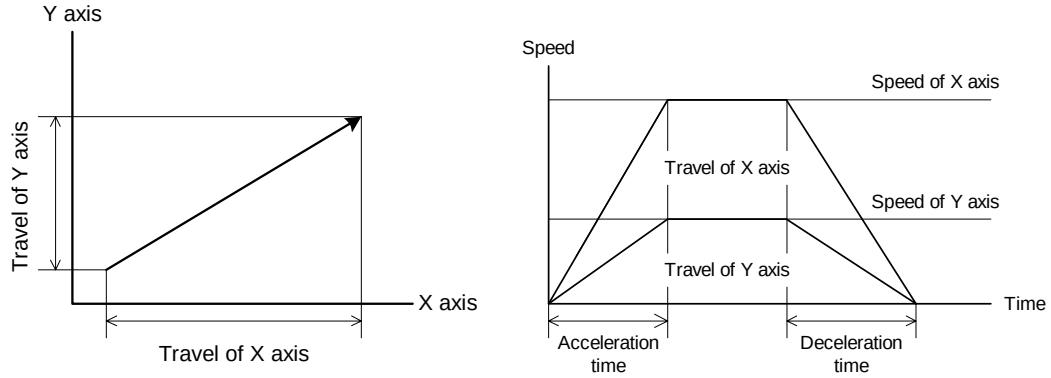


Figure 6.30 Linear Interpolation (An example of 2-axis linear interpolation)

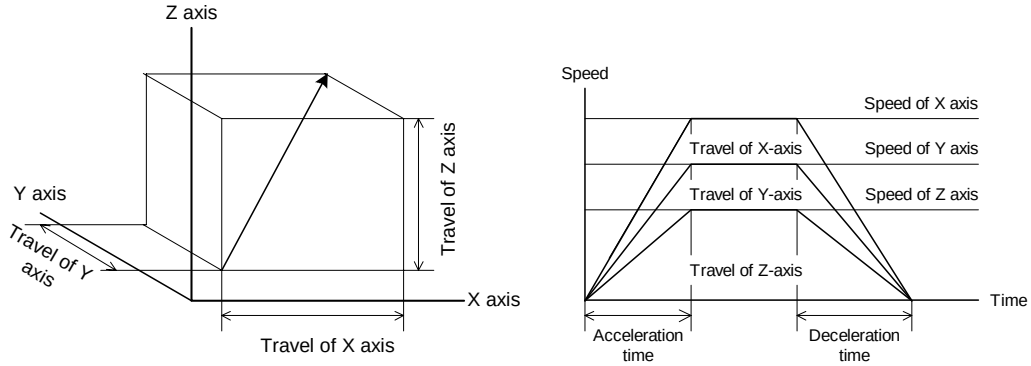


Figure 6.31 Linear Interpolation (An example of 3-axis linear interpolation)

■ Execution Procedure

● Command Parameters Used

Table 6.33 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

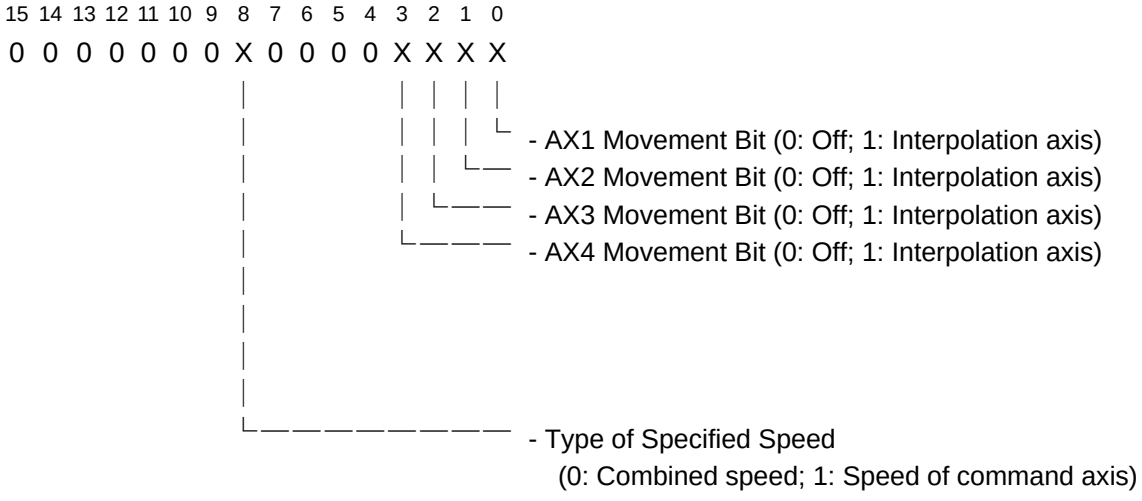
Table 6.33 Required Parameters of Linear Interpolation Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	1: Linear Interpolation	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	△
0204	0504	0804	1104	End Condition	0: Normal end; Non-zero: End condition code	△
0206	0506	0806	1106	Target Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	◎*1
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	-2,147,483,648 to 2,147,483,647 (position reference unit) or position data no. (1 to No. of Position Data Records Used)	◎*1
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	For combined speed: 1 to 2,147,483,647 (speed reference unit) For speed of command execution axis: 1 to Speed Limit (speed reference unit)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

*1: If the Target Position Mode is set to '2: Using position data no.', target position parameters for the other interpolation axes involved in the movement need not be set.

● Command Options

Bit data stored in the Command Options parameter is used to specify which other axes (interpolation axes) are involved in the interpolation movement with the command execution axis, as well as the type of the specified interpolation speed.



● Command Acceptance Conditions

Table 6.34 lists the pre-conditions for command execution.

Table 6.34 Command Acceptance Conditions for Linear Interpolation Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In position control mode		○
Not under index control		○
Not jogging		○
No origin search is in progress		○
No change target position action is in progress		○
No change in set of interpolation axes during movement.		○
Not waiting for trigger		○
No change in command execution axis		○

● Procedure

(1) Write Direct Command Code '1: Linear interpolation' and required parameters to axis command parameter areas of command axis and interpolation axes.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and movement begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns off when positioning begins. The Positioning Completed input relay turns on when the positioning movement reaches the target position.

■ Precautions

- Regardless of the value of the Startup Speed axis registered parameter, interpolation is always carried out, assuming a specified startup speed of 0.
- When specifying a combined speed for interpolation, the unit of all interpolation axes should be set to '1: mm'.
- Interpolated positioning is carried out according to the values of the axis registered parameters (acceleration/deceleration curve, etc.) of the command execution axis.
- If the speed limit of any axis is exceeded during interpolation, an error is generated and all axes are stopped immediately.
- The specified combined speed or command execution axis speed should be such that no speed limit of any interpolation axis is exceeded. In particular, an inappropriate speed specified for a command execution axis in interpolation movement may result in a short movement time for the command execution axis, and abrupt movements of the other interpolation axes.

- Changing the target position during interpolation movement is not allowed if it also changes the set of interpolation axes. If the new Target Position Mode parameter is set to '1: Using INC Position', the new target position is computed as an incremental position from the previous target position.

■ Sample Program

● Description

This sample program performs linear interpolated positioning of axes 1 and 2 for a positioning module installed in slot 3. It issues the Linear Interpolation command from axis 1.

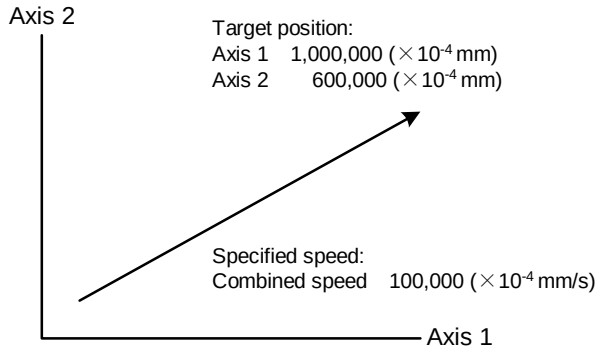


Figure 6.32 An Example of Linear Interpolation Command Operation

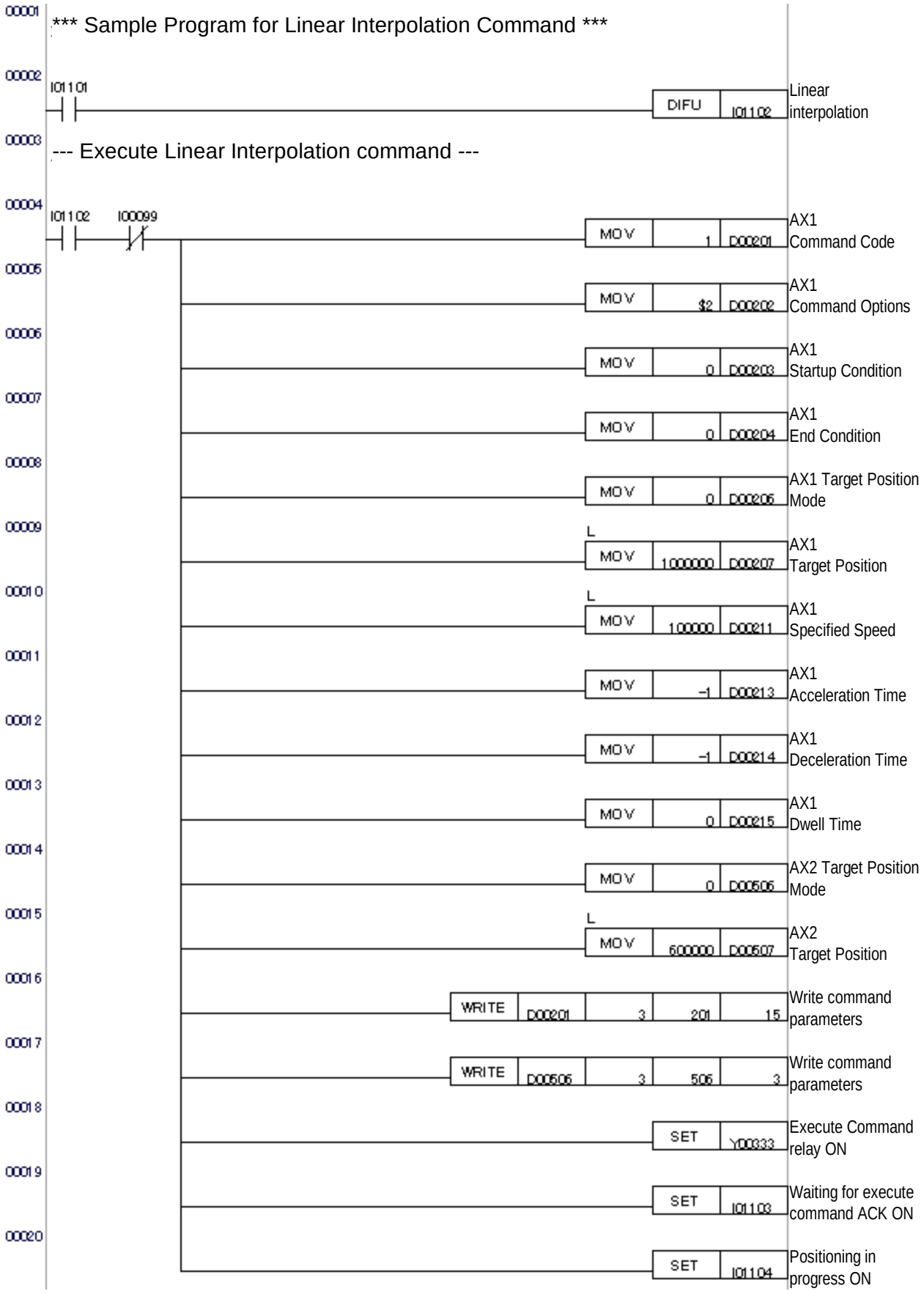
● List of Devices

Table 6.35 lists the devices used.

Table 6.35 List of Devices Used in Sample Program for Linear Interpolation Command

Device	Name	Data
D00201	AX1 Direct Command Code	1: Linear Interpolation
D00202	AX1 Command Options	$0002 (combined-speed with axis 2 as interpolation axis)
D00203	AX1 Startup Condition	0: Normal startup
D00204	AX1 End Condition	0: Normal end
D00206	AX1 Target Position Mode	0: Using ABS position
D00207/D00208	AX1 Target Position	1,000,000 (x 10^{-4} mm)
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4} mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D02001	AX1 Warning Status	
D00506	AX2 Target Position Mode	0: Using ABS position
D00507/D00508	AX2 Target Position	600,000 (x 10^{-4} mm)
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00306	AX2 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I01101	Linear interpolation	
I01102	Linear interpolation (differential up)	
I01103	Waiting for execute command ACK	
I01104	Positioning in progress	

- **Sample Program**



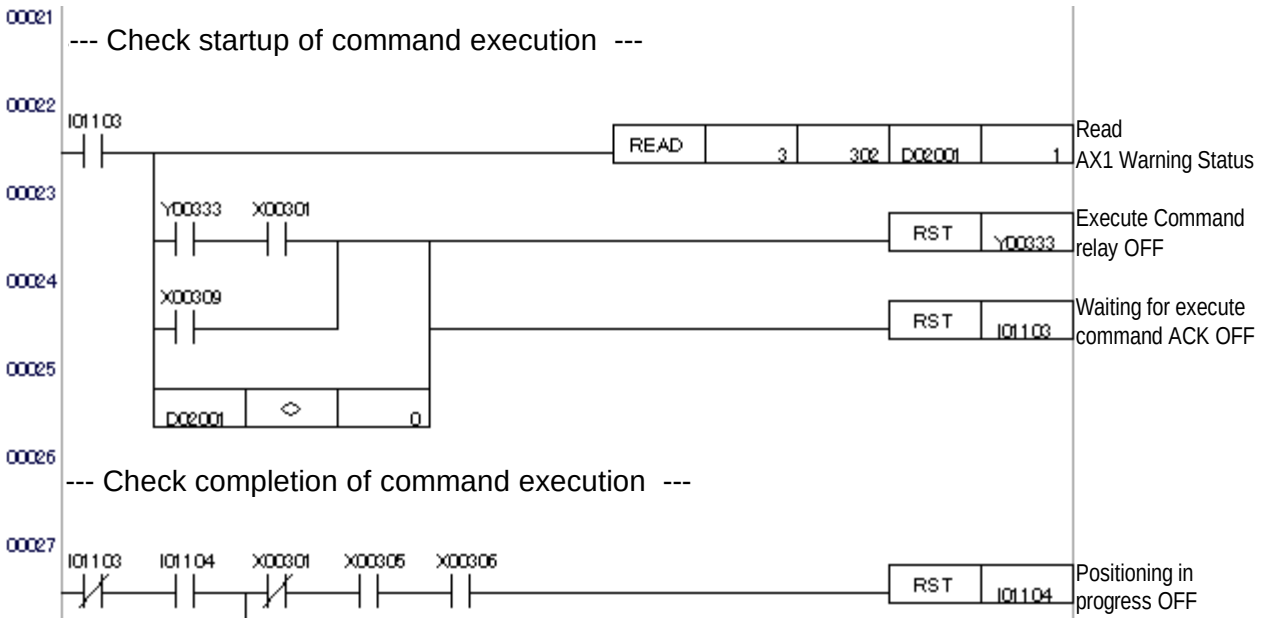


Figure 6.33 Linear Interpolation Program

● Timing Chart

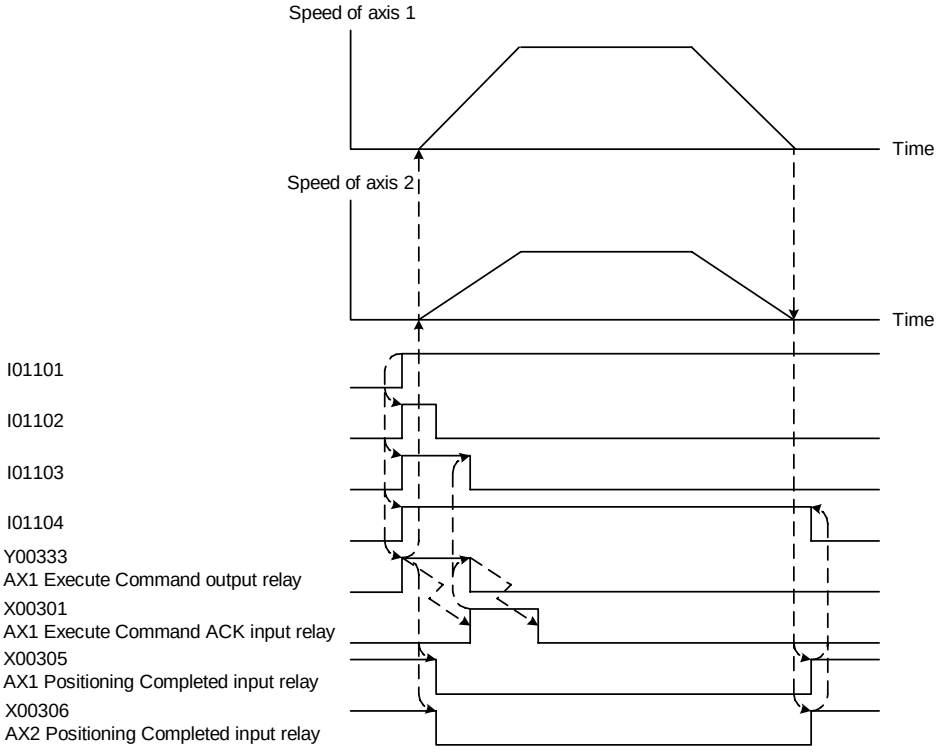


Figure 6.34 Timing Chart for Linear Interpolation Program

6.9.3 Circular Interpolation

■ Function

This command performs circular interpolated positioning of two axes according to the specified target position, specified speed, acceleration time and deceleration time. Executing this command during positioning movement changes the target position immediately, and the axes continue movement to the new target position.

- Three types of circular interpolation movement are available: circular interpolation using a sub point, CW circular interpolation using center, and CCW circular interpolation using center.
- Figure 6.35 shows the direction of movement for CW and CCW circular interpolations using a center point. The X axis in this figure denotes the axis with the smaller axis number, while the Y axis denotes the axis with the larger axis number. For instance, for circular interpolation involving axes 1 and 2, the X-axis denotes axis 1, while the Y-axis denotes axis 2; for circular interpolation involving axes 2 and 4, the X-axis denotes axis 2, while the Y axis denotes axis 4.
- The target position can be specified using an absolute position, an incremental position or a position data number. Similarly, the sub point and center point can also be specified using an absolute position, an incremental position or a position data number.
- The Specified Speed parameter in interpolation movement corresponds to the tangential speed along the circular arc.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual command execution.
- A dwell time at the end of positioning can be specified.
- Instead of starting positioning immediately after command execution, a startup condition can be specified to delay positioning until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- An end condition can be specified to turn on an external contact output when positioning completes.

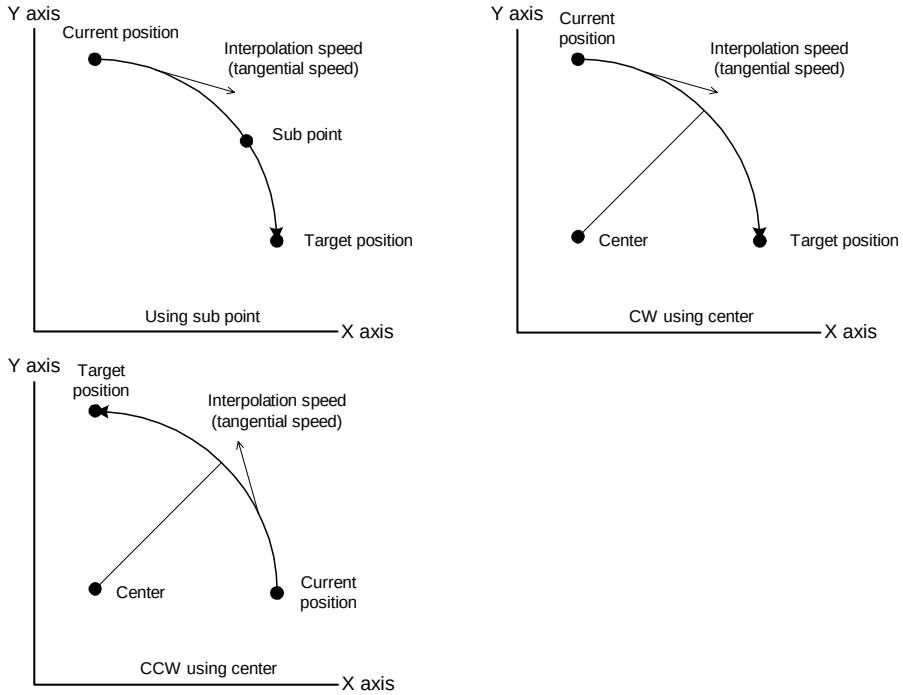


Figure 6.35 2-axis Circular Interpolation

■ Execution Procedure

● Command Parameters Used

Table 6.36 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

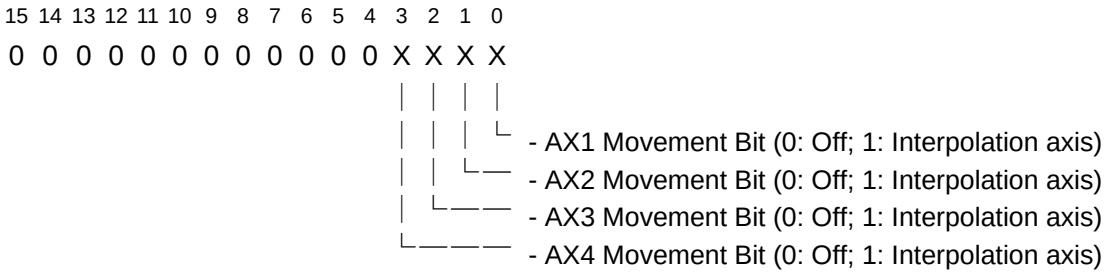
Table 6.36 Required Parameters of Circular Interpolation Commands

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	2: Circular Interpolation Using Sub Point 3: CW Circular Interpolation Using Center 4: CCW Circular Interpolation Using Center	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	△
0204	0504	0804	1104	End Condition	0: Normal end; Non-zero: End condition code	△
0206	0506	0806	1106	Target Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	◎*1
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	-2,147,483,648 to 2,147,483,647 (position reference unit) or position data no. (1 to No. of Position Data Records Used)	◎*1
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	1 to 2,147,483,647 (speed reference unit)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0219	0519	0819	1119	CI Turns	0 to 32,767 (turns)	○
0220	0520	0820	1120	CI Sub Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	◎*1
0221 /0222	0521 /0522	0821 /0822	1121 /1122	CI Sub Position	-2,147,483,648 to 2,147,483,647 (position reference unit) Or, position data no. (1 to 2,000)	◎*1
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

*1: If the Target Position Mode is set to '2: Using position data no.', target position parameters for the other interpolation axes involved in the movement need not be set.

● Command Options

Bit data stored in the Command Options parameter is used to specify which other axes (interpolation axes) are involved in the circular interpolation movement with the command execution axis.



Command Acceptance Conditions

Table 6.37 lists the pre-conditions for command execution.

Table 6.37 Command Acceptance Conditions for 2-axis Circular Interpolation Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In position control mode		○
Not under index control		○
Not jogging		○
No origin search is in progress		○
No change target position action is in progress		○
No change in set of interpolation axes during movement.		○
Not waiting for trigger		○
No change in command execution axis		○

Procedure

(1) Write Direct Command Code ('2: Circular Interpolation Using Sub Point', or '3: CW Circular Interpolation Using Center' or '4: CCW Circular Interpolation Using Center') and required parameters to axis command parameter areas of the command axis and interpolation axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and movement begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns off when positioning begins. The Positioning Completed input relay turns on when the positioning movement reaches the target position.

■ Precautions

- Regardless of the value of the Startup Speed axis registered parameter, interpolation is always carried out, assuming a specified startup speed of 0. .
- Set the unit of the two axes involved in the circular interpolation to '1: mm'.
- Interpolated positioning is carried out according to the values of the axis registered parameters (acceleration/deceleration curve, etc.) of the command execution axis.
- The specified sub position (center point or sub point) for circular interpolation must fall within the forward limits and reverse limits of all axes.
- In circular interpolation using sub point, the radius of the circular path must not exceed the maximum value that can be represented using 32 bits.
- If the speed limit of any axis is exceeded during interpolation, an error is generated and all axes are stopped immediately.

  The specified tangential speed along the circular path should be such that no speed limit of any interpolation axes is exceeded. (The tangential speed may sometimes exceed a speed limit during circular interpolation due to internal computational error. As such, it is recommended that some allowance be included when setting the speed limit of each axis. This phenomenon tends to occur when circular interpolation using a specified center point follows a whorl-like path.)
- If Forward Limit or Reverse Limit is exceeded during circular interpolation, an error is generated and all axes are stopped immediately.
- When performing circular interpolation using a specified center point, depending on the center position and the target position, a deviation may arise between the circular path and the target position. If this deviation exceeds the circular interpolation error tolerance defined by the CI Error Tolerance parameter, an error is generated and interpolation is not performed. If the deviation falls within the error tolerance, circular interpolation follows a whorl-like path.
- Changing the target position during interpolation movement is not allowed if it also changes the set of interpolation axes.

■ Sample Program

● Description

This sample program performs circular interpolation of axes 1 and 2 using a specified sub point for a positioning module installed in slot 3. It issues a Circular Interpolation Using Sub Point command from axis 1.

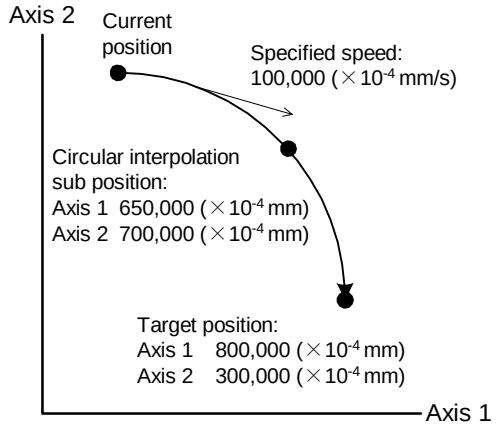


Figure 6.36 An Example of 2-axis Circular Interpolation Command Operation

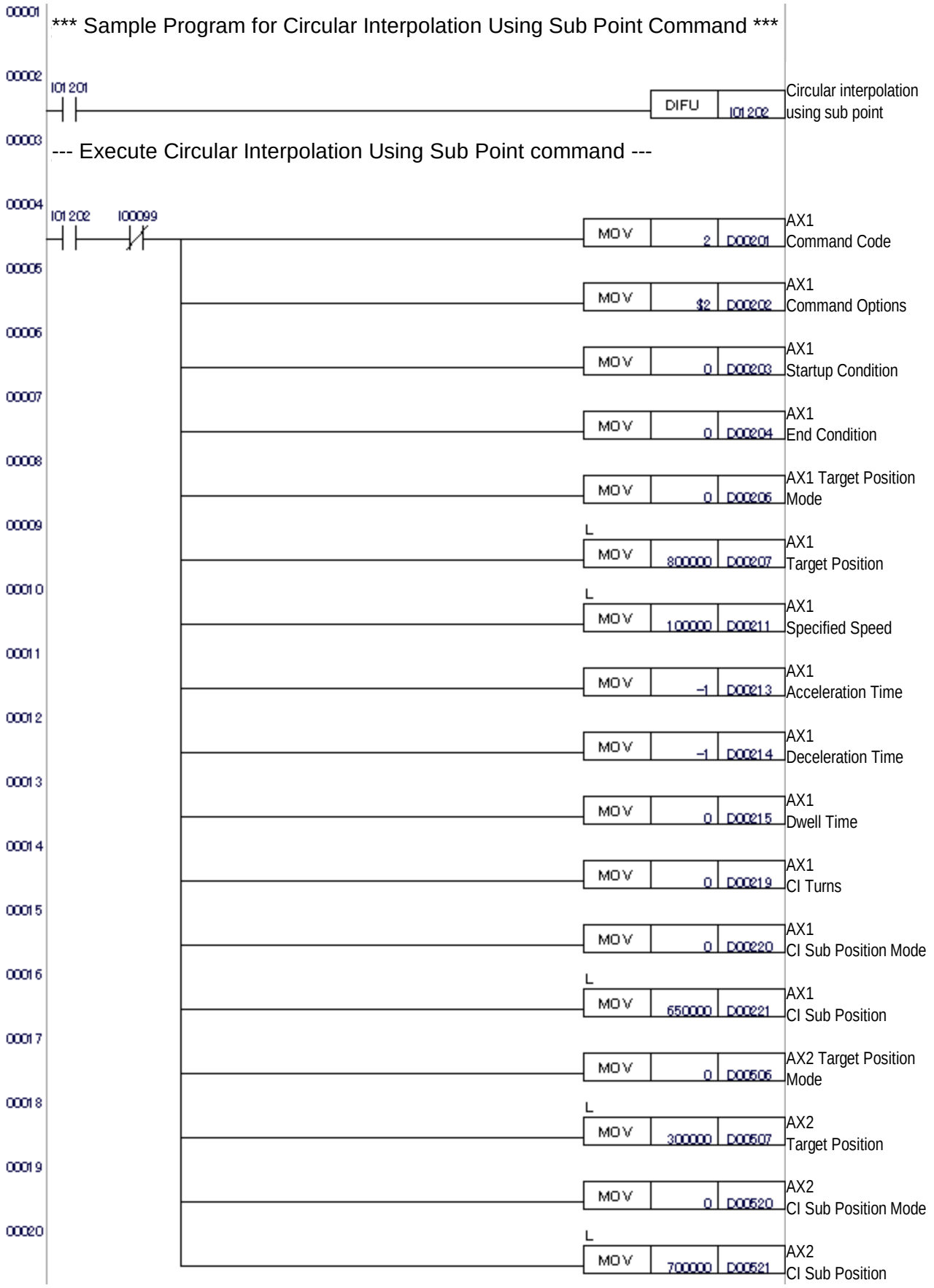
● List of Devices

Table 6.38 lists the devices used.

Table 6.38 List of Devices Used in Sample Program for 2-axis Circular Interpolation Command

Device	Name	Data
D00201	AX1 Direct Command Code	2: Circular Interpolation Using Sub Point
D00202	AX1 Command Options	$0002 (Axis 2 as interpolation axis)
D00203	AX1 Startup Condition	0: Normal startup
D00204	AX1 End Condition	0: Normal end
D00206	AX1 Target Position Mode	0: Using ABS position
D00207/D00208	AX1 Target Position	800,000 (x 10^{-4} mm)
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4}mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D00219	AX1 CI Turns	0 (turns)
D00220	AX1 CI Sub Position Mode	0: Using ABS position
D00221/D00222	AX1 CI Sub Position	650,000 (x 10^{-4} mm)
D02001	AX1 Warning Status	
D00506	AX2 Target Position Mode	0: Using ABS position
D00507/D00508	AX2 Target Position	300,000 (x 10^{-4} mm)
D00520	AX2 CI Sub Position Mode	0: Using ABS position
D00521/D00522	AX2 CI Sub Position	700,000 (x 10^{-4} mm)
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00306	AX2 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I01201	2-axis circular interpolation	
I01202	2-axis circular interpolation (differential up)	
I01203	Waiting for execute command ACK	
I01204	Positioning in progress	

- **Sample Program**



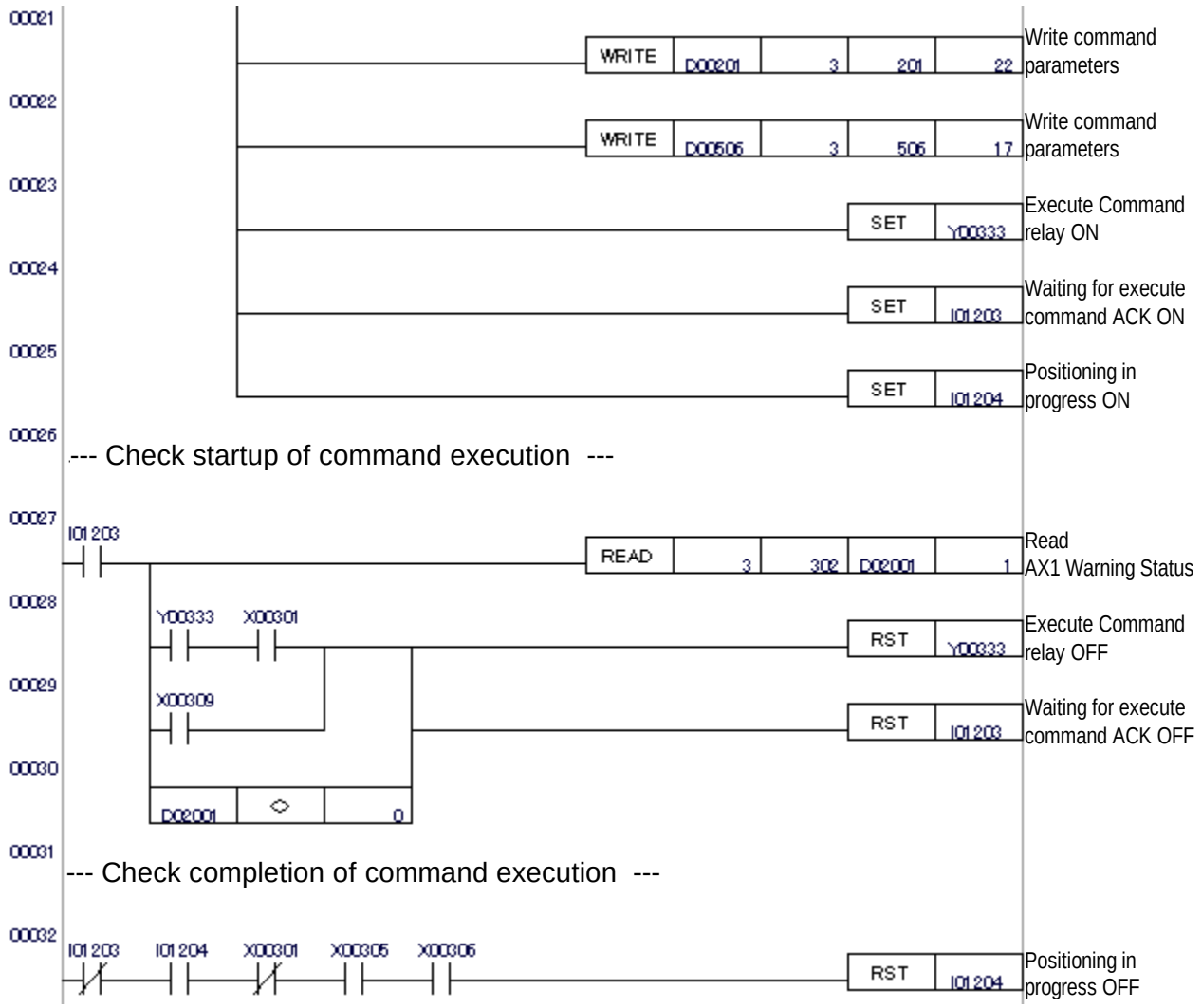


Figure 6.37 2-axis Circular Interpolation Program

● Timing Chart

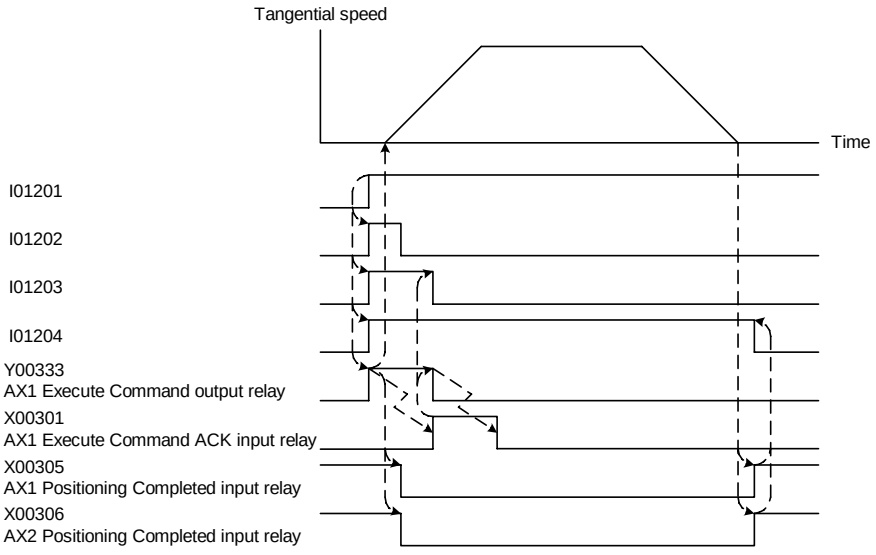


Figure 6.38 Timing Chart for 2-axis Circular Interpolation Program

6.9.4 Helical Interpolation

■ Function

This command performs helical interpolated positioning of 3 or 4 axes according to the specified target position, specified speed, acceleration time and deceleration time. Executing this command during positioning movement changes the target position immediately, and the axes continue movement to the new target position.

- Two types of helical interpolation movement are available: CW helical interpolation using specified center and CCW helical interpolation using specified center.
- Figure 6.39 shows the direction of movement for CW and CCW helical interpolations. The X-axis in this figure denotes the circular interpolation axis with the smaller axis number, while the Y-axis denotes the circular interpolation axis with the larger axis number. For instance, for circular interpolation involving axes 1 and 2, the X-axis denotes axis 1, while the Y-axis denotes axis 2; for circular interpolation involving axes 2 and 4, the X-axis denotes axis 2, while the Y-axis denotes axis 4.
- The target position can be specified using an absolute position, an incremental position or a position data number. Similarly, the center point can also be specified using an absolute position, an incremental position or a position data number.
- The Specified Speed parameter in helical movement corresponds to the tangential speed along the circular arc.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual command execution.
- A dwell time at the end of positioning can be specified.
- Instead of starting positioning immediately after command execution, a startup condition can be specified to delay positioning until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- An end condition can be specified to turn on an external contact output when positioning completes.

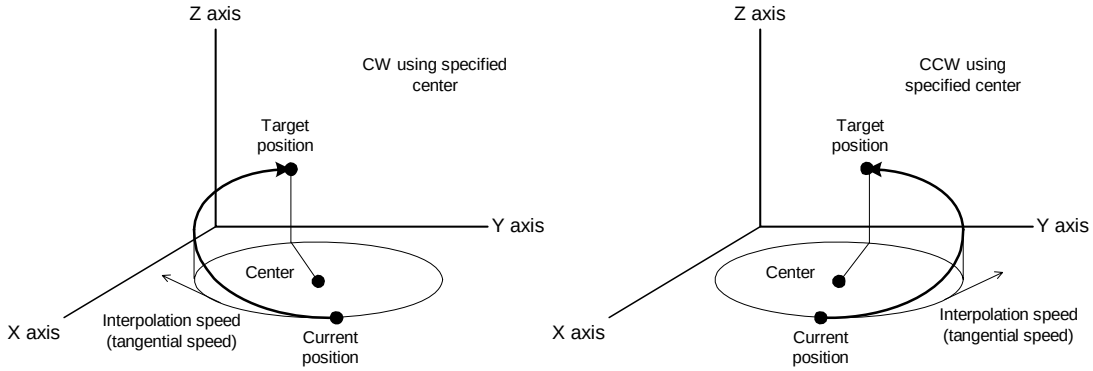


Figure 6.39 Helical Interpolation

■ Execution Procedure

● Command Parameters Used

Table 6.39 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

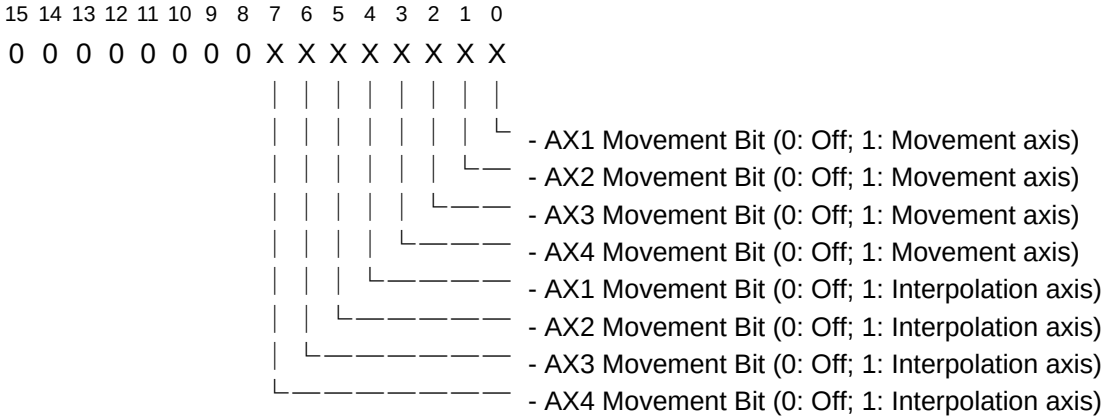
Table 6.39 Required Parameters of Helical Interpolation Commands

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	5: CW Helical Interpolation 6: CCW Helical Interpolation	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	△
0204	0504	0804	1104	End Condition	0: Normal end; Non-zero: End condition code	△
0206	0506	0806	1106	Target Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	◎*1
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	-2,147,483,648 to 2,147,483,647 (position reference unit) or position data no. (1 to No. of Position Data Records Used)	◎*1
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	1 to 2,147,483,647 (speed reference unit)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0219	0519	0819	1119	CI Turns	0 to 32,767 (turns)	○
0220	0520	0820	1120	CI Sub Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	◎*1
0221 /0222	0521 /0522	0821 /0822	1121 /1122	CI Sub Position	-2,147,483,648 to 2,147,483,647 (position reference unit) Or, position data no. (1 to 2,000)	◎*1
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

*1: If the Target Position Mode is set to '2: Using position data no.', target position parameters for the other interpolation axes involved in the movement need not be set.

● Command Options

Bit data stored in the Command Options parameter is used to specify which other axes (interpolation axes) are involved in the interpolation movement with the command execution axis. Two and only two interpolation axes must be specified.



Command Acceptance Conditions

Table 6.40 lists the pre-conditions for command execution.

Table 6.40 Command Acceptance Conditions for Helical Interpolation Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In position control mode		○
Not under index control		○
Not jogging		○
No origin search is in progress		○
No change target position action is in progress		○
No change in set of interpolation axes during movement.		○
Not waiting for trigger		○
No change in command execution axis		○

Procedure

(1) Write Direct Command Code ('5: CW Helical Interpolation' or '6: CCW Helical Interpolation') and required parameters to axis command parameter areas of the command axis and interpolation axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and interpolation begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns off when positioning begins. The Positioning Completed input relay turns on when the positioning movement reaches the target position.

■ Precautions

- Regardless of the value of the Startup Speed axis registered parameter, interpolation is always carried out, assuming a specified startup speed of 0. .
- Set the unit of the two axes involved in circular interpolation to '1: mm'.
- Interpolated positioning is carried out according to the values of the axis registered parameters (acceleration/deceleration curve, etc.) of the command execution axis.
- The specified sub position (center point or sub point) for circular interpolation must fall within the forward limits and reverse limits of all axes.
- In helical interpolation with a specified sub point for circular interpolation, the radius of the circular path must not exceed the maximum value that can be represented using 32 bits.
- If the speed limit of any axis is exceeded during interpolation, an error is generated and all axes are stopped immediately.

  The specified tangential speed along the circular path should be such that no speed limit of any interpolation axes is exceeded. (The tangential speed may sometimes exceed a speed limit during helical interpolation due to internal computational error. As such, it is recommended that some allowance be included when setting the speed limit of each axis. This phenomenon tends to occur when circular interpolation follows a whorl-like path.)
- If Forward Limit or Reverse Limit is exceeded during helical interpolation, an error is generated and all axes are stopped immediately.
- When performing helical interpolation using a specified center point, depending on the center position and the target position, a deviation may arise between the circular path and the target position. If this deviation exceeds the circular interpolation error tolerance defined by the CI Error Tolerance parameter, an error is generated and interpolation is not performed. If the deviation falls within the error tolerance, circular interpolation follows a whorl-like path.
- Changing the target position during interpolation movement is not allowed if it also changes the set of interpolation axes.

■ Sample Program

● Description

This sample program performs CW helical interpolation of axes 1, 2 and 3 for a positioning module installed in slot 3. It issues a CW Helical Interpolation command from axis 1 with axes 1 and 2 as circular interpolation axes.

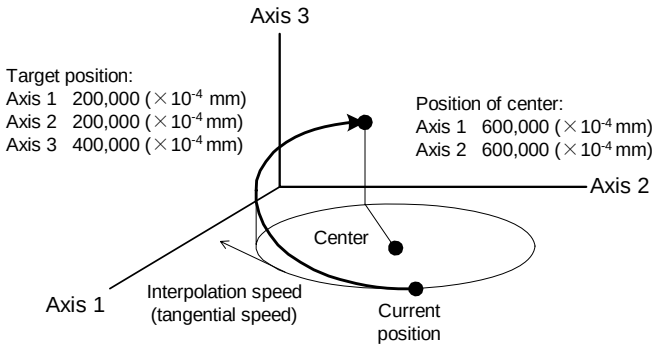


Figure 6.40 An Example of Helical Interpolation Command Operation

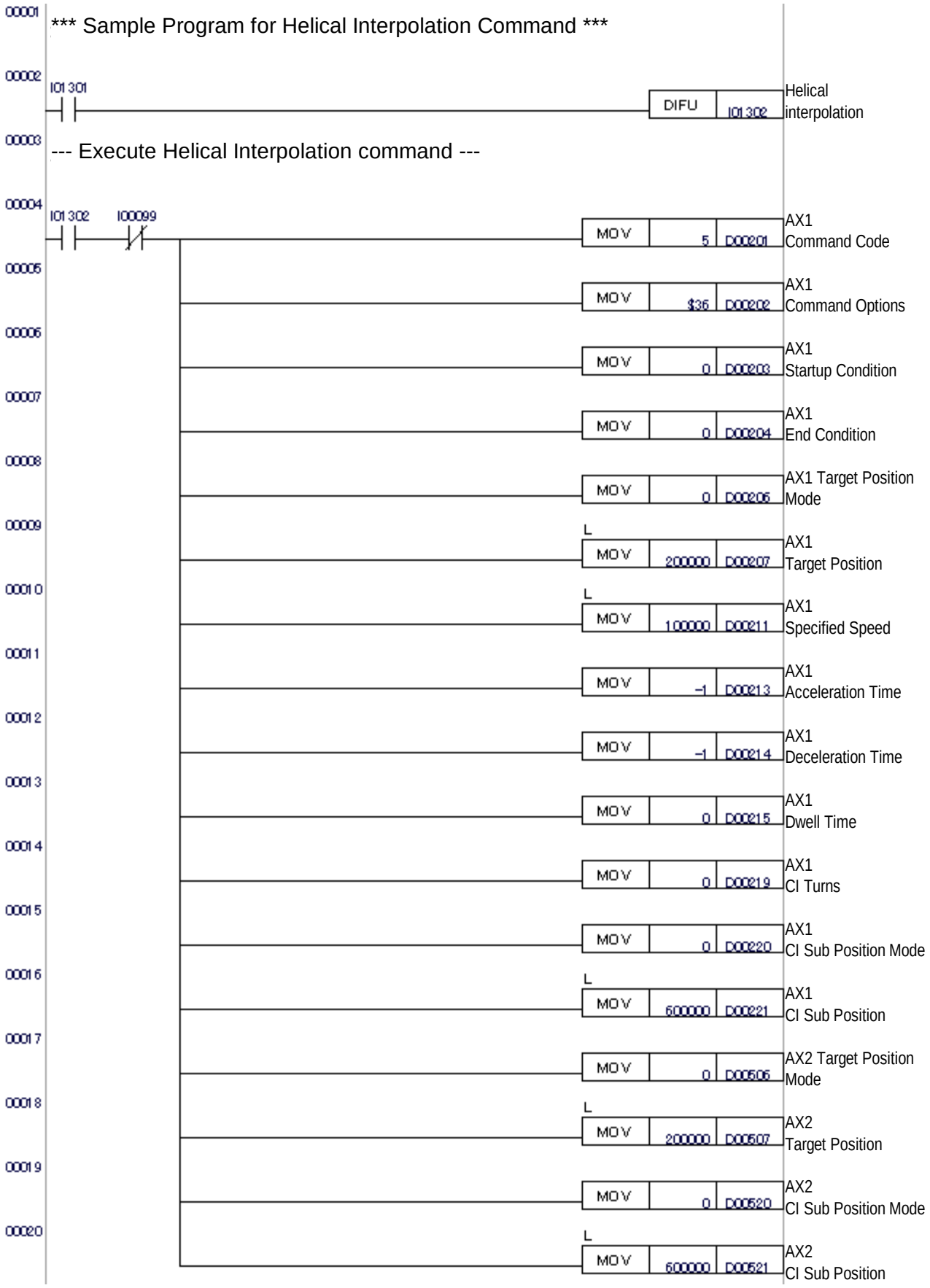
● List of Devices

Table 6.41 lists the devices used.

Table 6.41 List of Devices Used in Sample Program for Helical Interpolation Command

Device	Name	Data
D00201	AX1 Direct Command Code	5: CW Helical Interpolation
D00202	AX1 Command Options	$0036 (Axes 1 and 2 as interpolation axes; axes 1 to 3 as motion axes)
D00203	AX1 Startup Condition	0: Normal startup
D00204	AX1 End Condition	0: Normal end
D00206	AX1 Target Position Mode	0: Using ABS position
D00207/D00208	AX1 Target Position	200,000 (x 10^{-4} mm)
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4} mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D00219	AX1 CI Turns	0 (turns)
D00220	AX1 CI Sub Position Mode	0: Using ABS position
D00221/D00222	AX1 CI Sub Position	600,000 (x 10^{-4} mm)
D02001	AX1 Warning Status	
D00506	AX2 Target Position Mode	0: Using ABS position
D00507/D00508	AX2 Target Position	200,000 (x 10^{-4} mm)
D00520	AX2 CI Sub Position Mode	0: Using ABS position
D00521/D00522	AX2 CI Sub Position	600,000 (x 10^{-4} mm)
D00806	AX3 Target Position Mode	0: Using ABS position
D00807/D00808	AX3 Target Position	400,000 (x 10^{-4} mm)
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00306	AX2 Positioning Completed input relay	
X00307	AX3 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I01301	Helical Interpolation	
I01302	Helical Interpolation (differential up)	
I01303	Waiting for execute command ACK	
I01304	Positioning in progress	

- **Sample Program**



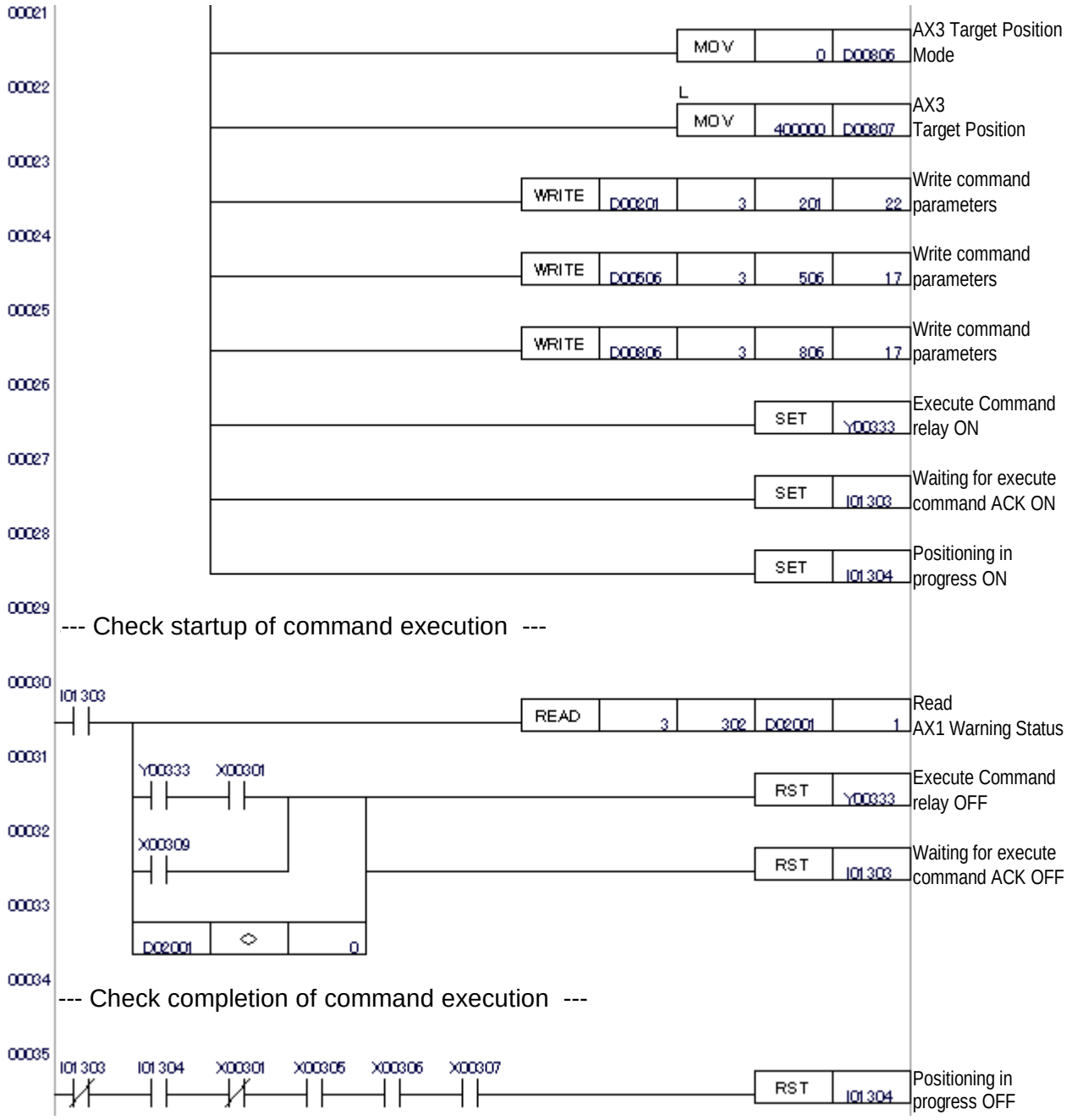


Figure 6.41 Helical Interpolation Program

Timing Chart

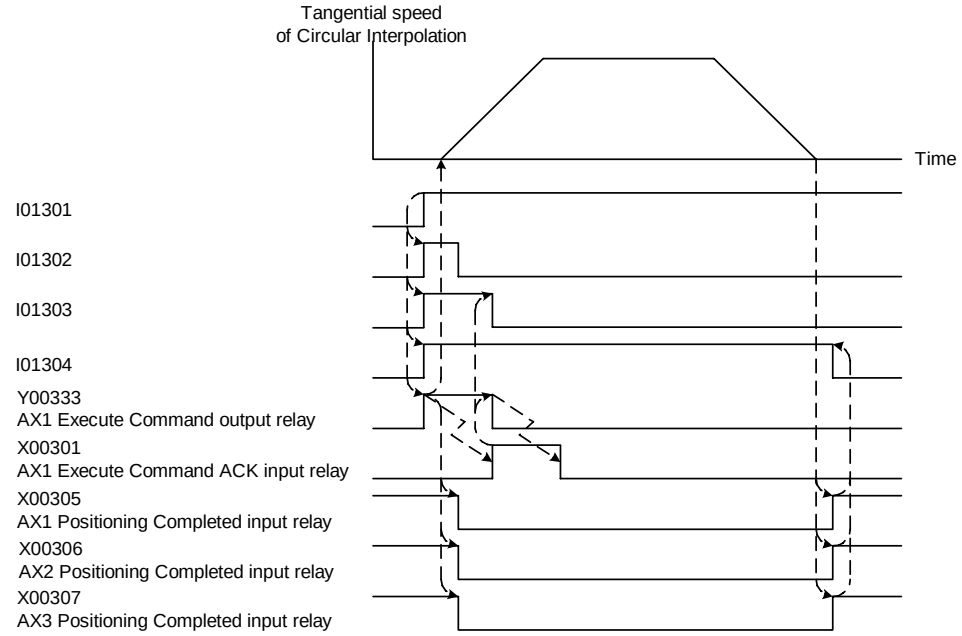


Figure 6.42 Timing Chart for Helical Interpolation Program

6.9.5 Changing Target Position during Movement

■ Function

When a positioning command with a new target position, specified speed, acceleration time and deceleration time is executed during positioning movement, positioning continues to the new target position without stopping at the original target position, changing the direction of movement, if required.

In the case of single-axis positioning, positioning continues to the new target position.

In the case of interpolation movement, the module overlaps the deceleration and stopping of the positioning movement in progress with the positioning movement to the new target position.

You can initiate a change in target position always from the same position by reading Remaining DCC Time Status or Remaining Travel Status of axis statuses.

- Without changing the set of movement axes (including the set of interpolation axes) and command axis, a movement that changes the target position can be initiated during any of the following positioning movements: single-axis positioning, linear interpolation, 2-axis circular interpolation and helical interpolation.
- The new target position can be specified using an absolute position, an incremental position or a position data number.
- If specified using an incremental position, it is taken as an incremental position from the target position of the movement in progress.
- A new Startup Condition, End Condition, Acceleration Time, Deceleration Time, Dwell Time, etc. can be optionally specified as in normal positioning commands.
- If specified, the values override the original End Condition and Dwell Time specified for the positioning movement in progress.

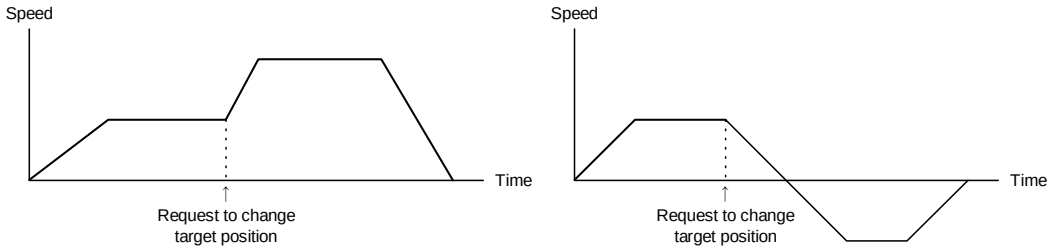


Figure 6.43 An Example of Target Position Change Movement (for Single-axis Positioning)

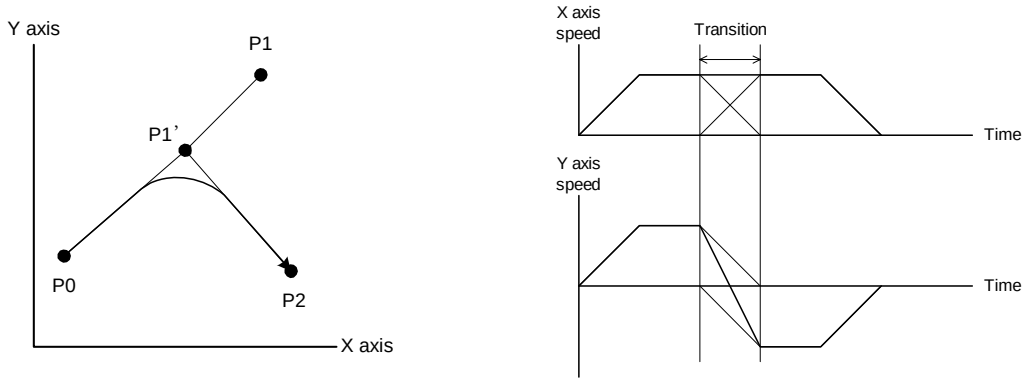


Figure 6.44 An Example of Target Position Change Movement (for 2-axis Linear Interpolation)

■ Execution Procedure

For details on how to execute individual positioning commands, refer to their respective descriptions.

■ Precautions

- If a positioning command issued during movement generates a parameter setup error or some other error, the positioning movement in progress is decelerated and stopped.
- If a Forward Limit or Reverse Limit is exceeded due to a target position change during movement, an error is generated and all axes are stopped immediately.

- Changing the target position during interpolation movement is not allowed if it also changes the set of interpolation axes.
- When changing the target position during interpolation movement, the command execution axis must be the same. In other words, the new positioning command must be issued from the same axis from which the current command being executed was previously executed.

- When a target position is changed for single-axis positioning, positioning will continue to the new target position according to the new acceleration/deceleration curve and other parameter values. If the module determines that the new parameter values do not allow the axis to stop at the target position normally, it first decelerates and stops the axis before re-initiating movement in the reverse direction. This is often the case when there is a change in direction of movement, but can also happen when there is no change in direction of movement if the new target position happens to be very close to the current position.
- If the specified speed, in addition to the target position, is also changed in single-axis positioning, the acceleration used for the speed change is the gradient obtained using the new specified speed and acceleration time. This gradient is also used for the deceleration curve if the new specified speed is lower than the speed before the change.
- Changing a target position by specifying a new incremental position is also allowed during circular interpolation or helical interpolation movement but the number of circular interpolation turns in progress will be reset.

■ Sample Program

● Description

This sample program initiates a movement that changes the target position of axis 1 of a positioning module installed in slot 3.

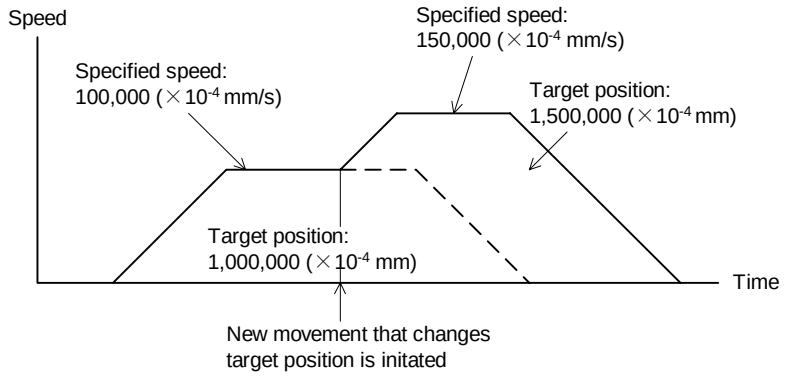


Figure 6.45 An Example of Target Position Change during Movement

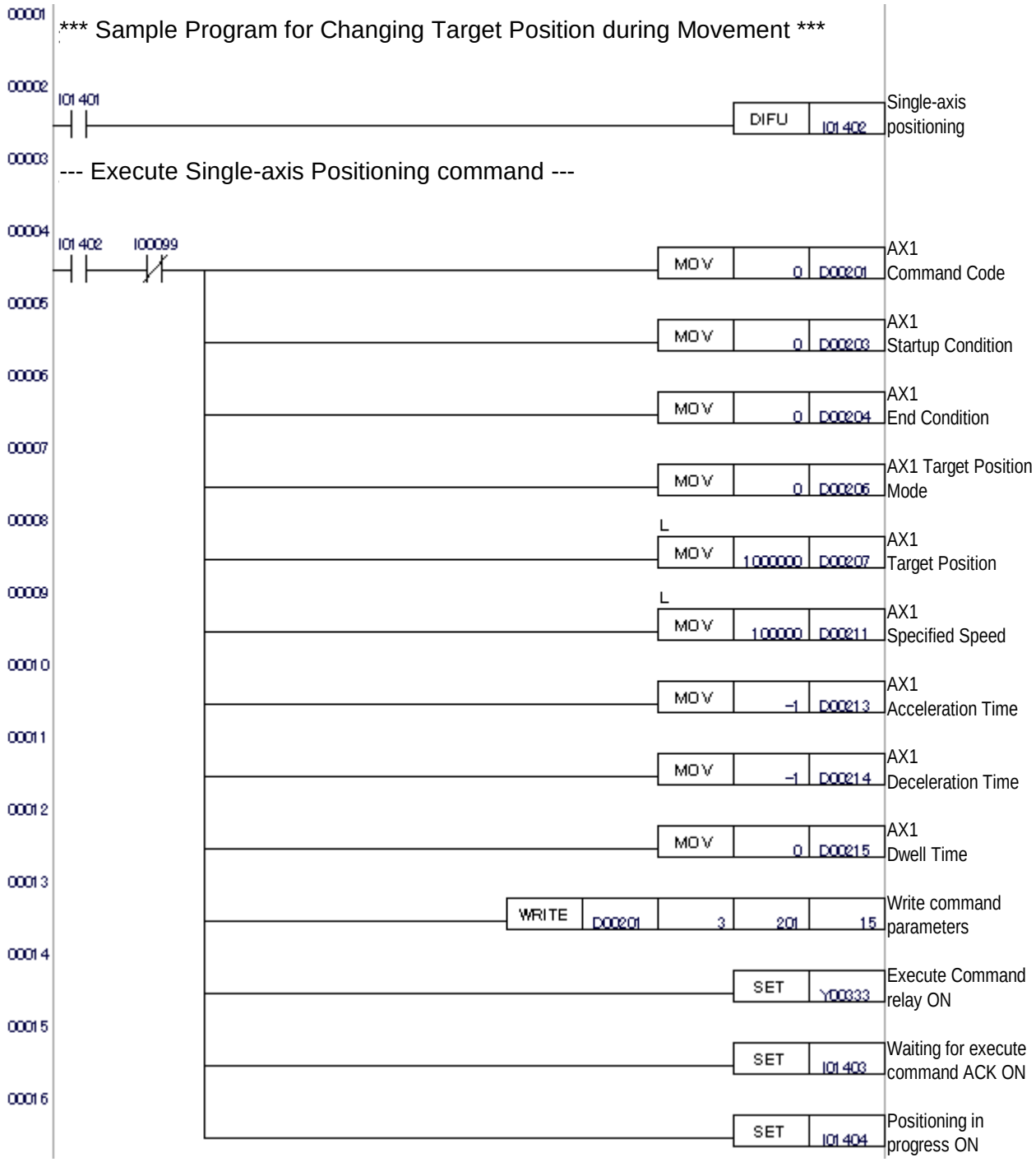
● List of Devices

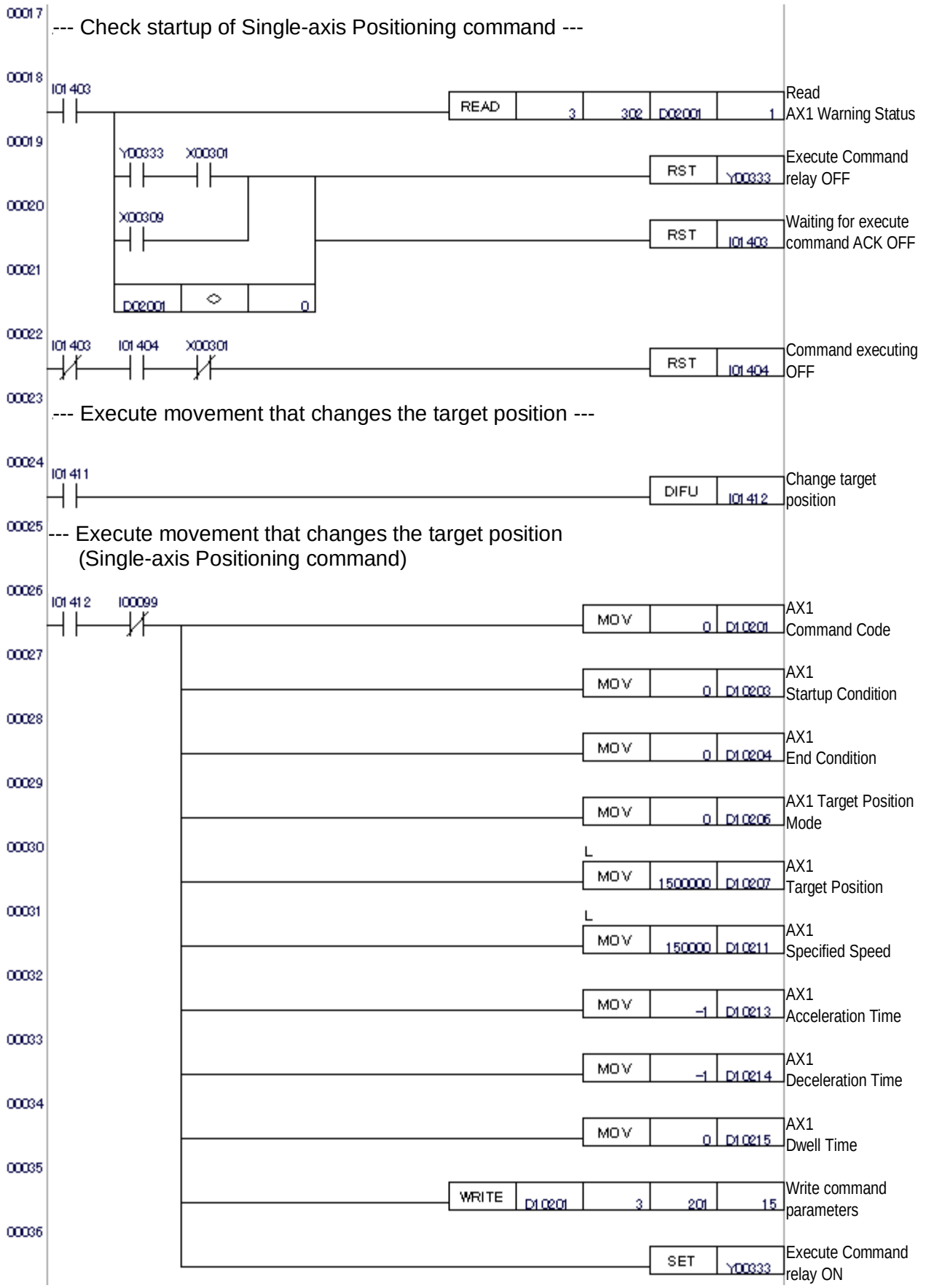
Table 6.42 lists the devices used.

Table 6.42 List of Devices Used in Sample Program for Changing Target Position during Movement

Device	Name	Data
D00201	AX1 Direct Command Code	0: Single-axis Positioning
D00203	AX1 Startup Condition	0: Normal startup
D00204	AX1 End Condition	0: Normal end
D00206	AX1 Target Position Mode	0: Using ABS position
D00207/D00208	AX1 Target Position	1,000,000 (x 10^{-4} mm)
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4}mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D02001	AX1 Warning Status	
D10201	AX1 Direct Command Code	0: Single-axis Positioning
D10203	AX1 Startup Condition	0: Normal startup
D10204	AX1 End Condition	0: Normal end
D10206	AX1 Target Position Mode	0: Using ABS position
D10207/D10208	AX1 Target Position	1,500,000 (x 10^{-4} mm)
D10211/D10212	AX1 Specified Speed	150,000 (x 10^{-4}mm/s)
D10213	AX1 Acceleration Time	-1: Default acceleration
D10214	AX1 Deceleration Time	-1: Default deceleration
D10215	AX1 Dwell Time	0 (ms)
D10302	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I01401	Single-axis positioning	
I01402	Single-axis positioning (differential up)	
I01403	Waiting for execute command ACK	
I01404	Command executing	
I01411	Change target position	
I01412	Change target position (differential up)	
I01413	Waiting for execute command ACK	
I01414	Positioning in progress	

- **Sample Program**




00017
--- Check startup of Single-axis Positioning command ---
00018
I01403
READ 3 302 D02001 1
Read AX1 Warning Status
00019
Y00333 X00301
RST Y00333
Execute Command relay OFF
00020
X00309
RST I01403
Waiting for execute command ACK OFF
00021
D02001 <> 0
00022
I01403 I01404 X00301
RST I01404
Command executing OFF
00023
--- Execute movement that changes the target position ---
00024
I01411
DIFU I01412
Change target position
00025
--- Execute movement that changes the target position
(Single-axis Positioning command)
00026
I01412 I00099
MOV 0 D10201
AX1 Command Code
00027
MOV 0 D10203
AX1 Startup Condition
00028
MOV 0 D10204
AX1 End Condition
00029
MOV 0 D10205
AX1 Target Position Mode
00030
L
MOV 1500000 D10207
AX1 Target Position
00031
L
MOV 150000 D10211
AX1 Specified Speed
00032
MOV -1 D10213
AX1 Acceleration Time
00033
MOV -1 D10214
AX1 Deceleration Time
00034
MOV 0 D10215
AX1 Dwell Time
00035
WRITE D10201 3 201 15
Write command parameters
00036
SET Y00333
Execute Command relay ON

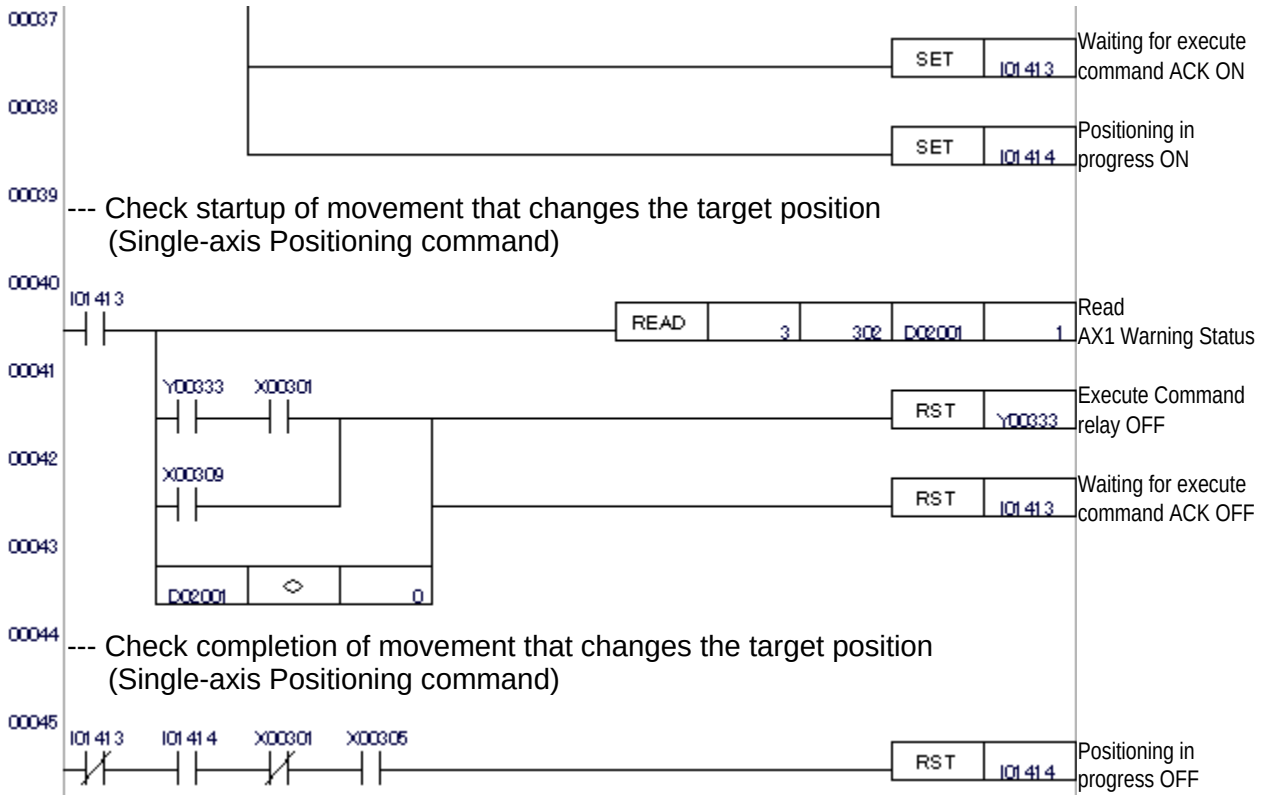


Figure 6.46 Change Target Position Program

- **Timing Chart**

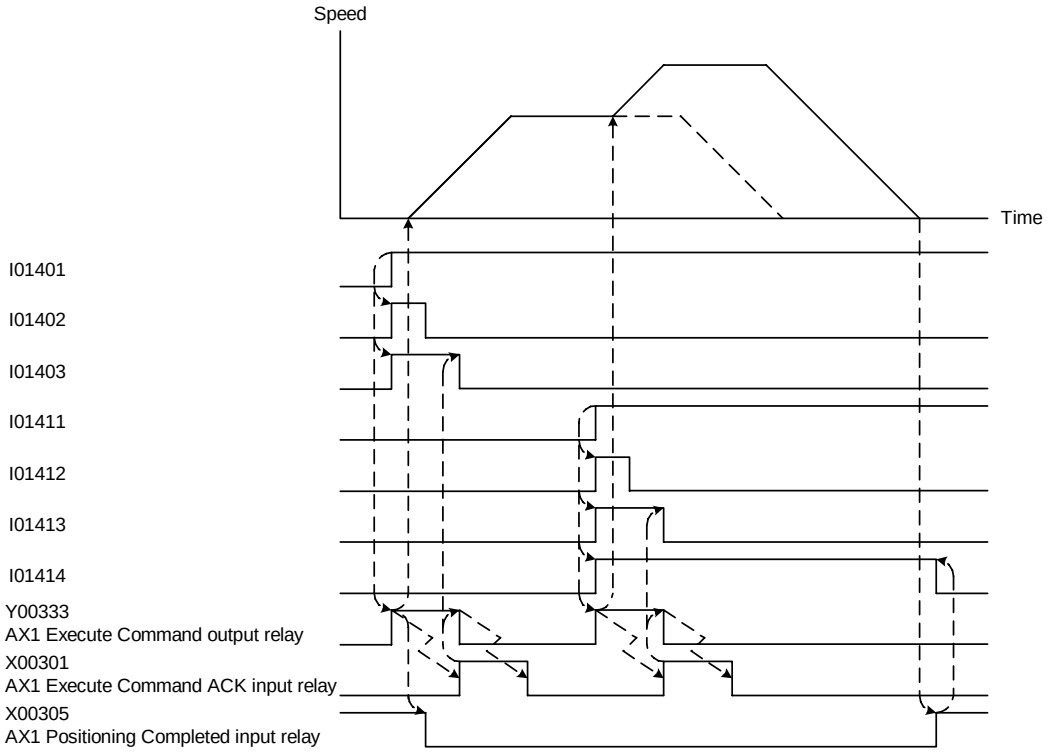


Figure 6.47 Timing Chart for Change Target Position Program

6.10 Speed Control

This section describes speed control commands.

6.10.1 Position Control to Speed Control

■ Function

This command switches from position control mode to speed control mode to prepare for execution of speed control movements.

■ Execution Procedure

● Command Parameters Used

Table 6.43 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.43 Required Parameters of Position Control to Speed Control Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	10: Position Control to Speed Control	○

● Command Acceptance Conditions

Table 6.44 lists the pre-conditions for command execution.

Table 6.44 Command Acceptance Conditions for Position Control to Speed Control Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
No axis error has been detected.		○
Not under index control		○
In Positioning Completed state		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '10: position control to speed control' to axis command parameter area of the command axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.

- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- All axes are in position control mode immediately after power up. To perform speed control movements, you must first execute a Position Control to Speed control command.
- After switching to speed control mode, the module remains in speed control mode until a Speed Control to Position Control command is executed. Beware of restrictions on certain functions (jog, manual pulse generator mode, etc.) in speed control mode.
- Forward limit and reverse limit defined by axis registered parameters are ignored during speed control movement.

■ Sample Program

● Description

This sample program switches axis 1 of a positioning module installed in slot 3 from position control mode to speed control mode.

● List of Devices

Table 6.45 lists the devices used.

Table 6.45 List of Devices Used in Sample Program for Position Control to Speed Control Command

Device	Name	Data
D00201	AX1 Direct Command Code	10: Position Control to Speed Control
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I01501	Position control to speed control	
I01502	Position control to speed control (differential up)	
I01503	Waiting for execute command ACK	
I01504	Command executing	

● Sample Program

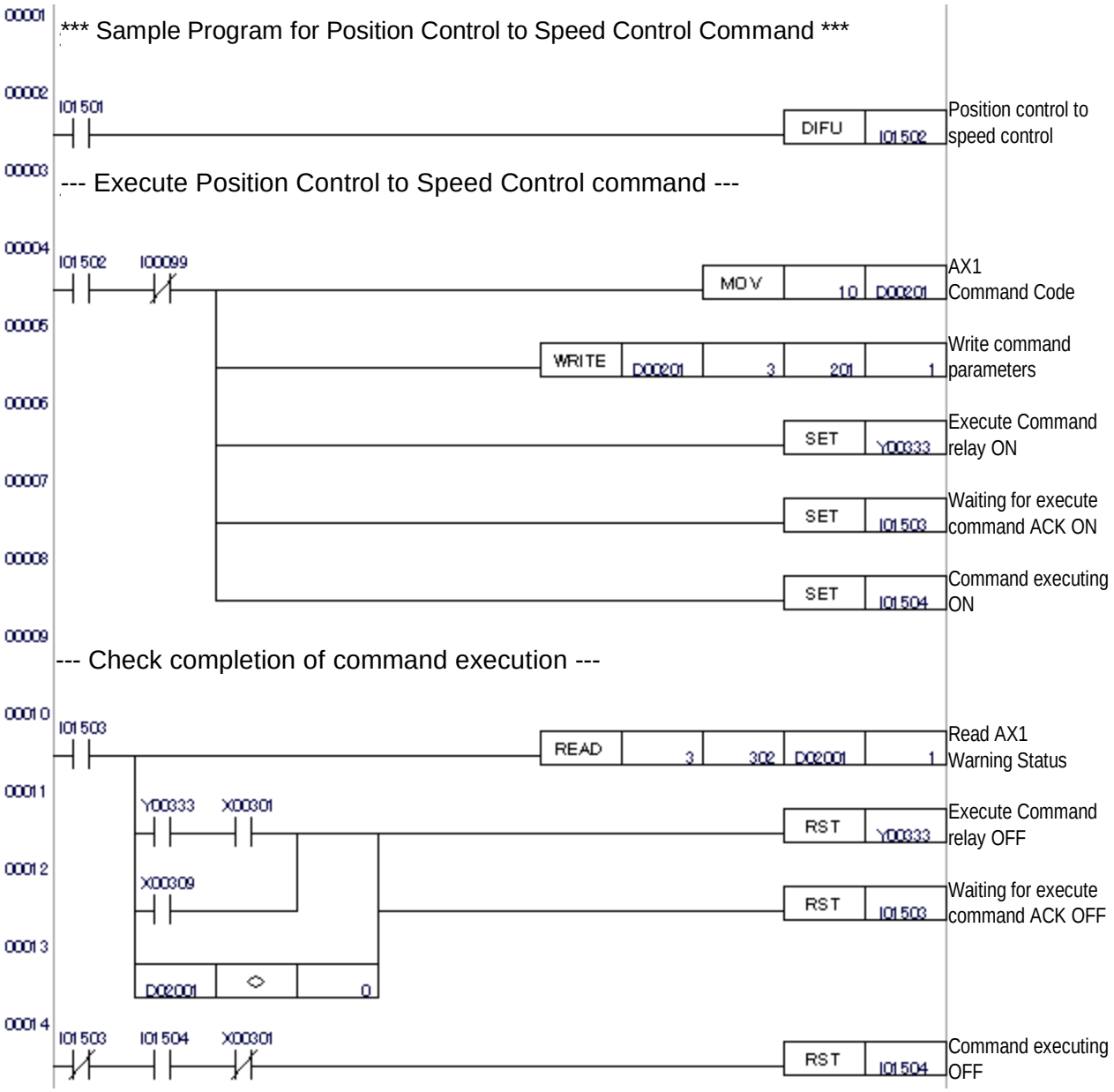


Figure 6.48 Position Control to Speed Control Program

● Timing Chart

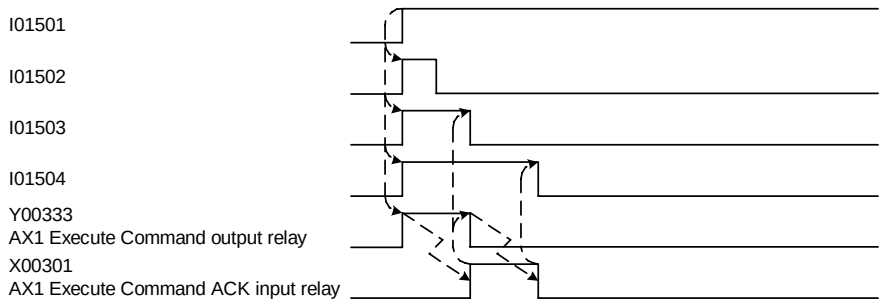


Figure 6.49 Timing Chart for Position Control to Speed Control Program

6.10.2 Speed Control to Position Control

■ Function

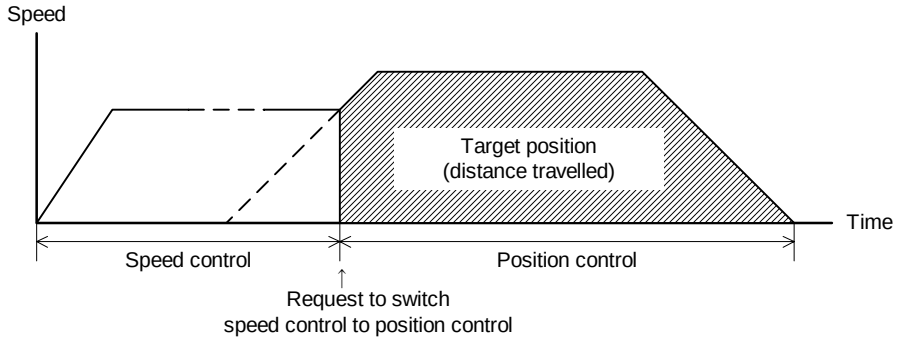
This command switches from speed control mode to position control mode.

If the command is executed in Positioning Completed state, the axis remains at rest, and switches to position control mode.

If the command is executed during speed control, the module performs positioning according to the specified target position, specified speed, acceleration time and deceleration time. You have the option to reset the current position at that point to zero or to continue with the current position value.

- The target position can be specified using an absolute position, an incremental position or a position data number.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual command execution.
- A dwell time at the end of positioning can be specified.
- Instead of starting positioning immediately after command execution, a startup condition can be specified to delay speed control to position control switchover until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- An end condition can be specified to turn on an external contact output when positioning completes.

● Z-phase Search Count is zero



● Z-phase Search Count is non-zero (Z-phase Edge Selection='Rising edge'; Z-phase Search Count=2)

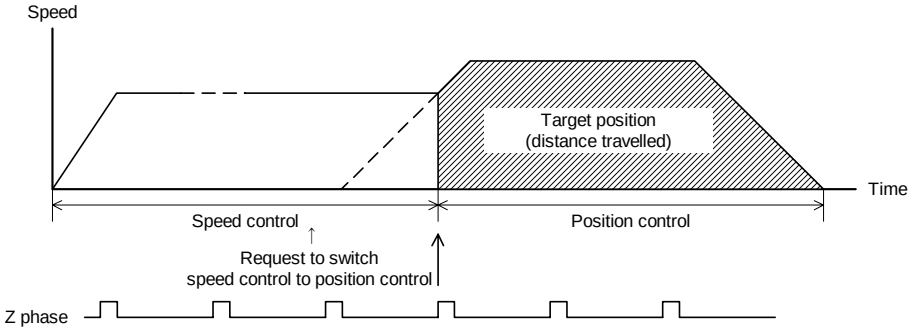


Figure 6.50 Speed Control to Position Control Switchover

■ Execution Procedure

● Command Parameters Used

Table 6.46 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.46 Required Parameters of Speed Control to Position Control Command (when axis is in Positioning Completed state)

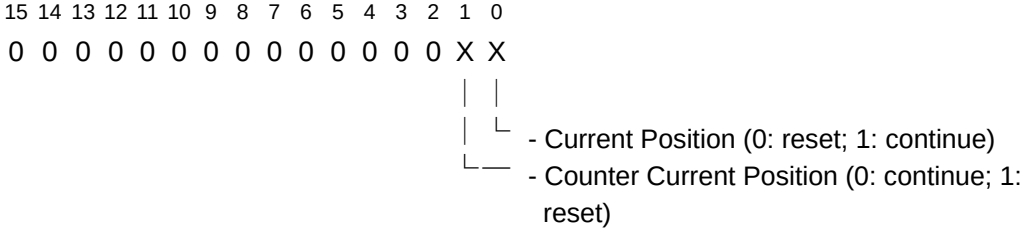
Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	11: Speed Control to Position Control	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○

Table 6.47 Required Parameters of Speed Control to Position Control Command (during speed control movement)

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	11: Speed Control to Position Control	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	△
0204	0504	0804	1104	End Condition	0: Normal end; Non-zero: End condition code	△
0206	0506	0806	1106	Target Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	○
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	-2,147,483,648 to 2,147,483,647 (position reference unit) or position data no. (1 to No. of Position Data Records Used)	○
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	Startup Speed to Speed Limit (reference speed unit)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

● Command Options

Bit data in the Command Options parameter specifies whether to reset or continue with the current position value and whether to reset or continue the counter current position when switching from speed control to position control mode.



● Command Acceptance Conditions

Table 6.48 lists the pre-conditions for command execution.

Table 6.48 Command Acceptance Conditions for Speed Control to Position Control Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In speed control mode		○
No change in set of interpolation axes during movement.		○
Error has been detected.		○
Counter is not used as manual pulse generator (when specified to reset counter current position).		○
Counter is not used as Sanyo's Absolute encoder. (When specified to reset counter current position)		○
Not waiting for trigger		○
No change in command execution axis		○

● Procedure

(1) Write Direct Command Code '11: Speed Control to Position Control' and required parameters to axis command parameter area of command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns on when the positioning movement reaches the target position.

■ Precautions

- Command operation and required parameters differ when the Speed Control to Position Control command is executed during speed control movement (when the Positioning Completed relay is off) and when the command is executed when an axis is at rest (Positioning Completed relay is on).
- All axes are in position control mode immediately after power up. To perform speed control movements, you must first execute a Position Control to Speed control command.
- Switching to position control mode is not allowed during linear interpolation speed control movement.
- Selecting to reset the counter current position to zero using the Command Options parameter is not allowed if Counter Type Selection of axis registered parameters is set to '1: Sanyo Denki's Manchester Coding'.
- The current position is continually updated during speed control movement but being a 32-bit ring counter, an overflow may occur during movement. If a command is then issued to switch from speed control to position control using the current position value and a new specified absolute target position, positioning may not proceed to the intended target position.

Therefore, when continuing with the current position and specifying an absolute target position, make sure there is no current position overflow.

- When switching from speed control to position control during speed control movement, positioning will continue to the new target position according to the new acceleration/deceleration curve and other parameter values. If the module determines that the new parameter values do not allow the axis to stop at the target position normally, it first decelerates and stops the axis before re-initiating movement in the reverse direction. This is often the case when there is a change in direction of movement, but can also happen when there is no change in direction of movement if the new target position happens to be very close to the current position.
- If the specified speed is changed when switching from speed control to position control during speed control movement, the acceleration used for the speed change is the gradient obtained using the new specified speed and acceleration time. This gradient is also used for the deceleration curve if the new specified speed is lower than the speed before the change.

■ Sample Program

● Description

This sample program switches axis 1 from speed control to position control during speed control movement for a positioning module installed in slot 3.

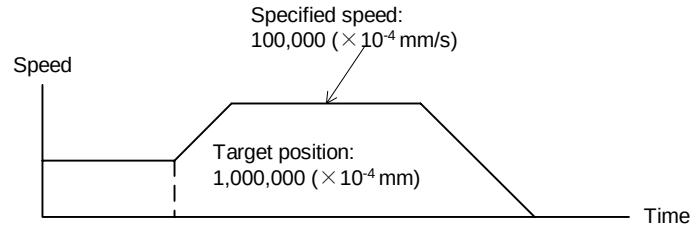


Figure 6.51 Example of Speed Control to Position Control Command Operation

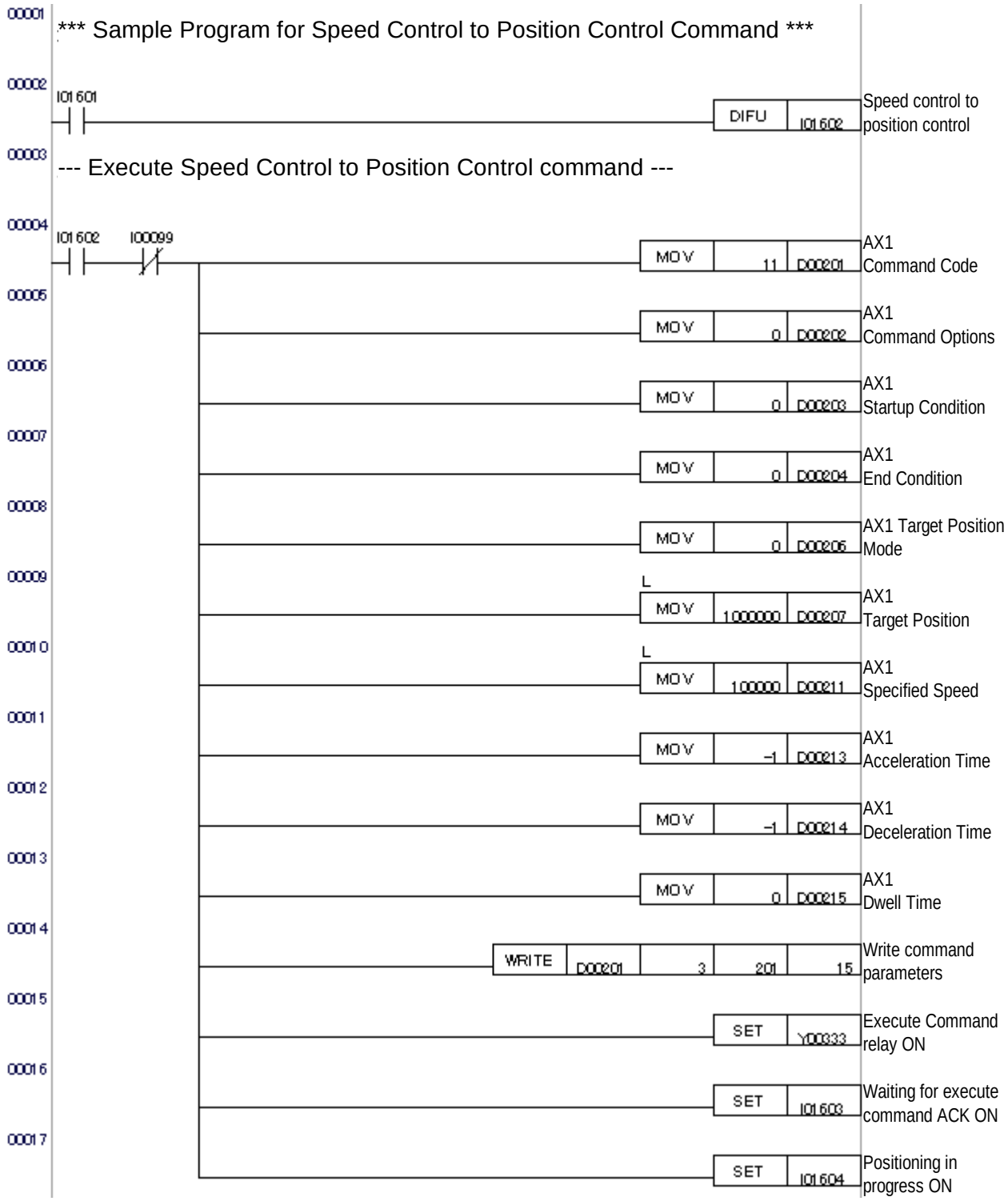
● List of Devices

Table 6.49 lists the devices used.

Table 6.49 List of Devices Used in Sample Program for Speed Control to Position Control Command

Device	Name	Data
D00201	AX1 Direct Command Code	11: Speed Control to Position Control
D00202	AX1 Command Options	$0000 (reset current position)
D00203	AX1 Startup Condition	0: Normal startup
D00204	AX1 End Condition	0: Normal end
D00206	AX1 Target Position Mode	0: Using ABS position
D00207/D00208	AX1 Target Position	1,000,000 (x 10^{-4} mm)
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4}mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I01601	Speed control to position control	
I01602	Speed control to position control (differential up)	
I01603	Waiting for execute command ACK	
I01604	Positioning in progress	

- **Sample Program**



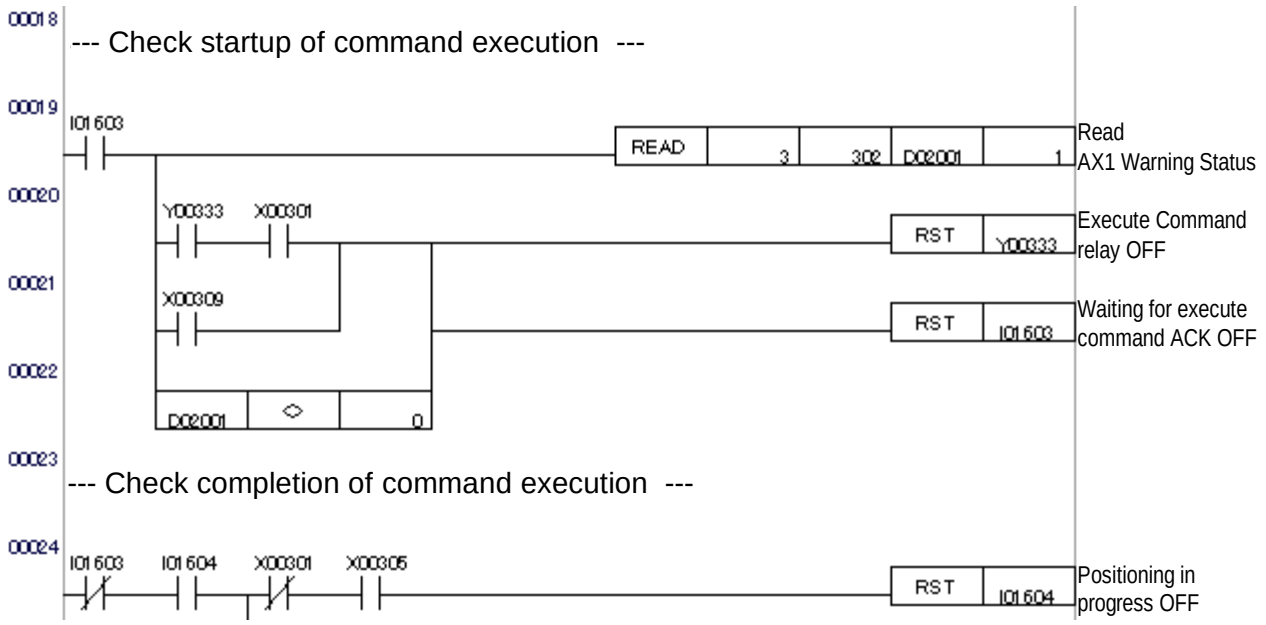


Figure 6.52 Speed Control to Position Control Program

- **Timing Chart**

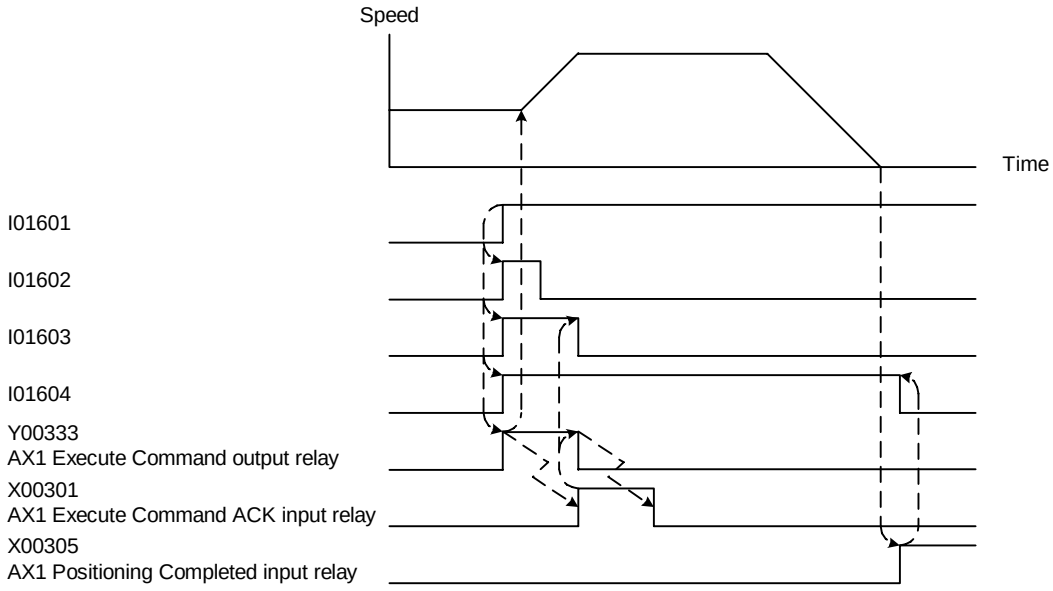


Figure 6.53 Timing Chart for Speed Control to Position Control Program

6.10.3 Single-axis Speed Control Movement

■ Function

This command performs speed control movement of a single axis using the specified speed, acceleration time and deceleration time.

Speed control movement continues until a Speed Control to Position Control command is executed, a Decelerate and Stop command is executed or the Stop Immediately output relay is turned from off to on.

- The sign of the specified speed determines the direction of rotation.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual command execution.
- A startup speed can be specified using an axis registered parameter.
- Instead of starting speed control movement immediately after command execution, a startup condition can be specified to delay movement until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- The deceleration time and dwell time to be used when stopping the speed control movement is specified when speed control movement is executed.

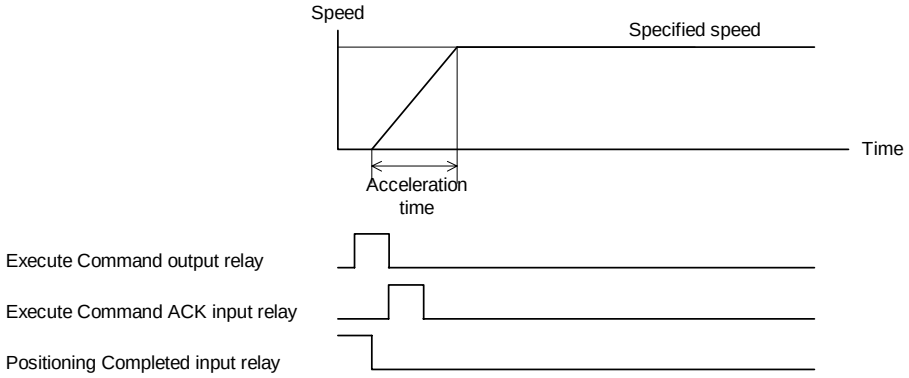


Figure 6.54 Single-axis Speed Control Movement

■ Execution Procedure

● Command Parameters Used

Table 6.50 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.50 Required Parameters of Single-axis Speed Control Movement Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	12: Single-axis Speed Control Movement	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	△
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	-(Speed Limit) to (Speed Limit) (reference speed unit) (The Specified Speed must be non-zero and equal or greater than the Startup Speed)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

● Command Acceptance Conditions

Table 6.51 lists the pre-conditions for command execution.

Table 6.51 Command Acceptance Conditions for Single-axis Speed Control Movement Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In speed control mode		○
In Positioning Completed state		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '12: single-axis speed control movement' and required parameters to axis command parameter area of command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and movement begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns off when speed control movement begins.

■ Precautions

- All axes are in position control mode immediately after powering up. To perform speed control movements, you must first execute a Position Control to Speed control command.
- Forward limit and reverse limit defined by axis registered parameters are ignored during speed control movement.
- The current position is continually updated during speed control movement, and operates as a 32-bit ring counter when and if an overflow occurs. (In reverse direction movement, if the current position falls below –2,147,483,648, decrement restarts from 2,147,483,647, in forward direction movement, if the current position exceeds 2,147,483,647, increment restarts from –2,147,483,648)

■ Sample Program

● Description

This sample program performs single-axis speed control movement of axis 1 of a positioning module installed in slot 3.

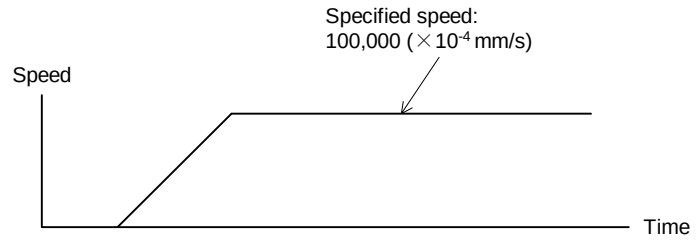


Figure 6.55 An Example of Single-axis Speed Control Movement Command Operation

● List of Devices

Table 6.52 lists the devices used.

Table 6.52 List of Devices Used in Sample Program for Single-axis Speed Control Movement Command

Device	Name	Data
D00201	AX1 Direct Command Code	12: Single-axis Speed Control Movement
D00203	AX1 Startup Condition	0: Normal startup
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4}mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I01701	Single-axis speed control movement	
I01702	Single-axis speed control movement (differential up)	
I01703	Waiting for execute command ACK	
I01704	Command executing	

- **Sample Program**

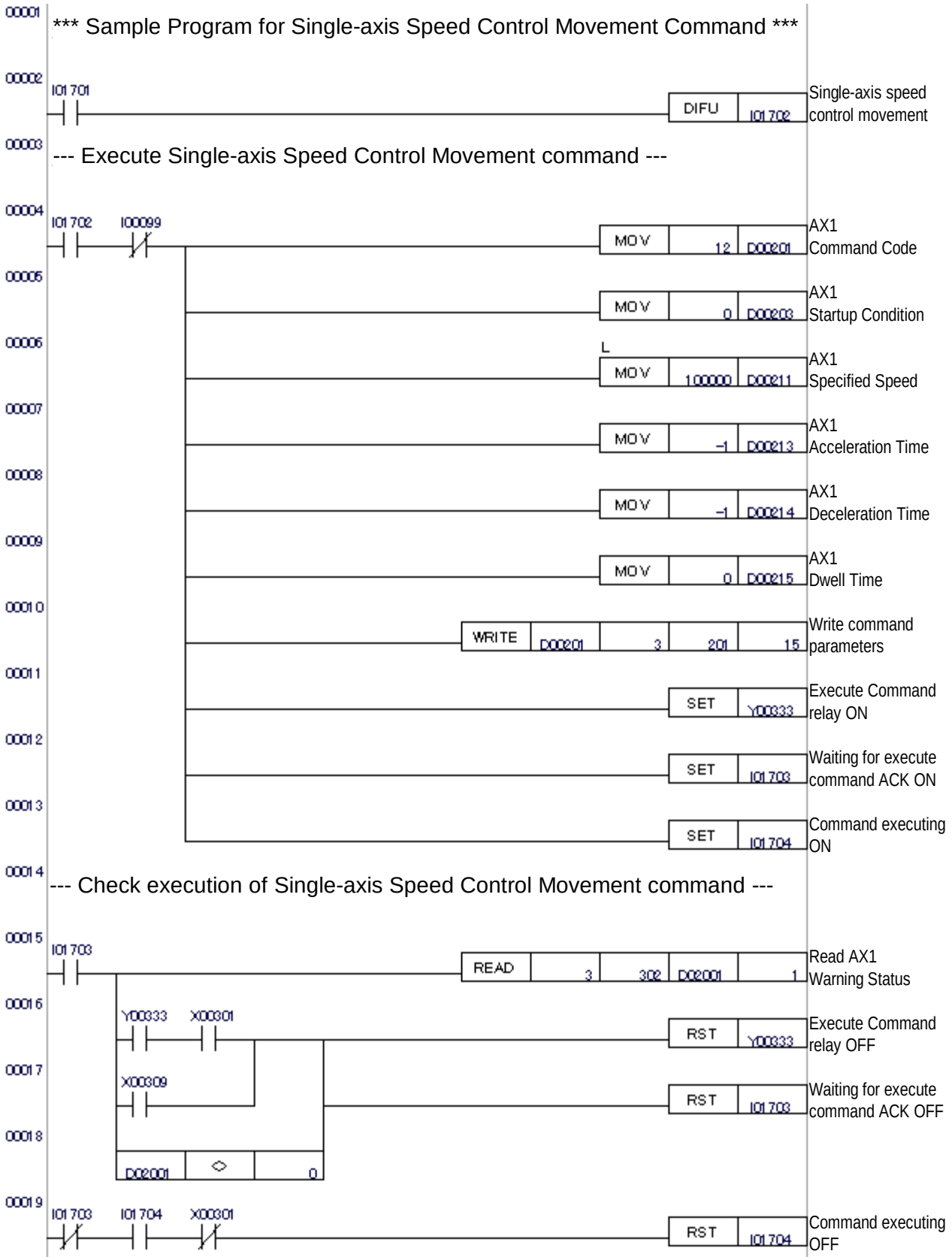


Figure 6.56 Single-axis Speed Control Movement Program

● Timing Chart

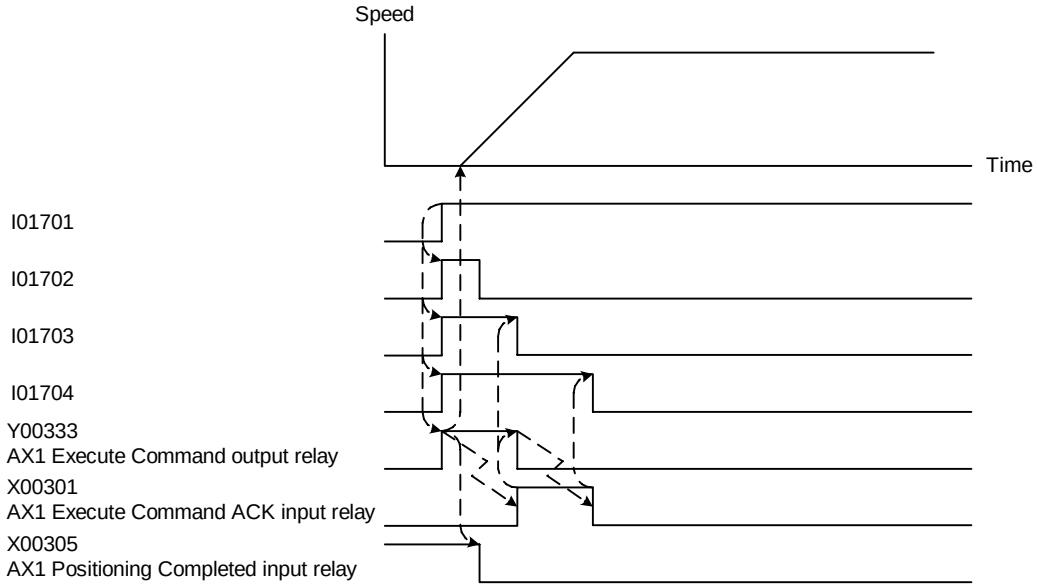


Figure 6.57 Timing Chart for Single-axis Speed Control Movement Program

6.10.4 Linear Speed Control Movement

■ Function

This command performs speed control movement of 2, 3 or 4 axes according to the specified speed, acceleration time and deceleration time.

Linear speed control movement continues until a Decelerate and Stop command is executed or the Stop Immediately output relay is turned from off to on.

- The sign of the specified speed determines the direction of rotation.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual command execution.
- Instead of starting speed control movement immediately after command execution, a startup condition can be specified to delay movement until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- The deceleration time and dwell time to be used when stopping the speed control movement is specified when speed control movement is executed.

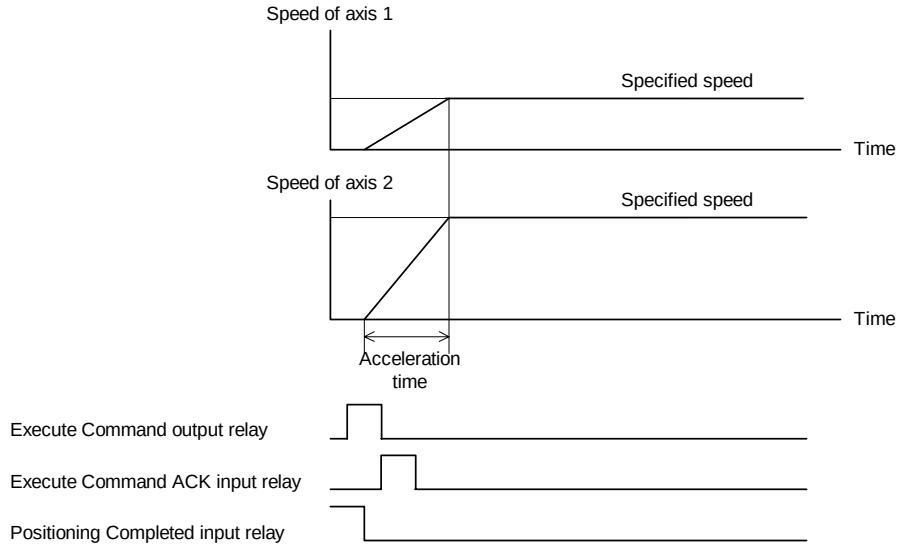


Figure 6.58 An Example of Linear Speed Control Movement (using 2 axes)

■ Execution Procedure

● Command Parameters Used

Table 6.53 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.53 Required Parameters of Linear Speed Control Movement Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	13: Linear Speed Control Movement	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	△
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	-(Speed Limit) to (Speed Limit) (reference speed unit) (must be non-zero)	◎
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

● Command Options

Bit data stored in the Command Options parameter is used to specify which other axes (interpolation axes) are involved in the linear speed control movement with the command execution axis.

```
15 14 13 12 11 10 9  8  7  6  5  4  3  2  1  0
0  0  0  0  0  0  0  0  0  0  0  0  X  X  X  X
                                    |  |  |  |
                                    |  |  |  └ - AX1 Movement Bit (0: Off; 1: Interpolation axis)
                                    |  |  └─── - AX2 Movement Bit (0: Off; 1: Interpolation axis)
                                    |  └────── - AX3 Movement Bit (0: Off; 1: Interpolation axis)
                                    └───────── - AX4 Movement Bit (0: Off; 1: Interpolation axis)
```

● Command Acceptance Conditions

Table 6.54 lists the pre-conditions for command execution.

Table 6.54 Command Acceptance Conditions for Linear Speed Control Movement Command

Command Acceptance Conditions	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In speed control mode		○
In Positioning Completed state		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '13: linear speed control movement' and required parameters to axis command parameter area of command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and movement begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns off when speed control movement begins.

■ Precautions

- All axes are in position control mode immediately after powering up. To perform speed control movements, you must first execute a Position Control to Speed control command.
- Forward limit and reverse limit defined by axis registered parameters are ignored during speed control movement.
- Interpolation is carried out according to the values of the axis registered parameters (acceleration/deceleration curve, etc.) of the command execution axis.
- The current position is continually updated during speed control movement, and operates as a 32-bit ring counter if and when an overflow occurs. (In reverse direction movement, if the current position falls below –2,147,483,648, decrement restarts from 2,147,483,647, in forward direction movement, if the current position exceeds 2,147,483,647, increment restarts from –2,147,483,648)
- The Speed Control to Position Control command cannot be executed during linear speed control movement. Linear speed control movement continues until a Decelerate and Stop command is executed or the Stop Immediately output relay is turned from off to on.

■ Sample Program

● Description

This sample program performs linear speed control movement of axes 1 and 2 for a positioning module installed in slot 3. It issues the Linear Speed Control Movement command from axis 1.

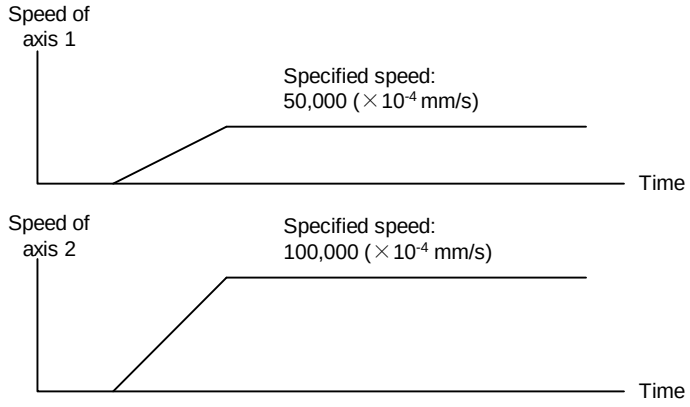


Figure 6.59 An Example of Linear Speed Control Movement Command Operation

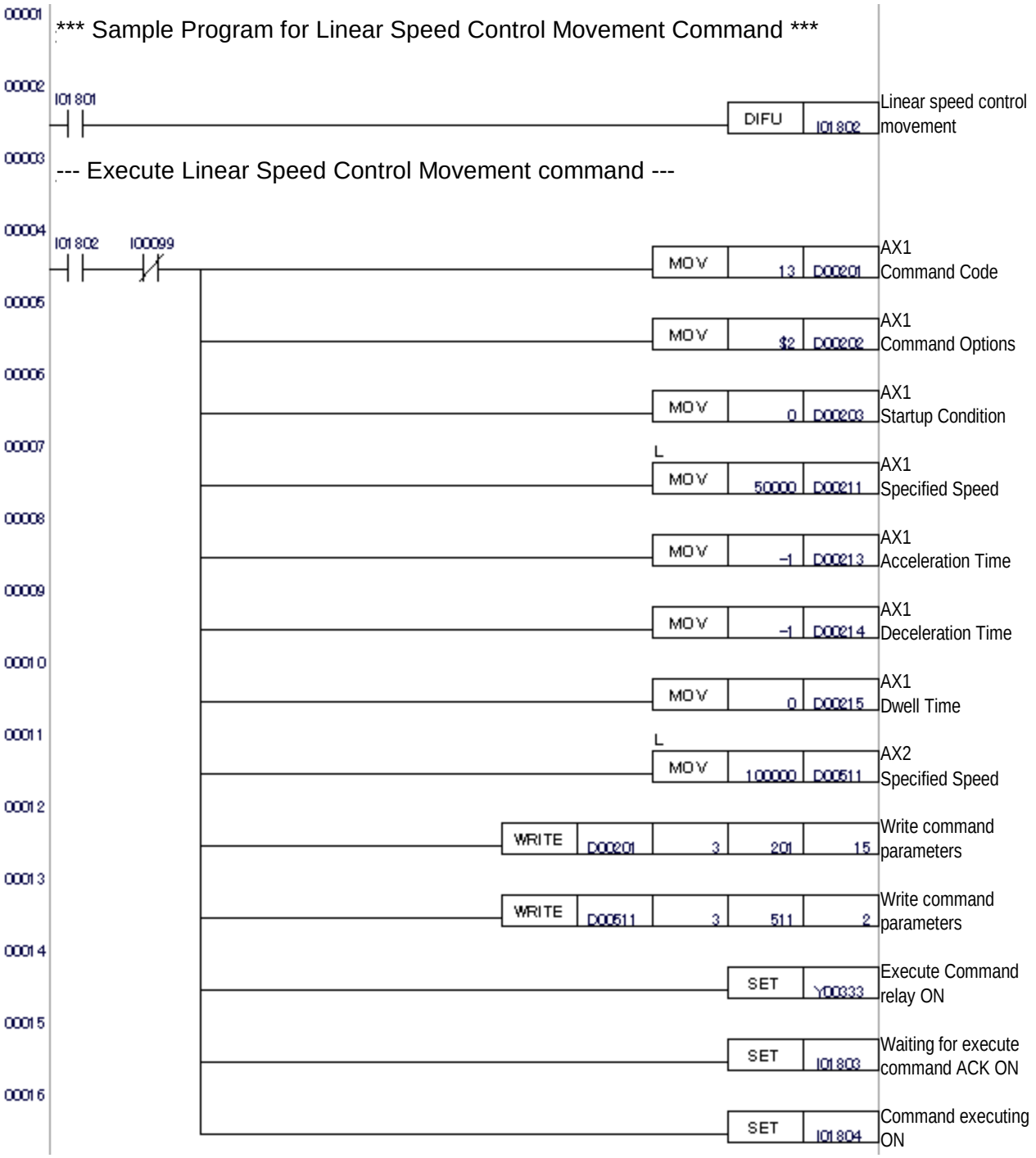
● List of Devices

Table 6.55 lists the devices used.

Table 6.55 List of Devices Used in Sample Program for Linear Speed Control Movement Command

Device	Name	Data
D00201	AX1 Direct Command Code	13: Linear Speed Control Movement
D00202	AX1 Command Options	$0002 (Axis 2 as interpolation axis)
D00203	AX1 Startup Condition	0: Normal startup
D00211/D00212	AX1 Specified Speed	50,000 (x 10^{-4}mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D02001	AX1 Warning Status	
D00511/D00512	AX2 Specified Speed	100,000 (x 10^{-4}mm/s)
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00306	AX2 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I01801	Linear speed control movement	
I01802	Linear speed control movement (differential up)	
I01803	Waiting for execute command ACK	
I01804	Command executing	

- **Sample Program**



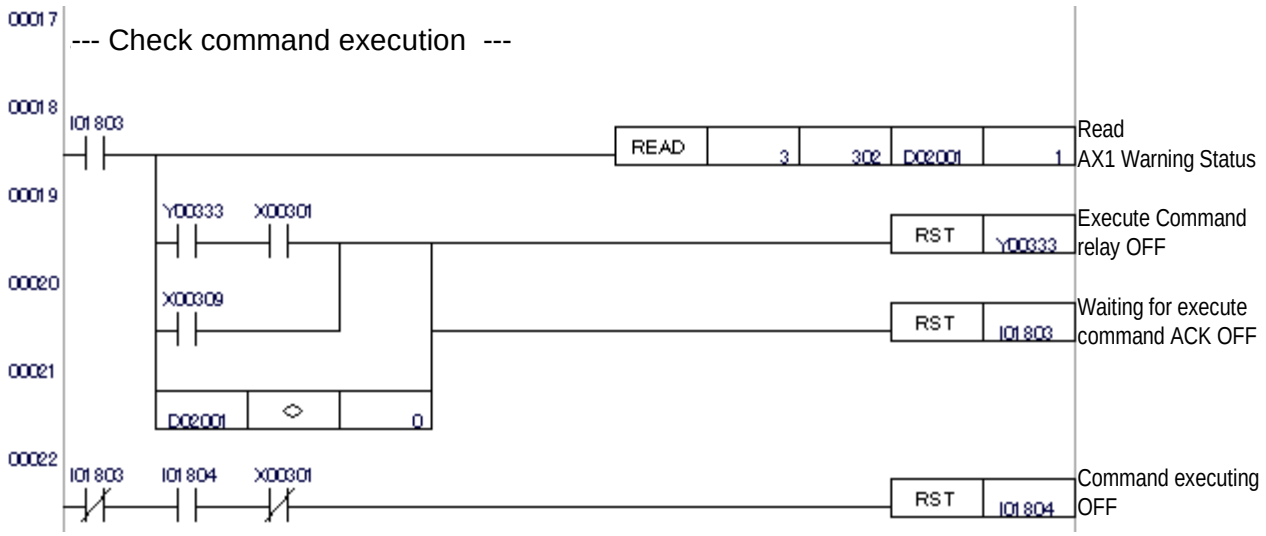


Figure 6.60 Linear Speed Control Movement Program

● Timing Chart

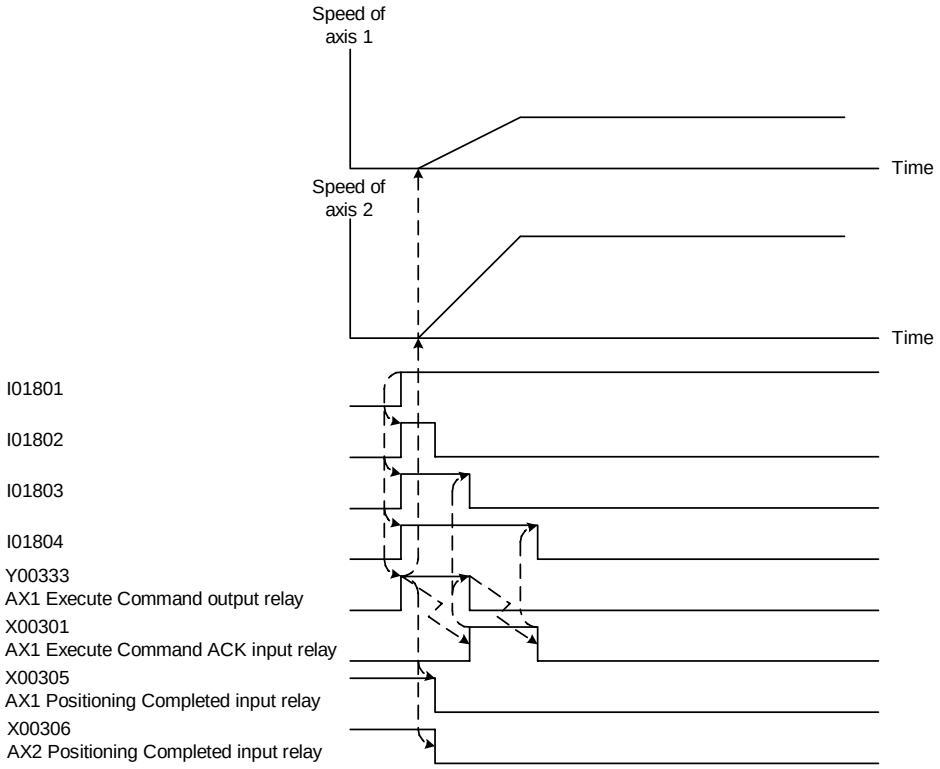


Figure 6.61 Timing Chart for Linear Speed Control Movement Program

6.11 Index Control

This section describes the index control command.

An axis with Index Control axis registered parameter set to "1: Index control" will be subject to index control.

Forward limit input error, reverse limit input error, forward limit error and reverse limit error are not reported for an axis subject to index control.

6.11.1 Index Positioning

■ Function

The Index Positioning command performs single-axis positioning of an axis with Index Control axis registered parameter set to "1: Index control" using a specified target position, specified speed, acceleration time and deceleration time.

Executing this command during index speed control movement moves the axis to the specified target position.

Executing this command during index positioning changes the target position, and moves the axis to the new target position.

- The target position can be specified using an absolute position, an incremental position or a position data number.

  If specified using an absolute position, the target position should be zero or greater but smaller than the Index Range (in position reference unit), and the module moves the axis to the target position using the shortest path.

  If specified using an incremental position, the sign of the target position indicates the direction of rotation. Multiple rotations can be achieved by specifying an incremental target position that exceeds the index range.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for individual positioning movements.
- A dwell time at the end of positioning can be specified.
- A startup speed can be specified using an axis registered parameter.
- Instead of starting positioning immediately after command execution, a startup condition can be specified to delay positioning until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- An end condition can be specified to turn on an external contact output when positioning completes.

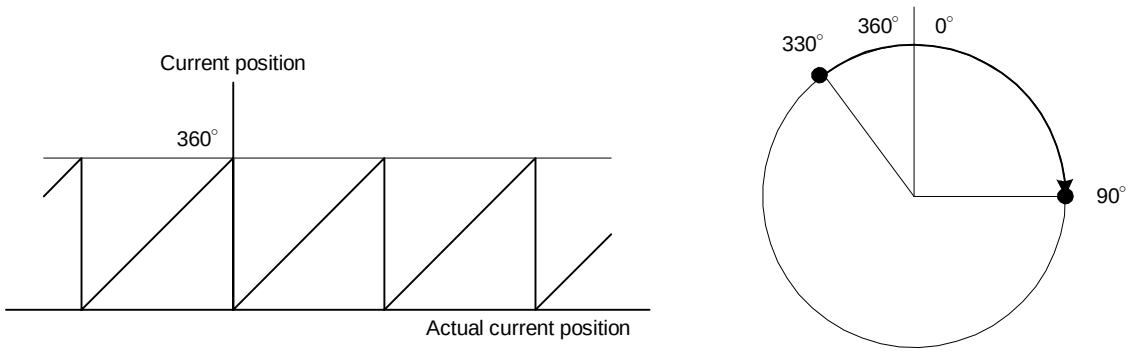


Figure 6.62 Index Positioning (example with index range of 0 to 360°)

Table 6.56 Detailed Operation of Index Positioning Command

State When Command is Executed	Position Reference	Operation
Positioning completed	Absolute position	Performs positioning from current position to target position in direction of shortest path. (shortest path control)
Positioning completed	Incremental position	Performs positioning from current position to target position computed using specified incremental position. The sign of the specified incremental position determines the direction of rotation. Multiple rotations can be achieved by specifying an incremental target position that exceeds the index range.
During index positioning	Absolute position	Determines the direction of shorter path to the target position from an imaginary computed position assuming a decelerate and stop movement is executed for the moving axis. From the computation, if a change in direction is required, or if the deceleration curve does not allow the axis to stop normally, decelerates and stops the axis before restarting movement to the new target position.
During index positioning	Incremental position	Computes the new target position using the previous target position and the specified incremental distance. From the computation, if a change in direction is required, or if the deceleration curve does not allow the axis to stop normally, decelerates and stops before restarting movement to the new target position.
Index speed control	Absolute position	Stops at the target position without changing direction of movement. Rotates beyond one revolution if necessary to achieve normal stop according to the deceleration curve.
Index speed control	Incremental position	Computes the new target position using the current position at the time of command execution and the specified incremental distance. From the computation, if a change in direction is required, or if the deceleration curve does not allow the axis to stop normally, decelerates and stops before restarting movement to the new target position.

■ Execution Procedure

● Command Parameters Used

Table 6.57 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.57 Required Parameters of Index Positioning Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	15: Index positioning	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	△
0204	0504	0804	1104	End Condition	0: Normal end; Non-zero: End condition code	△
0206	0506	0806	1106	Target Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	○
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	-2,147,483,648 to 2,147,483,647 (position reference unit) or position data no. (1 to No. of Position Data Records Used)	○
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	Startup Speed to Speed Limit (speed reference unit)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

● Command Acceptance Conditions

Table 6.58 lists the pre-conditions for command execution.

Table 6.58 Command Acceptance Conditions for Index Positioning Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
In position control mode		○
Under index control		○
Not jogging		○
No automatic origin search is in progress		○
No change in target position is in progress		○
Not waiting for trigger		○
No change in command execution axis		○

● Procedure

(1) Write Direct Command Code '15: index positioning' and required parameters to axis command parameter area of execution axis.

(2) Turn on the Execute Command output relay for the execution axis.

(3) The Execute Command ACK input relay turns on and index positioning begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed relay turns off when positioning begins. The Positioning Completed relay turns on when the axis reaches the target position.

■ Precautions

- Index Range of axis registered parameters should be set to a value such that the number of pulses after electronic gear conversion is an integer. Any fractional value may result in a deviation beyond one rotation.
- Forward limit and reverse limit defined by axis registered parameters are ignored during index positioning movement.
- Forward limit and reverse limit input errors are not detected during index positioning movement.
- The value of Current Position Status of axis statuses during index positioning ranges between 0 (inclusive) and the Index Range.
- An index overflow error will be generated during index positioning if the target position is changed repeatedly using incremental positions such that the accumulated incremental travel from the initial position exceeds 32 bits (4,294,967,296 position reference units). To avoid such errors, use index speed control or create applications that will stop and then restart an axis before accumulated incremental travel exceeds 32 bits (4,294,967,296 position reference units).

■ Sample Program

● Description

This sample program performs index positioning of axis 1 for a positioning module installed in slot 3.

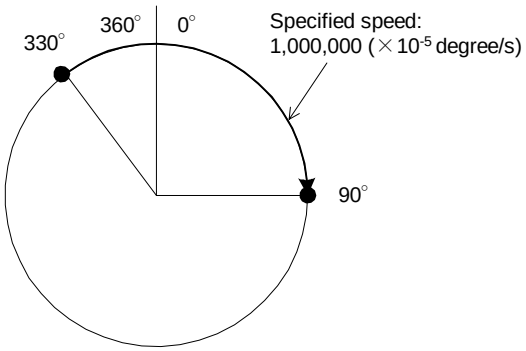


Figure 6.63 An Example of Index Positioning Command Operation

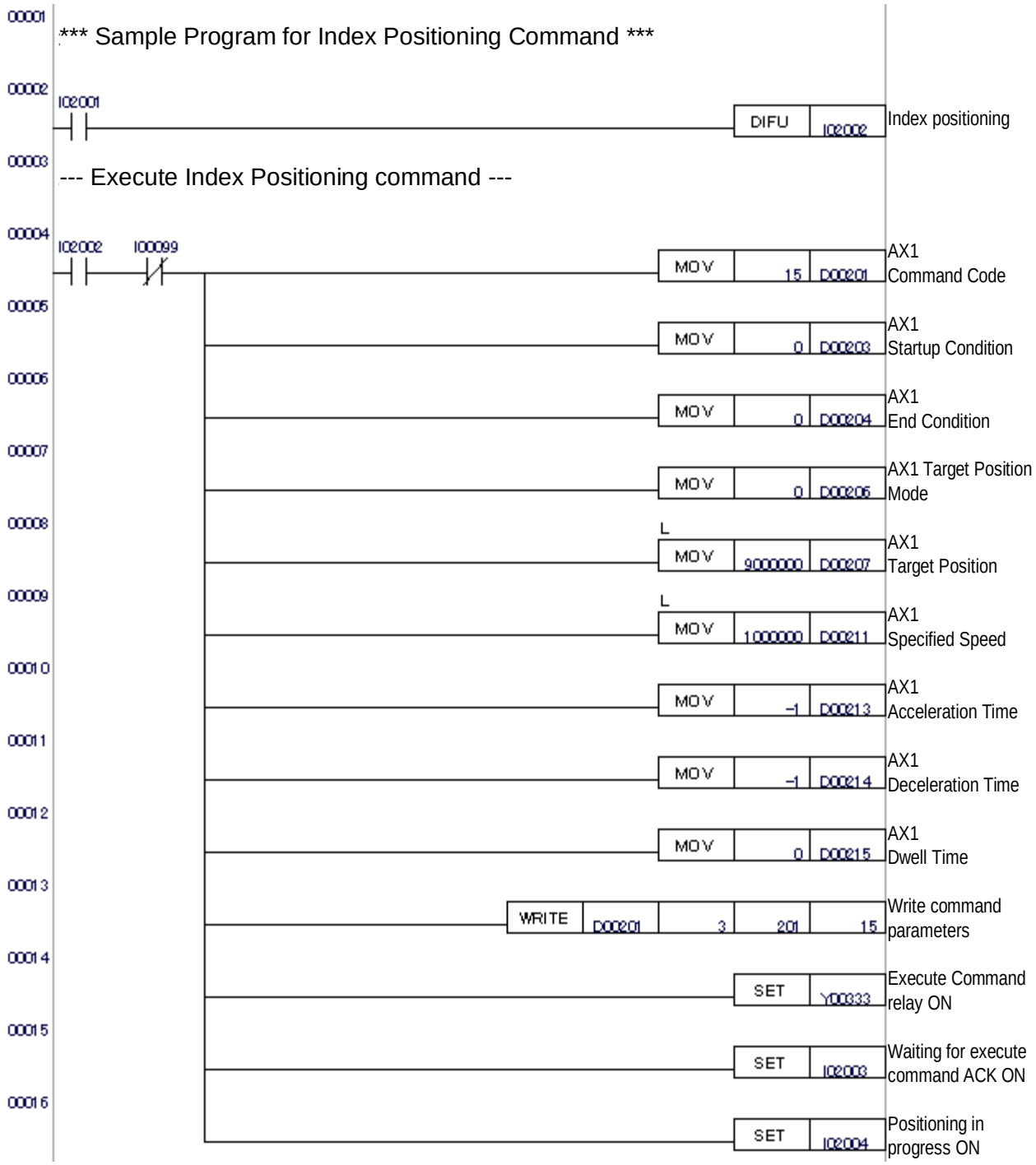
● List of Devices

Table 6.59 lists the devices used.

Table 6.59 List of Devices Used in Sample Program for Index Positioning Command

Device	Name	Data
D00201	AX1 Direct Command Code	15: Index positioning
D00203	AX1 Startup Condition	0: Normal startup
D00204	AX1 End Condition	0: Normal end
D00206	AX1 Target Position Mode	0: Using ABS position
D00207/D00208	AX1 Target Position	9,000,000 (x 10^{-5} degree)
D00211/D00212	AX1 Specified Speed	1,000,000 (x 10^{-5} degree/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I02001	Index positioning	
I02002	Index positioning (differential up)	
I02003	Waiting for execute command ACK	
I02004	Positioning in progress	

- **Sample Program**



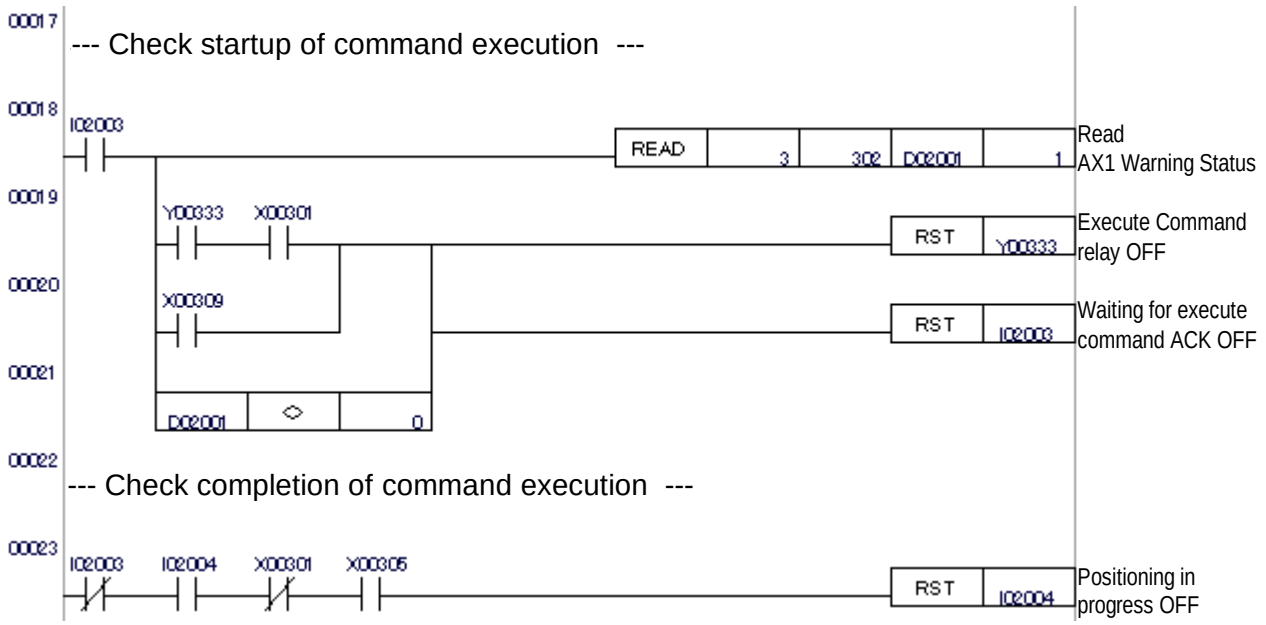


Figure 6.64 Index Positioning Program

- **Timing Chart**

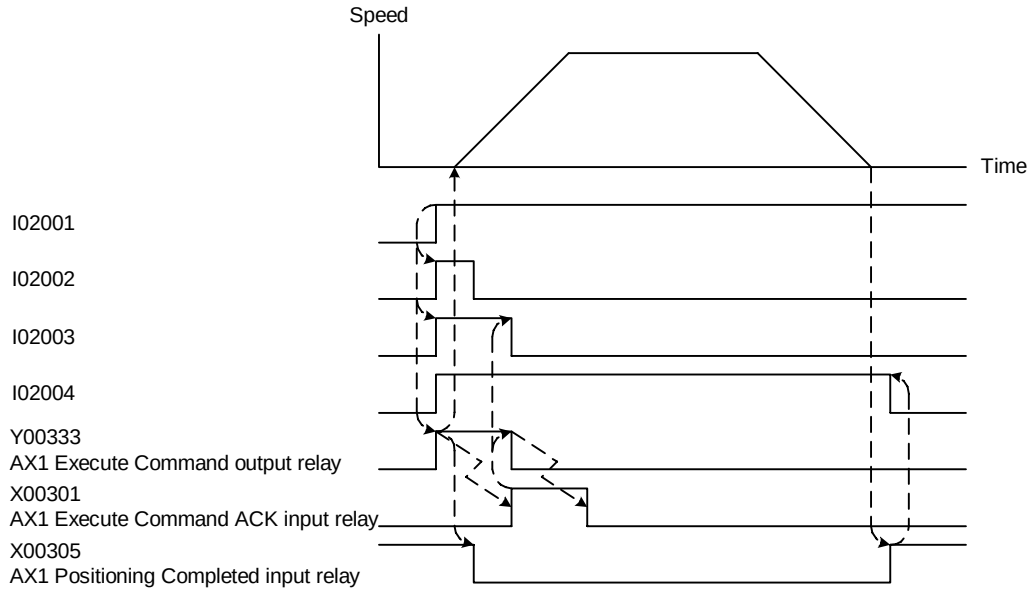


Figure 6.65 Timing Chart for Index Positioning Program

6.11.2 Index Speed Control Movement

■ Function

The Index Speed Control Movement command performs single-axis speed control movement of an axis with Index Control axis registered parameter set to "1: Index control" using a specified speed, acceleration time and deceleration time.

Index speed control movement continues until an Index Positioning command is executed, a Decelerate and Stop command is executed or the Stop Immediately output relay is turned from off to on.

- The sign of the specified speed determines the direction of rotation.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for individual positioning movements.
- A startup speed can be specified using an axis registered parameter.
- Instead of starting speed control movement immediately after command execution, a startup condition can be specified to delay speed control movement until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- The deceleration time and dwell time to be used for deceleration and stopping the axis if a Decelerate and Stop command is executed are specified when speed control movement is executed.

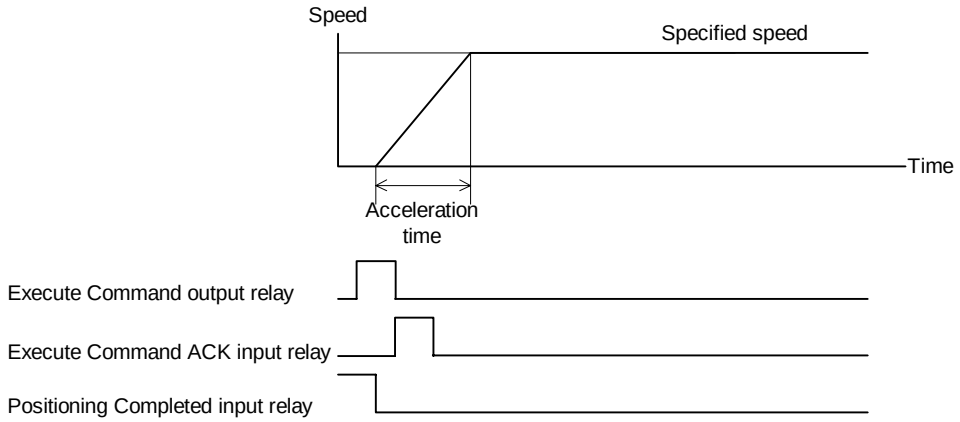


Figure 6.66 Index Speed Movement

■ Execution Procedure

● Command Parameters Used

Table 6.60 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.60 Required Parameters of Index Speed Control Movement Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	16: Index speed control movement	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	△
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	-(Speed Limit) to (Speed Limit) (reference speed unit) (must be non-zero, as well as equal or greater than Startup Speed)	○
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	△
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

● Command Acceptance Conditions

Table 6.61 lists the pre-conditions for command execution.

Table 6.61 Command Acceptance Conditions for Index Speed Control Movement Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
Under index Control		○
In Positioning Completed state		○
Not waiting for trigger		○
No change in command execution axis		○

● Procedure

(1) Write Direct Command Code '16: index speed control movement' and required parameters to axis command parameter area of command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and movement begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns off when speed control movement begins.

■ Precautions

- Index Range of axis registered parameters should be set to a value such that the number of pulses after electronic gear conversion is an integer. Any fractional value may result in a deviation beyond one rotation.
- Forward limit and reverse limit defined by axis registered parameters are ignored during index speed control movement.
- Forward limit and reverse limit input errors are not detected during index positioning movement.
- The value of Current Position Status of axis statuses during index speed control movement ranges between 0 (inclusive) and the Index Range.

■ Sample Program

● Description

This sample program performs index speed control movement of axis 1 of a positioning module installed in slot 3.

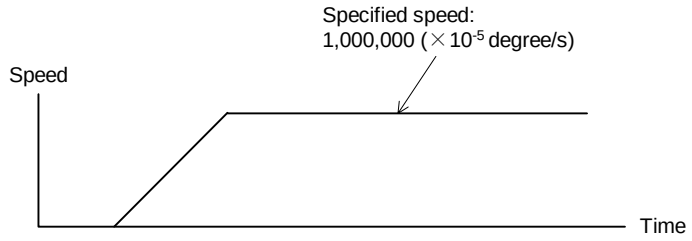


Figure 6.67 An Example of Index Speed Control Movement Command Operation

● List of Devices

Table 6.62 lists the devices used.

Table 6.62 List of Devices Used in Sample Program for Index Speed Control Movement Command

Device	Name	Data
D00201	AX1 Direct Command Code	16: Index speed control movement
D00203	AX1 Startup Condition	0: Normal startup
D00211/D00212	AX1 Specified Speed	1,000,000 (x 10^{-4} degree/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D00215	AX1 Dwell Time	0 (ms)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I02101	Index speed control movement	
I02102	Index speed control movement (differential up)	
I02103	Waiting for execute command ACK	
I02104	Command executing	

- **Sample Program**

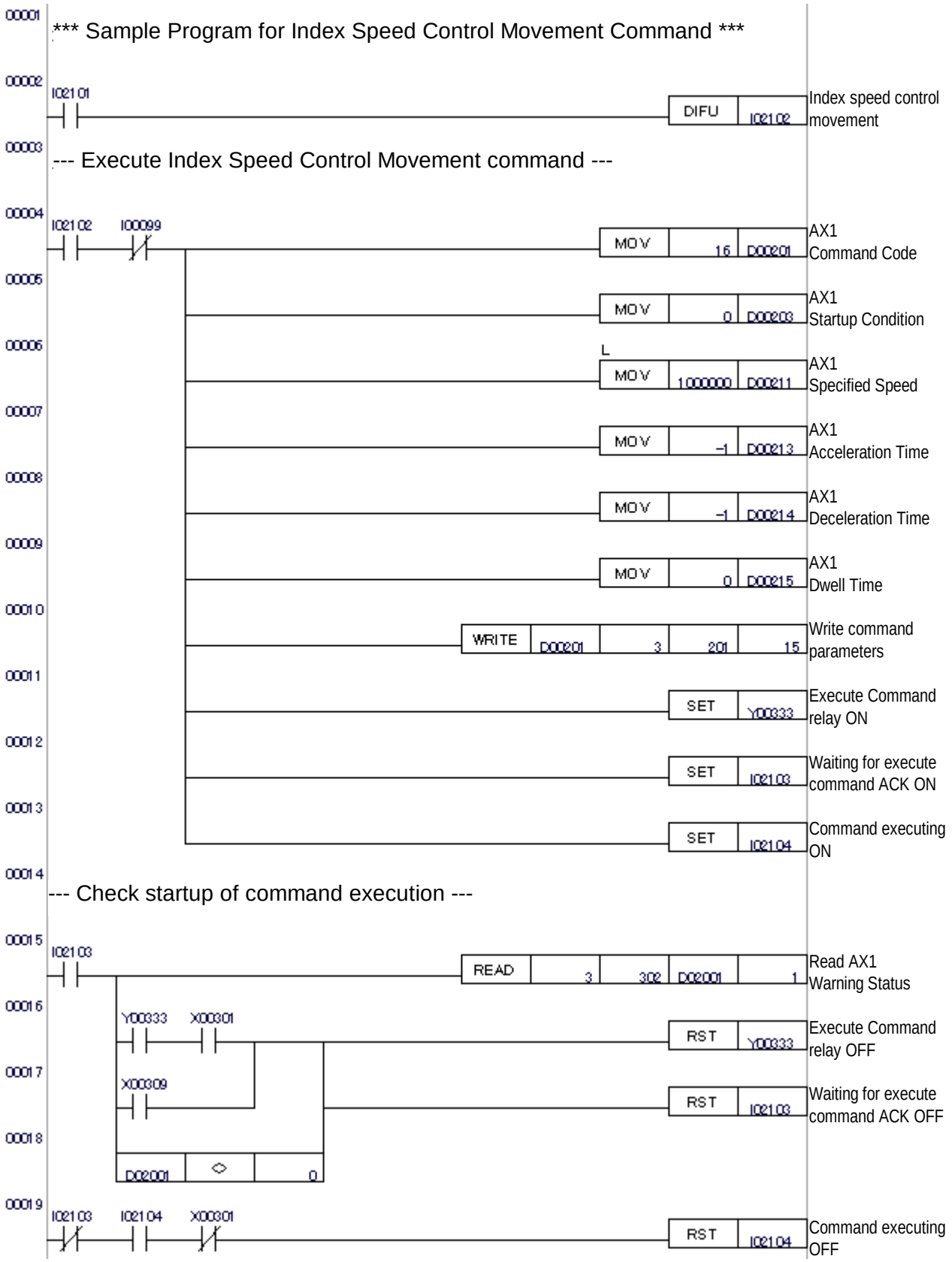


Figure 6.68 Index Speed Movement Program

Timing Chart

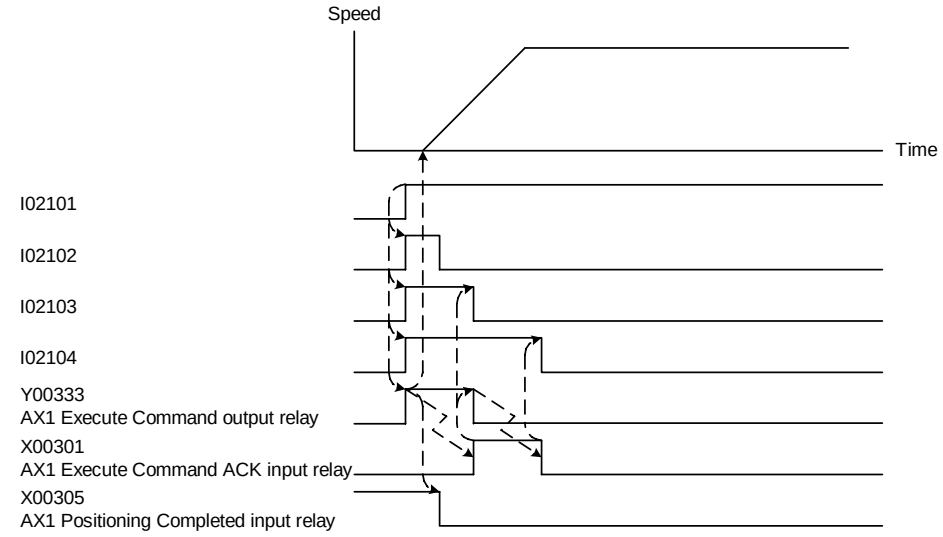


Figure 6.69 Timing Chart for Index Speed Control Movement Program

6.12 Change Speed

■ Function

This command changes movement speed to a new specified speed during positioning movement, speed control movement, index control movement or jogging.

If the command is issued during linear speed control movement, it changes the speed of all axes involved in the interpolation.

- When executed during speed control movement (including index speed control movement), the sign of the specified speed determines the direction of rotation. Changing the direction of movement is not allowed when changing speed.
- When the module decelerates and stops the axes after the speed change either to reach the target position or in response to a Decelerate and Stop command, it does so according to the deceleration time defined at the time when the Change Speed command was executed.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual command execution.
- Instead of starting speed control movement immediately after command execution, a startup condition can be specified to delay execution until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true. (No startup condition can be defined when changing speed during jogging.)

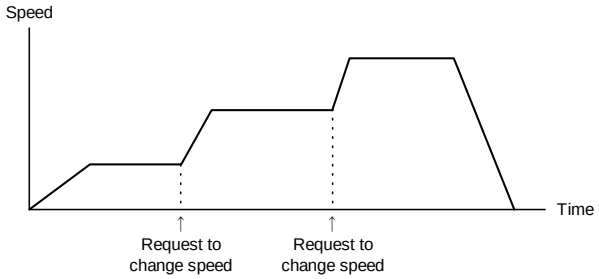


Figure 6.70 Change Speed Operation

- In position control, the acceleration or deceleration used to accelerate or decelerate from the speed just before speed change to the new specified speed is the gradient obtained from the new specified speed and acceleration time. (This gradient is also used for the deceleration curve if the new specified speed is smaller than the speed before the change. Note that the gradient is obtained using the acceleration time and not the deceleration time.)

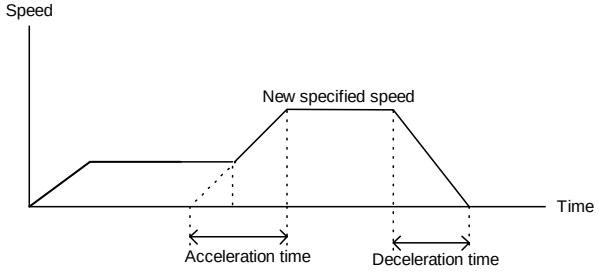


Figure 6.71 Changing Speed (in position control mode)

- In speed control movement (including index speed control), if the acceleration time is specified not as default (value –1) but as an actual numeric value (>0), the acceleration used to accelerate from the speed just before speed change to the new specified speed is computed such that the axis takes the specified acceleration time to reach the new specified speed.

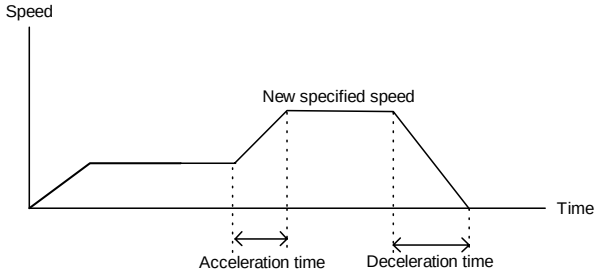


Figure 6.72 Changing Speed (in speed control mode)

■ Execution Procedure

● Command Parameters Used

Table 6.63 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.63 Required Parameters of Change Speed Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	21: Change Speed	○
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code (Normal startup is always used for speed change during jogging regardless of this setting)	△
0211 /0212	0511 /0512	0811 /0812	1111 /1112	Specified Speed	1 to Speed Limit (speed reference unit) or, -(Speed Limit) to (Speed Limit) (speed reference unit) (The required input follows the specified speed of the movement in progress.)	◎*1
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	△
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	△
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	▲
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	▲

*1: Setup is required for all movement axis only when changing speed during linear speed control movement.

● Command Acceptance Conditions

Table 6.64 lists the pre-conditions for command execution.

Table 6.64 Command Acceptance Conditions for Change Speed Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
Not in manual pulse generator mode		○
Not in Positioning Completed state		○
No origin search is in progress		○
No change in target position is in progress		○
Not waiting for trigger		○
No change in command execution axis		○

● Procedure

(1) Write Direct Command Code '21: change speed' and required parameters to axis command parameter area of command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and speed change movement begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- Movement speed cannot be changed during origin search or when in manual pulse generator mode.
- If a Change Speed command issued during movement generates a parameter setup error or some other error, the positioning movement in progress is decelerated and stopped.
- When executed during speed control movement, the sign of the specified speed determines the direction of rotation. Changing the direction of movement is not allowed when changing speed.

  To change the direction of movement, execute a Decelerate and Stop command before executing a Speed Control Movement command in the reverse direction.
- When changing speed during interpolation movement, the command execution axis must be the same. In other words, the Change Speed command must be issued from the same axis from which the movement in progress was previously initiated.

■ Sample Program

● Description

This sample program changes the speed during speed control movement of axis 1 of a positioning module installed in slot 3.

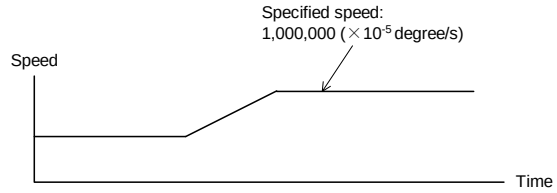


Figure 6.73 An Example of Change Speed Command Operation

● List of Devices

Table 6.65 lists the devices used.

Table 6.65 List of Devices Used in Sample Program for Change Speed Command

Device	Name	Data
D00201	AX1 Direct Command Code	21: Change Speed
D00203	AX1 Startup Condition	0: Normal startup
D00211/D00212	AX1 Specified Speed	100,000 (x 10^{-4}mm/s)
D00213	AX1 Acceleration Time	-1: Default acceleration
D00214	AX1 Deceleration Time	-1: Default deceleration
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I02201	Change speed	
I02202	Change speed (differential up)	
I02203	Waiting for execute command ACK	
I02204	Command executing	

- **Sample Program**

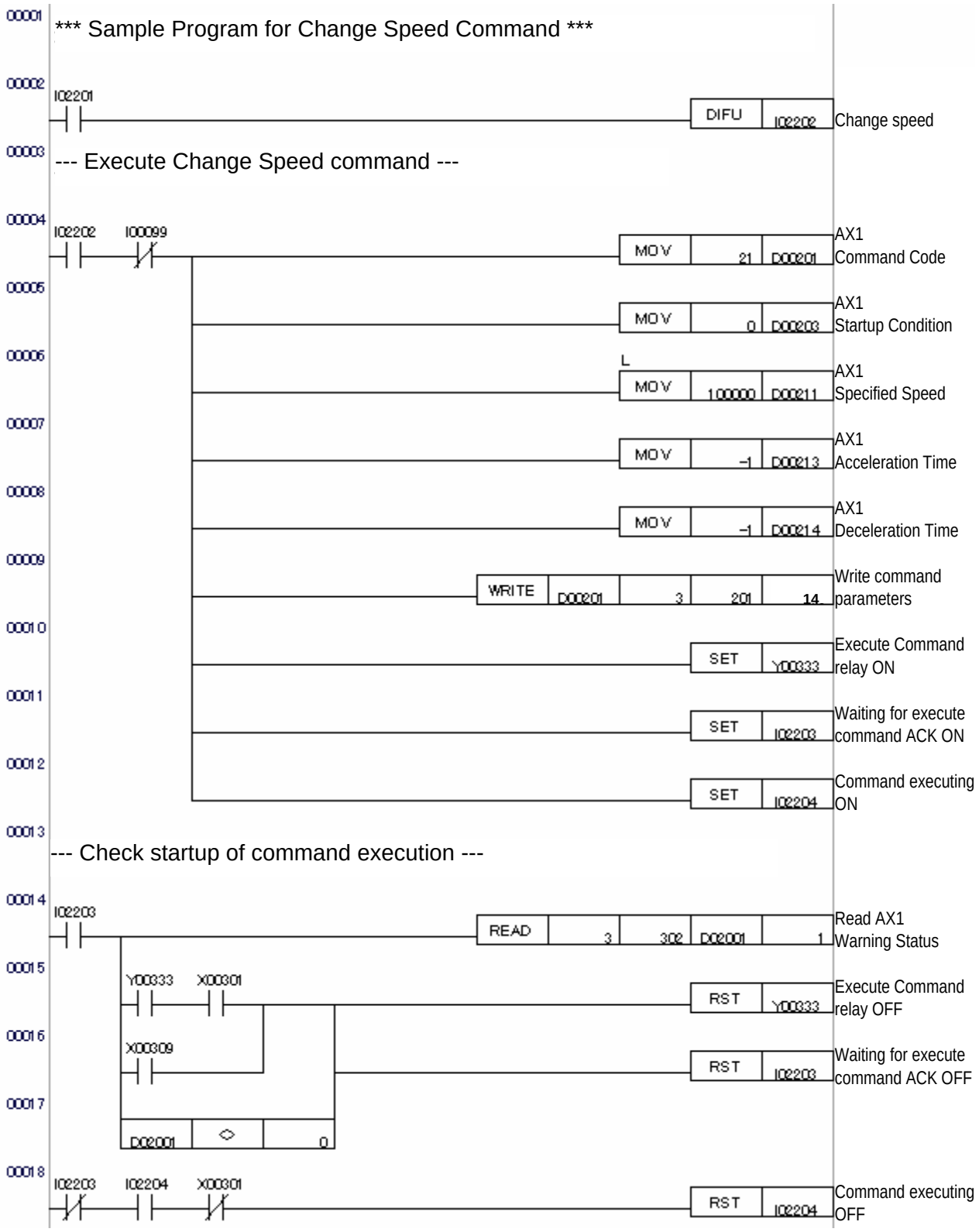


Figure 6.74 Change Speed Program

Timing Chart

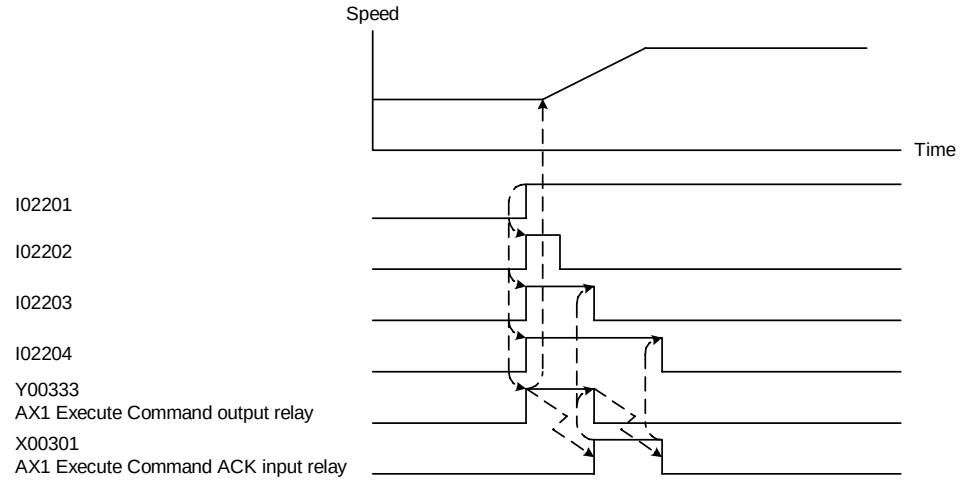


Figure 6.75 Timing Chart for Change Speed Program

6.13 Decelerate and Stop

■ Function

This command or action decelerates and stops one or more moving motors during positioning movement, speed control movement, origin search movement or other movement.

- The deceleration time and dwell time used for deceleration and stopping follow the values defined when the movement was first initiated (if the deceleration time was changed by another command during movement, the new value is used).
- If multiple axes are involved in a movement (e.g. linear interpolation), all axes are decelerated and stopped.
- All pending commands waiting for trigger conditions to become true (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) are cancelled.

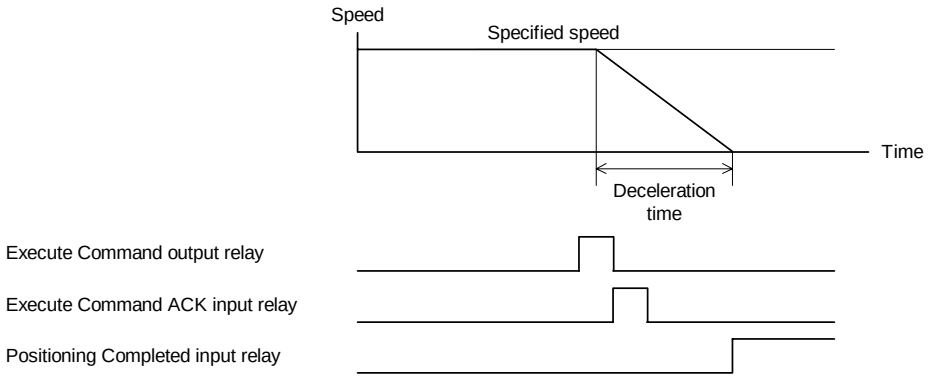


Figure 6.76 Decelerate and Stop Action

■ Execution Procedure

● Command Parameters Used

Table 6.66 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.66 Required Parameters of Decelerate and Stop Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	20: Decelerate and Stop	○

● Command Acceptance Conditions

Table 6.67 lists the pre-conditions for command execution.

Table 6.67 Command Acceptance Conditions for Decelerate and Stop Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
No axis error has been detected.		○
Not in manual pulse generator mode		○
Not jogging		○

● Procedure

(1) Write Direct Command Code '20: decelerate and stop' to axis command parameter area of command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) The Execute Command ACK input relay turns on and deceleration and stop movement begins. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns on when the positioning movement or speed control movement has been decelerated and stopped.

■ Precautions

- Executing a Decelerate and Stop command during jogging is not allowed. To do so, you need to first end jogging.
- An interpolation movement or pattern operation can be decelerated and stopped from any axis involved in the movement, even if it is not the command execution axis for the movement. For most applications, however, we recommend to execute the Decelerate and Stop command from the command execution axis.

■ Sample Program

● Description

This sample program decelerates and stops axis 1 of a positioning module installed in slot 3 during positioning movement.

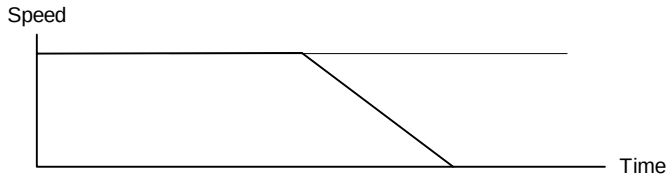


Figure 6.77 An Example of Decelerate and Stop Command Operation

● List of Devices

Table 6.68 lists the devices used.

Table 6.68 List of Devices Used in Sample Program for Decelerate and Stop Command

Device	Name	Data
D00201	AX1 Direct Command Code	20: Decelerate and Stop
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00305	AX1 Positioning Completed input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I02301	Decelerate and stop	
I02302	Decelerate and stop (differential up)	
I02303	Waiting for execute command ACK	
I02304	Decelerating and stopping	

- **Sample Program**

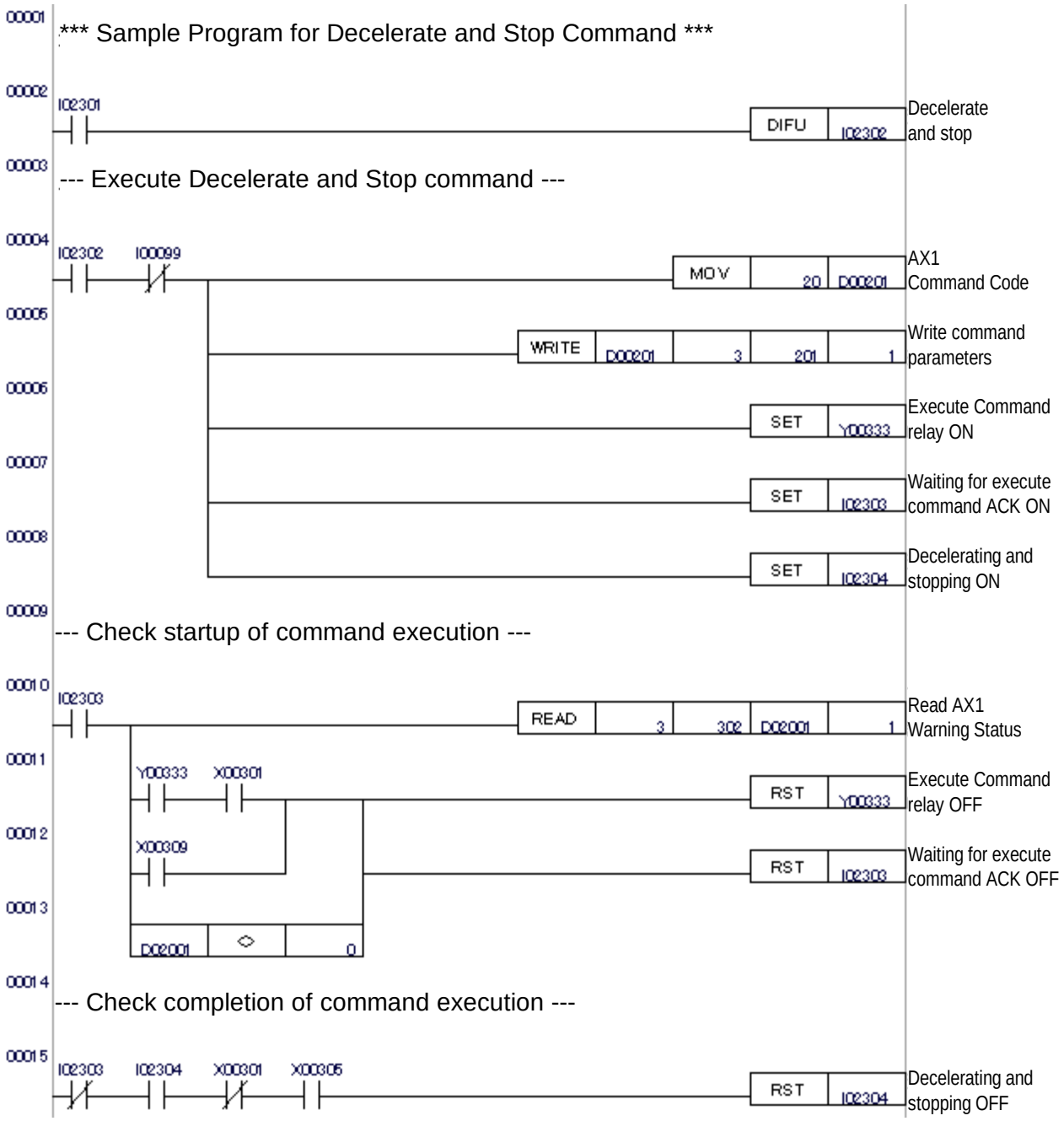


Figure 6.78 Decelerate and Stop Movement Program

Timing Chart

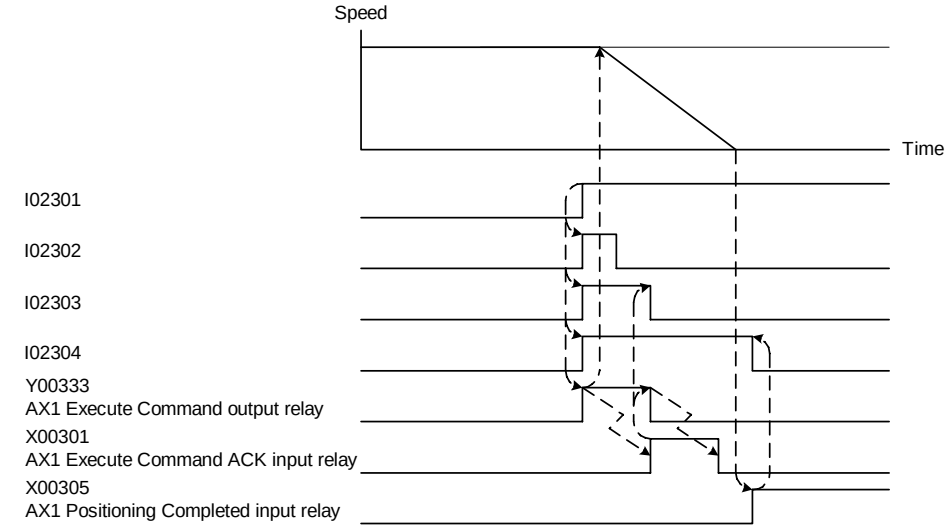


Figure 6.79 Timing Chart for Decelerate and Stop Movement Program

6.14 Stop Immediately

■ Function

This command or action stops one or more moving motors immediately without deceleration during positioning movement, speed control movement, origin search movement or other movement.

- If multiple axes are involved in a movement (e.g. linear interpolation), all axes are stopped immediately.
- All pending commands waiting for trigger conditions to become true (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) are cancelled.
- Executing the Stop Immediately command while a motor is moving in MPG mode stops the motor immediately without deceleration, and switches to position control mode.

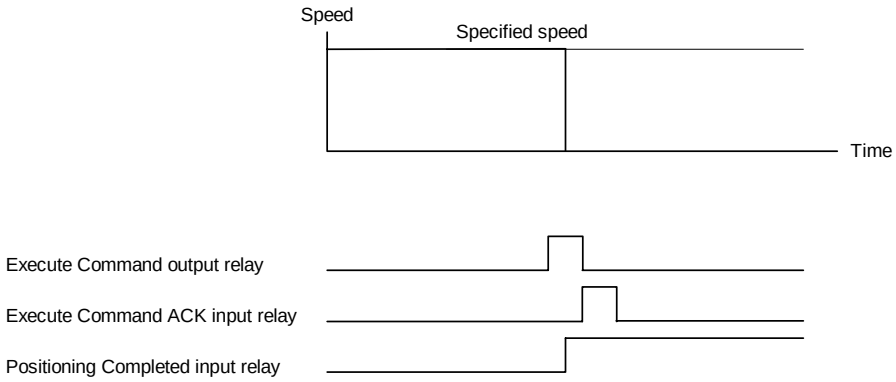


Figure 6.80 Stop Immediately Action

■ Execution Procedure

● Command Parameters Used

No command parameters need to be set.

● Command Acceptance Conditions

This command is always accepted.

● Procedure

(1) Turn on the Stop Immediately output relay for a moving axis.

(2) The axis is stopped immediately.

(3) The Positioning Completed input relay turns on when the positioning movement, speed control movement or jog operation stops. Turn off the Stop Immediately output relay after confirming that the Positioning Completed input relay has turned on.

■ Precautions

- Beware that executing an immediate stop in the midst of high speed movement may subject the mechanical system to a large impact.
- An interpolation movement or pattern operation can be stopped immediately from any axis involved in the movement, even if it is not the command execution axis for the movement. For most applications, however, we recommend to execute the Stop Immediately command from the command execution axis.

■ Sample Program

● Description

This sample program stops axis 1 of a positioning module installed in slot 3 immediately during positioning movement.

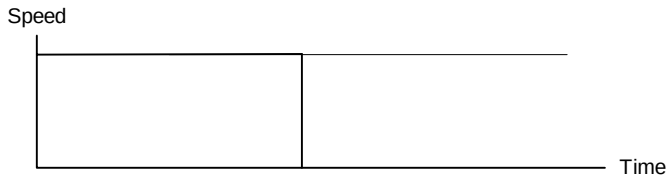


Figure 6.81 An Example of Stop Immediately Action

● List of Devices

Table 6.69 lists the devices used.

Table 6.69 List of Devices Used in Sample Program for Stop Immediately Command

Device	Name	Data
Y00337	AX1 Stop Immediately output relay	
X00305	AX1 Positioning Completed input relay	
I00099	Command execution disable (to be set elsewhere)	
I02401	Stop immediately	
I02402	Stop immediately (differential up)	

- **Sample Program**

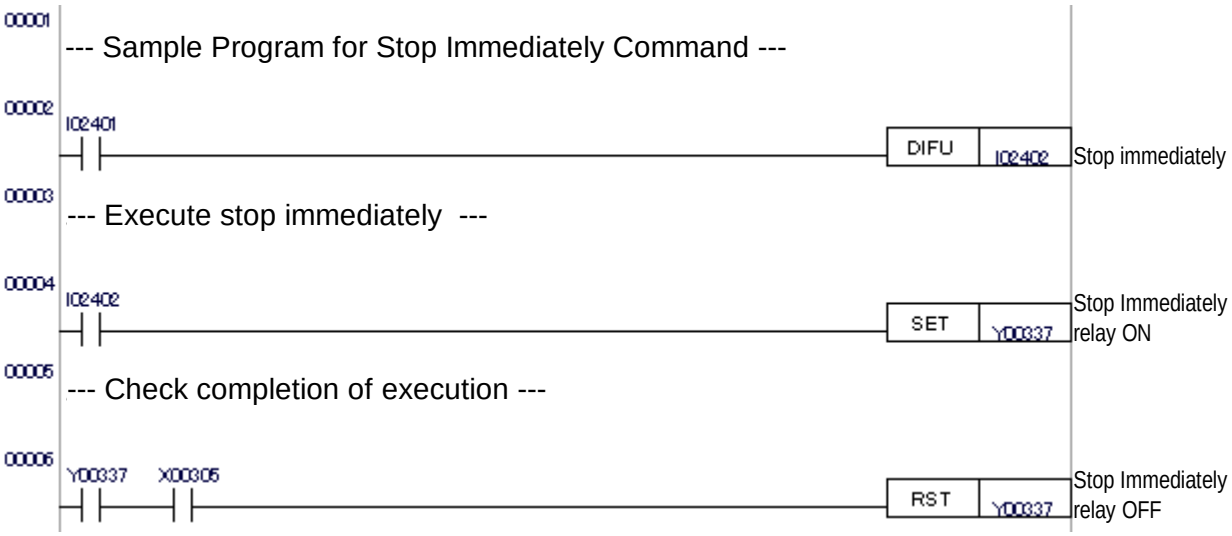


Figure 6.82 Stop Immediately Program

- **Timing Chart**

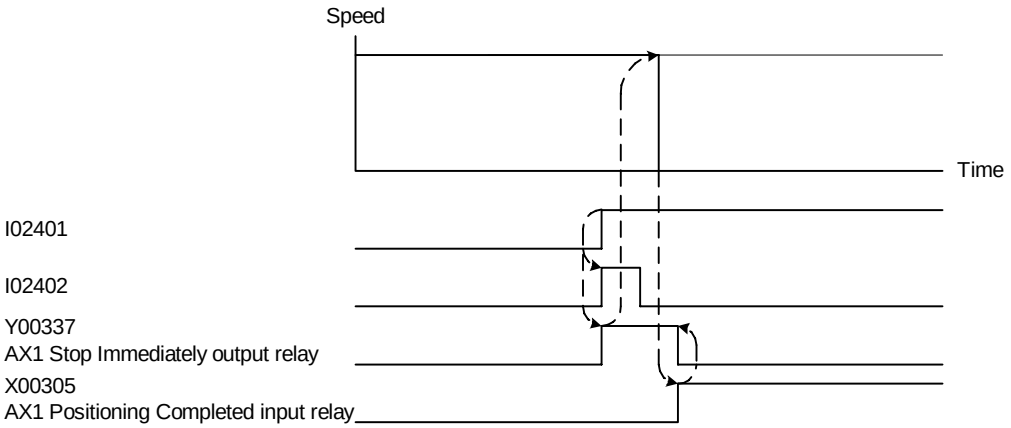


Figure 6.83 Timing Chart for Stop Immediately Program

6.15 Set Override

■ Function

This command changes the override value, which is used to scale specified speeds of positioning actions, speed control movement, index control movement and Jog operation by 1 to 500 (%).

If the override value is changed during movement, a change speed action is performed.

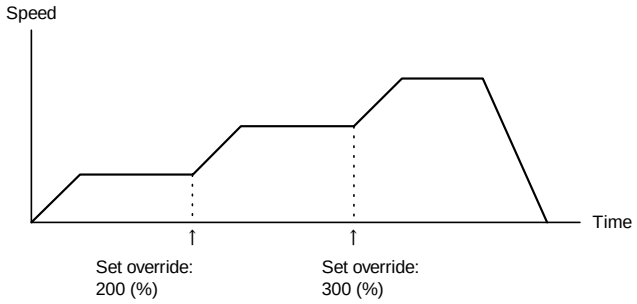


Figure 6.84 Set Override

When the override is changed, movement follows the gradient of the acceleration /deceleration curve defined by the non-scaled (override=100%) acceleration time, deceleration time and specified speed values. (As an exception, if the override is changed during speed control movement or index speed control movement, movement follows a fixed duration for speed change, ignoring the gradient of the acceleration/ deceleration curve.)

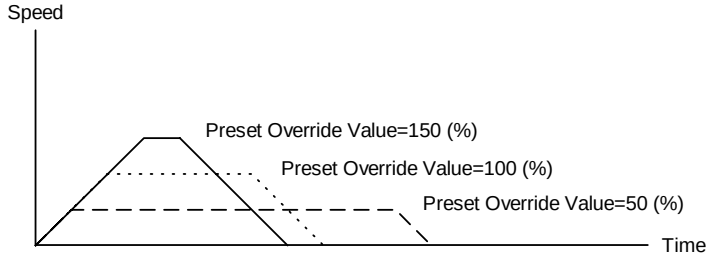


Figure 6.85 Set Override (fixed acceleration/deceleration curve)

The F3NC34-0N and F3NC32-0N positioning modules allow override values to be set at 8 and 4 different places respectively.

For instance, for linear interpolation involving axes 1 and 2, the Current Override Value of axis 1 is used when the command is executed from axis 1, while the Current Override Value of axis 2 is used when the command is executed from axis 2.

Table 6.70 Methods for Setting Override Value

Current Override Value	Override Value Changed by:	Override Value Applies to:
AX1 Current Override Value Status	Set Override command	Movement initiated by command executed from axis 1
AX2 Current Override Value Status		Movement initiated by command executed from axis 2
AX3 Current Override Value Status		Movement initiated by command executed from axis 3
AX4 Current Override Value Status		Movement initiated by command executed from axis 4
Pattern A Current Override Value	Set Pattern Override command	Pattern operation of pattern A
Pattern B Current Override Value		Pattern operation of pattern B
Pattern C Current Override Value		Pattern operation of pattern C
Pattern D Current Override Value		Pattern operation of pattern D

■ Execution Procedure

● Command Parameters Used

Table 6.71 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.71 Required Parameters of Set Override Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	22: Set Override	○
0216	0516	0816	1116	Preset Override Value	1 to 500 (%)	○

● Command Acceptance Conditions

Table 6.72 lists the pre-conditions for command execution.

Table 6.72 Command Acceptance Conditions for Set Override Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
Not in manual pulse generator mode		○
No automatic origin search is in progress		○
No change in target position is in progress		○
Speed limits are observed with new override value		○
Not waiting for trigger		○
No change in command execution axis		○

● Procedure

(1) Write Direct Command Code '22: set override' and required parameters to axis command parameter area of execution axis.

(2) Turn on the Execute Command output relay for the execution axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- The override value cannot be changed during origin search or when in manual pulse generator mode.
- Changing an override value during movement may cause the specified speed after override adjustment to exceed speed limits defined by axis registered parameters. If this happens, the Set Override command is not executed, and a warning code is stored in Warning Status of axis statuses.
- Even if the override value is changed, movement still follows the acceleration/ deceleration curve defined by the non-scaled (override=100%) values. Therefore, if a movement is approaching the target position at a speed below the specified speed, increasing the override value will not affect the movement (no speed increase).

■ Sample Program

● Description

This sample program changes the Preset Override Value of axis 1 for positioning module installed in slot 3 during speed control movement.

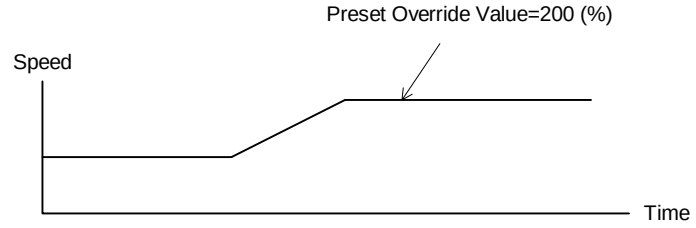


Figure 6.86 An Example of Set Override Command Operation

● List of Devices

Table 6.73 lists the devices used.

Table 6.73 List of Devices Used in Sample Program for Set Override Command

Device	Name	Data
D00201	AX1 Direct Command Code	22: Set Override
D00216	AX1 Preset Override Value	200 (%)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I02501	Set override	
I02502	Set override (differential up)	
I02503	Waiting for execute command ACK	
I02504	Command executing	

- **Sample Program**

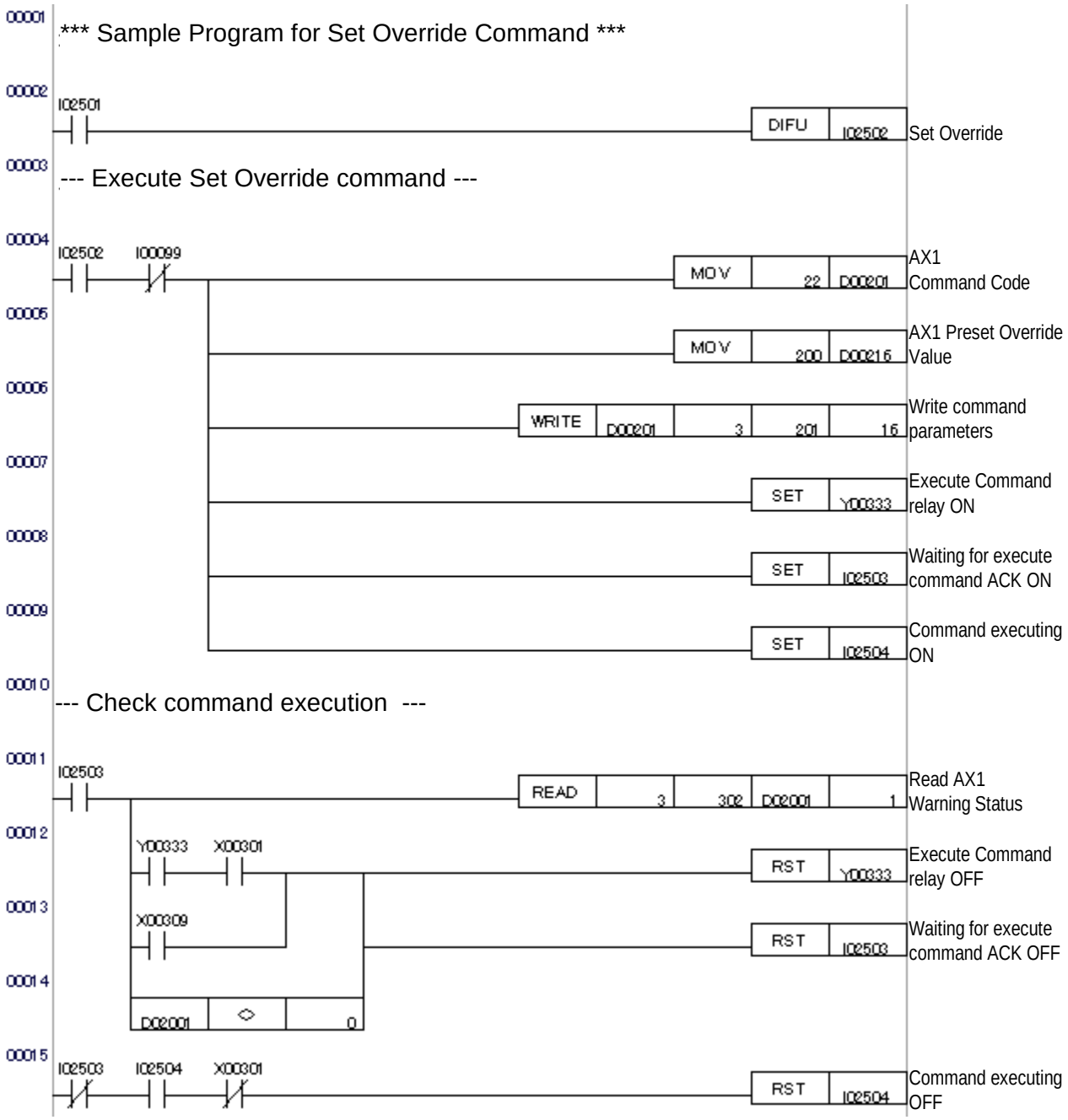


Figure 6.87 Set Override Program

Timing Chart

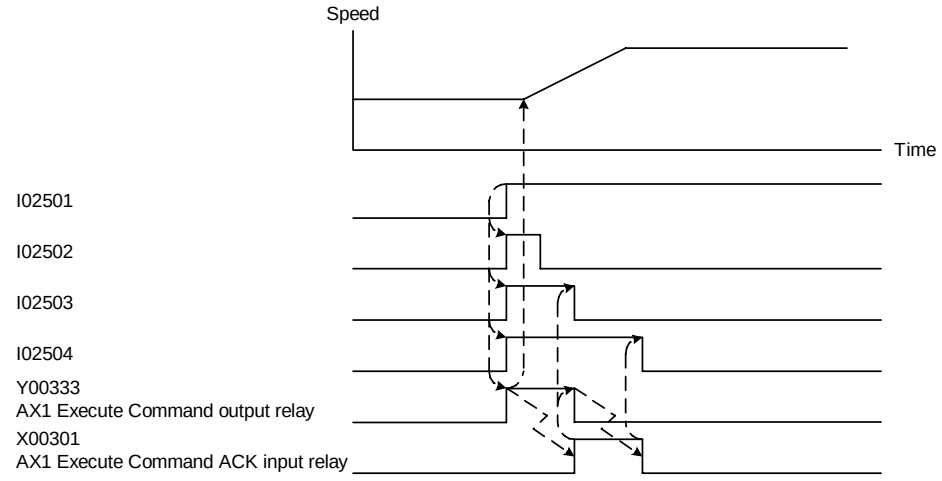


Figure 6.88 Timing Chart for Set Override Program

6.16 Teach

■ Function

This command or action writes the current position, counter current position or numeric data to the position data table.

- Besides writing data for the command execution axis, position data for multiple axes can also be written at the same time.

■ Execution Procedure

● Command Parameters Used

Table 6.74 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)
○: Parameters that must be set
△: Parameters that may be set as required (normally set to 0 or –1)
▲: Parameters that may require setup depending on other parameter values

Table 6.74 Required Parameters of Teach (Current Position/Counter Current Position) Command

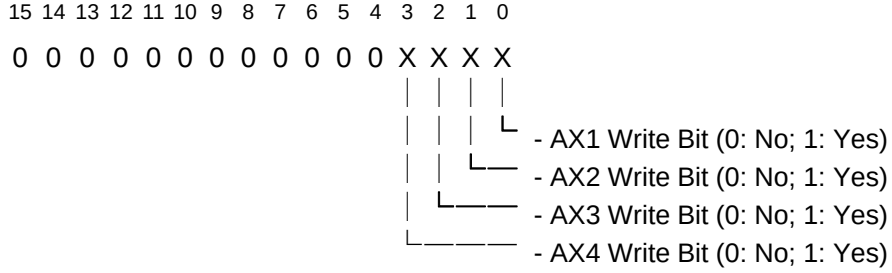
Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	41: Write Current Position 42: Write Counter Current Position	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0206	0506	0806	1106	Target Position Mode	0: Using ABS position 1: Using INC position	◎
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	Position data no. (1 to No. of Position Data Records Used)	○

Table 6.75 Required Parameters of Teach (Numeric Data) Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	43: Numeric Data	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0206	0506	0806	1106	Target Position Mode	2: Using position data no.	○
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	Position data no. (1 to No. of Position Data Records Used)	○
0220	0520	0820	1120	CI Sub Position Mode	0: Using ABS position 1: Using INC position	◎
0221 /0222	0521 /0522	0821 /0822	1121 /1122	CI Sub Position	-2,147,483,648 to 2,147,483,647 (position reference unit)	◎

● Command Options

Bit data stored in the Command Options parameter is used to specify additional axes, in addition to the command execution axis, to which data is to be written.



● Command Acceptance Conditions

Table 6.76 lists the pre-conditions for command execution.

Table 6.76 Command Acceptance Conditions for Teach Command (when writing current position and counter current position)

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
Not in speed control mode		○
In Positioning Completed state (except when executed in manual pulse generator mode)		○
Not waiting for trigger		○

Table 6.77 Command Acceptance Conditions for Teach Command (when writing numeric data)

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
Not waiting for trigger		○

● Procedure

(1) Write the appropriate direct command code and required parameters to axis command parameter area of command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- Position data written using Teach commands are cleared when the module is switched off. Execute a Save to Flash Memory command to save such position data if required.
- When writing position data to multiple axes, all axes must satisfy the command acceptance conditions.
- If the position data to be written by a Teach command exceeds the forward limit and reverse limit defined by axis registered parameters, an error is generated, and data is not written.
- The Teach command can be used to write numeric data to the position data table during pattern operation, but for the new values to be effective, they should be written at least 3 ms before pattern operation refers to the position data table. Otherwise, old values before the change may be used for execution instead.

■ Sample Program

● Description

This sample program writes the current position of axis 1 to position data record no. 100 in the position data table of a positioning module installed in slot 3.

● List of Devices

Table 6.78 lists the devices used.

Table 6.78 List of Devices Used in Sample Program for Teach Command

Device	Name	Data
D00201	AX1 Direct Command Code	41: Teach (Write Current Position)
D00202	AX1 Command Options	$0001 (write to axis 1)
D00206	AX1 Target Position Mode	0: Using ABS position
D00207/D00208	AX1 Target Position	100
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I02601	Teach	
I02602	Teach (differential up)	
I02603	Waiting for execute command ACK	
I02604	Command executing	

- **Sample Program**

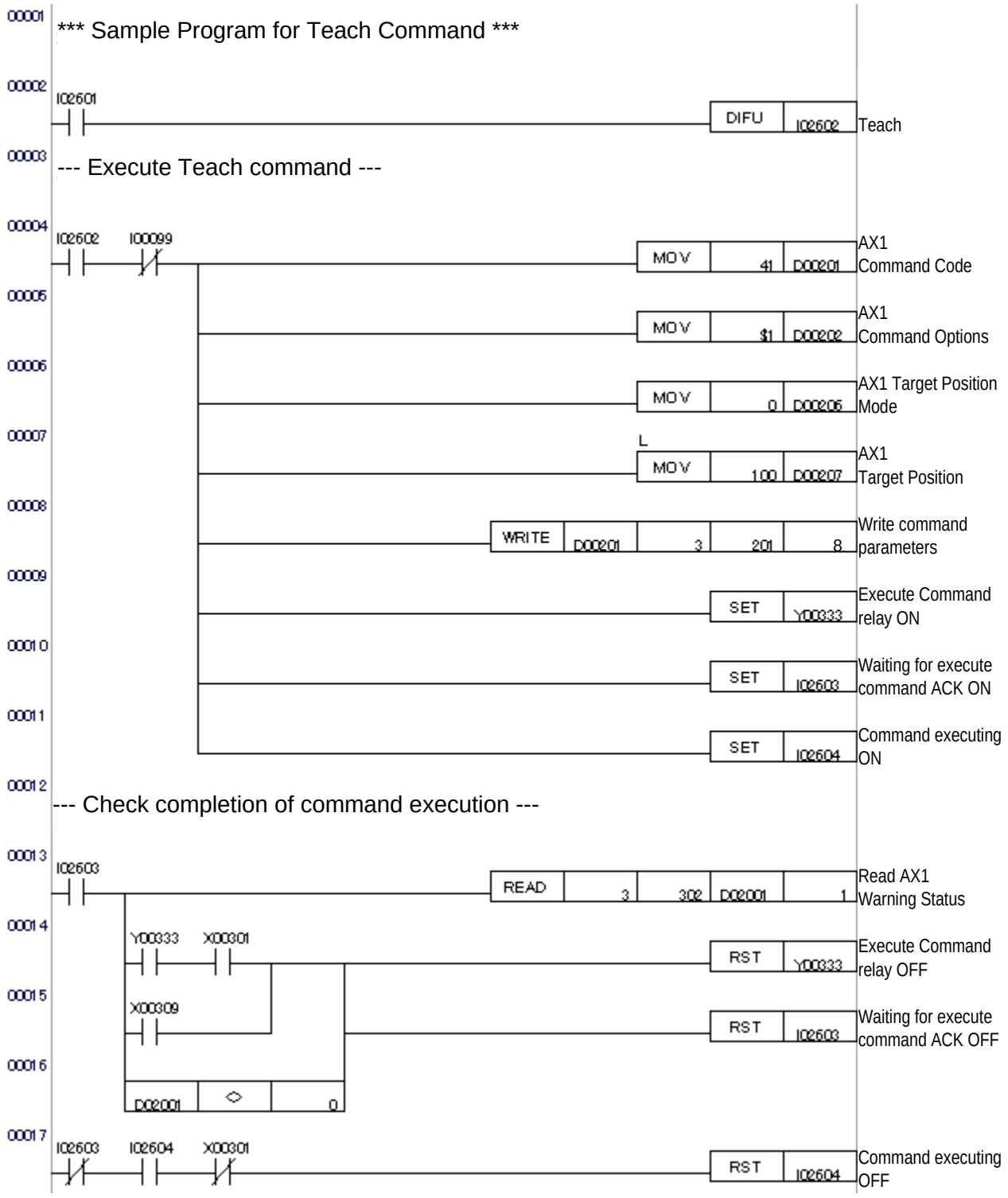


Figure 6.89 Teach Program

Timing Chart

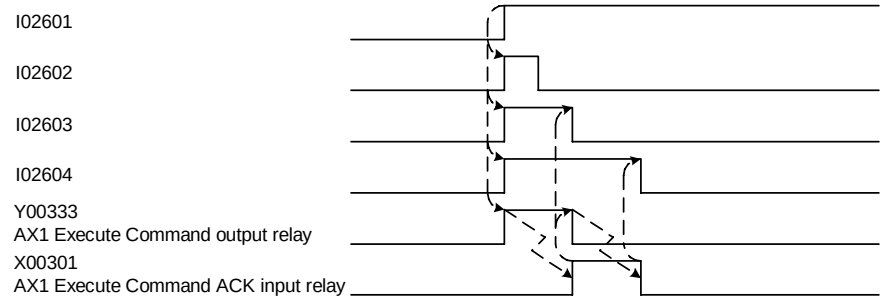


Figure 6.90 Timing Chart for Teach Program

6.17 Counter Functions

This section describes counter functions.

6.17.1 Set Counter Current Position

■ Function

This command changes the counter current position.

- The Set Counter Current Position command can also be used to write the current position value to the counter current position.

■ Execution Procedure

● Command Parameters Used

Table 6.79 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.79 Required Parameters of Set Counter Current Position Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	70: Set Counter Current Position	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0207 /0208	0507 /0508	0807 /0808	1107 /1108	Target Position	-2,147,483,648 to 2,147,483,647 (counter position reference unit)	△

● Command Options

Bit data stored in the Command Options parameter can be used to specify whether to write current position value or numeric data to the counter current position.

```
15 14 13 12 11 10  9  8  7  6  5  4  3  2  1  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  X
                                               |
                                               └ - Counter Current Position
                                                   (0: Current position; 1: Numeric data)
```

● Command Acceptance Conditions

Table 6.80 lists the pre-conditions for command execution.

Table 6.80 Command Acceptance Conditions for Set Counter Current Position Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
Counter is not used as manual pulse generator.		○
Counter is not used as Sanyo's Absolute encoder.		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '70: set counter current position' and required parameters to axis command parameter area of the command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- Changing the counter current position is not allowed if Counter Type Selection of axis registered parameters is set to '1: Sanyo Denki's Manchester Coding'.
  A warning will be generated when the Set Counter Current Position command is executed.
- If the Counter Index Control axis registered parameter is set to "1: Index control", the specified position value to be written should be between 0 (inclusive) and the Counter Index Range (position reference unit). Otherwise, a target position setup error will be generated. (Regardless of the Command Options value, a target position error is also generated when writing the current position value to the counter current position if the position value is out of range.)

■ Sample Program

● Description

This sample program changes the counter current position of axis 1 to 2,000,000 ($\times 10^{-4}$ mm) for a positioning module installed in slot 3.

● List of Devices

Table 6.81 lists the devices used.

Table 6.81 List of Devices Used in Sample Program for Set Counter Current Position Command

Device	Name	Data
D00201	AX1 Direct Command Code	70: Set Counter Current Position
D00202	AX1 Command Options	$0001 (write numeric data)
D00207/D00208	AX1 Target Position	2,000,000 (x 10^{-4} mm)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I03001	Set counter current position	
I03002	Set counter current position (differential up)	
I03003	Waiting for execute command ACK	
I03004	Command executing	

- **Sample Program**

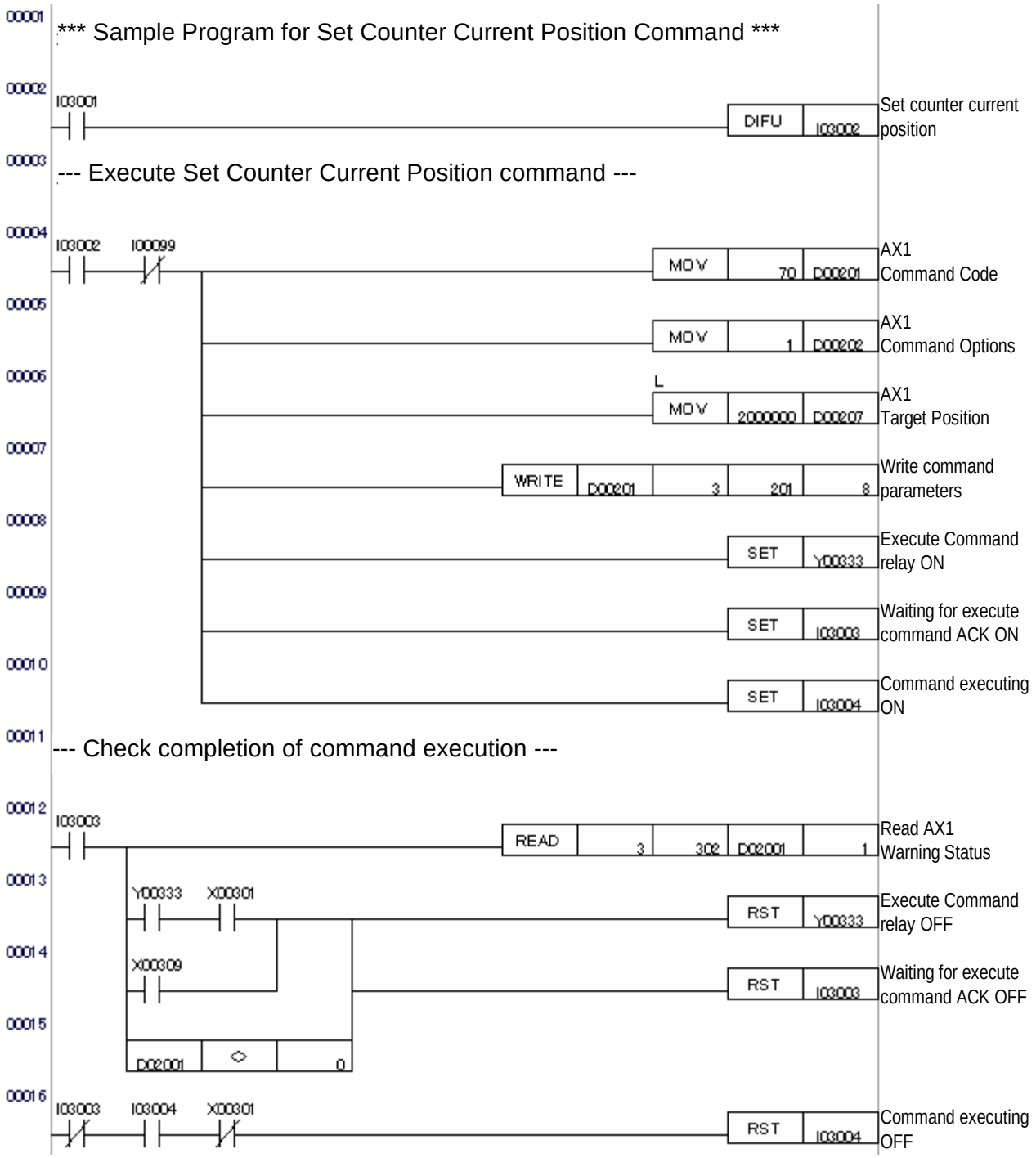


Figure 6.91 Set Counter Current Position Program

Timing Chart

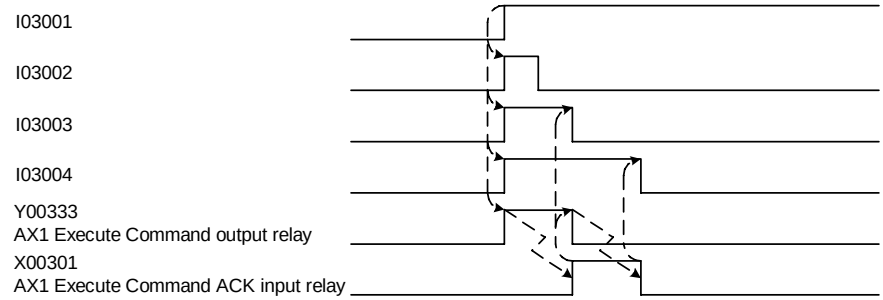


Figure 6.92 Timing Chart for Set Counter Current Position Program

6.17.2 Counter Setup

■ Function

This command sets up the Counter Usage Selection (counter coincidence or zone coincidence) and other counter-related parameters.

A counter can be configured to generate an event when the counter current position coincides with a preset value (counter coincidence) or falls within a preset range (zone coincidence). The event can be used to trigger a positioning action waiting to start or raise an interrupt signal to the CPU module.

- The Counter Setup command can be used to set or modify counter-related axis registered parameters, namely, Counter Usage Selection (counter coincidence or zone coincidence), Counter Coincidence Value, Counter Upper Limit and Counter Lower Limit.

● Counter Coincidence Detection

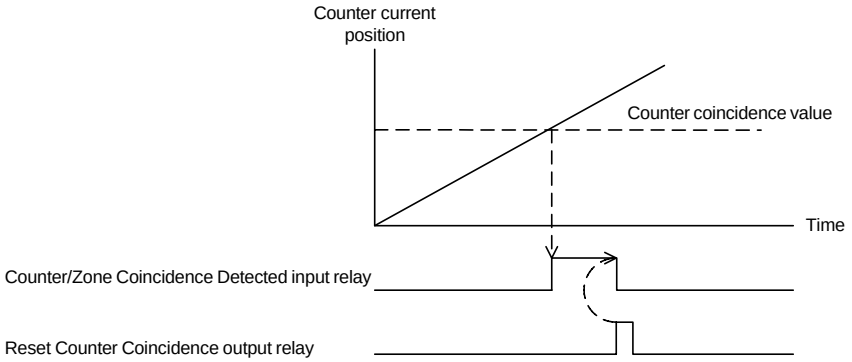


Figure 6.93 Counter Coincidence Detection Function

● Zone Coincidence Detection

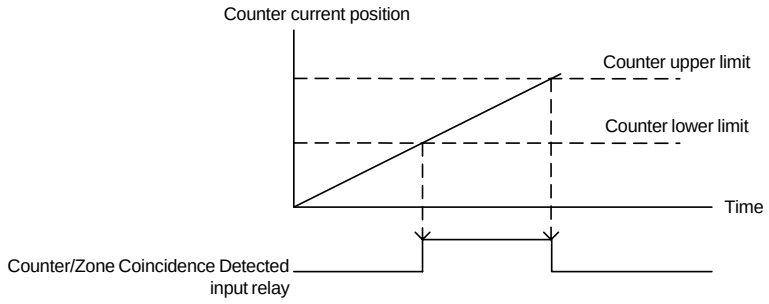


Figure 6.94 Zone Coincidence Detection Function

■ Execution Procedure

● Command Parameters Used

Table 6.82 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.82 Required Parameters of Counter Setup Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	71: Counter Setup	○
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	○
0235 /0236	0535 /0536	0835 /0836	1135 /1136	Counter Coincidence Value	-2,147,483,648 to 2,147,483,647 (Counter position reference unit)	○
0237 /0238	0537 /0538	0837 /0838	1137 /1138	Counter Upper Limit	-2,147,483,648 to 2,147,483,647 (Counter position reference unit)	○
0239 /0240	0539 /0540	0839 /0840	1139 /1140	Counter Lower Limit	-2,147,483,648 to (Counter Upper Limit) (Counter position reference unit)	○

● Command Options

Bit data stored in the Command Options parameter is used to specify the counter usage selection (counter coincidence or zone coincidence).

```
15 14 13 12 11 10 9  8  7  6  5  4  3  2  1  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  X
                                               |
                                               └ - Counter Usage Selection
                                                   (0: Counter coincidence; 1: Zone coincidence)
```

● Command Acceptance Conditions

Table 6.83 lists the pre-conditions for command execution.

Table 6.83 Command Acceptance Conditions for Counter Setup Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '71: counter setup' and required parameters to axis command parameter area of execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

(4) If counter usage is specified as counter coincidence, the Counter/Zone Coincidence Detected input relay of the axis turns on when the counter current position value coincides with the preset coincidence value. Turning on the Reset Counter Coincidence output relay turns off the Counter/Zone Coincidence Detected input relay.

- If counter usage is specified as zone coincidence, the Counter/Zone Coincidence Detected input relay of the axis turns on when the counter current position value falls within the preset range. When the counter current position goes beyond the preset range, the Counter/Zone Coincidence Detected input relay turns off.

■ Precautions

- The counter input of the positioning module is implemented by software, which operates with a maximum sampling period of 1 ms, resulting in a maximum possible delay of 1 ms.

■ Sample Program

● Description

This sample program sets up the counter of axis 1 for a positioning module installed in slot 3.

● List of Devices

Table 6.84 lists the devices used.

Table 6.84 List of Devices Used in Sample Program for Counter Setup Command

Device	Name	Data
D00201	AX1 Direct Command Code	71: Counter Setup
D00202	AX1 Command Options	$0000 (Counter coincidence)
D00235/D00236	AX1 Counter Coincidence Value	2,000,000 (x 10^{-4} mm)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I03101	Counter setup	
I03102	Counter setup (differential up)	
I03103	Waiting for execute command ACK	
I03104	Command executing	

- **Sample Program**

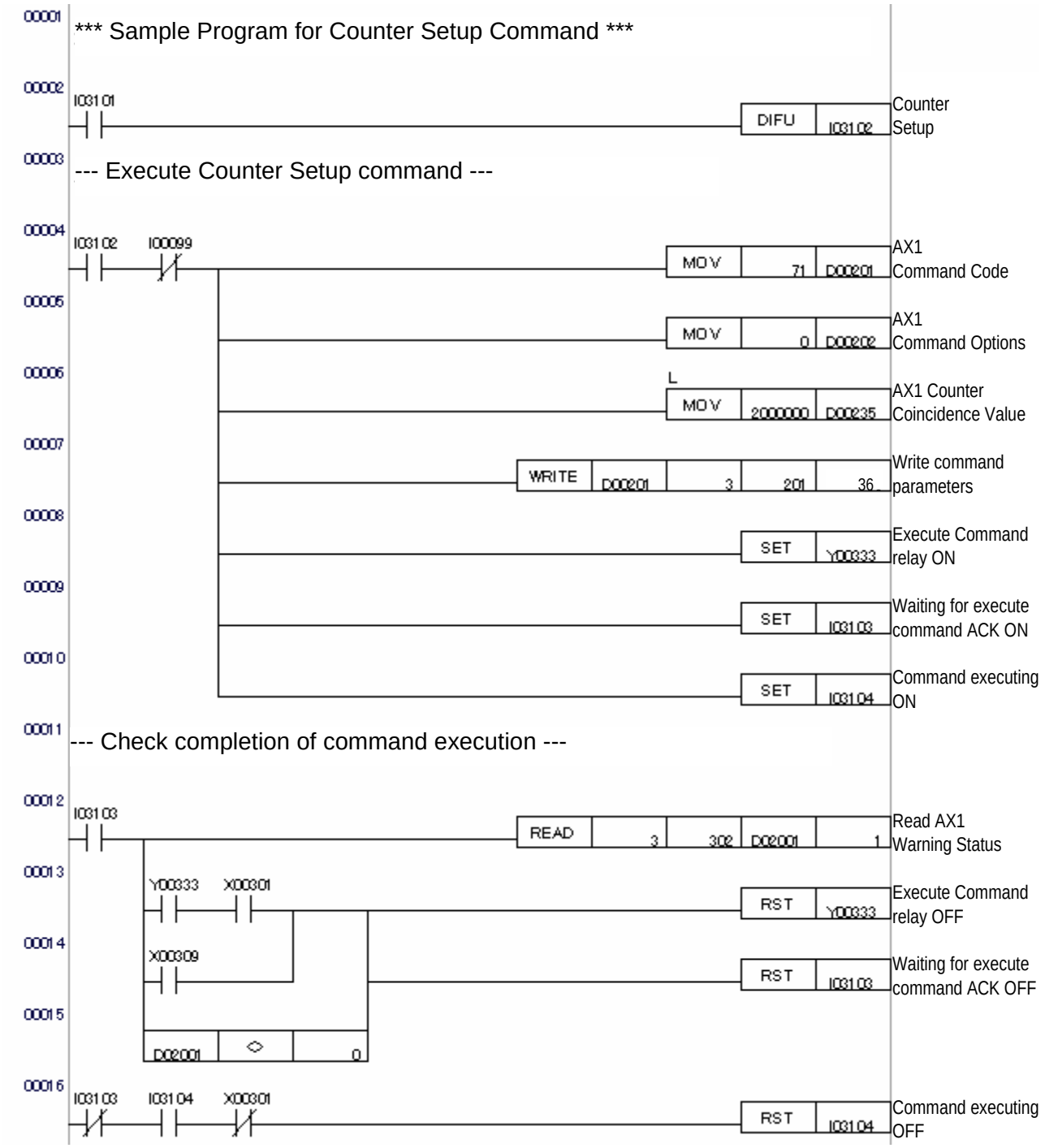


Figure 6.95 Counter Setup Program

Timing Chart

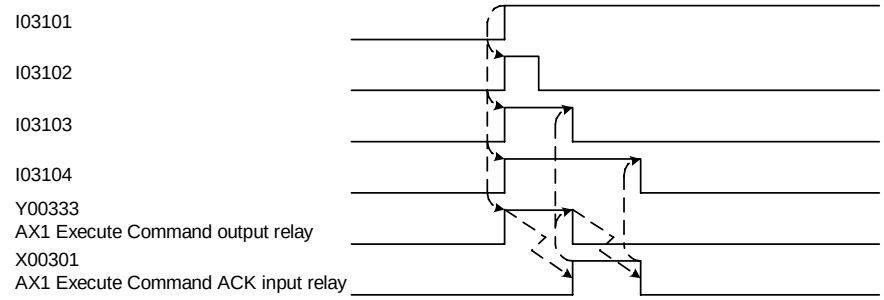


Figure 6.96 Timing Chart for Counter setup Program

6.17.3 Read Yaskawa ABS Encoder

■ Function

This command reads absolute data of a counter with Counter Type Selection of axis registered parameters set to '2: Yaskawa Electric's Serial'.

CAUTION

- Always execute the Read Yaskawa ABS Encoder command in Servo Off state. Executing the command in Servo On state may result in unexpected motor operation.
- For details on the transfer sequence of the absolute data and other precautions, read the instruction manual of the servo motor or servo package manufactured by Yaskawa Electric Corporation.

■ Execution Procedure

● Command Parameters Used

Table 6.85 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.85 Required Parameters of Read Yaskawa ABS Encoder Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	72: Read Yaskawa ABS Encoder	○

● Command Acceptance Conditions

Table 6.86 lists the pre-conditions for command execution.

Table 6.86 Command Acceptance Conditions for Read Yaskawa ABS Encoder Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
No axis error has been detected.		○
Not waiting for trigger		○

● Procedure

(1) Write Direct Command Code '72: Read Yaskawa ABS encoder' to axis command parameter area of command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.

- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- Always execute the Read Yaskawa ABS Encoder command in Servo Off state. Executing the command in Servo On state may result in unexpected motor operation.
- For details on the transfer sequence of the absolute data and other precautions, read the instruction manual of the servo motor/servo pack manufactured by Yaskawa Electric Corporation. (The manual also describes the timing of initial incremental pulses and rotation serial data, as well as other details.)
- Successful reading of absolute data takes about 500 ms.
- Initial incremental pulses are read for about several tens of milliseconds even after the Execute Command ACK input relay has turned on. (For details on actual time taken, read the instruction manual of the servo motor/servo pack manufactured by Yaskawa Electric Corporation.)

  The Execute Command ACK input relay turns on after rotation serial data is received.
- Executing the Read Yaskawa ABS Encoder command when the Counter Type Selection of axis registered parameters is not set to '2: Yaskawa Electric's Serial' generates an error.

■ Sample Program

● Description

This sample program reads absolute encoder data of axis 1 of a positioning module installed in slot 3.

● List of Devices

Table 6.87 lists the devices used.

Table 6.87 List of Devices Used in Sample Program for Read Yaskawa ABS Encoder Command

Device	Name	Data
D00201	AX1 Direct Command Code	72: Read Yaskawa ABS Encoder
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I03201	Read Yaskawa ABS encoder	
I03202	Read Yaskawa ABS encoder (differential up)	
I03203	Waiting for execute command ACK	
I03204	Command executing	

- **Sample Program**

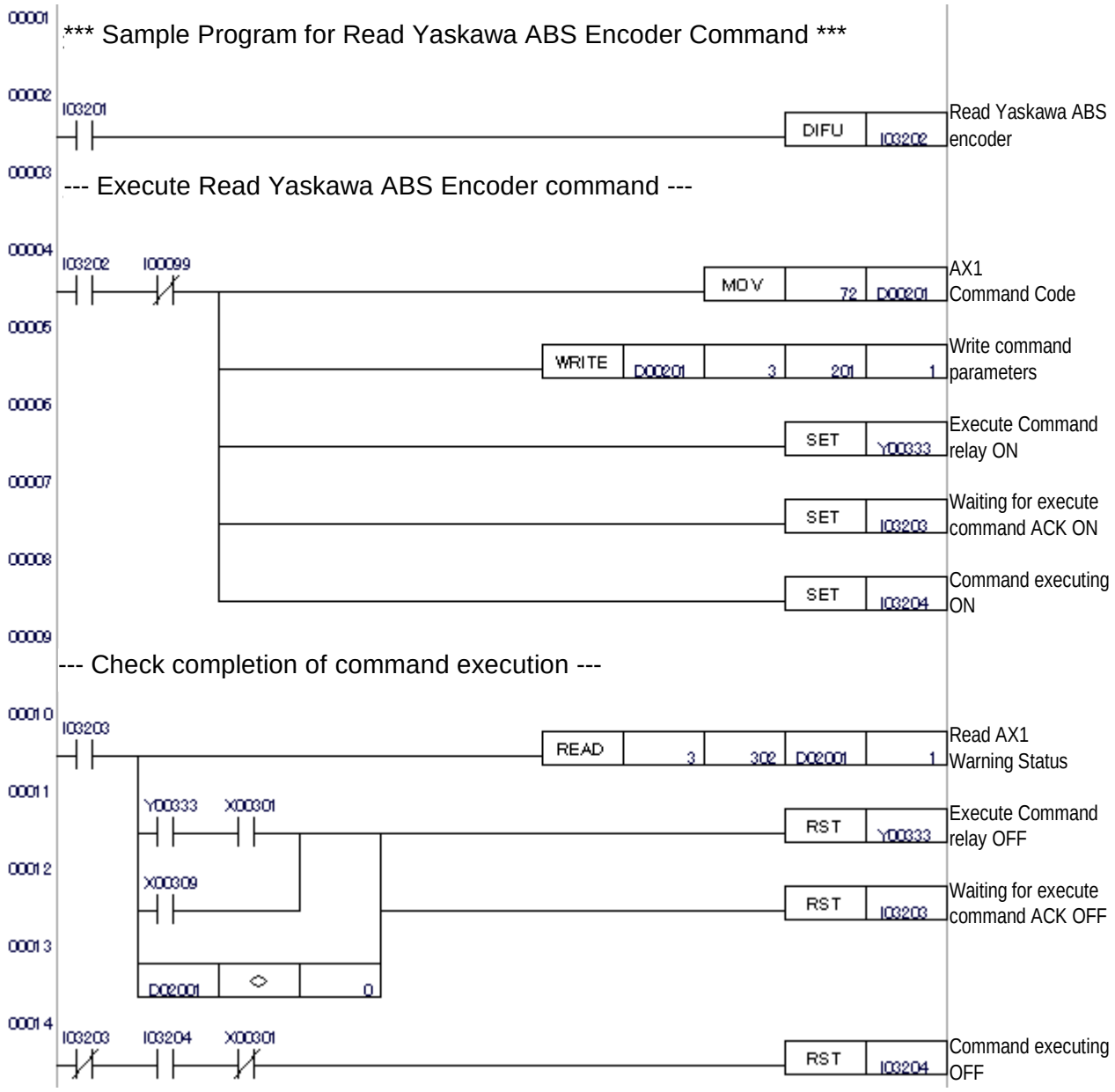


Figure 6.97 Read Yaskawa ABS Encoder Program

- **Timing Chart**

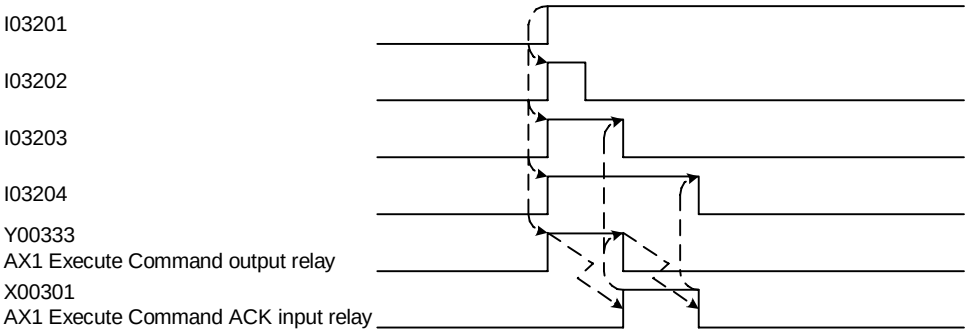


Figure 6.98 Timing Chart for Read Yaskawa ABS Encoder Program

6.18 Contact Outputs On/Off

■ Function

This command turns on or turns off selected external contact outputs configured as '1: Used As General I/O' by Contact Usage Selection of axis registered parameters.

■ Execution Procedure

● Command Parameters Used

Table 6.88 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

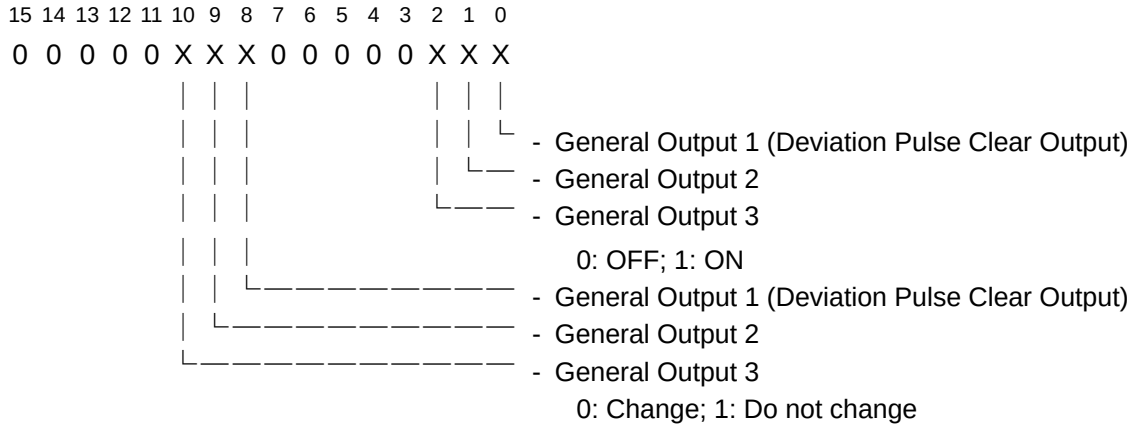
▲: Parameters that may require setup depending on other parameter values

Table 6.88 Required Parameters of Contact Outputs On/Off Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201	0501	0801	1101	Direct Command Code	23: Contact Outputs On/Off	○
0223	0523	0823	1123	Contact Output Setting	$0000 to $0707 (bit data)	○

● Contact Output Setting

Bit data in Contact Output Setting is used to specify whether to turn on or turn off an external contact output when executing a Contact Outputs On/Off command. One part of the bit data contains mask bits that indicate which general outputs are to be changed, while another part of the bit data indicates whether each bit to be changed is to be turned on or turned off.



● Command Acceptance Conditions

Table 6.89 lists the pre-conditions for command execution.

Table 6.89 Command Acceptance Conditions for Contact Outputs On/Off Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
Axis command parameters are valid.	○	
No axis error has been detected.		○
Not waiting for trigger		○

Procedure

(1) Write Direct Command Code '23: contact outputs on/off' and required parameters to axis command parameter area of command execution axis.

(2) Turn on the Execute Command output relay for the command axis.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- This command can only be used to turn on or turn off external contact outputs set to '1: Used As General Input/Output' by Contact Usage Selection of axis registered parameters. Attempting to manipulate an external contact set to '0: Used for Inherent Function' generates a contact output setup error when the command is executed.

■ Sample Program

Description

This sample program turns on General Output 3 of axis 1 for a positioning module installed in slot 3.

List of Devices

Table 6.90 lists the devices used.

Table 6.90 List of Devices Used in Sample Program for Contact Outputs On/Off Command

Device	Name	Data
D00201	AX1 Direct Command Code	23: Contact Outputs On/Off
D00223	AX1 Contact Output Setting	$0404 (turn on General Output 3)
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I03301	Contact outputs on/off	
I03302	Contact outputs on/off (differential up)	
I03303	Waiting for execute command ACK	
I03304	Command executing	

- **Sample Program**

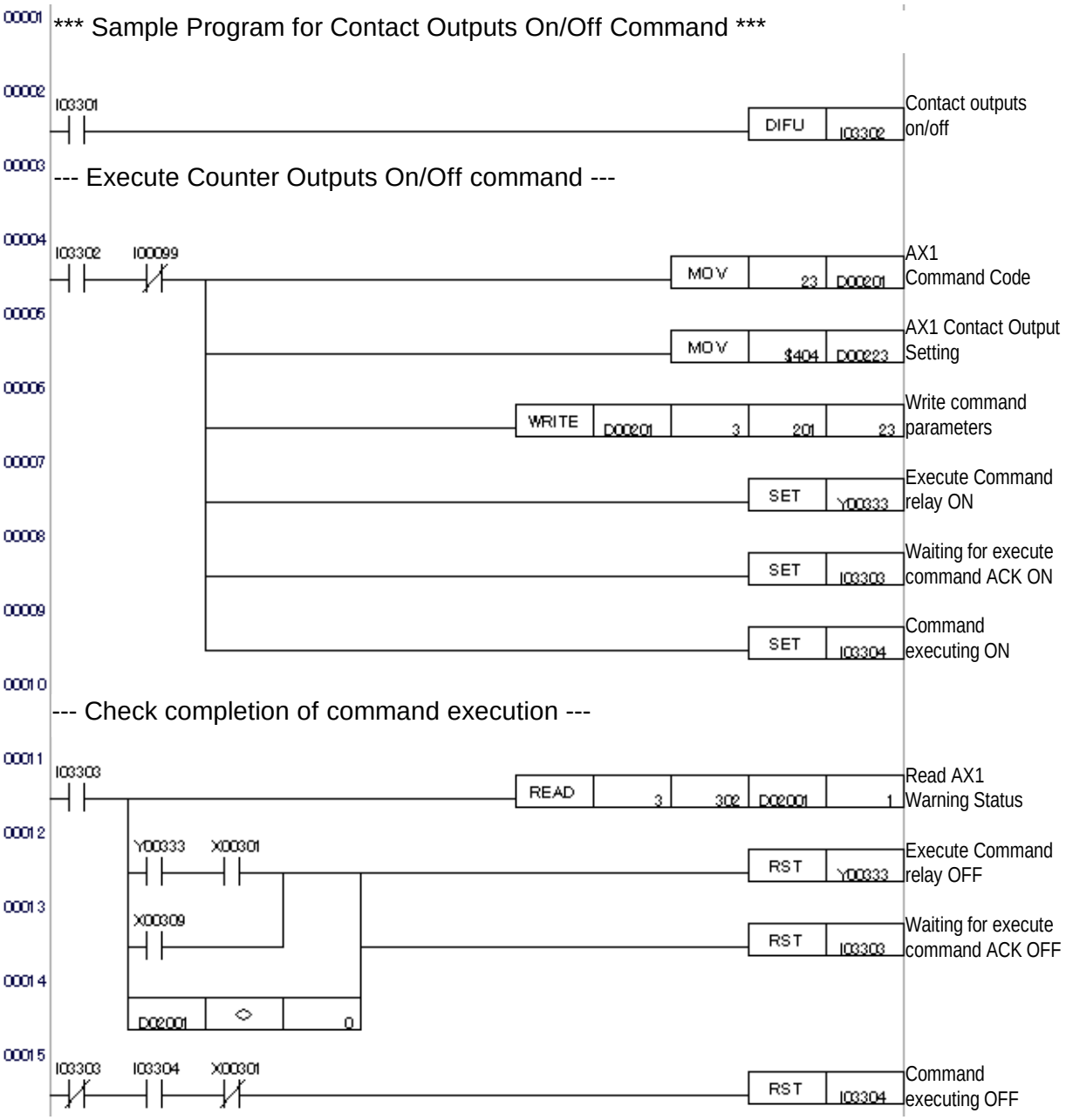


Figure 6.99 Contact Outputs On/Off Program

- **Timing Chart**

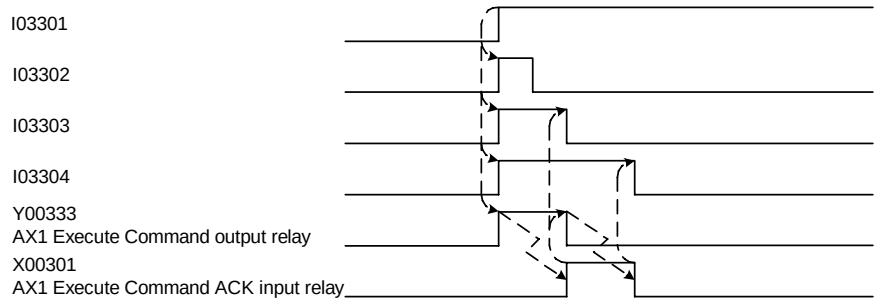


Figure 6.100 Timing Chart for Contact Outputs On/Off Program

6.19 Save to Flash Memory

■ Function

This command saves all registered parameters (axis registered parameters, pattern registered parameters, action pattern data table, position data table) to the flash memory in the module.

The Save to Flash Memory command can only be executed from axis 1.

- Content of the flash memory is loaded into the parameters at power up or system reset.

CAUTION

- Data saved in the flash memory will be lost if power is interrupted during parameter data saving.
- Do not save parameter data to the flash memory unnecessarily as there is a limit to the number of write operations to the flash memory (100,000 times).

■ Execution Procedure

● Command Parameters Used

Table 6.91 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.91 Required Parameters of Save to Flash Memory Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201				Direct Command Code	32: Save to Flash Memory	○

● Command Acceptance Conditions

Table 6.92 lists the pre-conditions for command execution.

Table 6.92 Command Acceptance Conditions for Save to Flash Memory Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
No axis error has been detected on any axis.		○
All axes are in Positioning Completed state		○
No axis is waiting for a trigger.		○
No pattern operation is in progress.		○
No pattern error has been detected for any pattern operation.		○

● Procedure

(1) Write Direct Command Code '32: save to flash memory' to axis command parameter area of axis 1.

(2) Turn on the Execute Command output relay for axis 1.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- The Save to Flash Memory command can only be executed from axis 1. Executing the command from any other axis generates an error when the command is executed.

■ Sample Program

● Description

This sample program saves all parameters to the flash memory of a positioning module installed in slot 3.

● List of Devices

Table 6.93 lists the devices used.

Table 6.93 List of Devices Used in Sample Program for Save to Flash Memory Command

Device	Name	Data
D00201	AX1 Direct Command Code	32: Save to Flash Memory
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I03401	Save to flash memory	
I03402	Save to flash memory (differential up)	
I03403	Waiting for execute command ACK	
I03404	Command executing	

- **Sample Program**

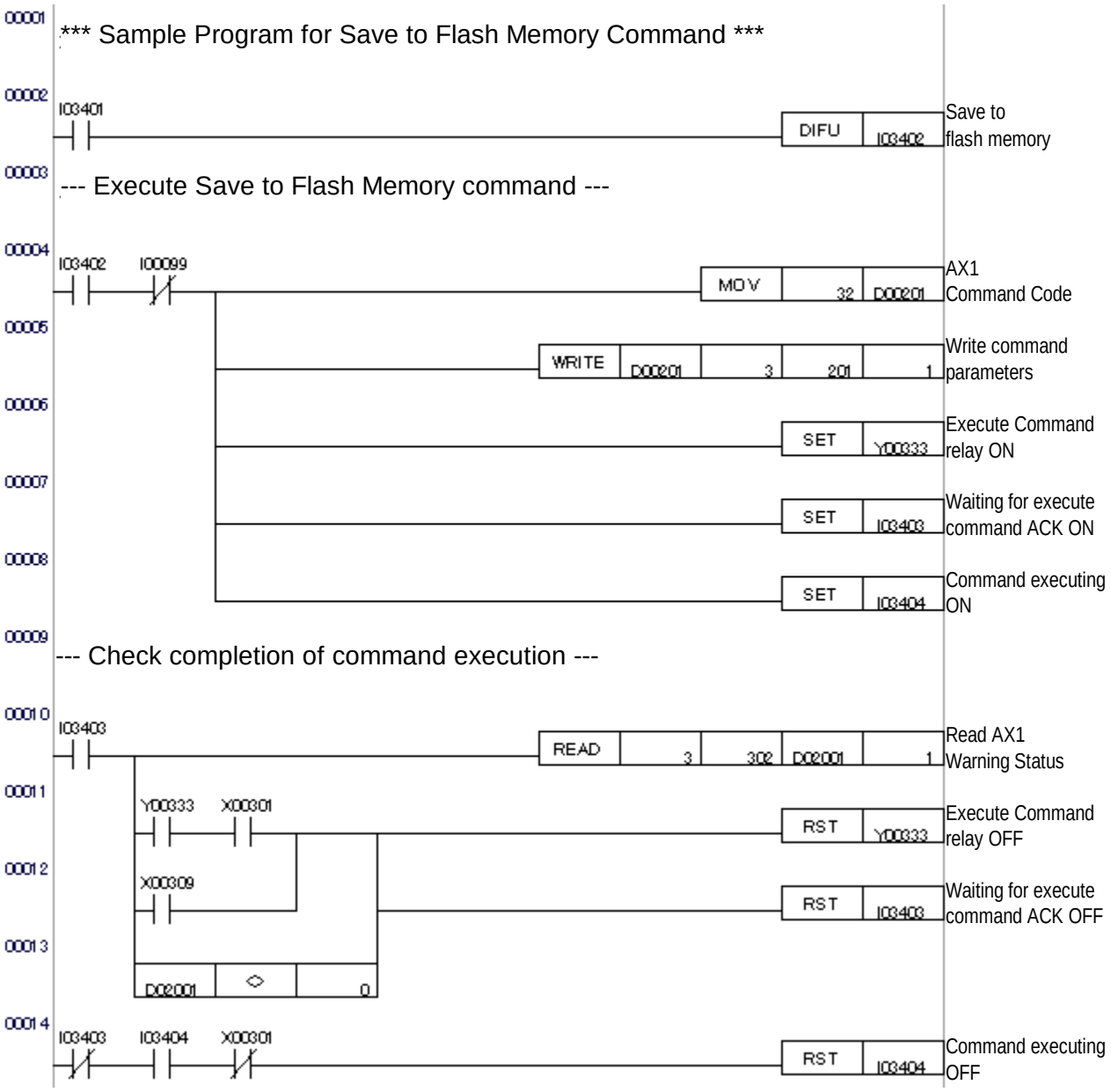


Figure 6.101 Save to Flash Memory Program

- **Timing Chart**

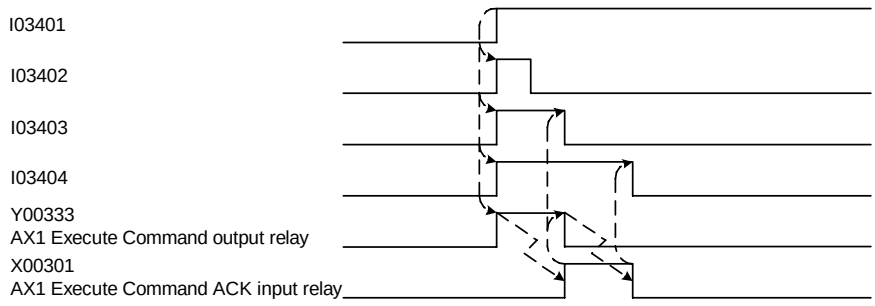


Figure 6.102 Timing Chart for Save to Flash Memory Program

6.20 Initialize Flash Memory

■ Function

This command initializes all registered parameter data (axis registered parameters, pattern registered parameters, action pattern data table, position data table) stored in the flash memory to their factory settings.

The Initialize Flash Memory command can only be executed from axis 1.

CAUTION

- Do not turn off the power during initialization of the flash memory.
- Do not initialize parameter data in the flash memory unnecessarily as there is a limit to the number of write operations to the flash memory (100,000 times).

■ Execution Procedure

● Command Parameters Used

Table 6.94 lists required parameters that must be set.

◎: Parameters that must be set not only for the command axis but also for other axes involved in the movement (e.g. interpolation axes for interpolation commands)

○: Parameters that must be set

△: Parameters that may be set as required (normally set to 0 or –1)

▲: Parameters that may require setup depending on other parameter values

Table 6.94 Required Parameters of Initialize Flash Memory Command

Data Position No.				Parameter Name	Data	Setup
AX1	AX2	AX3	AX4			
0201				Direct Command Code	33: Initialize Flash Memory	○

● Command Acceptance Conditions

Table 6.95 lists the pre-conditions for command execution.

Table 6.95 Command Acceptance Conditions for Initialize Flash Memory Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another direct command is in progress.		
All axes are in Positioning Completed state		○
No axis is waiting for a trigger.		○
No pattern operation is in progress.		○
ToolBox is not performing an action test		○

● Procedure

(1) Write Direct Command Code '33: initialize flash memory' to axis command parameter area of axis 1.

(2) Turn on the Execute Command output relay for axis 1.

(3) If command execution is successful, the corresponding Execute Command ACK input relay turns on. Turn off the Execute Command output relay after confirming that the Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Execute Command ACK input relay does not turn on. Instead, the Error Detected input relay turns on, and an error code is stored in Error Status of axis statuses.
- If any command acceptance condition is not satisfied, the Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Warning Status of axis statuses. Turning off the Execute Command output relay clears the warning code.

■ Precautions

- The Initialize Flash Memory command can only be executed from axis 1. Executing the command from any other axis generates an error when the command is executed.
- The state of the module after flash memory initialization is the same as the state when the module is first powered on with factory settings.

■ Sample Program

● Description

This sample program initializes the flash memory of a positioning module installed in slot 3.

● List of Devices

Table 6.96 lists the devices used.

Table 6.96 List of Devices Used in Sample Program for Initialize Flash Memory Command

Device	Name	Data
D00201	AX1 Direct Command Code	33: Initialize Flash Memory
D02001	AX1 Warning Status	
Y00333	AX1 Execute Command output relay	
X00301	AX1 Execute Command ACK input relay	
X00309	AX1 Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I03501	Initialize flash memory	
I03502	Initialize flash memory (differential up)	
I03503	Waiting for execute command ACK	
I03504	Command executing	

- **Sample Program**

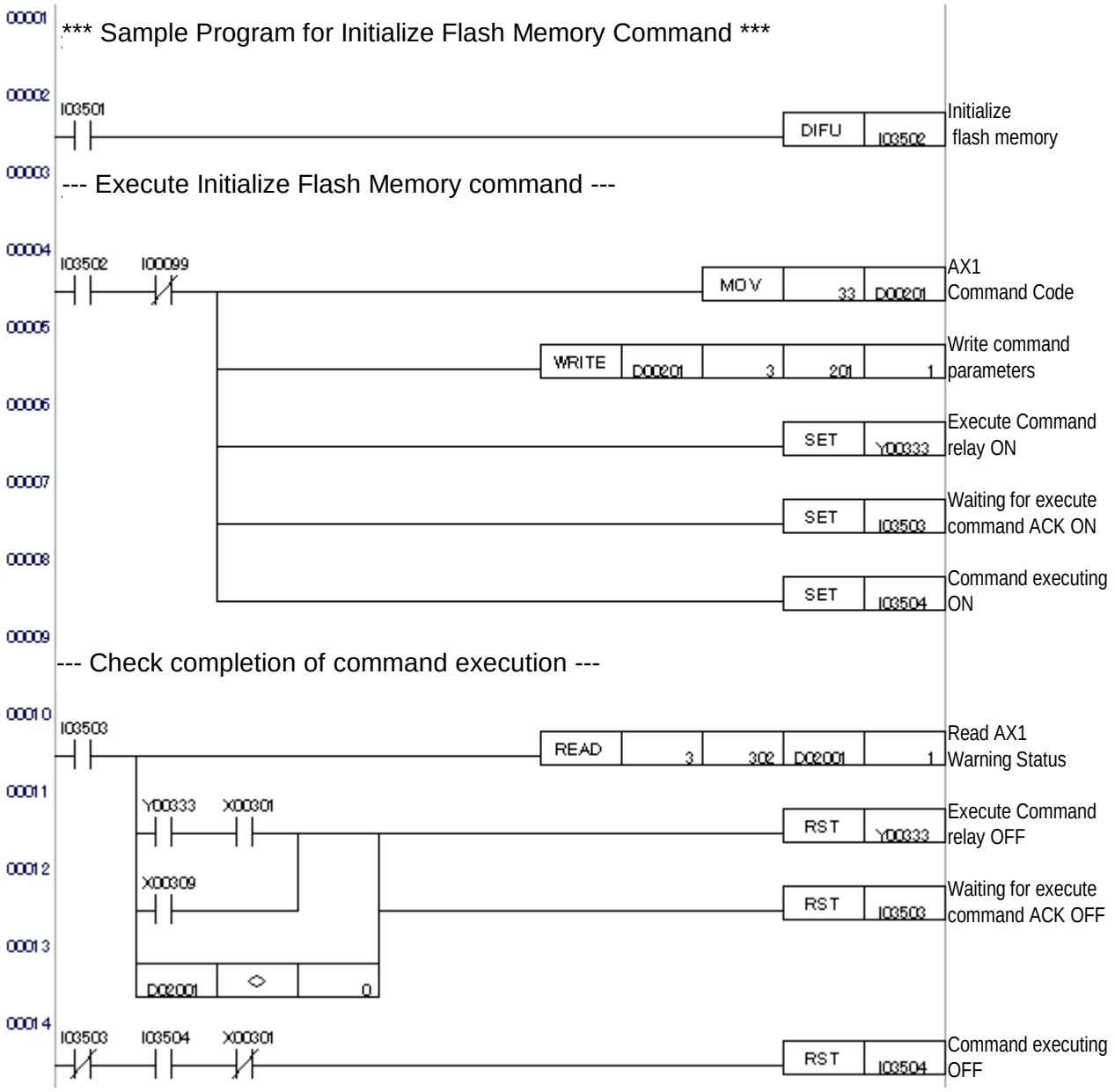


Figure 6.103 Initialize Flash Memory Program

- **Timing Chart**

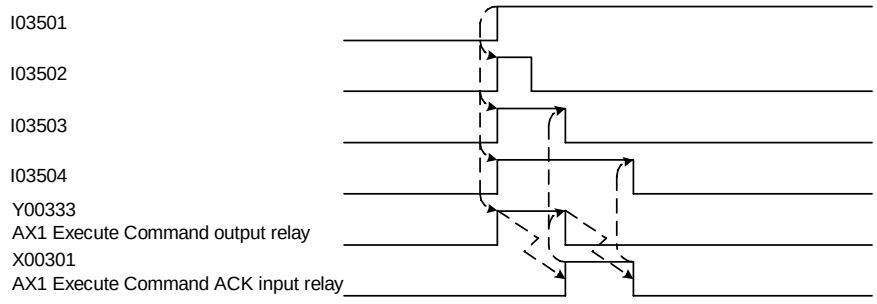


Figure 6.104 Timing Chart for Initialize Flash Memory Program

7. Pattern Operation Programming

In pattern operation, the positioning module performs positioning according to action pattern data (action pattern tables and position data table), pre-created and stored using the ToolBox for Positioning Modules software (SF662-ECW). In pattern operation mode, positioning can be initiated simply by specifying an action pattern from the CPU module. Up to two and four action patterns can be executed concurrently for F3NC32-0N and F3NC34-0N modules respectively.

This chapter describes pattern operation commands: their functions, method of execution, precautions and sample programs.

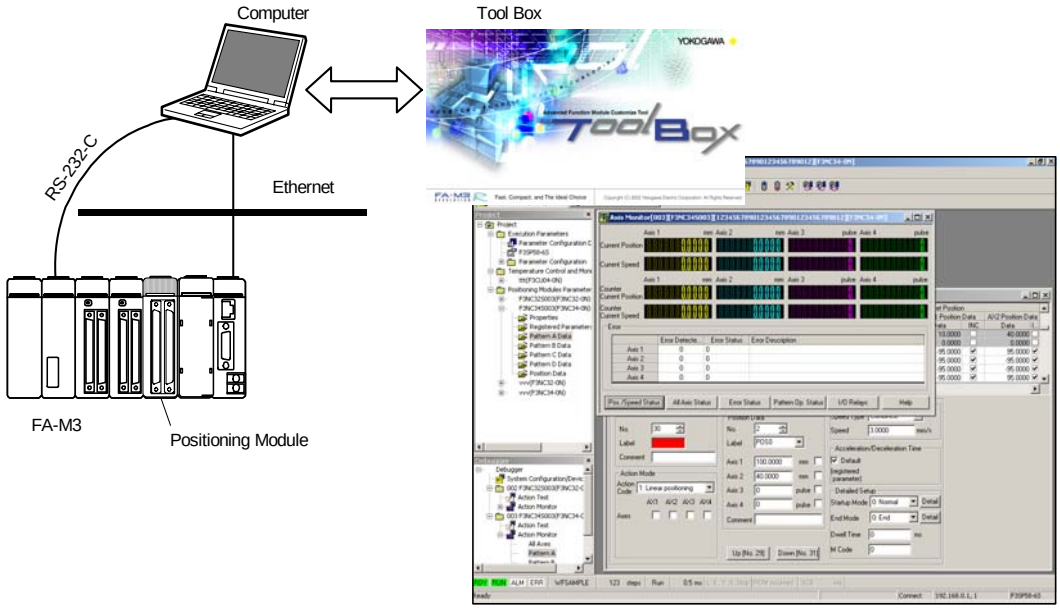


Figure 7.1 ToolBox for Positioning Modules (SF662-ECW)

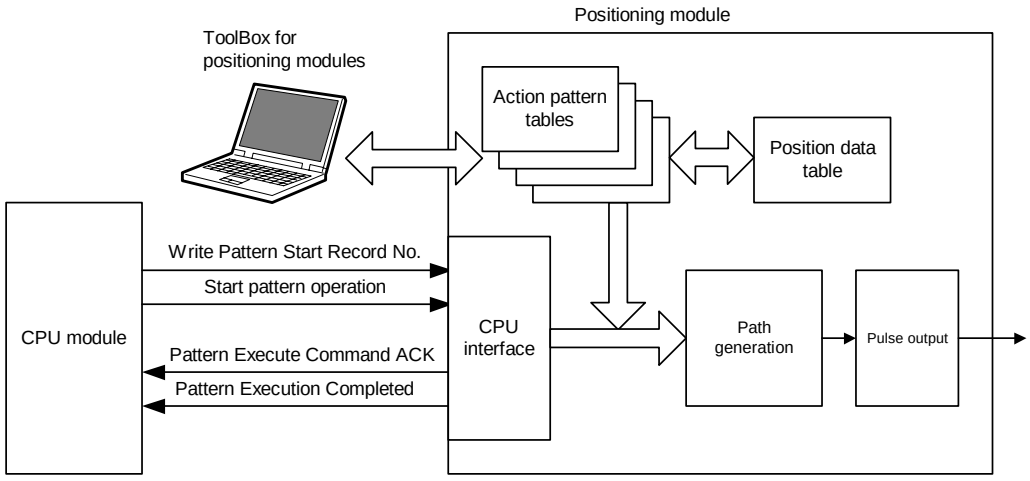


Figure 7.2 Pattern Operation

7.1 Operation Procedure

Figure 7.3 shows the operation procedure flowchart for pattern operation.

For details on how to set up action pattern data using the ToolBox for Positioning Modules software (SF662-ECW), see Chapter 8.

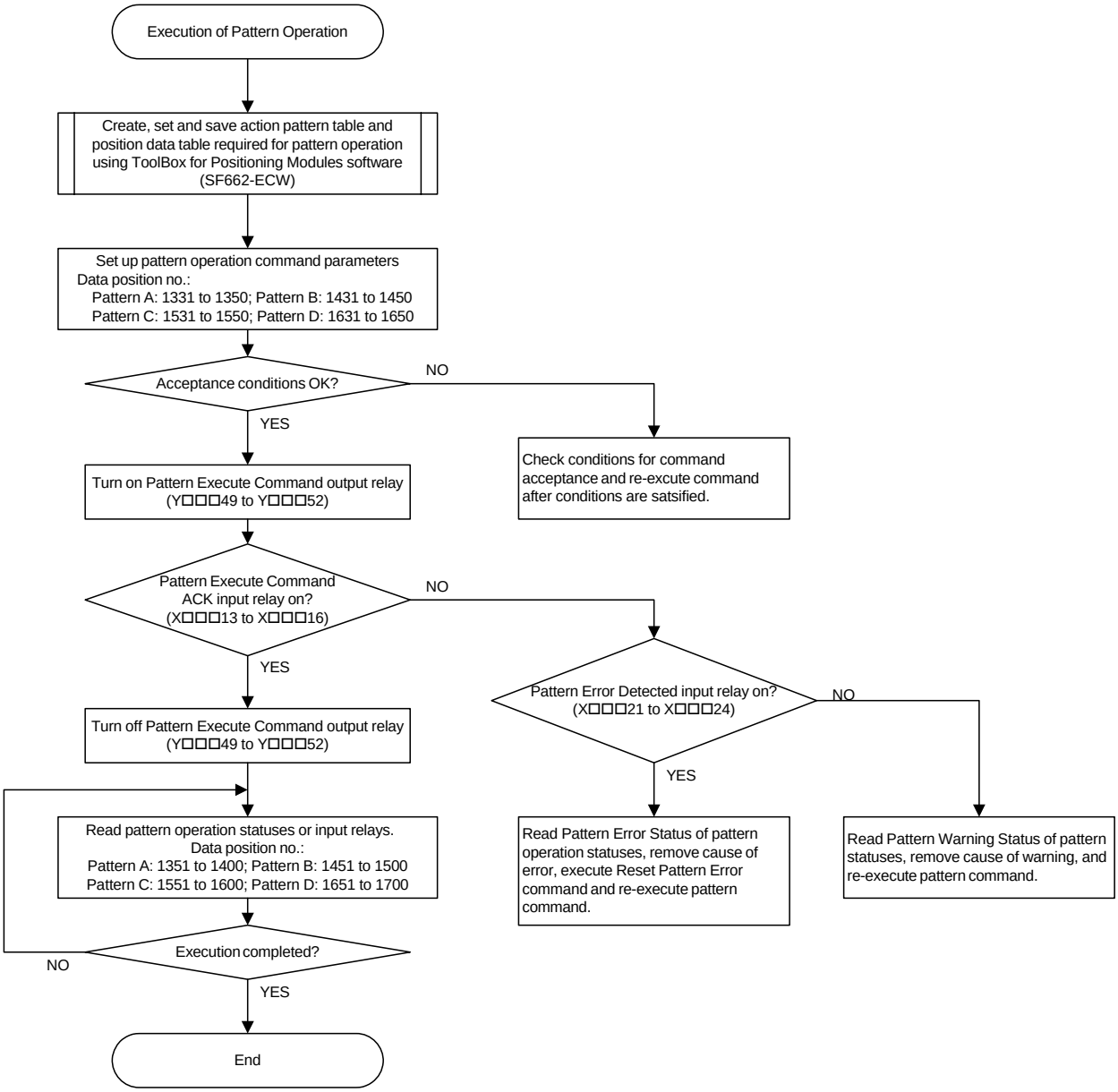


Figure 7.3 Operation Flow for Pattern Operation

7.2 Pattern Commands

7.2.1 List of Pattern Commands

Table 7.1 lists the pattern commands provided by the positioning module. For details on these commands, see sections 7.3 to 7.10.

Table 7.1 List of Pattern Commands

Command Code	Command Name	Function	See Also
5	Set Pattern Registered Parameters	Sets pattern registered parameters.	7-4
4	Reset Pattern Error	Clears error status of pattern operation.	7-8
0	Start Pattern Operation	Executes pattern.	7-11
1	Restart Pattern Operation	Restarts a pattern operation that was stopped by a Decelerate command.	7-15
3	Pattern Operation Test	Executes action pattern records between a specified Pattern Start Record No and a specified Pattern End Record No.	7-19
2	Decelerate and Stop Pattern Operation	Decelerates and stops pattern operation.	7-24
–	Stop Pattern Operation Immediately	Stops pattern operation immediately.	7-28
6	Set Pattern Override	Changes override value for pattern operation.	7-30

7.2.2 Required Parameters of Pattern Commands

Before executing a pattern command from the CPU module, you need to first set up required pattern command parameters.

Table 7.2 Required Parameters of Pattern Commands

Parameter Name	Pattern Commands							
	Set Pattern Registered Parameters	Reset Pattern Error	Start Pattern Operation	Restart Pattern Operation	Pattern Operation Test	Decelerate and Stop Pattern Operation	Stop Pattern Operation Immediately	Set Pattern Override
Pattern Command Code	5*1	4	0	1	3	2		6
Pattern Preset Override Value								○
Pattern Start Record No.			○		○			
Pattern End Record No.					○			

*1: Parameters are to be set in the pattern registered parameter area.

7.3 Set Pattern Registered Parameters

■ Function

This command sets pattern registered parameters.

You can also set pattern registered parameters using the Toolbox for Positioning Modules software (SF662-ECW).

■ Execution Procedure

● Command Parameters Used

Table 7.3 shows required parameters that must be set.

Table 7.3 Required Parameters of Set Pattern Registered Parameters Command

Data Position No.				Parameter Name	Data
Pattern A	Pattern B	Pattern C	Pattern D		
1331	1431	1531	1631	Pattern Command Code	5: Set Pattern Registered Parameters
1301 to 1330	1401 to 1430	15301 to 1530	1601 to 1630	Pattern Registered Parameters	See Section 5.2.5, "Pattern Registered Parameters" on how to set these parameters.

● Command Acceptance Conditions

Table 7.4 lists the pre-conditions for command execution.

Table 7.4 Command Acceptance Conditions for Set Pattern Registered Parameters Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another pattern command is in progress.		
Pattern registered parameters are valid.	○	
No pattern error has been detected. (except for error caused by Set Pattern Registered Parameters command)		○
In Pattern Execution Completed state		○

● Procedure

(1) Set up pattern registered parameters, and write Pattern Command Code '5: set pattern registered parameters' to pattern command parameter area of pattern to be executed.

(2) Turn on the Pattern Execute Command output relay for the pattern to be executed.

(3) If command execution is successful, the corresponding Pattern Execute Command ACK input relay turns on. Turn off the Pattern Execute Command output relay after confirming that the Pattern Execute Command ACK input relay has turned on.

- If registered parameter data is invalid, the Pattern Execute Command ACK input relay does not turn on. Instead, the Pattern Error Detected input relay turns on, and an error code is stored in Pattern Error Status of pattern operation statuses.
- If any command acceptance condition is not satisfied, the Pattern Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Pattern Warning Status of pattern operation statuses. Turning off the Pattern Execute Command output relay clears the warning code.

■ Precautions

- Pattern registered parameter data set using the Set Pattern Registered Parameters command are cleared at power off. Execute the Save to Flash Memory command to save parameter data if required.
- The Reset Pattern Error command cannot be used to reset a pattern registered parameter setup error generated during execution of a Set Pattern Registered Parameters command. To reset such an error, re-execute the Set Pattern Registered Parameters command with valid parameter data.

■ Sample Program

● Description

This sample program sets pattern registered parameters of pattern A for a positioning module installed in slot 3.

● List of Devices

Table 7.5 lists the devices used.

Table 7.5 List of Devices Used in Sample Program for Set Pattern Registered Parameters Command

Device	Name	Data
D01301 to D01304	Pattern A Registered Parameters	Set up data in this area before executing the Set Pattern Registered Parameters command.
D01331	Pattern A Command Code	5: Set Pattern Registered Parameters
D02002	Pattern A Warning Status	
Y00349	Pattern A Execute Command output relay	
X00313	Pattern A Execute Command ACK input relay	
I00099	Command execution disable (to be set elsewhere)	
I04001	Set pattern registered parameters	
I04002	Set pattern registered parameters (differential up)	
I04003	Waiting for execute command ACK	
I04004	Command executing	

- **Sample Program**

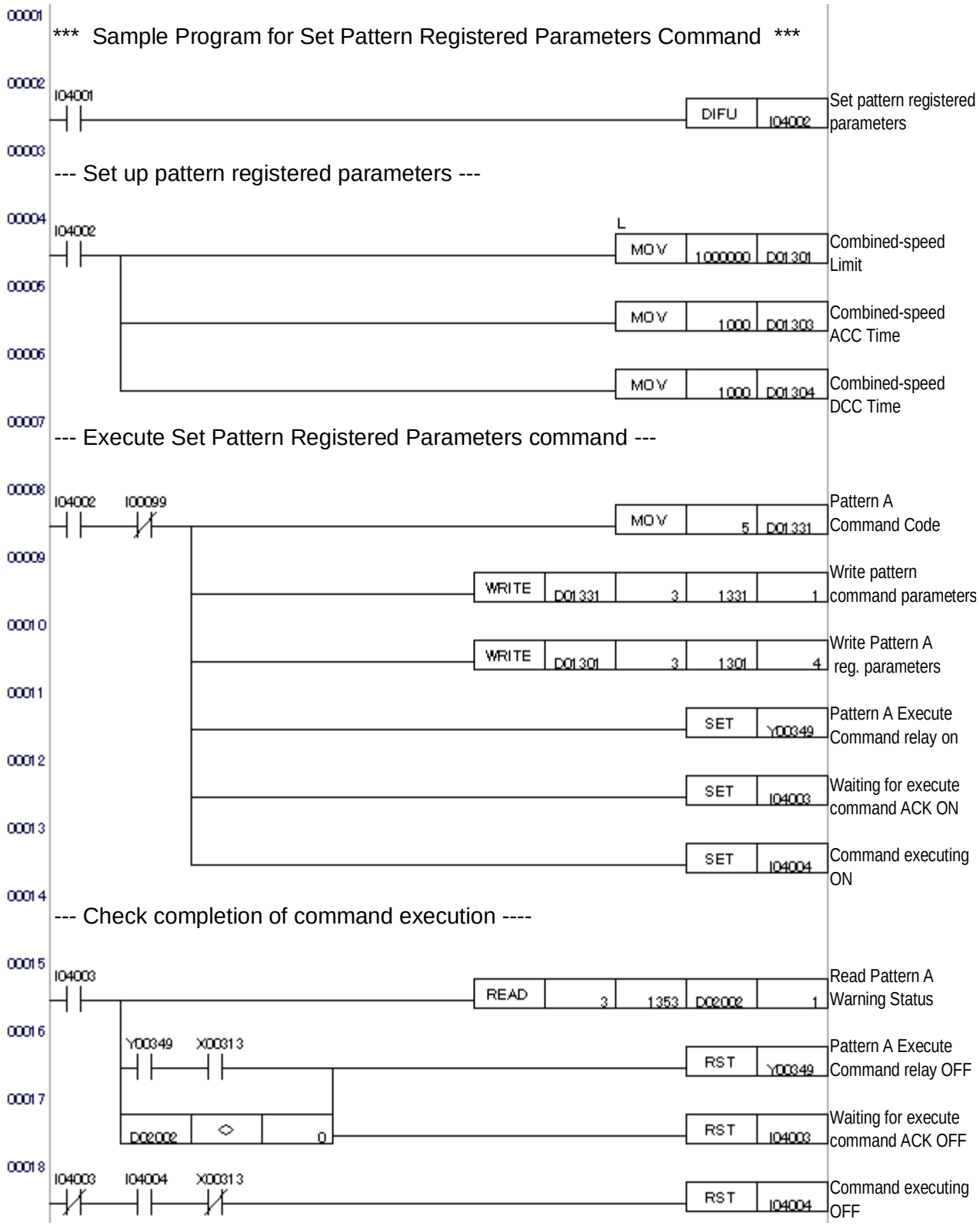


Figure 7.4 Set Pattern Registered Parameters Program

Timing Chart

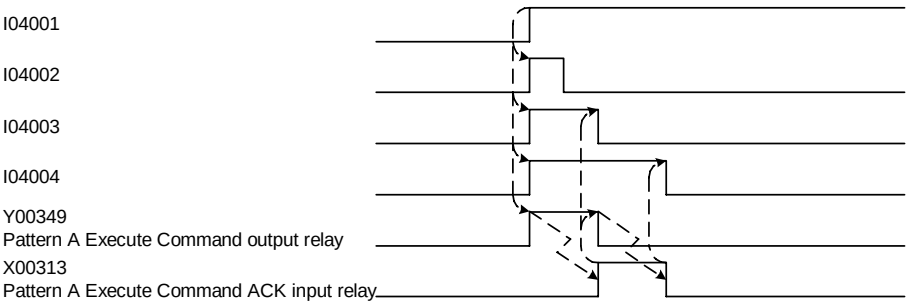


Figure 7.5 Timing Chart for Set Pattern Registered Parameters Program

7.4 Reset Pattern Error

■ Function

This command clears error status in pattern operation (state whereby Pattern Error Detected relay is on). It cannot be used, however, to clear a pattern registered parameter setup error.

■ Execution Procedure

● Command Parameters Used

Table 7.6 shows required parameters that must be set.

Table 7.6 Required Parameters of Reset Pattern Error Command

Data Position No.				Parameter Name	Data
Pattern A	Pattern B	Pattern C	Pattern D		
1331	1431	1531	1631	Pattern Command Code	4: Reset Pattern Error

● Command Acceptance Conditions

Table 7.7 lists the pre-conditions for command execution.

Table 7.7 Command Acceptance Conditions for Reset Pattern Error Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another pattern command is in progress.		
A pattern error has been detected. (except pattern registered parameters setup error)		○

● Procedure

(1) Write Pattern Command Code '4: reset pattern error' to pattern command parameter area of pattern to be executed.

(2) Turn on the Pattern Execute Command output relay for the pattern to be executed.

(3) If command execution is successful, the corresponding Pattern Execute Command ACK input relay turns on. Turn off the Pattern Execute Command output relay after confirming that the Pattern Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Pattern Execute Command ACK input relay does not turn on. Instead, the Pattern Error Detected input relay turns on, and an error code is stored in Pattern Error Status of pattern operation statuses.
- If any command acceptance condition is not satisfied, the Pattern Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Pattern Warning Status of pattern operation statuses. Turning off the Pattern Execute Command output relay clears the warning code.

■ Precautions

- Only two commands can be executed when a pattern is in error state (Pattern Error Detected input relay is on), namely, Reset Pattern Error command and Set Pattern Registered Parameters command.
- The Reset Pattern Error command cannot be used to clear a pattern registered parameter setup error generated during execution of a Set Pattern Registered Parameters command. To clear such an error, re-execute the Set Pattern Registered Parameters command with valid parameter data.

■ Sample Program

● Description

This sample program clears pattern error of pattern A for a positioning module installed in slot 3.

● List of Devices

Table 7.8 lists the devices used.

Table 7.8 List of Devices Used in Sample Program for Reset Pattern Error Command

Device	Name	Data
D01331	Pattern A Command Code	4: Reset Pattern Error
D02002	Pattern A Warning Status	
Y00349	Pattern A Execute Command output relay	
X00313	Pattern A Execute Command ACK input relay	
I00099	Command execution disable (to be set elsewhere)	
I04101	Reset pattern error	
I04102	Reset pattern error (differential up)	
I04103	Waiting for execute command ACK	
I04104	Command executing	

- **Sample Program**

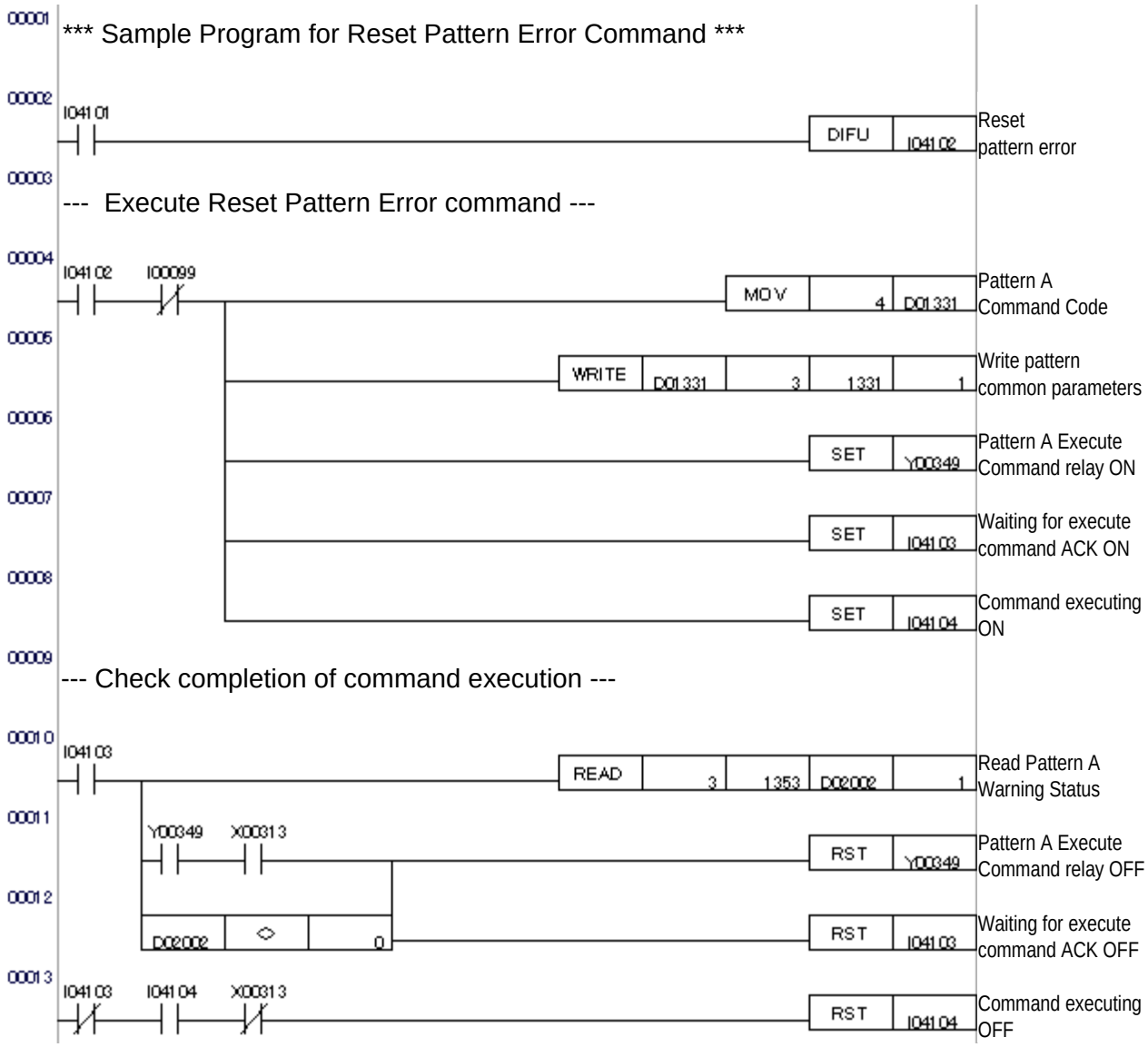


Figure 7.6 Reset Pattern Error Program

- **Timing Chart**

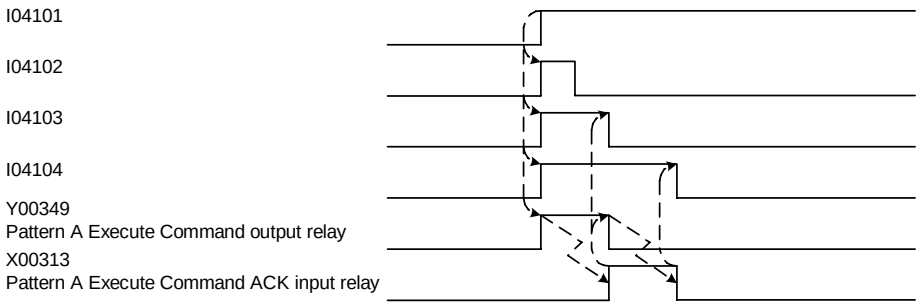


Figure 7.7 Timing Chart for Reset Pattern Error Program

7.5 Start Pattern Operation

■ Function

This command executes a pattern using an action pattern table and position data table preset in the positioning module, starting from a specified Pattern Start Record No.

Pattern execution continues until an action pattern with End Code value '0: End' is executed, a Decelerate and Stop Pattern Operation command is executed, or the Pattern Stop Immediately output relay is turned from off to on.

CAUTION

Operation is stopped immediately if any error (e.g. pattern setup error) is encountered during pattern operation. We recommend performing initial testing at low speeds using a Set Pattern Override command.

■ Execution Procedure

● Command Parameters Used

Table 7.9 shows required parameters that must be set.

Table 7.9 Required Parameters of Start Pattern Operation Command

Data Position No.				Parameter Name	Data
Pattern A	Pattern B	Pattern C	Pattern D		
1331	1431	1531	1631	Pattern Command Code	0: Start Pattern Operation
1332	1432	1532	1632	(System reserved)	Do not write any non-zero value.
1334	1434	1534	1634	Pattern Start Record No.	1 to No of Pattern Data Records Used defined (500 max.)

● Command Acceptance Conditions

Table 7.10 lists the pre-conditions for command execution.

Table 7.10 Command Acceptance Conditions for Start Pattern Operation Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another pattern command is in progress.		
Pattern command parameters are valid.	○	
No pattern error has been detected.		○
In Pattern Execution Completed state		○

● Procedure

(1) Write Pattern Command Code '0: start pattern operation' and required parameters to pattern command parameter area of the pattern to be executed.

(2) Turn on the Pattern Execute Command output relay for the pattern to be executed.

(3) The Pattern Execute Command ACK input relay turns on, and pattern operation begins. Turn off the Pattern Execute Command output relay after confirming that the Pattern Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Pattern Execute Command ACK input relay does not turn on. Instead, the Pattern Error Detected input relay turns on, and an error code is stored in Pattern Error Status of pattern operation statuses.
- If any command acceptance condition is not satisfied, the Pattern Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Pattern Warning Status of pattern operation statuses. Turning off the Pattern Execute Command output relay clears the warning code.

(4) The Pattern Execution Completed relay turns off when pattern operation begins. When an action pattern with End Mode value '0: End' is executed, pattern operation stops and the Pattern Execution Completed input relay turns on.

■ Precautions

- Operation is stopped immediately if any error (e.g. pattern setup error) is encountered during pattern operation. We recommend performing initial testing at low speeds using a Set Pattern Override command.

■ Sample Program

● Description

This sample program executes pattern A starting from action record number 200 for a positioning module installed in slot 3.

● List of Devices

Table 7.11 lists the devices used.

Table 7.11 List of Devices Used in Sample Program for Start Pattern Operation Command

Device	Name	Data
D01331	Pattern A Command Code	0: Start Pattern Operation
D01332	(System reserved)	0
D01334	Pattern A Start Record No.	200
D02002	Pattern A Warning Status	
Y00349	Pattern A Execute Command output relay	
X00313	Pattern A Execute Command ACK input relay	
X00317	Pattern A Execution Completed input relay	
X00321	Pattern A Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I04201	Start pattern operation	
I04202	Start pattern operation (differential up)	
I04203	Waiting for execute command ACK	
I04204	Pattern executing	

- **Sample Program**

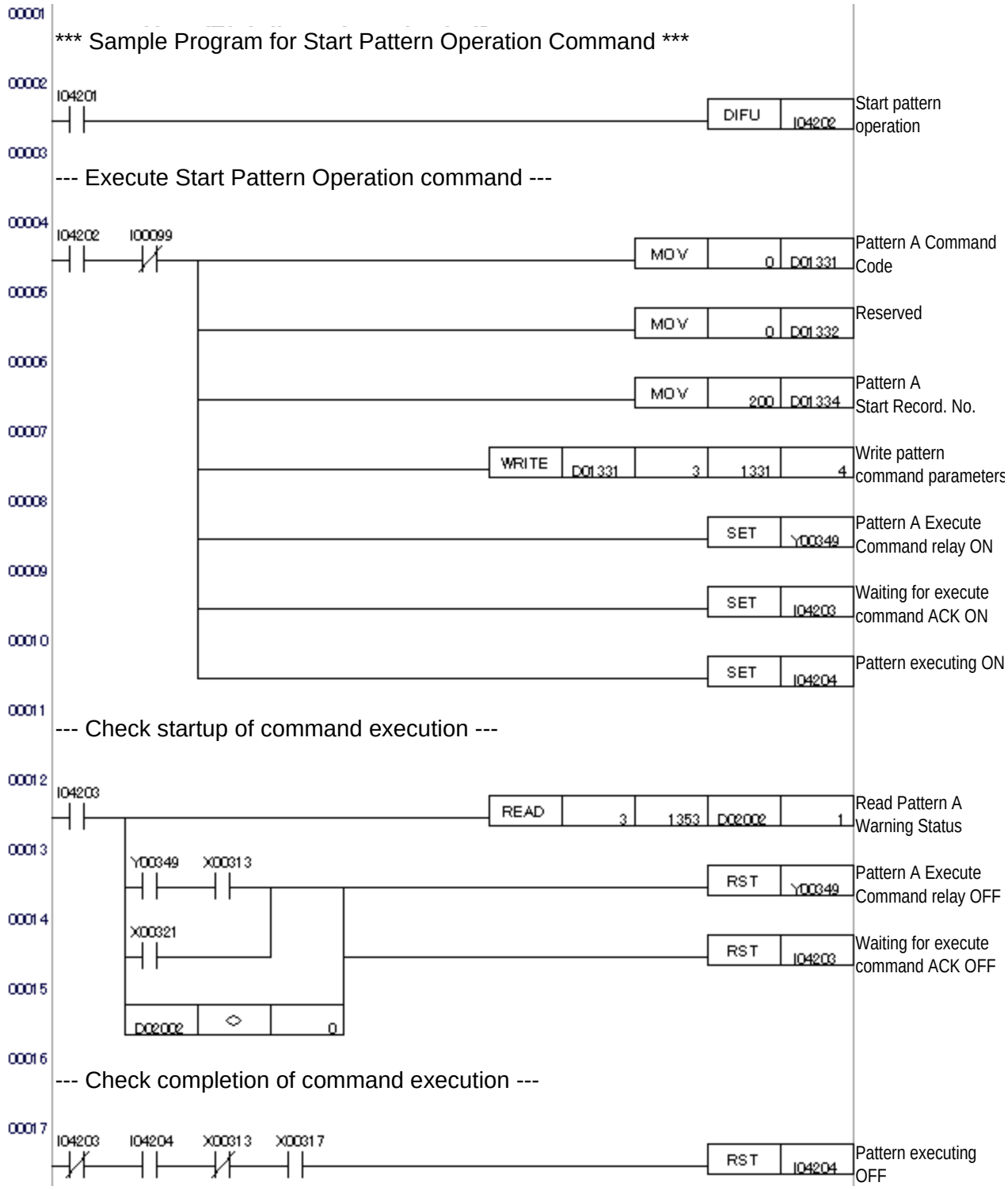


Figure 7.8 Start Pattern Operation Program

Timing Chart

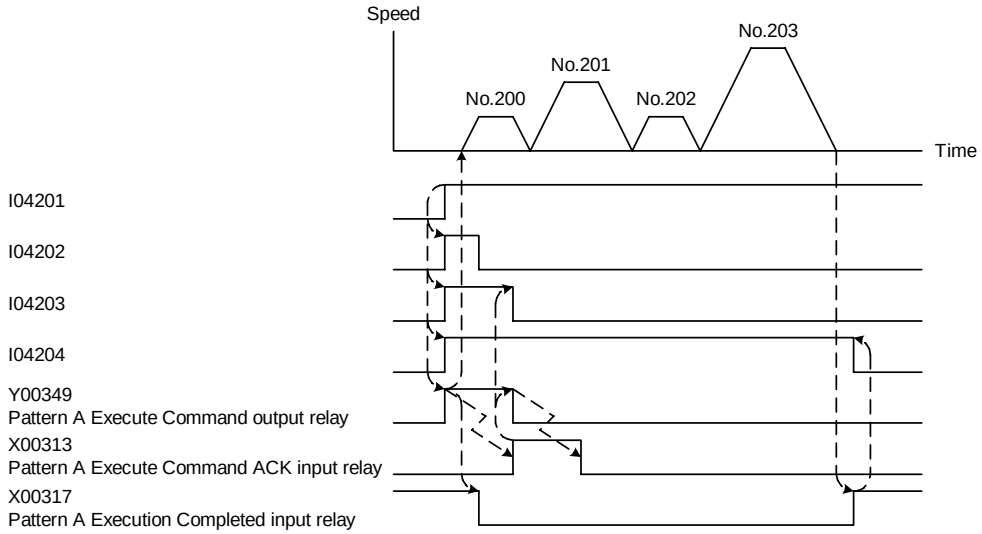


Figure 7.9 Timing Chart for Start Pattern Operation Program

7.6 Restart Pattern Operation

■ Function

This command restarts a pattern operation that has been stopped by execution of a Decelerate and Stop Pattern Operation command.

Pattern execution continues until an action with End Code value '0: End' is executed, a Decelerate and Stop Pattern Operation command is executed, or the Pattern Stop Immediately output relay is turned from off to on.

CAUTION

Operation is stopped immediately if any error (e.g. pattern setup error) is encountered during pattern operation. We recommend performing initial testing at low speeds using a Set Pattern Override command.

■ Execution Procedure

● Command Parameters Used

Table 7.12 shows required parameters that must be set.

Table 7.12 Required Parameters of Restart Pattern Operation Command

Data Position No.				Parameter Name	Data
Pattern A	Pattern B	Pattern C	Pattern D		
1331	1431	1531	1631	Pattern Command Code	1: Restart Pattern Operation
1332	1432	1532	1632	(System reserved)	Do not write any non-zero value.

● Command Acceptance Conditions

Table 7.13 lists the pre-conditions for command execution.

Table 7.13 Command Acceptance Conditions for Restart Pattern Operation Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another pattern command is in progress.		
Pattern command parameters are valid.	○	
No pattern error has been detected.		○
In Pattern Execution Completed state		○

● Procedure

(1) Write Pattern Command Code '1: restart pattern operation' and required parameters to pattern command parameter area of the pattern to be executed.

(2) Turn on the Pattern Execute Command output relay for the pattern to be executed.

(3) Pattern Execute Command ACK input relay turns on and pattern operation is restarted. Turn off the Pattern Execute Command output relay after confirming that the Pattern Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Pattern Execute Command ACK input relay does not turn on. Instead, the Pattern Error Detected input relay turns on, and an error code is stored in Pattern Error Status of pattern operation statuses.

- If any command acceptance condition is not satisfied, the Pattern Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Pattern Warning Status of pattern operation statuses. Turning off the Pattern Execute Command output relay clears the warning code.

(4) The Pattern Execution Completed relay turns off when pattern operation begins. When an action with End Mode value '0: End' is executed, pattern operation stops and the Pattern Execution Completed input relay turns on.

■ Precautions

- Only pattern operations that have been stopped by a Decelerate and Stop Pattern Operation command during movement can be restarted using the Restart Pattern Operation command.
- If a positioning movement was stopped and restarted, movement continues to the last target position in absolute position mode. If an index positioning movement was stopped and restarted, movement continues to the last target position in absolute position mode (shortest path control) regardless of whether the last target position was specified as an absolute position or incremental position.
- If a linear speed control movement or index speed control movement was stopped and restarted, it continues with the duration specified for the End Mode.
- If a pattern operation was stopped while waiting for a trigger and then restarted, it continues to wait for the trigger. If a linear speed control movement or index speed control movement was stopped while waiting for a trigger and restarted, it continues to wait for the trigger but its speed before the trigger is not restored. (After restarting, it waits for the trigger at rest.)
- If a pattern operation was stopped while waiting for M code reset and restarted, it continues to wait for M code reset. The Pattern M Code Detected relay that was turned off temporarily by the Decelerate and Stop Pattern Operation command is turned on again after operation is restarted.

■ Sample Program

● Description

This sample program restarts a pattern operation for a positioning module installed in slot 3 that was stopped by a rising edge of the Pattern Stop Immediately output relay.

● List of Devices

Table 7.14 lists the devices used.

Table 7.14 List of Devices Used in Sample Program for Restart Pattern Operation Command

Device	Name	Data
D01331	Pattern A Command Code	1: Restart Pattern Operation
D01332	(System reserved)	0
D02002	Pattern A Warning Status	
Y00349	Pattern A Execute Command output relay	
X00313	Pattern A Execute Command ACK input relay	
X00317	Pattern A Execution Completed input relay	
X00321	Pattern A Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I04301	Restart pattern operation	
I04302	Restart pattern operation (differential up)	
I04303	Waiting for execute command ACK	
I04304	Pattern executing	

- **Sample Program**

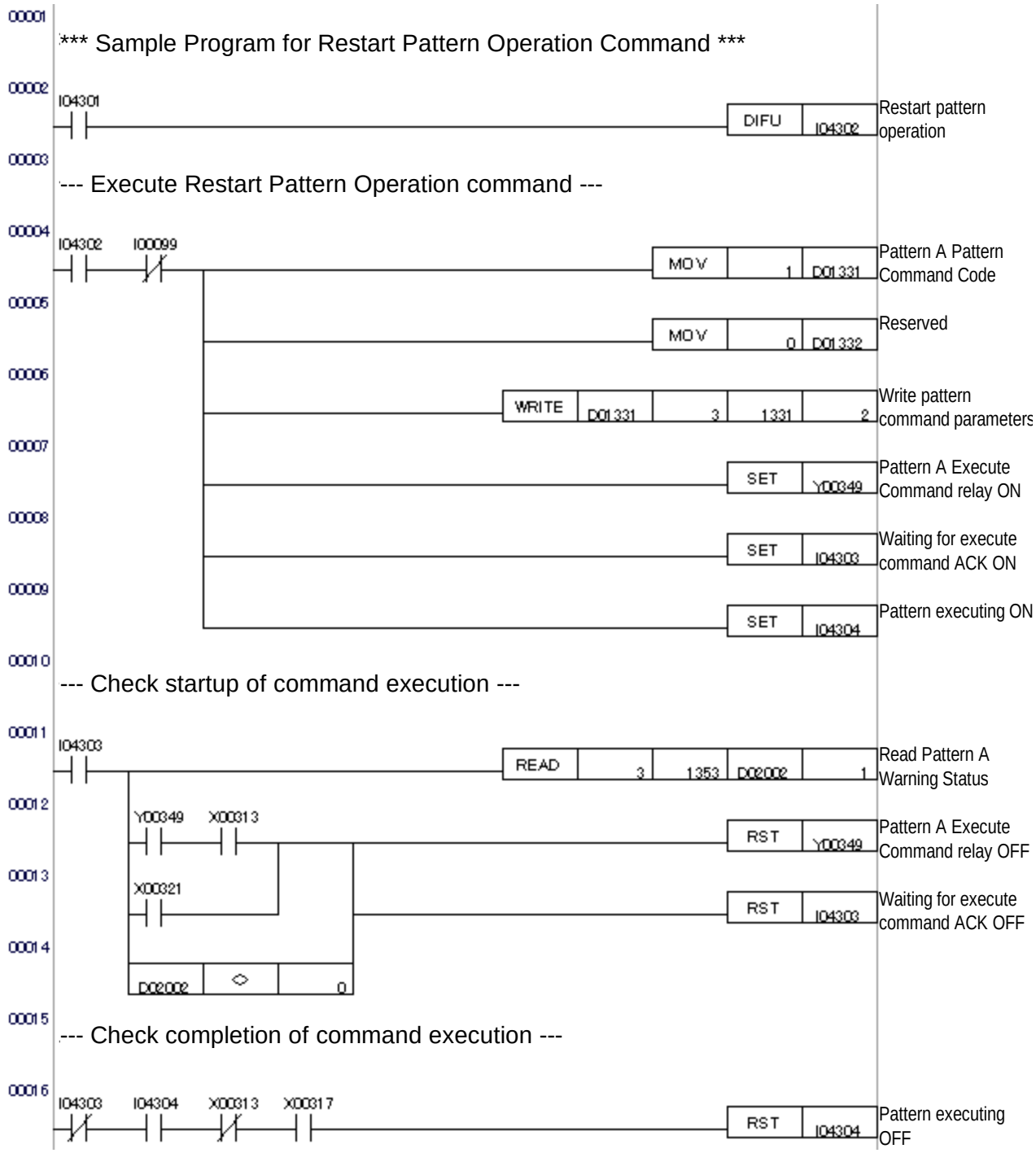


Figure 7.10 Restart Pattern Operation Program

Timing Chart

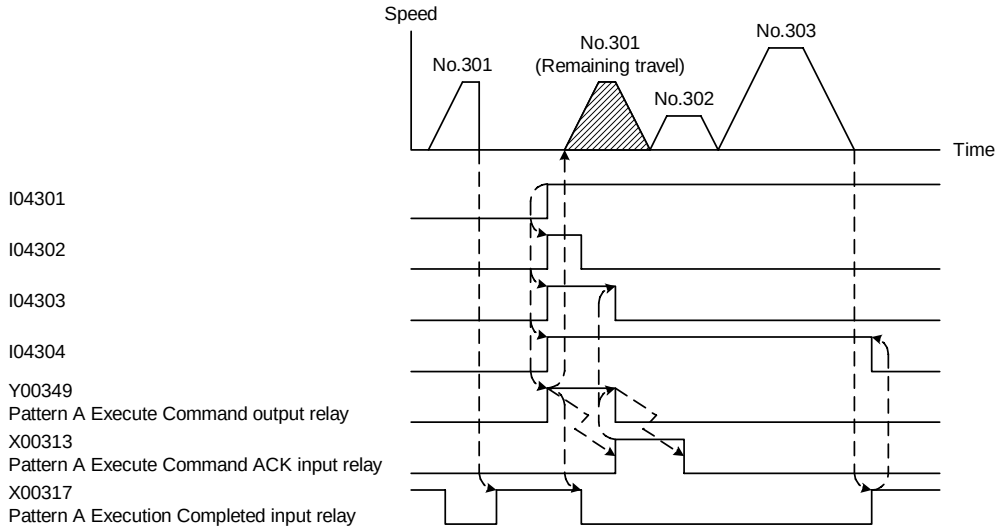


Figure 7.11 Timing Chart for Restart Pattern Operation Program

7.7 Pattern Operation Test

■ Function

This command executes a pattern operation using an action pattern table and position data table preset in the positioning module for action pattern records between a specified Pattern Start Record No and a specified Pattern End Record No.

Pattern execution continues until the action designated by the Pattern End Record No. is executed, an action with End Code value '0: End' is executed, a Decelerate and Stop Pattern Operation command is executed, or the Pattern Stop Immediately output relay is turned from off to on.

CAUTION

Operation is stopped immediately if any error (e.g. pattern setup error) is encountered during pattern operation. We recommend performing initial testing at low speeds using a Set Pattern Override command.

CAUTION

A pattern test operation will be forced to stop upon completion of execution of the action designated by the Pattern End Record No. parameter. If the last action to be executed is a speed control pass-through movement, speed control movement or some other movement that cannot be decelerated and stopped, a Stop Immediately action will be performed.

■ Execution Procedure

● Command Parameters Used

Table 7.15 shows required parameters that must be set.

Table 7.15 Required Parameters of Pattern Operation Test Command

Data Position No.				Parameter Name	Data
Pattern A	Pattern B	Pattern C	Pattern D		
1331	1431	1531	1631	Pattern Command Code	3: Pattern Operation Test
1332	1432	1532	1632	(System reserved)	Do not write any non-zero value.
1334	1434	1534	1634	Pattern Start Record No.	1 to No of Pattern Data Records Used defined (500 max.)
1339	1439	1539	1639	Pattern End Record No.	1 to No of Pattern Data Records Used defined (500 max.)

● Command Acceptance Conditions

Table 7.16 lists the pre-conditions for command execution.

Table 7.16 Command Acceptance Conditions for Pattern Operation Test Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another pattern command is in progress.		
Pattern command parameters are valid.	○	
No pattern error has been detected.		○
In Pattern Execution Completed state		○

Procedure

(1) Write Pattern Command Code '3: pattern operation test' and required parameters to pattern command parameter area of the pattern to be executed.

(2) Turn on the Pattern Execute Command output relay for the pattern to be executed.

(3) Pattern Execute Command ACK input relay turns on and pattern operation begins. Turn off the Pattern Execute Command output relay after confirming that the Pattern Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Pattern Execute Command ACK input relay does not turn on. Instead, the Pattern Error Detected input relay turns on, and an error code is stored in Pattern Error Status of pattern operation statuses.
- If any command acceptance condition is not satisfied, the Pattern Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Pattern Warning Status of pattern operation statuses. Turning off the Pattern Execute Command output relay clears the warning code.

(4) The Pattern Execution Completed relay turns off when pattern operation test begins. When the action designated by the Pattern End Record No. parameter is executed or an action with End Mode value '0: End' is executed, pattern operation stops and the Pattern Execution Completed input relay turns on.

Precautions

- FOR and NEXT action records must be properly paired even for pattern operation test. Otherwise, an error will be generated during execution.
- A pattern operation test stopped by a Decelerate and Stop Pattern Operation command cannot be restarted.

■ Sample Program

● Description

This sample program executes action records 200 to 202 of pattern A for a positioning module installed in slot 3.

● List of Devices

Table 7.17 lists the devices used.

Table 7.17 List of Devices Used in Sample Program for Pattern Operation Test Command

Device	Name	Data
D01331	Pattern A Command Code	3: Pattern Operation Test
D01332	(System reserved)	0
D01334	Pattern Start Record No.	200
D01339	Pattern End Record No.	202
D02002	Pattern A Warning Status	
Y00349	Pattern A Execute Command output relay	
X00313	Pattern A Execute Command ACK input relay	
X00317	Pattern A Execution Completed input relay	
X00321	Pattern A Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I04401	Pattern operation test	
I04402	Pattern operation test (differential up)	
I04403	Waiting for execute command ACK	
I04404	Pattern executing	

- **Sample Program**

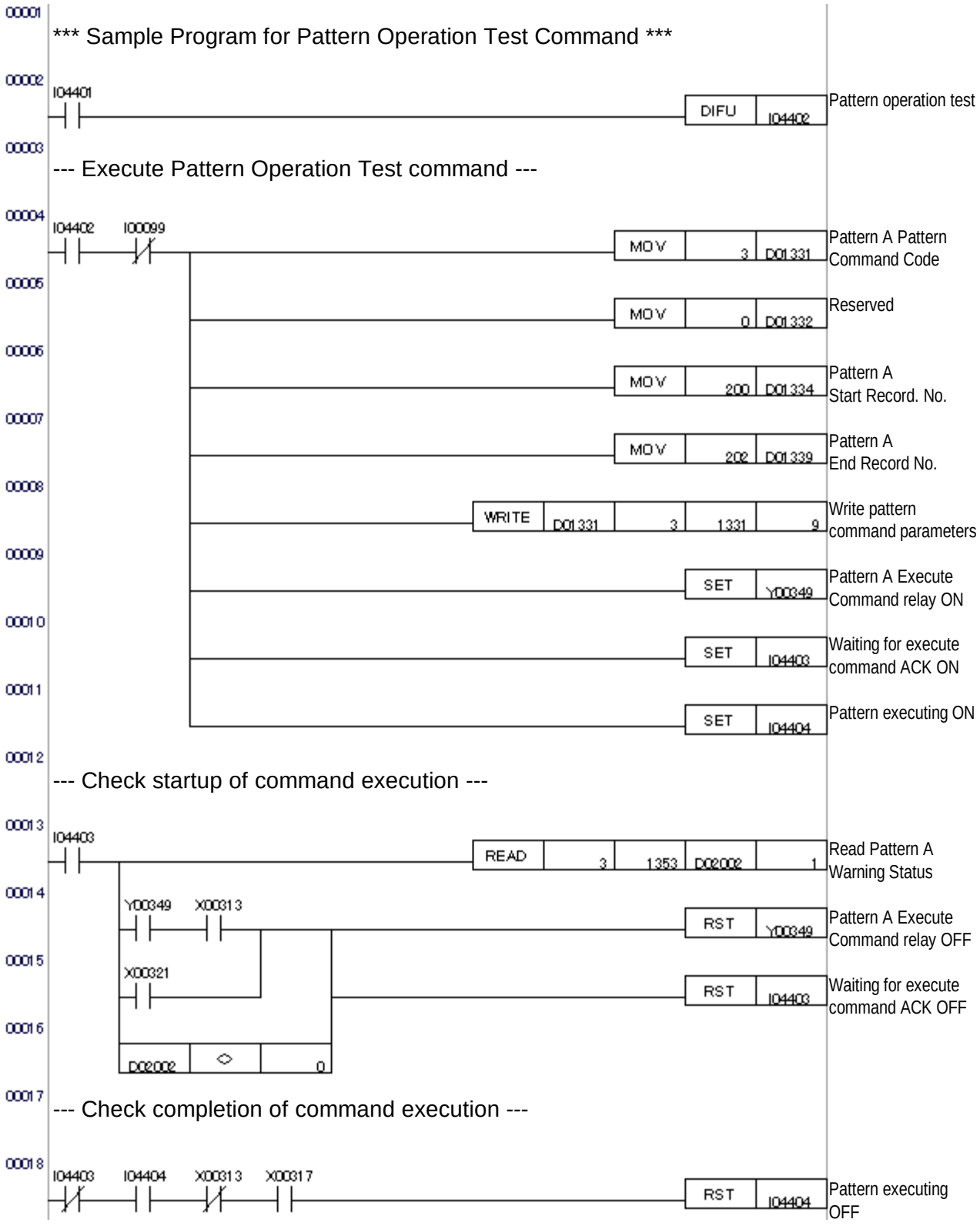


Figure 7.12 Pattern Operation Test Program

Timing Chart

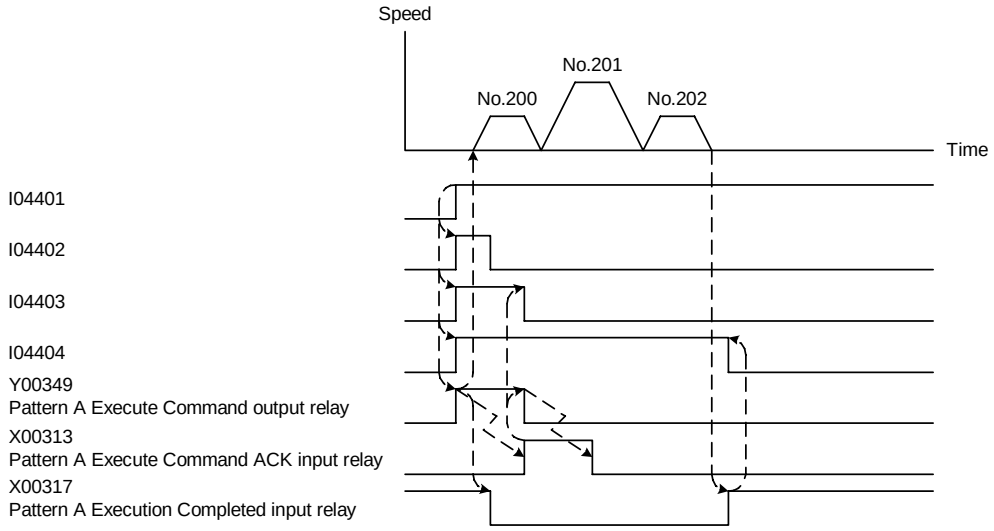


Figure 7.13 Timing Chart for Pattern Operation Test Program

7.8 Decelerate and Stop Pattern Operation

■ Function

This command decelerates and stops all moving motors involved in positioning during a pattern operation, and then stops the pattern operation. A pattern operation that has been stopped by a Decelerate and Stop Pattern Operation command can be restarted by a Restart Pattern Operation command. Deceleration is performed according to the deceleration time defined when the pattern is executed. If multiple axes are involved in a movement (e.g. linear positioning), all axes are decelerated and stopped.

CAUTION

If the current position is near the target position when a Decelerate and Stop Pattern Operation command is accepted, and the End Mode of the executing pattern is specified as 'pass through', an abrupt stop may be executed without following the deceleration curve.

■ Execution Procedure

● Command Parameters Used

Table 7.18 shows required parameters that must be set.

Table 7.18 Required Parameters of Decelerate and Stop Pattern Operation Command

Data Position No.				Parameter Name	Data
Pattern A	Pattern B	Pattern C	Pattern D		
1331	1431	1531	1631	Pattern Command Code	2: Decelerate and Stop Pattern Operation

● Command Acceptance Conditions

Table 7.19 lists the pre-conditions for command execution.

Table 7.19 Command Acceptance Conditions for Decelerate and Stop Pattern Operation Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another pattern command is in progress.		
No pattern error has been detected.		○
Not in Pattern Execution Completed state		○

● Procedure

(1) Write Pattern Command Code '2: deceleration and stop pattern operation' to pattern command parameter area of pattern to be executed.

(2) Turn on the Pattern Execute Command output relay for the pattern to be executed.

(3) The Pattern Execute Command ACK input relay turns on and deceleration and stop movement begins. Turn off the Pattern Execute Command output relay after confirming that the Pattern Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Pattern Execute Command ACK input relay does not turn on. Instead, the Pattern Error Detected input relay turns on, and an error code is stored in Pattern Error Status of pattern operation statuses.

- If any command acceptance condition is not satisfied, the Pattern Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Pattern Warning Status of pattern operation statuses. Turning off the Pattern Execute Command output relay clears the warning code.

(4) The Positioning Completed input relay turns on when the positioning movement of the pattern operation has been decelerated and stopped, while the Pattern Execution Completed input relay turns on when pattern operation stops.

■ Precautions

- If the current position is near the target position when a Decelerate and Stop Pattern Operation command is accepted, and the End Mode of the executing pattern is specified as 'pass through', an abrupt stop may be executed without following the deceleration curve.
- The Decelerate and Stop Pattern Operation command turns off the M Code Detected relay if it is on.

■ Sample Program

● Description

This sample program decelerates and stops execution of pattern A for a positioning module installed in slot 3.

● List of Devices

Table 7.20 lists the devices used.

Table 7.20 List of Devices Used in Sample Program for Decelerate and Stop Pattern Operation Command

Device	Name	Data
D01331	Pattern A Command Code	2: Decelerate and Stop Pattern Operation
D02002	Pattern A Warning Status	
Y00349	Pattern A Execute Command output relay	
X00313	Pattern A Execute Command ACK input relay	
X00317	Pattern A Execution Completed input relay	
X00321	Pattern A Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I04501	Decelerate and stop pattern operation	
I04502	Decelerate and stop pattern operation (differential up)	
I04503	Waiting for execute command ACK	
I04504	Command executing	

- **Sample Program**

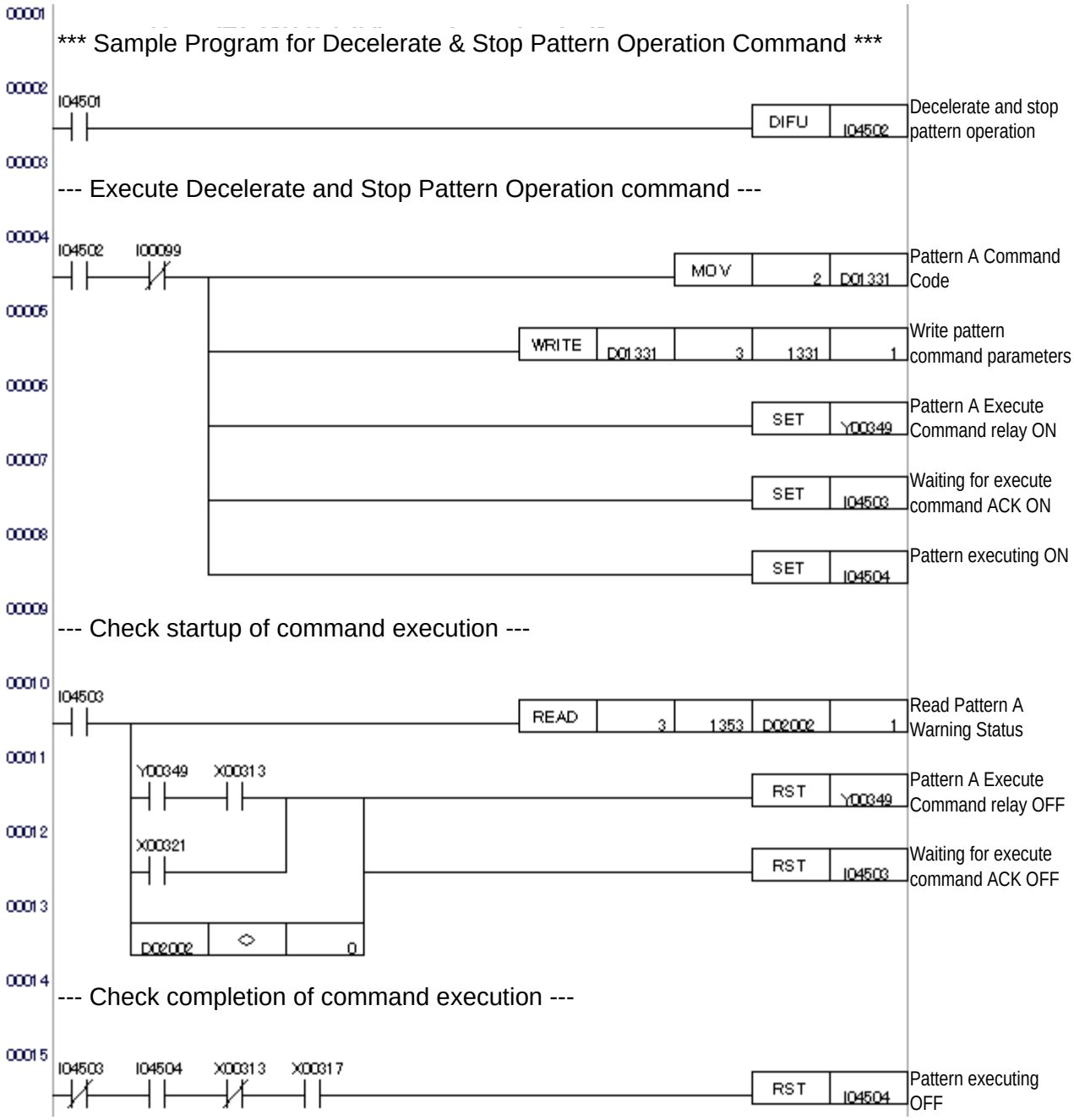


Figure 7.14 Decelerate and Stop Pattern Operation Program

Timing Chart

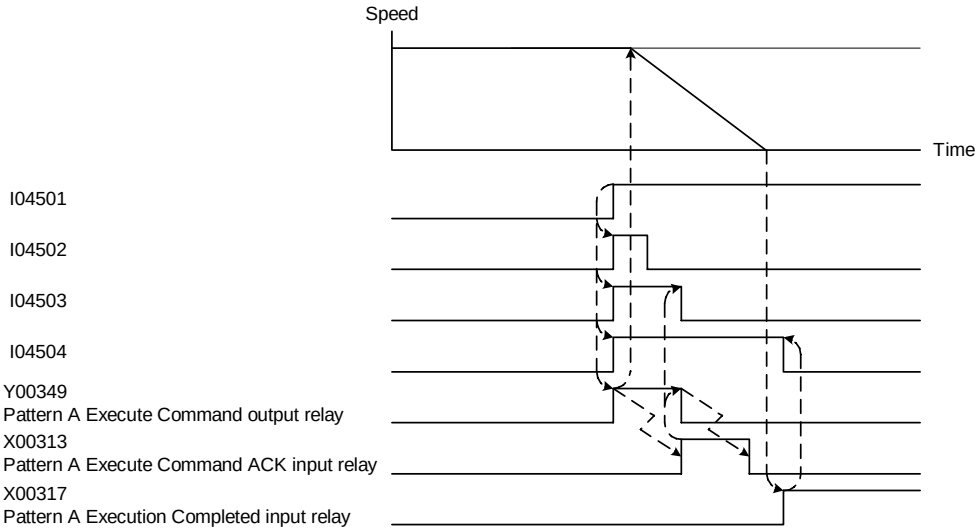


Figure 7.15 Timing Chart for Decelerate and Stop Pattern Operation Program

7.9 Stop Pattern Operation Immediately

■ Function

This command stops all moving motors involved in positioning during a pattern operation immediately without deceleration, and then stops the pattern operation.

- If multiple axes are involved in a movement (e.g. linear positioning), all axes are stopped immediately.

■ Execution Procedure

● Command Parameters Used

No pattern command parameters need to be set.

● Command Acceptance Conditions

This command is always accepted.

● Procedure

(1) Turn on the Pattern Stop Immediately output relay for the executing pattern.

(2) All axes involved are stopped immediately.

(3) The Positioning Completed input relay turns on when the positioning movement of the pattern operation stops, while the Pattern Execution Completed input relay turns on when pattern operation stops. Turn off the Pattern Execute Command output relay after confirming that the Pattern Execute Command ACK input relay has turned on.

■ Precautions

- Beware that executing an immediate stop in the midst of high speed movement may subject the mechanical system to a large impact.
- A pattern operation cancelled by a Stop Pattern Operation Immediately command cannot be restarted by a Restart Pattern Operation command. If you intend to restart the pattern operation, execute a Decelerate and Stop Pattern Operation command instead.
- The Stop Pattern Operation Immediately command turns off the M Code Detected relay if it is on.

■ Sample Program

● Description

This sample program stops execution of pattern A immediately for a positioning module installed in slot 3.

● List of Devices

Table 7.21 lists the devices used.

Table 7.21 List of Devices Used in Sample Program for Stop Pattern Operation Immediately Command

Device	Name	Data
Y00353	Pattern A Stop Immediately output relay	
X00317	Pattern A Execution Completed input relay	
I00099	Command execution disable (to be set elsewhere)	
I04601	Stop pattern operation immediately	
I04602	Stop pattern operation immediately (differential up)	

● Sample Program

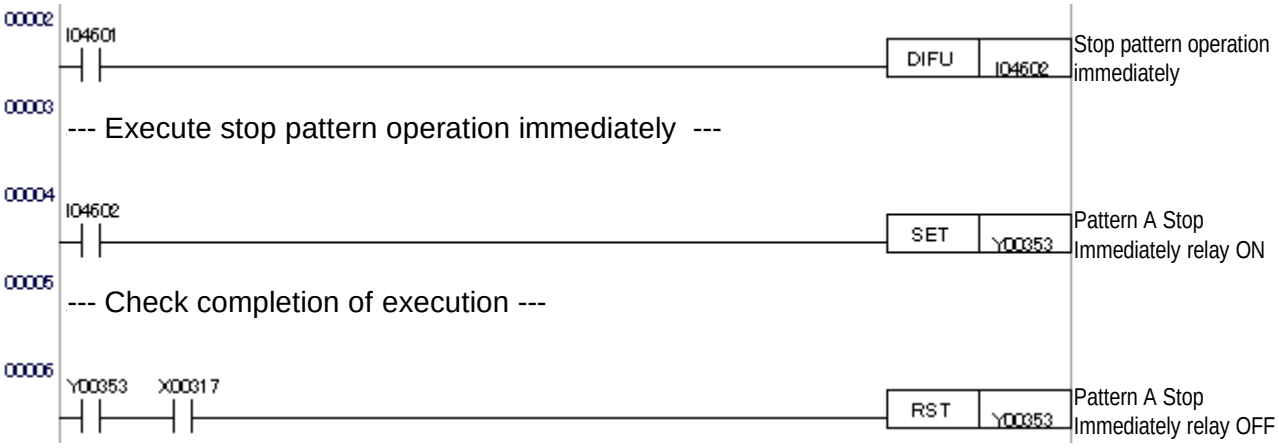


Figure 7.16 Stop Pattern Operation Immediately Program

● Timing Chart

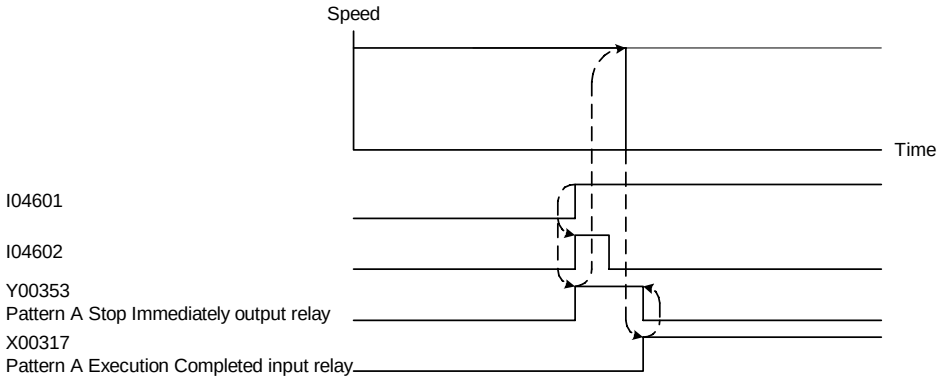


Figure 7.17 Timing Chart for Stop Pattern Operation Immediately Program

7.10 Set Pattern Override

■ Function

This command changes the override value, which scales specified speeds of positioning actions in pattern operation by 1 to 500 (%).

If the command is executed during pattern operation, the new override value is applied to subsequent action patterns.

When the override is changed, movement follows the gradient of the acceleration /deceleration curve defined by the non-scaled acceleration time, deceleration time and specified speed values. (As an exception, if the override value is changed during speed control movement or index speed control movement, movement follows a fixed duration for the speed change, ignoring the gradient of the acceleration/deceleration curve.)

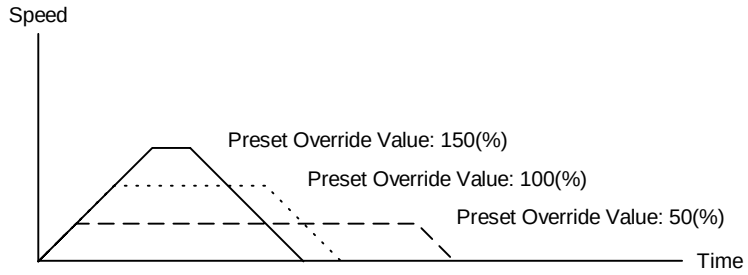


Figure 7.18 Set Override (acceleration/deceleration curve)

The F3NC34-0N and F3NC32-0N positioning modules allow override values to be set at 8 and 4 different places respectively.

For instance, for linear interpolation involving axes 1 and 2, the Pattern Current Override Value for pattern A is used for movements of pattern A, while the Pattern Current Override Value for pattern B is used for movements of pattern B.

Table 7.22 Methods for Setting Override Value

Current Override Value	Override Value Changed by:	Override Value Applies to:
AX1 Current Override Value Status	Set Override command	Movement initiated by command executed from axis 1
AX2 Current Override Value Status		Movement initiated by command executed from axis 2
AX3 Current Override Value Status		Movement initiated by command executed from axis 3
AX4 Current Override Value Status		Movement initiated by command executed from axis 4
Pattern A Current Override Value	Set Pattern Override command	Pattern operation of pattern A
Pattern B Current Override Value		Pattern operation of pattern B
Pattern C Current Override Value		Pattern operation of pattern C
Pattern D Current Override Value		Pattern operation of pattern D

■ Execution Procedure

● Command Parameters Used

Table 7.23 shows required parameters that must be set.

Table 7.23 Required Parameters of Set Pattern Override Command

Data Position No.				Parameter Name	Data
Pattern A	Pattern B	Pattern C	Pattern D		
1331	1431	1531	1631	Pattern Command Code	6: Set Pattern Override
1333	1433	1533	1633	Pattern Preset Override Value	1 to 500 (%)

● Command Acceptance Conditions

Table 7.24 lists the pre-conditions for command execution.

Table 7.24 Command Acceptance Conditions for Set Pattern Override Command

Command Acceptance Condition	Error Code	Warning Code
No acceptance of another pattern command is in progress.		
Pattern command parameters are valid.	○	
No pattern error has been detected.		○

● Procedure

(1) Write Pattern Command Code '6: set pattern override' and required parameters to pattern command parameter area of the pattern to be executed.

(2) Turn on the Pattern Execute Command output relay for the pattern to be executed.

(3) If command execution is successful, the corresponding Pattern Execute Command ACK input relay turns on. Turn off the Pattern Execute Command output relay after confirming that the Pattern Execute Command ACK input relay has turned on.

- If parameter data is invalid, the Pattern Execute Command ACK input relay does not turn on. Instead, the Pattern Error Detected input relay turns on, and an error code is stored in Pattern Error Status of pattern operation statuses.
- If any command acceptance condition is not satisfied, the Pattern Execute Command ACK input relay does not turn on. Instead, the command is not executed, and a warning code is stored in Pattern Warning Status of pattern operation statuses. Turning off the Pattern Execute Command output relay clears the warning code.

■ Precautions

- An override value may cause a speed after override adjustment to exceed the Pattern Combined-speed Limit of pattern registered parameters or the Speed Limit of axis registered parameters. If this happens during pattern operation, a pattern error is generated, and the module executes a stop immediately action. Pattern Error Code 1 stores the action pattern record number causing the error and Pattern Error Code 2 indicates a specified speed setup error. To rectify the problem, you should set an appropriate override value. If a Startup Speed is defined by axis registered parameters, the new override value should not cause the computed speed to fall below the preset startup speed.
- Even if the override value is changed, movement still follows the acceleration /deceleration curve defined by the non-scaled (override=100%) values. Therefore, if a movement is approaching the target position at a speed below the specified speed, increasing the override value will not affect the movement (no speed increase).

■ Sample Program

● Description

This sample program changes the Pattern Preset Override Value of pattern A for a positioning module installed in slot 3 during pattern operation.

List of Devices

Table 7.25 lists the devices used.

Table 7.25 List of Devices Used in Sample Program for Set Pattern Override Command

Device	Name	Data
D01331	Pattern A Command Code	6: Set Pattern Override
D01333	Pattern A Preset Override Value	200 (%)
D02002	Pattern A Warning Status	
Y00349	Pattern A Execute Command output relay	
X00313	Pattern A Execute Command ACK input relay	
X00321	Pattern A Error Detected input relay	
I00099	Command execution disable (to be set elsewhere)	
I04701	Set pattern override	
I04702	Set pattern override (differential up)	
I04703	Waiting for execute command ACK	
I04704	Command executing	

● Sample Program

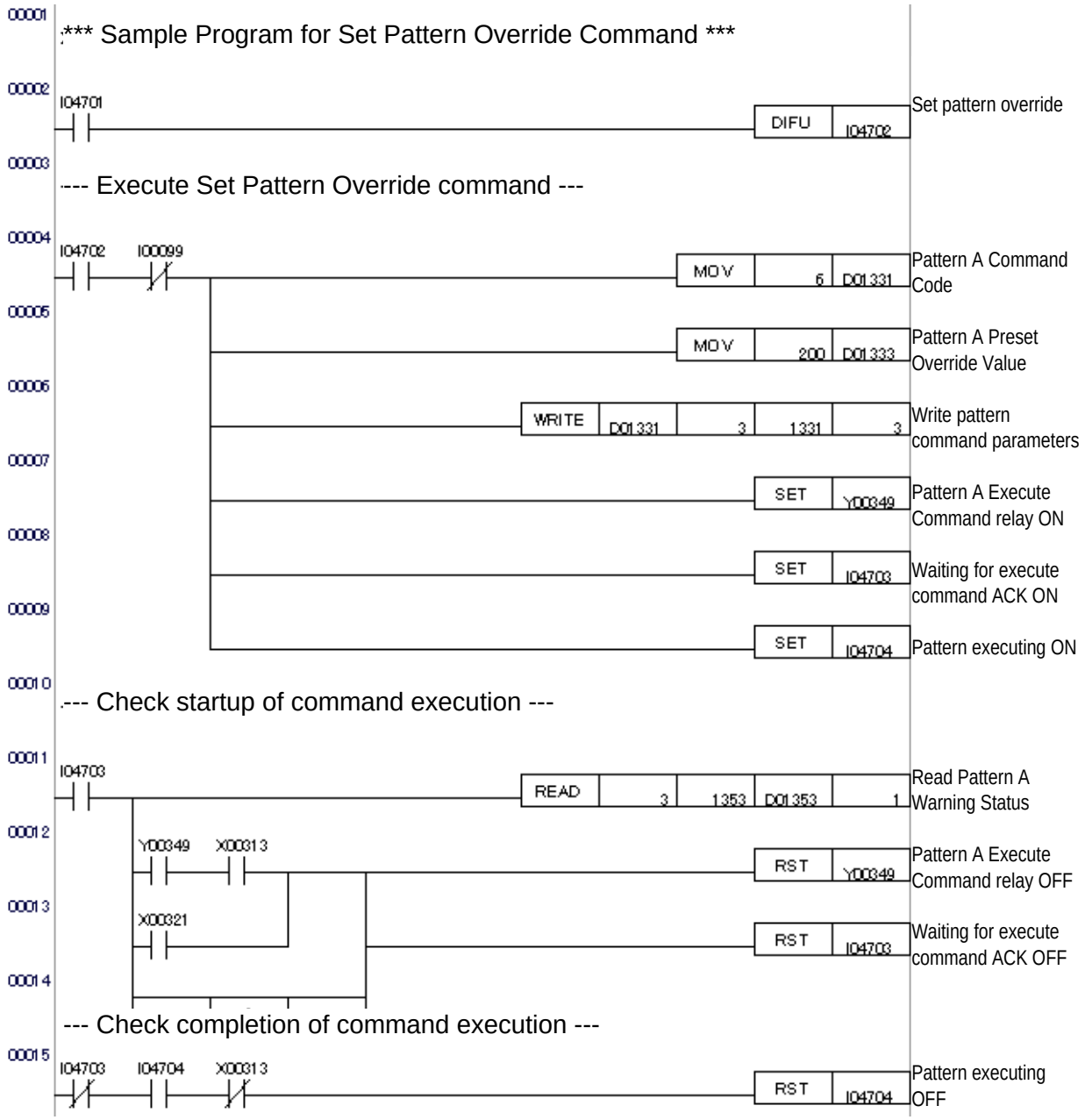


Figure 7.19 Set Pattern Override Program

● Timing Chart

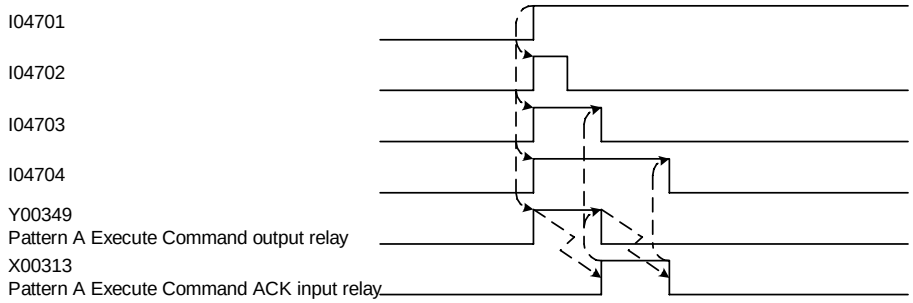


Figure 7.20 Timing Chart for Set Pattern Override Program

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8. Pattern Operation Action Pattern Data

This chapter describes how to set up action pattern data using the “ToolBox for Positioning Modules" (SF662-ECW) software.

Action pattern data is made up of action pattern tables and position data tables.

For details on the specifications, function and usage of the ToolBox for Positioning Modules (SF662-ECW) software, see the “FA-M3 ToolBox Manual” (IM34M6Q30-01E) and “FA-M3 ToolBox for Positioning Modules User’s Manual” (IM34M6Q31-01E).

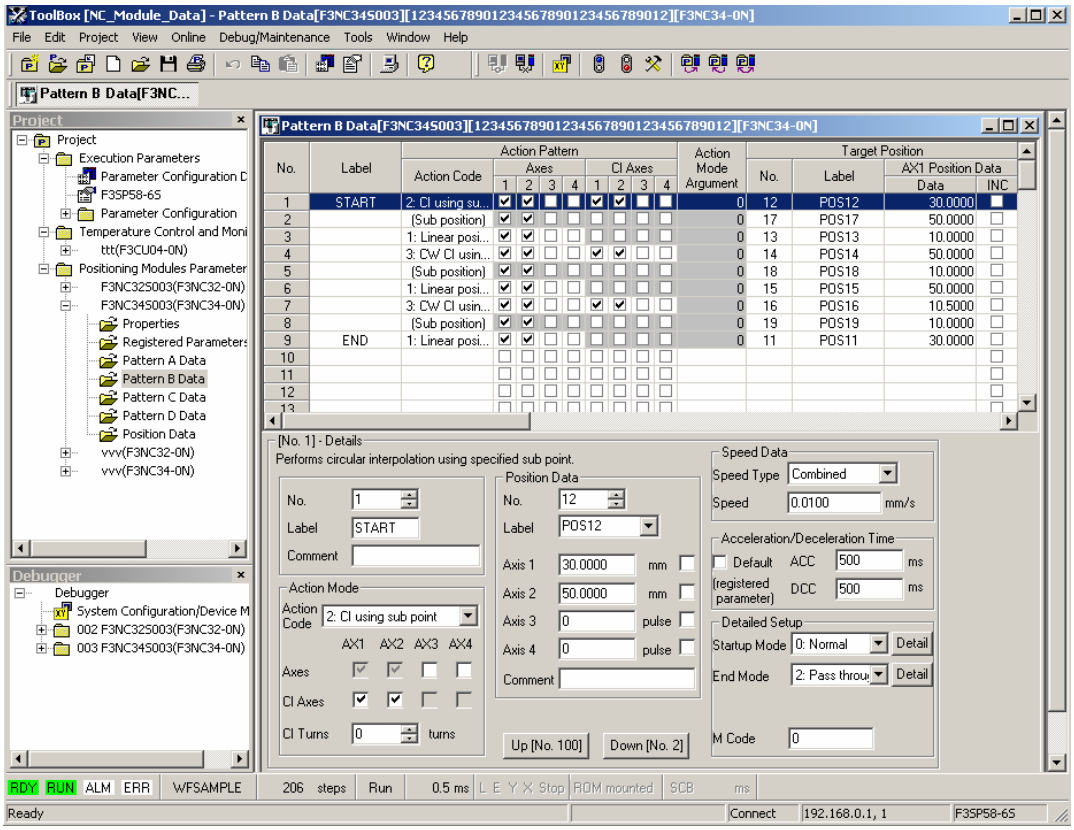


Figure 8.1 Screen Layout for the ToolBox for Positioning Modules (SF662-ECW) software

8.1 Action Pattern Data

8.1.1 List of Actions

Table 8.1 lists the action codes that can be specified in an action pattern table. For details on these action codes, see sections 8.2 to 8.10.

Table 8.1 List of Action Codes

Action Code	Action	Description	See Also
1	Linear positioning	Performs linear interpolated positioning using 1, 2, 3 or 4 axes.	8-19
2	CI using sub point	Performs circular interpolation or helical interpolation using a specified sub point.	8-24
3	CW CI using center	Performs clockwise circular interpolation or helical interpolation using a specified center point.	8-24
4	CCW CI using center	Performs counter-clockwise circular interpolation or helical interpolation using a specified center point.	8-24
5	Sub position	Specifies a sub position (sub point or center point) for circular interpolation or helical interpolation.	8-24
10	Position->speed	Switches from position control mode to speed control mode.	8-28
11	Speed->pos. (reset)	Switches from speed control mode to position control mode. (Resets the current position to zero)	8-30
12	Speed->pos. (continue)	Switches from speed control mode to position control mode. (Continuing with the current position value)	8-30
13	Speed control	Performs linear interpolated speed control movement using 1, 2, 3 or 4 axes.	8-34
15	Index positioning	Performs single-axis positioning under index control.	8-37
16	Index speed control	Performs single-axis speed control movement under index control.	8-41
20	Contact o/p on/off	Sets output of selected external contacts to ON or OFF.	8-44
21	Set current position	Changes the current position.	8-46
96	FOR	Executes action pattern records within the FOR-NEXT loop a specified number of iterations.	8-48
97	NEXT	Executes action pattern records within the FOR-NEXT loop a specified number of iterations.	8-48
98	JUMP	Jumps to a specified action pattern record number.	8-50
99	NOP	No operation. Moves to next action pattern record.	8-51

8.1.2 Required Parameters of Actions

Before executing a pattern operation, you need to first set up the required pattern command parameters in the action pattern table.

Table 8.2 shows required parameters that must be set for each action.

○ : Parameters that must be set

△ : Parameters that may be set as required (normally set to 0 or –1)

▲ : Parameters that may require setup depending on other parameter values

Empty : Non-required parameters (parameter values are ignored)

Table 8.2 Required Parameters of Actions

Parameter	Position Control					Speed Control				Index Control							
	Linear positioning	CI using sub point	CW CI using center	CCW CI using center	Sub position	Position->speed	Speed->pos. (reset)	Speed->pos. (continue)	Speed control	Index positioning	Index speed control	Contact o/p on/off	Set current position	FOR	NEXT	JUMP	NOP
Action Code	1	2	3	4	5	10	11	12	13	15	16	20	21	96	97	98	99
Axes	○	○	○	○		○	○	○	○	○	○		○				
CI Axes		○	○	○													
CI Turns		△	△	△													
Position Data	○	○	○	○	○		○	○		○			○				
Speed Data	○	○	○	○			○	○	○	○	○						
Acceleration /Deceleration Time	△	△	△	△			△	△	△	△	△						
Contact Output Data												○					
Startup Mode	△	△	△	△			△	△	△	△	△	△	△				
Startup Mode Options	▲	▲	▲	▲			▲	▲	▲	▲	▲	▲	▲				
End Mode	○	○	○	○		○	○	○	○	○	○	○	○				
End Mode Options	▲						▲	▲	○	▲	○						
Dwell Time	△	△	△	△			△	△	△	△	△						
M Code	△	△	△	△		△	△	△	△	△	△	△	△				
Action Mode Argument (FOR-NEXT iterations)														○			
Action Mode Argument (JUMP Destination)																○	

8.1.3 Command Acceptance Conditions of Actions

When executing a pattern, the command acceptance conditions vary for individual action codes. If the state of an axis involved in an action violates any of the following conditions during pattern execution, a pattern operation action error is generated, and pattern operation stops immediately. The action pattern record number associated with the error is stored in Pattern Error Code 1 and the action acceptance condition error is stored in Pattern Error Code 2.

○ : Condition must be satisfied for action command to be accepted.

Empty : Condition does not apply.

Table 8.3 Command Acceptance Conditions of Actions

Command Acceptance Conditions for Each Action	Position Control				Speed Control				Index Control				
	Linear positioning	CI using sub point	CW CI using center	CCW CI using center	Position->speed	Speed->pos. (reset)	Speed->pos. (continue)	Speed control	Index positioning	Index speed control	Contact o/p on/off	Set current position	FOR/NEXT/JUMP/NOP
No error has been detected	○	○	○	○	○	○	○	○	○	○	○	○	
In position control mode	○	○	○	○					○	○			
In speed control mode						○	○	○					
Not in speed control mode												○	
Not under index control	○	○	○	○	○								
Under index Control									○	○			
In Positioning Completed state					○							○	
Not jogging	○	○	○	○					○	○			
No origin search is in progress	○	○	○	○					○	○			
No change target position action is in progress	○	○	○	○									
No change in set of movement axes.	○	○	○	○		○	○	○					
Not waiting for trigger	○	○	○	○	○	○	○	○	○	○	○	○	
No change in command execution axis	○	○	○	○		○	○	○	○	○		○	

8.1.4 Startup Mode

You can use the Startup Mode to specify when to start an action in pattern operation.

Table 8.4 shows the list of action codes that allows the startup mode to be specified.

Table 8.4 Action Code and Startup Mode

Action Code	Action	Can Startup Mode be Specified?	Action Code	Action	Can Startup Mode be Specified?
1	Linear positioning	Yes	15	Index positioning	Yes
2	CI using sub point	Yes	16	Index speed control	Yes
3	CW CI using center	Yes	20	Contact o/p on/off	Yes
4	CCW CI using center	Yes	21	Set current position	Yes
5	Sub position		96	FOR	
10	Position->speed		97	NEXT	
11	Speed->pos. (reset)	Yes	98	JUMP	
12	Speed->pos. (continue)	Yes	99	NOP	
13	Speed control	Yes			

If the Startup Mode of an action is set to '0: Normal startup', the action is executed immediately after execution of the preceding action pattern is completed.

If the Startup Mode is set to a non-zero value, the action is executed only when a trigger condition becomes true after execution of the preceding action pattern is completed. The trigger event may be related to a timer startup, external trigger input, external trigger input & encoder Z–phase input, detection of counter coincidence or zone coincidence, positioning completion, etc. The trigger condition can be specified for axis 1, 2, 3 or 4 but only one axis should be selected.

Table 8.5 List of Startup Modes

Startup Code	Startup Mode	Startup Mode Options
0	Normal	None
1	Timer	- Timer value: 1 to 32,767 (ms)
2	External trigger	- Axes: 1 to 4
3	External trigger & Z-phase	- Axes: 1 to 4 - Z-phase Edge Selection: Rising Edge, Falling Edge Z-phase Search Count: 1 to 255 (pulses)
4	Counter/zone coincidence	- Axes: 1 to 4
5	Positioning Completed	- Axes: 1 to 4

- **0: Normal**

With normal startup, an action is executed immediately after completion of execution of the preceding action.

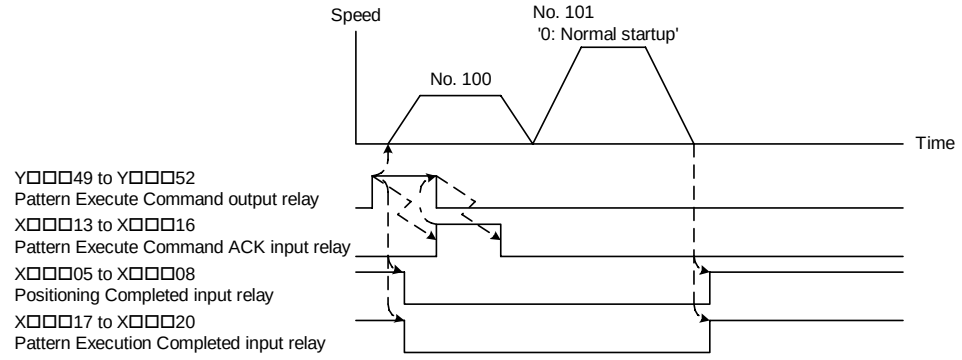


Figure 8.2 Action Execution When Startup Mode is Set to '0: Normal'

1: Timer

With timer startup, execution of an action is delayed after completion of the execution of the preceding action for a duration specified by the Startup Mode Options parameter.

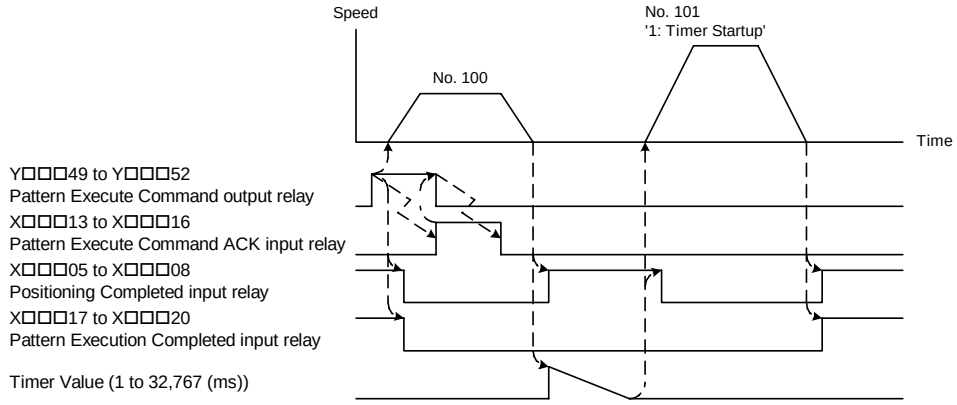


Figure 8.3 Action Execution When Startup Mode Is Set to '1: Timer''

2: Ext. trigger

With external trigger input startup, an action is executed when the External Trigger Input of the axis designated by the Startup Mode Options parameter is ON after completion of the execution of the preceding action.

The action is executed immediately if the External Trigger Input is ON when the execution of the preceding action pattern ends. The External Trigger Input is ignored even if it is ON if it is configured to be used as a General Input.

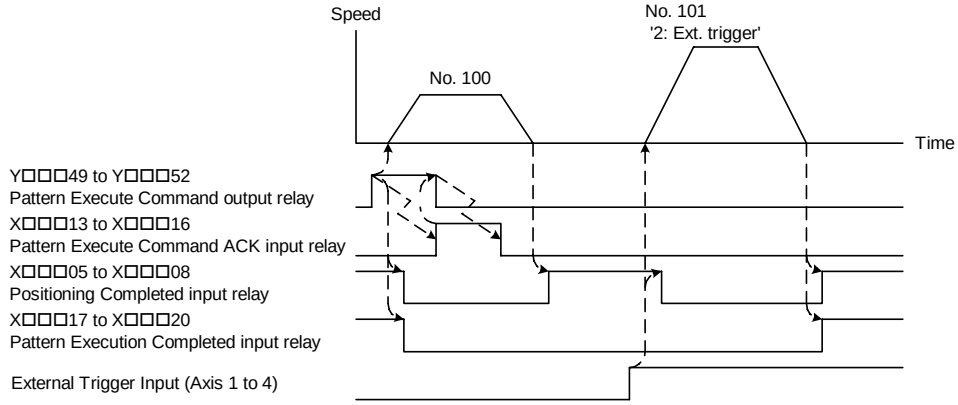


Figure 8.3 Action Execution When Startup Mode Is Set to '2: Ext. Trigger'

3: Ext. trigger & Z-phase

With 'External trigger input & encoder Z-phase input' startup, edge detection of the Encoder Z-phase Input is performed when the External Trigger Input of the axis designated by the Startup Mode Options parameter is ON after completion of the execution of the preceding action.

The module shifts to edge detection of the Encoder Z-phase Input immediately if the External Trigger Input is ON when the execution of the preceding action ends.

The Startup Options parameter is used to specify the Z-phase Edge Selection and the Z-phase Search Count. The External Trigger Input is ignored even if it is ON if it is configured to be used as a General Input.

Beware that an action may never be started if the motor involved in the startup condition is at rest.

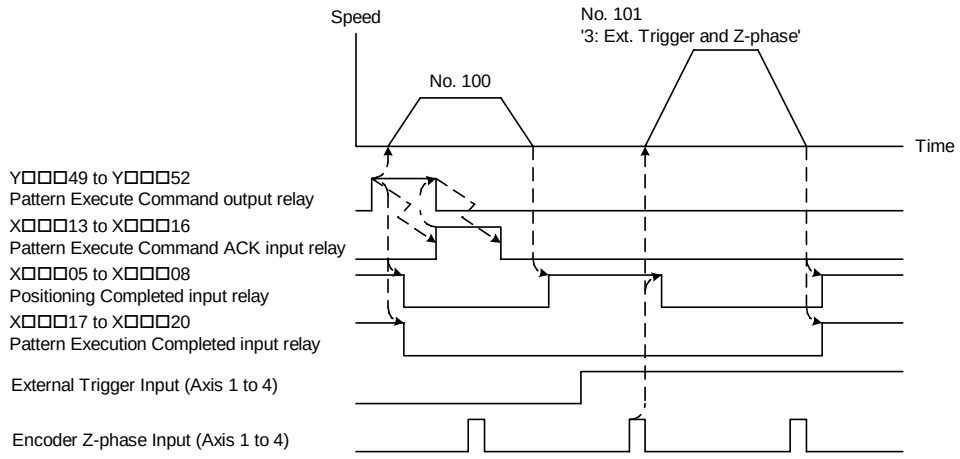


Figure 8.5 Action Execution When Startup Mode Is Set to '3: Ext. Trigger & Z-phase'

4: Counter/zone coincidence

With counter/zone coincidence startup, an action is executed when the Counter/Zone Coincidence Detected relay for the axis designated by the Startup Mode Options parameter is ON after completion of the execution of the preceding action.

The action is executed immediately if the Counter/Zone Coincidence Detected relay is ON when the execution of the preceding action pattern ends.

The behavior of the Counter/Zone Coincidence Detected input relay can be pre-configured using axis registered parameters or the Counter Setup command.

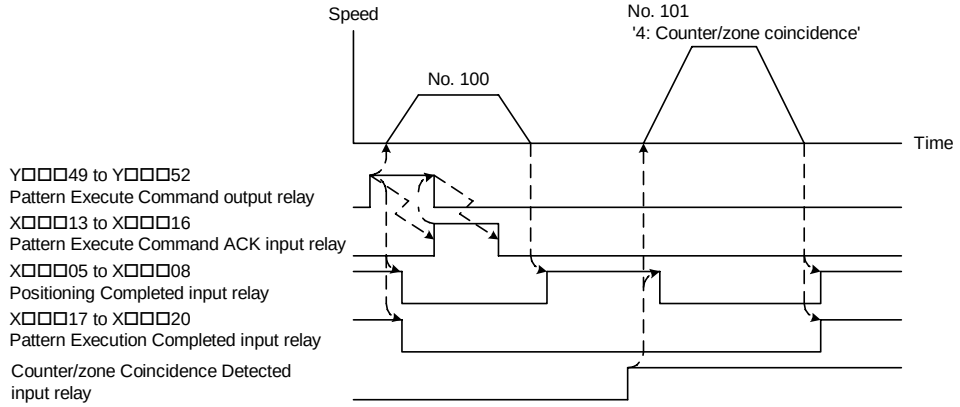


Figure 8.6 Action Execution When Startup Mode is Set to '4: Counter/zone coincidence'

- **5: Positioning Completed**

  With positioning completed startup, an action is executed when the Positioning Completed input relay of the axis designated by the Startup Mode Options parameter is ON after completion of the execution of the preceding action.

  The action is executed immediately if the Positioning Completed input relay is ON when the execution of the preceding action pattern ends.

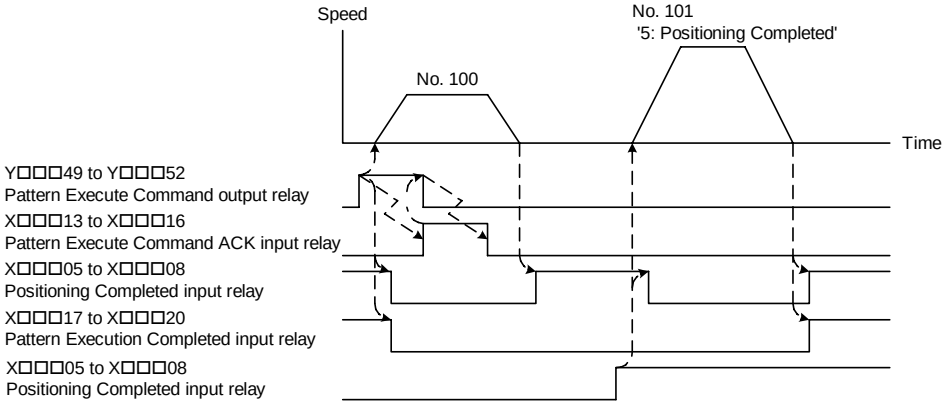


Figure 8.7 Action Execution When Startup Mode is Set to '5: Positioning Completed'

■ Precautions

- If an action is defined with a non-zero Startup Mode but the action pattern immediately preceding it is defined with an End Mode that specifies continuous movement without going through positioning completion (‘2: Pas through’ or ‘3: Pass by’), an error is generated.
- Trigger timeout processing is not performed by the module when the Startup Mode is set to any of the following values: '2: Ext. Trigger', '3: Ext. Trigger & Z-phase', '4: Counter/zone Coincidence' and '5: Positioning Completed'. Application programs should be written to handle the case where the trigger condition never becomes true.

8.1.5 End Mode

In pattern operation, the End Mode can be used to specify what to do when the execution of an action pattern ends: whether to continue with execution of the next action pattern, and if so, how movement should continue.

For the purpose of description, setup of end modes for individual actions can be classified into three scenarios (end mode setup for position control, end mode setup for speed control, end mode setup for other actions) according to the state of the movement at the end of the action as shown in Table 8.6.

Table 8.6 Action Code and End Mode

Action Code	Action	End Mode		
		Position Control	Speed Control	Other Actions
1	Linear positioning	○		
2	CI using sub point	○		
3	CW CI using center	○		
4	CCW CI using center	○		
5	Sub position			
10	Position->speed			○
11	Speed->pos. (reset)	○		
12	Speed->pos. (continue)	○		
13	Speed control		○	
15	Index positioning	○		
16	Index speed control		○	
20	Contact o/p on/off			○
21	Set current position			○
96	FOR			
97	NEXT			
98	JUMP			
99	NOP			

■ End Mode Setup for Position Control

When an action ends in position control movement, the valid End Mode options are '0: End', '1: Continue', '2: Pass through' and '3: Pass by'.

Table 8.7 End Mode for Position Control

End Code	End Mode	End Mode Options	Can Dwell-Time be Specified?
0	End	None	Yes
1	Continue	None	Yes
2	Pass through	None	No
3	Pass by	- Pass by Position: Automatic or Specify If specified, - Axes: 1 to 4 - Remaining distance for starting pass by movement	No

● 0: End

Decelerates and stops at the target position specified in position data, and ends pattern operation.

If a dwell time is specified, the Positioning Completed relay and Pattern Execution Completed relay turns on when the specified duration has elapsed.

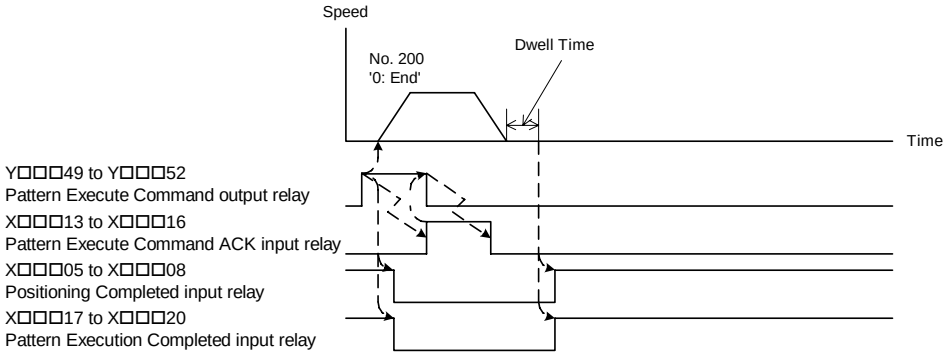


Figure 8.8 Action Pattern Execution When End Mode is Set to '0: End'

● 1: Continue

Decelerates and stops at the target position of the current action pattern, and then starts movement to the target position of the next action pattern.

If a dwell time is specified, movement to the target position of the next action pattern is delayed by the specified duration.

Positioning continues until an action pattern with End Mode set to '0: End' is encountered.

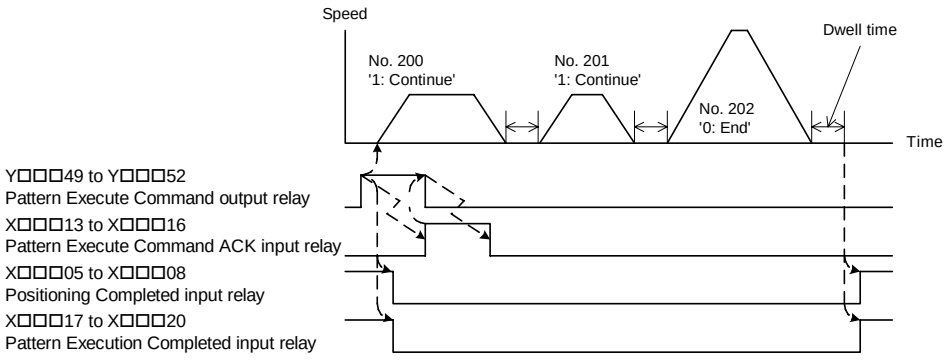


Figure 8.9 Action Pattern Execution When End Mode is Set to '1: Continue'

2: Pass through

Continues movement to the target position of the next action pattern, passing through but without decelerating and stopping at the target position of the current action pattern.

Positioning continues until an action pattern with End Mode set to '0: End' is encountered.

Execution of the next action pattern begins with the specified speed of the current action pattern. If the two action patterns have different specified speeds, the module changes to the new specified speed. The acceleration or deceleration used is the gradient obtained from the new specified speed and acceleration time of the next action pattern. (This gradient is also used for the deceleration curve if the new specified speed is lower than the speed before the pass through movement.)

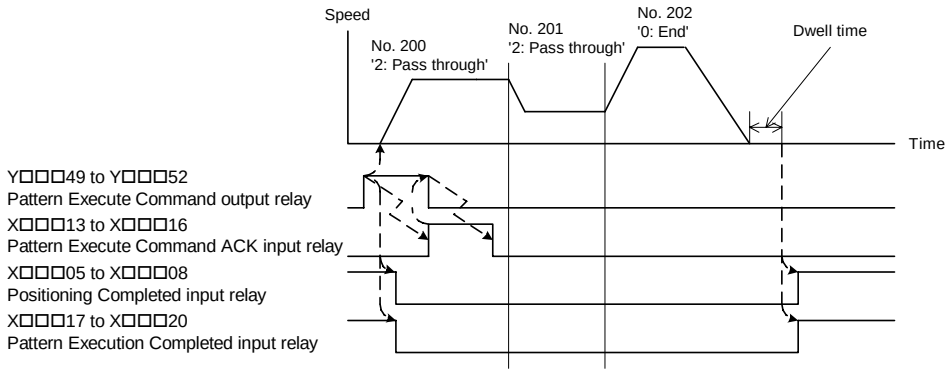


Figure 8.10 Action Pattern Execution When End Mode is Set to '2: Pass through' (Example for Single-axis Linear Interpolation)

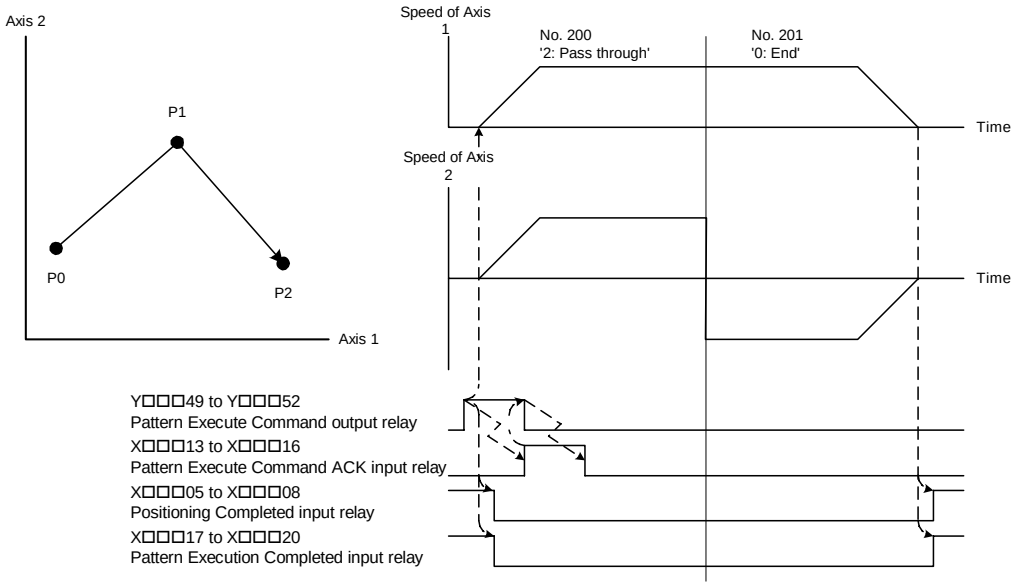


Figure 8.11 Action Pattern Execution When End Mode is Set to '2: Pass through' (Example for 2-axis Linear Interpolation)

3: Pass by

Continues movement to the target position of the next action pattern, passing by but without stopping at the target position of the current action pattern by overlapping acceleration to the target position of the next action pattern and deceleration to the target position of the current action pattern.

Positioning continues until an action pattern with End Mode set to '0: End' is encountered.

In the case of single-axis movement with a specified startup speed, the module performs pass-by movement using the same startup speed.

Normally, the starting position of the pass-by action is calculated automatically by the positioning module but it can also be specified using the End Mode Options parameter by specifying the remaining travel to the target position of the current positioning action. The starting position of the pass-by action cannot be specified, however, for circular interpolated positioning.

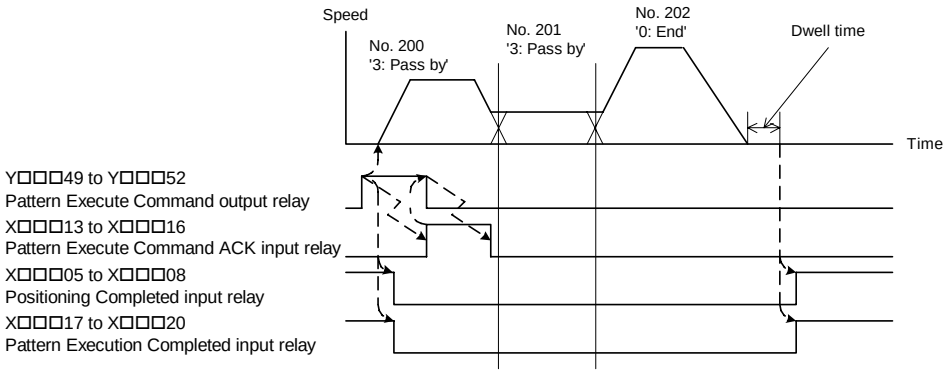


Figure 8.12 Action Pattern Execution When End Mode is Set to '3: Pass by (Example for Single-axis Linear Interpolation)

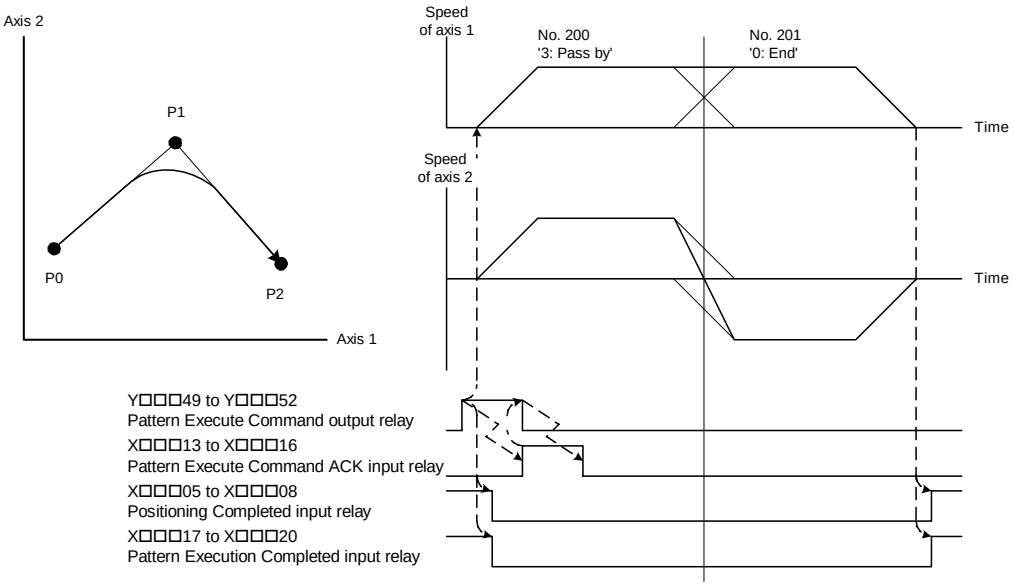


Figure 8.13 Action Pattern Execution When End Mode is Set to '3: Pass by (Example for Two-axis Linear Interpolation)

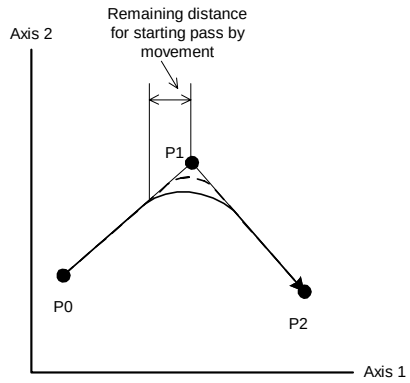


Figure 8.14 Specifying Starting Position for Pass by Movement

■ End Mode Setup for Speed Control

When an action ends in speed control movement, the valid End Mode options are '0: End', '1: Continue' and '2: Pass through'.

Table 8.8 End Modes for Speed Control

End Code	End Mode	End Mode Options	Can Dwell Time be Specified?
0	End	- Constant Speed Time: 1 to 3,600 (s)	Yes
1	Continue	- Constant Speed Time: 1 to 3,600 (s)	Yes
2	Pass through	- Constant Speed Time: 0 to 3,600 (s)	No

● 0: End

Begins with speed control movement at the specified speed of the action pattern, moves at constant speed for a duration defined by the End Mode Options parameter, then decelerates and stops movement, and finally stops pattern operation.

If a dwell time is specified, the Positioning Completed relay and Pattern Execution Completed relay turns on when the specified duration has elapsed.

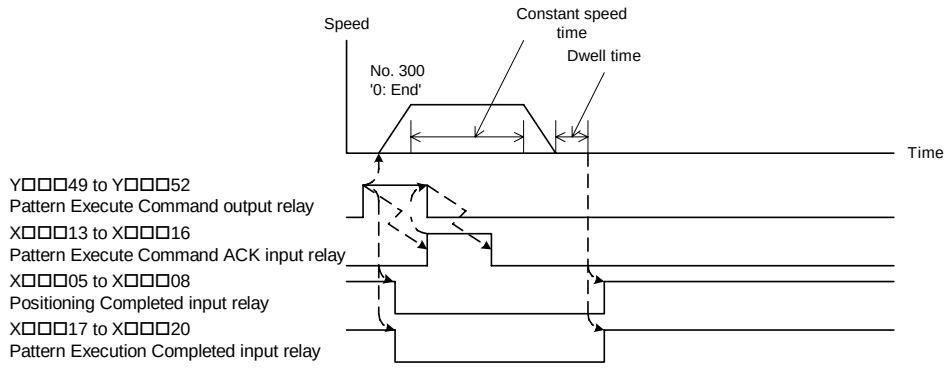


Figure 8.15 Action Pattern Execution When End Mode is Set to '0: End'

● 1: Continue

Begins with speed control movement at the specified speed of the action pattern, moves at constant speed for a duration defined by the End Mode Options parameter, and then decelerates and stops movement. After that, continues with execution of next action pattern.

If a dwell time is specified, execution of the next action pattern is delayed by the specified duration.

Pattern execution continues until an action pattern with End Mode set to '0: End' is encountered.

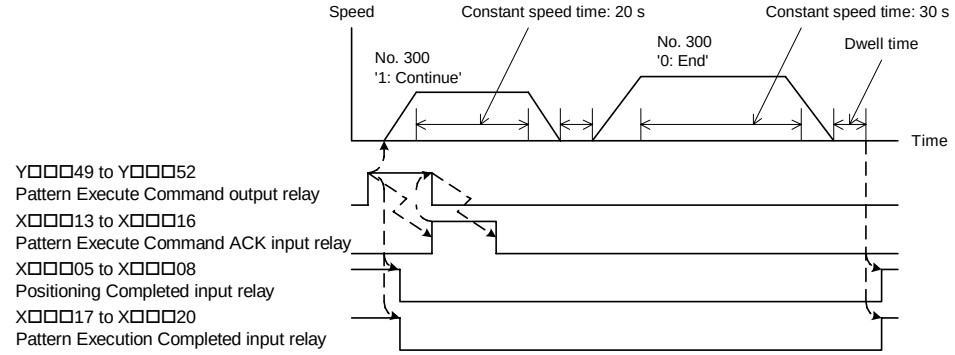


Figure 8.16 Action Pattern Execution When End Mode is Set to '1: Continue'

● 2: Pass through

Begins with speed control movement at the specified speed of the action pattern, moves at constant speed for a duration defined by the End Mode Options parameter, then continues with execution of the next action pattern.

Pattern execution continues until an action pattern with End Mode set to '0: End' is encountered.

Execution of the action pattern following pass through begins with the specified speed of the action pattern immediately preceding pass through. If the two action patterns have different specified speeds, movement changes to and maintains the new specified speed after pass through. The transition time for the speed change is the new acceleration time specified for the action pattern following pass through.

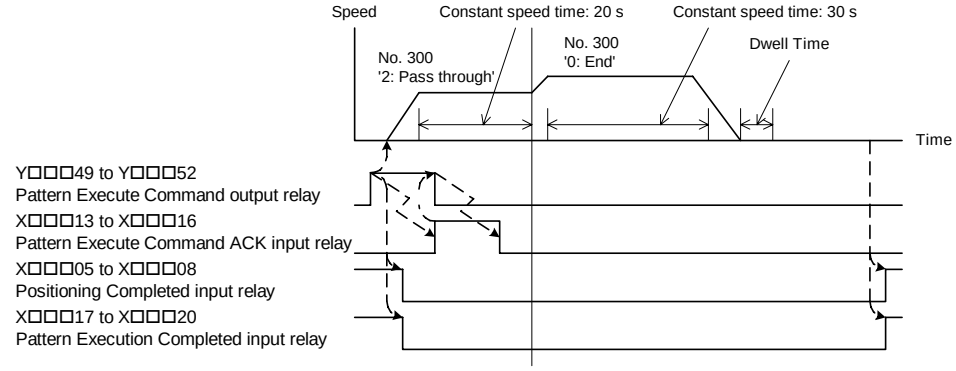


Figure 8.17 Action Pattern Execution When End Mode is Set to '2: Pass through'

■ End Mode Setup for Other Actions

Besides actions that end either in position control movement or speed control movement, the valid End Mode options for the remaining actions are '0: End' and '1: Continue'.

Table 8.9 End Modes for Other Actions

End Code	End Mode	End Mode Options	Can Dwell Time Be Specified
0	End	None	No
1	Continue	None	No

● 0: End

Stops pattern operation after executing action pattern.

● 1: Continue

Begins execution of the next action pattern after execution of the current action pattern completes.

A Contact Outputs On/off action with End Mode set to '1: Continue' can be used to turn on or turn off external contact outputs for pass by or pass through movement.

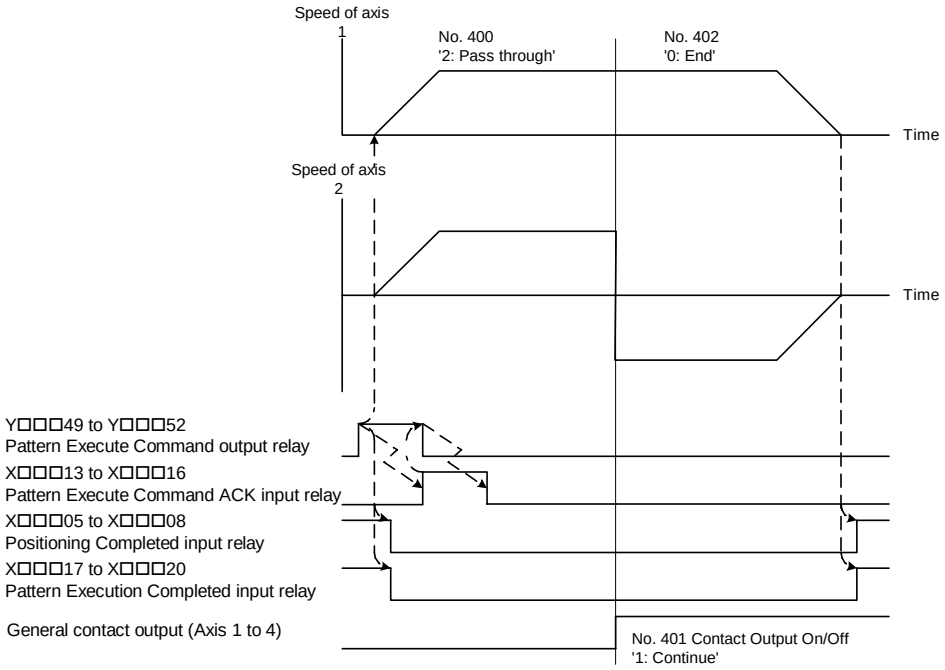


Figure 8.18 Action Pattern Execution When End Mode of Contact Outputs On/Off Action Is Set to '1: Continue'

■ Precautions

- When End Mode is set to '2: Pass through' or '3: Pass by', both actions preceding and following pass by or pass through must be specified with the same set of axes. If any of these axes is static in the action preceding pass by or pass through, set its travel distance to zero.
- If an action that ends with position control is specified with End Mode '2: Pass through' so that it continues with a second action that requires a change in movement direction, an acute reverse movement occurs. Beware that this may subject the mechanical system to a large impact under high speed conditions.

- To avoid acute reverse movement, set the End Mode to '1: Continue' or '3: Pass by'.
- When End Mode is set to '2: Pass through', the movement speed and the target position of the action following pass through may disallow the axis to stop at the target position according to the specified deceleration time. If this happens, the axis will be stopped immediately when it reaches the target position.
- When End Mode is set to '3: Pass by' for an action that ends in position control with the pass by option specifying a remaining travel to the target position for starting pass by movement, regardless of the specified value, pass by action will not begin before the action preceding pass by starts deceleration.

8.1.6 M Code

By specifying the M Code for an action pattern as a value from 1 to 32,767, a pattern operation can be suspended and later restarted by an instruction from the CPU module when external equipment completes an action.

The table below shows the action codes for which M Code can be specified.

Table 8.10 Action Codes and M Code Setup

Action Code	Action	Can M Code Be Specified?
1	Linear positioning	Yes
2	CI using sub point	Yes
3	CW CI using center	Yes
4	CCW CI using center	Yes
5	Sub position	
10	Position->speed	Yes
11	Speed->pos. (reset)	Yes
12	Speed->pos. (continue)	Yes
13	Speed control	Yes
15	Index positioning	Yes
16	Index speed control	Yes
20	Contact o/p on/off	Yes
21	Set current position	Yes
96	FOR	
97	NEXT	
98	JUMP	
99	NOP	

If an M Code is specified for an action pattern in pattern operation, the positioning module stores this value to the M Code Status of pattern operation statuses, and turns on the Pattern M Code Detected input relay at the end of the positioning action.

The CPU module checks the Pattern M Code Detected input relay, reads the value of the M Code Status of pattern operation statuses, and initiates execution of the corresponding external equipment.

After the external equipment completes execution, the CPU module turns on the Pattern Reset M Code output relay to begin execution of the next action pattern.

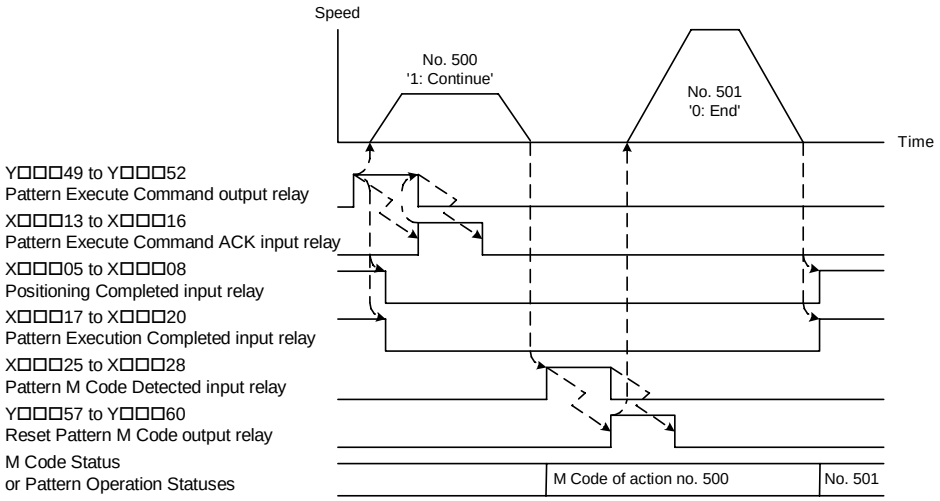


Figure 8.19 M Code Operation (for action that ends with position control)

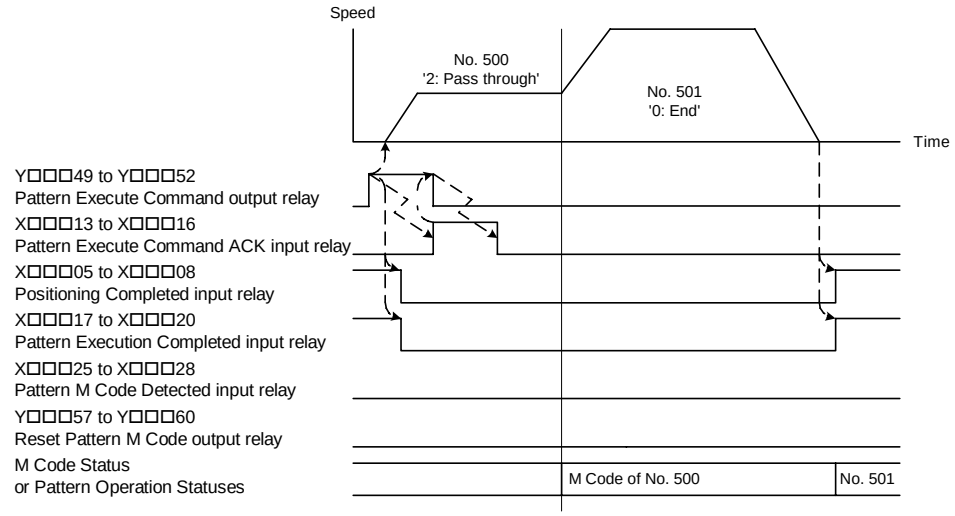


Figure 8.20 M Code Operation (for pass by or pass through movement)

■ Precautions

- If an action is specified with End Mode '2: Pass through' or '3: Pass by' to continue movement without going through positioning completion, its M Code is stored in M Code Status of pattern operation statuses and movement continues with the next action pattern. Beware that the M Code Detected input relay does not turn on in this case.

8.2 Position Control

8.2.1 Specifying Linear Interpolation

■ Function

Performs linear interpolated positioning of 1, 2, 3 or 4 axes according to the specified target position, specified speed, acceleration time and deceleration time.

- Any set of movement axes can be specified. Selecting multiple axes performs linear interpolation. Selecting only one axis performs single-axis positioning with startup speed.
- The target position can be specified as an absolute position or an incremental position using a position data number. The speed type can be specified as combined-speed or speed of a movement axis.
- The acceleration time and deceleration time normally follow preset axis registered parameter values or pattern registered parameter values but can also be specified for an individual action pattern.
- Instead of executing an action immediately after the preceding action pattern completes execution, a startup condition can be specified to delay execution until a trigger condition (e.g. timer, external trigger input, external trigger to encoder Z-phase input, counter/zone coincidence or positioning completion) becomes true.
- The End Mode can be used to specify what to do when the execution of an action pattern ends: whether to continue with execution of the next action pattern, and if so, how movement should continue.
- A dwell time at the end of the execution of the pattern action, as well as an M code can be specified.

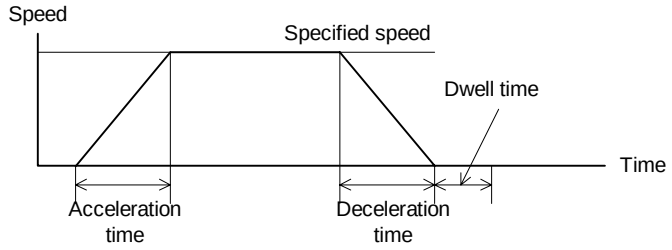


Figure 8.21 Specifying Linear Interpolation Action (An example of single axis positioning)

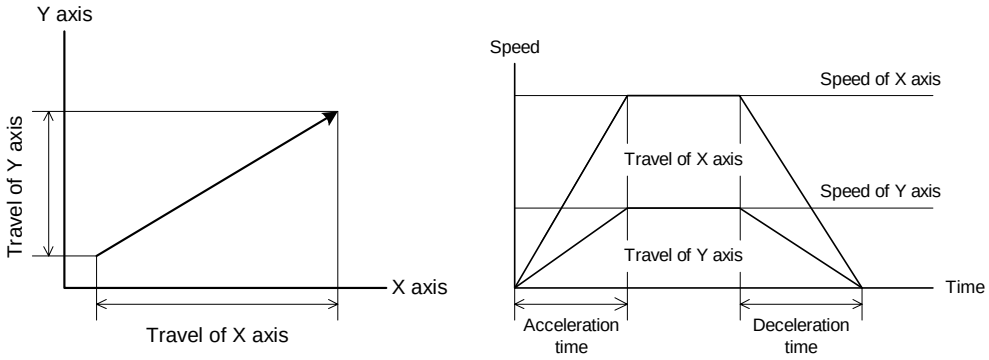


Figure 8.22 Specifying Linear Interpolation Action (An example of 2-axis linear interpolation)

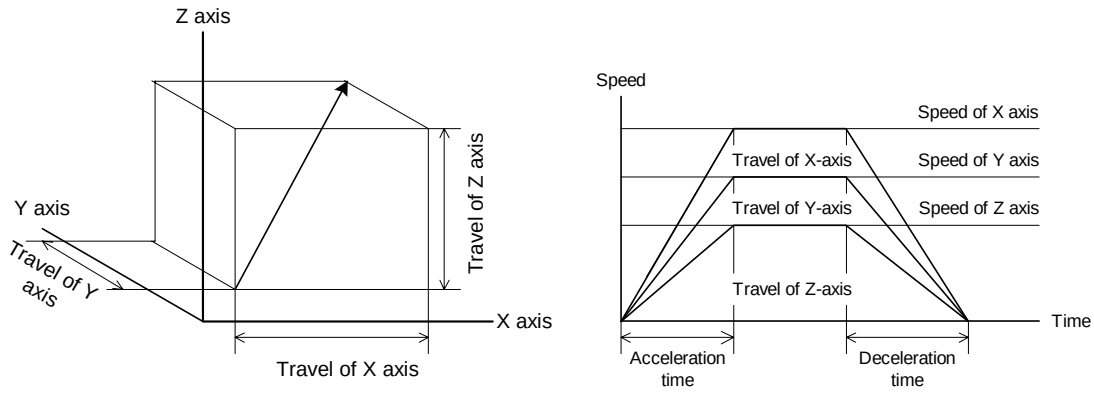


Figure 8.23 Specifying Linear Interpolation Action (An example of 3-axis linear interpolation)

■ Parameter Setup

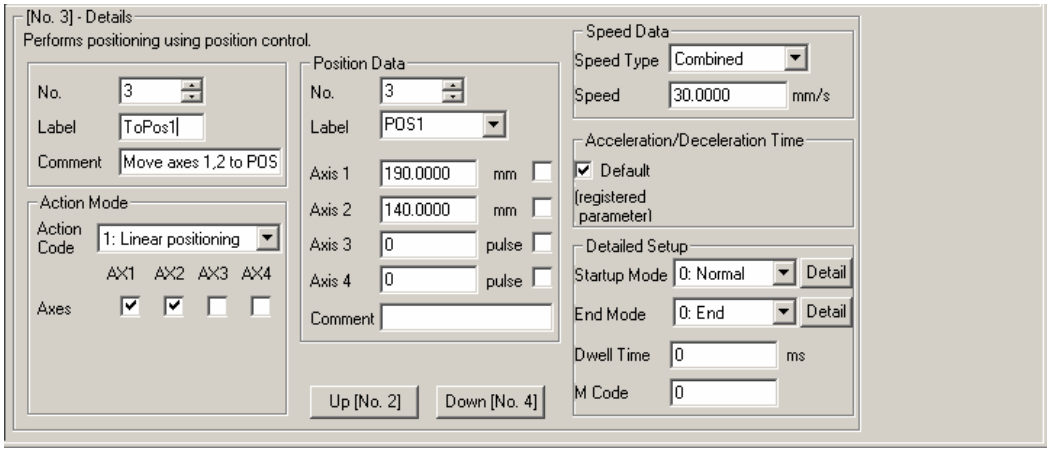


Figure 8.24 Screen for Specifying Linear Interpolation Action

● Action Mode

[Data Description]

Action Code **1: Linear positioning**
Axes **AX1, AX2, AX3, AX4**

Specify the action code and axes.

You can specify from 1 to 4 axes for concurrent movement.

Selecting only one axis performs single-axis positioning with startup speed.

● Position Data

[Data Description]

Position Data No.: 1 to No. of Position Data Records Used defined (2000 max.)

Specify the target position. The target position can be specified as an absolute position or an incremental position using a position data number.

Absolute position data specified must fall within the forward limits and reverse limits (position reference unit) of all movement axes.

Incremental position data specified must be such that the final target position falls within the forward limits and reverse limits (position reference unit) of all movement axes.

Speed Data

[Data Description]

Speed Type **Combined, Axis 1, Axis 2, Axis 3 or Axis 4**
Speed **1 to 2,147,483,647 (speed reference unit)**

Specify the speed type and speed.

The speed type can be specified as combined-speed or the speed of a movement axis.

- If the speed type is specified as combined-speed, specify the speed as the combined speed for linear interpolation.
  In this case, the specified speed must be between 1 and the Pattern Combined-speed Limit (speed reference unit).
- If the speed type is specified as an axis speed, specify the speed of the selected axis.
  In this case, the specified speed must be between 1 and the Speed Limit (speed reference unit) of the selected axis.

In the case of single-axis positioning, the specified speed, whether specified as combined-speed or axis speed, must not be lower than the Startup Speed.

In the case of multi-axis interpolation, the speed and speed limit of each movement axis must be setup.

Acceleration/Deceleration Time

[Data Description]

Acceleration Time can be specified as default or using numerical value input.
ACC **-1, 0 to 32,767 (ms)**
DCC **-1, 0 to 32,767 (ms)**

Specify the acceleration time and deceleration time.

Selecting default acceleration/deceleration selects the acceleration time and deceleration time defined by the pattern registered parameters if a combined speed is specified but selects the acceleration time and deceleration time defined by axis registered parameters if the speed of an axis is specified.

A non-default acceleration time and deceleration time can also be specified if required.

Detailed Setup

[Data Description]

Startup Mode **0 to 5**
End Mode **0 to 3**
Dwell Time **0 to 32,767 (ms)**
M Code **0 to 32,767**

Specify the startup mode, end mode, dwell time and M code.

The following table lists the available startup mode and end mode options.

Table 8.11 Startup Mode

Startup Code	Startup Mode	Startup Mode Options
0	Normal	None
1	Timer	- Timer value: 1 to 32,767 (ms)
2	External trigger	- Axes: 1 to 4
3	External trigger & Z-phase	- Axes: 1 to 4 - Z-phase Edge Selection: Rising Edge, Falling Edge - Z-phase Search Count: 1 to 255 (pulses)
4	Counter/zone coincidence	- Axes: 1 to 4
5	Positioning Completed	- Axes: 1 to 4

Table 8.12 End Modes for Position Control

End Code	End Mode	End Mode Options	Can Dwell Time be Specified?
0	End	None	Yes
1	Continue	None	Yes
2	Pass through	None	No
3	Pass by	- Pass by Position: Automatic or Specify If specified, - Axes: 1 to 4 - Remaining distance for starting pass-by movement	No

■ Precautions

- Regardless of the value of the Startup Speed axis registered parameter, interpolation is always carried out, assuming a specified startup speed of 0. (Startup speed is used when only one axis is selected.)
- When specifying a combined speed for interpolation, the unit of all interpolation axes must be set to '1: mm'.
- If an axis speed is specified, the acceleration/deceleration curve follows the axis registered parameter values of the specified axis. If a combined speed is specified, the acceleration/deceleration curve follows the axis registered parameter values of the axis with the smallest axis number among all the selected movement axes.
- If the speed limit of any axis is exceeded during interpolation, an error is generated and all axes are stopped immediately.
- The specified combined speed or axis speed should be such that no speed limit of any interpolation axis is exceeded. In particular, an inappropriate speed specified for an axis in interpolation movement may result in a short movement time and abrupt movements of the other interpolation axes.
- When End Mode is set to '2: Pass through' or '3: Pass by', both actions preceding and following pass by or pass through must be specified with the same set of axes.

8.2.2 Specifying Circular Interpolation

■ Function

Performs circular interpolated positioning of 2 axes or helical interpolated positioning of 3 or 4 axis according to the specified target position, specified speed, acceleration time and deceleration time.

- Three types of circular interpolation movement are available: circular interpolation using a sub point, CW circular interpolation using center, and CCW circular interpolation using center.
- Any set of movement axes and circular interpolation axes can be specified.
- Figure 8.25 shows the direction of movement for CW and CCW interpolations. The X-axis in this figure denotes the circular interpolation axis with the smaller axis number, while the Y-axis denotes the circular interpolation axis with the larger axis number. For instance, for circular interpolation involving axes 1 and 2, the X-axis denotes axis 1, while the Y-axis denotes axis 2; for circular interpolation involving axes 2 and 4, the X-axis denotes axis 2, while the Y-axis denotes axis 4.
- The target position can be specified as an absolute position or an incremental position using a position data number.
- The specified speed must be a combined speed.
- The acceleration time and deceleration time normally follow preset pattern registered parameter values but can also be specified for an individual action pattern.
- Instead of executing an action immediately after the preceding action pattern completes execution, a startup condition can be specified to delay execution until a trigger condition (e.g. timer, external trigger input, external trigger to encoder Z-phase input, counter/zone coincidence or positioning completion) becomes true.
- The End Mode can be used to specify what to do when the execution of an action pattern ends: whether to continue with execution of the next action pattern, and if so, how movement should continue.
- A dwell time at the end of the execution of the pattern action, as well as an M code can be specified.

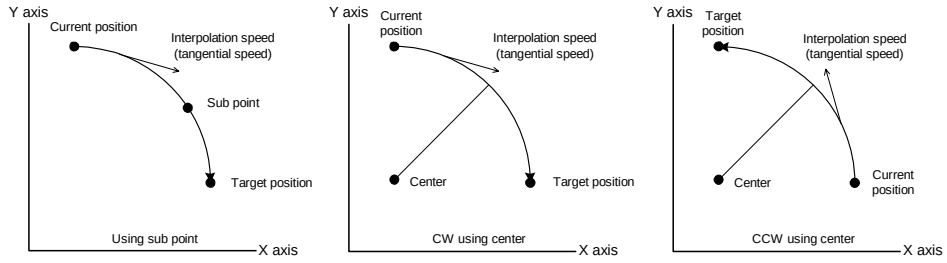


Figure 8.25 Specifying Circular Interpolation Action (An example of 2-axis circular interpolation)

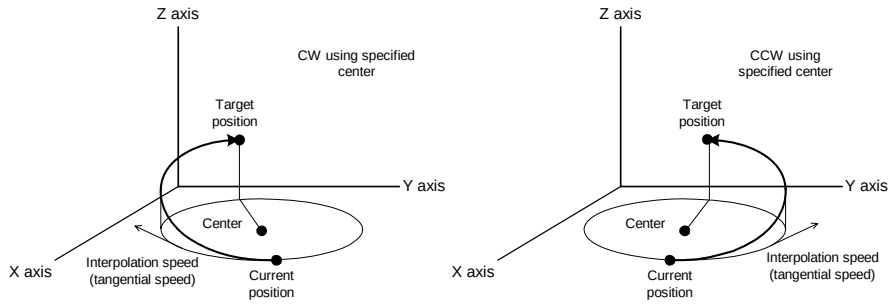


Figure 8.26 Specifying Circular Interpolation Action (An example of 3-axis helical interpolation)

■ Parameter Setup

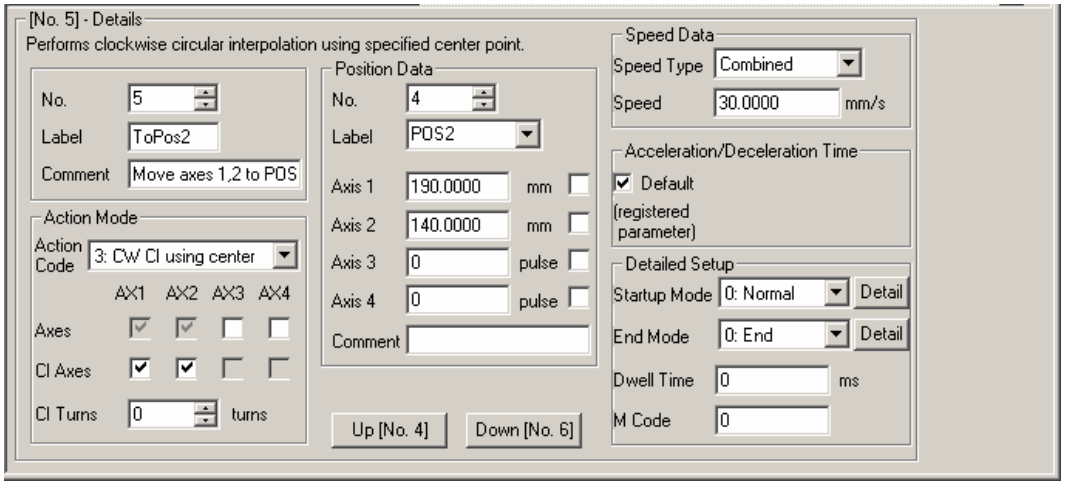


Figure 8.27 Screen for Specifying Circular Interpolation Action

● Action Mode

[Data Description]

Action Code	**2: CI using sub point**
	3: CW CI using center
	4: CCW CI using center
Axes	**AX1, AX2, AX3, AX4**
CI Axes	**AX1, AX2, AX3, AX4**
CI Turns	**0 to 32,767 (pulses)**

Specify the action code, axes and circular interpolation turns.

You can specify from 2 to 4 axes for concurrent motion.

You must specify two axes to be used as CI Axes for circular interpolation.

Setting CI Turns to zero moves directly to the target position without making any turns.

Setting CI Turns to a non-zero integer rotates for the specified number of turns from the starting position before moving to the target position.

Position Data

[Data Description]

Position Data No.: 1 to No. of Position Data Records Used defined (2000 max.)

Specify the target position. The target position can be specified as an absolute position or an incremental position using a position data number.

Absolute position data specified must fall within the forward limits and reverse limits (position reference unit) of all movement axes.

Incremental position data specified must be such that the final target position falls within the forward limits and reverse limits (position reference unit) of all movement axes.

Speed Data

[Data Description]

Speed Type Combined
Speed 1 to Pattern Combined-speed Limit (speed reference unit)

Specify the speed type and speed.

Specify the speed type as combined speed, which refers to the tangential speed along the circular path.

Acceleration/Deceleration Time

[Data Description]

Acceleration Time can be specified as default or using numerical value input.
ACC -1, 0 to 32,767 (ms)
DCC -1, 0 to 32,767 (ms)

Specify the acceleration time and deceleration time.

Selecting default acceleration/deceleration selects the acceleration time and deceleration time defined by the pattern registered parameters.

A non-default acceleration time and deceleration time can also be specified if required.

Detailed Setup

[Data Description]

Startup Mode 0 to 5
End Mode 0 to 3
Dwell Time 0 to 32,767 (ms)
M Code 0 to 32,767

Specify the startup mode, end mode, dwell time and M code.

The following table lists the available startup mode and end mode options.

Table 8.13 Startup Mode

Startup Code	Startup Mode	Startup Mode Options
0	Normal	None
1	Timer	- Timer value: 1 to 32,767 (ms)
2	External trigger	- Axes: 1 to 4
3	External trigger & Z-phase	- Axes: 1 to 4 - Z-phase Edge Selection: Rising Edge, Falling Edge - Z-phase Search Count: 1 to 255 (pulses)
4	Counter/zone coincidence	- Axes: 1 to 4
5	Positioning Completed	- Axes: 1 to 4

Table 8.14 End Modes for Position Control

End Code	End Mode	End Mode Options	Can Dwell Time Be Specified?
0	End	None	Yes
1	Continue	None	Yes
2	Pass through	None	No
3	Pass by	None (Pass by Position: always Automatic)	No

- **Sub position**

  [Data Description]

  Position Data No.: 1 to No. of Position Data Records Used defined (2000 max.)

  Specify a sub position for circular interpolation. The sub position for circular interpolation can be specified as an absolute position or an incremental position using a position data number.

  Absolute sub position data specified must fall within the forward limits and reverse limits (position reference unit) of all movement axes.

  Incremental sub position data specified must be such that the final sub position falls within the forward limits and reverse limits (position reference unit) of all movement axes.

■ Precautions

- Regardless of the value of the Startup Speed axis registered parameter, interpolation is always carried out, assuming a specified startup speed of 0.
- Set the unit of the two axes involved in the circular interpolation to '1: mm'.
- The acceleration/deceleration curve follows the axis registered parameter values of the axis with the smallest axis number among all movement axes.
- If the speed limit of any axis is exceeded during interpolation, an error is generated and all axes are stopped immediately.

  The specified tangential speed along the circular path should be such that no speed limit of any interpolation axis is exceeded. (The tangential speed may sometimes exceed a speed limit during circular interpolation due to internal computational error. As such, it is recommended that some allowance be included when setting the speed limit of each axis. This phenomenon tends to occur when circular interpolation using a specified center point follows a whorl-like path.)
- The Forward Limit and Reverse Limit may be exceeded during circular interpolation. If this happens, an error is generated and all axes are stopped immediately.
- When performing circular interpolation using a specified center point, depending on the center position and the target position, a deviation may arise between the circular path and the target position. If this deviation exceeds the circular interpolation error tolerance defined by the CI Error Tolerance parameter, an error is generated and interpolation is not performed. If the deviation falls within the error tolerance, circular interpolation follows a whorl-like path.
- In circular interpolation using sub point, the radius of the circular path must not exceed the maximum value that can be represented using 32 bits.
- When End Mode is set to '2: Pass through' or '3: Pass by', both actions preceding and following pass by or pass through must be specified with the same set of axes.

8.3 Speed Control

8.3.1 Specifying Position Control to Speed Control Switchover

■ Function

Switches from position control mode to speed control mode to prepare for execution of speed control movements.

- Any set of movement axes can be specified.
- The End Mode can be used to specify what to do when the execution of an action pattern ends: whether to continue with execution of the next action pattern, and if so, how movement should continue.
- An M Code at the end of the execution of the action pattern can be specified.

■ Parameter Setup

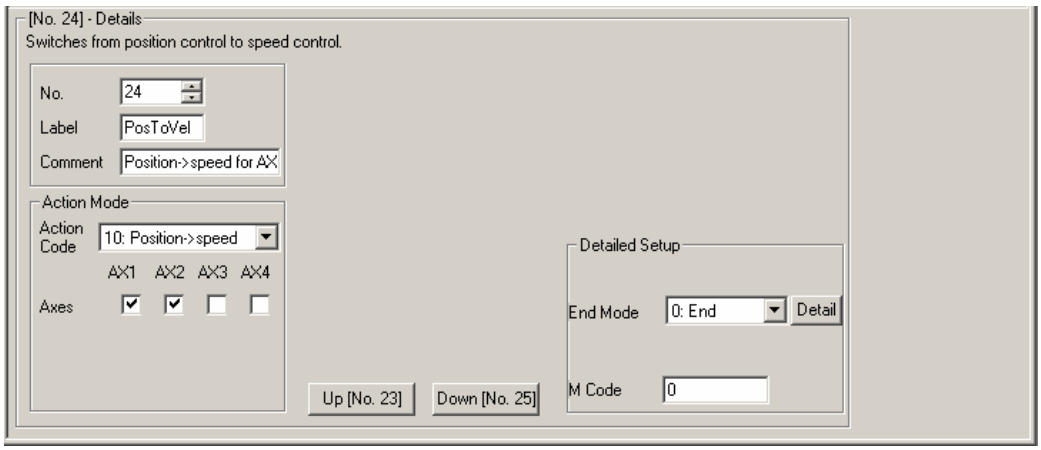


Figure 8.28 Screen for Specifying Position Control to Speed Control Action

● Action Mode

[Data Description]

Action Code **10: Position->speed**
Axes **AX1, AX2, AX3, AX4**

Specify the action code and axes.

You can specify from 1 to 4 axes for concurrent switchover.

● Detailed Setup

[Data Description]

End Mode **0 to 1**
M Code **0 to 32,767**

Specify the end mode and M code.

The following table lists the available end mode options.

Table 8.15 End Modes for Other Actions

End Code	End Mode	End Mode Options	Can Dwell Time Be Specified?
0	End	None	No
1	Continue	None	No

■ Precautions

- All axes are in position control mode immediately after power up. To perform speed control movements, you must first specify and execute a Position Control to Speed Control action. Beware of restrictions on certain functions (jog, manual pulse generator mode, etc.) in speed control mode.
- Forward limit and reverse limit defined by axis registered parameters are ignored during speed control movement.
- Do not specify consecutive execution of more than ten pattern actions that do not turn off the Positioning Completed relay (NOP, JUMP, FOR, NEXT, Set Current Position, Contact Outputs On/Off and Position Control to Speed Control). Doing so will generate an error during pattern operation and stops pattern operation immediately. This restriction is built into the module to avoid infinite loops.

8.3.2 Specifying Speed Control to Position Control Switchover

■ Function

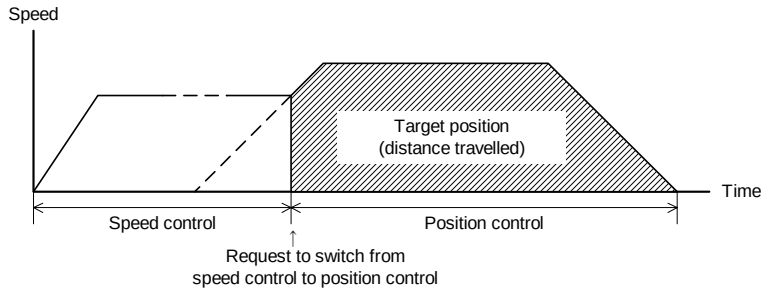
Switches an axis from speed control mode to position control mode, and then moves it to the target position.

You can choose to reset the current position to zero or to continue with the current position value at the point of switchover by selecting the appropriate action code.

- Only one axis can be specified for this action.
- Even if the specified axis is in Positioning Completed state in Speed Control mode, this action switches the axis to position control mode and moves it to the target position.

  (Take note that this behavior is different from that of a Speed Control to Position Control command executed in direct operation.)
- The target position can be specified as an absolute position or an incremental position using a position data number.
- Specify the speed as the speed of the movement axis.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual action pattern.
- Instead of executing an action immediately after the preceding action pattern completes execution, a startup condition can be specified to delay execution until a trigger condition (e.g. timer, external trigger input, external trigger to encoder Z-phase input, counter/zone coincidence or positioning completion) becomes true.
- The End Mode can be used to specify what to do when the execution of an action pattern ends: whether to continue with execution of the next action pattern, and if so, how movement should continue.
- A dwell time at the end of the execution of the pattern action, as well as an M code can be specified.

- **If Z-phase Search Count is zero:**



- **If Z-phase Search Count is non zero**
  (Z-phase Edge Selection='Rising Edge' and Z-phase Search Count=2):

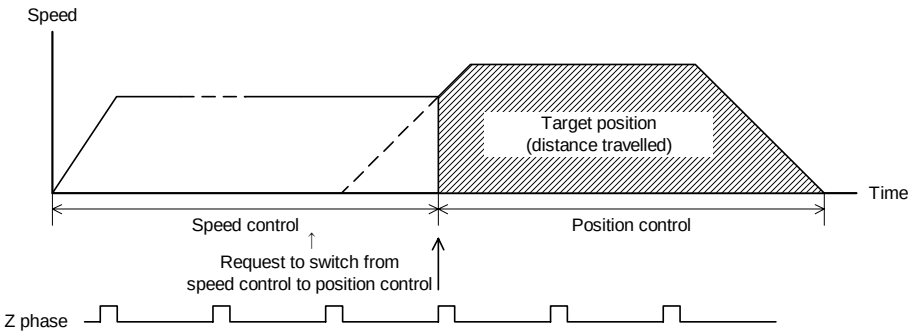


Figure 8.29 Specifying Speed Control to Position Control Switchover

■ Parameter Setup

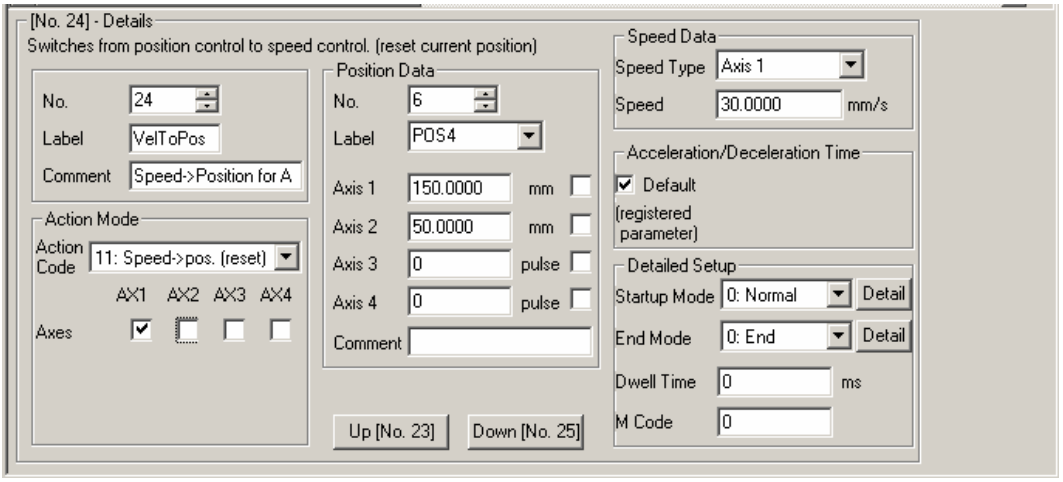


Figure 8.30 Screen for Specifying Speed Control to Position Control Action

● Action Mode

[Data Description]

Action Code **11: Speed->pos. (reset)**
12: Speed->pos. (continue)
Axes **AX1, AX2, AX3, AX4**

Specify the appropriate action code and axes. You must select one and only one axis in [Axes].

● Position Data

[Data Description]

Position Data No.: 1 to No. of Position Data Records Used defined (2000 max.)

Specify the target position. The target position can be specified as an absolute position or an incremental position using a position data number.

Absolute position data specified must fall within the forward limits and reverse limits (position reference unit) of the movement axis.

Incremental position data specified must be such that the final target position falls within the forward limits and reverse limits (position reference unit) of the movement axis.

● Speed Data

[Data Description]

Speed Type **Axis 1, Axis 2, Axis 3 or Axis 4**
Speed **Startup Speed to Speed Limit (speed reference unit)**

Specify the speed type and speed.

The speed type can only be specified as the speed of a movement axis.

● Acceleration/Deceleration Time

[Data Description]

Acceleration Time can be specified as default or using numerical value input.
ACC **-1, 0 to 32,767 (ms)**
DCC **-1, 0 to 32,767 (ms)**

Specify the acceleration time and deceleration time.

Selecting default acceleration/deceleration time selects the acceleration time and deceleration time defined by the axis registered parameters.

A non-default acceleration time and deceleration time can also be specified if required.

- **Detailed Setup**

[Data Description]

Startup Mode	**0 to 5**
End Mode	**0 to 3**
Dwell Time	**0 to 32,767 (ms)**
M Code	**0 to 32,767**

Specify the startup mode, end mode, dwell time and M code.

The following table lists the available startup mode and end mode options.

Table 8.16 Startup Mode

Startup Code	Startup Mode	Startup Mode Options
0	Normal	None
1	Timer	- Timer value: 1 to 32,767 (ms)
2	External trigger	- Axes: 1 to 4
3	External trigger & Z-phase	- Axes: 1 to 4 - Z-phase Edge Selection: Rising Edge, Falling Edge - Z-phase Search Count: 1 to 255 (pulses)
4	Counter/zone coincidence	- Axes: 1 to 4
5	Positioning Completed	- Axes: 1 to 4

Table 8.17 End Modes for Position Control

End Code	End Mode	End Mode Options	Can Dwell Time Be Specified?
0	End	None	Yes
1	Continue	None	Yes
2	Pass through	None	No
3	Pass by	- Pass by Position: Automatic or Specify If specified, - Axes: 1 to 4 - Remaining distance for starting pass by movement	No

■ Precautions

- All axes are in position control mode immediately after power up. To perform speed control movements, you must first specify and execute a Position Control to Speed Control action.
- Forward limit and reverse limit defined are ignored during speed control movement.
- When End Mode is set to '2: Pass through' or '3: Pass by', both actions preceding and following pass by or pass through must be specified with the same set of interpolation axes.
- Even if the specified axis is in Positioning Completed state in Speed Control mode, this action switches the axis to position control mode and moves it to the target position.

  (Take note that this behavior is different from that of a Speed Control to Position Control command executed in direct operation.)
- When switching from speed control to position control during speed control movement, positioning will continue to the new target position according to the new acceleration/deceleration curve and other parameter values. If the module determines that the new parameter values do not allow the axis to stop at the target position normally, it first decelerates and stops the axis before re-initiating movement in the reverse direction. (This is often the case when there is a change in direction of movement, but can also happen when there is no change in direction of movement if the new target position happens to be very close to the current position.)

- If the specified speed is changed when switching from speed control to position control during speed control movement, the acceleration used for the speed change is the gradient obtained using the new specified speed and acceleration time. (This gradient is also used for the deceleration curve if the new specified speed is lower than the speed before the change.)

8.3.3 Specifying Linear Speed Control Movement

■ Function

Performs linear interpolated speed control movement of 1, 2, 3 or 4 axes according to the specified speed, acceleration time and deceleration time of an action pattern.

- Any set of movement axes can be specified. Selecting multiple axes performs linear interpolated speed control movement. Selecting only one axis performs single-axis speed control movement with startup speed.
- The sign of the specified speed determines the direction of rotation.
- Instead of executing an action immediately after the preceding action pattern completes execution, a startup condition can be specified to delay execution until a trigger condition (e.g. timer, external trigger input, external trigger to encoder Z-phase input, counter/zone coincidence or positioning completion) becomes true.
- The End Mode can be used to specify what to do when the execution of an action pattern ends: whether to continue with execution of the next action pattern, and if so, how movement should continue.
- A dwell time at the end of the execution of the pattern action, as well as an M code can be specified.

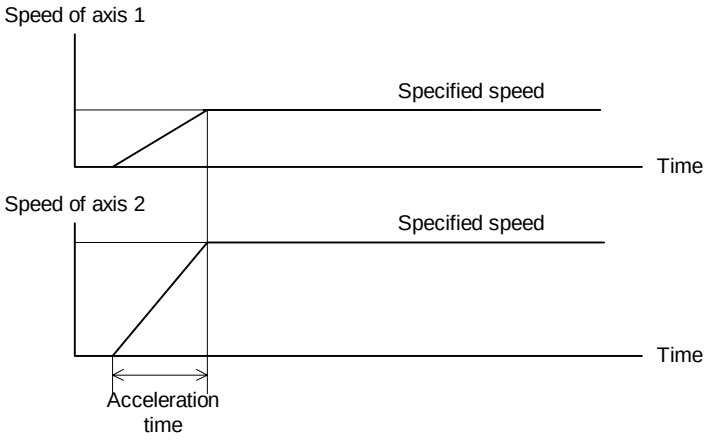


Figure 8.31 Specifying Linear Speed Control Movement

■ Parameter Setup

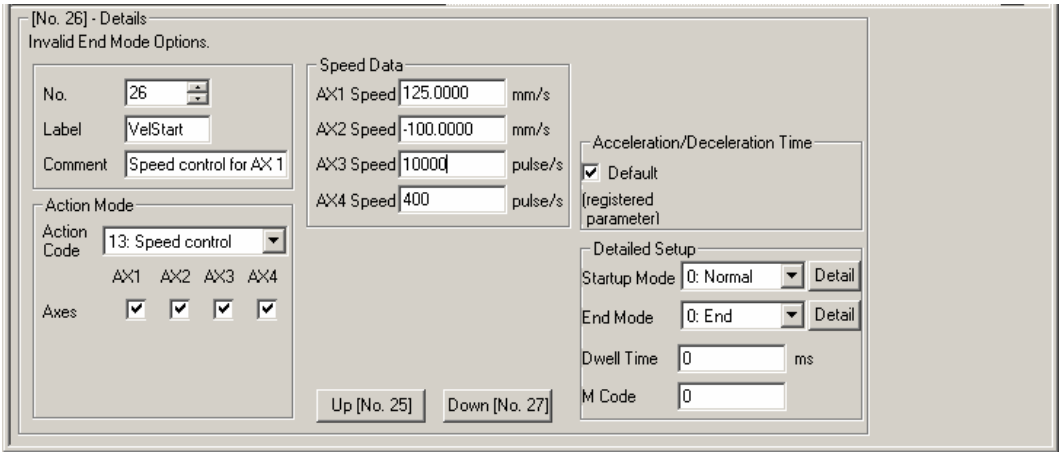


Figure 8.32 Screen for Specifying Linear Speed Control Movement

● Action Mode

[Data Description]

Action Code **13: Speed control**
Axes **AX1, AX2, AX3, AX4**

Specify the action code and axes.

You can specify from 1 to 4 axes for concurrent movement.

Selecting only one axis performs single-axis speed-control movement.

● Speed Data

[Data Description]

AX1 Speed **-(Speed Limit) to (Speed Limit) (speed reference unit)**
AX2 Speed **-(Speed Limit) to (Speed Limit) (speed reference unit)**
AX3 Speed **-(Speed Limit) to (Speed Limit) (speed reference unit)**
AX4 Speed **-(Speed Limit) to (Speed Limit) (speed reference unit)**

Specify the target speed for each movement axis. For single-axis speed control movement, the specified speed must not be lower than the startup speed. Specified speed must be non-zero.

● Acceleration/Deceleration Time

[Data Description]

Acceleration Time can be specified as default or using numerical value input.
ACC **-1, 0 to 32,767 (ms)**
DCC **-1, 0 to 32,767 (ms)**

Specify the acceleration time and deceleration time.

If you select default acceleration/deceleration time, the module computes the acceleration time and deceleration time of each movement axis using its specified speed, as well as its Default Acceleration Time and Default Deceleration Time axis registered parameters, and selects the longest acceleration time and deceleration time from the computed values.

- **Detailed Setup**

[Data Description]

Startup Mode	**0 to 5**
End Mode	**0 to 2**
Dwell Time	**0 to 32,767 (ms)**
M Code	**0 to 32,767**

Specify the startup mode, end mode, dwell time and M code.

The following table lists the available startup mode and end mode options.

Table 8.18 Startup Mode

Startup Code	Startup Mode	Startup Mode Options
0	Normal	None
1	Timer	- Timer value: 1 to 32,767 (ms)
2	External trigger	- Axes: 1 to 4
3	External trigger & Z-phase	- Axes: 1 to 4 - Z-phase Edge Selection: Rising Edge, Falling Edge - Z-phase Search Count: 1 to 255 (pulses)
4	Counter/zone coincidence	- Axes: 1 to 4
5	Positioning Completed	- Axes: 1 to 4

Table 8.19 End Modes for Speed Control

End Code	End Mode	End Mode Options	Can Dwell Time Be Specified?
0	End	- Constant Speed Time: 1 to 3,600 (s)	Yes
1	Continue	- Constant Speed Time: 1 to 3,600 (s)	Yes
2	Pass through	- Constant Speed Time: 0 to 3,600 (s)	No

■ Precautions

- All axes are in position control mode immediately after power up. To perform speed control movements, you must first specify and execute a Position Control to Speed Control action.
- Forward limit and reverse limit defined by axis registered parameters are ignored during speed control movement.
- The current position is continually updated during speed control movement, and operates as a 32-bit ring counter if and when an overflow occurs. (In reverse direction movement, if the current position falls below –2,147,483,648, decrement restarts from 2,147,483,647; in forward direction movement, if the current position exceeds 2,147,483,647, increment restarts from –2,147,483,648)
- When End Mode is set to '2: Pass through', both actions preceding and following pass through must be specified with the same set of axes.
- The acceleration/deceleration curve follows the axis registered parameter values of the axis with the smallest axis number among all movement axes.

8.4 Index Control

This section describes index control.

An axis with Index Control axis registered parameter set to ‘1: Index control’ will be subject to index control.

Forward limit input error, reverse limit input error, forward limit error and reverse limit error are not reported for an axis subject to index control.

8.4.1 Specifying Index Positioning

■ Function

Performs single-axis positioning of an axis with Index Control axis registered parameter set to ‘1: Index control’ at a specified target position, specified speed, acceleration time and deceleration time.

- The target position can be specified using an absolute position, an incremental position or a position data number.

  If specified using an absolute position, the specified target position should be greater than or equal to 0 and smaller than the Index Range (in position reference unit), and the module moves the axis to the target position using the shortest path.

  If specified using an incremental position, the sign of the target position indicates the direction of rotation. Multiple rotations can be achieved by specifying an incremental target position that exceeds the index range.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual action.

  A dwell time at the end of positioning can be specified.

  A startup speed can be specified using an axis registered parameter.
- Instead of starting positioning immediately after command execution, a startup condition can be specified to delay positioning until a trigger condition (e.g. external trigger input, external trigger to encoder Z-phase input, or counter/zone coincidence) becomes true.
- The End Mode can be used to specify what to do when the execution of an action pattern ends: whether to continue with execution of the next action pattern, and if so, how movement should continue.
- A dwell time at the end of the execution of the pattern action or an M code can be specified.

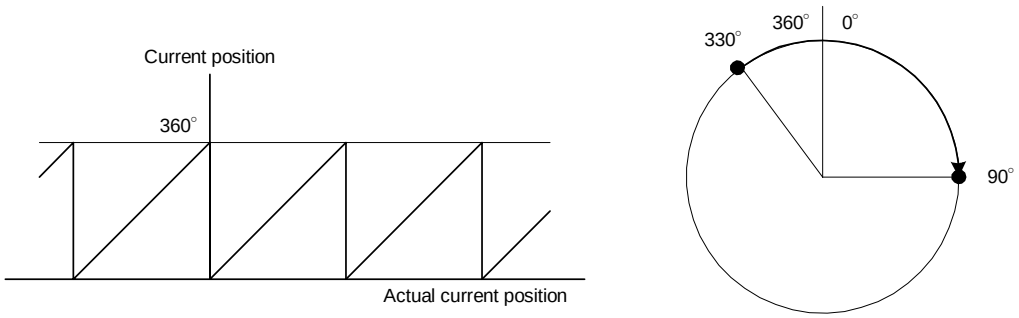


Figure 8.33 Specifying Index Positioning (example with index range of 0 to 360°)

Table 8.20 describes the behavior of index positioning under index speed control.

Table 8.20 Detailed Operation of Index Positioning Command

State When Command is Executed	Position Reference	Operation
Index speed control	Absolute position	Stops at the target position without changing direction of movement. Rotates beyond one revolution if necessary to achieve normal stop according to the deceleration curve.
Index speed control	Incremental position	Computes the new target position using the current position at the time of command execution and the specified incremental distance. From the computation, if a change in direction is required, or if a normal stop according to the deceleration curve cannot be achieved, decelerates and stops before restarting movement to the new target position.

■ Parameter Setup

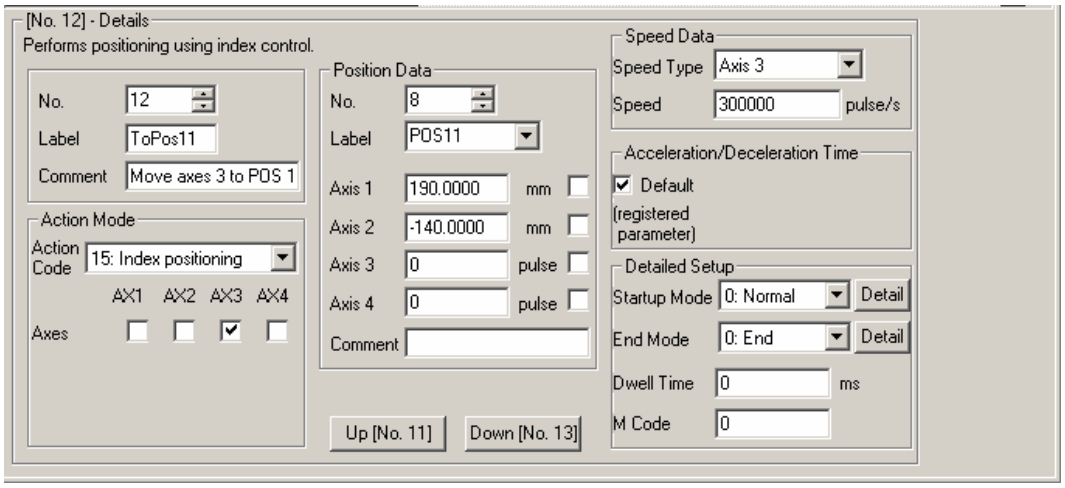


Figure 8.34 Screen for Specifying Index Positioning

● Action Mode

[Data Description]

Action Code **15: Index positioning**
Axes **AX1, AX2, AX3, AX4**

Specify the action code and axes.

You must select one and only one movement axis in [Axes].

● Position Data

[Data Description]

Position Data No.: 1 to No. of Position Data Records Used defined (2000 max.)

Specify the target position. The target position can be specified as an absolute position or an incremental position using a position data number.

Absolute position data specified must be between 0 (inclusive) and the Index Range (position reference unit).

● Speed Data

[Data Description]

Speed Type **Axis 1, Axis 2, Axis 3 or Axis 4**
Speed **Startup Speed to Speed Limit (speed reference unit)**

Specify the speed type and speed.

The speed type can only be specified as the speed of a movement axis.

● Acceleration/Deceleration Time

[Data Description]

Acceleration Time can be specified as default or using numerical value input.

ACC -1, 0 to 32,767 (ms)
DCC -1, 0 to 32,767 (ms)

Specify the acceleration time and deceleration time.

Selecting default acceleration/deceleration time selects the acceleration time and deceleration time defined by the axis registered parameters.

A non-default acceleration time and deceleration time can also be specified if required.

● Detailed Setup

[Data Description]

Startup Mode 0 to 5
End Mode 0 to 3
Dwell Time 0 to 32,767 (ms)
M Code 0 to 32,767

Specify the startup mode, end mode, dwell time and M code.

The following table lists the available startup mode and end mode options.

Table 8.21 Startup Mode

Startup Code	Startup Mode	Startup Mode Options
0	Normal	None
1	Timer	- Timer value: 1 to 32,767 (ms)
2	External trigger	- Axes: 1 to 4
3	External trigger & Z-phase	- Axes: 1 to 4 - Z-phase Edge Selection: Rising Edge, Falling Edge - Z-phase Search Count: 1 to 255 (pulses)
4	Counter/zone coincidence	- Axes: 1 to 4
5	Positioning Completed	- Axes: 1 to 4

Table 8.22 End Modes for Position Control

End Code	End Mode	End Mode Options	Can Dwell Time Be Specified?
0	End	None	Yes
1	Continue	None	Yes
2	Pass through	None	No
3	Pass by	- Pass by Position: Automatic or Specify If specified, - Axes: 1 to 4 - Remaining distance for starting pass by movement	No

■ Precautions

- Index Range of axis registered parameters should be set to a value such that the number of pulses after electronic gear conversion is an integer. Any fractional value may result in a deviation beyond one rotation.
- Forward limit and reverse limit defined by axis registered parameters are ignored during index positioning movement.
- Forward limit and reverse limit input errors are not detected during index positioning movement.
- The value of Current Position Status of axis statuses during index positioning ranges between 0 (inclusive) and the preset Index Range.
- When End Mode is set to '2: Pass through' or '3: Pass by', both actions preceding and following pass by or pass through must be specified with the same set of axes.

- If an index positioning movement was stopped by a Decelerate and Stop Pattern Operation command and then restarted, beware that movement continues to the last target position in absolute position mode regardless of whether the last target position was specified as an incremental position or absolute position.

8.4.2 Specifying Index Speed Control Movement

■ Function

Performs single-axis speed control movement of an axis with Index Control axis registered parameter set to '1: Index control' at a specified speed, acceleration time and deceleration time.

- Only one axis can be specified for this action.
- The sign of the specified speed determines the direction of rotation.
- The acceleration time and deceleration time normally follow preset axis registered parameter values but can also be specified for an individual action pattern.
- Instead of executing an action immediately after the preceding action pattern completes execution, a startup condition can be specified to delay execution until a trigger condition (e.g. timer, external trigger input, external trigger to encoder Z-phase input, counter/zone coincidence or positioning completion) becomes true.
- The End Mode can be used to specify what to do when the execution of an action pattern ends: whether to continue with execution of the next action pattern, and if so, how movement should continue.
- A dwell time at the end of the execution of the pattern action or an M code can be specified.

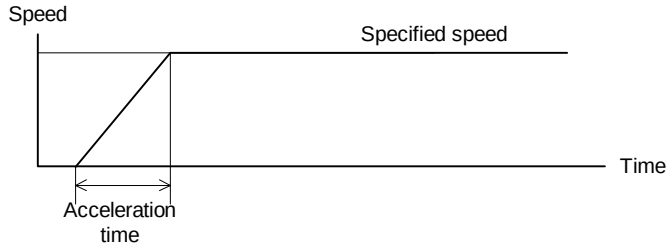


Figure 8.35 Specifying Index Speed Control Movement

■ Parameter Setup

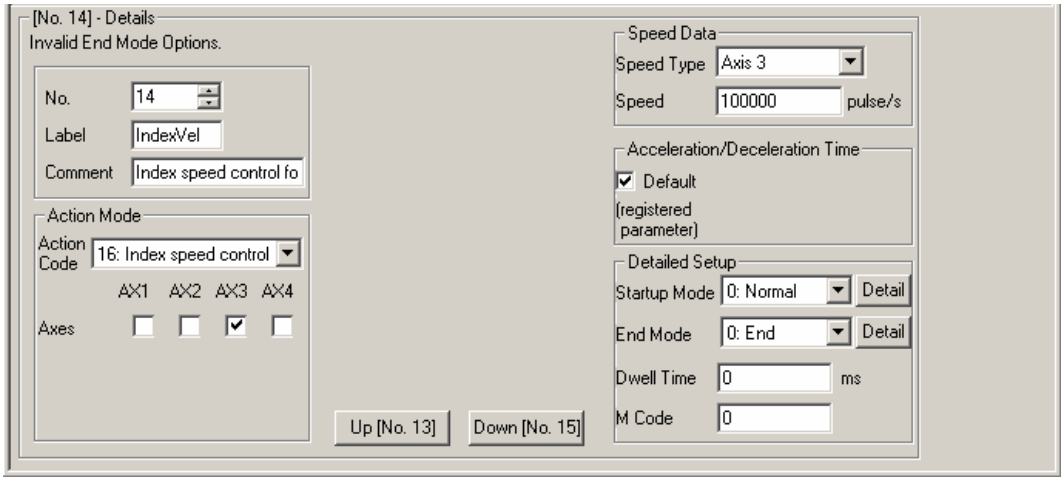


Figure 8.36 Screen for Specifying Index Speed Control Movement

Action Mode

[Data Description]

Action Code **16: Index speed control**
Axes **AX1, AX2, AX3, AX4**

Specify the action code and axes.

You must select one and only one movement axis in [Axes].

Speed Data

[Data Description]

Speed Type **Axis 1, Axis 2, Axis 3 or Axis 4**
Speed **-(Speed Limit) to (Speed Limit) (speed reference unit)**

Specify the speed type and speed. The speed type can only be specified as the speed of a movement axis. The specified speed must be non-zero and cannot be lower than the startup speed.

Acceleration/Deceleration Time

[Data Description]

Acceleration Time can be specified as default or using numerical value input.
ACC **-1, 0 to 32,767 (ms)**
DCC **-1, 0 to 32,767 (ms)**

Specify the acceleration time and deceleration time.

Selecting default acceleration/deceleration time selects the acceleration time and deceleration time defined by the axis registered parameters.

A non-default acceleration time and deceleration time can also be specified if required.

Detailed Setup

[Data Description]

Startup Mode **0 to 5**
End Mode **0 to 2**
Dwell Time **0 to 32,767(ms)**
M Code **0 to 32,767**

Specify the startup mode, end mode, dwell time and M code.

The following table lists the available startup mode and end mode options.

Table 8.23 Startup Mode

Startup Code	Startup Mode	Startup Mode Options
0	Normal	None
1	Timer	- Timer value: 1 to 32,767 (ms)
2	External trigger	- Axes: 1 to 4
3	External trigger & Z-phase	- Axes: 1 to 4 - Z-phase Edge Selection: Rising Edge, Falling Edge - Z-phase Search Count: 1 to 255 (pulses)
4	Counter/zone coincidence	- Axes: 1 to 4
5	Positioning Completed	- Axes: 1 to 4

Table 8.24 End Modes for Speed Control

End Code	End Mode	End Mode Options	Can Dwell Time Be Specified?
0	End	- Constant Speed Time: 1 to 3,600 (s)	Yes
1	Continue	- Constant Speed Time: 1 to 3,600 (s)	Yes
2	Pass through	- Constant Speed Time: 0 to 3,600 (s)	No

■ Precautions

- Index Range of axis registered parameters should be set to a value such that the number of pulses after electronic gear conversion is an integer. Any fractional value may result in a deviation beyond one rotation.
- Forward limit and reverse limit defined by axis registered parameters are ignored during index speed control movement.
- Forward limit and reverse limit input errors are not detected during index speed control movement.
- The value of Current Position Status of axis statuses during index speed control movement ranges between 0 (inclusive) and the preset Index Range.
- When End Mode is set to '2: Pass through', both actions preceding and following pass through must be specified with the same set of axes.

8.5 Specifying Contact Outputs On/Off

■ Function

Turns on or turns off external contact outputs set to '1: Used As General Input/Output' by Contact Usage Selection of axis registered parameters.

- Any set of general outputs can be turned on or turned off by specifying contact output data. Multiple general outputs can be turned on or turned off concurrently.
- Instead of executing an action immediately after the preceding action pattern completes execution, a startup condition can be specified to delay execution until a trigger condition (e.g. timer, external trigger input, external trigger to encoder Z-phase input, counter/zone coincidence or positioning completion) becomes true.
- The End Mode can be used to specify whether to continue with execution of the next action pattern.

■ Parameter Setup

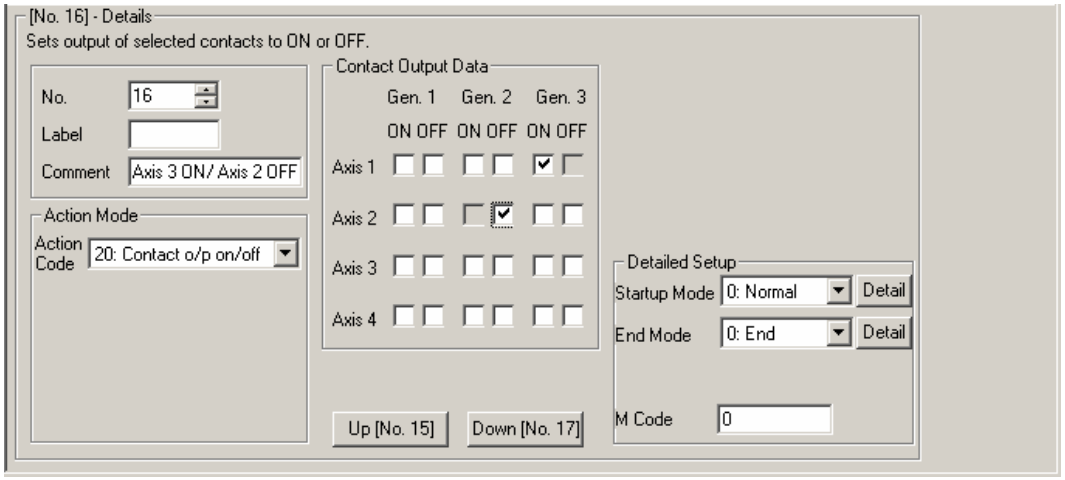


Figure 8.37 Screen for Specifying Contact Outputs On/Off

● Action Mode

[Data Description]

Action Code **20: Contact o/p on/off**

Specify the action code.

● Contact Output Data

[Data Description]

Axis 1 **General 1: ON/OFF, General 2: ON/OFF, General 3: ON/OFF**
Axis 2 **General 1: ON/OFF, General 2: ON/OFF, General 3: ON/OFF**
Axis 3 **General 1: ON/OFF, General 2: ON/OFF, General 3: ON/OFF**
Axis 4 **General 1: ON/OFF, General 2: ON/OFF, General 3: ON/OFF**

Specify the external contact outputs to be turned on or off. Outputs of unselected contacts will remain unchanged.

● Detailed Setup

[Data Description]

Startup Mode **0 to 5**
End Mode **0 to 1**
M Code **0 to 32,767**

Specify the startup mode, end mode and M code.

The following table lists the available startup mode and end mode options.

Table 8.25 Startup Mode

Startup Code	Startup Mode	Startup Mode Options
0	Normal	None
1	Timer	- Timer value: 1 to 32,767 (ms)
2	External trigger	- Axes: 1 to 4
3	External trigger & Z-phase	- Axes: 1 to 4 - Z-phase Edge Selection: Rising Edge, Falling Edge - Z-phase Search Count: 1 to 255 (pulses)
4	Counter/zone coincidence	- Axes: 1 to 4
5	Positioning Completed	- Axes: 1 to 4

Table 8.26 End Modes for Other Actions

End Code	End Mode	End Mode Options	Can Dwell Time Be Specified?
0	End	None	No
1	Continue	None	No

■ Precautions

- This command can only be used to turn on or turn off external contact outputs set to '1: Used As General Input/Output' by Contact Usage Selection of axis registered parameters.
- Do not specify consecutive execution of more than ten pattern actions that do not turn off the Positioning Completed relay (NOP, JUMP, FOR, NEXT, Set Current Position, Contact Outputs On/Off and Position Control to Speed Control). Doing so will generate an error during pattern operation and stops pattern operation immediately. This restriction is built into the module to avoid infinite loops.

8.6 Specifying Set Current Position Action

■ Function

Changes the current position.

- Any set of axes whose current positions are to be changed can be specified in [Axes]. Current position of multiple axes can be changed concurrently.
- The new current position can only be specified as an absolute position using a position data number.
- Instead of executing an action immediately after the preceding action pattern completes execution, a startup condition can be specified to delay execution until a trigger condition (e.g. timer, external trigger input, external trigger to encoder Z-phase input, counter/zone coincidence or positioning completion) becomes true.
- The End Mode can be used to specify whether to continue with execution of the next action pattern.

■ Parameter Setup

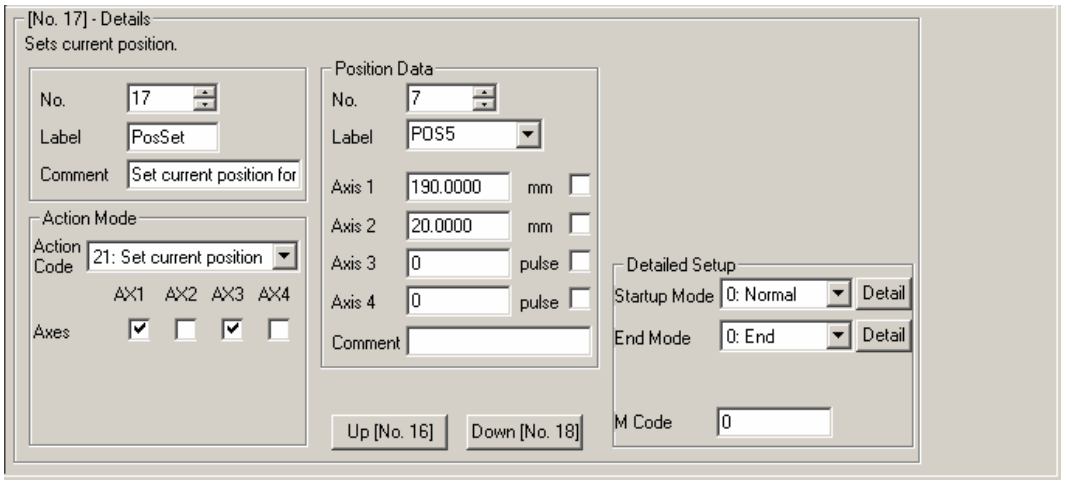


Figure 8.3 Screen for Specifying Set Current Position Action

● Action Mode

[Data Description]

Action Code **21: Set current position**
Axes **AX1, AX2, AX3, AX4**

Specify the action code and axes.

You can select from 1 to 4 axes for changing current position.

● Position Data

[Data Description]

Position Data No.: 1 to No. of Position Data Records Used defined (2000 max.)

Enter the new current position.

The new current position should only be specified as an absolute position using a position data number. Beware that if an increment position is specified, the current position will still be written as an absolute position.

Nevertheless, the specified current position is always written as an absolute position even if an incremental position is specified.

Position data specified must fall within the forward limits and reverse limits (position reference unit) of each specified axis. If Index Control axis registered parameter of an axis is set to '1: Index control', the specified current position value to be set should be

between 0 (inclusive) and the Index Range (position reference unit).

- **Detailed Setup**

[Data Description]

Startup Mode **0 to 5**
End Mode **0 to 1**
M Code **0 to 32,767**

Specify the startup mode, end mode and M code.

The following table lists the available startup mode and end mode options.

Table 8.27 Startup Mode

Startup Code	Startup Mode	Startup Mode Options
0	Normal	None
1	Timer	- Timer value: 1 to 32,767 (ms)
2	External trigger	- Axes: 1 to 4
3	External trigger & Z-phase	- Axes: 1 to 4 - Z-phase Edge Selection: Rising Edge, Falling Edge - Z-phase Search Count: 1 to 255 (pulses)
4	Counter/zone coincidence	- Axes: 1 to 4
5	Positioning Completed	- Axes: 1 to 4

Table 8.28 End Modes for Other Actions

End Code	End Mode	End Mode Options	Can Dwell Time Be Specified?
0	End	None	No
1	Continue	None	No

■ Precautions

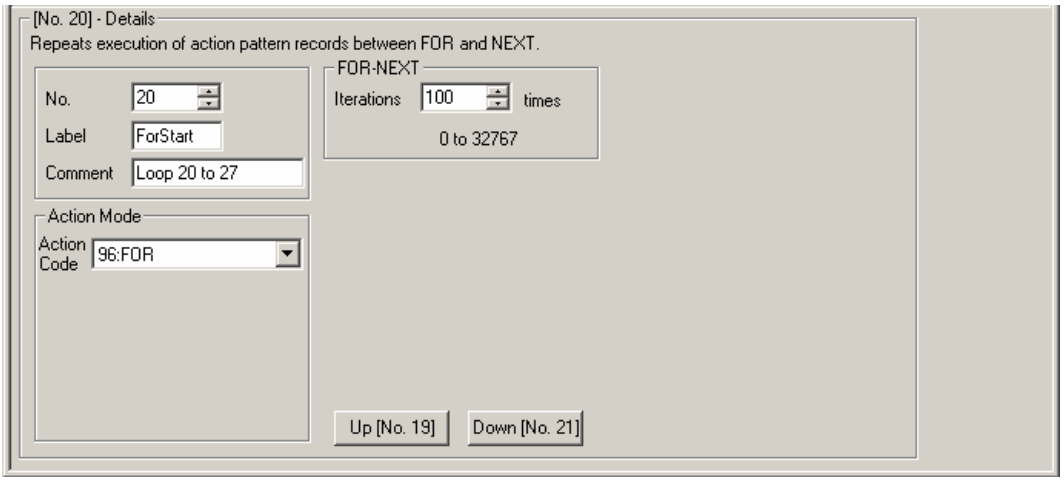
- Executing a Set Current Position command discards fractional pulse counts to the right of the decimal point that are stored in the positioning module. As a result, an error of less than one pulse may occur.
- Do not specify consecutive execution of more than ten pattern actions that do not turn off the Positioning Completed relay (NOP, JUMP, FOR, NEXT, Set Current Position, Contact Outputs On/Off and Position Control to Speed Control). Doing so will generate an error during pattern operation and stops pattern operation immediately. This restriction is built into the module to avoid infinite loops.

8.7 Specifying FOR-NEXT Actions

■ Function

Executes action pattern records within the FOR-NEXT loop a specified number of iterations.

■ Parameter Setup



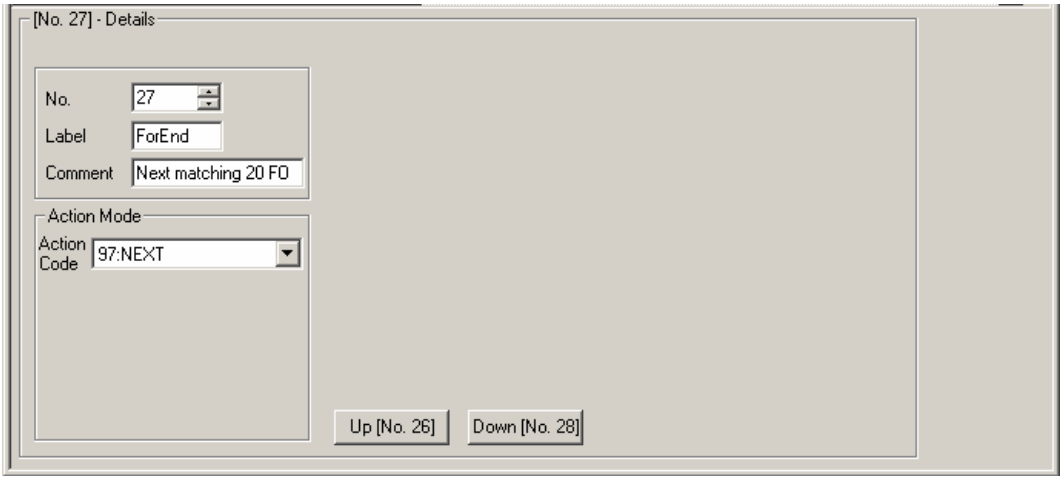


Figure 8.39 Screen for Specifying FOR-NEXT Actions

● Action Mode

[Data Description]

Action Code **96: FOR**
97: NEXT

Specify the action code.

- **Action Mode Argument (FOR-NEXT iterations)**

  [Data Description]

  Iterations **0 to 32,767**

  Specify the number of iterations for repeating execution of action pattern records between FOR and NEXT.

  (Specifying 0 or 1 iteration produces the same result)

■ Precautions

- Nesting of FOR-NEXT loops are not allowed.
- Ending a pattern on a NEXT action is not allowed.
- No checking for FOR-NEXT mismatch is performed during editing or downloading of an action pattern table. Any mismatch will generate an error during execution.
- At least one action (excluding NOP actions) must be specified within the FOR-NEXT loop.
- Do not specify consecutive execution of more than ten pattern actions that do not turn off the Positioning Completed relay (NOP, JUMP, FOR, NEXT, Set Current Position, Contact Outputs On/Off and Position Control to Speed Control). Doing so will generate an error during pattern operation and stops pattern operation immediately. This restriction is built into the module to avoid infinite loops.

8.8 Specifying JUMP Action

■ Function

Jumps to a specified action pattern record number.

■ Parameter Setup

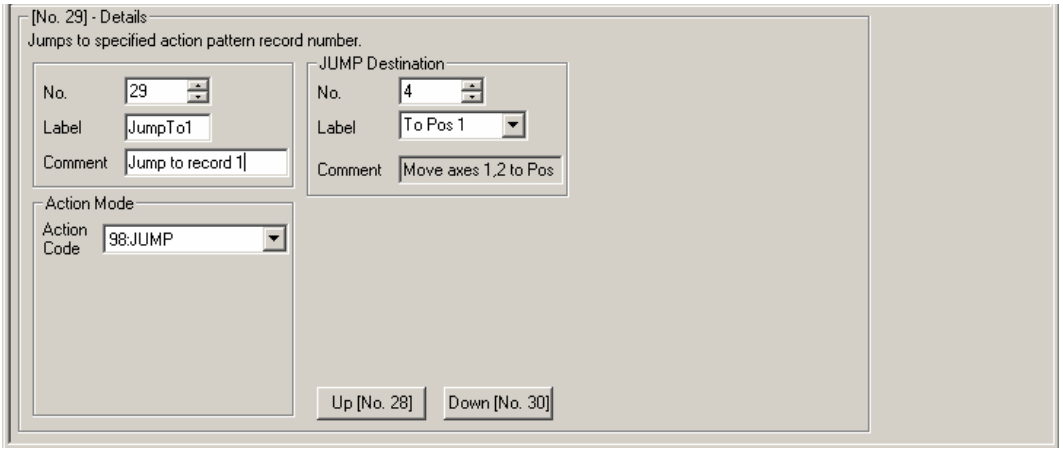


Figure 8.40 Screen for Specifying JUMP Action

● Action Mode

[Data Description]
Action Code 98: JUMP
Specify the action code.

● Action Mode Argument (JUMP Destination)

[Data Description]
JUMP Destination 1 to No of Pattern Data Records Used defined (500 max.)
Specify the destination action pattern record number for the jump action.

■ Precautions

- An action must be specified in the action pattern record designated by JUMP Destination in a JUMP command.
- Do not specify consecutive execution of more than ten pattern actions that do not turn off the Positioning Completed relay (NOP, JUMP, FOR, NEXT, Set Current Position, Contact Outputs On/Off and Position Control to Speed Control). Doing so will generate an error during pattern operation and stops pattern operation immediately. This restriction is built into the module to avoid infinite loops.

8.9 Specifying NOP Action

■ Function

No operation. Executes the action of the next action pattern record.

- Do not specify consecutive execution of more than ten pattern actions that do not turn off the Positioning Completed relay (NOP, JUMP, FOR, NEXT, Set Current Position, Contact Outputs On/Off and Position Control to Speed Control). Doing so will generate an error during pattern operation and stops pattern operation immediately. This restriction is built into the module to avoid infinite loops.

■ Parameter Setup

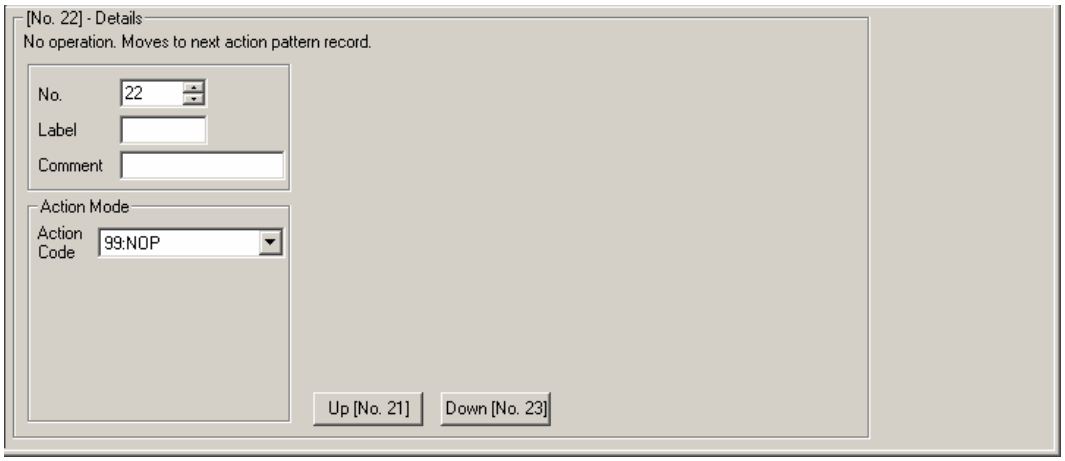


Figure 8.41 Screen for Specifying NOP Action

● Action Mode

[Data Description]

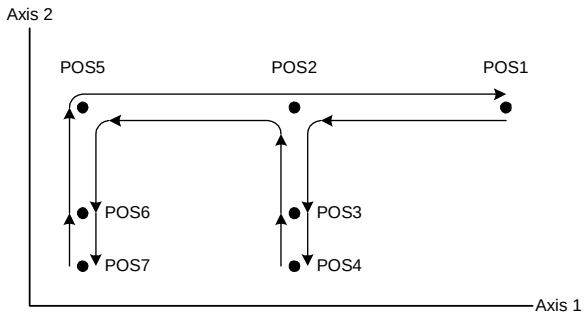
Action Code 99: NOP

Specify the action code.

8.10 Examples of Action Pattern Data Setup

8.10.1 Position Control Setup Example 1

■ Movement Description



(1) Moves from POS1 toward POS2 at speed 100.0 (mm/s).
(2) Passes by POS2 without stopping toward POS3.
(3) Moves from POS3 toward POS4 at speed 50.0 (mm/s), and then decelerates and stops at POS4.
(4) Moves from POS4 toward POS3 at speed 50.0 (mm/s).
(5) Moves from POS3 toward POS2, accelerating to speed 100.0 (mm/s).
(6) Passes by POS2 without stopping toward POS5.
(7) Passes by POS5 without stopping toward POS6.
(8) Moves from POS6 toward POS7 decelerating to 50.0 (mm/s) and then stopping at POS7.
(9) Moves from POS7 toward POS6 at speed 50.0 (mm/s).
(10) Moves from POS6 toward POS5, accelerating to speed 100.0 (mm/s).
(11) Passes by POS5 without stopping toward POS1, and finally stops at POS1.

Figure 8.42 Movement Description of Position Control Setup Example 1

■ Action Pattern Table

Pattern C Data[F3NC34S003][12345678901234567890123456789012][F3NC34-0N]

No.	Label	Action Pattern: Action Code	Axes 1	Axes 2	Axes 3	Axes 4	CI Axes 1	CI Axes 2	CI Axes 3	CI Axes 4	Action Mode Argument	Target Position: No.	Target Position: Label	Speed Type	Specified Speed	End Mode	Dwell Time	M Code
1	START	1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	2	POS2	Combined	100.0000	3: Pass by	0	0
2		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	3	POS3	Combined	100.0000	2: Pass through	0	0
3		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	4	POS4	Combined	50.0000	1: Continue	100	1
4		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	3	POS3	Combined	50.0000	2: Pass through	0	0
5		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	2	POS2	Combined	100.0000	3: Pass by	0	0
6		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	5	POS5	Combined	100.0000	3: Pass by	0	0
7		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	6	POS6	Combined	100.0000	2: Pass through	0	0
8		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	7	POS7	Combined	50.0000	1: Continue	100	2
9		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	6	POS6	Combined	50.0000	2: Pass through	0	0
10		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	5	POS5	Combined	100.0000	3: Pass by	0	0
11	END	1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	1	POS1	Combined	100.0000	0: End	100	3
12			☐	☐	☐	☐	☐	☐	☐	☐								
13			☐	☐	☐	☐	☐	☐	☐	☐								

Figure 8.43 Action Pattern Table of Position Control Setup Example 1

■ Position Data Table

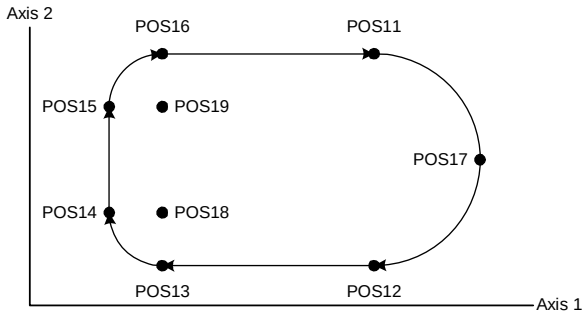
Position Data[F3NC34S003][12345678901234567890123456789012][F3NC34-0N]

No.	Label	Axis 1/INC	Axis 2/INC	Axis 3/INC	Axis...
1	POS1	500.0000 ☐	400.0000 ☐	0 ☐	0
2	POS2	300.0000 ☐	400.0000 ☐	0 ☐	0
3	POS3	300.0000 ☐	100.0000 ☐	0 ☐	0
4	POS4	300.0000 ☐	50.0000 ☐	0 ☐	0
5	POS5	100.0000 ☐	400.0000 ☐	0 ☐	0
6	POS6	100.0000 ☐	100.0000 ☐	0 ☐	0
7	POS7	100.0000 ☐	50.0000 ☐	0 ☐	0

Figure 8.44 Position Data Table for Position Control Setup Example 1

8.10.2 Position Control Setup Example 2

■ Movement Description



(1) Performs circular interpolation from POS11 to POS12 at speed 100.0 (mm/s).
(2) Passes through POS12 without stopping and performs linear interpolation to POS13.
(3) Passes through POS13 without stopping and performs circular interpolation to POS14.
(4) Passes through POS14 without stopping and performs linear interpolation to POS15.
(5) Passes through POS15 without stopping and performs circular interpolation to POS16.
(6) Passes through POS16 without stopping and performs linear interpolation to POS11.

Figure 8.45 Movement Description of Position Control Setup Example 2

■ Action Pattern Table

Pattern B Data[F3NC345003][12345678901234567890123456789012][F3NC34-0N]

No.	Label	Action Pattern: Action Code	Axes 1	Axes 2	Axes 3	Axes 4	CI Axes 1	CI Axes 2	CI Axes 3	CI Axes 4	Action Mode Argument	Target Position: No.	Target Position: Label	Speed Type	Specified Speed	End Mode	Dwell Time	M C o...
1	START	2: CI using su...	☑	☑	☐	☐	☑	☑	☐	☐	0	12	POS12	Combined	0.0100	2: Pass through	0	0
2		(Sub position)	☐	☐	☐	☐	☐	☐	☐	☐	0	17	POS17	Combined	0.0000	0: End	0	0
3		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	13	POS13	Combined	0.0100	2: Pass through	0	0
4		3: CW CI usin...	☑	☑	☐	☐	☑	☑	☐	☐	0	14	POS14	Combined	0.0100	2: Pass through	0	0
5		(Sub position)	☐	☐	☐	☐	☐	☐	☐	☐	0	18	POS18	Combined	0.0000	0: End	0	0
6		1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	15	POS15	Combined	0.0100	2: Pass through	0	0
7		3: CW CI usin...	☑	☑	☐	☐	☑	☑	☐	☐	0	16	POS16	Combined	0.0100	2: Pass through	0	0
8		(Sub position)	☐	☐	☐	☐	☐	☐	☐	☐	0	19	POS19	Combined	0.0000	0: End	0	0
9	END	1: Linear posi...	☑	☑	☐	☐	☐	☐	☐	☐	0	11	POS11	Combined	0.0100	0: End	100	11
10			☐	☐	☐	☐	☐	☐	☐	☐								
11			☐	☐	☐	☐	☐	☐	☐	☐								
12			☐	☐	☐	☐	☐	☐	☐	☐								
13			☐	☐	☐	☐	☐	☐	☐	☐								

Figure 8.46 Action Pattern Table of Position Control Setup Example 2

■ Position Data Table

Position Data[F3NC345003][12345678901234567890123456789012][F3NC34-0N]

No.	Label	Axis 1/INC	Axis 2/INC	Axis 3/INC	Axis...
11	POS11	300.0000 ☐	450.0000 ☐	0 ☐	0
12	POS12	300.0000 ☐	50.0000 ☐	0 ☐	0
13	POS13	100.0000 ☐	50.0000 ☐	0 ☐	0
14	POS14	50.0000 ☐	100.0000 ☐	0 ☐	0
15	POS15	50.0000 ☐	400.0000 ☐	0 ☐	0
16	POS16	100.0000 ☐	450.0000 ☐	0 ☐	0
17	POS17	500.0000 ☐	250.0000 ☐	0 ☐	0
18	POS18	100.0000 ☐	100.0000 ☐	0 ☐	0
19	POS19	100.0000 ☐	400.0000 ☐	0 ☐	0

Figure 8.47 Position Data Table for Position Control Setup Example 2

8.10.3 Speed Control Setup Example

■ Movement Description

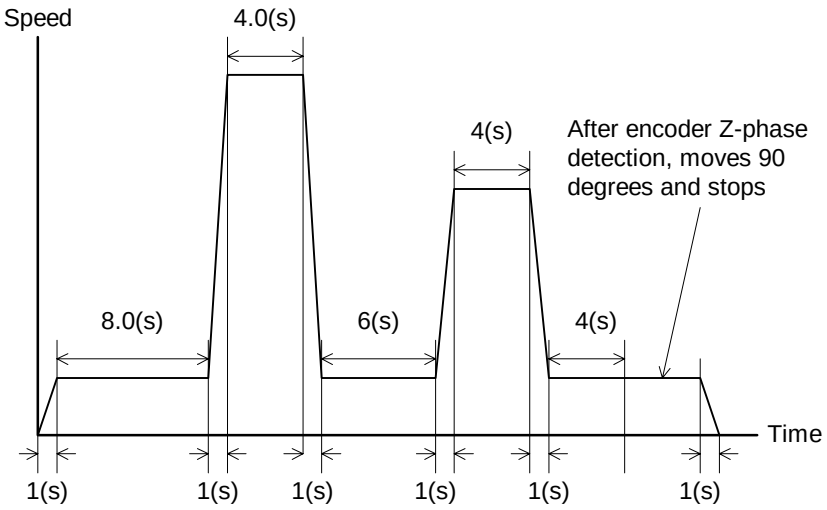


Figure 8.48 Movement Description of Speed Control Setup Example

■ Action Pattern Table

Pattern B Data[F3NC325003][F3NC32-0N]

No.	Label	Action Pattern					Action Mode Argument	Target Position		Speed Type	Specified Speed	Acceleration Time	Deceleration Time	End Mode	Dwell Time	M Code
		Action Code	Axes 1	Axes 2	Cl Ax... 1	Cl Ax... 2		No.	Label							
1	START	10: Position->...	☑	☐	☐	☐	0	1	POS1	Combined	0.0000	-1	-1	1: Continue	0	0
2		13: Speed co...	☑	☐	☐	☐	0	1	POS1	Axis 1	10.0000	1000	1000	2: Pass through	0	0
3		13: Speed co...	☑	☐	☐	☐	0	1	POS1	Axis 1	50.0000	1000	1000	2: Pass through	0	0
4		13: Speed co...	☑	☐	☐	☐	0	1	POS1	Axis 1	10.0000	1000	1000	2: Pass through	0	0
5		13: Speed co...	☑	☐	☐	☐	0	1	POS1	Axis 1	40.0000	1000	1000	2: Pass through	0	0
6		13: Speed co...	☑	☐	☐	☐	0	1	POS1	Axis 1	10.0000	1000	1000	2: Pass through	0	0
7	END	11: Speed->p...	☑	☐	☐	☐	0	21	POS21	Axis 1	10.0000	1000	1000	0: End	100	21
8			☐	☐	☐	☐										

Figure 8.49 Action Pattern Table of Speed Control Setup Example

■ Position Data Table

Position Data[F3NC345003][12345678901234567890123456789012][F3NC34-0N]

No.	Label	Axis 1/INC		Axis 2/INC		Axis 3/INC		Axis...
21	POS21	90.0000	☐	0.0000	☐	0.0000	☐	0
22			☐		☐		☐	
23			☐		☐		☐	
24			☐		☐		☐	

Figure 8.50 Position Data Table of Speed Control Setup Example

9. Accessing the Module

9.1 Accessing from Sequence CPU

The following instructions can be used for accessing the module from a sequence CPU using a ladder sequence program. For more information on each instruction, see “Sequence CPU Modules — Instructions” (IM34M6P12-03E).

● Reading and Writing Parameters and Statuses

Reading and writing must be performed using word-based instructions. Long word based instructions cannot be used.

- **Specific Module Read Instruction (READ Instruction)**

READ	SL	n1	D	k

SL: number of slot where the module is installed
n1: data position number for the first word of data to be read
D: first device for storing the read data
k: number of words of data to be read

- **Specific Module Write Instruction (WRITE Instruction)**

WRITE	S	SL	n2	k

S: first device storing the write data
SL: number of slot where the module is installed
n2: first data position number for writing
k: number of words of data to be written

- **Specific Module High-Speed Read Instruction (HRD Instruction)**

HRD	SL	n1	D	k

SL: number of slot where the module is installed
n1: data position number for the first word of data to be read
D: first device for storing the read data
k: number of words of data to be read

- **Specific Module High-Speed Write Instruction (HWR Instruction)**

HWR	S	SL	n2	k

S: first device for storing the write data
SL: number of slot where the module is installed
n2: first data position number for writing
k: number of words of data to be written

● Interrupt Handling

All input relays (X□□□01 to X□□□32) of the module can be used in interrupt processing. A rising edge in an interrupt input triggers execution of an interrupt program sandwiched between an INTP instruction and an IRET instruction.

INTP	S

IRET

S: input relay raising interrupt

9.2 Accessing from BASIC CPU

The following instructions can be used for accessing the module from a BASIC CPU. For details of each instruction, see “Basic CPU Modules and YM-BASIC/FA Programming Language” (IM 34M6Q22-01E).

Function	Statement Format	Description
Declare use of module	`ASSIGN NC93=SL` SL : slot number	Declares use of a module or CPU module.
Read parameter or status	`ENTER SL,n NOFORMAT;I` SL : slot number n : data position number I : Name of integer or integer array variable for storing read data	Reads the parameter or status at a data position number (n) of the module installed in a slot (SL), and stores it in a variable (I).
Write parameter	`OUTPUT SL,n NOFORMAT;I` SL : slot number n : data position number I : Name of integer or integer array variable storing write data	Overwrites the parameter at a data position number (n) of the module installed in a slot (SL) with the value stored in a variable (I).
Read input relays *1	`STATUS SL,n;P` SL : slot number n : data position no. (101 or 102) P : Name of integer variable for storing read data	Reads the status of input relays of a module that is installed in a slot (SL), and stores it in a variable (P).
Write output relays *2	`CONTROL SL,n;P,M` SL : slot number n : data position no. (101 or 102) P : output data M : mask pattern	Overwrites output relays of a module installed in a slot (SL) with a value stored in a variable (P). The mask pattern (M) allows writing only to selected output relays.

Declare interrupt	`ON INT SL,nn GOSUB {label}`
	`ON INT SL,nn CALL {subprogram}`
	`ON INT SL,nn GOTO {label}`
	SL : slot number
	nn : input relay no.
		Declares branch destination for handling interrupt request from the CPU module.

Clear interrupt declaration	`OFF INT SL,nn` SL : slot number nn : input relay no.	Clears an ON INT statement.

*1: 101 and 102 refer to input relays having data position numbers (X□□□01 to X□□□16) and (X□□□17 to X□□□32) respectively.

*2: 101 and 102 refer to output relays having data position numbers (Y□□□33 to Y□□□48) and (Y□□□49 to Y□□□64) respectively.

● How To Handle 2-Word Data

Before writing long word parameter data to the positioning module, you need to convert it into two words of integer data. Similarly, after reading a two-word parameter from the positioning module into two integer variables, you may need to convert it into long word data. A sample program for these conversions is shown below.

`LDAT` : long-word integer variable to be converted

`IDD, IDU` : integer variables for storing the data after conversion (low order/high order)

```
100 IDD=VAL("$"+RIGHT$(LHEX$(LDAT),4))
110 IDU=VAL("$"+LEFT$(LHEX$(LDAT),4))
```

`ISD,ISU` : Integer variables storing the two words read (low order/high order)

`LST` : long-word integer variable after conversion

```
100 LST=VAL(HEX$(ISU)+HEX$(ISD))
```

9.3 Precautions on Reading Two-word Data

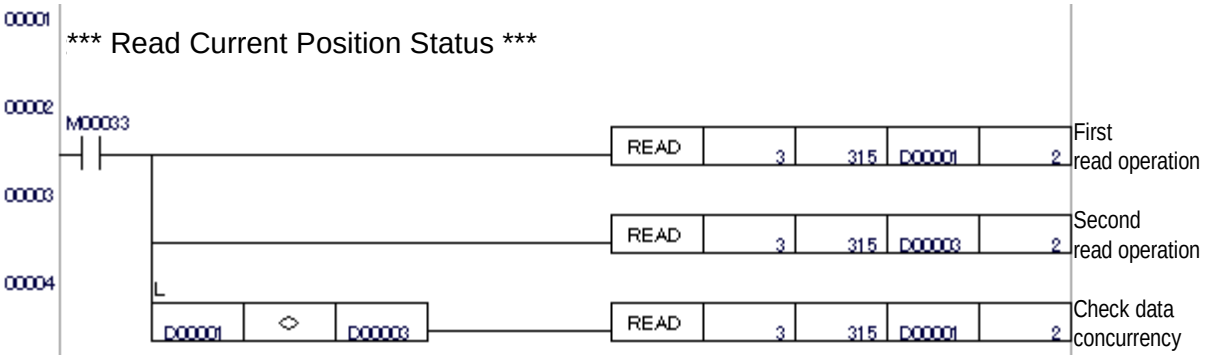
When the CPU module reads 2-word data (e.g. current position status) of an axis status from the positioning module, concurrency of the high-order word and low-order word of the 2-word data is not assured due to conflicts between the timing of reading from the CPU module and the data update period of the positioning module.

To ensure that the high-order word and low-order word of 2-word data are concurrent when reading from a sequence CPU, use the READ instruction to read the data twice consecutively, and verify that the data read are the same in both instances. If the Specific Module High-speed Read (HRD) command is used, data concurrency is not assured even if you confirm that the data are the same.

Data concurrency cannot be assured when reading from a BASIC CPU.

- **Sample Program**

  This sample program reads the current position status of axis 1 for a positioning module installed in slot 3.



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10. Errors and Troubleshooting

Errors and warnings detected by the module can be classified into two categories: axis errors/warnings and pattern errors/warnings. Axis errors and warnings are generated when executing direct commands or during positioning movement; pattern errors and warnings are generated during pattern operation.

10.1 When An Axis Error or Warning Occurs

■ Axis Error

Axis errors can be classified into positioning errors, axis registered parameter setup errors and direct command execution errors. When an axis error occurs, the Error Detected input relay of the axis turns on, and an error code is stored in Error Status of axis statuses. At the same time, the red ERR LED located on the front side of the module lights up.

Table 10.1 Error Detected Relays

Input Relay No.	Relay Name	Description
X□□□09	AX1 Error Detected	Turns on when error is encountered on axis 1.
X□□□10	AX2 Error Detected	Turns on when error is encountered on axis 2.
X□□□11	AX3 Error Detected	Turns on when error is encountered on axis 3.
X□□□12	AX4 Error Detected	Turns on when error is encountered on axis 4.

Table 10.2 Axis Error Statuses

Data Position No.				Status Name	Data Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0301	0601	0901	1201	Error Status	Error code when error occurs (see Tables 10.7, 10.8 and 10.9)	5-42

● Positioning Errors

A positioning error is generated when an error that does not allow movement to continue is detected during positioning movement.

When a positioning error occurs, the Error Detected input relay of the error axis turns on, an error code is stored in Error Status of axis statuses, and the positioning movement either stops immediately or decelerates and stops depending on the cause of the error.

If an error is generated during interpolation movement involving multiple axes, the Error Detected relays of all interpolating axes turn on, and all interpolating axes either stop immediately, or decelerate and stop. An error code indicating the cause of the error is stored in Error Status of axis statuses for the axis encountering the error, and the error code of '41: Interpolation axis error' is stored in Error Status of axis statuses for each of the interpolation axes.

You should clear a positioning error using the Reset Error command.

● Axis Registered Parameter Setup Errors

An axis registered parameter setup error is generated when a Set Axis Registered Parameters command is executed with invalid or out of range parameter values in the axis registered parameter area.

When this happens, the Set Axis Registered Parameters command is not executed. Instead, the Error Detected input relay of the command execution axis from which the command is executed turns on, and an error code is stored in Error Status of axis statuses for the same axis.

You cannot clear an axis registered parameter setup error using the Reset Error command. To clear such an error, re-execute the Set Axis Registered Parameters command with valid parameter data.

● Direct Command Execution Errors

A direct command execution error is generated when a direct operation command is executed with invalid or out of range parameter values in the axis command parameter area.

When this happens, the direct operation command is not executed. Instead, the Error Detected input relay of the command execution axis from which the command is executed turns on, and an error code is stored in Error Status of axis statuses for the same axis.

If a positioning command or a Change Speed command issued during positioning movement generates an error, the positioning movement in progress is decelerated and stopped.

You should clear a direct command execution error using the Reset Error command.

■ Axis Warnings

An axis warning is generated when a direct command to be executed does not satisfy all command acceptance conditions.

When this happens, the direct command is ignored, and a warning code is stored in Warning Status of axis statuses for the command execution axis from which the direct command is issued.

The Error Detected input relay does not turn on when an axis warning is encountered.

Turning off the Execute Command output relay clears the warning code.

Table 10.3 Axis Warning Status

Data Position No.				Status Name	Data Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0302	0602	0902	1202	Warning Status	Warning code when warning occurs (see Table 10.10)	5-43

10.2 When A Pattern Error or Warning Occurs

■ Pattern Errors

Pattern operation errors can be classified into pattern action errors, pattern operation restart errors, pattern axis errors, pattern registered parameter setup errors and pattern command execution errors. When a pattern operation error occurs, the Pattern Error Detected input relay of the pattern turns on, an error code is stored in Pattern Error Status of pattern operation statuses, and detailed error codes are stored in Pattern Error Code 1 and Pattern Error Code 2 of pattern operation statuses. At the same time, the red ERR LED located on the front side of the module lights up.

Table 10.4 Pattern Error Detected Relays

Input Relay No.	Relay Name	Description
X□□□21	Pattern A Error Detected	Turns on when error is encountered during pattern A execution.
X□□□22	Pattern B Error Detected	Turns on when error is encountered during pattern B execution.
X□□□23	Pattern C Error Detected	Turns on when error is encountered during pattern C execution.
X□□□24	Pattern D Error Detected	Turns on when error is encountered during pattern D execution.

Table 10.5 Pattern Error and Warning Statuses

Data Position No.				Status Name	Data Description	See Also
Pattern A	Pattern B	Pattern C	Pattern D			
1352	1452	1552	1652	Pattern Error Status	Error code when error occurs (see Tables 10.11, 10.13, 10.14 and 10.15)	5-52
1354	1454	1554	1654	Pattern Error Code 1	Detailed error code 1 when error occurs	5-52
1355	1455	1555	1655	Pattern Error Code 2	Detailed error code 2 when error occurs (see Table 10.12)	5-53

● Pattern Action Errors

A pattern action error occurs when pattern operation cannot be executed when pattern operation is started or during pattern execution because an action pattern record contains invalid or out of range parameter data.

When this happens, the Pattern Error Detected input relay of the pattern encountering an error turns on, and the error code of '10001: Pattern action error' is stored in Pattern Error Status of pattern operation statuses. In addition, the action pattern record number associated with the error is stored in Pattern Error Code 1 and detailed information regarding the error is stored in Pattern Error Code 2.

If an action pattern data error is encountered when a pattern is executed, pattern operation is not executed. If an action pattern data error is encountered during pattern execution, the positioning movement in progress is stopped immediately and pattern operation stops.

● Pattern Operation Restart Errors

A pattern operation restart error is generated when an attempt is made to restart a pattern operation but the pattern operation cannot be continued.

When this happens, the Pattern Error Detected input relay of the pattern encountering an error turns on, and the error code of '10002: Pattern restart error' is stored in Pattern Error Status of pattern operation statuses. In addition, the action pattern record number associated with the error is stored in Pattern Error Code 1 and detailed information regarding the error is stored in Pattern Error Code 2.

● Pattern Axis Errors

A pattern axis error is generated when an axis error that does not allow movement to continue is detected during pattern execution.

When this happens, the Pattern Error Detected input relay of the pattern encountering an error turns on, and the error code of '10003: Pattern axis error' is stored in Pattern Error Status of pattern operation statuses. In addition, the Error Detected input relay of the error axis turns on, and an error code is stored in Error Status of axis statuses. The positioning movement in progress is either stopped immediately or decelerated and stopped depending on the cause of the error, and pattern operation stops.

If an error is generated during interpolation movement involving multiple axes, the Error Detected relays of all interpolating axes turn on, and all interpolating axes stop immediately. An error code indicating the cause of the error is stored in Error Status of axis statuses for the axis encountering the error, and the error code of '41: Interpolation axis error' is stored in Error Status of axis statuses for each of the interpolation axes.

You should clear a pattern axis error using the Reset Pattern Error command.

You should also clear the positioning error of each error axis using the Reset Error command.

● Pattern Registered Parameter Setup Errors

A pattern registered parameter setup error is generated when a Set Pattern Registered Parameters command is executed with invalid or out of range parameter values in the pattern registered parameter area.

When this happens, the Set Pattern Registered Parameters command is not executed. Instead, the Pattern Error Detected input relay for the corresponding pattern turns on, and an error code is stored in Pattern Error Status of pattern operation statuses for the same pattern.

You cannot clear a pattern registered parameter setup error using the Reset Pattern Error command. To clear such an error, re-execute the Set Pattern Registered Parameters command with valid parameter data.

● Pattern Command Execution Errors

A pattern command execution error is generated when a pattern command is executed with invalid or out of range parameter values in the pattern command parameter area.

When this happens, the pattern command is not executed. Instead, the Pattern Error Detected input relay for the corresponding pattern turns on, and an error code is stored in Pattern Error Status of pattern operation statuses for the same pattern. If a movement is in progress, it is decelerated and stopped, and pattern operation stops. You should clear a pattern command execution error using the Reset Pattern Error command.

■ Pattern Warnings

A pattern warning is generated when a pattern command to be executed does not satisfy all command acceptance conditions.

If this happens, the pattern command is ignored, and a warning code is stored in Pattern Warning Status of pattern operation statuses for the corresponding pattern.

The Pattern Error Detected input relay does not turn on when a pattern warning is encountered.

Turning off the Pattern Execute Command output relay clears the warning code.

Table 10.6 Pattern Error and Warning Statuses

Data Position No.				Status Name	Data Description	See Also
Pattern A	Pattern B	Pattern C	Pattern D			
1353	1453	1553	1653	Pattern Warning Status	Warning code when warning occurs	5-52

10.3 List of Axis Error and Warning Codes

■ Axis Errors

Axis errors can be classified into positioning errors, axis registered parameter setup errors and direct command execution errors.

● Positioning Errors

A positioning error is generated when an error that does not allow a positioning movement to continue is detected during movement.

Table 10.7 List of Positioning Errors

Error Code	Error Description (Module action when error occurs)	Possible Causes	Remedy
1	Flash memory error	Data of flash memory is corrupted. Power was turned off while data was being written to flash memory. (The Error Detected input relay of all axes turn on)	Execute the Initialize Flash Memory command to clear the error and set up parameters again. If the error recurs, the module may be faulty. Check the number of write operations to flash memory using axis common statuses.
11	Emergency Stop Input error (Stop immediately)	- An attempt was made to move a motor, which was in Emergency Stop state (Emergency Stop Input is off). - An emergency stop was triggered while a motor was moving.	Exit from Emergency Stop state (by turning on the Emergency Stop Input). You can check the state of the Emergency Stop Input by reading Contact Input Status of axis statuses.
12	Forward Limit Input error (Stop immediately)	- An attempt was made to output a forward pulse when the Forward Limit Input was on. - The Forward Limit input turned on during output of forward pulses.	Reset the limit input (check the wiring, usage and polarity setup for the limit input). You can check the state of the limit input by reading Contact Input Status of axis statuses.
13	Reverse Limit Input error (Stop immediately)	- An attempt was made to output a reverse pulse when the Reverse Limit Input was on. - The Reverse Limit input turned on during output of reverse pulses.	
14	Driver Alarm Input error (Stop immediately)	- An attempt was made to output a pulse when the Driver Alarm Input was on. - The Driver Alarm Input turned on during pulse output.	Reset the Driver Alarm Input (check the wiring, usage and polarity setup for the Driver Alarm Input). You can check the state of the Driver Alarm Input by reading Contact Input Status of axis statuses.
15	Pulse overflow error (Stop immediately)	An attempt was made to move an axis beyond the positioning module's operatingrange (maximum value that can be represented using 32 bits) during jogging, origin search or manual pulse generator mode. This error will never be generated for an axis configured for index control.	Keep within the operating range (maximum value that can be represented using 32 bits) of the positioning module.
16	Origin search error (Stop immediately)	Failure to detect Z-phase after starting Z-phase search, and moving through the number of pulses designated by the AOS Z-phase Search Range parameter during execution of an Automatic Origin Search command. Failure to detect Z-phase after starting Z-phase search, and moving through the number of pulses designated by the Z-phase Search Range parameter during execution of an Origin Search command.	Set the Z-phase Search Range parameter to a value above the Z-phase output period. If error still occurs, check the Z-phase Input. You can check the state of the Z-phase Input by reading Contact Input Status of axis statuses.
17	Forward limit error (Stop immediately)	Position reference values exceeded the Format Limit parameter value during positioning movement. If target position is larger than the Forward Limit, a command execution error will be generated.	Ensure that position reference values during positioning do not exceed Forward Limit or Reverse Limit during circular interpolation, pass by movement and other movements. Check the path of circular interpolation or pass by movement when performing setup.

Error Code	Error Description (Module action when error occurs)	Possible Causes	Remedy
18	Reverse limit error (Stop immediately)	Position reference value was smaller than the Reverse Limit parameter value during positioning movement. If target position is smaller than the Reverse Limit, a command execution error will be generated.	
19	Speed limit error (Stop immediately)	Current speed exceeded Speed Limit parameter value during positioning movement.	Ensure that speed reference values during movement do not exceed Speed Limit during circular interpolation, pass by and other movements. Check the combined speed value of circular interpolation and pass by movements when performing setup.
20	Trigger execution condition error (Decelerate & stop)	A command acceptance condition error was encountered when a command associated with a trigger condition was executed. Not all command acceptance conditions were satisfied when a command waiting for a trigger was executed, or when a command whose trigger condition became true was executed. (If the same command had been executed without a trigger condition, a warning code would have been stored).	Ensure that all command acceptance conditions are satisfied when the command waiting for a trigger is executed, or when the command whose trigger condition becomes true is executed.
21	Interpolation axis error (Decelerate & stop, or stop immediately)	An error was encountered on an axis involved in interpolation during interpolation, or upon execution of a command initiating interpolation.	Remove the cause of error associated with the error axis.
22	CI deviation tolerance error (Decelerate & stop)	Deviation during circular interpolation or helical interpolation exceeded the CI Error Tolerance parameter value.	Check the values of circular interpolation and helical interpolation execution parameters, as well as the CI Error Tolerance parameter.
23	Index control overflow error (Decelerate & stop)	An Index overflow error was encountered during index control. An index overflow error will be generated during positioning under index control if the target position is changed repeatedly without stopping using incremental positions such that the accumulated incremental travel from the initial startup position exceeds 32 bits (4,294,967,296 reference position units).	To avoid such errors, use index speed control or rewrite the application so that it momentarily stop and then restart an axis before accumulated incremental travel exceeds 32 bits (4,294,967,296 position reference units).
31	ABS encoder error (Decelerate & stop)	Invalid data was received when using Sanyo Denki's absolute encoder.	Check the wiring, parameters, driver specifications associated with the encoder input.
32	ABS encoder data error (Decelerate & stop)	Invalid absolute encoder value was received when using Yaskawa Electric's absolute encoder. (Receiving was normal but received data value was invalid)	
33	ABS encoder read error (Decelerate & stop)	A Read Yaskawa ABS Encoder command was executed but the encoder could not be read. (Receiving was unsuccessful)	
34	Counter overflow error (Decelerate & stop)	Counter Input data exceeded the maximum value that can be represented using 32 bits when not under index control.	If overflow is to be allowed, configure the counter for index control.
35	Z-phase input error (Decelerate & stop)	Z-phase chattering was encountered while counting Encoder Z-phase pulses. Overly frequent (> 10 times per millisecond) on/off changes in Z-phase were encountered while counting Encoder Z-phase pulses. This error does not occur if no Z-phase pulse counting is specified.	Check wiring for Z-phase. If Z-phase chattering occurs when a motor is at rest, do not issue a command that counts Z-phases when the motor is at rest.
40	ToolBox Positioning Module communication error (Decelerate & stop)	A communication error was encountered during execution of an action test using the ToolBox for Positioning Modules software. Checking of communication errors is done as a precaution against a runaway motor.	Check the communication timeout value defined in ToolBox. When performing an action test using the ToolBox for Positioning Modules software, always follow proper protocol when the action test completes.

Axis Registered Parameter Setup Errors

An axis registered parameter setup error is generated when a Set Axis Registered Parameters command is executed with invalid or out of range parameter values in the axis registered parameter area.

Table 10.8 List of Axis Registered Parameter Setup Errors

Error Code	Error Description	Possible Causes	Remedy
101	Maximum Speed Selection setup error	Axis registered parameter setup value is out of valid range. Even if individual parameters are within valid data range, this error may be reported if a combination of parameter values is out of valid data range. The error code stores the data position number of the invalid registered parameter for axis 1.	Re-execute the Set Axis Registered Parameters command with valid axis registered parameter data. For details on the valid data range of individual axis registered parameters, see Section 5.2.2, "Axis Registered Parameters". These errors cannot be cleared using a Reset Error command.
102	Pulse Output Mode setup error		
103	Motor Direction Selection setup error		
104	Contact Usage Selection setup error		
105	Contact I/O Polarity setup error		
109	Display Unit setup error		
111	Electronic Gear M Value setup error		
113	Electronic Gear N Value setup error		
116	Index Control setup error		
117	Index Range setup error		
121	Forward Limit setup error		
123	Reverse Limit setup error		
125	Speed Limit setup error		
128	Acceleration/deceleration Curve setup error		
129	Startup Speed setup error		
131	Default Acceleration Time setup error		
132	Default Deceleration Time setup error		
135	CI Error Tolerance setup error		
150	AOS Mode setup error		
151	AOS Direction setup error		
152	AOS Dwell Time setup error		
153	AOS Speed 1 setup error		
155	AOS Speed 2 setup error		
157	AOS Acceleration Time setup error		
158	AOS Deceleration Time setup error		
159	AOS Z-phase Edge Selection setup error		
160	AOS Z-phase Search Count setup error		
161	AOS Z-phase Search Range setup error		
163	AOS Deviation Pulse Clear Time setup error		
165	AOS Offset setup error		
172	Counter Type Selection setup error		
173	Counter Direction Selection setup error		
174	Counter Multiplication setup error		
175	Counter Display Unit setup error		
177	Counter Electronic Gear M Value setup error		
179	Counter Electronic Gear N Value setup error		
182	Counter Index Control setup error		
183	Counter Index Range setup error		
185	ABS Encoder Offset setup error		
187	ABS Encoder Pulses Per Rev. setup error		
189	ABS Encoder Bit Length setup error		
190	Counter Usage Selection setup error		
191	Counter Coincidence Value setup error		
193	Counter Upper Limit setup error		
195	Counter Lower Limit setup error		

Direct Command Execution Errors

A direct command execution error is generated when a direct command is executed with invalid or out of range parameter values in the axis command parameter area.

Table 10.9 List of Direct Command Execution Errors

Error Code	Error Description	Possible Causes	Remedy
201	Direct Command Code setup error	An axis registered parameter value is out of valid range. Even if an individual parameter is within valid data range, this error may be reported if it is out of valid data range when considered in combination with other parameter values, or with the condition current when the command is executed. The error code stores the data position number of the invalid command parameter for axis 1.	Clear the error and re-execute the direct command with valid command parameter data. For details on the valid data range of individual command parameters, see Section 5.2.3, "Axis Command Parameters". Some examples of error related to the condition when a command is executed are given below. - Target Position setup error If the target position is specified as an incremental position, the error also relates to the starting position. - Speed Type setup error This error also relates to the current override value.
202	Command Options setup error		
203	Startup Condition setup error		
204	End Condition setup error		
206	Target Position Mode setup error		
207	Target Position setup error		
211	Specified Speed setup error		
213	Acceleration Time setup error		
214	Deceleration Time setup error		
215	Dwell Time setup error		
216	Preset Override Value setup error		
219	CI Turns setup error		
220	CI Sub Position Mode setup error		
221	CI Sub Position setup error		
223	Contact Output Setting setup error		
224	MPG Mode Multiplication setup error		
225	MPG Mode Decimal Point setup error		
228	Origin Search Direction setup error		
229	Z-phase Edge Selection setup error		
230	Z-phase Search Count setup error		
231	Z-phase Search Range setup error		
233	Deviation Pulse Clear Time setup error		
235	Counter Coincidence Value setup error		
237	Counter Upper Limit setup error		
239	Counter Lower Limit setup error		

■ Axis Warnings

An axis warning is generated when a direct command to be executed does not satisfy all command acceptance conditions.

Table 10.10 List of Axis Warnings

Warning Code	Command Acceptance Condition	Possible Causes	Remedy
1	No error has been detected.	Command was executed in error state.	Clear error before executing command.
2	In position control mode	Command executed is only allowed in position control mode.	Switch to position control mode before executing command.
3	In speed control mode	Command executed is only allowed in speed control mode.	Switch to speed control mode before executing command.
4	Not in speed control mode	Command executed is not allowed in speed control mode.	Switch to some other mode before executing command.
5	Not in manual pulse generator mode	Command executed is not allowed in manual pulse generator mode.	End manual pulse generater mode before executing command.
6	In manual pulse generator mode	Command executed is only allowed in manual pulse generator mode.	Switch to manual pulse generater mode before executing command.
7	Not under index control	Command executed is not allowed under index control.	Check the Index Control axis registered parameter value, and re-execute command.
8	Under index Control	Command executed is only allowed under index control.	Check Index Control of axis registered parameters, and re-execute command.
9	In Positioning Completed state	Command executed is not allowed while positioning.	Check that positioning has completed before executing command.
10	Not in Positioning Completed state	Command executed is not allowed in Positioning Completed state.	Execute command while positioning.
11	Not jogging	Command executed is not allowed while jogging.	Stop jogging before executing command.
12	No origin search is in progress	Command executed is not allowed during origin search.	End origin search before executing command.
13	No change target position action is in progress.	Command executed is not allowed while changing target position. (A pass by movement that is in progress is also considered as a change target position movement in progress).	Execute command after the change target position action ends.
14	No change in set of interpolation axes during movement.	The set of interpolation axes was changed during movement.	Stop movement before executing command.
15	An error has been detected.	Reset Error command was executed when not in error state, or Reset Error command was executed for an error that cannot be cleared using the Reset Error command.	Execute the Reset Error command only when in error state. (Some errors such as registered parameter setup error cannot be cleared using the Reset Error command.)
16	Counter is not used as manual pulse generator.	Set Current Position command was executed for a counter used as manual pulse generator.	Do not execute Set Current Position command for a counter used as manual pulse generator.
17	Counter is not used as Sanyo's Absolute encoder.	Set Counter Current Position command was executed for axis used as Sanyo's Absolute Encoder.	Check the Counter Type Selection axis registered parameter value, and re-execute command. Changing counter current position is not allowed for Sanyo's Absolute Encoder.
18	Speed limits are observed with new override value	The Maximum Speed or Startup Speed limit defined for an axis was exceeded when executing a Set Override command during movement.	Check the preset override value before executing the command.
19	Not waiting for trigger	Command executed is not allowed while waiting for a trigger.	Exit from Waiting for Trigger state before executing command.
20	No change in command execution axis.	An attempt was made to move a moving axis whose movement was started by another command. Once a movement is started by a command issued from an axis or a pattern, issuing another command from another axis or pattern to change this movement in progress is not allowed.	When executing a command during movement, always execute it from the original axis or pattern where the movement was previously initiated.
21	No pattern operation is in progress.	Command executed is not allowed during pattern operation.	Stop pattern operation before executing command.
22	No pattern error has been detected for any pattern operation.	Command executed is not allowed when in pattern operation error state.	Clear pattern error before executing command.
30	ToolBox is not performing an action test	Command executed is not allowed during Toolbox action test.	End ToolBox action test before executing command.

10.4 List of Pattern Error and Warning Codes

■ Pattern Errors

Pattern operation errors can be classified into pattern action errors, pattern restart errors, pattern axis errors, pattern registered parameter setup errors and pattern command execution errors.

● Pattern Action Errors and Pattern Restart Errors

A pattern action error is generated during pattern operation if an attempt is made to execute a pattern that does not allow movement to continue.

Table 10.11 List of Pattern Action Errors and Pattern Restart Errors

Error Code	Error Description (Module action when error occurs)	Possible Causes	Remedy
10001	Pattern action error (Stop immediately)	Error was encountered during pattern execution. The action pattern record number associated with the error is stored in Pattern Error Code 1, and detailed information regarding the error is stored in Pattern Error Code 2.	Clear the pattern error and re-execute pattern operation with valid action pattern data.
10002	Pattern restart error (Stop immediately)	Error was encountered when restarting pattern execution. The action pattern record number associated with the error is stored in Pattern Error Code 1, and detailed information regarding the error is stored in Pattern Error Code 2. This error will be generated if the stop position or state of individual axes has been changed by another command so that pattern operation can no longer be restarted.	The action pattern cannot be restarted. Clear the pattern error.

Table 10.12 Pattern Error Code 2

Error Code	Error Description	Possible Causes	Remedy
1	Pattern Number setup error	Even if an individual parameter is within valid data range, this error may be reported if it is out of valid data range when considered in combination with other parameter values or with the condition current when a pattern is started.	For details on the valid data range of individual action patterns, see Chapter 8, "Pattern Operation Action Pattern Data". Even if an individual parameter is within valid data range, this error may be reported if it is out of valid data range when considered with the condition current when a pattern is started. Some examples of error related to the condition when a pattern is started are given below. - Target Position setup error If the target position is specified as an incremental position, the error also relates to the starting position. - Specified Speed setup error This error also relates to the current override value.
2	Label setup error		
3	Action Code setup error		
4	Axes setup error		
5	CI Axes setup error		
6	Action Mode Argument setup error		
7	Target Position setup error		
8	Speed Type setup error		
9	Specified Speed setup error		
10	Acceleration Time setup error		
11	Deceleration Time setup error		
12	Startup Mode setup error		
13	Startup Mode Options setup error		
14	End Mode setup error		
15	End Mode Options setup error		
16	Dwell Time setup error		
17	M Code setup error		
21	CI Turns setup error		
22	Contact Output ON Setting setup error		
23	Contact Output OFF Setting setup error		
24	CI Sub Position setup error		
31	FOR-NEXT error	A FOR-NEXT mismatch has been found.	Ensure that FOR and NEXT actions are properly paired.

Error Code	Error Description	Possible Causes	Remedy
32	Loop prevention error	There are too many consecutive NOP, JUMP actions, etc. This error is generated if consecutive execution of more than ten actions that do not turn off the Positioning Completed relay is found. (This restriction is built into the module to avoid infinite loops).	Do not specify consecutive execution of more than ten actions that do not turn off the Positioning Completed relay.
33	Pattern continuation execution error	Error is encountered when continuing a pattern operation. This error is generated if the travel of a pattern is too short for a pass through positioning movement.	When continuing pass through movements, ensure that the execution time for each positioning action is 2 ms or longer.
34	Pattern CI deviation tolerance error	Deviation during circular interpolation or helical interpolation in pattern operation exceeded the CI Error Tolerance parameter value.	Check the values of circular interpolation and helical interpolation execution parameters, as well as the CI Error Tolerance parameter.
1xx	Action acceptance error	A command acceptance condition error was encountered when an action was executed. This error is generated during pattern operation when not all command acceptance conditions of an action to be executed are satisfied. The error code stores the value of 100 plus the axis warning code (see Table 10.10).	Ensure that all command acceptance conditions of the action are satisfied.

● Pattern Axis Errors

A pattern axis error is generated when an axis error that does not allow movement to continue is detected during pattern execution.

Table 10.13 List of Pattern Axis Errors

Error Code	Error Description (Module action when error occurs)	Possible Causes	Remedy
10003	Pattern axis error (Stop immediately)	A positioning error was encountered on a moving axis. An error code is stored in Error Status of axis statuses. For details on axis errors, see Section 10.3, "List of Axis Error and Warning Codes".	Remove the cause of error, clear the error of all axes, clear the pattern error, and re-execute the pattern operation.

● Pattern Registered Parameter Setup Errors

A pattern registered parameter setup error is generated when a Set Pattern Registered Parameters command is executed with invalid or out of range parameter values in the pattern registered parameter area.

Table 10.14 List of Pattern Registered Parameter Setup Errors

Error Code	Error Description	Possible Causes	Remedy
1301	Pattern Combined-speed Limit setup error	A pattern registered parameter value is out of valid range. Even if individual parameters are within valid data range, this error may be reported if a combination of parameter values is out of valid data range. The error code stores the data position number of the invalid pattern registered parameter for pattern A.	Re-execute the Set Pattern Registered Parameters command with valid pattern registered parameter data. For details on the valid data range of individual pattern registered parameters, see Section 5.2.5, "Pattern Registered Parameters". These errors cannot be cleared using a Reset Pattern Error command.
1303	Pattern Combined-speed ACC Time setup error		
1304	Pattern Combined-speed DCC Time setup error		

● Pattern Command Execution Errors

A pattern command execution error is generated when a pattern command is executed with invalid or out of range parameter values in the pattern command parameter area.

Table 10.15 List of Pattern Command Execution Errors

Error Code	Error Description	Possible Causes	Remedy
1331	Pattern Command Code setup error	A pattern command parameter value is out of valid range. Even if individual parameters are within valid data range, this error may be reported if a combination of parameter values is out of valid data range. The error code stores the data position number of the invalid pattern command parameter for pattern A.	Clear the pattern error and re-execute the pattern command with valid command parameter data. For details on the valid data range of individual pattern command parameters, see Section 5.2.6, "Pattern Command Parameters".
1333	Pattern Preset Override Value setup error		
1334	Pattern Start Record No. setup error		
1339	Pattern End Record No. setup error		

■ Pattern Warnings

A pattern warning is generated when a pattern command to be executed does not satisfy all command acceptance conditions.

Table 10.16 List of Pattern Warnings

Warning Code	Command Acceptance Condition	Possible Causes	Remedy
1	No pattern error has been detected.	Command was executed in error state.	Clear error before executing command.
2	A pattern error has been detected.	Reset Error command was executed when not in error state, or Reset Error command was executed for an error that cannot be cleared using the Reset Error command.	Execute the Reset Error command only when in error state. (Some errors such as registered parameter setup error cannot be cleared using the Reset Error command.)
3	No pattern operation movement is in progress	Command executed is not allowed while a pattern operation movement is in progress.	Check that no pattern operation movement is in progress before executing command.
4	Pattern operation movement is in progress	Command executed is not allowed when no pattern operation movement is in progress.	Check that a pattern operation movement is progress before executing command.
5	Restarting of pattern operation is allowed.	A Restart Pattern Operation command was executed for a pattern operation that cannot be restarted.	Only pattern operations that have been stopped by a Decelerate and Stop Pattern Operation command during movement can be restarted using the Restart Pattern Operation command. Check the 'Stopped but restartable' bit of Pattern Acton Status to determine if an operation can be restarted.
6	ToolBox is not performing an action test	Command executed is not allowed during Toolbox action test.	End ToolBox action test before executing command.

10.5 Flowchart for Troubleshooting

This section describes how to perform troubleshooting for the positioning module.
It assumes that the FA-M3 has been powered on and the module is properly mounted.

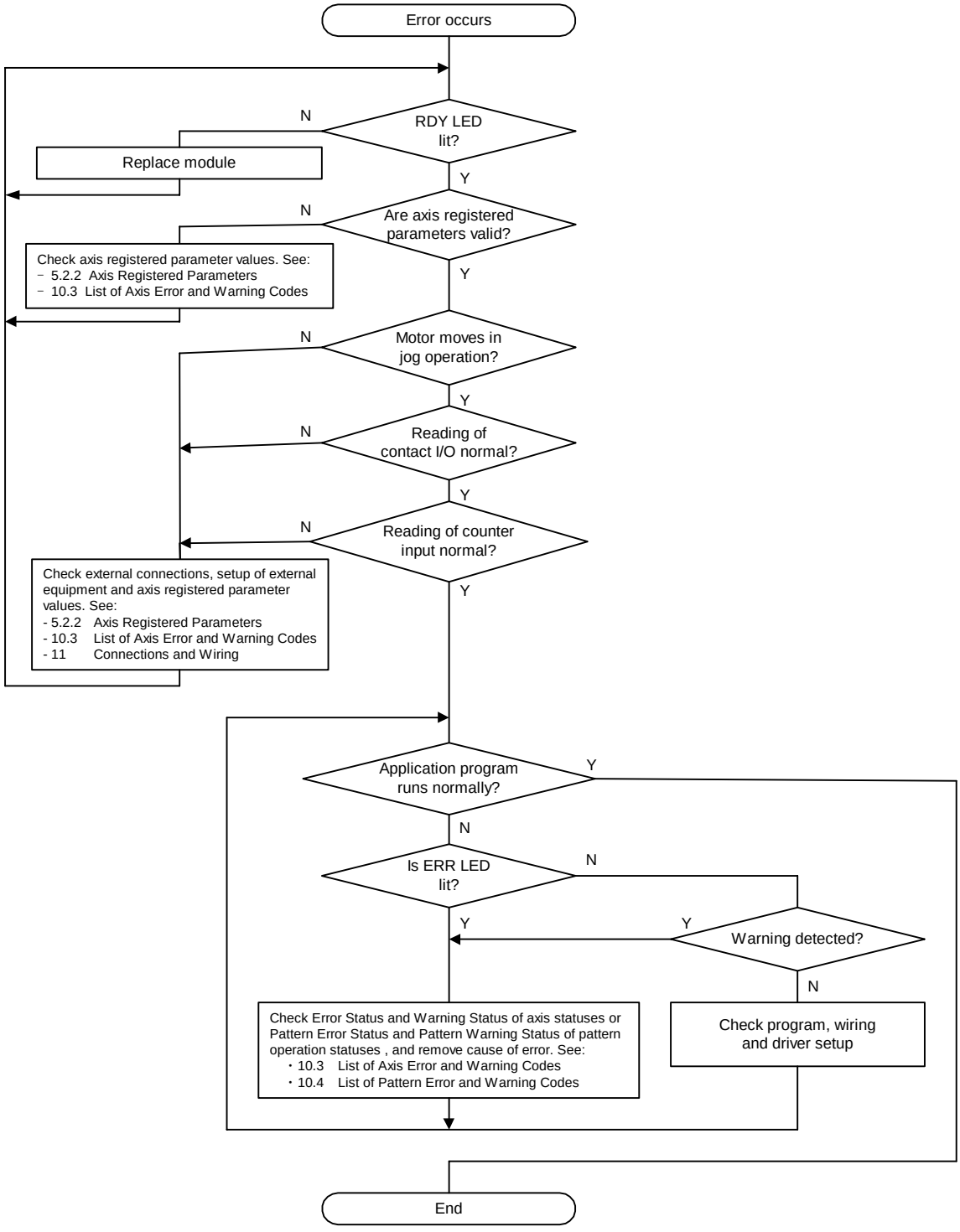

Figure 10.1 Flowchart for Troubleshooting

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11. Connections and Wiring

11.1 Attaching/Detaching the Module

■ Attaching the Module

Figure 11.1 shows how to attach this module to the base module. First hook the anchor slot at the bottom of the module to be attached onto the anchor pin on the bottom of the base module. Push the top of the module toward the base module until the anchor/release button clicks into place.

Always switch off the power before attaching or detaching the module.

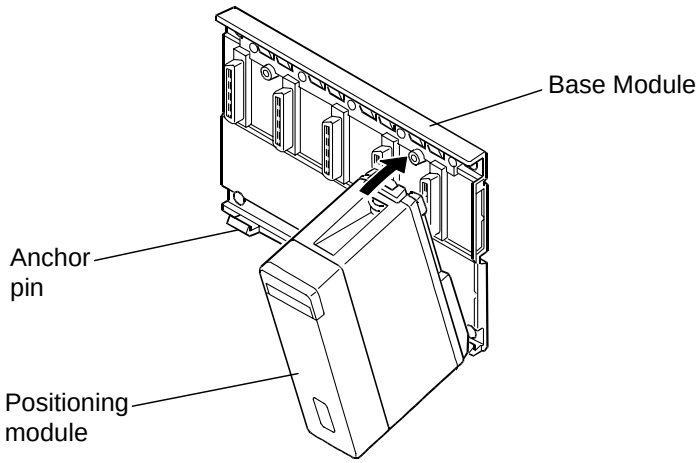


Figure 11.1 Attaching/Detaching the Module

CAUTION

Do not over-tighten the module fixing screw.

CAUTION

Do not bend the connector on the rear of the module by force during the above operation. If the module is pushed with improper force, the connector may bend causing an error.

■ Detaching the Module

To remove this module from the base module, reverse the above operation.

Press the anchor/release button on the top of this module to unlock it and tilt the module away from the base module.

■ Attaching the Module in Intense Vibration Environments

If the module is used in intense vibration environments, fasten the module with a screw.

Use screws of type listed in the table below.

Insert these screws into the screw holes on top of the module and tighten them with a Phillips screwdriver.

Required Screw
Binding head machine screw M4 of 12 to 15 mm long, or washer screw of 14-15 mm long.

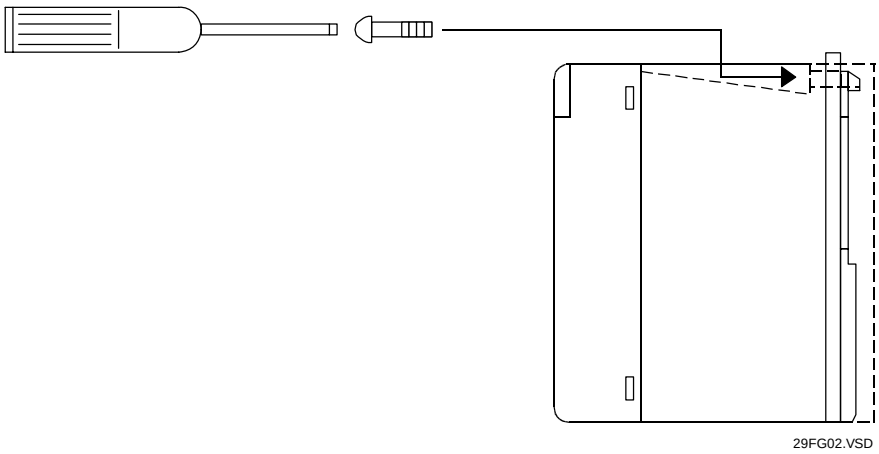


Figure 11.2 Securing Module Using Screws

■ Grounding of Cables

Use a shielded cable for conforming equipment incorporating the positioning module to CE Marking. Remove part of the cable insulation to expose the shield, and ground and secure the shield with an FG clamp.

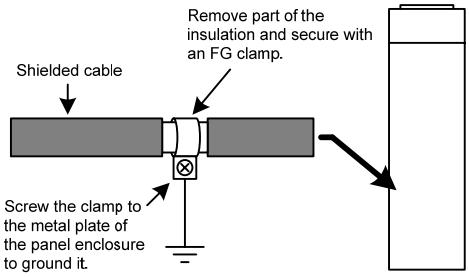


Figure 11.3 How to Ground Cables

11.2 Signal Specifications

For a list of the external connection signals, see Section 2.8, "External Connection Diagram". This section describes the specifications and method of connection of each signal.

CAUTION

The positioning module is not provided with circuits to protect against over voltage in input circuits and circuits to protect against short circuit in output circuits. Thus, if a signal exceeds its rated voltage (or rated current) due to incorrect wiring or other reasons, it may lead to module failure.

11.2.1 24-V External Power Supply Input

This input provides external power supply for the pulse output circuits and external contact output circuits.

Table 11.1 Power Supply Specification

Item	Specification
Rated input voltage	24 VDC (20.4 to 26.4 VDC)

11.2.2 Emergency Stop Input

The Emergency Stop Input is a 24 V DC normally closed contact input independent of the External Contact Inputs. When the input is off (normal operation), apply a 24V DC voltage across pins 2a and 2b. Only the Emergency Stop Input signal in the connector for axes 1 and 2 (left connector) is valid, and it is shared by all axes.

Table 11.2 Signal Specification

Item	Specification
Isolation method	Photocoupler isolation
Input impedance	About 7.4kΩ
Rated input voltage (allowable input voltage range)	24 V DC (20.4 to 26.4 V DC)
Rated input current	3.1 mA
Input voltage/current for emergency stop reset	19.2 V DC min./2.4 mA min.
Input voltage/current for emergency stop	5.8 V DC max./0.9 mA max.

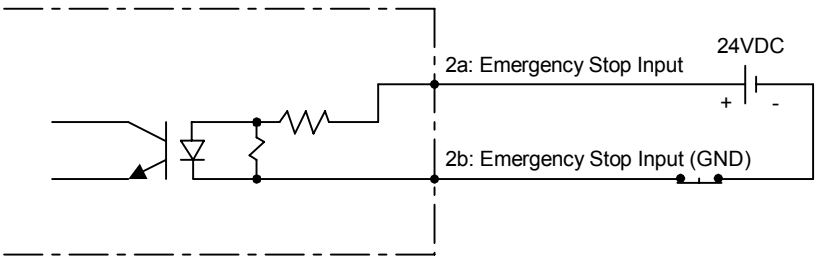


Figure 11.4 Connecting Emergency Stop Input

11.2.3 Pulse Output

The positioning modules output positioning reference pulses as RS422-compliant differential signals. An external power supply (24VDC±5%) is required for positioning reference pulse output.

The reference potential of the signal is Pulse Output (GND), which is shared with the SEN Signal Output (GND).

Shielded twisted pair cables should be used for connection.

Table 11.3 Signal Specification

Item	Specification
Isolation method	Photocoupler isolation
Electrical specification	RS-422A compliant different line driver (AM26C31 or equivalent)
Maximum speed	5,000,000 pps

Table 11.4 Signal Polarity

Signal Pin	Off (break)	On (mark)
Output (+)	High level (differential positive)	Low level (differential negative)
Output (-)	Low level (differential negative)	High level (differential positive)

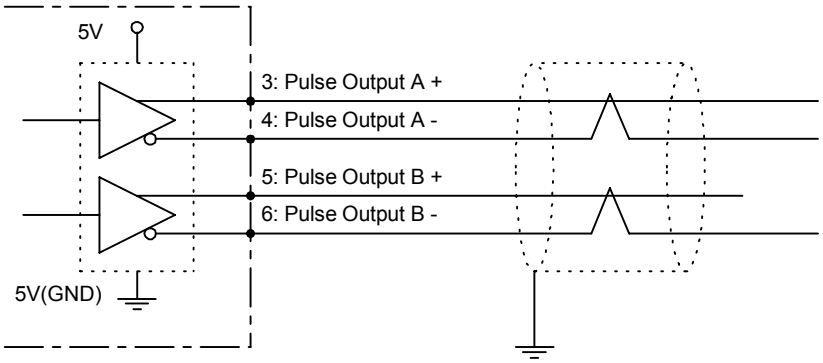


Figure 11.5 Connecting Pulse Output

CAUTION

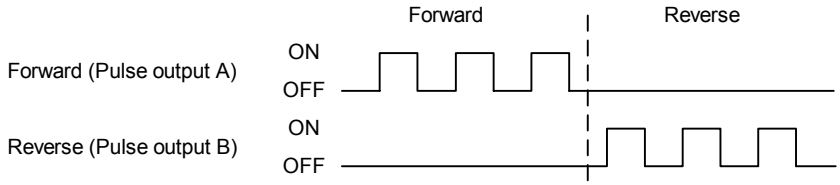
Make sure that the polarity of the '+' signal and '-' signal during signal off matches the specification of the target driver. When connected with reverse polarities, the driver may not operate.

The pulse output type can be defined using registered parameters as CW/CCW pulse, travel/direction or phase A/phase B to match the motor/driver to be connected.

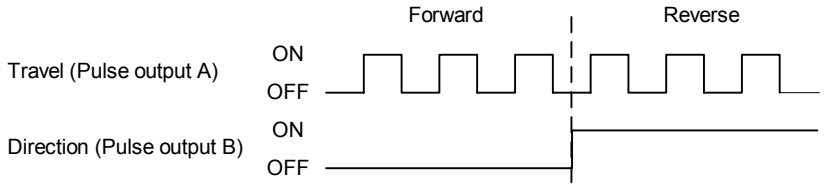
Table 11.5 Pulse Output Type and Output Signals

Pulse Output Type	Output A	Output B
CW/CCW pulse	CW	CCW
Travel/direction	Travel	Direction
Phase A/phase B	Phase A	Phase B

- **CW/CCW pulse**



- **Travel/direction**



- **Phase A/phase B**

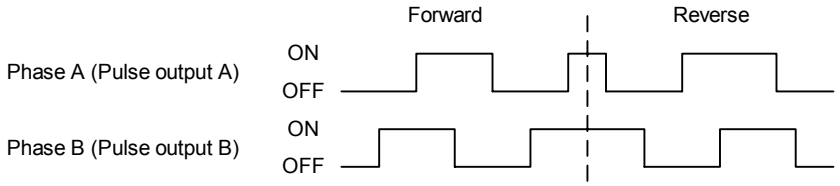


Figure 11.6 Direction of Motor Rotation and Pulse Output

CAUTION

Make sure that the polarity of the '+' signal and '-' signal during signal off matches the specification of the target driver. When connected with reverse polarities, the driver may not operate.

11.2.4 External Contact Inputs

These are 24 V DC inputs with a common terminal across all axes. The polarity of the common may be either positive or negative. It is isolated from the internal circuitry by a photocoupler.

All input contacts can be individually configured as normally-open (NO) or normally-closed (NC) contact using axis registered parameters.

Origin Input, Forward Limit Input, Reverse Limit Input, Driver Alarm Input, External Trigger Input can be configured as general inputs using axis registered parameters.

The contact input COM terminal (common to all four axes) connects to a switch circuit inside the module. The switch circuit is normally off, and turns on only at the time when a contact input is read. Thus, if the switch circuit is off, no input current flows even when an external contact input terminal is provided with voltage to turn on the input. Never supply the module with more than one 24 V DC external power supply; otherwise external contact inputs may malfunction when the switch circuit is off.

CAUTION

When the internal switch circuit of the module is off, observe the following precautions when using the module so as to prevent malfunction.

1. Connect the external contact output signals (sensor, switch, etc.) to the contact inputs of the module only.

   If the signals are connected in parallel to other input equipment other than the module, it may result in malfunction of the module and the respective input equipment.

2. Use the external contact inputs with one external power supply.

   If the external contact inputs are connected to two or more external power supplies, malfunction may result.

3. Connection to equipment such as 2-wire type sensors, which require power to be supplied via the external contact input circuit, is not allowed.

Table 11.6 Signal Specification

Item	Specification
Isolation method	Photocoupler isolation
Input impedance	about 7.4kΩ
Rated input voltage (allowable input voltage range)	24 V DC (20.4 to 26.4 V DC)
Rated input current	3.1 mA
Voltage/current for ON signal (for normally open contact)	19.2 V DC min./2.4 mA min.
Voltage/current for OFF signal (for normally open contact)	5.8 V DC max./0.9 mA max.
Common type	Shared common
Response Time	2 ms max.

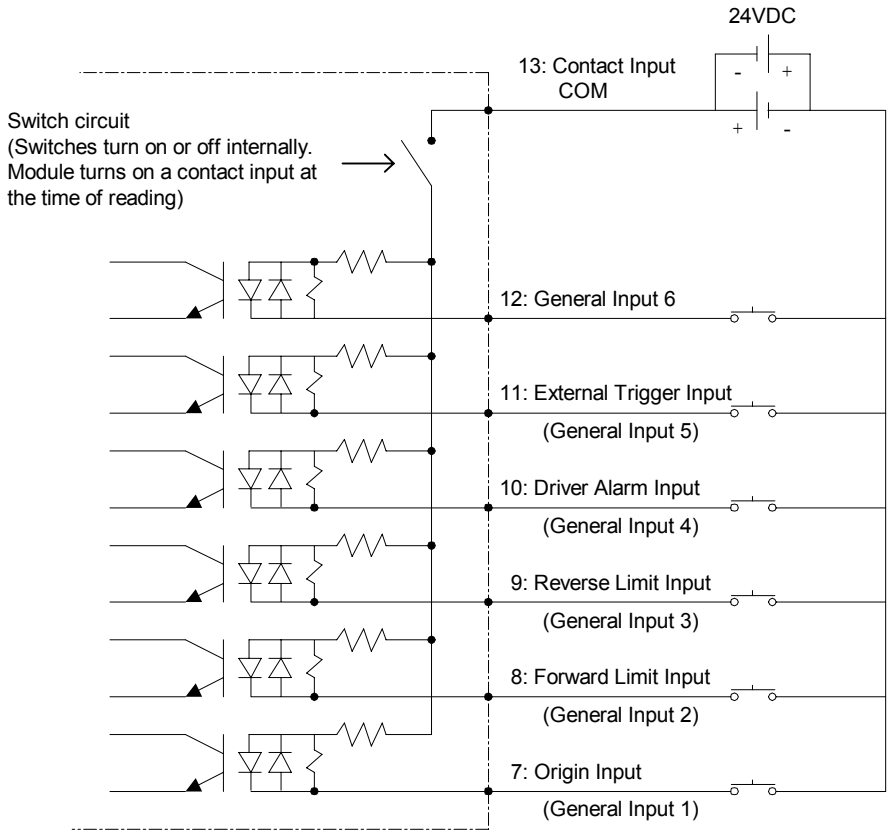


Figure 11.7 Connecting External Contact Inputs

11.2.5 External Contact Output

The external contact outputs are sink-type, open-collector outputs with a common terminal. Therefore, a 24 V DC external power supply is needed for external output circuits to function normally. The external contact outputs are isolated from the internal circuitry by a photocoupler.

All output contacts can be individually configured as normally-open (NO) or normally-closed (NC) contact using axis registered parameters.

The Deviation Pulse Clear Output can be configured as General Output using registered parameters.

Table 11.7 Signal Specification

Item	Specification
Isolation method	Photocoupler isolation
Rated load voltage	24 V DC
Maximum load current	50 mA per contact
OFF leakage current	0.1 mA max.
ON residual voltage	1 V DC max.
Common type	Shared common
External power supply	24 V DC

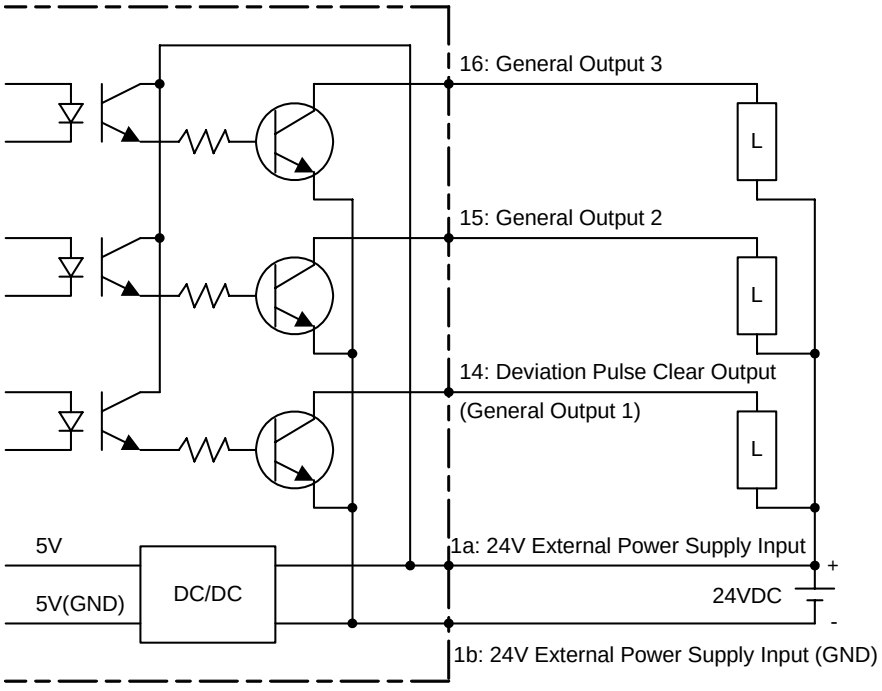


Figure 11.8 Connecting External Contact Outputs

11.2.6 Encoder Z-phase Input

This input connects to the encoder Z-phase. It can also be connected to a RS-422A compliant differential input signal.

Shielded twisted pair cables should be used for connection.

Table 11.8 Signal Specification

Item	Specification
Isolation method	Photocoupler isolation
Input impedance	240 Ω
Rated input voltage (allowable input voltage range)	5 V DC (4.25 to 5.5 V DC)
Rated input current	15.3 mA
Voltage/current for ON signal	3.5 V DC min./9 mA min.
Voltage/current for OFF signal	1.5 V DC max./2 mA max.
Common type	Separate commons
Response Time	1 ms max.

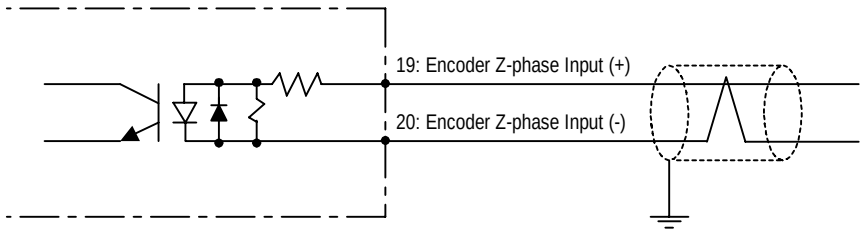


Figure 11.9 Connecting Encoder Z-phase Input

11.2.7 Counter Input

This signal pin is used to accept encoder input signal or input signal from a manual pulse generator. It can also accept an RS-422A compliant differential input signal. When connected to an absolute encoder, it receives signals at counter Phase A input.

Shielded twisted pair cables should be used for connection.

Table 11.9 Signal Specification

Item	Specification
Isolation method	Photocoupler isolation
Input impedance	240 Ω
Rated input voltage (allowable input voltage range)	5 V DC (4.25 to 5.5 V DC)
Rated input current	15.3 mA
Voltage/current for ON signal	3.5 V DC min./9 mA min.
Voltage/current for OFF signal	1.5 V DC max./2 mA max.
Common type	Separate commons
Sampling period	Configurable from 0.1 to 1 ms

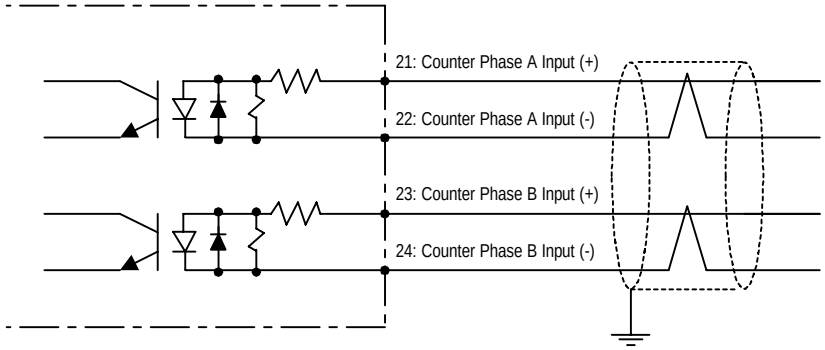


Figure 11.10 Connecting Counter Input

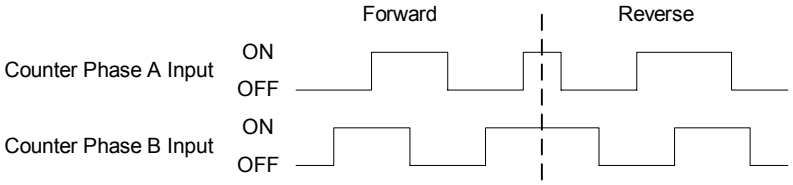


Figure 11.11 Direction of Encoder Rotation and Counter Input

CAUTION

When connecting the counter input to the encoder of a motor or driver, ensure that the Phase A/Phase B specification of the motor/driver and that of the positioning module agree with each other. To do so, confirm the relationship between the rotating direction and the phases of an encoder by referring to the user's manual, and connect the encoder to the counter input such that the counter Phase B input terminal receives pulses earlier than the counter Phase A input terminal if the encoder rotates in the forward direction.

11.2.8 SEN Signal Output (for Yaskawa's absolute encoder)

This is the SEN signal for absolute encoders manufactured by Yaskawa Electric Corporation. It outputs a 5 V DC signal.

Table 11.10 Signal Specification

Item	Specification
Output voltage at no load	5 V DC
Maximum load current	10 mA (at DC 4.5 V)
OFF leakage current	10 µA max

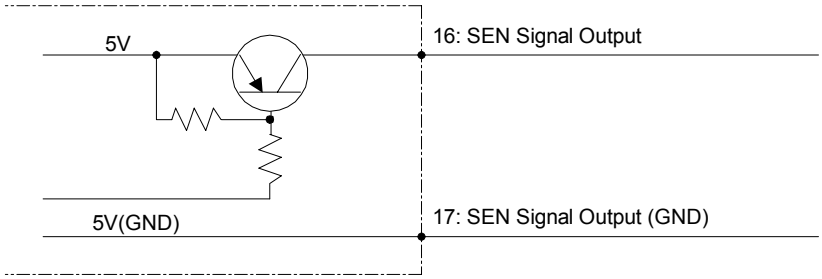


Figure 11.12 Connecting SEN Signal Output

11.3 Examples of Connections to Third-party Motors/Drivers

This section presents examples on connection between the positioning module to motors or drivers. Note that the figures indicate canonical connections. Depending on your application, some unconnected signals (enclosed within dotted boxes in the figures) may also need to be connected.

CAUTION

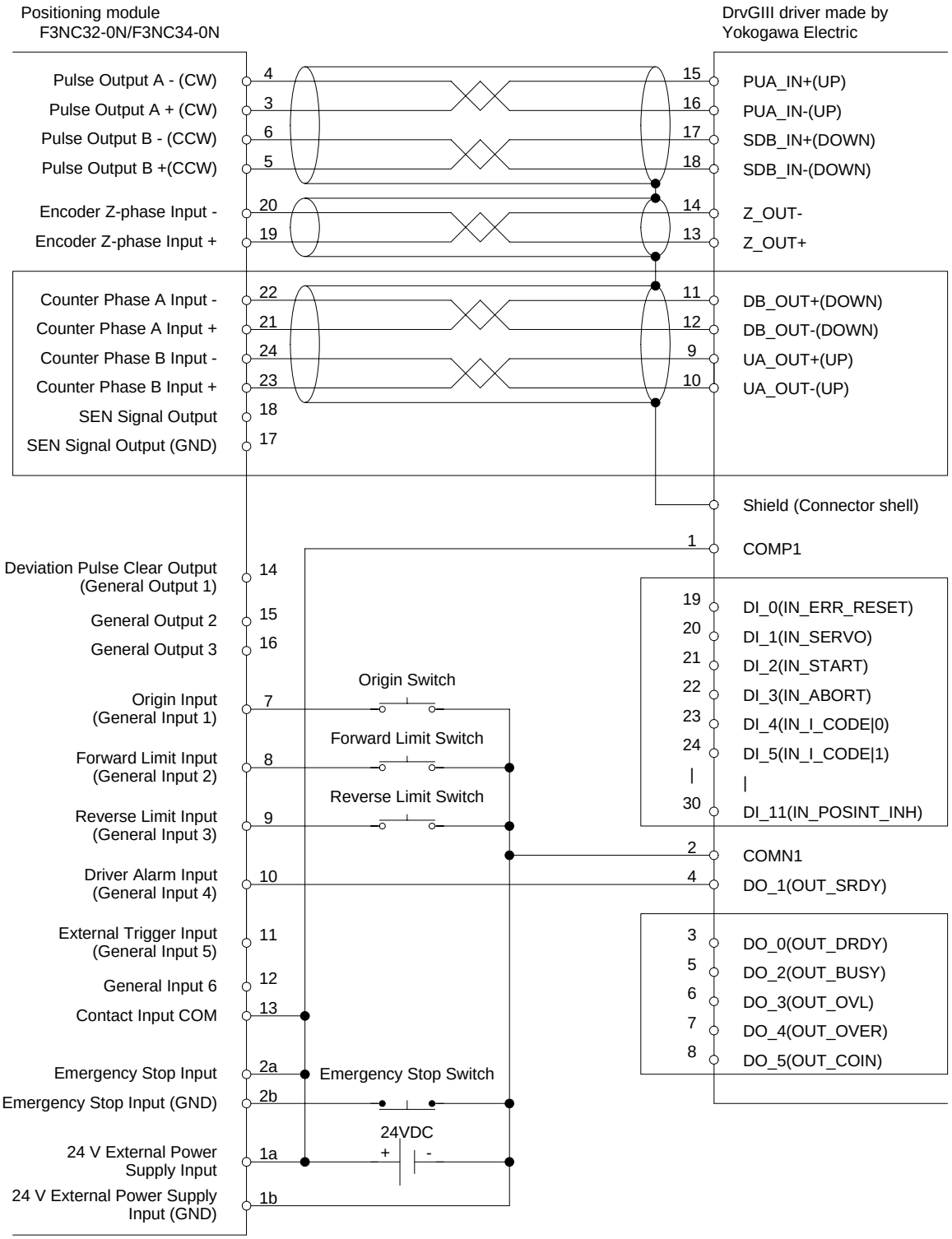
Always check the manuals of equipment to be connected to confirm signal specifications (connection method and electric specifications) before performing connection.

CAUTION

- Make sure that the polarity of the '+' signal and '-' signal during signal off matches the specification of the target driver. When connected with reverse polarities, the driver may not operate.
- When connecting the counter input to the encoder of a motor or driver, ensure that the Phase A/Phase B specification of the motor/driver and that of the positioning module agree with each other. To do so, confirm the relationship between the rotating direction and the phases of an encoder by referring to the user's manual, and connect the encoder to the counter input such that the counter Phase B input terminal receives pulses earlier than the counter Phase A input terminal if the encoder rotates in the forward direction.
- Use shielded cables to connect signal lines and connect the shield to the FG terminal of the driver/motor.

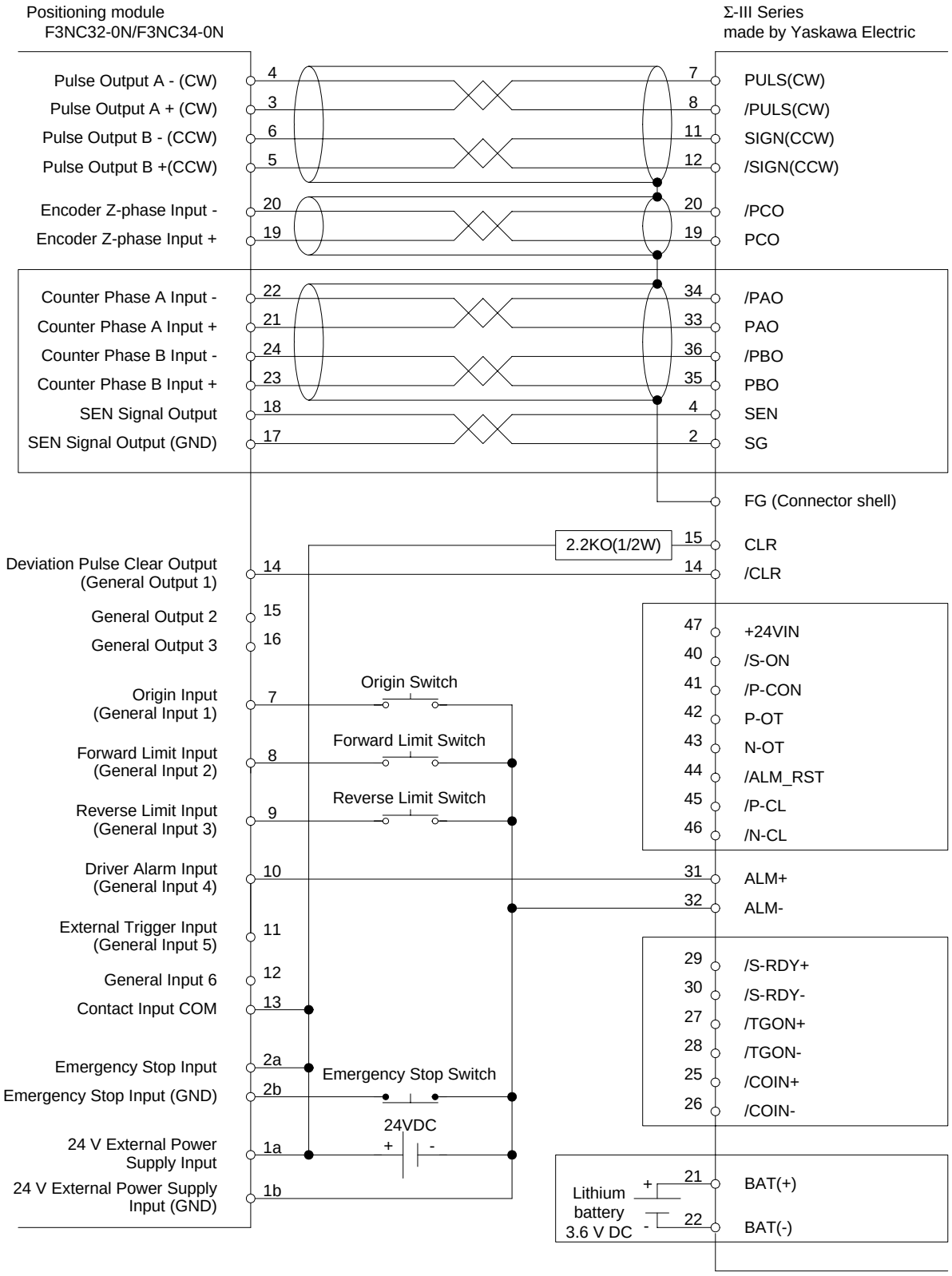
11.3.1 Example of Connection to Servo Amplifier Made by Yokogawa

■ Example of Connection to DRvG III Driver



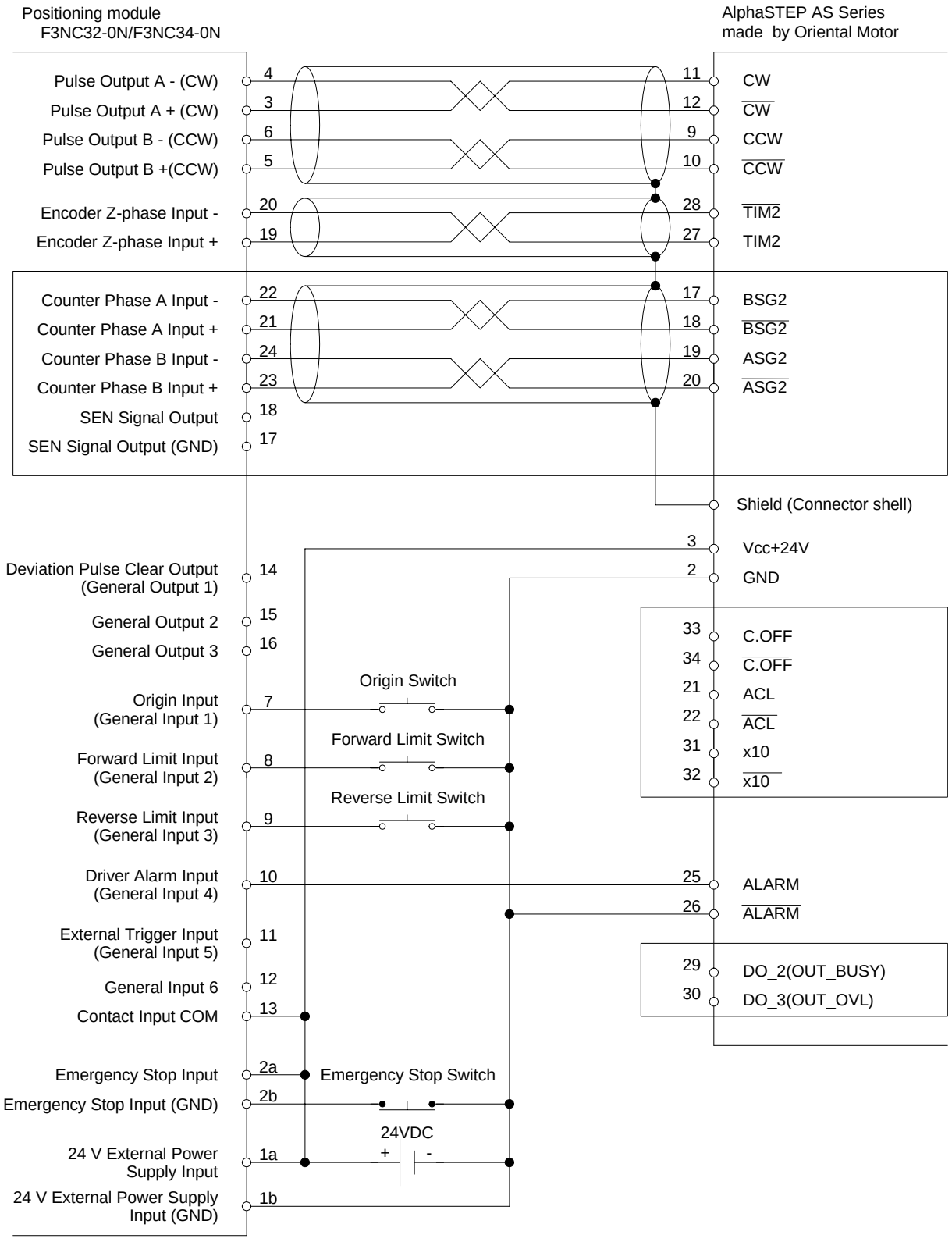
11.3.2 Example of Connection to Servo Amplifier Made by Yaskawa

■ Example of Connection to Σ-III Series

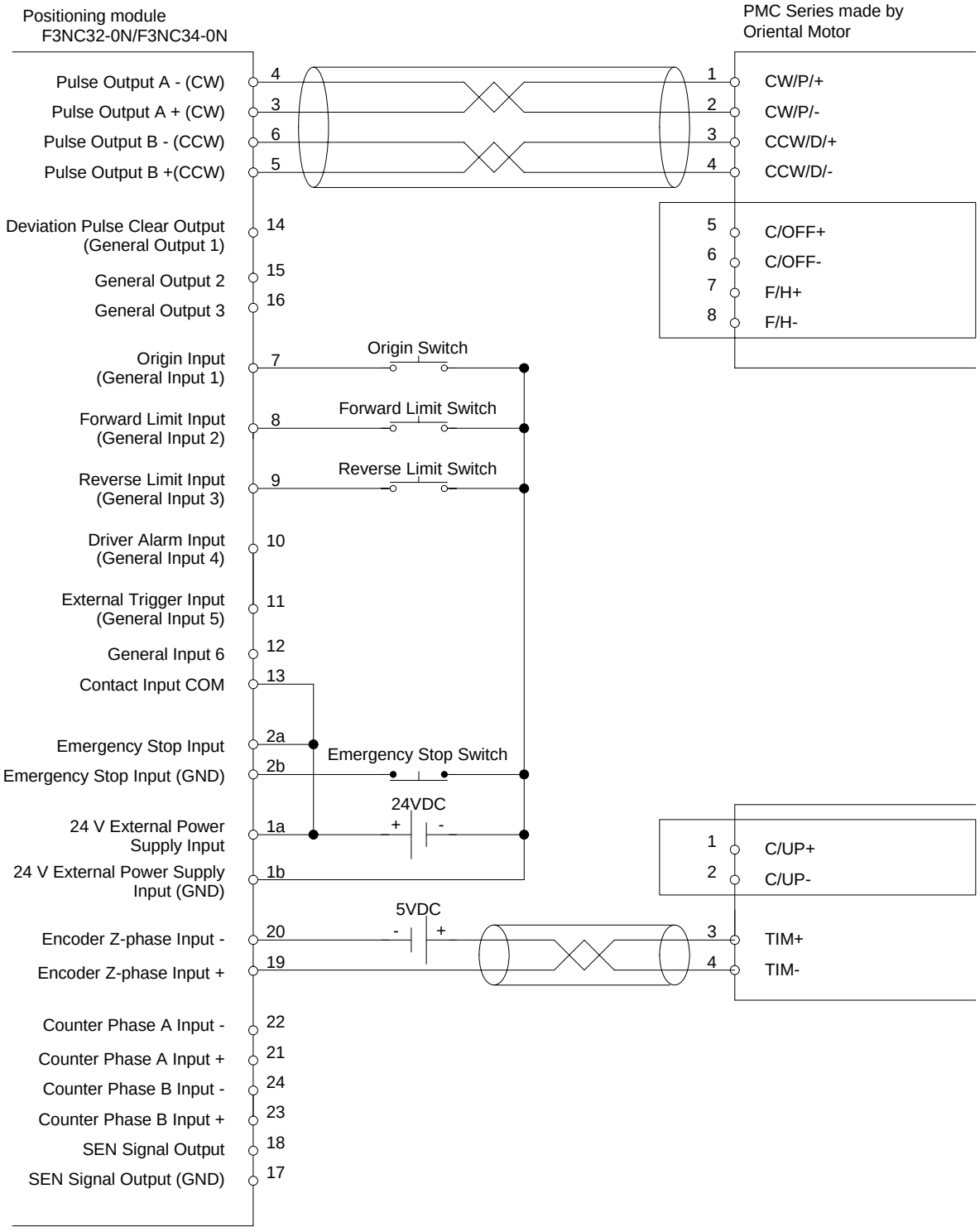


11.3.3 Examples of Connection to Stepper Motor Made by Oriental Motor

■ Example of Connection to AlphaSTEP AS Series

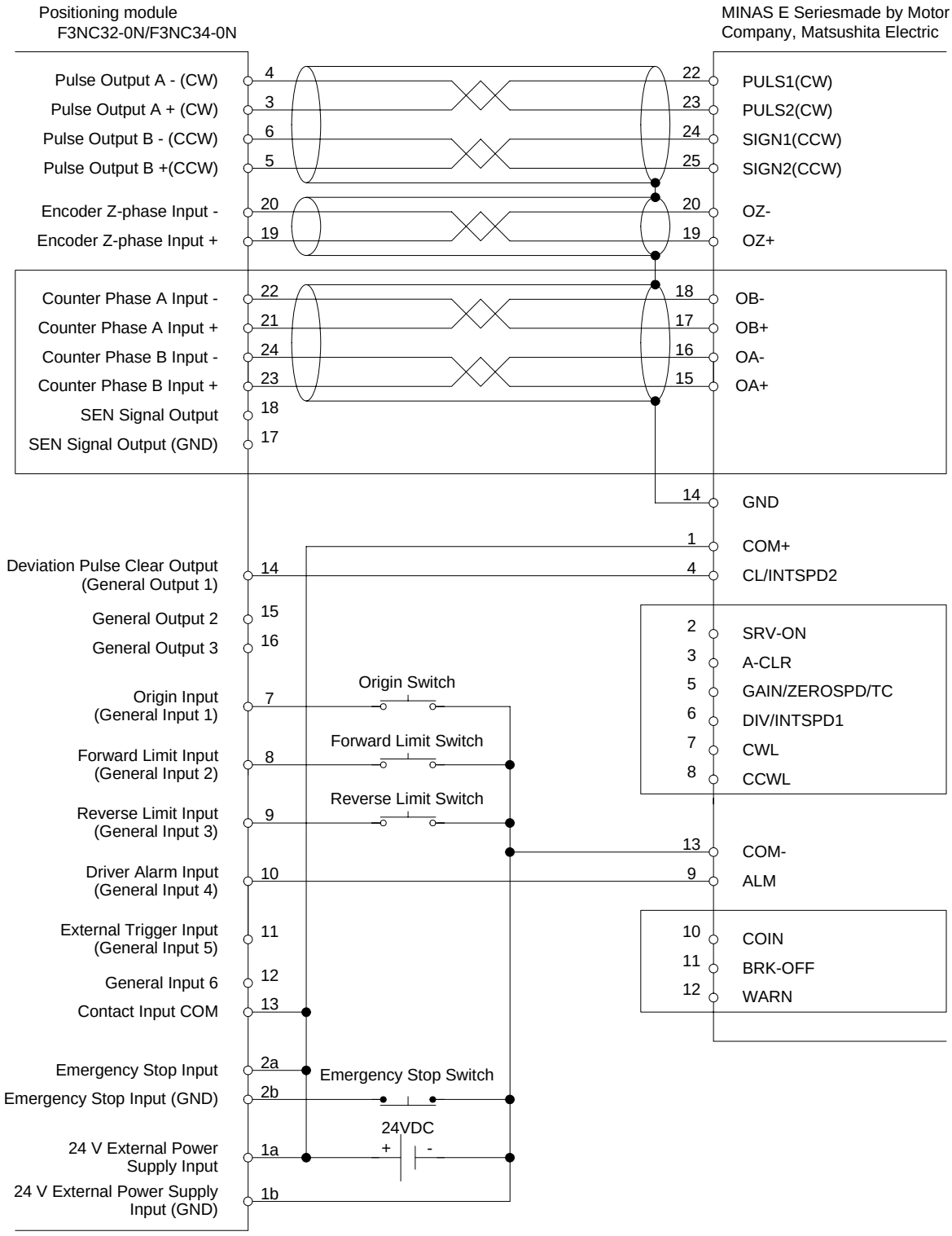


■ Example of Connection to PMC Series



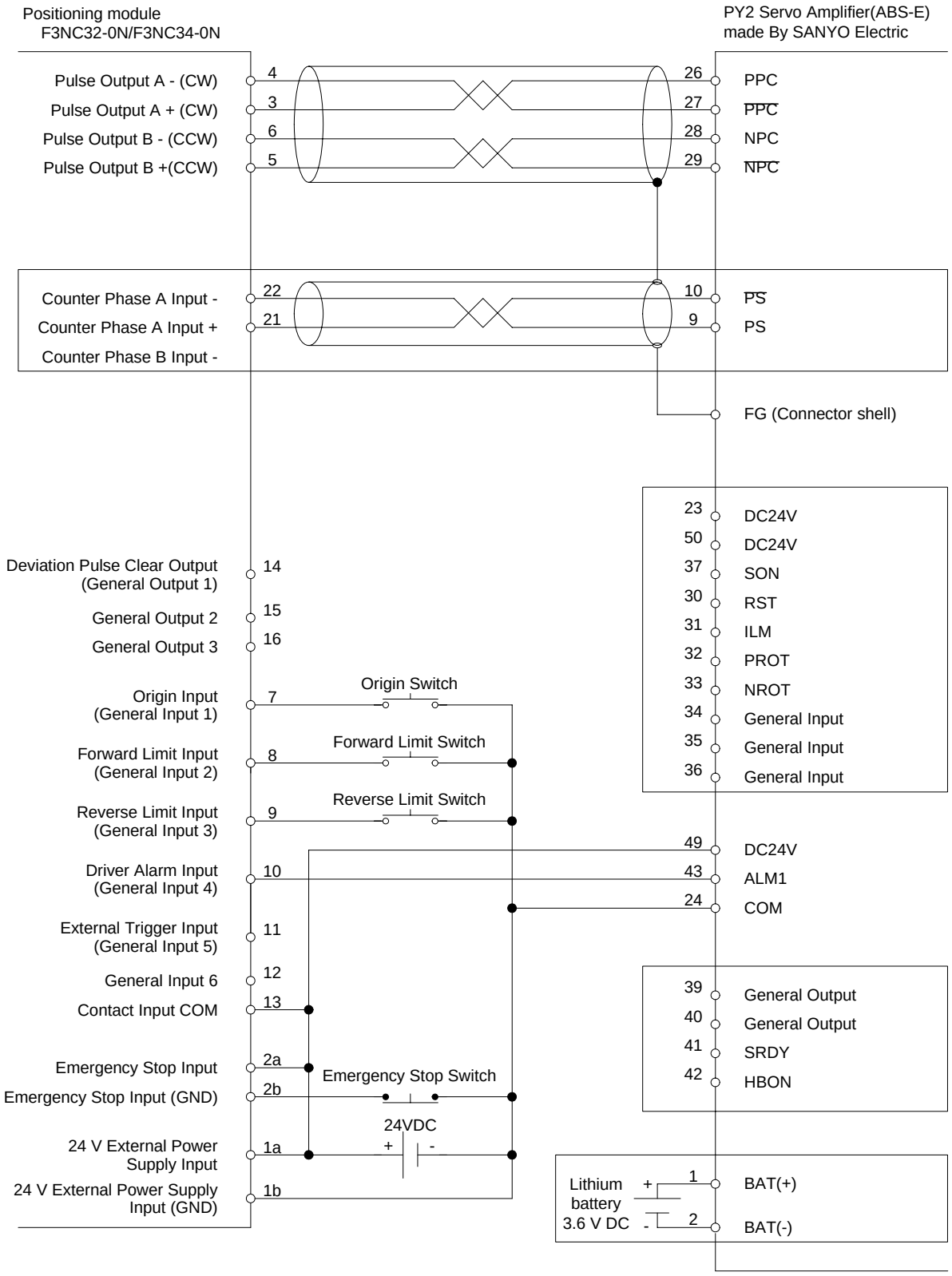
11.3.4 Example of Connection to Servo Amplifier Made by Matsushita

■ Example of Connection to MINAS E Series



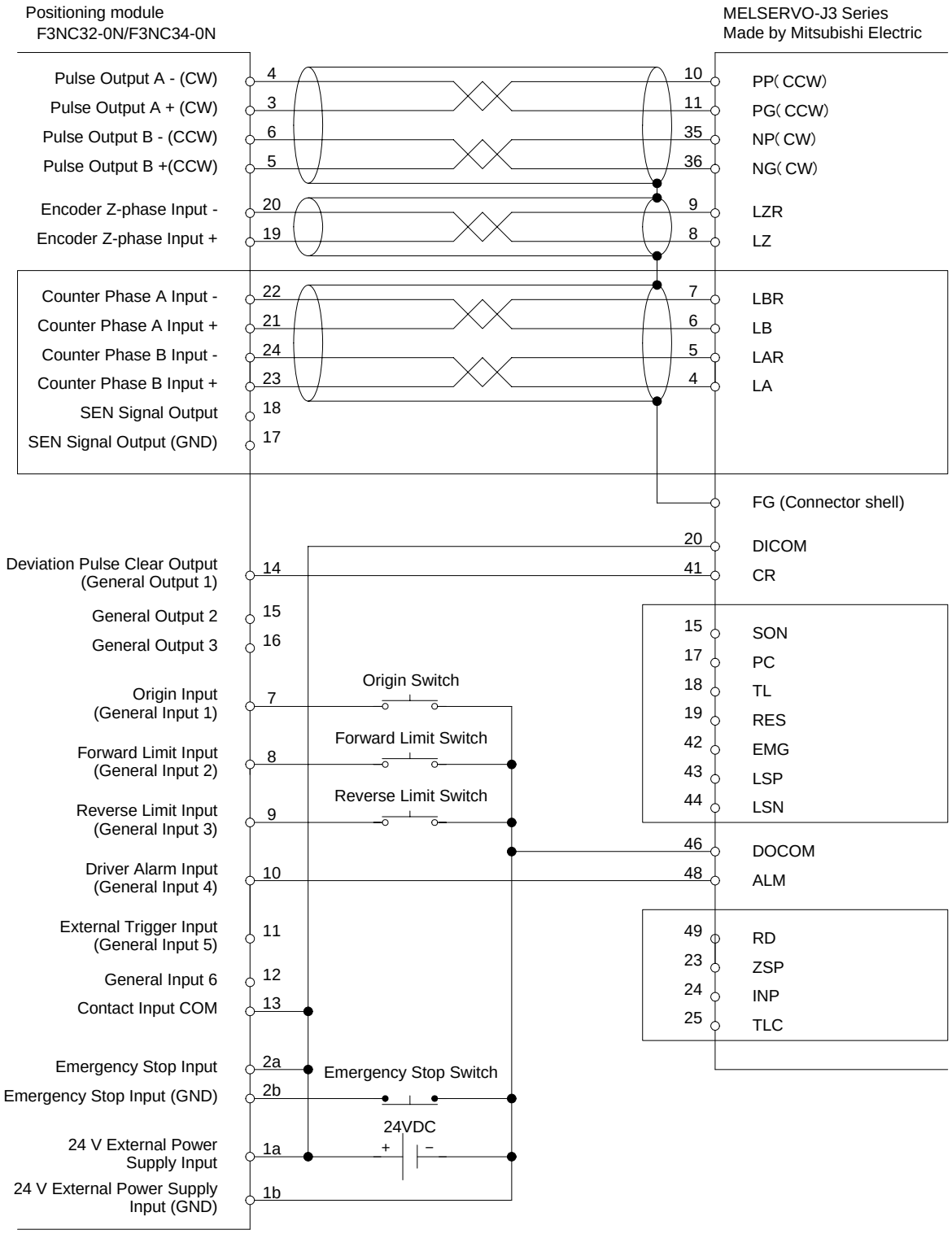
11.3.5 Example of Connection to Servo Amplifier Made by SANYO

■ Example of Connection to PY2 Series



11.3.6 Example of Connection to Servo Amplifier Made by Mitsubishi

■ Example of Connection to MELSERVO-J3 Series



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Appendix 1. List of I/O Relays

Appx. 1.1 Input Relays

The following table lists the input relays available in the positioning module.

In the table, □□□ denotes the slot number of the FA-M3 where the positioning module is installed.

Table Appx. 1.1 List of Input Relays

Input Relay No.	Signal Name	Description	Relationship with Other Relays
X□□□01	AX1 Execute Command ACK	Turns on when execution of direct command for axis 1 is successfully completed.	Turning off Y□□□33 turns off this relay.
X□□□02	AX2 Execute Command ACK	Turns on when execution of direct command for axis 2 is successfully completed.	Turning off Y□□□34 turns off this relay.
X□□□03	AX3 Execute Command ACK	Turns on when execution of direct command for axis 3 is successfully completed.	Turning off Y□□□35 turns off this relay.
X□□□04	AX4 Execute Command ACK	Turns on when execution of direct command for axis 4 is successfully completed.	Turning off Y□□□36 turns off this relay.
X□□□05	AX1 Positioning Completed	Turns on when axis 1 is in positioning completed state.	
X□□□06	AX2 Positioning Completed	Turns on when axis 2 is in positioning completed state.	
X□□□07	AX3 Positioning Completed	Turns on when axis 3 is in positioning completed state.	
X□□□08	AX4 Positioning Completed	Turns on when axis 4 is in positioning completed state.	
X□□□09	AX1 Error Detected	Turns on when error is encountered on axis 1.	
X□□□10	AX2 Error Detected	Turns on when error is encountered on axis 2.	
X□□□11	AX3 Error Detected	Turns on when error is encountered on axis 3.	
X□□□12	AX4 Error Detected	Turns on when error is encountered on axis 4.	
X□□□13	Pattern A Execute Command ACK	Turns on when execution of pattern command of pattern A is successfully completed.	Turning off Y□□□49 turns off this relay.
X□□□14	Pattern B Execute Command ACK	Turns on when execution of pattern command of pattern B is successfully completed.	Turning off Y□□□50 turns off this relay.
X□□□15	Pattern C Execute Command ACK	Turns on when execution of pattern command of pattern C is successfully completed.	Turning off Y□□□51 turns off this relay.
X□□□16	Pattern D Execute Command ACK	Turns on when execution of pattern command of pattern D is successfully completed.	Turning off Y□□□52 turns off this relay.

Input Relay No.	Signal Name	Description	Relationship with Other Relays
X□□□17	Pattern A Execution Completed	Turns on when execution of pattern A is successfully completed.	
X□□□18	Pattern B Execution Completed	Turns on when execution of pattern B is successfully completed.	
X□□□19	Pattern C Execution Completed	Turns on when execution of pattern C is successfully completed.	
X□□□20	Pattern D Execution Completed	Turns on when execution of pattern D is successfully completed.	
X□□□21	Pattern A Error Detected	Turns on when error is encountered during pattern A execution.	
X□□□22	Pattern B Error Detected	Turns on when error is encountered during pattern B execution.	
X□□□23	Pattern C Error Detected	Turns on when error is encountered during pattern C execution.	
X□□□24	Pattern D Error Detected	Turns on when error is encountered during pattern D execution.	
X□□□25	Pattern A M Code Detected	Turns on during M Code output of pattern A.	Turning onY□□□57 turns off this relay.
X□□□26	Pattern B M Code Detected	Turns on during M Code output of pattern B.	Turning on Y□□□58 turns off this relay.
X□□□27	Pattern C M Code Detected	Turns on during M Code output of pattern C.	Turning on Y□□□59 turns off this relay.
X□□□28	Pattern D M Code Detected	Turns on during M Code output of pattern D.	Turning on Y□□□60 turns off this relay.
X□□□29	AX1 Counter/Zone Coincidence Detected	Turns on when counter coincidence or zone coincidence is detected on axis 1.	Turning on Y□□□61 when counter coincidence is detected turns off this relay
X□□□30	AX2 Counter/Zone Coincidence Detected	Turns on when counter coincidence or zone coincidence is detected on axis 2.	Turning on Y□□□62 when counter coincidence is detected turns off this relay

X□□□31	AX3 Counter/Zone Coincidence Detected	Turns on when counter coincidence or zone coincidence is detected on axis 3.	Turning on Y□□□63 when counter coincidence is detected turns off this relay
X□□□32	AX4 Counter/Zone Coincidence Detected	Turns on when counter coincidence or zone coincidence is detected on axis 4.	Turning on Y□□□64 when counter coincidence is detected turns off this relay

Appx. 1.2 Output Relays

The following table lists the outputs relays available in the positioning module.

In the table, □□□ denotes the slot number of the FA-M3 where the positioning module is installed.

Table Appx. C1.2 List of Output Relays

Output Relay No.	Signal Name	Description	Relationship with Other Relays
Y□□□33	AX1 Execute Command	Request to execute direct command for axis 1.	Turn this relay off after confirming that X□□□01 has turned on.
Y□□□34	AX2 Execute Command	Request to execute direct command for axis 2.	Turn this relay off after confirming that X□□□02 has turned on.
Y□□□35	AX3 Execute Command	Request to execute direct command for axis 3.	Turn this relay off after confirming that X□□□03 has turned on.
Y□□□36	AX4 Execute Command	Request to execute direct command for axis 4.	Turn this relay off after confirming that X□□□04 has turned on.
Y□□□37	AX1 Stop Immediately	Request to stop axis 1 immediately.	
Y□□□38	AX2 Stop Immediately	Request to stop axis 2 immediately.	
Y□□□39	AX3 Stop Immediately	Request to stop axis 3 immediately.	
Y□□□40	AX4 Stop Immediately	Request to stop axis 4 immediately.	
Y□□□41	AX1 Forward Jog	Request to jog axis 1 forward.	
Y□□□42	AX2 Forward Jog	Request to jog axis 2 forward.	
Y□□□43	AX3 Forward Jog	Request to jog axis 3 forward.	
Y□□□44	AX4 Forward Jog	Request to jog axis 4 forward.	
Y□□□45	AX1 Reverse Jog	Request to jog axis 1 backward.	
Y□□□46	AX2 Reverse Jog	Request to jog axis 2 backward.	
Y□□□47	AX3 Reverse Jog	Request to jog axis 3 backward.	
Y□□□48	AX4 Reverse Jog	Request to jog axis 4 backward.	

Output Relay No.	Signal Name	Description	Relationship with Other Relays
Y□□□49	Pattern A Execute Command	Request to execute pattern command of pattern A.	Turn this relay off after confirming that X□□□13 has turned on.
Y□□□50	Pattern B Execute Command	Request to execute pattern command of pattern B.	Turn this relay off after confirming that X□□□14 has turned on.
Y□□□51	Pattern C Execute Command	Request to execute pattern command of pattern C.	Turn this relay off after confirming that X□□□15 has turned on.
Y□□□52	Pattern D Execute Command	Request to execute pattern command of pattern D.	Turn this relay off after confirming that X□□□16 has turned on.
Y□□□53	Pattern A Stop Immediately	Request to stop pattern A operation immediately.	
Y□□□54	Pattern B Stop Immediately	Request to stop pattern B operation immediately.	
Y□□□55	Pattern C Stop Immediately	Request to stop pattern C operation immediately.	
Y□□□56	Pattern D Stop Immediately	Request to stop pattern D operation immediately.	
Y□□□57	Pattern A Reset M Code	Request to reset M Code Detected relay for pattern A.	Turn this relay off after confirming that X□□□25 has turned off.
Y□□□58	Pattern B Reset M Code	Request to reset M Code Detected relay for pattern B.	Turn this relay off after confirming that X□□□26 has turned off.
Y□□□59	Pattern C Reset M Code	Request to reset M Code Detected relay for pattern C.	Turn this relay off after confirming that X□□□27 has turned off.
Y□□□60	Pattern D Reset M Code	Request to reset M Code Detected relay for pattern D.	Turn this relay off after confirming that X□□□28 has turned off.
Y□□□61	AX1 Reset Counter Coincidence	Request to reset Counter Coincidence Detected relay for axis 1.	Turn this relay off after confirming that X□□□29 has turned off.
Y□□□62	AX2 Reset Counter Coincidence	Request to reset Counter Coincidence Detected relay for axis 2.	Turn this relay off after confirming that X□□□30 has turned off.
Y□□□63	AX3 Reset Counter Coincidence	Request to reset Counter Coincidence Detected relay for axis 3.	Turn this relay off after confirming that X□□□31 has turned off.
Y□□□64	AX4 Reset Counter Coincidence	Request to reset Counter Coincidence Detected relay for axis 4.	Turn this relay off after confirming that X□□□32 has turned off.

Appendix 2. List of Parameters and Statuses

Table Appx. 2.1 shows the areas for storing registered parameters, command parameters and statuses of the module.

For details on each data area, refer to Tables Appx. 2.1 to 2.7.

Table Appx. 2.1 Layout of Parameter and Status Areas

Data Position No.	Description
0001 to 0100	Axis Common Statuses
0101 to 0200 0201 to 0300 0301 to 0400	Axis 1 Registered Parameters Axis 1 Command Parameters Axis 1 Statuses
0401 to 0500 0501 to 0600 0601 to 0700	Axis 2 Registered Parameters Axis 2 Command Parameters Axis 2 Statuses
0701 to 0800 0801 to 0900 0901 to 1000	Axis 3 Registered Parameters Axis 3 Command Parameters Axis 3 Statuses
1001 to 1100 1101 to 1200 1201 to 1300	Axis 4 Registered Parameters Axis 4 Command Parameters Axis 4 Statuses
1301 to 1330 1331 to 1350 1351 to 1400	Pattern A Registered Parameters Pattern A Command Parameters Pattern A Statuses
1401 to 1430 1431 to 1450 1451 to 1500	Pattern B Registered Parameters Pattern B Command Parameters Pattern B Statuses
1501 to 1530 1531 to 1550 1551 to 1600	Pattern C Registered Parameters Pattern C Command Parameters Pattern C Statuses
1601 to 1630 1631 to 1650 1651 to 1700	Pattern D Registered Parameters Pattern D Command Parameters Pattern D Statuses
1701 onwards	(System reserved)

Appx. 2.1 Axis Common Statuses

This table lists status information common to all axes.

Table Appx. 2.2 List of Axis Common Statuses

Data Position No.	Parameter Name	Data Range and Description	See Also
0001	Module Information	"F3"	5-6
0002	Module Information	"NC"	5-6
0003	Module Information	"32" or "34"	5-6
0004	Module Information	"0N"	5-6
0005	Module Information	" "	5-6
0006	Module Information	" "	5-6
0007	Module Information	"RV"	5-6
0008	Module Information	"□□□" ("□□□" denotes the revision number)	5-6
0009	(System reserved)		–
0010	(System reserved)		–
0011 / 0012	No. of Write Operations to Flash Memory	non-negative integer	5-6
0013	No. of Pattern Data Records Used	1 to 500	5-6
0014	No. of Position Data Records Used	1 to 2000	5-7
0015 to 0100	(System reserved)		–

Appx. 2.2 Axis Operation Statuses

This section lists registered parameters for each axis in separate tables.

Table Appx. 2.3 List of Axis Registered Parameters (Basic Parameters)

Data Position No.				Parameter Name	Data Range and Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0101	0401	0701	1001	Maximum Speed Selection	0: Standard mode; 1: High-speed mode (Factory setting: 0)	5-13
0102	0402	0702	1002	Pulse Output Mode	0: CW/CCW pulse 1: Travel/direction 2: Phase A/B (x4) 3: Phase A/B (x2) 4: Phase A/B (x1) (Factory setting: 0)	5-13
0103	0403	0703	1003	Motor Direction Selection	0: Forward movement produces CW pulse output 1: Reverse movement produces CW pulse output (Factory setting: 0)	5-14
0104	0404	0704	1004	Contact Usage Selection	$0000 to $011F (bit data) (Factory setting: $0000)	5-14
0105	0405	0705	1005	Contact I/O Polarity	$0000 to $073F (bit data) (Factory setting: $0000)	5-15
0106 to 0108	0406 to 0408	0706 to 0708	1006 to 1008	(System reserved)		–
0109	0409	0709	1009	Display Unit	0: pulse; 1: mm; 2: degree (Factory setting: 0)	5-15
0110	0410	0710	1010	(System reserved)		–
0111 / 0112	0411 / 0412	0711 / 0712	1011 / 1012	Electronic Gear M Value	1 to 2,147,483,647 (Factory setting: 1)	5-16
0113 / 0114	0413 / 0414	0113 / 0714	1013 / 1014	Electronic Gear N Value	1 to 2,147,483,647 (M/N<100) (Factory setting: 1)	5-16
0115	0415	0715	1015	(System reserved)		–
0116	0416	0716	1016	Index Control	0: No index control 1: Index control (Factory setting: 0)	5-17
0117 / 0118	0417 / 0418	0717 / 0718	1017 / 1018	Index Range	4 to 2,147,483,647 (position reference unit) (Factory setting: 4)	5-18
0119 to 0120	0419 to 0420	0719 to 0720	1019 to 1020	(System reserved)		–
0121 / 0122	0421 / 0422	0721 / 0722	1021 / 1022	Forward Limit	-2,147,483,648 to 2,147,483,647 (position reference unit) (Factory setting: 2,147,483,647)	5-18
0123 / 0124	0423 / 0424	0723 / 0724	1023 / 1024	Reverse Limit	-2,147,483,648 to (Forward Limit – 1) (position reference unit) (Factory setting: -2,147,483,648)	5-18
0125 / 0126	0425 / 0426	0725 / 0726	1025 / 1026	Speed Limit	1 to 5,000,000 (pulse/s) 1 to 2,147,483,647 (x 10^{-4}mm/s) 1 to 2,147,483,647 (x 10^{-5}degree/s) (Valid data range depends on Display Unit) (Factory setting: 1,000,000)	5-19
0127	0427	0727	1027	(System reserved)		
0128	0428	0728	1028	Acceleration/deceleration Curve	0: Automatic trapezoidal acceleration/deceleration 1: S-shape acceleration/deceleration (Factory setting: 0)	5-19
0129 / 0130	0429 / 0430	0729 / 0730	1029 / 1030	Startup Speed	0 to Speed Limit (speed reference unit) (Factory setting: 0)	5-20
0131	0431	0731	1031	Default Acceleration Time	0 to 32,767 (ms) (Default Acceleration Time specified for Speed Limit) (Factory setting: 1,000)	5-21
0132	0432	0732	1032	Default Deceleration Time	0 to 32,767 (ms) (Default Deceleration Time specified for Speed Limit) (Factory setting: 1,000)	5-21
0133 to 0134	0433 to 0434	0733 to 0734	1033 to 1034	(System reserved)		
0135 / 0136	0435 / 0436	0735 / 0736	1035 / 1036	CI Error Tolerance	0 to 2,147,483,647 (x 10^{-4}mm/s) (Factory setting: 1,000)	5-21
0137 to 0149	0437 to 0449	0737 to 0749	1037 to 1049	(System reserved)		–

Table Appx. 2.4 List of Axis Registered Parameters (Automatic Origin Search)

Data Position No.				Parameter Name	Data Range and Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0150	0450	0750	1050	AOS Mode	$0000 to $0003 (bit data) (Factory setting: $0000)	5-21
0151	0451	0751	1051	AOS Direction	0: Reverse; 1: Forward (Factory setting: 0)	5-22
0152	0452	0752	1052	AOS Dwell Time	0 to 32,767 (ms) (Factory setting: 10)	5-22
0153 / 0154	0453 / 0454	0753 / 0754	1053 / 1054	AOS Speed 1	1 to Speed Limit (speed reference unit) (Factory setting: 10,000)	5-22
0155 / 0156	0455 / 0456	0755 / 0756	1055 / 1056	AOS Speed 2	1 to AOS Speed 1 (speed reference unit) (Factory setting: 1,000)	5-22
0157	0457	0757	1057	AOS Acceleration Time	0 to 32,767 (ms) (Factory setting: 1,000)	5-22
0158	0458	0758	1058	AOS Deceleration Time	0 to 32,767 (ms) (Factory setting: 1,000)	5-23
0159	0459	0759	1059	AOS Z-phase Edge Selection	0: Rising edge; 1: Falling edge (Factory setting: 0)	5-23
0160	0460	0760	1060	AOS Z-phase Search Count	0 to 32,767 (pulses) (Factory setting: 0)	5-23
0161 / 0162	0461 / 0462	0761 / 0762	1061 / 1062	AOS Z-phase Search Range	0 to 2,147,483,647 or 0 to AOS Z-phase Search Count (position reference unit) (Factory setting: 2,147,483,647)	5-23
0163	0463	0763	1063	AOS Deviation Pulse Clear Time	0 to 32,767 (ms) (Factory setting: 10)	5-23
0164	0464	0764	1064	(System reserved)		–
0165 / 0166	0465 / 0466	0765 / 0766	1065 / 1066	AOS Offset	-2,147,483,648 to 2,147,483,647 (position reference unit) (Factory setting: 0)	5-24
0167 to 0171	0467 to 0471	0767 to 0771	1067 to 1071	(System reserved)		–

Table Appx. 2.5 List of Axis Registered Parameters (Counter/Encoder)

Data Position No.				Parameter Name	Data Range and Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0172	0472	0772	1072	Counter Type Selection	0: General-purpose incremental 1: Sanyo Denki's Manchester Coding 2: Yaskawa Electric's Serial (Factory setting: 0)	5-24
0173	0473	0773	1073	Counter Direction Selection	0: Forward pulse input denotes forward movement 1: Reverse pulse input denotes forward movement (Factory setting: 0)	5-25
0174	0474	0774	1074	Counter Multiplication	1: x1; 2: x2; 4: x4 (Factory setting: 4)	5-25
0175	0475	0775	1075	Counter Display Unit	0: pulse; 1: mm; 2: degree (Factory setting: 0)	5-26
0176	0476	0776	1076	(System reserved)		—
0177 / 0178	0477 / 0478	0777 / 0778	1077 / 1078	Counter Electronic Gear M Value	1 to 2,147,483,647 (Factory setting: 1)	5-26
0179 / 0180	0479 / 0480	0779 / 0780	1079 / 1080	Counter Electronic Gear N Value	1 to 2,147,483,647 (M/N<100) (Factory setting: 1)	5-26
0181	0481	0781	1081	(System reserved)		–
0182	0482	0782	1082	Counter Index Control	0: No index control 1: Index control (Factory setting: 1)	5-27
0183 / 0184	0483 / 0484	0783 / 0784	1083 / 1084	Counter Index Range	0; 4 to 2,147,483,647 (counter position reference unit) (Factory setting: 0)	5-27
0185 / 0186	0485 / 0486	0785 / 0786	1085 / 1086	ABS Encoder Offset	0 to 2,147,483,647 (counter position reference unit) (Factory setting: 0)	5-27
0187 / 0188	0487 / 0488	0787 / 0788	1087 / 1088	ABS Encoder Pulses Per Rev.	-2,147,483,648 to 2,147,483,647 (pulse) (Factory setting: 32,768)	5-28
0189	0489	0789	1089	ABS Encoder Bit Length	17 to 28 (bits) (Factory setting: 28)	5-28
0190	0490	0790	1090	Counter Usage Selection	0: Counter coincidence 1: Zone coincidence (Factory setting: 0)	5-29
0191 / 0192	0491 / 0492	0791 / 0792	1091 / 1092	Counter Coincidence Value	-2,147,483,648 to 2,147,483,647 (counter position reference unit) (Factory setting: 0)	5-29
0193 / 0194	0493 / 0494	0793 / 0794	1093 / 1094	Counter Upper Limit	-2,147,483,648 to 2,147,483,647 (counter position reference unit) (Factory setting: 2,147,483,647)	5-30
0195 / 0196	0495 / 0496	0795 / 0796	1095 / 1096	Counter Lower Limit	-2,147,483,648 to Counter Upper Limit (counter position reference unit) (Factory setting: -2,147,483,648)	5-30

Appx. 2.3 Axis Command Parameters

The following table lists command parameters of each axis.

Table Appx. 2.6 List of Axis Command Parameters

Data Position No.				Parameter Name	Data Range and Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0201	0501	0801	1101	Direct Command Code	0 to 32,767	5-32
0202	0502	0802	1102	Command Options	$0000 to $FFFF (meaning depends on Direct Command Code)	5-32
0203	0503	0803	1103	Startup Condition	0: Normal startup; Non-zero: Startup condition code	5-32
0204	0504	0804	1104	End Condition	0: Normal end; Non-zero: End condition code	5-35
0205	0505	0805	1105	(System reserved)		–
0206	0506	0806	1106	Target Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	5-35
0207 / 0208	0507 / 0508	0807 / 0808	1107 / 1108	Target Position	-2,147,483,648 to 2,147,483,647 (position reference unit) or position data no. (1 to No. of Position Data Records Used)	5-35
0209 to 0210	0509 to 0510	0809 to 0810	1109 to 1110	(System reserved)		–
0211 / 0212	0511 / 0512	0811 / 0812	1111 / 1112	Specified Speed	1 to Speed Limit (speed reference unit) or -(Speed Limit) to (Speed Limit) (speed reference unit)	5-36
0213	0513	0813	1113	Acceleration Time	-1: Default acceleration; 0 to 32,767 (ms)	5-36
0214	0514	0814	1114	Deceleration Time	-1: Default deceleration; 0 to 32,767 (ms)	5-36
0215	0515	0815	1115	Dwell Time	0 to 32,767 (ms)	5-37
0216	0516	0816	1116	Preset Override Value	1 to 500 (%)	5-37
0217 to 0218	0517 to 0518	0817 to 0818	1117 to 1118	(System reserved)		–
0219	0519	0819	1119	CI Turns	0 to 32,767 (turns)	5-38
0220	0520	0820	1120	CI Sub Position Mode	0: Using ABS position 1: Using INC position 2: Using position data no.	5-38
0221 / 0222	0521 / 0522	0821 / 0822	1121 / 1122	CI Sub Position	-2,147,483,648 to 2,147,483,647 (position reference unit) Or, position data no. (1 to 2,000)	5-38
0223	0523	0823	1123	Contact Output Setting	$0000 to $0707 (bit data)	5-38
0224	0524	0824	1124	MPG Mode Multiplication	-32,768 to 32,767	5-39
0225	0525	0825	1125	MPG Mode Decimal Point	0: x 1; 1: x 1/10; 2: x 1/100; 3: x 1/1,000; 4: x 1/10,000	5-39
0226 to 0227	0526 to 0527	0826 to 0827	1126 to 1127	(System reserved)		–
0228	0528	0828	1128	Origin Search Direction	0: Reverse; 1: Forward	5-39
0229	0529	0829	1129	Z-phase Edge Selection	0: Rising edge; 1: Falling edge	5-40
0230	0530	0830	1130	Z-phase Search Count	0 to 32,767 (pulses)	5-40
0231 / 0232	0531 / 0532	0831 / 0832	1131 / 1132	Z-phase Search Range	0 to 2,147,483,647 or 0 to Z-phase Search Count (position reference unit)	5-40
0233	0533	0833	1133	Deviation Pulse Clear Time	0 to 32,767 (ms)	5-40
0234	0534	0834	1134	(System reserved)		–
0235 / 0236	0535 / 0536	0835 / 0836	1135 / 1136	Counter Coincidence Value	-2,147,483,648 to 2,147,483,647 (counter position reference unit)	5-41
0237 / 0238	0537 / 0538	0837 / 0838	1137 / 1138	Counter Upper Limit	-2,147,483,648 to 2,147,483,647 (counter position reference unit)	5-41
0239 / 0240	0539 / 0540	0839 / 0840	1139 / 1140	Counter Lower Limit	-2,147,483,648 to Counter Upper Limit (counter position reference unit)	5-41
0241 to 0300	0541 to 0600	0841 to 0900	1141 to 1200	(System reserved)		–

Appx. 2.4 Axis Statuses

The following table lists statuses of each axis.

Table Appx. 2.7 List of Axis Statuses

Data Position No.				Status Name	Data Range and Description	See Also
Axis 1	Axis 2	Axis 3	Axis 4			
0301	0601	0901	1201	Error Status	Error code when error occurs	5-42
0302	0602	0902	1202	Warning Status	Warning code when warning occurs	5-43
0303	0603	0903	1203	Extended Status 1	Action information such as axis or pattern where action was initiated	5-43
0304	0604	0904	1204	Extended Status 2	Movement information such as whether axis is accelerating, decelerating or changing speed.	5-44
0305	0605	0905	1205	Origin Search Status	Status related to origin search	5-44
0306	0606	0906	1206	(System reserved)		–
0307	0607	0907	1207	Contact Input Status	State of contact inputs (bit data)	5-44
0308	0608	0908	1208	Contact Output Status	State of contact outputs (bit data)	5-45
0309	0609	0909	1209	(System reserved)		–
0310	0610	0910	1210	Remaining DCC Time Status	-1: Accelerating or moving at constant speed 0: At rest 1 to 32,767: Remaining deceleration time (ms)	5-45
0311 / 0312	0611 / 0612	0911 / 0912	1211 / 1212	Remaining Travel Status	Remaining travel to target position 0 to 2,147,483,647 (position reference unit)	5-45
0313	0613	0913	1213	Current Override Value Status	1 to 500 (%)	5-46
0314	0614	0914	1214	(System reserved)		–
0315 / 0316	0615 / 0616	0915 / 0916	1215 / 1216	Current Position Status	-2,147,483,648 to 2,147,483,647 (position reference unit)	5-46
0317 / 0318	0617 / 0618	0917 / 0918	1217 / 1218	Target Position Status	-2,147,483,648 to 2,147,483,647 (position reference unit)	5-46
0319 / 0320	0619 / 0620	0919 / 0920	1219 / 1220	Current Speed Status	-5,000,000 to 5,000,000 (pulse/s) -2,147,483,648 to 2,147,483,647 (x 10^{-4}mm/s) -2,147,483,648 to 2,147,483,647 (x 10^{-5}degree/s) (Data range depends on Display Unit)	5-46
0321 / 0322	0621 / 0622	0921 / 0922	1221 / 1222	Counter Current Position Status	-2,147,483,648 to 2,147,483,647 (Counter position reference unit)	5-47
0323 / 0324	0623 / 0624	0923 / 0924	1223 / 1224	Counter Current Speed Status	-5,000,000 to 5,000,000 (pulse/s) -2,147,483,648 to 2,147,483,647 (x 10^{-4}mm/s) -2,147,483,648 to 2,147,483,647 (x 10^{-5}degree/s) (Data range depends on Display Unit)	5-47
0325 / 0326	0625 / 0626	0925 / 0926	1225 / 1226	Counter Latched Position Status	-2,147,483,648 to 2,147,483,647 (Counter position reference unit)	5-47
0327 / 0328	0627 / 0628	0927 / 0928	1227 / 1228	Counter Absolute Data Status	Received raw absolute data (when Counter Type Selection is Sanyo Denki's Manchester Coding) Absolute position status (when Counter Type Selection is Yaskawa Electric's Serial)	5-47
0329 to 0400	0629 to 0700	0929 to 1000	1229 to 1300	(System reserved)		–

Appx. 2.5 Pattern Registered Parameters

The following table lists pattern registered parameters.

Table Appx. 2.8 List of Pattern Registered Parameters

Data Position No.				Parameter Name	Data Range and Description	See Also
Pattern A	Pattern B	Pattern C	Pattern D			
1301 / 1302	1401 / 1402	1501 / 1502	1601 / 1602	Pattern Combined-speed Limit	1 to 2,147,483,647 (x 10^{-4}mm/s) (Factory setting: 1,000,000)	5-48
1303	1403	1503	1603	Pattern Combined-speed ACC Time	0 to 32,767 (ms) (Default acceleration time specified for Pattern Combined-speed Limit) (Factory setting: 1,000)	5-48
1304	1404	1504	1604	Pattern Combined-speed DCC Time	0 to 32,767 (ms) (Default deceleration time specified for Pattern Combined-speed Limit) (Factory setting: 1,000)	5-49
1305 to 1330	1405 to 1430	1505 to 1530	1605 to 1630	(System reserved)		–

Appx. 2.6 Pattern Command Parameters

The following table lists pattern command parameters.

Table Appx. 2.9 List of Pattern Command Parameters

Data Position No.				Parameter Name	Data Range and Description	See Also
Pattern A	Pattern B	Pattern C	Pattern D			
1331	1431	1531	1631	Pattern Command Code	0 to 32,767	5-50
1332	1432	1532	1632	(System reserved)	Do not write any non-zero value.	–
1333	1433	1533	1633	Pattern Preset Override Value	1 to 500 (%)	5-50
1334	1434	1534	1634	Pattern Start Record No.	1 to No. of Pattern Data Records Used	5-51
1335 to 1338	1435 to 1438	1535 to 1538	1635 to 1638	(System reserved)		–
1339	1439	1539	1639	Pattern End Record No.	1 to No. of Pattern Data Records Used	5-51
1340 to 1350	1440 to 1450	1540 to 1550	1640 to 1650	(System reserved)		–

Appx. 2.7 Pattern Operation Statuses

The following table lists pattern operation statuses.

Table Appx. 2.10 List of Pattern Operation Statuses

Data Position No.				Status Name	Data Range and Description	See Also
Pattern A	Pattern B	Pattern C	Pattern D			
1351	1451	1551	1651	M Code Status	0 to 32,767	5-52
1352	1452	1552	1652	Pattern Error Status	Error code when error occurs	5-52
1353	1453	1553	1653	Pattern Warning Status	Warning code when warning occurs	5-52
1354	1454	1554	1654	Pattern Error Code 1	Detailed error code 1 when error occurs	5-53
1355	1455	1555	1655	Pattern Error Code 2	Detailed error code 2 when error occurs	5-53
1356	1456	1556	1656	Pattern Action Status	Movement information for pattern operation	5-53
1357	1457	1557	1657	Pattern Action Record No.	1 to 500	5-54
1358	1458	1558	1658	Pattern Current Override Value	1 to 500 (%)	5-54
1359 to 1362	1459 to 1462	1559 to 1562	1659 to 1662	Pattern Action Record Label	Label corresponding to Pattern Action Record No.	5-54
1363 to 1400	1463 to 1500	1563 to 1600	1663 to 1700	(System reserved)		–

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FA-M3

Positioning Module (with pulse output)

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Revision Information

Document Name : Positioning Modules (with Pulse Output)
Document No. : IM 34M6H56-02E

Edition	Date	Revised Item
1st	25 Feb. 2005	New publication
2nd	15 Jul. 2007	Corrections. Added connection and wiring information for CE marking conformance and servo amplifier by Mitsubishi.

Written by International Sales & Marketing Gr.
PLC Product Marketing Dept.
Industrial Automation Systems Business
Yokogawa Electric Corporation
Published by Yokogawa Electric Corporation
2-9-32 Nakacho, Musashino-shi, Tokyo, 180-8750, JAPAN
Printed by Kohoku Publishing & Printing Inc.

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