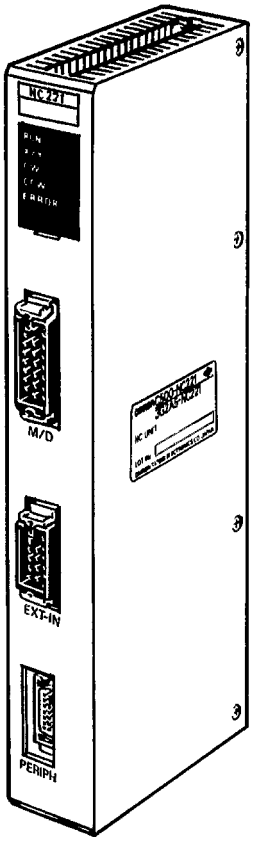
C500-NC222-E
Two-axis Position Control Unit

Operation Manual

Produced January 1995



Notice:

OMRON products are manufactured for use according to proper procedures by a qualified operator and only for the purposes described in this manual.

The following conventions are used to indicate and classify precautions in this manual. Always heed the information provided with them. Failure to head precautions can result in injury to people or damage to the product.

DANGER! Indicates information that, if not heeded, is likely to result in loss of life or serious injury.

WARNING Indicates information that, if not heeded, could possibly result in loss of life or serious injury.

Caution Indicates information that, if not heeded, could result in relative serious or minor injury, damage to the product, or faulty operation.

OMRON Product References

All OMRON products are capitalized in this manual. The word “Unit” is also capitalized when it refers to an OMRON product, regardless of whether or not it appears in the proper name of the product.

The abbreviation “Ch,” which appears in some displays and on some OMRON products, often means “word” and is abbreviated “Wd” in documentation in this sense.

The abbreviation “PC” means Programmable Controller and is not used as an abbreviation for anything else.

Visual Aids

The following headings appear in the left column of the manual to help you locate different types of information.

Note Indicates information of particular interest for efficient and convenient operation of the product.

1, 2, 3... 1. Indicates lists of one sort or another, such as procedures, checklists, etc.

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About this Manual:

The C500-NC222-E Position Control Unit is a Special I/O Unit for SYSMAC C500, C1000H, C2000H, CV500, CV1000, CV2000, and CVM1 Programmable Controllers (PCs) that support WRIT (87) and READ (88). This Position Control Unit (PCU) is designed to control positioning through voltage outputs to a motor driver according to PC programming and external control inputs.

This manual covers the specifications and procedures necessary for installation and operation. It also describes data layouts and examples for communication between the PC and NC222-E module. Before attempting to operate the Position Control Unit, be sure to thoroughly familiarize yourself with the information contained in this manual. During operation, refer also to your PC Operation Manual for programming and system details. If you wish to enter data manually via the Teaching Box, please use this manual for wiring and setup only. Refer to the Teaching Box operation manual for data entry and operations.

Section 1 contains information on the features of the Position Control Unit, system configuration, and an overview of control system principles. It also outlines the differences between the NC222-E and the earlier C500-NC221-E Position Control Unit.

Section 2 contains wiring diagrams and other information necessary for installation and connection of the Position Control Unit, as well as illustrations of the the Unit's switches and indicators. It also provides the minimum information necessary to assemble and test a servomotor driver system using both axes.

Sections 3, 4, and 5 provide information essential for operation, including data configuration, the setting of parameters and positioning actions, communication between the Position Control Unit and the PC, and the use of status flags.

Section 6 provides a description of command format. It also contains tables of system, servo control, and data processing commands, including the functions and usage examples for each.

Section 7 shows how to establish the origin, which must be done to establish a reference point before executing positioning actions.

Section 8 provides a variety of programming examples to illustrate the principles covered in this manual.

Sections 9 covers error processing.

Section 10 covers Teaching Box operations, including key operations, PC contents and permitted settings, and error codes.

The appendices contain specifications, an error code list, and data coding sheets.

WARNING Failure to read and understand the information provided in this manual may result in personal injury or death, damage to the product, or product failure. Please read each section in its entirety and be sure you understand the information provided in the section and related sections before attempting any of the procedures or operations given.

SECTION 1
Introduction

The C500-NC222-E Position Control Unit (PCU) is a Special I/O Unit that receives positioning commands from the Programmable Controller (PC) and outputs control voltages to two servomotor drivers. Since it outputs control voltages rather than pulses, it can be directly connected to any of a variety of servomotor drivers. It can be used with the C500, C1000H, C2000H, CV500, CV1000, CV2000 or CVM1 PC.

Each of the two servomotor drivers controls a servomotor which rotates one of the two positioning axes. The Position Control Unit can control the axes independently or simultaneously. Both straight-line and circular arc interpolation are also possible.

This section describes the basic features, components, and operation of the Position Control Unit, as well as the basic configuration and principles of positioning control systems. It also shows the relationship between the C500-NC222-E and the earlier C500-NC221-E Position Control Unit. Reading this section first will give you a familiarity with the essential terminology used in this manual and an understanding of the fundamentals necessary for successful operation.

1-1 Features

The Functions of Two Units Combined into One

With one DIP switch setting, this Unit can be used as a C500-NC221-E Position Control Unit, with all of the features described in the C500-NC221-E Position Control Unit Operation Manual. Simply changing the DIP switch setting allows it to be used as a C500-NC222-E Position Control Unit, with the modifications and added features described below.

Applicable Motor Drivers

A control output voltage range from −10 V to +10 V enables connection to various servomotor drivers.

Number of Control Axes and Controlling Capacity

The Position Control Unit is designed to control two axes. Data configuration consisting of parameters, speeds, dwell times, acceleration and deceleration times, and positioning actions permits straight-line interpolation or circular arc interpolation by simultaneous dual-axis operation. Each motor axis may also be operated independently.

Error Diagnostics

Troubleshooting is facilitated by error code transmission from the Position Control Unit to the PC as well as by error code display on the External Display.

Large Data Capacity with Backup

The data capacity in the Position Control Unit provides 300 positioning actions per axis, 19 parameters per axis, 100 speeds, 10 dwell times per axis, and 10 acceleration and deceleration times per axis. All data is stored in the built-in EEPROM for battery-free and maintenance-free backup. Data is read into the RAM from the EEPROM when power is turned ON.

Teaching Box

Connecting the Teaching Box permits position inputs, position input reading, teaching inputs, and operation monitoring.

High-speed Communications Between PC and PCU

All data and command communications between the Programmable Controller and Position Control Unit use PC Intelligent I/O Read and Write instructions permitting high-speed processing.

External Display for Visual Confirmation

Connect the C500-ND201 External Display to show the current position, status flags, and error codes.

Applicable CPUs

The C500-NC221-E Position Control Unit can be used with a C500,C1000H, or C2000H PC. The C500-CPU11-EV1 CPU must be used with the C500 PC. Any C1000H, C2000H, CV1000, CV2000, and CVM1 CPU may be used.

Modifications and Added Features

Servo-free Function

Switching between servo-lock and servo-free has been made possible. With servo-free, present values can be refreshed and teaching is enabled.

Error Counter

The contents of the error counter can be checked with the Teaching Box. In addition, the counter can be reset and the size the counter can be changed.

Synchronous Startup

Either axis can be preset to begin operation automatically when the other axis reaches a prescribed position during operation.

Zone Settings

Zones can be set for any positions, and in-zone and out-of-zone signals can be received for status and external outputs.

Protect Functions In addition to the existing PC protect function, external input protect and Teaching Box protect have been provided, thereby further simplifying debugging operations.

Safety-oriented Check Functions Checks for disconnected or faulty wiring provide safer operation.

1-2 Comparing the Units

The C500-NC222-E Position Control Unit is based on the earlier C500-NC221-E, with certain modifications and added features. The differences between the two models are outlined on the following pages.

1-2-1 Changes

External Input Allocations

NC221

Pin	Symbol	Name	Cntct
1	DC GND	0 V	
2	CCWLX	X-axis CCW limit	NC
3	STPX	X-axis external interrupt	NO
4	ORGX	X-axis origin	NO
5	EMGX	X-axis emergency stop	NC
6	CWLX	X-axis CW limit	NC
7	FG	Frame ground	---
8	+24V	24-V input	
9	+24V	---	
10	---		
11	DC GND	0 V	
12	CCWLY	Y-axis CCW limit	NC
13	STPY	Y-axis external interrupt	NO
14	ORGY	Y-axis origin	NO
15	EMGY	Y-axis emergency stop	NC
16	CWLY	Y-axis CW limit input	NC

NC222

Pin	Symbol	Name	Cntct
1	DC GND	0 V	
2	CCWLX	X-axis CCW limit	NC
3	STPX	X-axis external interrupt	NO
4	ORGX	X-axis origin	NO
5	SERVOX	X-axis servo-free input	NC
6	CWLX	X-axis CW limit	NC
7	FG	Frame ground	---
8	+24V	24-V input	
9	+24V	---	
10	---		
11	DC GND	0 V	
12	CCWLY	Y-axis CCW limit	NC
13	STPY	Y-axis external interrupt	NO
14	ORGY	Y-axis origin	NO
15	SERVOY	Y-axis servo-free input	NC
16	CWLY	Y-axis CW limit input	NC

Changed External Inputs

NC221

Symbol	Name
External interrupt	The accumulated count of the error counter decreases naturally through inertia to cause a stop.
Emergency stop	Pulse string input to the error counter is stopped, and the error counter is cleared. Positioning stops immediately. The origin setting is lost and must be redefined before restarting operation.

NC222

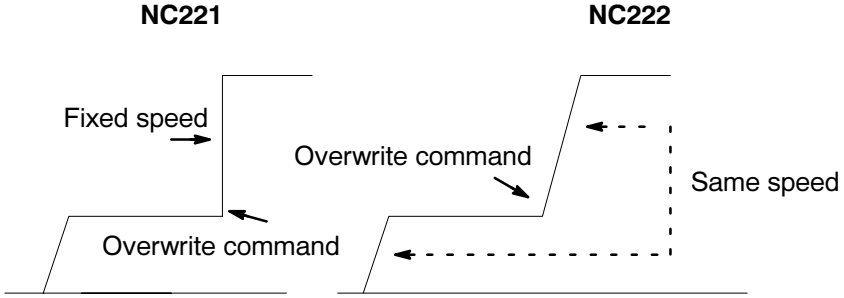
Symbol	Name
External interrupt	(Parameter data: X axis: 418; Y axis: 818) During positioning: Acceleration/deceleration pattern During JOG operations: Stops according to deceleration stop pulse amount.
Servo-free input	Switches between servo-lock and servo-free. Servo-free is activated when this input is turned ON and servo-lock is activated when this input is turned OFF.

Changes When Limit LS is On

NC221	NC222
If an error occurs when the limit LS is on, the position is removed from the LS by means of the JOG operation and the error is cleared by executing error reset. The origin setting is lost.	If an error occurs when the limit LS is on, the error is automatically reset by executing a command (jogging, inching, origin search) in the opposite direction from the LS, and the command is then carried out. The origin setting is not lost.

Changes in Overwrite Acceleration/Deceleration Speeds

When overwrite is executed for the C500-NC221-E, positioning accelerates or decelerates accorded to a fixed speed. With the C500-NC222-E, however, acceleration or deceleration is executed at the same speed as that which is set for positioning.



Overwrite Coefficient Expansion

The overwrite coefficient range has been expanded and the minimum setting increment has been decreased.

NC221	NC222
Range: 0% to 200%	Range: 0% to 999.9%
Increment: 10%	Increment: 0.1%

Teaching Box Speed Settings

With the C500-NC221-E, the Teaching Box JOG speed, JOG acceleration and deceleration speeds, pulse rate, and the deceleration pattern for a deceleration stop must be set whenever the System is powered up. With the

C500-NC222-E, however, these data are set as parameter data and do not need to be reset with every power up.

Parameter data address	NC221	NC222
X axis: 412 Y axis: 812	High jogging speed (Upper limit specification for jogging speed)	Teaching Box speed settings (Specification of jogging deceleration pattern, pulse rate, and jogging speed)
X axis: 418 Y axis: 818	Deceleration stop pulse rate (Specification of pulse rate until positioning comes to a stop, after an external interrupt is received during jogging)	Deceleration stop (In addition to the pulse rate described on the left, the deceleration patterns for the deceleration stop key on the Teaching Box and for external interrupts are added.)

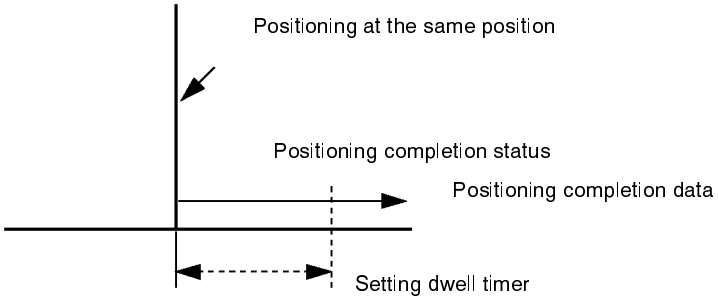
1-2-2 Added Features

Servo-free Command

With the C500-NC222-E, it is possible to switch between servo-free and servo-lock by means of either the Teaching Box or commands from the PC.

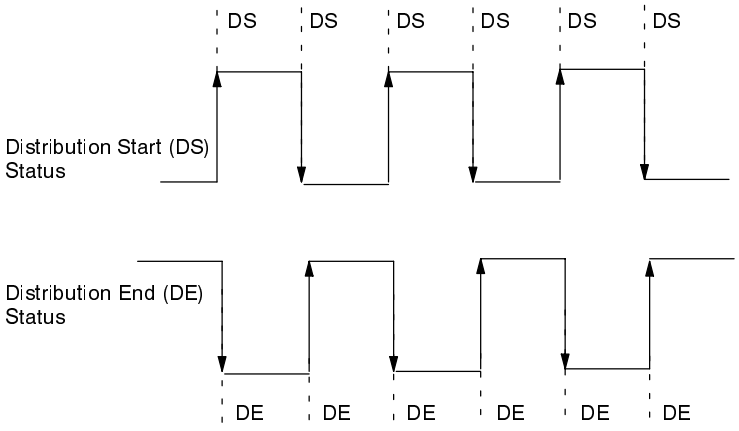
Dwell Timer Cancellation

When positioning is executed in the same position as the present value, the dwell timer is automatically rendered invalid.



Distribution Start Status, End Status

In order to facilitate recognition by the PC that positioning has been executed to the same position, Distribution Start Status (X axis: word 3, bit 13; Y axis: word 10, bit 13) and Distribution End Status (X axis: word 3, bit 12; Y axis: word 10, bit 12) have been added. These flags turn ON and OFF during operation as shown in the illustration below.



Wiring Check

By means of a command, the NC222 can check for faulty wiring or disconnections. In addition, if an error occurs when the disconnection check is spe-

cified, A-phase and B-phase switching is executed automatically. (A-phase and B-phase switching is also possible by means of a parameter (encoder type) setting.

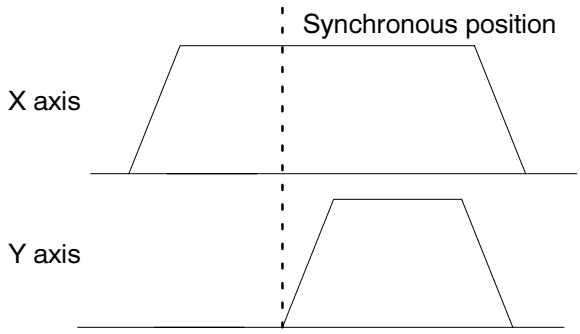
The faulty wiring diagnostic function of the C500-NC221-E is not supported in the C500-NC222-E. (This function prevents a control voltage beyond ±0.3 from being output.)

Error Counter Capacity Changes and Overflow Status

Error counter capacity can be set for the C500-NC222-E with respect to parameter data. With this function it is possible to have the error counter overflow status bit turn ON when the error counter value exceeds the set value, and to have the external output 1 specification turn ON and OFF according to the parameter data. The capacity of the error counter can be set, in 1-pulse units, from a minimum of 10 pulses to a maximum of 32,768 pulses.

Synchronous Startup

Either axis can be preset to begin operation automatically when the other axis reaches a prescribed position during operation. When the second axis begins operation, it has no effect on the operation of the first axis.



Error Counter Reset

This function resets the error counter to 0 by means of a command while positioning is stopped. At the same time it sets the present value to 0.

Expansion of Zone Setting Function

When the workpiece enters the range of the zone setting, the external outputs can be turned ON together along with the status of the zone data execution. Zone settings of eight points each can be made for the X axis and the Y axis. Acceleration zones for the NC222-E are the same as for the NC221-E.

Protect Functions

The NC221-E provides a “PC protect” function by means of which the Position Control Unit can be temporarily protected from receiving commands from the PC. In addition to this, the NC222-E provides a “Teaching Box protect” function, which temporarily protects against keyed inputs from the Teaching Box, and an “external input protect” function, which temporarily protects against external inputs.

Error Counter Content Display

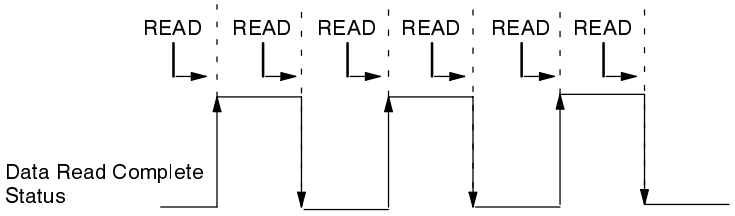
The contents of the error counter are displayed in BCD in the PC status areas and at the Teaching Box. The PC status areas are as follows:

X axis: words n + 17 and n + 18
Y axis: words n + 19 and n + 20

Data Reading Complete Status

In order to facilitate the continuous reading of data, the Data Reading Complete status has been added to bit 00 of word n. As shown in the illustration

below, this flag is turned ON and OFF as data is read (i.e., as READ is executed).



Z Phase and Origin Input Display

After an origin search operation has been completed, the interval between the Z phase is displayed at the Teaching Box.

Limit Input Status Monitoring

With the NC221-E, the status of origin inputs cannot be monitored by means of the Teaching Box. With the NC222-E, however, the Teaching Box can monitor the Z phase status of clockwise (CW) and counterclockwise (CCW) limit inputs.

Teaching Box Safety Features

The following three functions have been added to enhance safety for Teaching Box operations.

a) It is now possible, by means of a key word, to switch the status of the Teaching Box (i.e., to Teaching Box protect) so that it cannot be operated. Thus even if the Teaching Box is handled by unauthorized personnel there will be no danger.

b) The Teaching Box is often used for the trial operation of machinery, and it can be dangerous to suddenly conduct trial operations at actual speed. Therefore it has been made possible to preset a positioning speed coefficient in the high speed parameter data, and to start operations at a speed lower than the actual speed.

c) With the NC221-E, startup from the Teaching Box involves moving to the target position when the key is pressed. In order to abort this positioning, it is necessary to press the deceleration stop key, and sometimes this kind of operation is undesirable. With the NC222-E, therefore, an improvement has been made. For startup from the Teaching Box, operation continues as long as the key is being pressed, and positioning stops as soon as the key is released.

1-2-3 Commands Added and Eliminated

NC221-E Commands

---			Rightmost digit									
Type		**Leftmost digits**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
System commands		00	END Command end	NOP No operation	ERST Error reset	OUT External output control	---	---	---	---	---	---
Servo control commands	X axis	01	XSRT Start	XSTP Deceleration stop	XJOG Jogging	XPLS Inching	XORG Origin search	XOVR Override	XHLD Pause	XREL Pause release	XEMG Emergency stop	---
	Y axis	02	YSRT Start	YSTP Deceleration stop	YJOG Jogging	YPLS Inching	YORG Origin search	YOVR Override	YHLD Pause	YREL Pause release	YEMG Emergency stop	---
	Interpolation	03	ISRT Start	ISTP Deceleration stop	IJOG Jogging	IPLS Inching	IORG Origin search	IOVR Override	IHLD Pause	IREL Pause release	IEMG Emergency stop	---
Data proceeding commands		04	ACLR All clear	CLR Clear	BCLR Block clear	STORE EEPROM write (data save)	RESTR EEPROM read	READ Data read	MOV Data transfer	---	---	---
		05	TEACH Teaching	CCHG Change current position	HSFT Home shift	---	---	---	---	---	---	---

NC222-E Commands

---			Rightmost digit									
Type		**Leftmost digits**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
System commands		00	END Command end	NOP No operation	ERST Error reset	OUT External output control	CREST Error counter reset	SERVO Servo-free	WCHK Wiring check	---	---	---
Servo control commands	X axis	01	XSRT Start	XSTP Deceleration stop	XJOG Jogging	XPLS Inching	XORG Origin search	XOVR Override	XHLD Pause	XREL Pause release	---	---
	Y axis	02	YSRT Start	YSTP Deceleration stop	YJOG Jogging	YPLS Inching	YORG Origin search	YOVR Override	YHLD Pause	YREL Pause release	---	---
	Interpolation	03	ISRT Start	ISTP Deceleration stop	IJOG Jogging	IPLS Inching	IORG Origin search	IOVR Override	IHLD Pause	IREL Pause release	---	---
Data proceeding commands		04	ACLR All clear	CLR Clear	BCLR Block clear	STORE EEPROM write (data save)	RESTR EEPROM read	READ Data read	MOV Data transfer	---	---	---
		05	TEACH Teaching	CCHG Change current position	HSFT Home shift	---	---	---	---	---	---	---

Commands added: CREST, SERVO, WCHK
Commands eliminated: XEMG, YEMG, IEMG

1-2-4 Changes in Status Word Allocations

The PC uses the intelligent I/O Read instruction READ(88) to read status from the Position Control Unit. The NC222 status area has been modified, as shown below, as compared with that of the NC221.

(1) Added:

Servo-free, Data Read Complete, Teaching Box Protect, External Input Protect, Error Counter Overflow (X, Y), Synchronous Start Waiting (X, Y), Zone Flag Area, Distribution Start, and Distribution End

(2) Eliminated:

Inching, Emergency Stop, and Parameters Cleared

(3) Changed:

- Speeds Cleared
  Word 00, bit 02 (for both X and Y axes) ⟶ Word 00, bit 15
- Positioning Data Cleared
  X axis: Word 03, bit 12 ⟶ Word 08, bit 15
  Y axis: Word 10, bit 12 ⟶ Word 15, bit 15
- External Interrupt ⟶ External Interrupt (with deceleration stop)
- External Emergency Stop ⟶ External Servo-free Input

The following table shows the status word allocations for the NC221. The corresponding table for the NC222, with the new status words included, is provided in *5-2 Status Word Allocations*.

NC221 Status Word Allocations

	Wd \ Bit	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
X–Y common area	D+0	Command Ready	PCU Ready	Teaching Box Ready	Teaching Box Connected	External Display Connected			PC Communications Disabled	Interpolating Circular Arc	Interpolating Straight Line	Reading EE-PROM	Writing EE-PROM	EE-PROM Write Completed	Speeds Cleared		
		System status flags															
	D+1	Hardware Error	Communications Error	Y-axis System Error	X-axis System Error	System /data Processing Error	Interpolating Error	Y-axis Command Error	X-axis Command Error	Error code (10^1 digit)				Error code (10^0 digit)			
		Error code and system error status flags															
	D+2	Error-related OP code (leftmost digit)				Error-related OP code (middle digit)				Error-related OP code (rightmost digit)				Number of error-related OP codes			
		Error codes															
X-axis area	D+3	Parameters Enabled	Origin Set	Parameters Cleared	Positioning Data Cleared	Home Shift	Override	Dwelling	Positioning Completed	Origin search	Inching	Jogging	Positioning	Stop	Pause	Emergency Stop	Current Position Sign
		Status flags (1)															
	D+4	CW Movement	CCW Movement	Accelerating	Constant Speed	Decelerating	In Position	Acceleration Zone	Deceleration Zone	Origin	OUT2 Output	OUT1 Output	CWLS Input	CCWLS Input	External Interrupt	External Emergency Stop	Origin Input
		Status flags (2)															
	D+5	BCD (10^7 digit)				BCD (10^6 digit)				BCD (10^5 digit)				BCD (10^4 digit)			
		Current position (leftmost digits)															
	D+6	BCD (10^3 digit)				BCD (10^2 digit)				BCD (10^1 digit)				BCD (10^0 digit)			
		Current position (rightmost digits)															
	D+7									M code (10^1 digit)				M code (10^0 digit)			
		M code															
	D+8	Multiplier: 1, 2, 4				Current positioning action address (10^2 digit)				Current positioning action address (10^1 digit)				Current positioning action address (10^0 digit)			
		Multiplier/Current positioning action address															
	D+9	Current speed address (10^1 digit)				Current speed address (10^0 digit)				Override coefficient (10^1 digit)				Override coefficient (10^0 digit)			
		Current speed address/Override coefficient															

	Wd \ Bit	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Y-axis area	D + 10	Parameters Enabled	Origin Set	Parameters Cleared	Positioning Data Cleared	Home Shift	Override	Dwelling	Positioning Completed	Origin search	Inching	Jogging	Positioning	Stop	Pause	Emergency Stop	Current Position Sign
		Status flags (1)															
	D + 11	CW Movement	CCW Movement	Accelerating	Constant Speed	Decelerating	In Position	Acceleration Zone	Deceleration Zone	Origin	OUT2 Output	OUT1 Output	CWLS Input	CCWLS Input	External Interrupt	External Emergency Stop	Origin Input
		Status flags (2)															
	D + 12	BCD (10^7 digit)				BCD (10^6 digit)				BCD (10^5 digit)				BCD (10^4 digit)			
		Current position (leftmost digits)															
	D + 13	BCD (10^3 digit)				BCD (10^2 digit)				BCD (10^1 digit)				BCD (10^0 digit)			
		Current position (rightmost digits)															
	D + 14	Unused								M code (10^1 digit)				M code (10^0 digit)			
		M code															
	D + 15	Multiplier: 1, 2, 4				Current positioning action address (10^2 digit)				Current positioning action address (10^1 digit)				Current positioning action address (10^0 digit)			
		Multiplier/Current positioning action address															
	D + 16	Current speed address (10^1 digit)				Current speed address (10^0 digit)				Override coefficient (10^1 digit)				Override coefficient (10^0 digit)			
		Current speed address/Override coefficient															
X–Y common area	D + 17																
		Read Data Area															
		≀															
	D + 126																
		Read Data Area															

Note 1. When a READ(88) instruction is executed, data values are placed in the Read Data Area. There are 110 words (17-126) set aside for this use.
2. During interpolation, the X-axis attributes and parameters are used for all shaded parameters above.

1-3 Basic Operating Principles

The basic operation of the C500-NC222-E Position Control Unit, like that of the C500-NC221-E, is fairly simple. The Position Control Unit controls a servomotor driver in accordance with data stored in its memory. This data includes parameters, speeds, positions, and other information necessary for effective control. Before the Position Control Unit can be operated, you must first input the essential data. This is generally done via the Teaching Box.

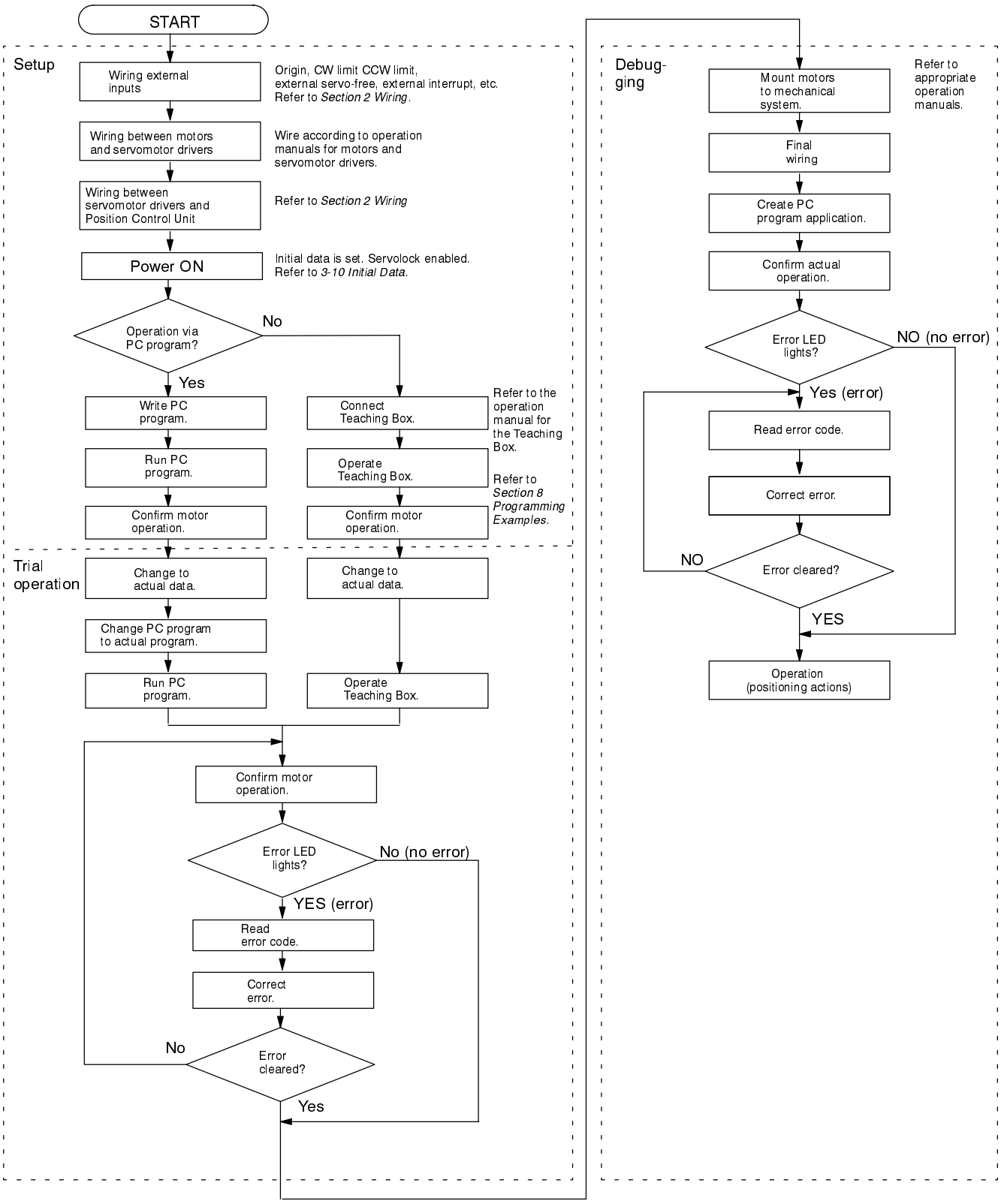
The way in which the Position Control Unit makes use of this data is determined by the program in the PC. The program does not control all of the Position Control Unit's operations directly, but rather, transfers commands to the Position Control Unit for execution. The commands control such functions as the starting and stopping of positioning, returning to the origin, and so on. Thus, while the Position Control Unit functions as an integral part of your

overall control system, it also exercises a good deal of autonomy. This capability is essential to the concept of distributed control, whereby control of each portion of an automated system is located near the devices actually being controlled.

The fundamental unit of positioning is the positioning action. A particular positioning action moves the workpiece along the axis in a direction, at a speed, and to a position determined by the data which has been set specifically for the positioning action. The positioning action begins when the start command is transferred by the PC program (XSRT, YSRT, or ISRT, depending on whether you want to position along the X axis, the Y axis, or both simultaneously). Before beginning execution of positioning actions, it is necessary to define the origin as a reference point by, for example, executing origin search (XORG, YORG, or IORG). The origin is simply the point which is designated as 0 at any given time. Positioning actions are described in detail in *3-4 Setting Positioning Actions*, using commands to start positioning actions is described in *Section 6 Commands*, and using commands with the origin is described in *Section 7 Establishing the Origin*.

1-4 Operational Flow

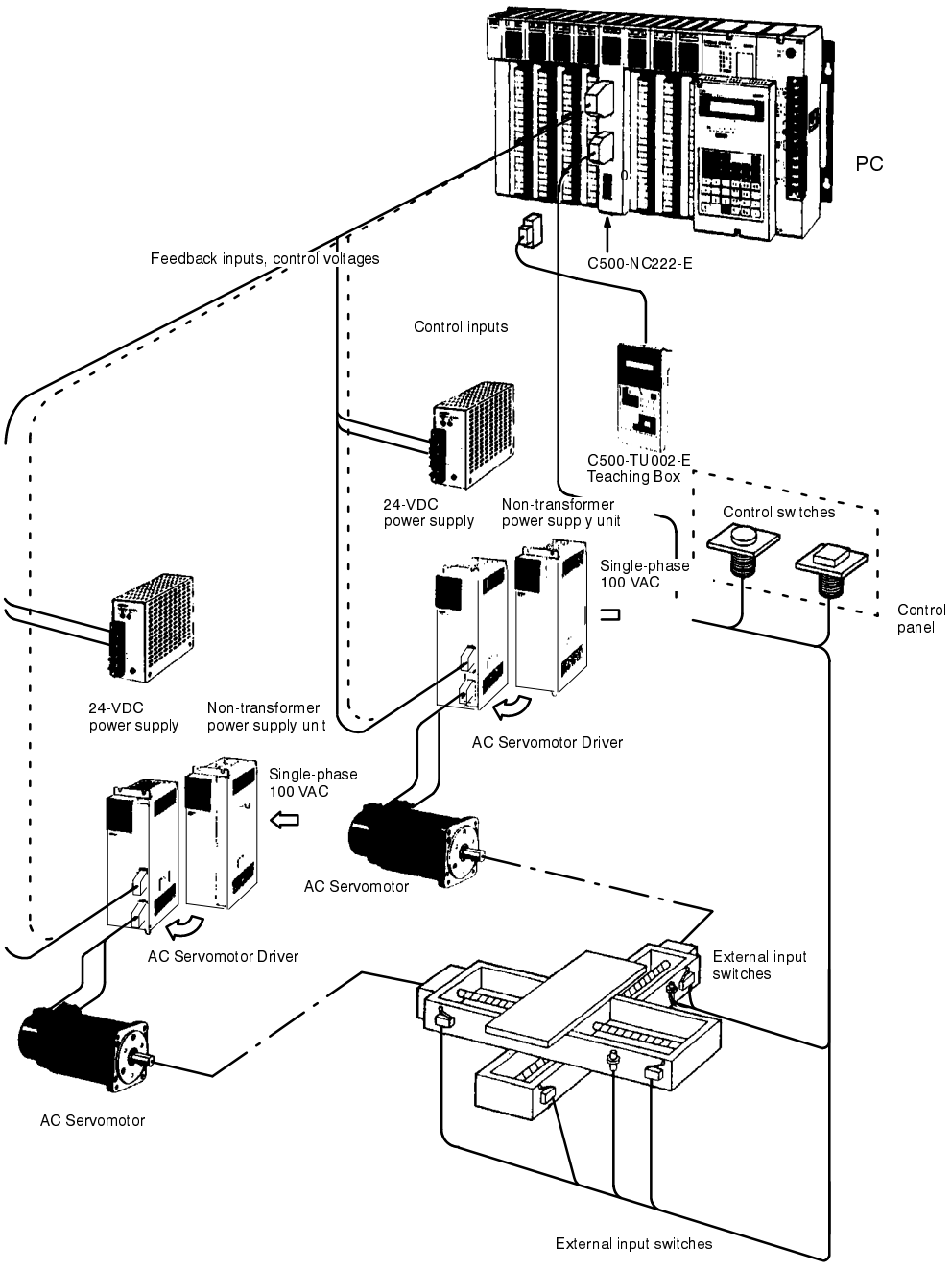
Positioning operations generally involve the following steps.



1-5 System Configuration

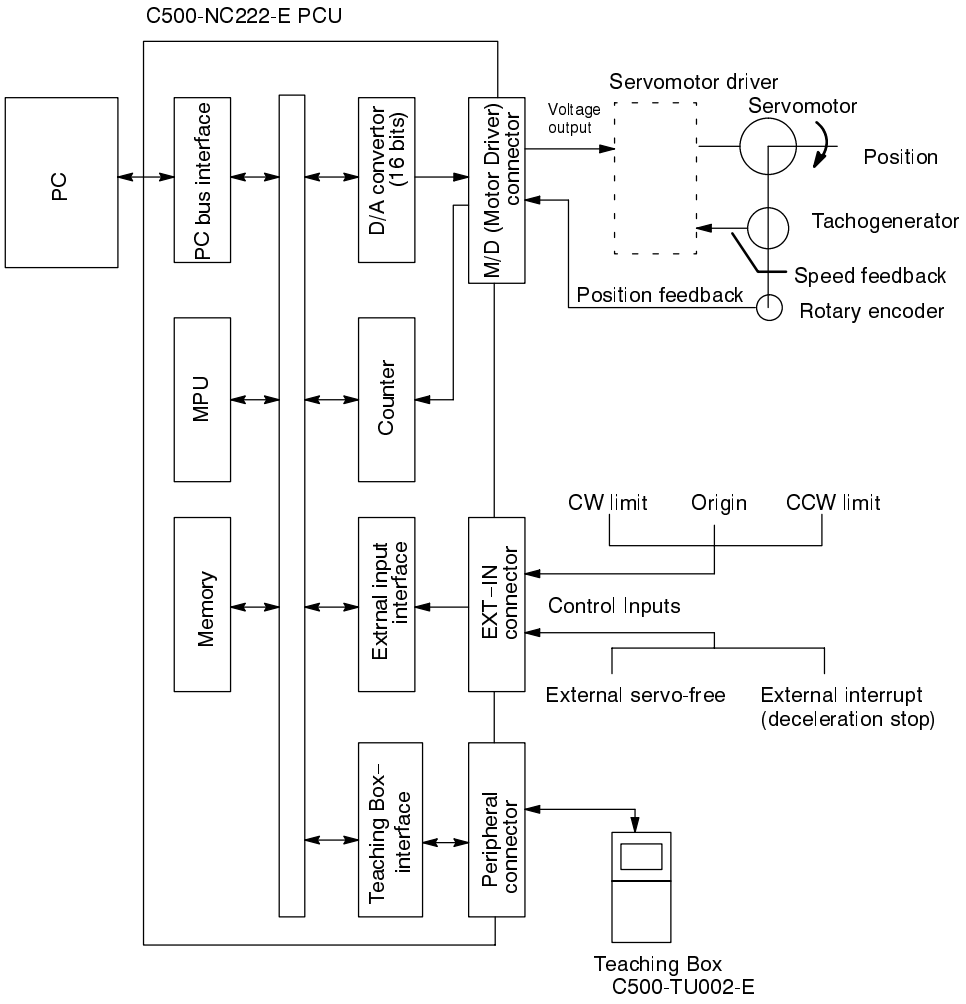
The following configuration illustrates example connections for a working system. The Position Control Unit receives control inputs from the control panel and feedback inputs from the encoder, and outputs voltages to the servomotor drivers.

Caution The Position Control Unit cannot be used if mounted to a Slave Rack.



1-6 Control System Configuration

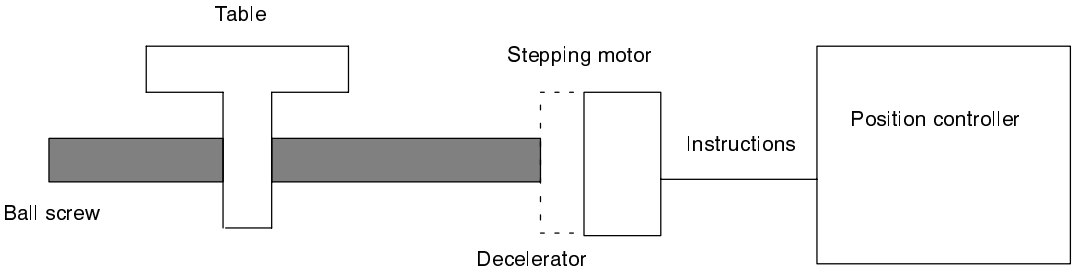
The following block diagram shows a control system for a servomotor driver. The Position Control Unit is arranged in a semiclosed-loop system.



1-7 Control System Principles

Open-loop Systems

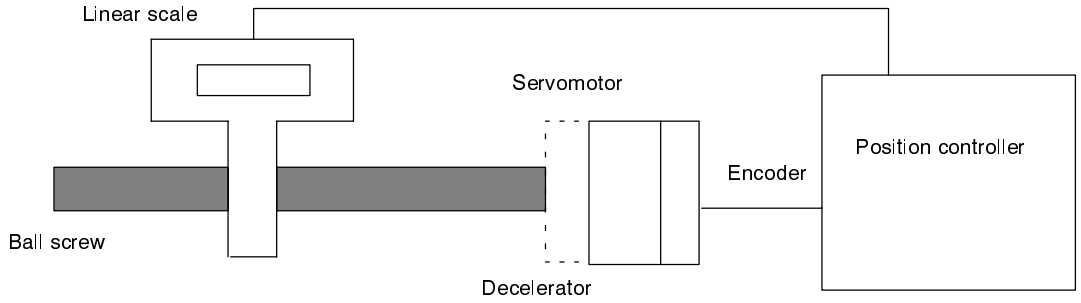
Control systems can be quite simple or relatively complex. The most basic is an open-loop system, in which a particular operation is carried out, according to programmed instructions, but in which no feedback is provided for automatic adjustments. In an open-loop system, positioning is generally executed by means of a stepping motor.



Closed-loop Systems

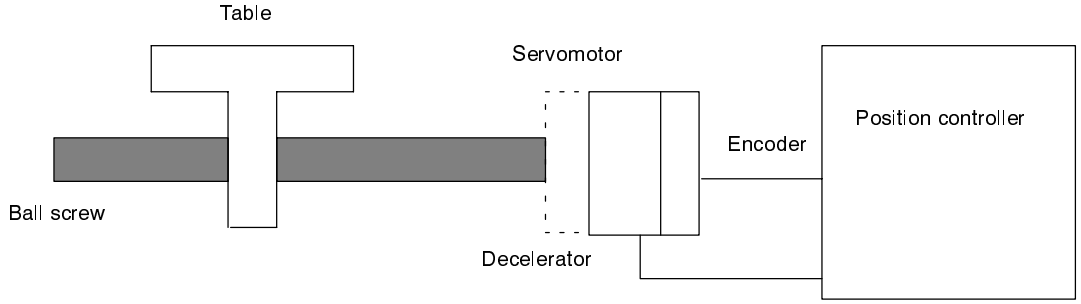
In a closed-loop system, the PC controls an external process without human intervention. The servomotor provides direct feedback so that actual values (of positions, speeds, and so on) are continuously adjusted to bring them more closely in line with target values. The digital feedback signals are commonly transmitted to a digital-to-analog converter to complete the feedback loop, thereby permitting automated control of the process. While closed-loop systems can provide extremely high-precision positioning, the inevitable differences between the drive system and the position sensors tend to make them quite complex.

In principle, it would be possible to use the NC222-E in a closed-loop system. In practice, however, the NC222-E is not designed to function with the mechanical vibration and other conditions that would result from factors such as gear backlash, differences in feed screw pitch, and tension on screws, nuts, and so on. Therefore the NC222-E should not be used in a closed-loop system.

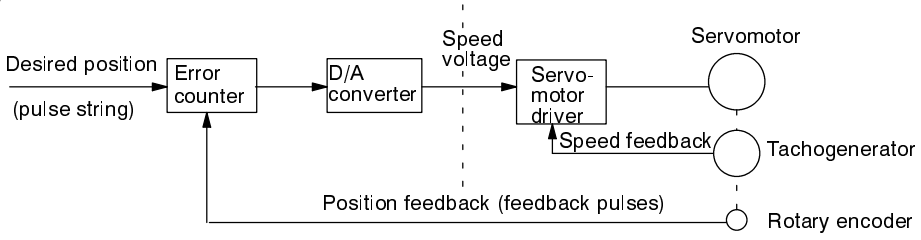


Semiclosed-loop Systems

The NC222-E, like the NC221-E, is designed for use in a semiclosed-loop system. Semiclosed-loop systems occupy the mainstream in modern servosystems applied to positioning devices. A semiclosed-loop system is similar to a closed-loop system, except that feedback is provided by a tachogenerator and a rotary encoder rather than directly by the servomotor. This system, which also includes an error counter, a D/A converter, and a servomotor driver, detects machine movements by rotation of the motor in relation to the target, computes the error between the target value and actual movement, and zeroes the error through feedback.



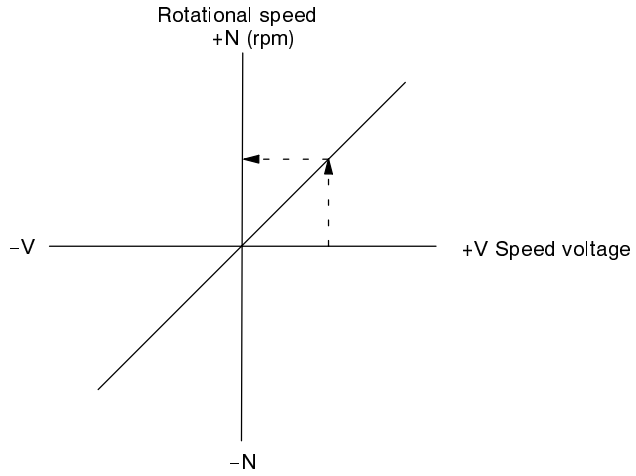
Internal Configuration



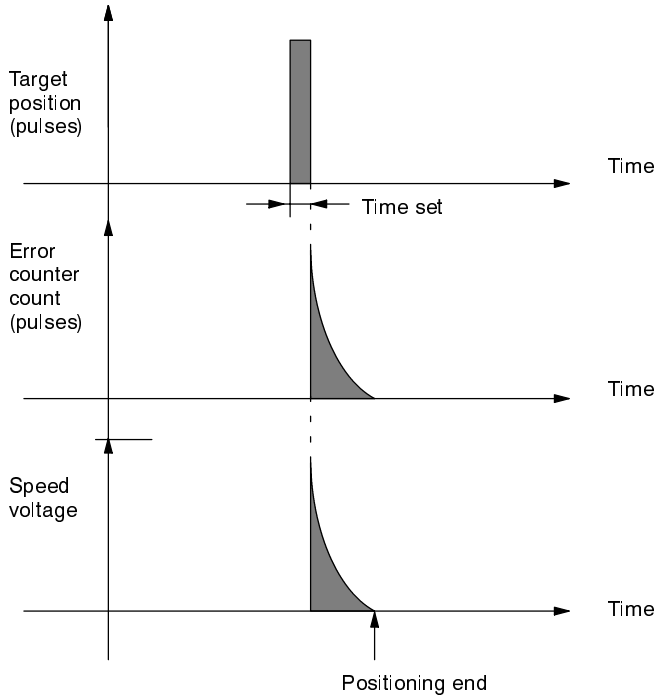
Position Control Unit Operation

1. First, the error counter receives a target position in units of encoder pulses. The error counter transfers its contents to the D/A convertor which converts the contents to analog speed voltages for the servomotor driver.

Servomotor Driver Speed Characteristics



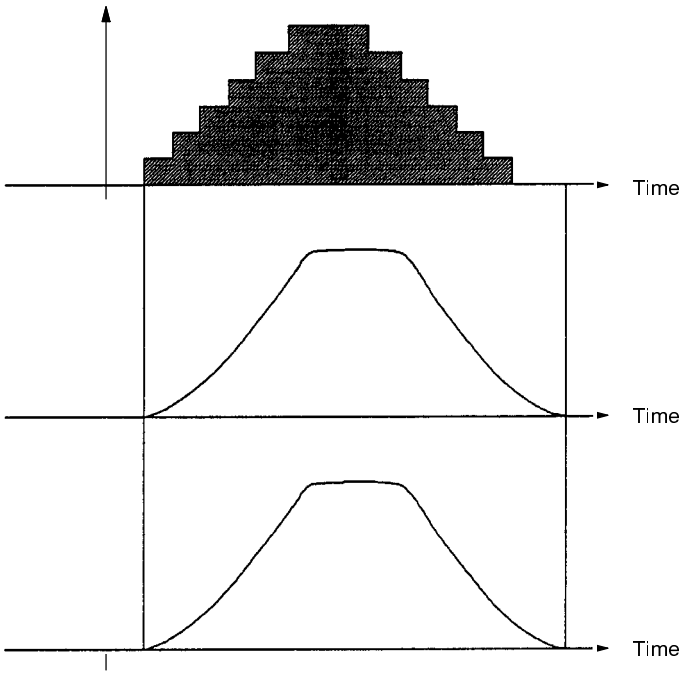
2. The motor rotates at a speed corresponding to the speed voltage. The rotary encoder connected to the motor axis rotates in sync with the motor, generates feedback pulses, and subtracts error counter contents.



3. Consequently, the encoder rotation is equivalent to the target position, and the motor stops rotating when the error counter count and the speed voltage becomes zero (stopping motor rotation).
4. While the motor is stopped, the rotary encoder constantly maintains the stopped position through correction. If the motor axis moves slightly, the error counter receives a feedback pulse from the rotary encoder and a rotation voltage is emitted in the reverse direction, causing the motor to

rotate toward its original position. This operation is called servolock or servoclamp.

5. In order to execute positioning by the semiclosed-loop method with acceleration and deceleration, target positions are set consecutively in the error counter for processing, thus enabling smooth acceleration and deceleration.



6. The target position becomes the error counter content which is converted to a speed voltage for the servomotor driver. Thus, the position equals the total count of target positions (shaded area in the figure), and the speed will depend on the target position desired per unit time.

Machinery that Can be Used

The NC222-E was developed for simple positioning applications using a servomotor, and not for applications requiring a high degree of precision. There may be some variation depending on the accuracy of the machinery used, but in general the NC222-E can provide accuracy up to approximately 100 μm. Therefore the following machinery can be used.

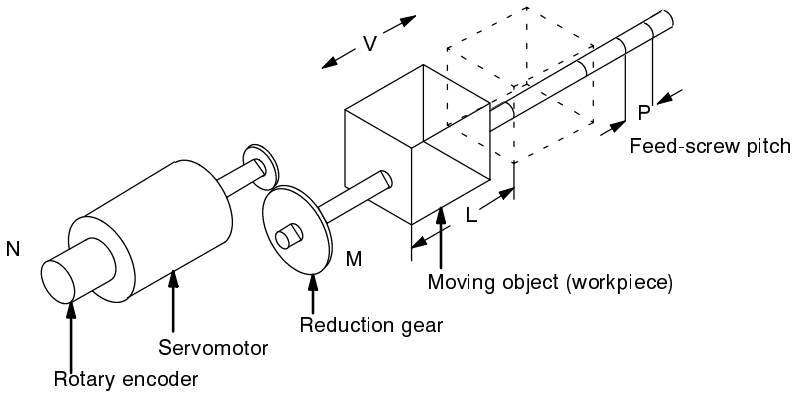
(1) Conveyer machinery: X/Y tables, palletizers/depalletizers, loaders/unloaders, etc.

(2) Assembly machinery: Simple robots, simple automated assembly machinery, etc.

The NC222-E cannot be used for positioning applications in production systems that require high precision.

Simplified Positioning System Design

Consider the following positioning system where millimeter is selected as the unit:



Where:
N = rotary encoder resolution (pulse/rev)
M = reduction ratio
V = speed of moving object (mm/s)
P = feed-screw pitch (mm/rev)
L = distance moved (mm)

Here,

$$\text{Pulse rate} = \frac{\text{Feed-screw pitch}}{\text{Encoder pulses x reduction ratio}}$$

$$= \frac{\text{P (mm/rev)}}{\text{N (pulse/rev) x M}} = \frac{P}{N \times M} \text{ (mm/pulse)}$$

Next, the required pulse speed from the encoder is:

$$\text{Required pulse speed} = \frac{\text{Feeding speed}}{\text{Pulse rate}} = \frac{\text{V (mm/s)}}{\text{Pulse rate (mm/pulse)}}$$

$$= \frac{V \times N \times M}{P}$$

For a movement of L mm:

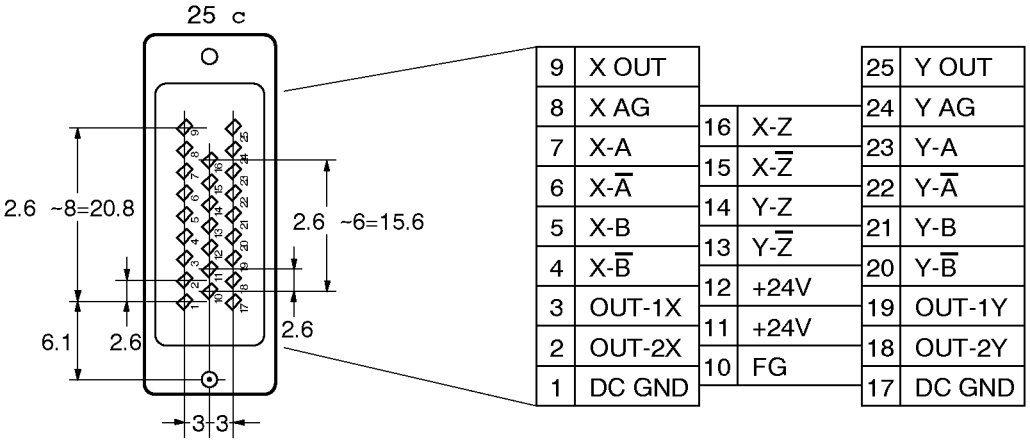
$$\text{Requisite no. of pulses} = \frac{\text{Distance moved}}{\text{Pulse rate}} = \frac{L}{\frac{P}{N \times M}} = \frac{N \times M \times L}{P} \text{ (pulses)}$$

SECTION 2
Wiring

This section provides procedures for connecting the C500-NC222-E Unit's servomotor driver I/O, external inputs and power supply. Example circuits are provided along with examples of faulty wiring, its effects and features for checking faulty and disconnected wiring. In order to insure system performance and reliability, wiring precautions are presented to avoid malfunctions which are often difficult to diagnose and correct. Finally, the Unit's switches and indicators are explained along with a suggested trial operation to enable the operator to run the Unit under simple and safe conditions.

2-1 M/D Connector

The M/D (motor driver) connector is used for wiring servomotor driver I/O points. Control voltage outputs and feedback pulse inputs go through here. The connector type and pin layouts are shown below.



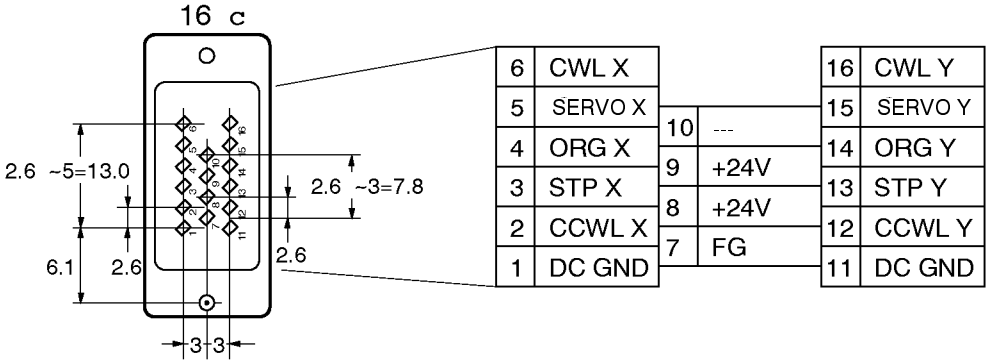
(Layout shown from wiring side)

Pin Terminal Functions

Pin No.	Symbol	Name	Description
1	DC GND	0 V	0-V terminal for pins 11 and 12
2	OUT-2X	X-axis OUT2 output	User defined output (for X axis)
3	OUT-1X	X-axis OUT1 output	
4	X-$\overline{B}$	X-axis Phase $\overline{B}$ input	Phase $\overline{B}$ feedback input for X axis
5	X-B	X-axis Phase B input	Phase B feedback input for X axis
6	X-$\overline{A}$	X-axis Phase $\overline{A}$ input	Phase $\overline{A}$ feedback input for X axis
7	X-A	X-axis Phase A input	Phase A feedback input for X axis
8	XAG	X-axis speed 0 V	0-V output for X-axis speed voltage to servomotor driver
9	XOUT	X-axis speed	X-axis speed voltage output to servomotor driver
10	FG	Frame ground	Ground terminal
11	+24V	24 V for OUT output	+24 VDC input terminal for OUT output
12	+24V		
13	Y-$\overline{Z}$	Y-axis phase $\overline{Z}$ input	Phase $\overline{Z}$ feedback input for Y axis
14	Y-Z	X-axis phase Z input	Phase Z feedback input for Y axis
15	X-$\overline{Z}$	X-axis phase $\overline{Z}$ input	Phase $\overline{Z}$ feedback input for X axis
16	X-Z	Y-axis phase Z input	Phase Z feedback input for X axis
17	DC GND	0 V	0-V terminal for pins 18 and 19
18	OUT 2Y	Y-axis OUT2 output	User defined output (for Y axis)
19	OUT 1Y	Y-axis OUT1 output	
20	Y-$\overline{B}$	Y-axis Phase $\overline{B}$ input	Phase $\overline{B}$ feedback input for Y axis
21	Y-B	Y-axis Phase B input	Phase B feedback input for Y axis
22	Y-$\overline{A}$	Y-axis Phase $\overline{A}$ input	Phase $\overline{A}$ feedback input for Y axis
23	Y-A	Y-axis Phase A input	Phase A feedback input for Y axis
24	YAG	Y-axis speed 0 V	0-V output for Y-axis speed voltage to servomotor driver
25	YOUT	Y-axis speed instruction	Y-axis speed voltage output to servomotor driver

2-2 EXT-IN Connector

The EXT-IN (external input) connector is used for wiring external inputs. Since the C500-NC221-E Position Control Unit allows dual axis control, the EXT-IN connector provides inputs for both X and Y axes for connecting inputs from limit switches, from switches to stop the system, and from the mechanical origin. The connector type and pin layouts are shown below.



(Layout shown from wiring side)

Pin Functions

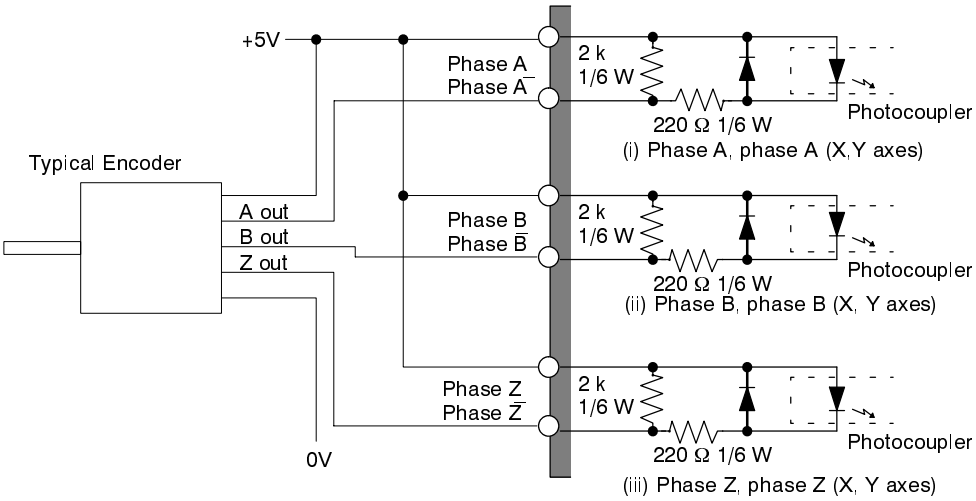
Pin No.	Symbol	Name	Description
1	DC GND	0 V	Ground (0 V) terminal for external 24-VDC power supply
2	CCWLX	X-axis CCW limit	Limit switch input for X-axis in CCW direction (NC)
3	STPX	X-axis external interrupt	Used for stopping X axis earlier than normal deceleration stop (NO). Active at its leading edge.
4	ORGX	X-axis origin	Used as X-axis mechanical origin (NO).
5	SERVO X	X-axis external servo-free input	Used to switch between servo-lock and servo-free (NC) .
6	CWLX	X-axis CW limit	Limit switch input for X axis in CW direction (NC)
7	FG	Frame ground	Ground terminal
8	+24V	24-V input	Positive (+24 V) terminal for external 24-VDC power supply
9	+24V	---	
10	---		Unused
11	DC GND	0 V	Ground (0 V) terminal for external 24-VDC power supply
12	CCWLY	Y-axis CCW limit	Limit switch input for Y axis in CCW direction (NC)
13	STPY	Y-axis external interrupt	Used for stopping Y axis earlier than normal deceleration-stop (NO). Active at its leading edge.
14	ORGY	Y-axis origin	Used as Y-axis mechanical origin (NO).
15	SERVO Y	Y-axis external servo-free input	Used to switch between servo-lock and servo-free (NC).
16	CWLY	Y-axis CW limit input	Limit switch input for Y axis in CW direction (NC)

Note 1. Even when only one axis (either X or Y) can be used, wire the NC external input of the unused axis to DC GND. This can be done simply by short circuiting at the connector.

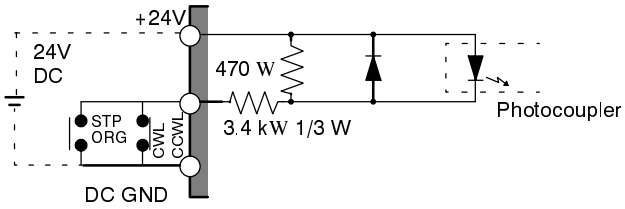
2. The M/D connector 24 V (pins 11 and 12) and the EXT-IN connector 24 V (pins 8 and 9) are connected (short circuited) internally.
The M/D connector FG (pin 10) and the EXT-IN connector FG (pin 7) are connected (short circuited) internally.
The M/D connector DC GND (pins 1 and 17) and the EXT-IN connector DC GND (pins 1 and 11) are connected (short circuited) internally.

Input Circuits (Feedback Inputs for Phases A, B, and Z)

• M/D Connector

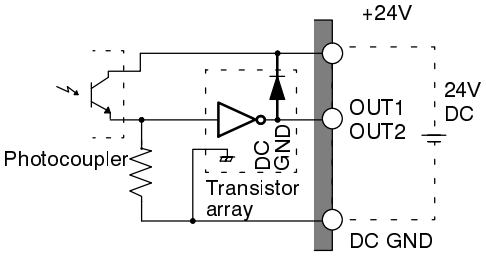


• EXT-IN Connector

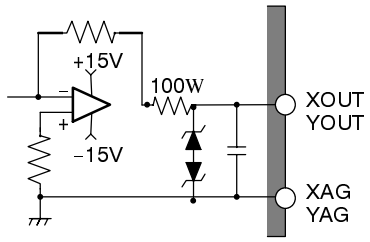


STP, ORG, CWL, CCWL inputs (X,Y axes)

Output Circuit (OUT Outputs and Speeds)



OUT1/OUT2 outputs (X,Y axes)

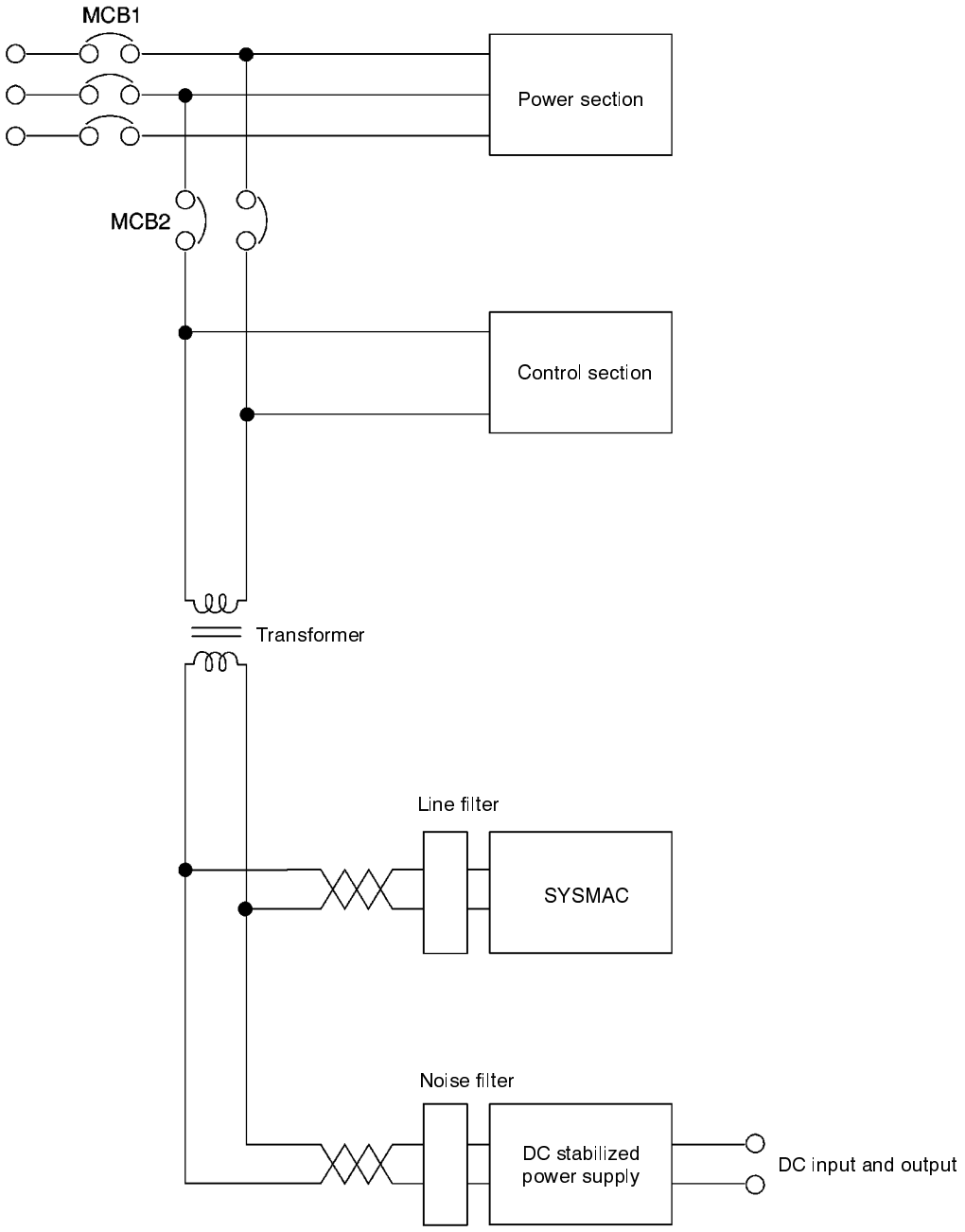


Speed outputs (X,Y axes)

2-3 Power Supply Wiring

Power Supply System

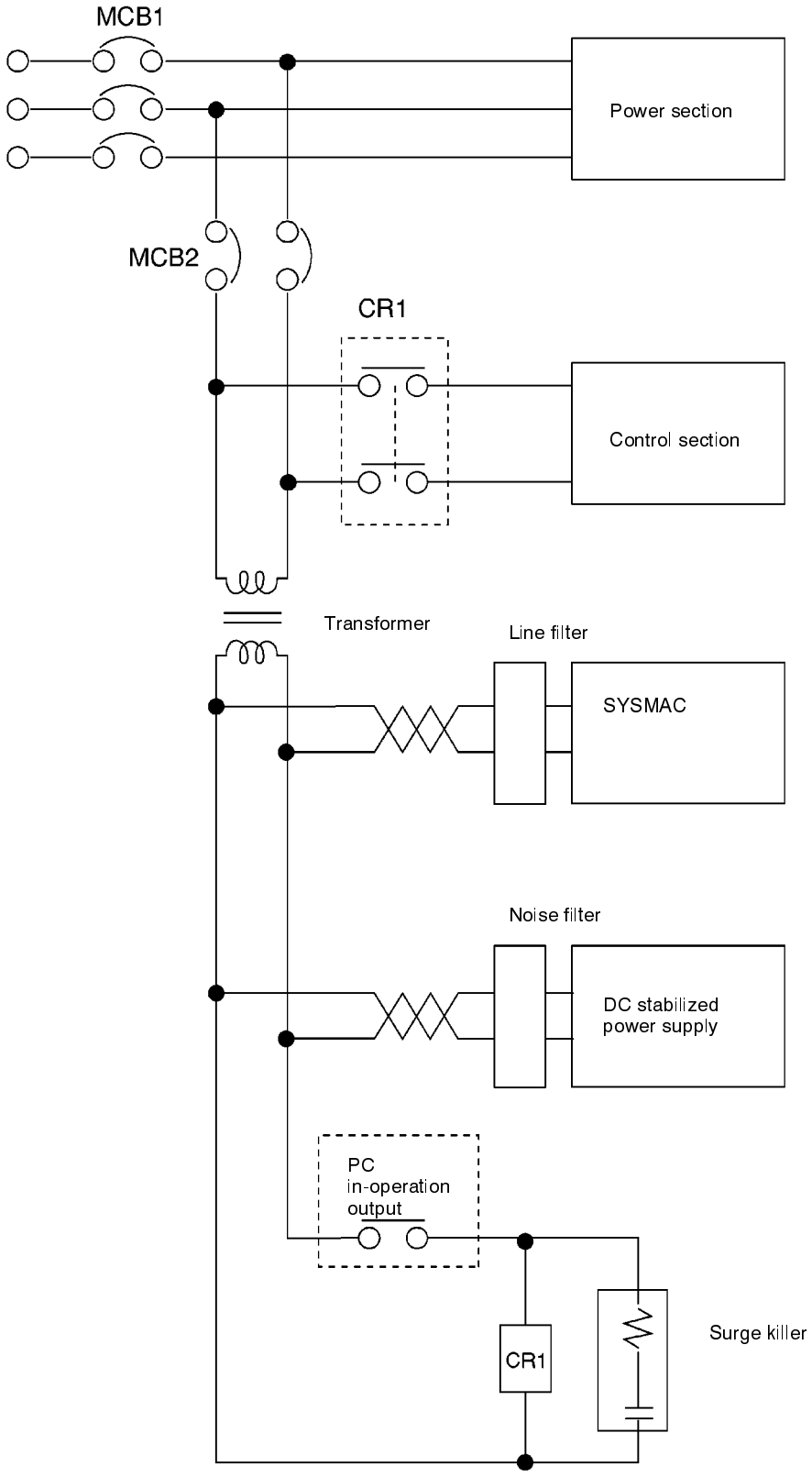
For the power supply, wire separately the power system, the control system, the SYSMAC system, and the DC input system.



PC Emergency Stop Circuit

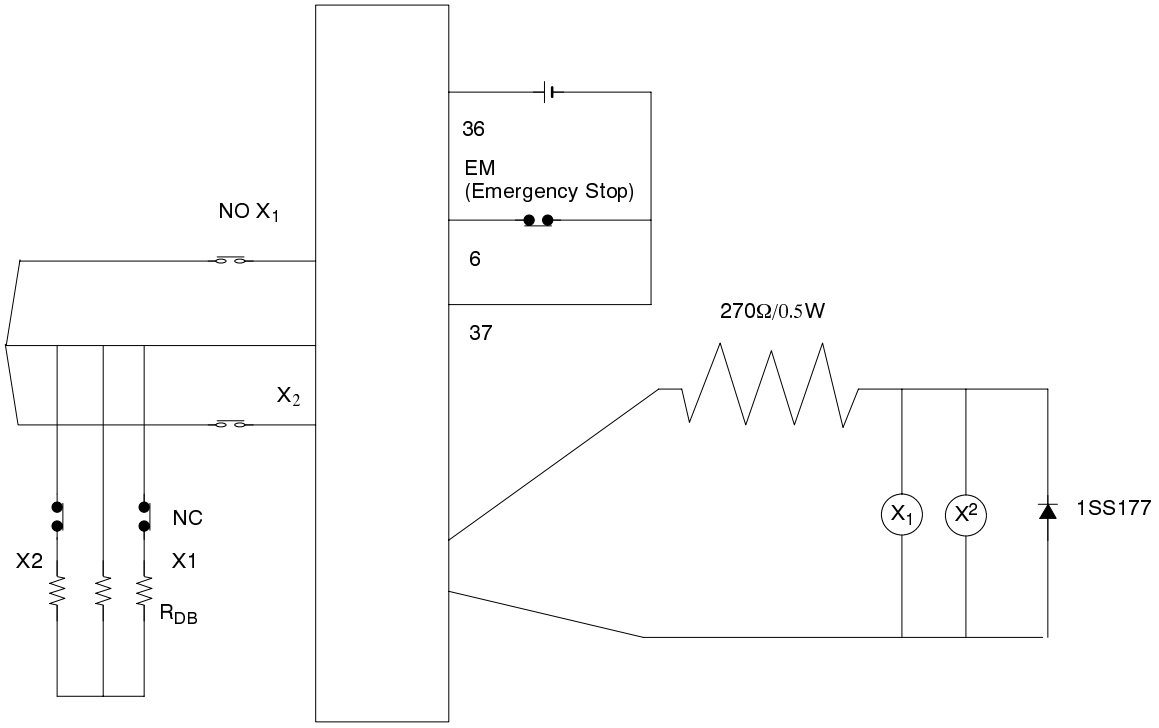
In order for a PC breakdown or malfunction to not adversely affect the entire system, incorporate the PC's in-operation output terminal into an external

relay circuit (CR1 in the following wiring diagram), and set up an emergency stop circuit as shown in the following figure.



Servosystem Emergency Stop Circuit

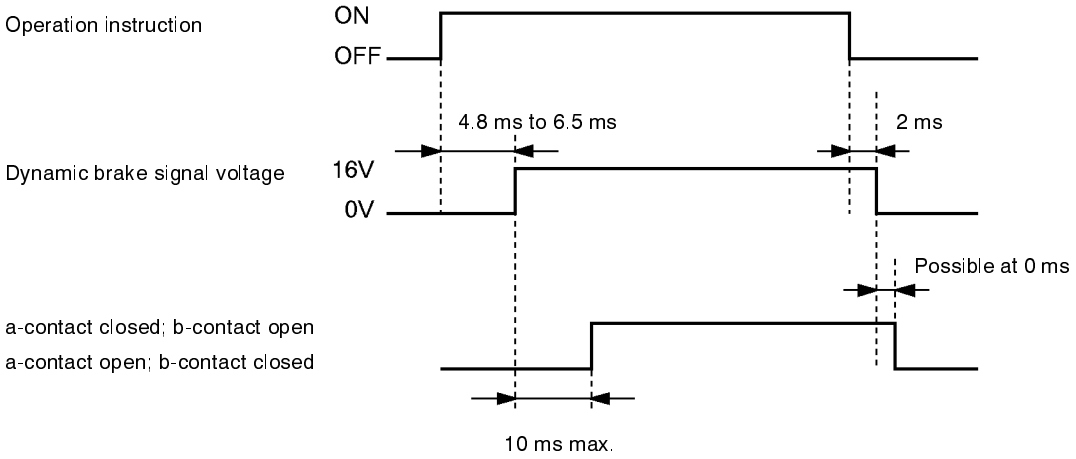
The standard procedure is to use a dynamic brake for servosystem emergency stops. A dynamic brake is a method whereby the regenerative electric power of a motor is used for stopping the system. Brake torque is applied to the motor by means of short-circuiting between the motor and an armature. Ordinarily a timing signal is output from the servomotor driver, so this can be used for the dynamic brake. The following diagram provides an example of wiring an OMNUC H-series system.



RDB:
50-W to 300-W motor: 0 Ω
500-W to 1.1-kw motor: 8.2 Ω 15

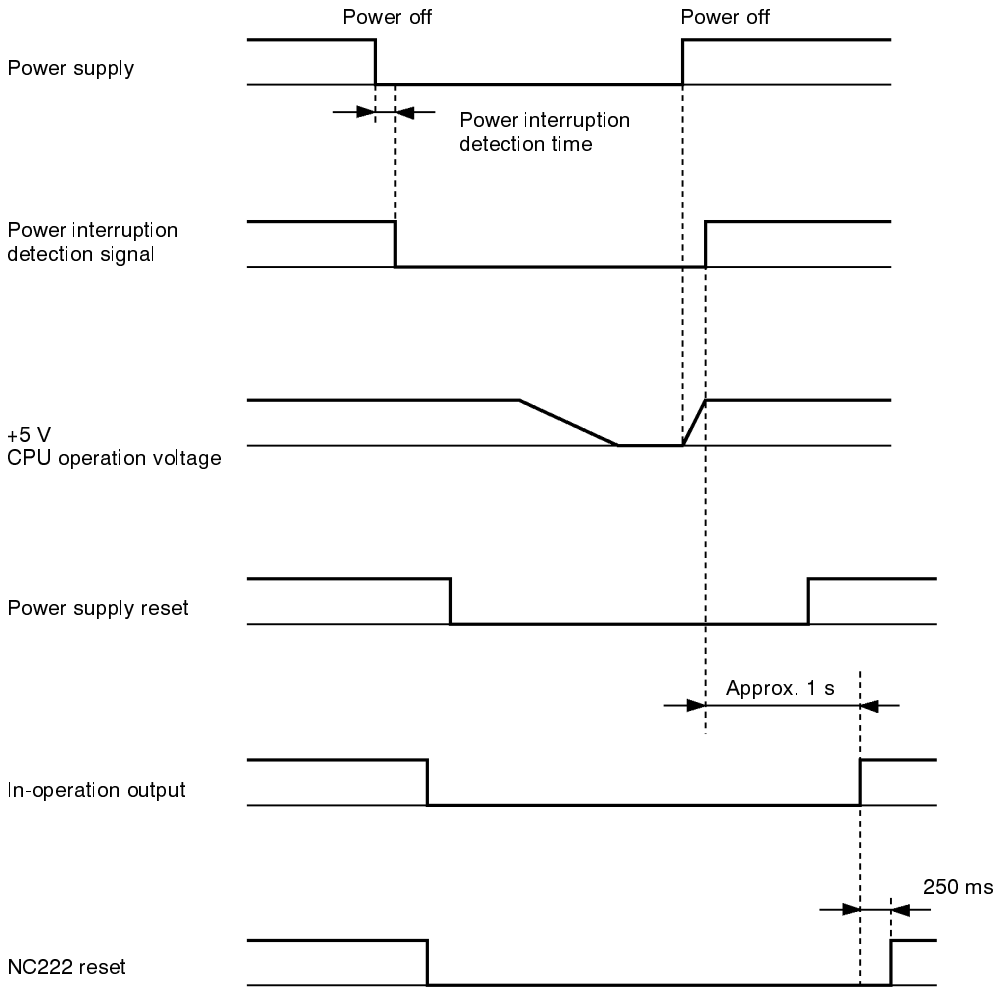
Caution The dynamic brake output signals must not exceed 16 V and 30 mA. If these specifications are exceeded, it will cause damage to the control system. Exercise care in selecting the relays. For relays X1 and X2, use G6C-2117P relays (12-VDC 1a and 1b contacts) by OMRON.

Establish the ON/OFF timing for the relays as shown in the following illustration. Select relays that will operate within 10 ms from when the dynamic brake signal is output.



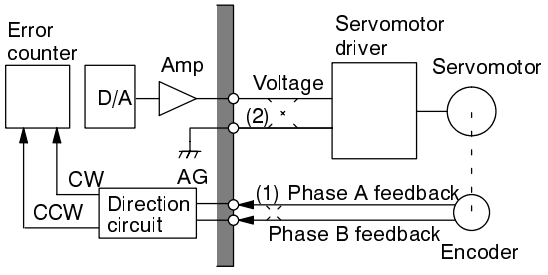
Power Supply Sequence

The following illustration provides a power-up time chart. The power supply for the NC222 is provided by the Power Supply Unit, and all momentary power interruptions and voltage drop detection are handled by the Power Supply Unit.



2-4 Motor Runaway Due to Faulty or Disconnected Wiring

In a servo system employing a servomotor, faulty or disconnected wiring may cause the servomotor to run out of control. When the wiring is correct, the servomotor maintains the stopped position as long as a position loop is formed and servolock is in effect.



(1) Faulty wiring at phase feedbacks A and B.
(2) Faulty wiring at ground and positive lines of speed voltage output.

For example, suppose that rotation occurs in the CW direction during servolock due to a factor such as temperature drift. The rotation is detected by an encoder, and the Position Control Unit's internal error counter is notified of the direction and amount of rotation by means of feedback signals. The count of the error counter is ordinarily zero unless otherwise designated, so when the motor moves in the CW direction and the feedback signals transfer the direction and amount of movement as a count to the error counter, it will zero this count figure by outputting the appropriate control voltage to rotate the motor in the CCW direction.

The control voltage is output to the servomotor driver, and the motor rotates in the CCW direction. Again, when the motor rotates in this CCW direction the encoder detects the movement and notifies the error counter in the Position Control Unit with feedback signals. This position loop subtracts the count figure in the error counter to zero it. Hence, the creation of a position control loop and valid servolock will ordinarily allow the servomotor to constantly correct and maintain its stopped position.

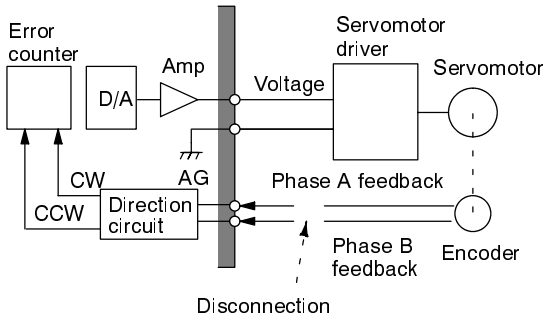
Runaway Due to Faulty Wiring

If the phase A and phase B feedback input lines are wired in reverse (broken lines at (1) in the figure above), the servolock will not be effective and the motor will run out of control. Suppose, for example, that the motor rotates in the CW direction due to drift or some other cause, and that the direction and amount of movement are detected by the encoder and transmitted to the error counter in the Position Control Unit. Because the feedback input wiring is reversed at the Position Control Unit, the error counter receives the information as a rotation amount in the CCW direction. Then the error counter attempts to zero the count figure by outputting a control voltage in the CW direction.

The reversed wiring thus causes further CW rotation when the servomotor driver receives this control voltage. The error counter continues to total a count in the CCW direction, and the motor runs out of control in the CW direction as the cycle repeats. This can occur not only from reversed wiring of phases A and B of the feedback inputs, but also from reversed wiring of the speed voltage and the ground lines (broken lines at (2) in the figure above). Runaway motors can be quite dangerous because they become apparent only after switching power on.

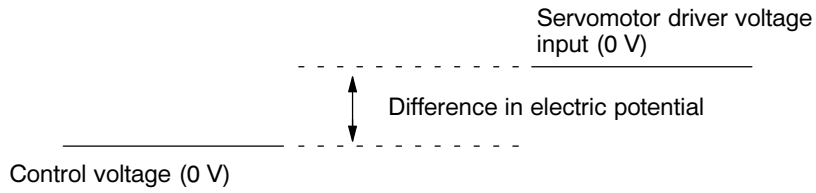
Runaway Due to Disconnected Wiring

Motor runaway can occur not only due to faulty wiring but also due to disconnected wiring.



For example, in the illustration above, the feedback lines are broken and correct feedback signals cannot be returned. Thus the Position Control Unit control voltage remains at zero without changing. When the servomotor receives the control voltage of 0 V, it tries to stop servomotor rotation. In fact, however, the motor may move in one direction without stopping. This is caused by a

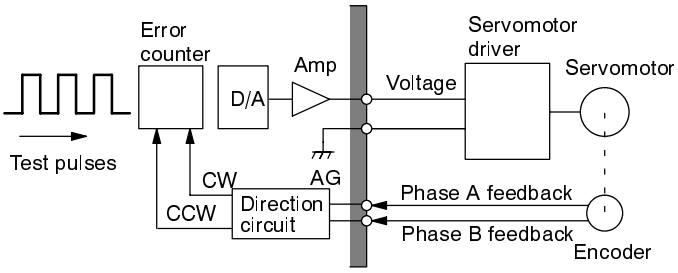
discrepancy between the 0 V of the Position Control Unit's control voltage and the 0 V of the servomotor driver's voltage input.



When the two 0 voltages do not match, an electric potential difference is generated, resulting in a false control voltage. This in turn causes the servomotor to move in one direction without stopping. In order to prevent this, repair the wiring or adjust the 0 V of either the Position Control Unit or the servomotor driver so that the 0 V levels match. Motor movement due to nonmatching 0 V levels can occur during servo-free as well as servolock, based on the same principles.

2-5 Faulty and Disconnected Wiring Check Functions

The NC222-E is provided with check functions to guard against the conditions described above. When the command is executed to check the wiring, a specified number of pulses is output in the specified direction, and a check is performed to determine whether correct feedback pulses can be read.



For example, in the above illustration, suppose that a specified number of test pulses has been set in the error counter. After a fixed period of time the contents of the error counter can be checked to determine whether the number of pulses that was initially set is correctly returned. With the faulty wiring test, if the feedback pulses return only the pulse number that was originally set, then that is okay. If there is faulty (i.e., reversed) wiring, then a pulse number will be returned that exceeds the number of pulses that was set, and a faulty wiring error (X axis error code: 20; Y axis error code: 21) will be generated by the NC222-E. The servolock will be cleared and the voltage output will go to 0 V.

To correct a faulty wiring error, either turn off the power and fix the reversed wiring or reset the A/B phase switch in the encoder classification of the parameter data.

Caution When the parameter data is changed, the motor may rotate rapidly due to the remaining count in the error counter.

If the number of feedback pulses returned is less than the number of test pulses that was set, a disconnected wiring error (X axis error code: 22; Y axis

error code: 23) will be generated. Just as with a faulty wiring error, the servolock will be cleared and the voltage output will go to 0 V.

To correct a disconnected wiring error, turn off the power and repair the wiring.

Note Faulty wiring checks and disconnected wiring checks can be carried out simultaneously. (It is also possible to carry out a faulty wiring check alone.) If they are both carried out simultaneously, the A phase and B phase switching for feedback will be executed automatically in the NC222-E if the wiring is reversed.

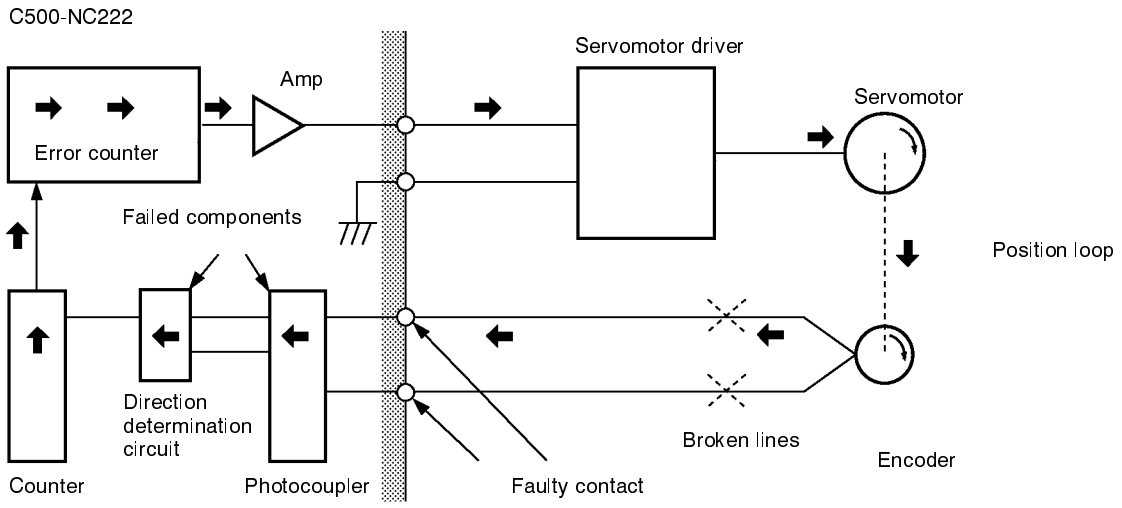
2-6 System Failsafe Circuits

To protect against unforeseen problems that may occur during operation, provide failsafe circuits, such as those shown below, in the positioning system in which the NC222-E is used.

Errors During Positioning Operations

As illustrated below, motor runaway may occur during operation without a position loop being formed. This can result from the following:

1) Failure of internal components in the NC222-E
2) Disconnected external wiring or faulty connections



Error Counter Capacity Setting

With the NC222-E, the error counter capacity can be set according to the operating conditions by means of a parameter setting. This makes the error counter overflow detection more sensitive. Follow the procedure outlined below to set the error counter capacity.

1, 2, 3...

1. Conduct a trial operation of the machinery, and use the Teaching Box to check how the count changes in the error counter.
2. Check the maximum count value, and set the parameter data such that the error counter capacity is 30% to 50% less than that value.

Check Based on Error Counter Overflow

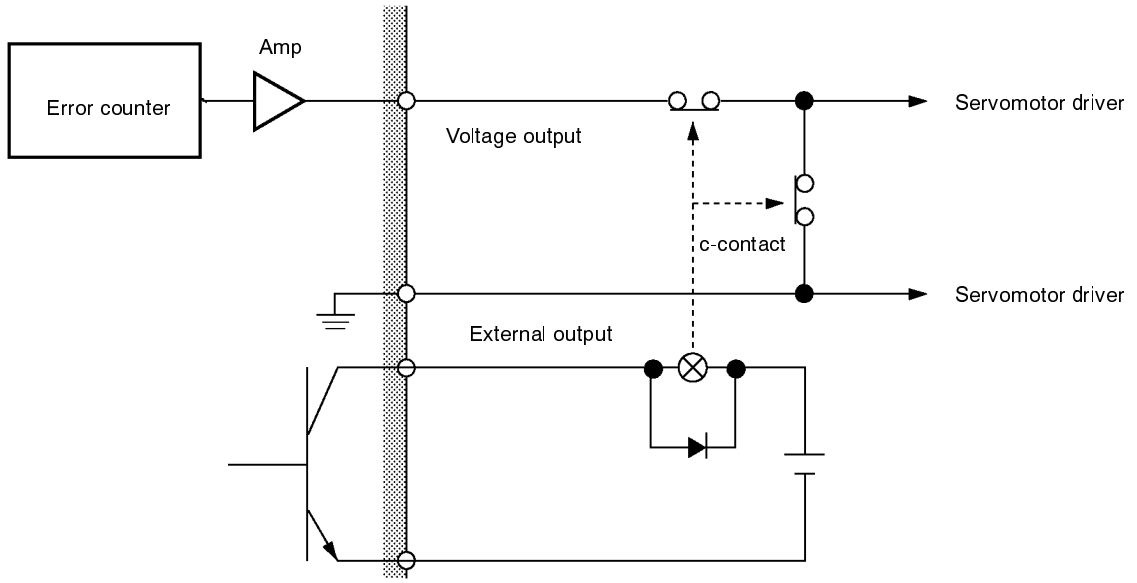
If motor runaway occurs during a positioning operation, as described above, the NC222-E checks for errors according to the count of the error counter, and executes the following processes:

1, 2, 3...

1. Outputs an “error counter overflow” error.
2. Sets the voltage output to 0 V.
3. Turns “external output” ON or OFF according to the parameter data settings.

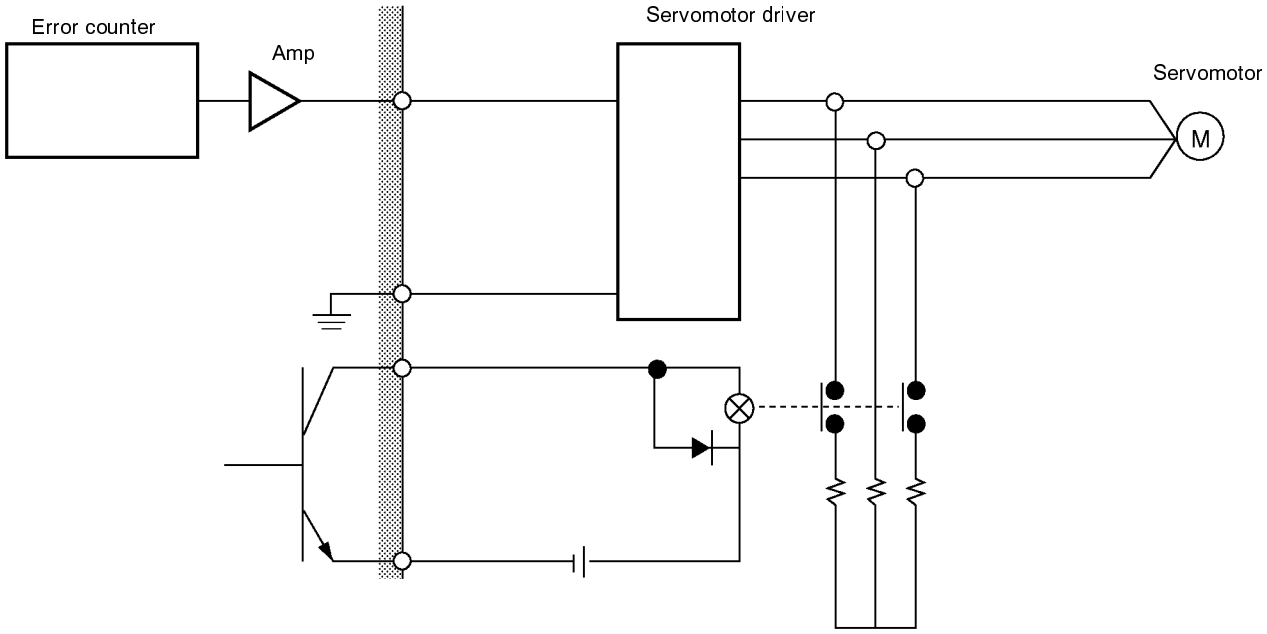
These processes provide external stop circuit operation timing as shown in the diagrams below when an error occurs during a positioning operation.

Example 1



When an error counter overflow occurs, the external contact for the c-contact is moved by means of an external output, and the voltage output to the servomotor driver is short-circuited and stopped.

Example 2

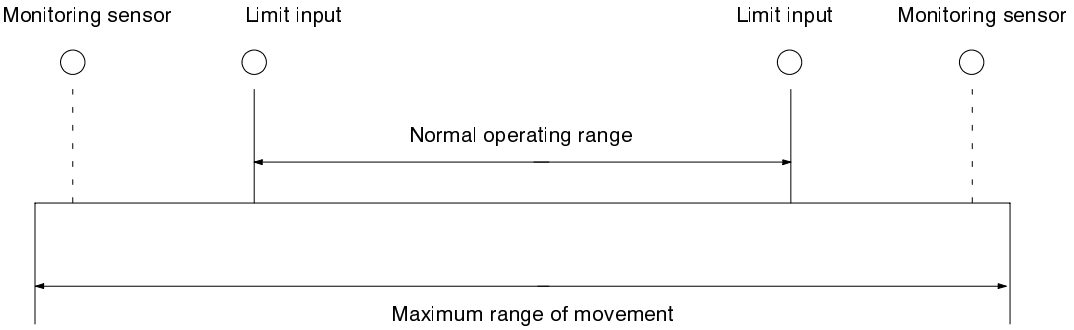


When an error counter overflow occurs, the motor's dynamic brake is applied by means of an external output, and motor operation is stopped.

Caution In either of the above examples, be careful enough so that the sudden stop when the error counter overflows will not result in damage to the machinery.

External Emergency Stop Circuit

In addition to the failsafe circuits shown above, a failsafe circuit is normally set up whereby monitoring sensors are installed at the edges of the workpiece's range of movement and operation is stopped if runaway occurs and abnormal workpiece movement is detected.



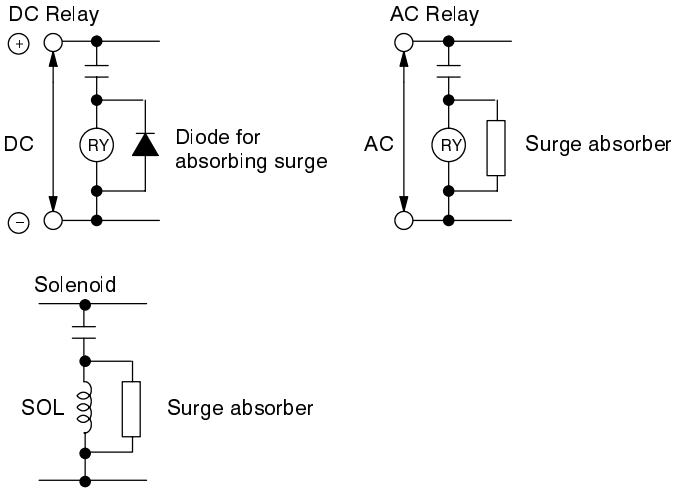
In this safety system, as illustrated in the above diagram, monitoring sensors are installed outside of the limit inputs. If the workpiece reaches one of the sensors, the power is turned off to the servomotor driver and then the dynamic brake is applied to stop the motor.

2-7 Wiring Precautions

Electronically controlled equipment may malfunction because of noise generated by power supply lines or external loads. Such malfunctions are difficult to reproduce; hence, determining the cause often requires a great deal of time. The following tips should aid in avoiding noise malfunction and improving system reliability.

1, 2, 3...

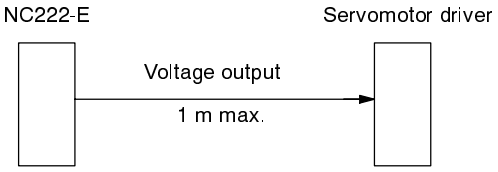
1. Always use designated electrical cables.
2. Separate power cables (AC power supply, motor power supply) and control cables (pulse outputs, external I/O). Do not group the two types together or place them in the same conduit.
3. Control cables must be shielded.
4. For inductive loads (relays, solenoids, solenoid valves), connect surge absorbing circuits. Connect surge absorbing components close to the relay or solenoid. For a DC relay, use a surge-absorbing diode with a voltage tolerance at least five times greater than the circuit voltage.



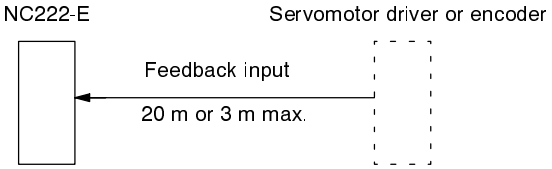
5. Noise from the power supply line (e.g., when using the same power supply with an electric welder or electrical discharge unit, or when a

high-frequency noise generator is nearby) can be alleviated by inserting a noise filter at the power supply input.

6. Use a twisted pair cable for power supply lines.
7. Use adequate grounds (i.e., at least class 3) with a cross-section of 1.25 mm^2 or greater.
8. Use twisted pair and shielded cables for the control voltage output signals and the feedback input signals.
9. For the control voltage output signals, wire a maximum of one meter between the NC222-E and the servomotor driver.



10. For the feedback input signals, wire the distance between the NC222-E and the generator of the feedback pulses (i.e., the encoder or the servomotor driver) as follows:
    a) When the feedback pulses are line driver output, wire at a maximum length of 20 meters.
    b) When the feedback pulses are open connector or voltage output, wire at a maximum length of 3 meters.

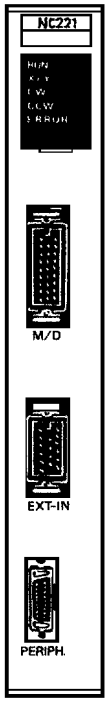


11. The I/O terminals that operate the 24-V system are isolated with photocouplers to reduce external noise effects on the control system. In accordance with this provision, avoid connections between the analog control voltage ground (AG) and 24-V ground (DC GND).

2-8 Switches and Indicators

Position Control Unit Front Panel

The front panel of the Position Control Unit is arranged for connections to the Teaching Box (refer to *Section 10 Teaching Box Operations*), the servomotor drivers (refer to *Appendix A Position Control Unit Specifications*), external input switches, etc. In addition, four indicators are located on the panel to indicate the current status of the Position Control Unit.



Indicator display

	ON	Flashing	OFF
RUN	Hardware normal	---	Hardware abnormal
X/Y	X-axis independent operation	Interpolation	Y-axis independent operation, stop
CW	CW direction operation	---	No CW direction operation
CCW	CCW direction operation	---	No CCW direction operation
ERROR	System error, command error	Communications error	No errors

M/D (Motor Driver) Converter
Connect the servomotor drivers here. This port has I/O assignments for speed voltage, feedback input, output 1, output 2, etc.

EXT-IN (External Input) Connector
Connect external inputs here necessary for positioning such as origin, external interrupt, CW limit, CCW limit, and external servo-free.

Peripheral Connector
Connect the Teaching Box here as needed.

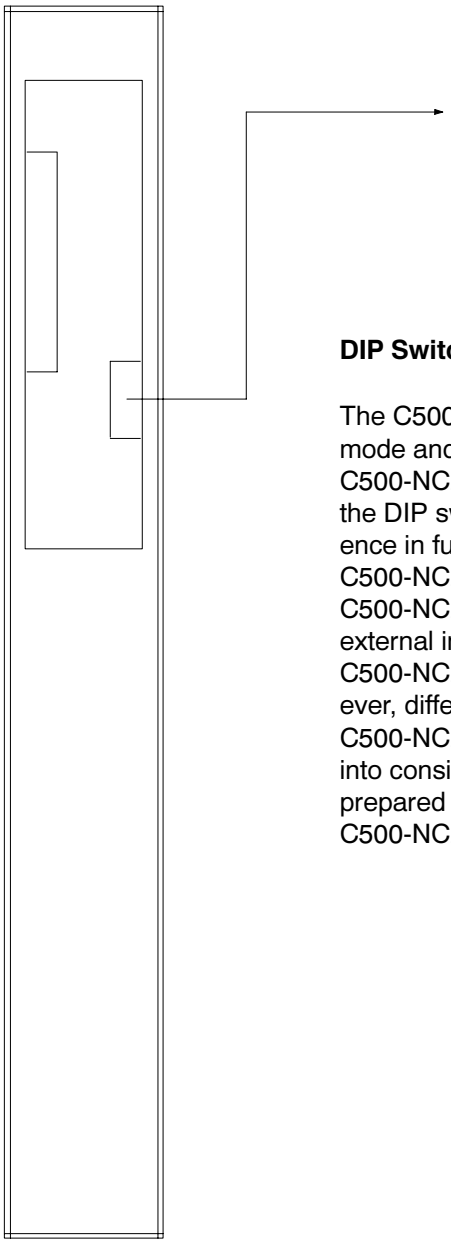
Definition of CW and CCW

Clockwise (CW) and counterclockwise (CCW) rotation of the motor shaft are in reference to a viewer facing the shaft on the end of the motor that has no lead cables attached, i.e., the end from which the shaft extends from the motor for connection.

Position Control Unit Rear Panel

The rear panel of the NC222-E contains a DIP switch which allows the user to select whether the Position Control Unit is to function as an NC221-E or an NC222-E. This DIP switch has two pins, and only pin no. 1 is used. To use the Unit as an NC222-E, turn pin no. 1 ON. To use it as an NC221-E, turn the pin OFF.The NC222 in NC221 mode functions as the NC221 except for distributed cycle timing and external input timing, which the user should take into consideration when using programs created for the NC221.

NC222-E Rear Panel DIP Switch



DIP Switch Settings

Pin no.	Content	Setting
1	Not used.	
2	Select NC222-E.	ON
	Select NC221-E.	OFF

DIP Switch Settings for Model Selection

The C500-NC222-E will be in NC221-E mode and can be used as a C500-NC221-E model by setting pin 2 of the DIP switch to OFF. There is no difference in function between the C500-NC222-E in NC221-E mode and the C500-NC221-E. The distribution cycle and external input timings of the C500-NC222-E in NC221-E mode is, however, different from those of the C500-NC221-E. The user must take this into consideration when applying programs prepared for the C500-NC221-E to the C500-NC222-E in NC221-E mode.

2-9 Trial Operation

Follow the procedure outlined below to conduct a trial operation. The purpose of the trial operation is to run the motor under simple conditions without an actual workpiece mounted. Use the servomotors for both axes. For external inputs, use a temporary switchbox rather than actual limit switches and proximity switches.

2-9-1 Procedure

1, 2, 3... 1. Wire the external inputs.

Referring to the example connection diagram, wire the switchbox to the EXT-IN connector of the NC222-E. An external 24-VDC power supply is required. (Use the C500-PS221 24-VDC service power supply.)

The normal external I/O status is as shown in the following table.

Name	Contact
CWL	NC
External interrupt (decel. stop)	NO
External servo-free input	NC
Origin input	NO
CCWL	NC

2. Wire the servomotor driver to the NC222-E.

Referring to the example connection diagram, wire the servomotor driver to the M/D connector of the NC222-E. Be sure to follow the instructions in the servomotor driver operation manual.

3. Wire the Input Unit to the switchbox.

Referring to the example connection diagram, mount the C500-ID213 Input Unit and wire it to the switchbox. Then mount the C500-OC221 Output Unit and set the NC222-E. (Refer to *page 84 IR Area Allocations*) After completing the wiring up to this point, make sure that it is correct before proceeding.

4. Wire the motor, the servomotor driver, and the power supply.

Referring to the example connection diagram, wire the motor, and the C500-PS221 Power Supply Unit. When wiring the servomotor driver, be sure to follow the instructions in the servomotor driver operation manual.

5. Turn on the power supply.

After the wiring has been completed, turn on the 100-VAC power supply (for the PC) and the 200-VAC power supply (for the servomotor driver) in order.

NC222-E: Internally, when the power is turned on, the initial data stored in the EEPROM for the trial operation will be read and set to RAM automatically. (Refer to *3-10 Initial Data*.) This initial data is factory set, and saves time in setting data when first running a trial operation. Use it for checking and correcting data.

Motor/servomotor driver: As the power is turned on, servolock is enabled and the axis position will be maintained even if the user tries to turn it by hand. If servolock does not go into effect, then turn off the power again and recheck the wiring.

6. Write the command group to DM.

Following the example program provided in *4-2 PC Programs*, write the program to the PC. Just as when writing commands to data memory, check from the beginning after the program has been written.

7. After the PC program has been written, the trial operation can be carried out. Put the PC in either RUN or MONITOR mode.

PC Input Switch Functions

The functions of the switches in the PC input switchbox are as shown in the following table.

Switch name	Function
INPUT (1)	Takes the stopped position of the X and Y axes as the origin.
INPUT (2)	Executes X axis origin search.
INPUT (3)	Executes Y axis origin search.
INPUT (4)	Executes positioning for X axis alone. The motor rotates once (CW direction).
INPUT (5)	Executes positioning for Y axis alone. The motor rotates once (CW direction).
INPUT (6)	Executes positioning for X axis alone, but with a speed change during positioning. The motor rotates three times (CCW direction).
INPUT (7)	Executes positioning for Y axis alone, but with a speed change during positioning. The motor rotates three times (CCW direction).
INPUT (8)	Executes positioning for X and Y axes simultaneously. The motor rotates twice (CCW direction).

Items to Check

Item	Procedure
1. Display	Check the Output Unit's display. If the ready signal (bit no. 15) is lit, then the preparation is complete.
2. Determining the origin	Either of the following two methods can be used for determining the origin: 1) Use the "change present value" command to make the present position the origin. 2) Use the "origin search" command to search for the origin. For the first of these, turn input 1 ON and OFF to make the present position the origin for both the X and Y axes. For the second method, turn input 2 ON and OFF to begin X axis operation. When the origin input (X axis external input) is turned ON and OFF, positioning will come to a deceleration stop and the origin determination will be completed. To begin Y axis operation, turn input 3 ON and OFF. The origin is determined by turning the origin input (Y axis external input) is turned ON and OFF. When the origin has been determined, bit no. 13 (for the Y axis) and bit no. 14 (for the X axis) should light at the Output Unit's display.
3. Positioning (at fixed speed)	Turn input 4 ON and OFF to rotate the X-axis motor for one revolution in the CW direction at a speed of 1 Kpps. After positioning, bit no. 0 should light at the Output Unit's display. Turn input 5 ON and OFF to rotate the Y-axis motor for one revolution in the CW direction at a speed of 1 Kpps. After positioning, bit no. 1 should light at the Output Unit's display.
4. Positioning (with speed change)	Turn input 6 ON and OFF to rotate the X-axis motor for three revolutions in the CCW direction. This time the speed should change with each revolution from 3 Kpps to 2 Kpps to 1 Kpps. At the Output Unit's display, a different bit no. should light with each revolution (first bit no. 2, then 4, then 6). After positioning, bit no. 6 should be lit. Turn input 7 ON and OFF to rotate the X-axis motor for three revolutions in the CCW direction. As with the X axis, the speed should change with each revolution from 3 Kpps to 2 Kpps to 1 Kpps. At the Output Unit's display, a different bit no. should light with each revolution (first bit no. 3, then 5, then 7). After positioning, bit no. 7 should be lit.
5. Both axes returning to the origin simultaneously	Turn input 8 ON and OFF to operate both axes simultaneously. Both the X axis and the Y axis should rotate two times in the CW direction, at a speed of 1 Kpps, and return to the origin. At the Output Unit's display, bit nos. 13 and 14 should turn ON again to indicate the origin.

After all of the items outlined above have been checked, the trial operation will be complete. To repeat the procedure, you can either a) start again from item 3 or b) turn the power supply off and then on again and then start again from the beginning (i.e., from item 1).

Notes 1. When the PC is placed in MONITOR mode or RUN mode, if bit nos. 9 and 15 light at the Output Unit's display it indicates a system error. If that should occur, turn off the power supply and recheck the wiring.

2. While turning ON inputs 1 through 8, if bit nos. 8 and 15 light at the Output Unit's display it indicates a command error. If that should occur, place the PC in PROGRAM mode and check for mistakes in the program.
3. This trial operation format can also be used to check origin search patterns, external input functions, and other simple functions.

SECTION 3
Data Configuration

Before executing positioning actions, you must enter the necessary data into the EEPROM of the Position Control Unit. The C500-NC222-E Position Control Unit has a large data capacity. The EEPROM can store data for 300 positioning actions, 100 speeds, 21 parameters, 10 dwell times, and 10 acceleration and deceleration times per axis. You can set data most conveniently with the Teaching Box, but it is also possible to send data from the PC to the Position Control Unit.

Data is automatically transferred from EEPROM to RAM when the Position Control Unit is powered up. The commands transferred from the DM area of the PC (see *Section 6 Commands* for details) contain settings which access this data.

3-1 Overview

The Position Control Unit (PCU) outputs control voltage pulses to motor drivers. The basic control unit, therefore, is the pulse; control voltages differ by the number of pulses they contain.

Pulse Rate

Pulses are signals sent to motor drivers to command precise motor motion. In order to facilitate programming, the Teaching Box accepts input in units of pulses, millimeters (mm), or inches. The type of unit is set with the Teaching Box or PC and entered at parameter address 400 for the X axis and 800 for the Y axis. The magnitude of the pulse rate is entered at address 401 for the X axis and 801 for the Y axis.

The pulse rate is equivalent to dividing the movement, x, of an object attached to a motor by the number of pulses, n, required for this movement. The pulse rate thus equals x/n. In actual operation, the data input in normal units of distance is translated by the Teaching Box so the data is stored directly as pulses.

Setting Data

The most convenient way to set data is with the Teaching Box. Specific memory areas in the Position Control Unit are designated for certain types of data. The data provides the precise information necessary to drive a stepping motor or servomotor through a number of specific motions. There are five types of data: parameters, speeds, dwell times, acceleration and deceleration times, and positioning actions. When setting data for the first time, you must set parameters first, followed by speeds, dwell times, acceleration and deceleration times, and then positioning actions.

3-2 Data Allocations

Commands, parameters, speeds, positioning actions, dwell times, and acceleration and deceleration times are stored at the following addresses. Posi-

tioning actions include the position, speed, and other attributes. Parameters categorically establish limits and directions for positioning actions.

Data	PCU Address	No. of PC Words	Description	Permitted Settings
Positioning actions	100 to 399	5	For the X axis	+99,999,999 pulses (for desired position)
Parameters	400	2	Unit	0 to 2
	401	3	Pulse rate	(1 to 10,000) x10^{-4} (unit/pulse)
	402	2	Rotation direction	0 or 1
	403	2	Encoder type	0 or 1 and 1, 2, 4
	404	2	Gain	(1 to 999) x 10 μV/pulse
	405	2	In-position zone	1 to 999 pulses
	406	2	Backlash compensation	0 to 9,999 pulses
	407	3	Stroke limit (+)	0 to 99,999,999 pulses
	408	3	Stroke limit (–)	0 to 99,999,999 pulses
	409	3	Zone setting	0 to 9,999 pulses
	410	3	Home shift	+999,999 pulses
	411	3	Maximum speed	1 to 300,000 pps
	412	3	Teaching Box speed	1 to 300,000 pps
	413	2	Origin search direction	0 or 1
	414	3	Origin compensation	+999,999 pulses
	415	3	High origin search speed	1 to 300,000 pps
	416	2	Origin search accel./decel.	0 to 9
	417	3	Low origin search speed	1 to 10,000 pps
	418	3	External interrupt	1 to 10,000 pulses
	419	3	Wiring check	Check time: 0 to 990 ms Check pulses: 0 to 999
	420	3	External output control	Counter: 10 to 32,768 p
Dwell times	450 to 459	2	For the X axis	0 to 9,990 ms (in 10-ms increments)
Acceleration/ Deceleration	460 to 469	3	For the X axis	10 to 4,990 ms (in 10-ms increments)
Synchronous positioning	470 to 479	5	For the X axis	0 to ±99,999,999 pulses
Zone data	480 to 489	6	For the X axis	0 to ±99,999,999 pulses
Positioning	500 to 799	5	For the Y axis	+99,999,999 pulses (for desired position)
Parameters	800 to 818	2 or 3	For the Y axis; analogous to 400 to 418 for X axis	-
Dwell times	850 to 859	2	For the Y axis	0 to 9,990 ms (in 10-ms increments)
Acceleration/ Deceleration	860 to 869	3	For the Y axis	10 to 4,990 ms (in 10-ms increments)
Synchronous positioning	870 to 879	5	For the Y axis	0 to ±99,999,999 pulses
Zone data	880 to 889	6	For the Y axis	0 to ±99,999,999 pulses
Speeds	900 to 999	3	Speeds for both axes	1 to 300,000 pps (in 1-pps increments)

3-3 Setting Parameters

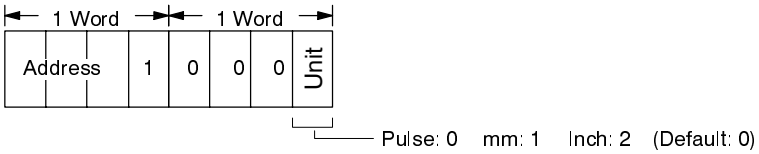
When writing data into the Position Control Unit for the first time, you must start with parameters. The word *parameters*, as used here, has a specific meaning and refers to certain data settings (described below) which delineate particular aspects of operation. Each parameter is allocated either two or three 16-bit words in the EEPROM. The first of these words is always used to designate the address. The remaining one or two words are used to write data specific to that particular parameter. Two sets of data (one for each axis) must be written for each parameter. X-axis parameter addresses are numbered from 400 through 420, and Y-axis parameter addresses are numbered from 800 through 820.

In the following explanations, the addresses for both axes are listed for each parameter. The table above provides a comprehensive listing of addresses. Default settings refer to the initial data loaded for the trial operation. See *3-10 Initial Data* for a comprehensive listing of initial data settings.

Caution The following data is for setup within the PC for transfers. If the Teaching Box (C500-TU002-E) is to be used, see the *Section 10 Teaching Box Operations*. The data within the parentheses contains the PCU address for the data being described.

Unit
(X axis: 400, Y axis: 800)

Designates the unit to be used with the Teaching Box. (Internal processing in the PC is executed in pulse units.)

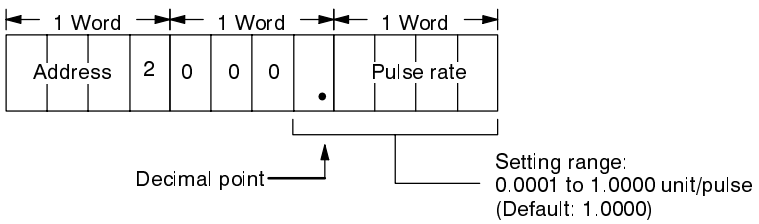


Pulse Rate
(X axis: 401, Y axis: 801)

Determines the amount of workpiece movement (with the selected unit) per pulse. For precision, the setting allows for 4 digits beyond the decimal point; however, the fourth digit may be rounded off when data is converted from millimeters.

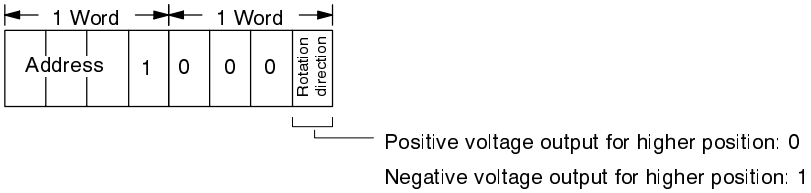
Previously set parameters do not change their value when the pulse rate changes. Always reconfirm affected parameters when you change the pulse rate; as a general rule, always set the pulse rate first. Parameters defined under a former pulse rate will be ignored.

Caution A pulse rate setting of 0 (if the parameter are all cleared, for instance) will actually assign the default pulse rate of 1.0000.



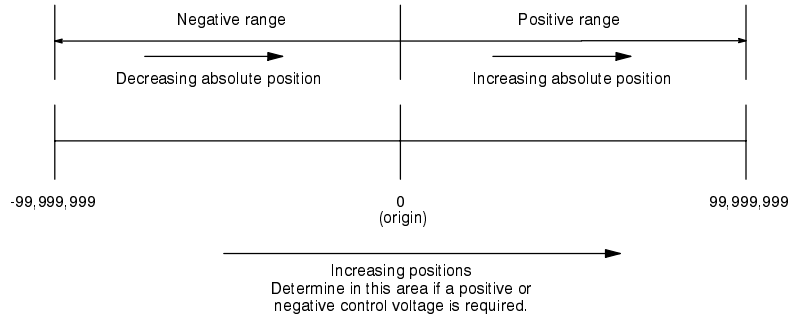
Rotation Direction (X axis: 402, Y axis: 802)

Relates to the position field sign bit. This parameter designates the control voltage as positive or negative. The position field sign establishes the position field as positive or negative.



The following table shows the relationship between the sign designated for the positioning action, the rotation direction designated above, the motor driver voltage, and the direction of motor rotation.

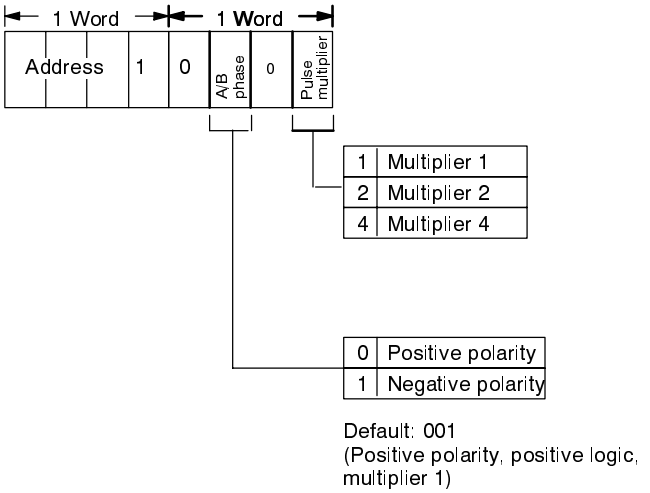
Position field sign	Rotation direction	Direction of motor operation	Driver control voltage	Resulting rotation
Positive (in direction of increasing absolute positions)	Positive voltage (0)	CW	Positive	CW
		CCW	Positive	CCW
	Negative voltage (1)	CW	Negative	CW
		CCW	Negative	CCW
Negative (in direction of decreasing absolute positions)	Positive voltage (0)	CW	Positive	CW
		CCW	Positive	CCW
	Negative voltage (1)	CW	Negative	CW
		CCW	Negative	CCW



Caution Erroneous settings for this parameter can cause the servomotor system to run out of control. Change these settings immediately after turning on power when the motor is not engaged to a load.

Encoder Type (X axis: 403, Y axis: 803)

This parameter determines encoder characteristics.

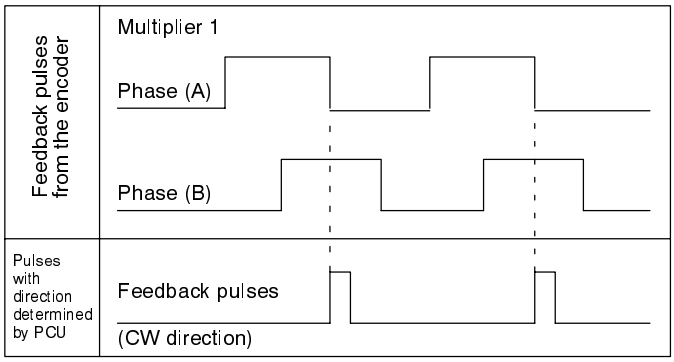


A/B Phase

In case of reversed wiring for the phase-difference signals from the encoder, switch between A phase and B phase to receive feedback pulses.

Pulse Multiplier

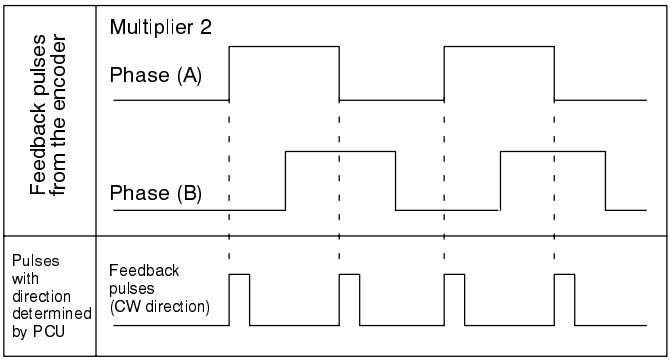
Select 1, 2, or 4 for the pulse multiplier depending on what type of phase-difference signals (Phases A and B) you require from the feedback pulses. Multiplier 1 sets the motor resolution equal to the encoder resolution. This means an encoder with a resolution of 1,000 pulses/revolution connected to a motor controls minimum motor rotation units in 1/1,000 revolution increments. With Multiplier 1 for example, for feedback pulses in the CW direction the figure below shows the generation of feedback pulses at the trailing edge of Phase A when Phase B is high.

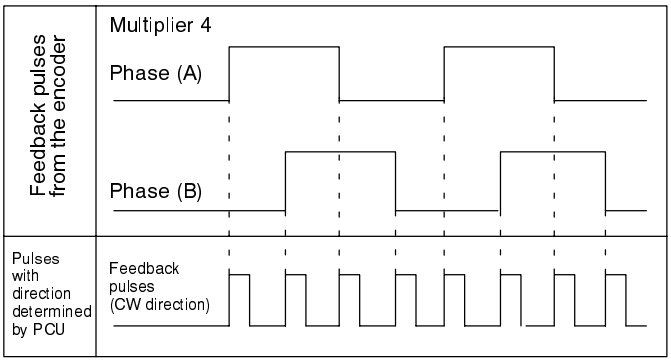


Caution The NC222-E's maximum response frequency of 300 kpps applies to Multiplier 1. If Multiplier 4 is used, then the maximum response frequency drops to 1/4 of 300 (i.e., to 75 kpps).

Multiplier 2 and Multiplier 4 provide double and quadruple resolutions of the encoder for the motor, respectively. If an encoder with a resolution of 1,000 pulses/revolution is connected to a motor, the encoder controls minimum mo-

tor rotation units in 1/2,000 revolution increments for Multiplier 2 and in 1/4,000 revolution increments for Multiplier 4. The respective precisions double and quadruple, but speeds drop respectively to 1/2 and 1/4.



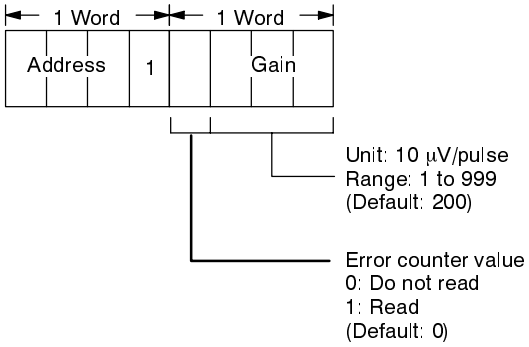


With Multiplier 2, feedback pulses are generated at the leading edge of Phase A when Phase B is low and at the trailing edge of Phase A when Phase B is high. With Multiplier 4, feedback pulses are generated in addition at the leading edge of Phase B when Phase A is high and at the trailing edge of Phase B when Phase A is low.

Caution Change the multiplier parameter immediately after power ON or origin search. Changing it at other times may cause the motor to move to its new "current position" at high speed based on the new multiplier.

Gain
(X axis: 404, Y axis: 804)

Designates the voltage output per pulse. Also sets whether the contents of the error counter are to be read in the status area.

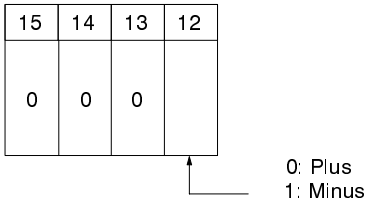


If the error counter value is set to be read, the value will be output in eight digits BCD to words 17 through 20 (in the data read area) in the status area. (If only one axis is used, then the value will only be read to words 17 and 18.) The following chart shows the allocation in words 17 through 20 when both axes are used. Note that the leading word of the data read area changes according to how many axes the value is read for.

- Leading word when read for both axes: 21
- Leading word when read for one axis: 19
- Leading word when not read for either axis: 17

Wd	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
17	X- axis sign				X axis 10^6				X axis 10^5				X axis 10^4				X axis
18	X axis 10^3				X axis 10^2				X axis 10^1				X axis 10^0				
19	Y- axis sign				Y axis 10^6				Y axis 10^5				Y axis 10^4				Y axis
20	Y axis 10^3				Y axis 10^2				Y axis 10^1				Y axis 10^0				
21	Leading word of data read area																

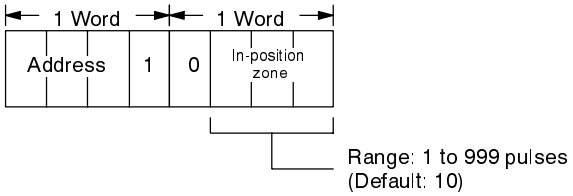
Turn bit no. 12 ON or OFF to set the sign to minus or plus respectively.



Note If the gain is too low, it will reduce the responsiveness of the motor and the motor will not be able to achieve the desired acceleration. If the gain is too high, vibration or other irregularities will result.

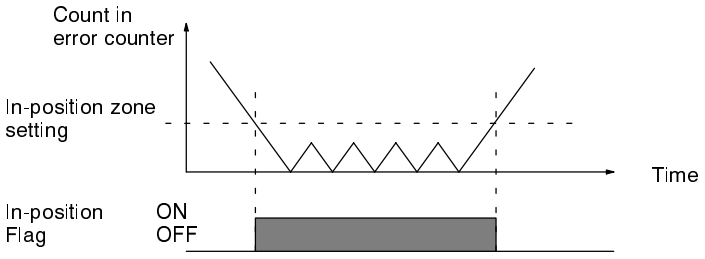
In-Position Zone (X axis: 405, Y axis: 805)

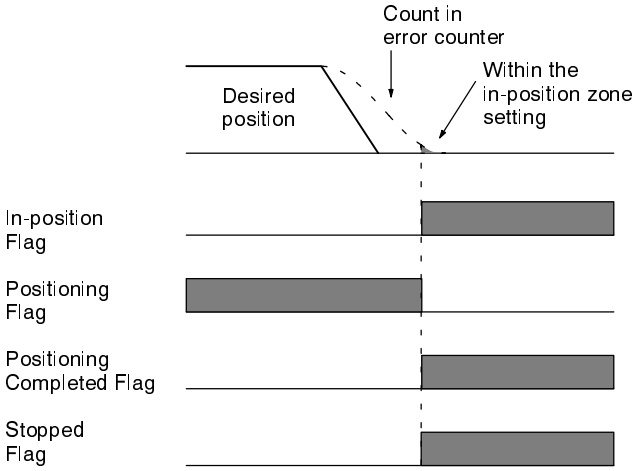
Checks the error counter count of the servo system. When the count in the error counter reaches the value set here, the corresponding In Position flag turns ON and relays this condition externally. The flag remains ON as long as the count remains below the in-position zone. This flag will not turn ON while pulses are being input into the error counter regardless of the value of the counter.



The following diagram and timing chart show the relationships between the error counter count, the in-position zone, the In-position Flag, and other positioning flags. As shown below, positioning is considered complete when the

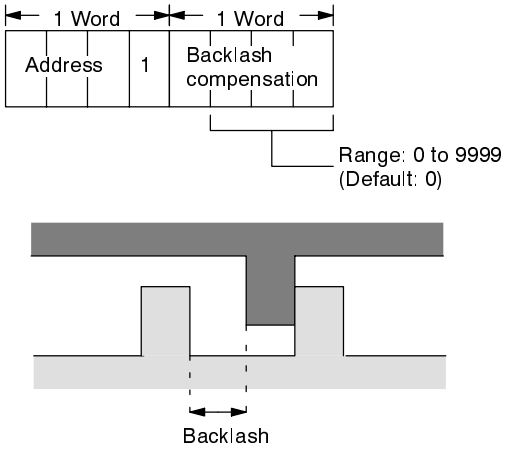
count in the error counter is less than or equal to the value set for the in-position zone. At that point the Positioning Completed Flag turns ON.





Backlash Compensation (X axis: 406, Y axis: 806)

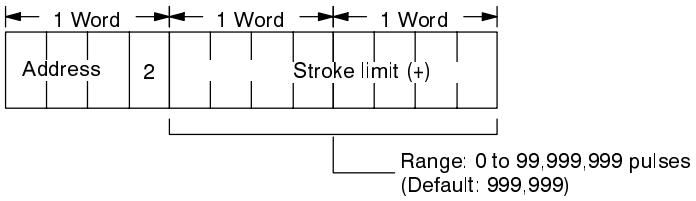
Backlash refers to the amount of mechanical play present in gears. The meshing tolerance in the situation shown below would become a problem if the next positioning action were in the reverse direction. Generally, compensation is necessary whenever the direction changes.



Stroke Limit (+) (X axis: 407, Y axis: 807)

Designates the limit in pulses for positive (+ area) positioning actions. A positioning action is positive or negative depending on the setting of the sign bit in the Attribute 1 field. To prevent overrunning of the motor, an error occurs

when execution of positioning actions beyond the set value is attempted. This parameter occupies two words for a maximum 8-digit entry.

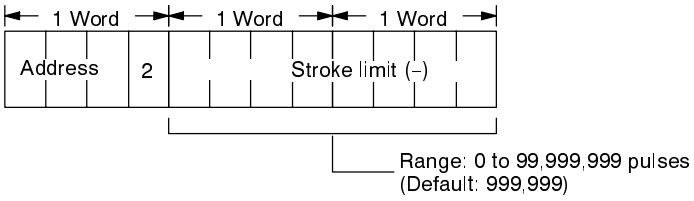


Caution With both stroke limits at 0 (default settings), the stroke limits are not effective; i.e., motor overrun cannot be prevented with such settings. Furthermore, the stroke limit remains unchecked for JOG and pulse operations and for points passed during circular arc interpolation.

Stroke Limit (–) (X axis: 408, Y axis: 808)

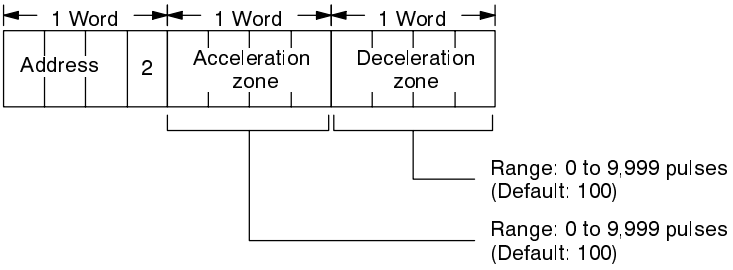
Designates the limit in pulses for negative (– area) positioning actions. A positioning action is positive or negative depending on the setting of the sign bit in the Attribute 1 field. To prevent overrunning of the motor, an error occurs when execution of positioning actions beyond the set value is attempted. This parameter occupies 2 words for a maximum 8-digit entry.

Caution With both stroke limits at 0 (default settings), the stroke limits are not effective; therefore, motor overrun cannot be prevented with such settings. Furthermore, the stroke limit remains unchecked for JOG and pulse operations and for points passed during circular arc interpolation.



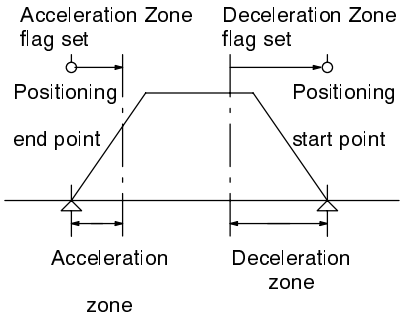
Zone Setting (X axis: 409, Y axis: 809)

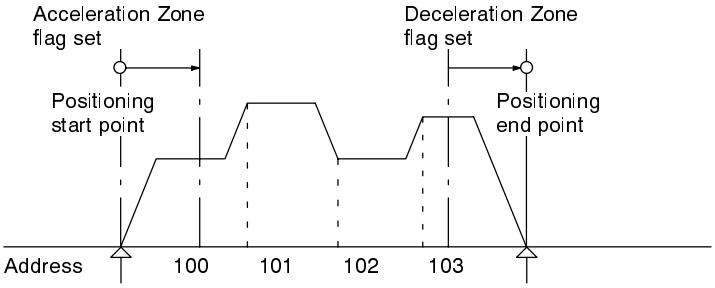
Sets the acceleration zone and deceleration zone pulse counts. You can use these zones to check the amount of movement during acceleration and deceleration.



Set the acceleration zone in order to check the amount of movement from the positioning starting point. The Acceleration Zone flag remains ON while

the positioning action executes the number of pulses set for the acceleration zone. Similarly the Deceleration Zone flag will stay ON while the positioning action executes the number of pulses in the deceleration zone. The Acceleration Zone and Deceleration Zone flags are OFF before and after the start and end positioning points. They are ON only during part of the positioning action. The zone setting parameter is invalid during circular arc interpolation. This parameter is effective for single-axis positioning and for straight-line interpolation only.

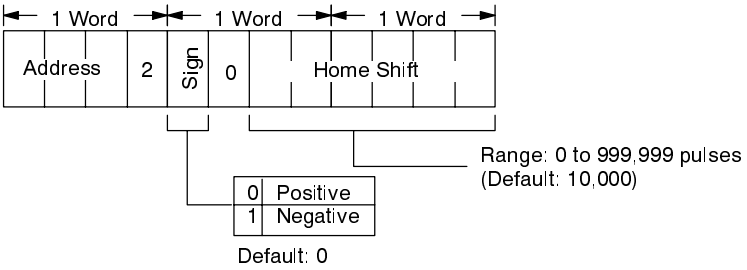




In a series of continuous positioning actions (completion codes = 1) the acceleration zone is effective for the first positioning action only; the deceleration zone, for the last positioning action only.

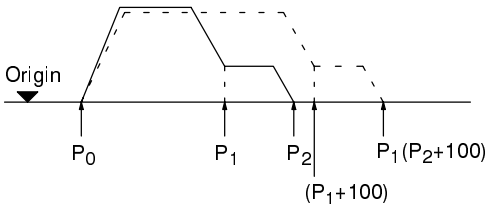
Home Shift (X axis: 410, Y axis: 810)

You can use home shift to add a designated number of pulses to any positioning action without affecting the origin. If HSFT (the home shift command) has been executed to enable home shift, the specified positioning action will shift positions by the amount of pulses set in this parameter. Refer to *Section 6 Commands* for details on HSFT.



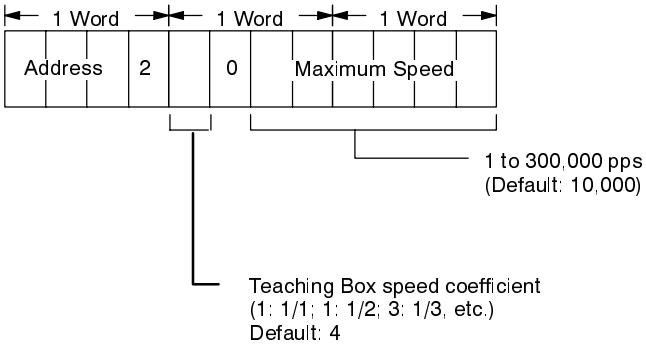
In the figure below for example, the parameter is set to shift positioning by 100 pulses. If the HSFT is enabled for positioning from P0 to P1 and to P2 (solid line), then positioning goes to (P1 + 100) and to (P2 + 100) (broken

line). Home shift is not effective for absolute positions of 0, i.e., moves to the origin.



Maximum Speed (X axis: 411, Y axis: 811)

Defines the maximum speed used. You can set this parameter to prevent overrunning of the motor. The speed set here will be the maximum at which the motor will run, even if a command is executed with a dangerously high speed set by mistake. The acceleration and deceleration times also make use of this parameter.

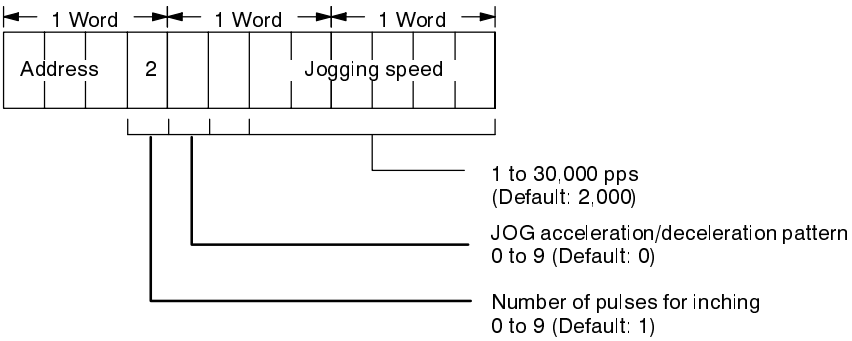


When positioning is executed from the Teaching Box, the Teaching Box speed coefficient allows positioning to be carried out at a specified fraction of the speed that has been set.

Caution If the Teaching Box speed coefficient is set to “0,” then it will be regarded as a 1/1 setting, and positioning will be carried out at the speed that has been set.

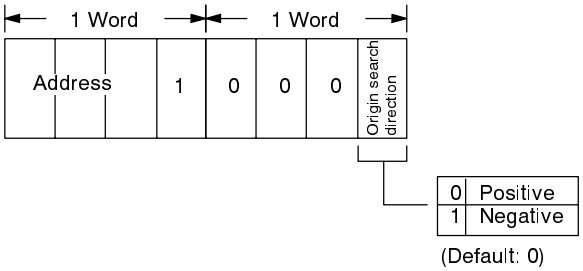
Teaching Box Speed (X axis: 412, Y axis: 812)

Defines the speed and the acceleration/deceleration pattern for when jogging is executed from the Teaching Box, and sets the number of pulses for when inching is executed from the Teaching Box.



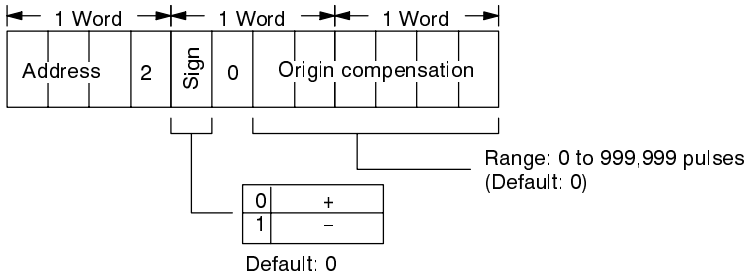
Origin Search Direction (X axis: 413, Y axis: 813)

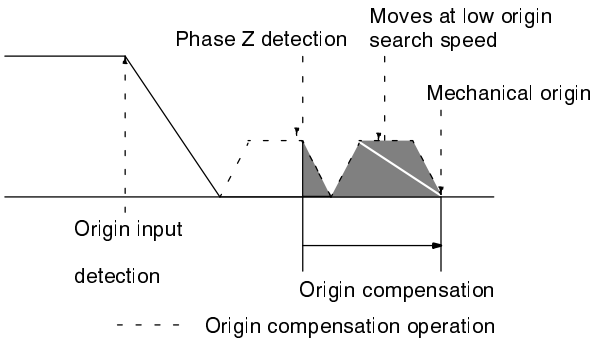
Determines the direction approach for an origin search. The positive direction means movement toward the positive (+) position field area. The negative direction means movement toward the negative (–) position field area. The position field sign is set in the Attribute 1 field of positioning actions. For more detail on establishing the origin, refer to *Section 7 Establishing the Origin*.



Origin Compensation (X axis: 414, Y axis: 814)

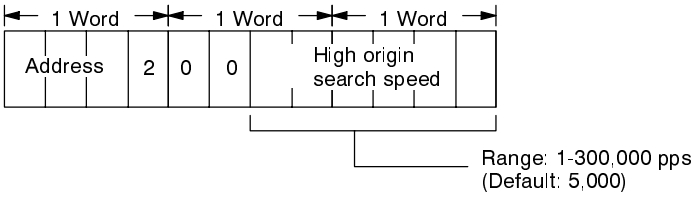
Corrects the mechanical origin detected via the phase Z origin search. There may be times when the mechanical origin which is detected may not be sufficiently precise. In such cases, you can use this parameter to add a designated number of pulses to the mechanical origin. The new point then becomes the origin. For more detail on establishing the origin, refer to *Section 7 Establishing the Origin*.

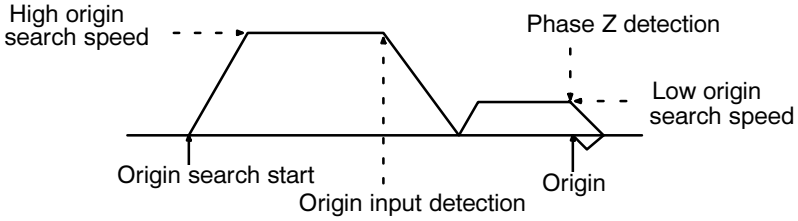




High Origin Search Speed (X axis: 415, Y axis: 815)

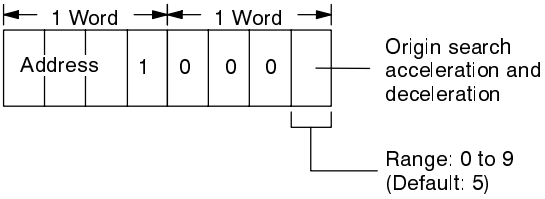
This speed is used in origin search until an origin input is detected. An origin search starts with this high speed and changes to the low speed with an origin input detection.



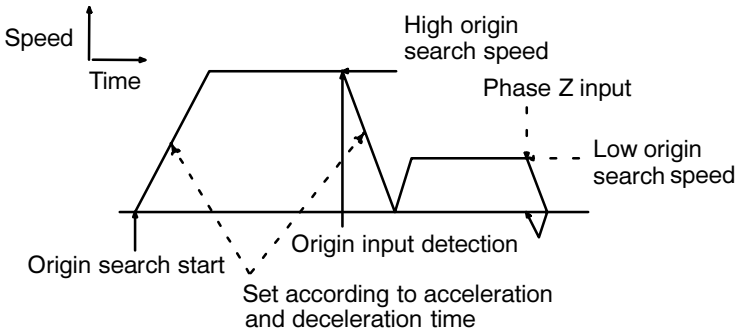


Origin Search Acceleration and Deceleration (X axis: 416, Y axis 816)

Sets the acceleration and deceleration times for origin search.



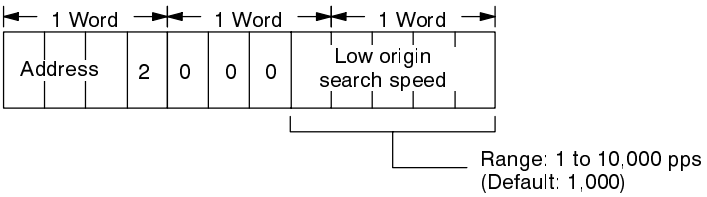
The times available are stored in addresses 460-469 for the X axis and 860-869 for the Y axis. Select the times by storing the last address digit here (e.g., 8 for time set at address 468). For setting acceleration and deceleration times, refer to *3-6 Setting Acceleration and Deceleration Times*.



Low Origin Search Speed (X axis: 417, Y axis: 817)

This speed is used in origin search after an origin input is detected. An origin search starts with the high speed and changes to this low speed from the origin input detection until the first phase Z detection. See the previous figure under *High Origin Search Speed*. When the origin search is executed from

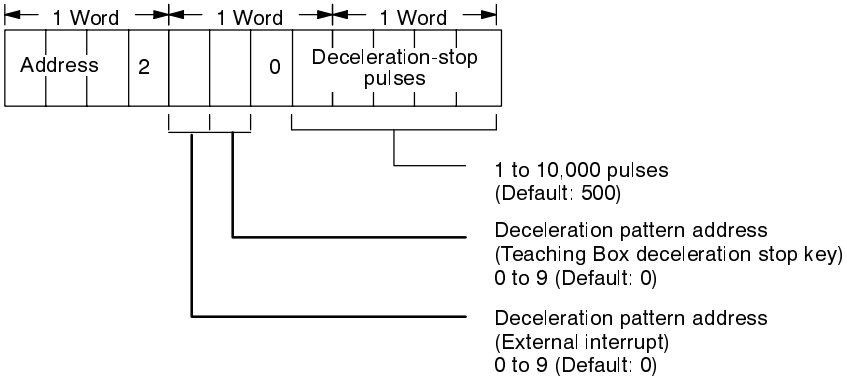
the Teaching Box, the distance from the origin input to the Z phase is displayed. Use this for adjusting the origin input and the Z phase.



Deceleration Stop (X axis: 418, Y axis: 818)

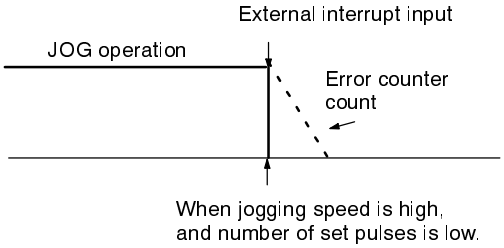
The Deceleration Stop setting can be used to control how fast the positioning system will stop when an external interrupt is received during execution of JOG. When the external interrupt is received, the system will proceed for only the number of pulses set here.

Two types of deceleration patterns can be set. The first applies to external interrupts received during positioning or origin search operations, and the second applies to interrupts resulting from the deceleration stop key on the Teaching Box being pressed.



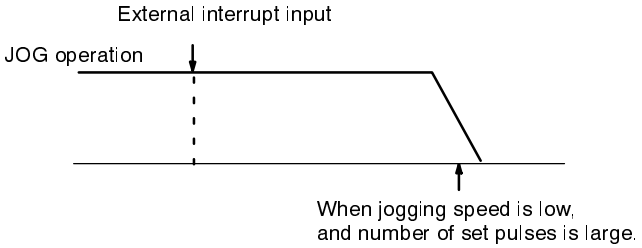
External Interrupt Received During Jogging

The count in the error counter may also affect the stopping speed. When the external interrupt input turns ON, the deceleration stop value is compared to the count in the error counter. If the count in the error counter is greater than the deceleration stop value (i.e., the set number of pulses), the deceleration stop value is not used and the system will stop after the positioning system has moved by the pulse count already in the error counter. This occurs when the jogging speed is high (creating a high count in the error counter) and the deceleration stop value is low.



If the count in the error counter is less than the deceleration stop value, then the count in the error counter is increased to equal the deceleration stop val-

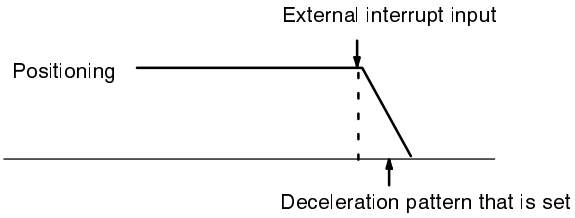
ue and the system will stop after the positioning system has moved by the number of pulses designated for the deceleration stop.



Therefore, if you want to stop as soon as possible for external interrupts, set the deceleration stop value low in comparison to the jogging speed. If you want to ensure that a specific distance is moved after receiving an external interrupt, set the deceleration stop value high in comparison to the jogging speed.

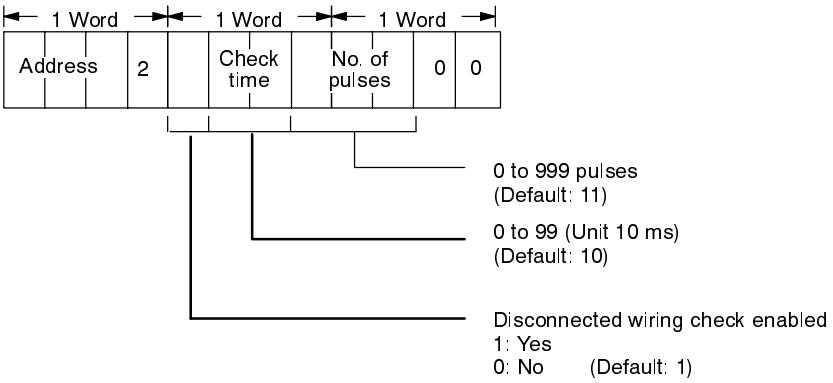
Interrupt Received During Positioning or Origin Search Operations

If a deceleration stop input is received during a positioning or origin search operation, then the system will stop according to the deceleration pattern that has been set. For example, the following illustration shows a case where an external deceleration stop input is received during positioning. (The operation would be similar if the input were received during an origin search.)



Wiring Check (X axis: 419, Y axis: 819)

Checks, at the time of powering up, for disconnections or faulty (i.e., reversed) wiring in the feedback system.

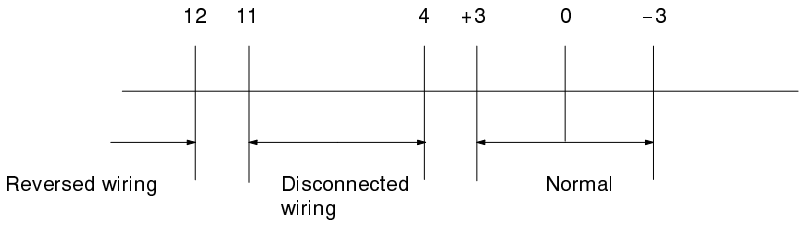


If the disconnected wiring check is not enabled, then the faulty wiring check will be executed and an error will result if the wiring is reversed. If the disconnected wiring check is enabled, then the disconnected wiring check will be executed and an error will result if the wiring is disconnected. In addition, the faulty wiring check will be executed but, instead of an error being generated in case of reversed wiring, the A and B phases will be switched.

The number of check pulses first becomes effective beyond the in-position. For example, suppose that the settings are made as follows:

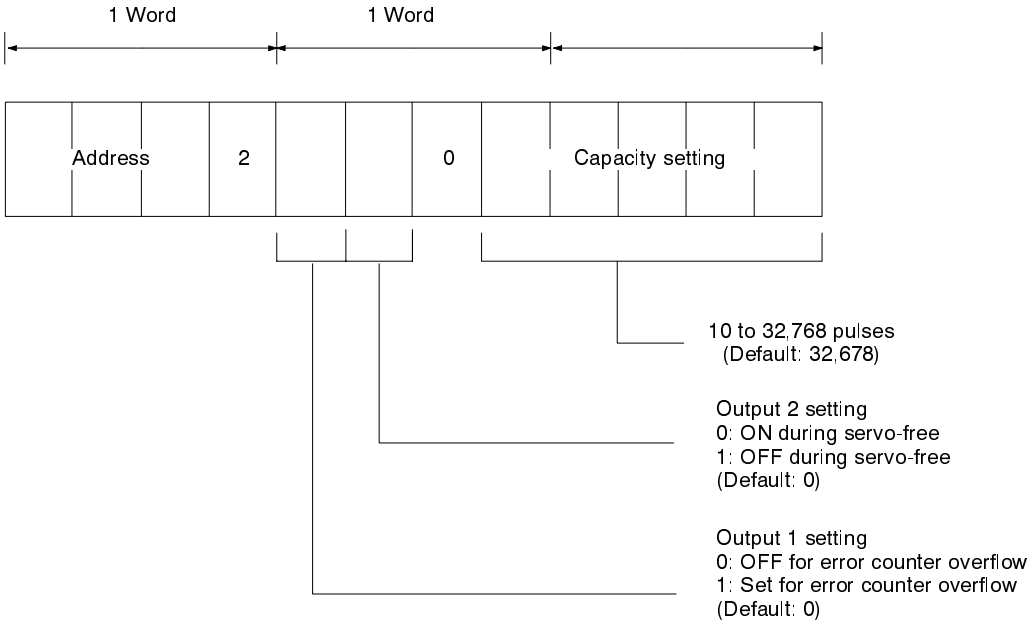
a) In-position: 3 pulses
b) No. of check pulses: 11 pulses
c) Check time: 100 ms

The 11 pulses will be set to the error counter. Then, after a check time of 100 ms, the judgement will be made according to the contents of the error counter, as shown below.



External Output Control (X axis: 420, Y axis: 820)

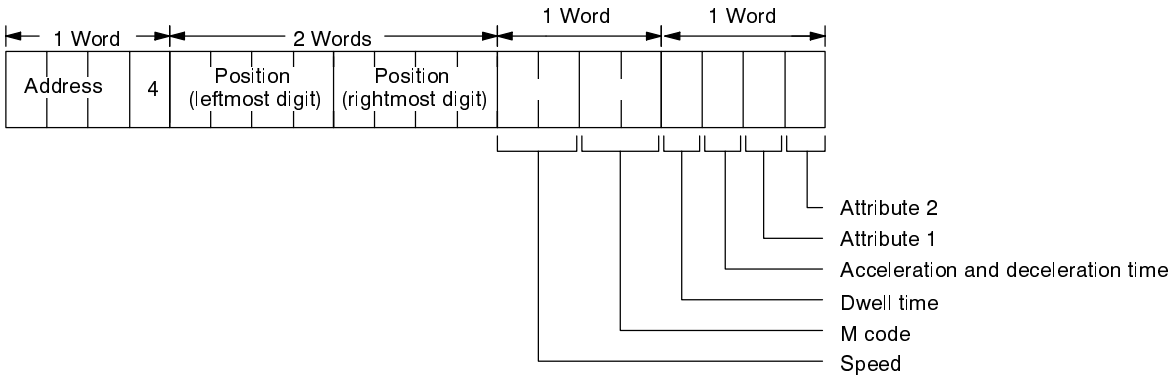
Sets error counter capacity and external output control. External output 1 (OUT1) is turned ON and OFF according to its ON/OFF setting when there is an error counter overflow. External output 2 (OUT2) is turned ON and OFF according to its ON/OFF setting when servo-free goes into effect.



3-4 Setting Positioning Actions

Write in the data for positioning actions last, after making all of the other settings. Parameter settings are described in the previous subsections; dwell time, acceleration and deceleration, and speed settings are described in the following subsections. You can store up to 300 positioning actions for each axis in the EEPROM.

As shown in the following figure, each positioning action requires five words and consists of eight fields: address, position, speed, M code, dwell time, acceleration and deceleration time, attribute 1, and attribute 2.



Address Field

The first of the five words for each positioning action is used to store its address, in three digits BCD. There are addresses from 100-399 for the X axis and 500-799 for the Y axis for up to 300 possible positioning actions for each axis.

Position Field

Positions for positioning actions are set using eight digits BCD and may be set for between –99,999,999 and +99,999,999 pulses. Out of the eight digits, the leftmost four digits are held in one word and the rightmost eight digits are held in another word. These words only hold the numeric value of the position; the sign of the position is held in the attribute 1 field. If the position field is zero, the M code and dwell time are still valid.

Speed Field

In this field you designate the speed for the move to the designated position. You can designate any of the 100 speeds (900-999) which you previously entered as speeds. For details, see *3-9 Setting Speeds*. This field occupies 1/2 of a word. The range 00-99 designates speed addresses 900-999. A setting of 12, for example, executes positioning at the speed registered at address 912.

M Code Field

The M code (machine code) field occupies the other half of the fourth word. You use this field to directly register an M code (00 to 99) for each positioning action. The M code is a user-defined number that is passed to the PC for use in ladder programming. You can use it, for example, to set various code numbers for various positions so that when the workpiece passes particular positions the PC will respond with appropriate actions. The M code is valid when the positioning action has been completed.

Dwell Time Field

In this field you designates a dwell time for the positioning action. You may designate any of the 10 dwell times previously entered (addresses 450-459 for the X axis and 850-859 for the Y axis). For details, see *3-5 Setting Dwell Times*. This field occupies 1/4 of a word. The range 0-9 designates dwell time addresses 450-459 for the X axis. For example, a setting of 5 for an X-axis positioning action executes positioning with the dwell time registered at address 455.

Acceleration and Deceleration Time Field

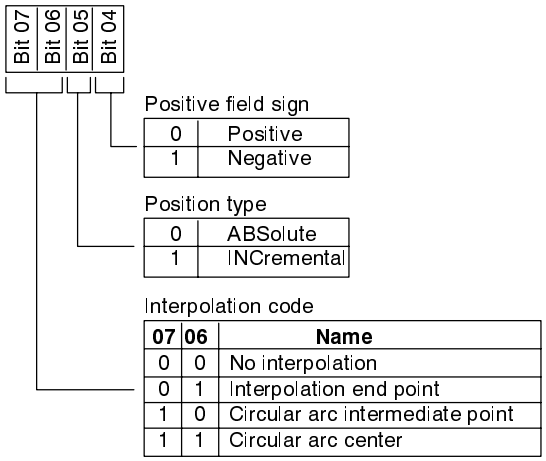
In this field you designate the acceleration and deceleration time to the desired position. You can designate any of the 10 times previously entered (addresses 460-469 for the X axis and 860-869 for the Y axis). For details, see

3-9 Setting Speeds. This field occupies 1/4 of a word. For example, a setting of 7 for an X-axis positioning action executes positioning at the acceleration and deceleration times registered at address 467. The acceleration/deceleration time is not used for circular arc interpolation; i.e., the designated speed is reached immediately.

Attribute 1 Field

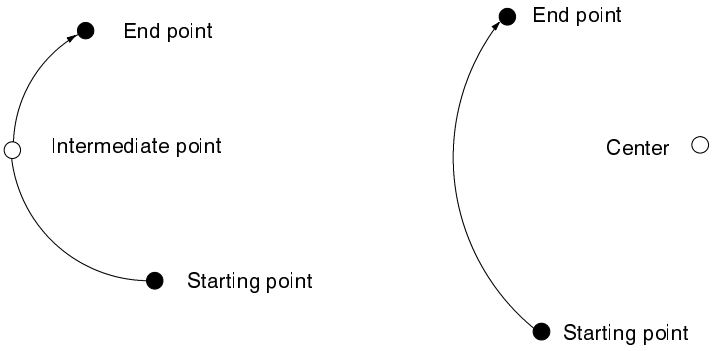
You use this field to designate the interpolation code, position type (INC/ABS), and position field sign (+/–).

Attribute 1 field



Interpolation Code (Bits 07 and 06)

The interpolation code bits determine whether a positioning action uses interpolating or not, and define which interpolating point the positioning action employs. “No interpolation” indicates that the positioning action will operate one axis independently, without interpolation. “Interpolation end point” indicates that the position is the final one in an interpolation operation. This is used for both straight-line and circular-arc interpolation. Together with the end point, the “circular arc intermediate point” determines the locus for the arc. Whereas the intermediate point specifies a transit point for drawing the arc, the “circular arc center” specifies what would be the center if the arc were extended into a full circle.

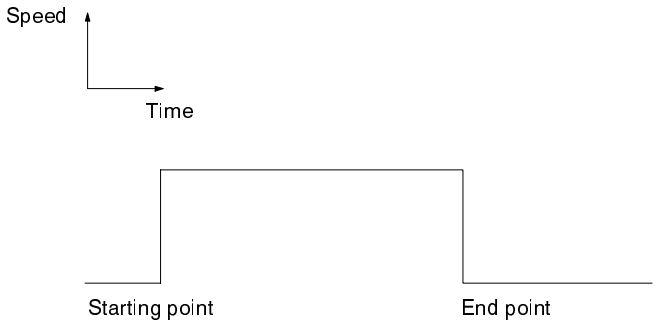


Interpolation data must be specified for the X axis. In order for an interpolating operation to be executed, a set of data which includes both axes is required. For the NC222-E, the correspondence between X-axis and Y-axis data is determined as follows:

(Corresponding Y axis address) = (X axis address) + 400

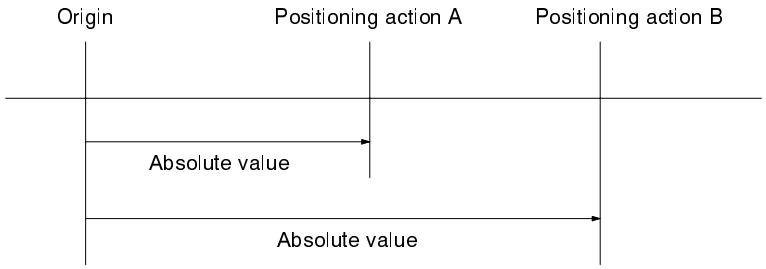
For example, if the interpolation attribute is set for X axis address 100, then the corresponding Y axis position data will automatically be set for address 500.

Positioning actions with circular arc interpolation do not accelerate and decelerate, but position at the target speed.

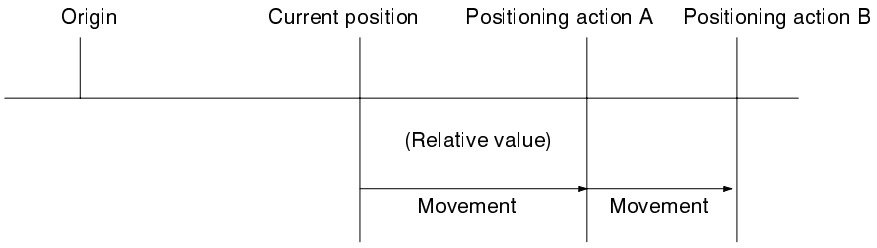


Position Type (INC/ABS, Bit 05)

The position type bit designates the positioning action as absolute (set to 0) or incremental (set to 1). An absolute position designates the position from the origin.

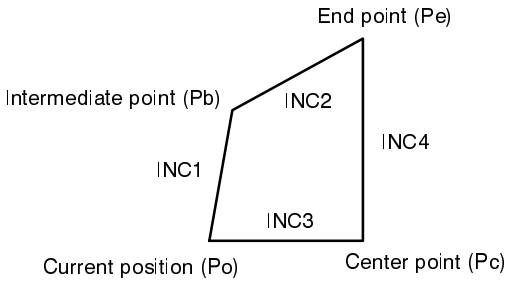


An incremental position designates a position relative to the current position. Incremental positions may be subject to an cumulative rounding error if the selected unit is millimeter or inch.



When setting circular arc interpolation data by the incremental method, specify the circular arc intermediate point and center point with incremental values from the current position. Then specify the end point with an incremental value from either the intermediate point or the center point.

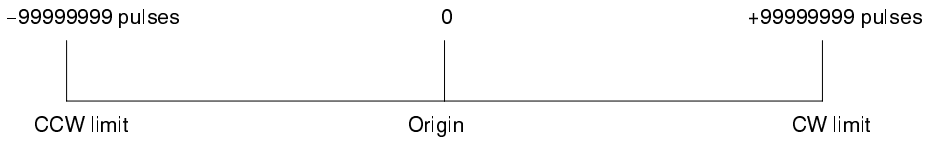
Center point (Pc) = Current position (Po) + INC3
Intermediate point (Pb) = Current position (Po) + IN1
End point (Pe) = Center point (Pc) + INC4 or
Intermediate point (Pb) + INC2



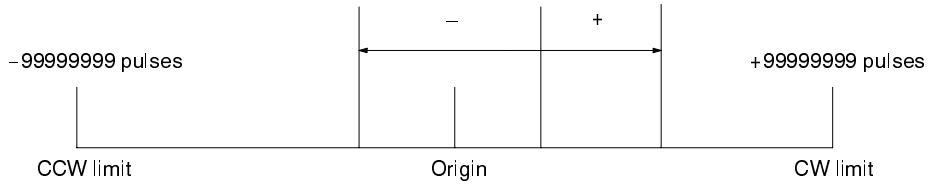
Position Field Sign (+/−, Bit 04)

Finally, the position field sign divides the position field range centered at the origin from −99,999,999 pulses to +99,999,999 pulses. With the NC222-E, when a positive voltage is output, the motor rotates in the clockwise (CW) direction. When a negative voltage is output, the motor rotates in the counter-clockwise (CCW) direction.

In the absolute method, the origin is taken as the center. The CW direction is positive and the CCW direction is negative.

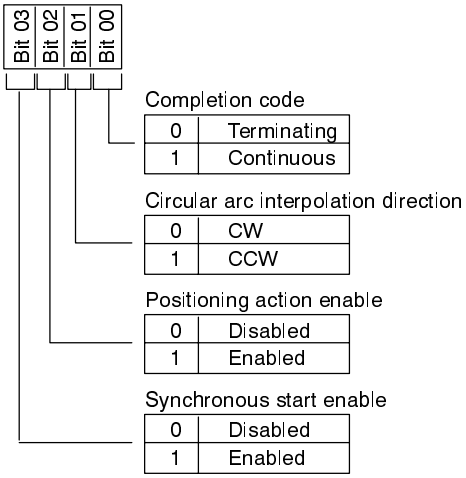


In the incremental method, movement in the CW direction is positive, and movement in the CCW direction is negative.



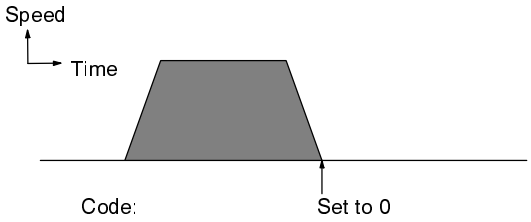
Attribute 2 Field

The attribute 2 field designates the completion code, circular arc interpolation direction, positioning action enable/disable status, and synchronous start enable/disable status.

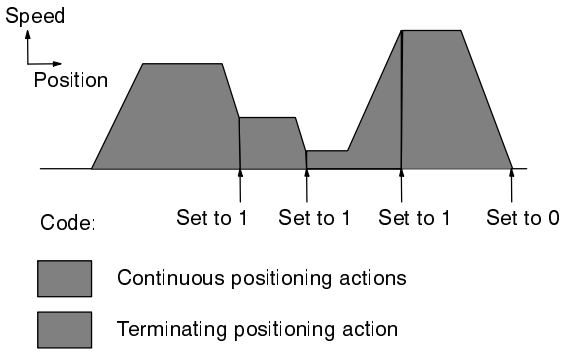


Completion Codes

The completion code determines whether a certain positioning action is part of a series or whether it terminates a series. Setting bit 00 to 0 designates a positioning action as terminating as shown below. In this case, the positioning action terminates at a speed of 0.



Setting bit 00 to 1 designates the positioning action as continuous, as shown below. This illustration shows three continuous positioning actions, followed by a terminating positioning action. The speeds for the continuous actions do not drop to 0 upon completion of positioning.

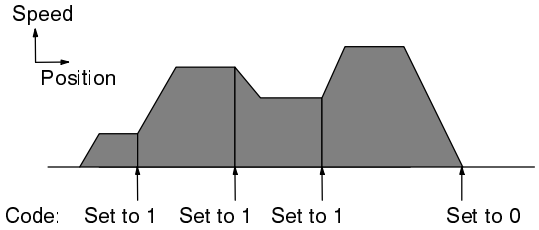


For NC221-E and NC222-E Position Control Units, a completion code set to 1 differs slightly from the meaning in other Position Control Units. Here, positioning actions include the change in speed (acceleration or deceleration) for the next positioning action, instead of the change in speed for the current

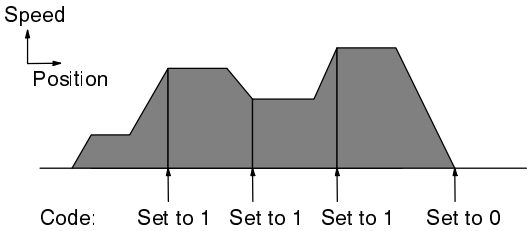
positioning action. The first positioning action in a series also includes the acceleration time needed to reach the first speed.

When positioning actions are set as continuous by means of completion code 1, there will be a brief (approximately 3 to 6 ms) drop in the control voltage at each junction between positioning actions.

Speed Changes in Previous Positioning Action



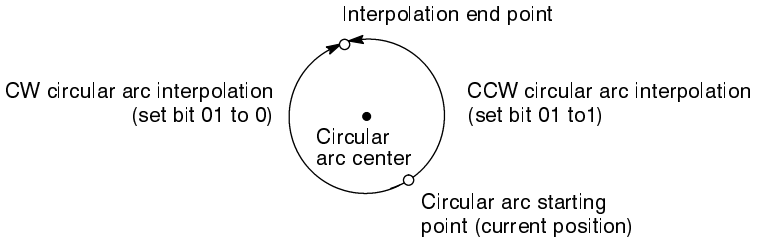
Speed Changes in Current Positioning Action



Always set the completion codes for the last positioning actions (addresses 399 and 799) to 0.

Circular Arc Interpolation Direction

This bit establishes the direction of interpolation when the circular arc center and circular arc end point are defined.



Positioning Action Enable

The positioning action enable bit (bit 02) determines whether a positioning action is enabled or disabled. When positioning actions are all enabled, they will be executed in sequence. When a positioning action is disabled, it will be skipped (i.e., treated as NOP), although its completion code will still be effective (see below).

Disabled Actions and Completion Codes

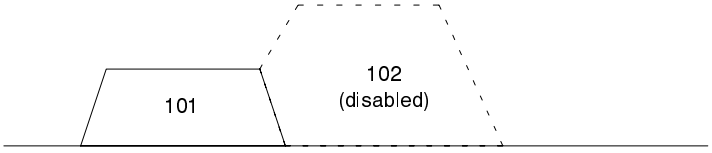
Execution of disabled positioning actions depends on their completion codes. If the completion code of the disabled action is 0 (terminating), then no positioning will take place and the address counter will be incremented. If the completion code of the disabled action is 1 (continuous), the next positioning action will be executed according to its parameters. Naturally, if the next positioning action is also disabled, operation will then be based on the completion code for it. In simple terms, the completion codes of all positioning actions

are effective, even if the positioning action is disabled and no positioning is carried out for it.

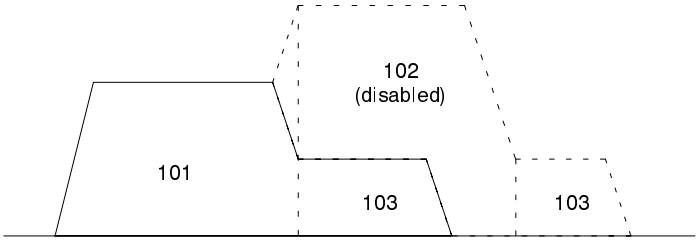
The following examples illustrates the relationship between disabled positioning actions and completion codes. The pertinent parameters for the positioning actions is as follows:

Address	Parameters
101	Incremental position, completion code of 1, enabled
102	Incremental position, completion code of 0, disabled
103	Incremental position, completion code of 0, enabled

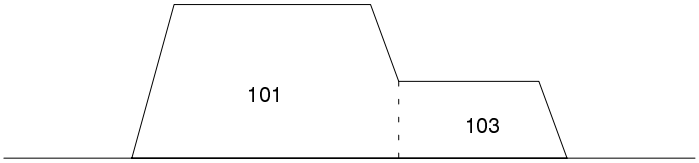
If execution was started from address 101, the following action would result and the address counter would end up being set to 103.



If the positioning action at address 102 had a completion code of 1, the following action would result.



If the positioning action at address 103 was to an absolute position rather than an incremental one, the following action would result.

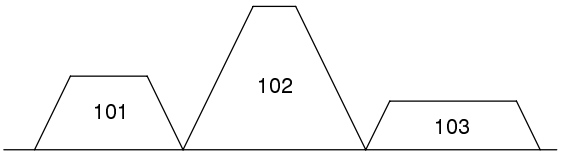


As you can see, enabling/disabling various positioning actions can be used to achieve a wide range of positioning without requiring changes in the ladder program.

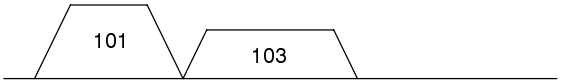
The following example also shows how to control positioning without changing the ladder diagram by enabling/disabling positioning actions.

If we set up a ladder diagram program to execute three positioning actions at addresses 101, 102, and 103, the following positioning movements could be achieved by enabling/disabling different actions. In all cases, the next address to be executed would be 104. It is assumed that all actions have a completion code of 0.

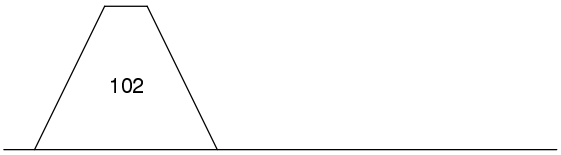
If all three positioning actions were enabled, the following movements would take place.



If only the positioning actions at 101 and 103 were enabled, the following movements would take place.



If only the positioning action at 102 was enabled, the following movements would take place.



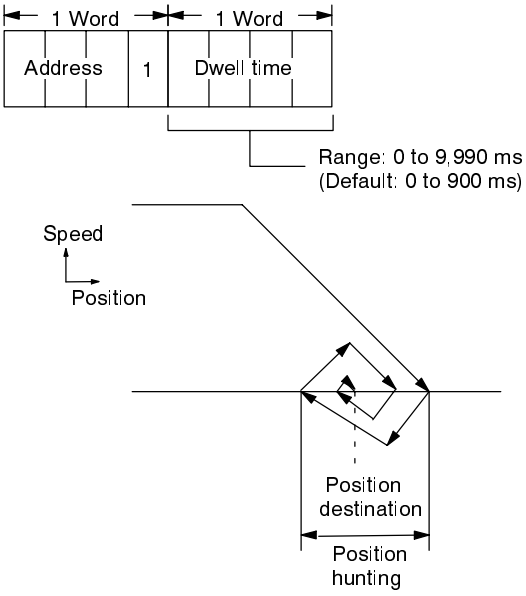
Synchronous Start Enable The synchronous start enable/disable bit (bit 03) determines whether synchronous starting of the X axis and the Y axis will be enabled.

Note When deceleration is executed for only one axis during continuous straight-line interpolation, the other axis may also decelerate momentarily due to the relationship between the axes.

3-5 Setting Dwell Times

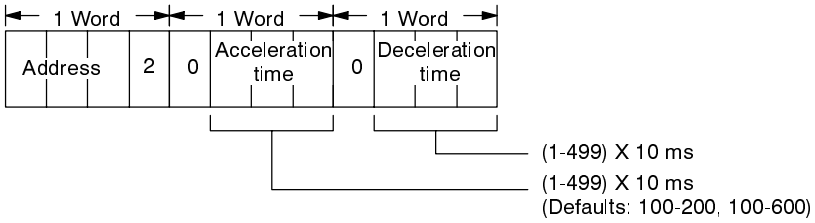
In servomotor positioning, hunting can occur near the positioning destination because of gain. Sudden deceleration and high-speed movement over a short distance aggravate the tendency to hunt. To minimize the effects of hunting, positioning completed signals can be held for a certain duration or dwell time before they are set. You can enter one of 10 dwell times at addresses 450-459 for the X axis and 850-859 for the Y axis. Positioning actions call these times as abbreviated addresses. The dwell time allows positioning to complete before another positioning action begins. For a comprehensive listing of default values see *3-10 Initial Data*.

Note The dwell time will be automatically cancelled if positioning is executed to the current position.



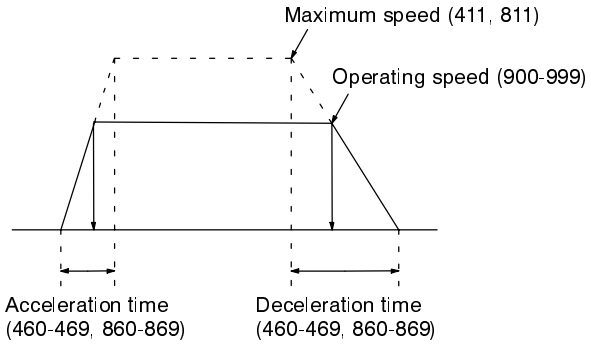
3-6 Setting Acceleration and Deceleration Times

The acceleration and deceleration times are stored in addresses 460-469 for the X axis and 869-869 for the Y axis. The values in the addresses set the time it takes to accelerate to maximum speed (addresses 411, 811) from a stop and decelerate from maximum speed to a stop. Positioning actions also call these times as abbreviated addresses. You can set one of 10 acceleration and 10 deceleration times (each address stores acceleration and deceleration times in separate words). Select the times appropriately for your needs by computing proportionally for acceleration to the operating speed needed. For a comprehensive list of default values see *3-10 Initial Data*.



Acceleration time to operating speed = Acceleration time x (Target speed)/(Maximum speed)

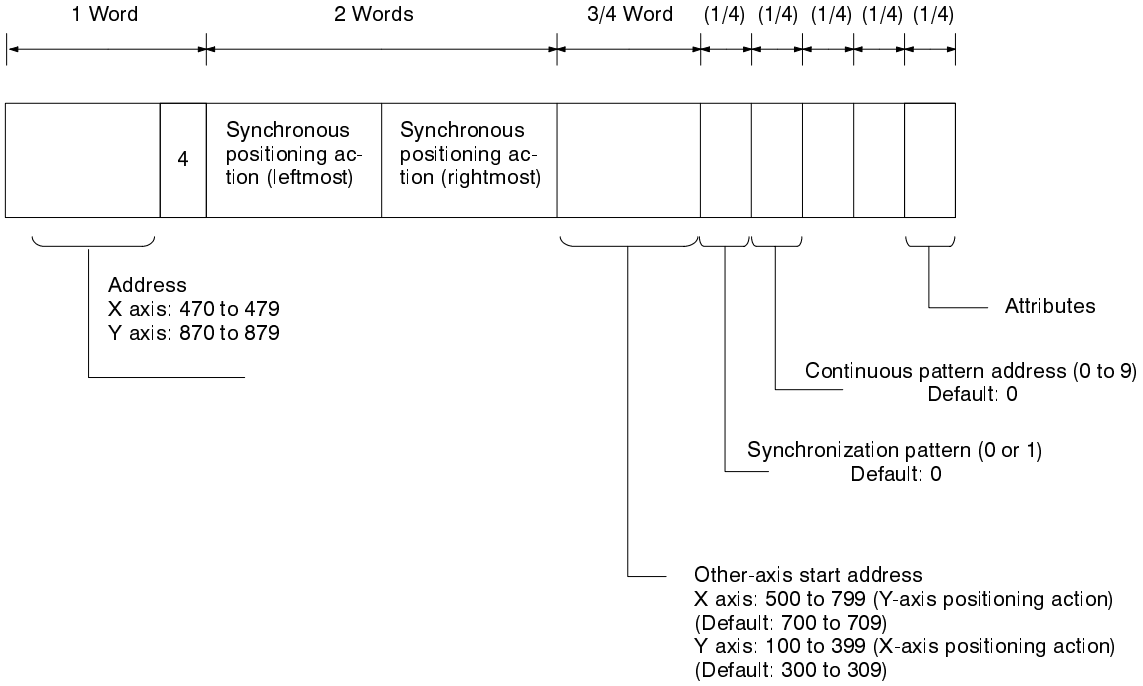
Deceleration time to operating speed = Deceleration time x (Target speed)/(Maximum speed)



Acceleration and deceleration times are effective for the following operations only: Positioning actions; deceleration-stop commands (XSTP, YSTP, ISTP) from the PC or Teaching Box (deceleration only); JOG commands (XJOG, YJOG, IJOG) (acceleration only); origin search commands (XORG, YORG, IORG); pauses (XHLD, YHLD, IHLD) (deceleration only); pause releases (XREL, YREL, IREL) (acceleration only); and external interrupt inputs.

3-7 Setting Synchronous Positioning Actions

Synchronous positioning actions can be set in five words, including one for the address, one for each of the positioning actions and two for the various settings required for execution. They can be set in addresses 470 through 479 for the X axis, and 870 through 879 for the Y axis, in four digits BCD.



Synchronous Positioning Actions

The synchronous position data is defined within a range of ±99,999,999 pulses. The default is 00,000,000. The data occupies two words, of four digits each. The sign depends on the sign bit in the attribute setting.

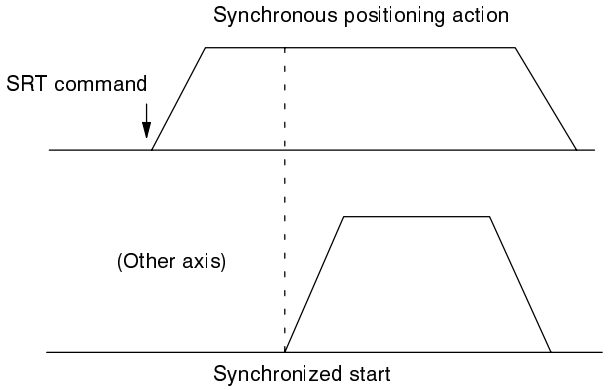
Other-axis Start Address

The other-axis start address indirectly specifies the positioning action along the other axis. For example, if address 512 is set for the other axis, then the position action registered at address 512 will start in synchronization with the positioning action being executed.

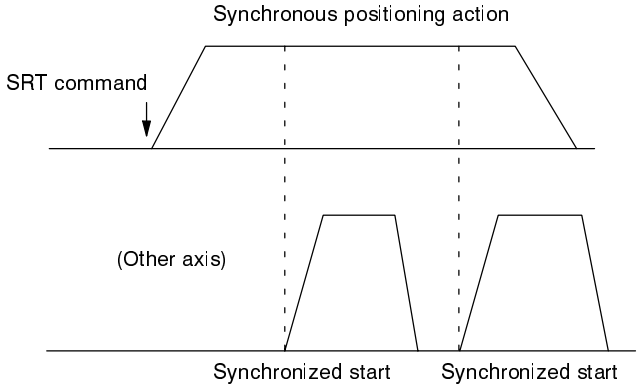
Synchronization Pattern

This setting determines whether, with respect to one start, startup will be executed for a single positioning action or with more than one positioning action. Set to 0 for a single positioning action, and to 1 for multiple positioning actions. The default setting is 0, for a single positioning action. The following illustration shows the pattern when the setting is made for a single

positioning action. The positioning action for the other axis, which is registered in the synchronous positioning action, is started at the specified time.



The following illustration shows the pattern when the setting is made for more than one positioning action.



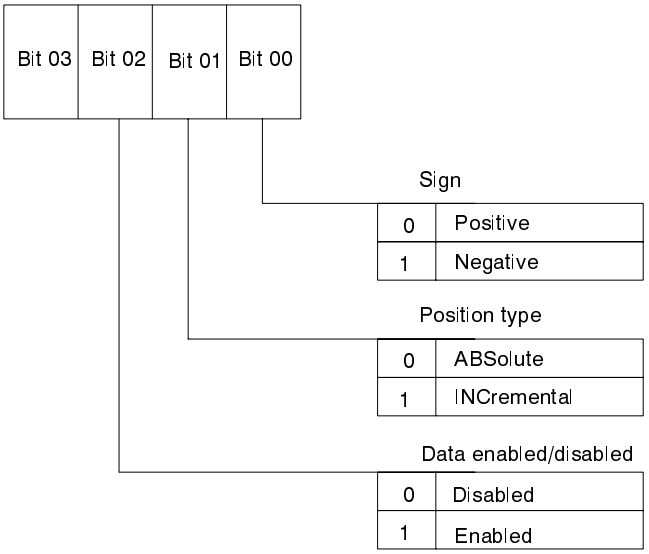
Continuous Pattern Address

Continuous pattern addresses 0 through 9 indirectly specify synchronous positioning action addresses. For the X axis, continuous pattern addresses 0 through 9 specify synchronous positioning action addresses 470 through 479. For the Y axis, continuous pattern addresses 0 through 9 specify synchronous positioning action addresses 870 through 879.

Note If a long dwell time is set for a continuous synchronized operation, and positioning passes through the next synchronous position during the dwell execution, the next other-axis start will not be executed. If this situation should occur, either shorten the dwell time or change the speed.

Attributes

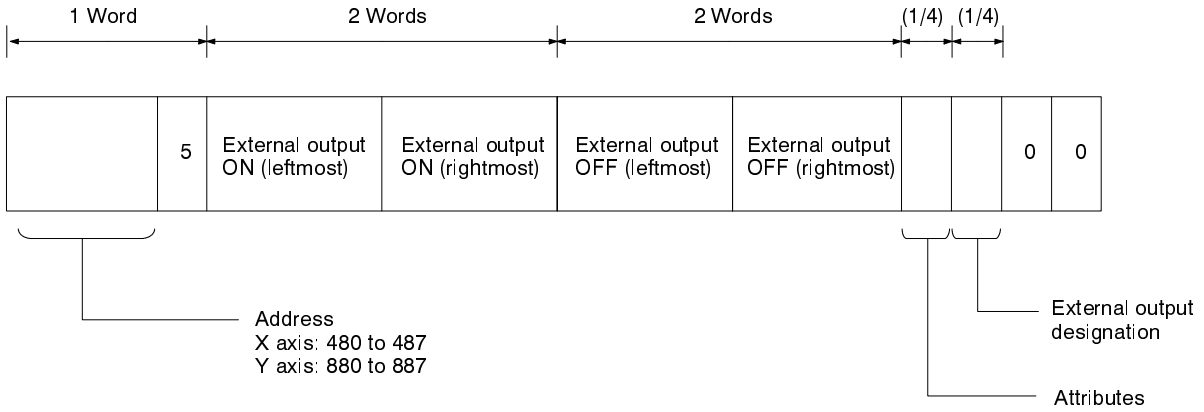
The attribute settings determine whether the data is to be enabled or disabled, whether the position type is be absolute or incremental, and whether the sign is to be positive or negative.



The data enabled/disabled setting determines whether or not the applicable data will be treated as NOP. The position type setting determines whether the absolute or incremental method will be used for positioning. The sign setting specifies the range of data with the origin taken as the center. Set “0” for positive and “1” for negative.

3-8 Setting Zones

The data addresses allocated for zones are addresses 480 through 487 for the X axis, and 880 through 887 for the Y axis. The address for each zone is comprised of four digits BCD, as shown below.



External Output ON Data

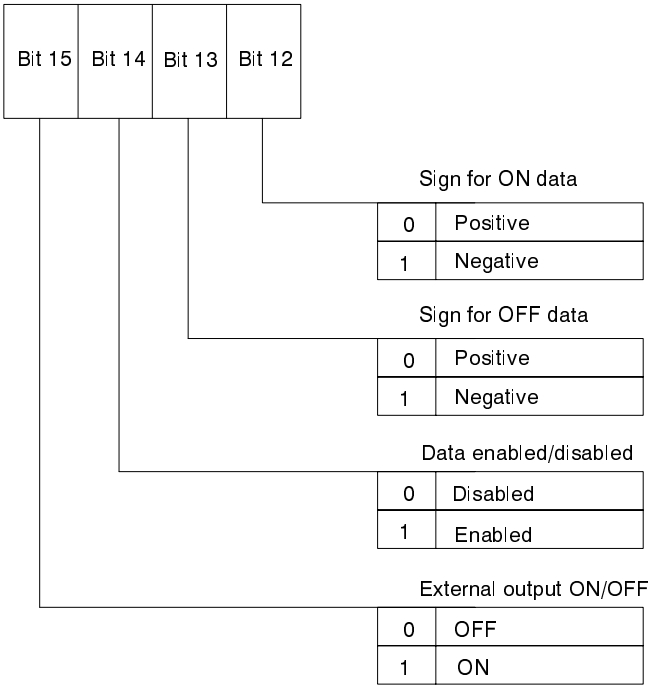
The external output ON data is defined within a range of ±99,999,999 pulses. The default is 00,000,000. The data occupies two words, of four digits each. The sign depends on the sign bit in the attribute setting.

External Output OFF Data

The external output OFF data is defined within a range of ±99,999,999 pulses. The default is 00,000,000. The data occupies two words, of four digits each. The sign depends on the sign bit in the attribute setting.

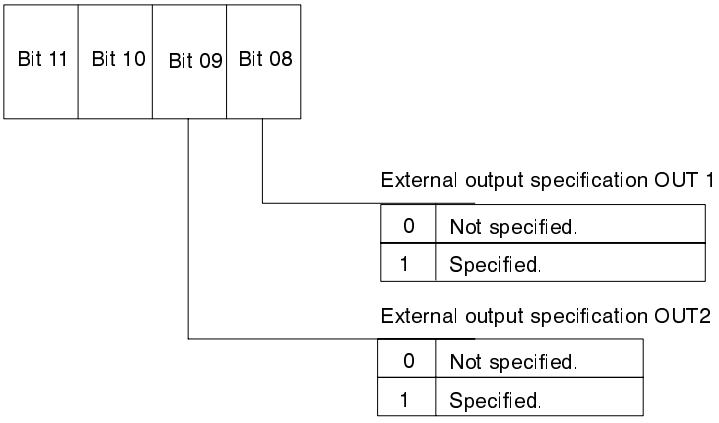
Attributes

The attribute settings determine the whether the external output will be ON or OFF, whether the data will be enabled or disabled, and whether the signs for the ON data and the OFF data will be positive or negative.



External Output Specification

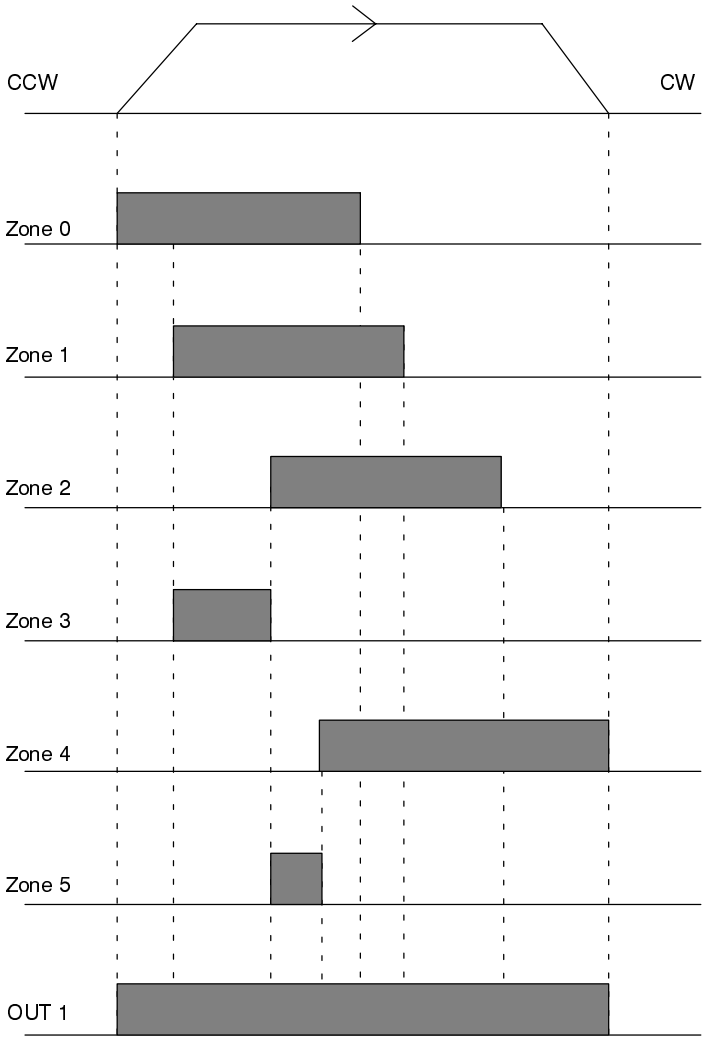
Bits 08 and 09 of the word for external output specification corresponds to the following.



OUT1 is set with bit 08 and OUT2 is set with bit 09.

Zone Data Setting Example

The following timing chart shows the ON and OFF timings of OUT1 when OUT1 is specified by zones 0 to 5.



OUT1 will be turned ON or OFF with the OR conditions set with zones 0 to 5.

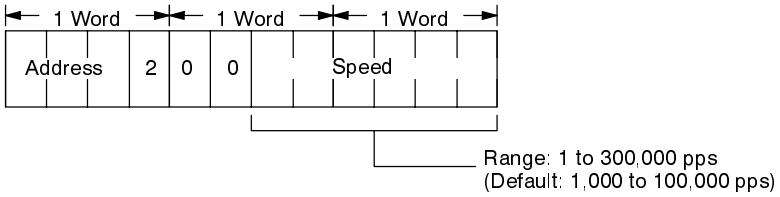
External output ON data and external output OFF data are the upper limit data and lower limit data used to specify the range of zone data. Therefore, no zone flag ON or OFF range varies with the moving direction.

Priority Order of OUT Read

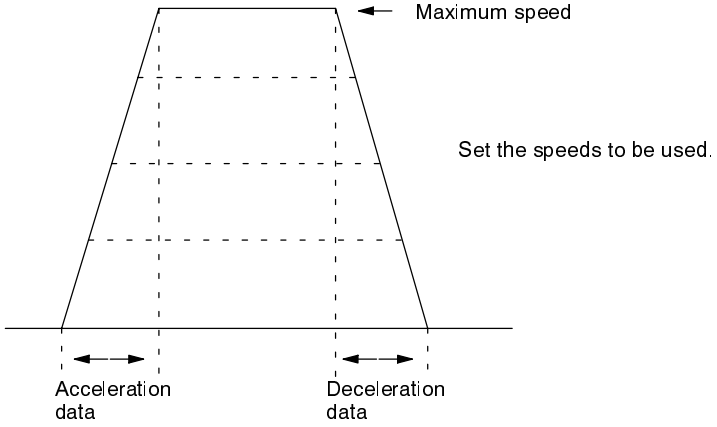
The zone output of OUT Read has priority. If the zone specified is effective, the OUT of the zone will have priority when motor free or differential counter overflow results.

3-9 Setting Speeds

Speeds are allocated three words each, one for the address and two for up to 6 BCD digits. Speeds occupy addresses 900 through 999 for both axes. Up to 100 speeds needed in your application may be entered for positioning and jogging. Positioning actions and the JOG commands call these speeds. For a comprehensive listing of default values see *3-10 Initial Data*.



These settings determine the speeds to be used from the trapezoid that is formed from the maximum speed and the acceleration and deceleration data.



When the pulse rate and the unit have been set, speed data with the unit converted will be displayed at the Teaching Box. The PC internally processes all data as pulse units (i.e., as pulses per second. Thus if the speed for a given axis is set at the PC, it will be described in terms of pps, and the display at the Teaching Box will be converted to mm/s according to the pulse rate.

PC (internal)	Pulse rate	Teaching Box speed display	Axis
Speed data (A pps)	α mm/p	Aα mm/s	X
	β mm/p	Aβ mm/s	Y

Conversely, if the speed is set at the Teaching Box, it will be converted to pps at the PC.

PC (internal)	Pulse rate	Teaching Box speed display	Axis
(B/α) pps	α	B mm/s	X
(C/β) pps	β	C mm/s	Y

If the speed is set in the X-axis mode, the display will be as follows in the Y-axis mode. In addition, the X-mode and Y-mode speed settings at the Teaching Box will be used with the X-axis pulse rate converted.

$$B\ (mm/s) \times \frac{\beta\ (\text{Y-axis pulse rate})}{\alpha\ (\text{X-axis pulse rate})} \quad [mm/s]$$

3-10 Initial Data

The following tables list the default data loaded originally in the EEPROM at the factory. The operation of each of these is described in the previous subsections in this section. This data will be automatically loaded to RAM whenever power is turned on. The contents of EEPROM can be changed with the Write EEPROM (STORE) command.

X-Axis Positioning Actions

Address	Description	Setting	Attributes
100	X-axis test data (1)	Position = 2000 pulses Speed = 1 kpps M code = 01	Dwell time = 500 ms Absolute, terminating Acceleration time = 200 ms Deceleration time = 200 ms
101	X-axis test data (2)	Position = –2000 pulses Speed = 3 kpps M code = 02	Dwell time = 0 ms Absolute, continuous Acceleration time = 100 ms Deceleration time = 100 ms
102	X-axis test data (2)	Position = –2000 pulses Speed = 2 kpps M code = 03	Dwell time = 500 ms Absolute, continuous Acceleration time = 100 ms Deceleration time = 300 ms
103	X-axis test data (2)	Position = –2000 pulses Speed = 1 kpps M code = 04	Dwell time = 0 ms Absolute, terminating Acceleration time = 100 ms Deceleration time = 200 ms
104	X- and Y-axis test data (1)	Position = 0 pulses Speed = 1 kpps M code = 05	Dwell time = 100 ms Absolute, interpolating end Acceleration time = 100 ms Deceleration time = 200 ms

X-Axis Parameters

Address	Description	Setting	Attributes
400	Unit setting	0	Pulse
401	Pulse rate	1	1 unit/pulse
402	Rotation direction	0	Positive voltage output with incremental positioning actions
403	Encoder type	001	Single multiplier, positive logic
404	Gain	200	2,000 μV/pulse
405	In-position zone	10	10 pulses
406	Backlash compensation	0	None
407	Stroke limit (+)	999,999	999,999 pulses
408	Stroke limit (–)	999,999	999,999 pulses
409	Zone settings	01000100	Acceleration zone: 100 pulses Deceleration zone: 100 pulses
410	Home shift	0	0 pulses
411	Maximum speed	40010000	Maximum speed = 10 kpps Teaching Box coefficient = 4
412	Teaching Box speed	10002000	JOG speed = 2 kpps JOG accel/decel pattern address = 0 Number of pulses for inching = 1
413	Origin search direction	0	Direction of positive voltage output
414	Origin compensation	0	0 pulses
415	High origin search speed	5,000	5,000 kpps
416	Origin search acceleration and deceleration	5	Acceleration time = 200 ms Deceleration time = 200 ms
417	Low origin search speed	1,000	1 kpps
418	External interrupt acceleration and deceleration	00000500	External interrupt pattern address = 0 Number of deceleration stop pulses = 500 Teaching Box key pattern address = 0
419	Wiring check function	10101100	Disconnected wiring check: enabled Check time = 100 ms Number of check pulses = 11
420	External output control setting	00032768	Counter capacity = 32,768 pulses External output: ON

Note The initialized data of the C500-NC222-E will not be effective when the C500-NC222-E is set to NC221-E mode. If the C500-NC222-E is set to NC221-E mode, check the initialized data of the C500-NC222-E.

Dwell Times (X and Y Axes)

Address	Description	Setting	Attributes
450/850	Dwell time #0	0	ms
451/851	Dwell time #1	100	ms
452/852	Dwell time #2	200	ms
453/853	Dwell time #3	300	ms
454/854	Dwell time #4	400	ms
455/855	Dwell time #5	500	ms
456/856	Dwell time #6	600	ms
457/857	Dwell time #7	700	ms
458/858	Dwell time #8	800	ms
459/859	Dwell time #9	900	ms

Acceleration and Deceleration Times (X and Y Axes)

Address	Description	Setting	Attributes
460/860	Accel./ Decel. time #0	00100010	Acceleration time = 100 ms Deceleration time = 100 ms
461/861	Accel./ Decel. time #1	00100020	Acceleration time = 100 ms Deceleration time = 200 ms
462/862	Accel./ Decel. time #2	00100030	Acceleration time = 100 ms Deceleration time = 300 ms
463/863	Accel./ Decel. time #3	00100040	Acceleration time = 100 ms Deceleration time = 400 ms
464/864	Accel./ Decel. time #4	00100050	Acceleration time = 100 ms Deceleration time = 500 ms
465/865	Accel./ Decel. time #5	00200020	Acceleration time = 200 ms Deceleration time = 200 ms
466/866	Accel./ Decel. time #6	00200030	Acceleration time = 200 ms Deceleration time = 300 ms
467/867	Accel./ Decel. time #7	00200040	Acceleration time = 200 ms Deceleration time = 400 ms
468/868	Accel./ Decel. time #8	00200050	Acceleration time = 200 ms Deceleration time = 500 ms
469/869	Accel./ Decel. time #9	00200060	Acceleration time = 200 ms Deceleration time = 600 ms

X-Axis Synchronous Positioning Actions

Address	Description	Setting	Attributes
470	Synchronous positioning action (1)	0000000070000000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
471	Synchronous positioning action (2)	0000000070100000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
472	Synchronous positioning action (3)	0000000070200000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
473	Synchronous positioning action (4)	0000000070300000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
474	Synchronous positioning action (5)	0000000070400000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
475	Synchronous positioning action (6)	0000000070500000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
476	Synchronous positioning action (7)	0000000070600000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
477	Synchronous positioning action (8)	0000000070700000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
478	Synchronous positioning action (9)	0000000070800000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
479	Synchronous positioning action (10)	0000000070900000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0

X-Axis Zone Data

Address	Description	Setting	Attributes
480	Zone position data (1)	0000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
481	Zone position data (2)	0000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
482	Zone position data (3)	0000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
483	Zone position data (4)	0000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
484	Zone position data (5)	0000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
485	Zone position data (6)	0000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
486	Zone position data (7)	0000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
487	Zone position data (8)	0000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0

Y-Axis Positioning Actions

Address	Description	Setting	Attributes
500	X-axis test data (1)	Position = 2000 pulses Speed = 1 kpps M code = 01	Dwell time = 500 ms Absolute, terminating Acceleration time = 200 ms Deceleration time = 200 ms
501	X-axis test data (2)	Position = 0 pulses Speed = 3 kpps M code = 02	Dwell time = 0 ms Absolute, continuous Acceleration time = 100 ms Deceleration time = 100 ms
502	X-axis test data (2)	Position = –2000 pulses Speed = 2 kpps M code = 03	Dwell time = 500 ms Absolute, continuous Acceleration time = 100 ms Deceleration time = 300 ms
503	X-axis test data (2)	Position = –4000 pulses Speed = 1 kpps M code = 04	Dwell time = 0 ms Absolute, terminating Acceleration time = 100 ms Deceleration time = 200 ms
504	X- and Y-axis test data (1)	Position = 0 pulses Speed = 1 kpps M code = 05	Dwell time = 100 ms Absolute, interpolating end Acceleration time = 100 ms Deceleration time = 200 ms

Y-Axis Parameters

Address	Description	Setting	Attributes
800	Unit setting	0	Pulse
801	Pulse rate	1	1 unit/pulse
802	Rotation direction	0	Positive voltage output with incremental positioning actions
803	Encoder type	001	Single multiplier, positive logic
804	Gain	200	2,000 μV/pulse
805	In-position zone	10	10 pulses
806	Backlash compensation	0	None
807	Stroke limit (+)	999,999	999,999 pulses
808	Stroke limit (–)	999,999	999,999 pulses
809	Zone settings	01000100	Acceleration zone: 100 pulses Deceleration zone: 100 pulses
810	Home shift	0	0 pulses
811	Maximum speed	40010000	Maximum speed = 10 kpps Teaching Box coefficient = 4
812	Teaching Box speed	10002000	JOG speed = 2 kpps JOG accel/decel pattern address = 0 Number of pulses for inching = 1
813	Origin search direction	0	Direction of positive voltage output
814	Origin compensation	0	0 pulses
815	High origin search speed	5,000	5,000 kpps
816	Origin search acceleration and deceleration	5	Acceleration time = 200 ms Deceleration time = 200 ms
817	Low origin search speed	1,000	1 kpps
818	External interrupt acceleration and deceleration	00000500	External interrupt pattern address = 0 Number of deceleration stop pulses = 500 Teaching Box key pattern address = 0
819	Wiring check function	10101100	Disconnected wiring check: enabled Check time = 100 ms Number of check pulses = 11
820	External output control setting	00032768	Counter capacity = 32,768 pulses External output: ON

Y-Axis Synchronous Positioning Actions

Address	Description	Setting	Attributes
870	Synchronous positioning action (1)	0000000030000000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
871	Synchronous positioning action (2)	0000000030100000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
872	Synchronous positioning action (3)	0000000030200000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
873	Synchronous positioning action (4)	0000000030300000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
874	Synchronous positioning action (5)	0000000030400000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
875	Synchronous positioning action (6)	0000000030500000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
876	Synchronous positioning action (7)	0000000030600000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
877	Synchronous positioning action (8)	0000000030700000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
878	Synchronous positioning action (9)	0000000030800000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0
879	Synchronous positioning action (10)	0000000030900000	Synchronous position = 0 pulses ABS data = disabled Synchronous pattern = 0

X-Axis Zone Data

Address	Description	Setting	Attributes
880	Zone position data (1)	00000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
881	Zone position data (2)	00000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
882	Zone position data (3)	00000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
883	Zone position data (4)	00000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
884	Zone position data (5)	00000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
885	Zone position data (6)	00000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
886	Zone position data (7)	00000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0
887	Zone position data (8)	00000000000000000000	ON position data = 0 Pulse data = disabled OFF position data = 0 External output designation = 0

Speeds

Address	Description	Setting	Attributes
900	Speed #0	10,000	pps
901	Speed #1	1,000	pps
902	Speed #2	2,000	pps
903	Speed #3	3,000	pps
904	Speed #4	4,000	pps
905	Speed #5	5,000	pps
906	Speed #6	6,000	pps
907	Speed #7	7,000	pps
908	Speed #8	8,000	pps
909	Speed #9	9,000	pps

SECTION 4
Data Communication with PC

This section provides information essential for communications between the Position Control Unit and the PC, and the use of status flags.

4-1 Compatible Models and Words

Both data and commands can be transferred between the Position Control Unit (PCU) and Programmable Controller (PC) through the use of Intelligent I/O Read and Write instructions executed by the PC.

Compatible Models

The Intelligent I/O Read instruction READ(88) and Intelligent I/O Write instruction WRIT(87) control PCU-PC communication. The CPU must be able to use these two instructions. Use of the NC222-E is thus possible with the following PCs only.

- C500 (with CPU model C500-CPU11-EV1 only)
- C1000H (with any CPU)
- C2000H (with any CPU)
- CV500 (with any CPU)
- CV1000 (with any CPU)
- CV2000 (with any CPU)
- CVM1 (with any CPU)

Caution The NC222-E must be mounted either to a CPU Rack or Expansion I/O Rack to operate. Communications via READ(88) and WRIT(87) will not be possible if it is mounted to a Slave Rack.

IR Area Allocations

Two I/O words are allocated for the Position Control Unit to communicate with the PC.

Word	Bit	Name	Description
n (OUT)	00	(PC Busy)	Used in WRIT(87) / READ(88) instruction.
	01	(PC Writing)	
	02	(PC Read Completed)	
	03 to 15	---	Uses within the PCU,and not available to the user.
n+1 (IN)	00	(PCU Busy)	Used in WRIT(87) / READ(88) instruction.
	01	(Reading PCU)	
	02	(PCU Write Completed)	
	03 to 15	---	Used within the PCU,and not available to the user.

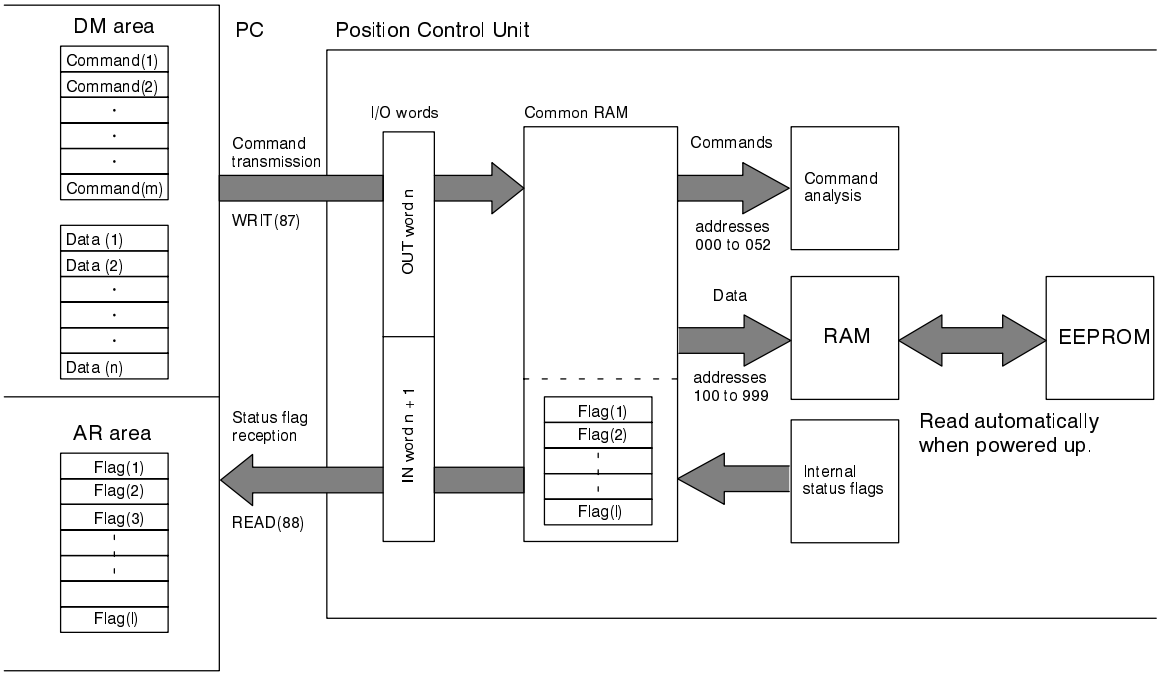
Note

1. The input and output words allocated to the Position Control Unit must not be used by any instruction other than WRIT(87) or READ(88). Do not use MOV(21) or OUT with these words.
2. The mode of the PC has no affect on the operation of the NC222-E, i.e., the NC222-E will continue to operate regardless of the PC mode.
3. Commands and/or data can be sent to the NC222-E from either the PC (i.e., the program) or the Teaching Box. If a transmission is attempted from both at the same time, the transmission that arrives first will be given priority.

4-2 PC Programs

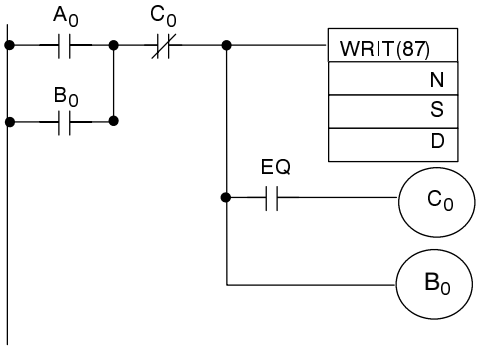
The PC program maintains two data flow directions.

- PC to Position Control Unit (PCU) command and parameter transmission uses the Intelligent I/O Write instruction WRIT(87). Commands and parameters are differentiated by address inside the PCU.
- Position Control Unit to PC status reception uses the Intelligent I/O Read instruction READ(88).



- One or more commands stored in the DM area of the PC are transmitted in a stream to the Position Control Unit, where they are executed sequentially. The Position Control Unit functions according to the commands sent.
- Data (parameters) stored in the DM area are transmitted to the PCU and stored in RAM. Commands can then be used to transfer RAM contents to EEPROM.
- For status flag reception, flag allocations are determined by the Position Control Unit; therefore, the same status flags are transferred to the AR area each time the Intelligent I/O Read instruction is executed.
- Because command transmission and status reception rely on the Intelligent I/O Read and Write instructions, a standard PC program can be developed. The use of such a standard program is strongly recommended.

4-2-1 Basic Command Transmission Program (PC to PCU)

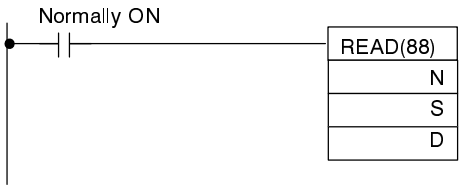


A_0: Start input (differentiated input)
B_0: Status-holding work bit
C_0: Transmission completed work bit
N_0: Differentiation no.
N: Transferred word count
S: Transfer source start word
D: I/O word for transfer destination (word n occupied by the PCU)
EQ: Equals flag

Note The Equals flag indicates that READ(88) or WRIT(87) has been executed.

4-2-2 Basic Status Flag Reception Program (Position Control Unit to PC)

Status flag reception should be written at the end of the PC program.

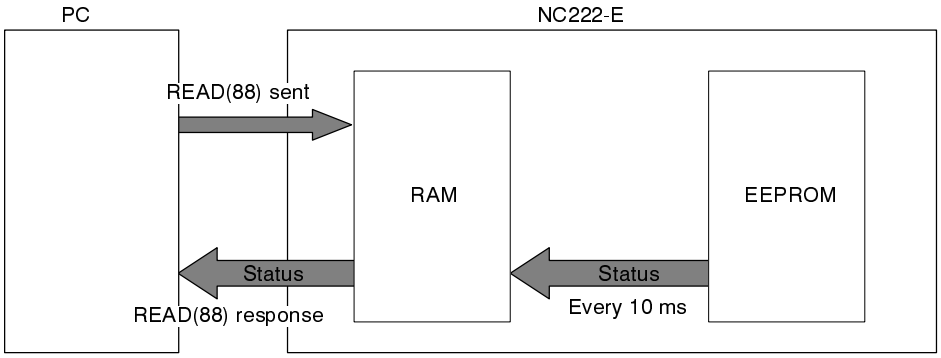


N: Transfer word count (17 words minimum)
S: Transfer source I/O word (word n + 1 occupied by the PCU)
D: Transfer destination start word (For details, refer to *5-2 Status Word Allocations*)

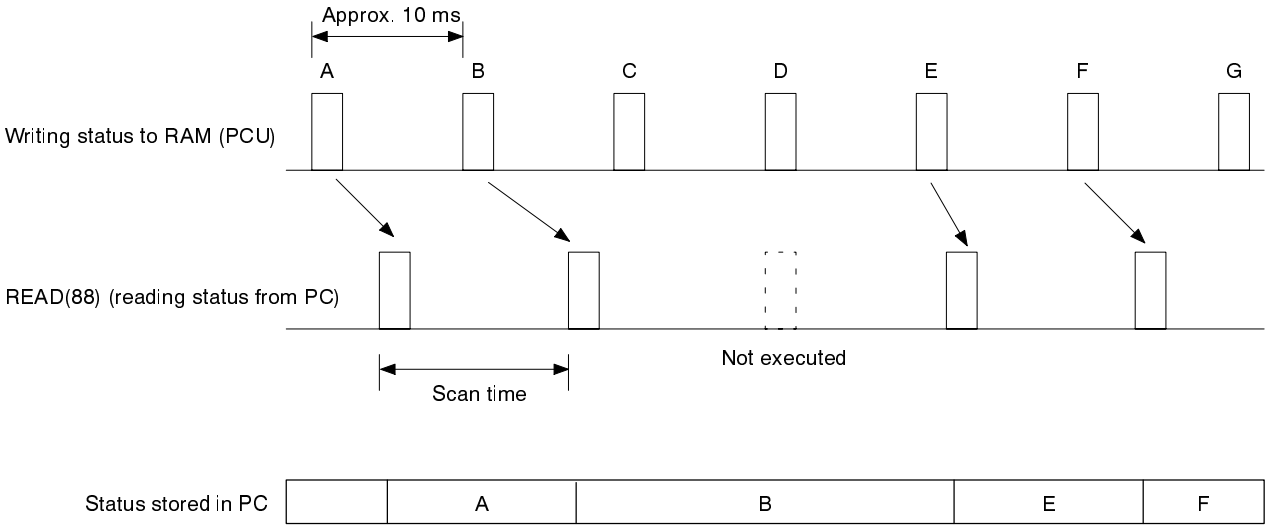
Refer to your PC's *Operation Manual* for further details on the Intelligent I/O Read and Write Instructions.

Status Reception Problems

The RAM in the PCU that contains status data is accessed both by the PCU to write the status and by the PC to read status (READ(88)). Both of these operations cannot take place at the same time.



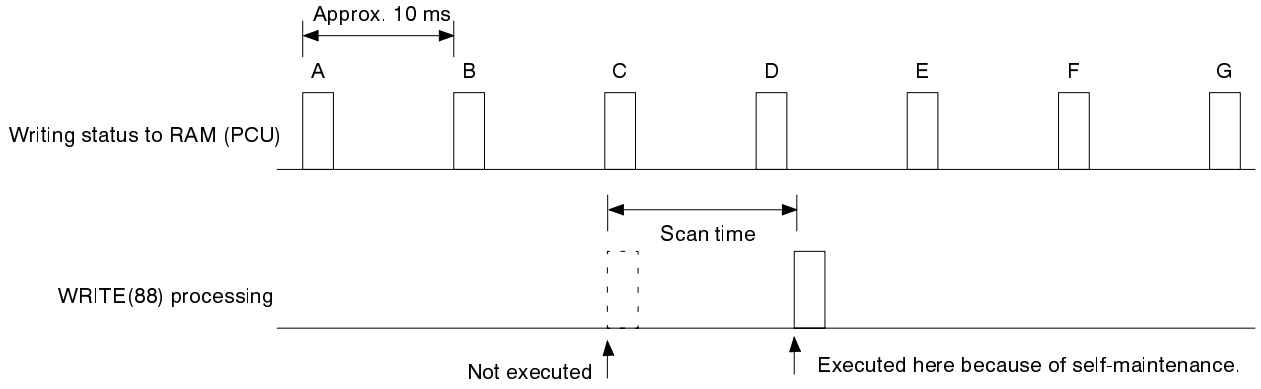
If a READ(88) is attempted while the PCU is writing status, READ(88) will be ignored. The status write operation is performed approximately every 10 ms and requires approximately 1 ms to complete, i.e., there is up to about a 1 in 10 chance that READ(88) will not be executed as programmed. This situation is illustrated below.



Problems in Transferring Commands

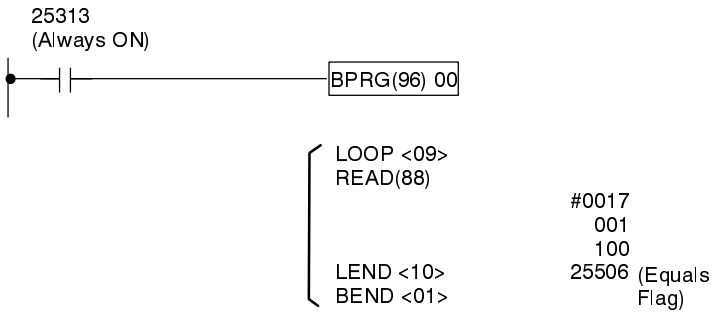
A similar problem arises if WRIT(87) is attempted during a scan. As described above, the status write operation is performed approximately every 10 ms and requires approximately 1 ms to complete. WRIT(87) also accesses the RAM when transferring commands from the PC, and, here too, both of these operations cannot take place at the same time. In this case it will be WRIT(87) that is ignored if it is attempted while the PCU is writing status. For that reason, a self-maintaining program structure has been adopted,

and the self-maintenance is cleared by the Equals flag which indicates that an instruction has been executed.



Reading During Each Scan

If it is necessary to ensure that status is read during each program scan, block programming can be used. One example of how to do this is shown below. This example reads out 17 status words to IR 100 to IR 116 for a PCU allocated IR 000 and IR 001. The loop in the block program will be taken until the Equals Flag (=) turns ON (i.e., until IR 1200 turns ON).



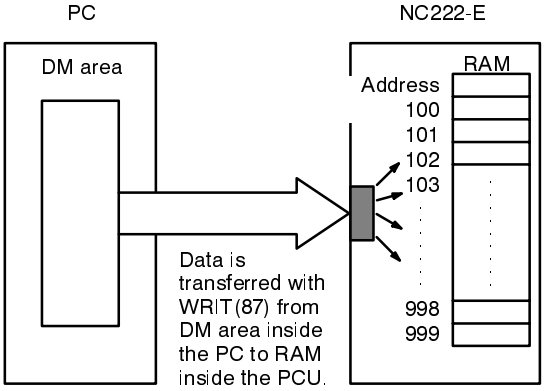
4-2-3 Transferring and Saving Data

Data Transfers

Parameters and positioning actions stored in the DM area can be transferred to RAM in the PCU using a program like the one shown below. Be sure the first DM word contains an addresses and that no more than 127 words are transferred at once. If it is necessary to transfer more words, repeat the program section. When repeating the transfer, always used the work bit turned on by the Equals Flag (=) in the first transfer (IR 5002 in the following example) to activate the second transfer.

When transferring data, addresses need not be consecutive. If they are not consecutive, each address will need to be specified individually. If they are consecutive, only the first address need be designated.

Data Transmission Example The following program can be used to transfer data written in the DM area of the PC to the NC222-E. When transferring data, it is important that the first word designate the address and that data for the required number of words is set properly.



Up to 127 words can be transferred each time WRIT(87) is executed. When it is necessary to transfer more words, the Equals Flag should be used to activate further transmissions with WRIT(87), as shown below.

When data is transferred into the NC222-E, data is automatically stored in RAM according to the addresses given. If the addresses of the data being transferred are consecutive, it is only necessary to designate the address of the first one.

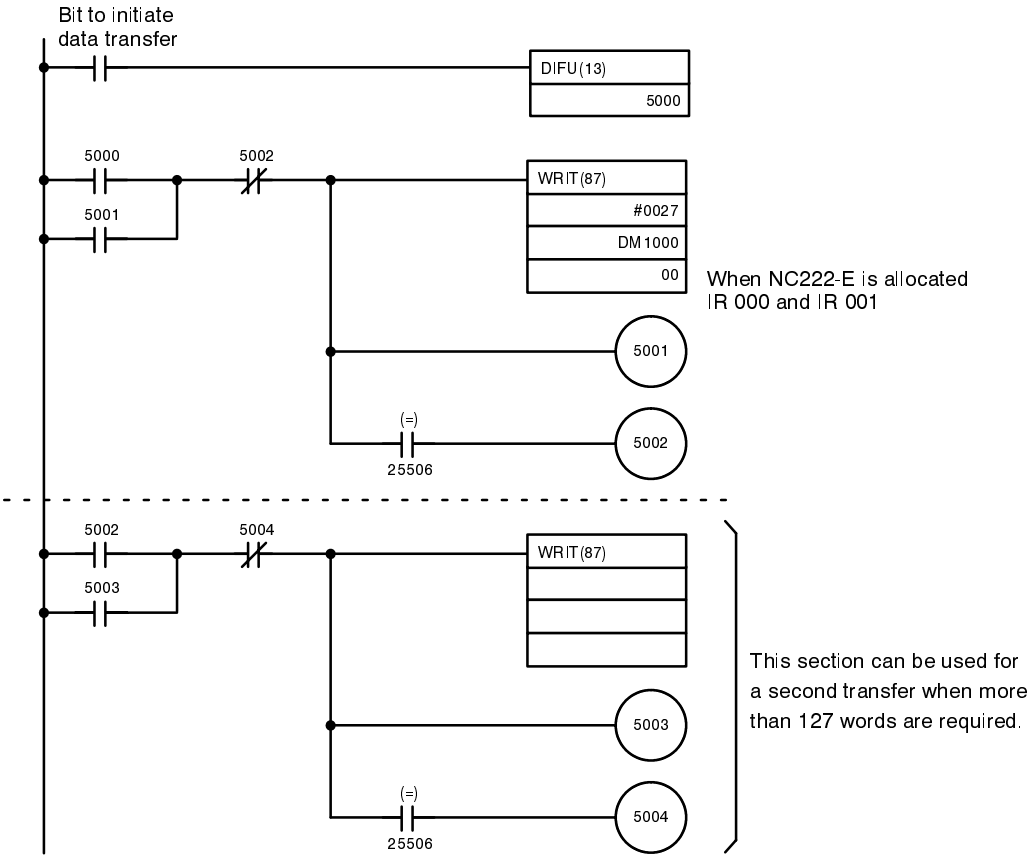
The data prepared for transfer and the program used are shown below.

Caution Data cannot be transferred while the NC222-E is positioning, i.e., while one or more axes are moving.

Data

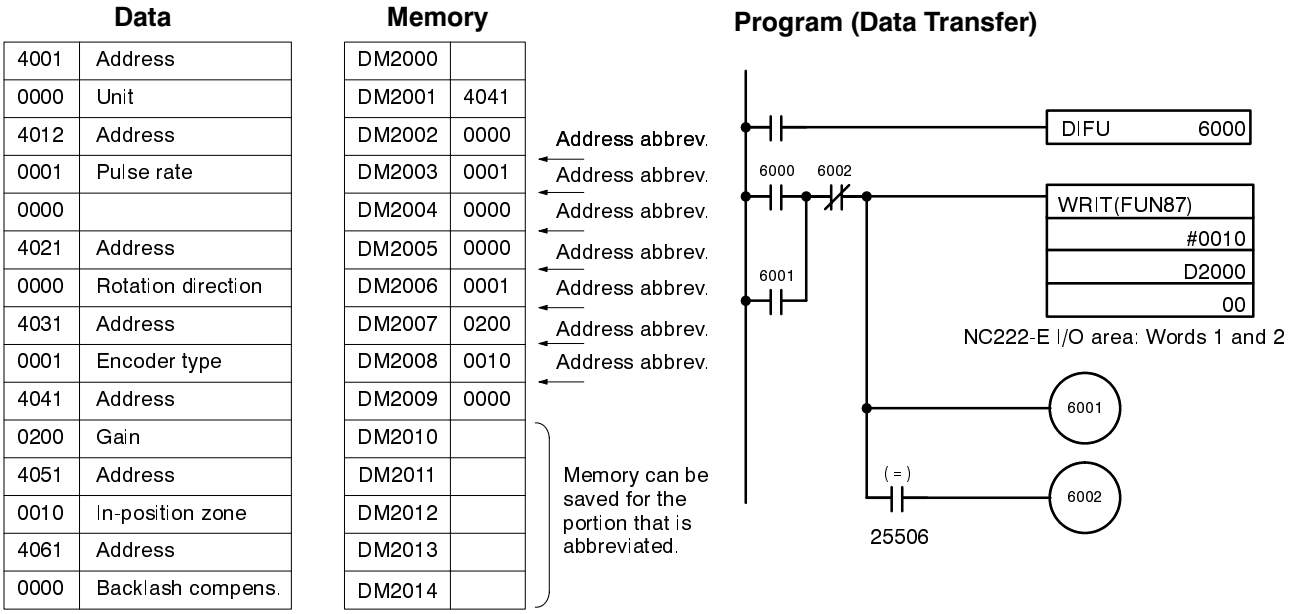
DM 1000	4	1	1	2	Maximum speed (X)
DM 1001	0	0	0	5	Address: 411
DM 1002	0	0	0	0	
DM 1003	4	1	3	1	Origin search direction (X)
DM 1004	0	0	0	1	Address: 413
DM 1005	4	5	0	1	Dwell time 0 (X)
DM 1006	0	0	1	0	Address: 450
DM 1007	4	6	6	2	Acceleration pattern 6 (X)
DM 1008	0	0	3	0	Address: 466
DM 1009	0	0	4	0	
DM 1010	2	0	0	4	Positioning action 100 (X)
DM 1011	0	0	0	2	Address: 200
DM 1012	5	0	0	0	
DM 1013	0	0	1	0	
DM 1014	0	6	4	4	
DM 1015	9	0	0	2	Speed 0 (X, Y)
DM 1016	0	0	0	0	Address: 900
DM 1017	1	0	0	0	
DM 1018	8	0	4	2	Gain (Y)
DM 1019	0	0	2	0	Address: 804
DM 1020	8	0	5	2	In-position zone (Y)
DM 1021	0	0	2	0	Address: 805
DM 1022	6	0	0	4	Positioning action 100 (Y)
DM 1023	0	0	0	1	Address: 600
DM 1024	0	0	0	0	
DM 1025	0	0	1	0	
DM 1026	0	6	4	4	

Program



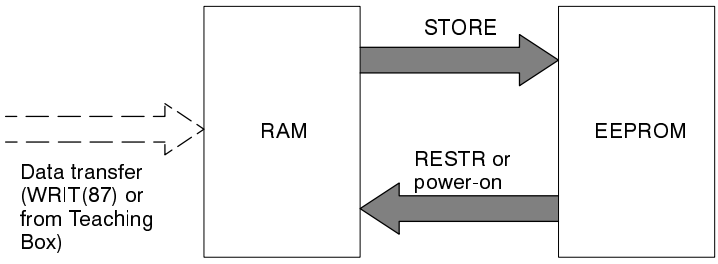
Address Abbreviation

When a series of consecutive addresses occurs in order, the addresses can be abbreviated as shown below.



Storing RAM Data

PCU operation is based on the parameters and positioning actions contained in RAM. When power is turned on, the data in EEPROM is read into RAM. The data in RAM can then be changed by transferring data with WRIT(87) or from the Teaching Box. This data will be deleted and replaced by EEPROM data the next time power is turned off and back on. There is a command available, however, to write RAM data to EEPROM (STORE), as well as one to restore EEPROM data to RAM (RESTR). These commands can be used along with WRIT(88) (or the Teaching Box) to control the data in RAM. This situation is illustrated below.

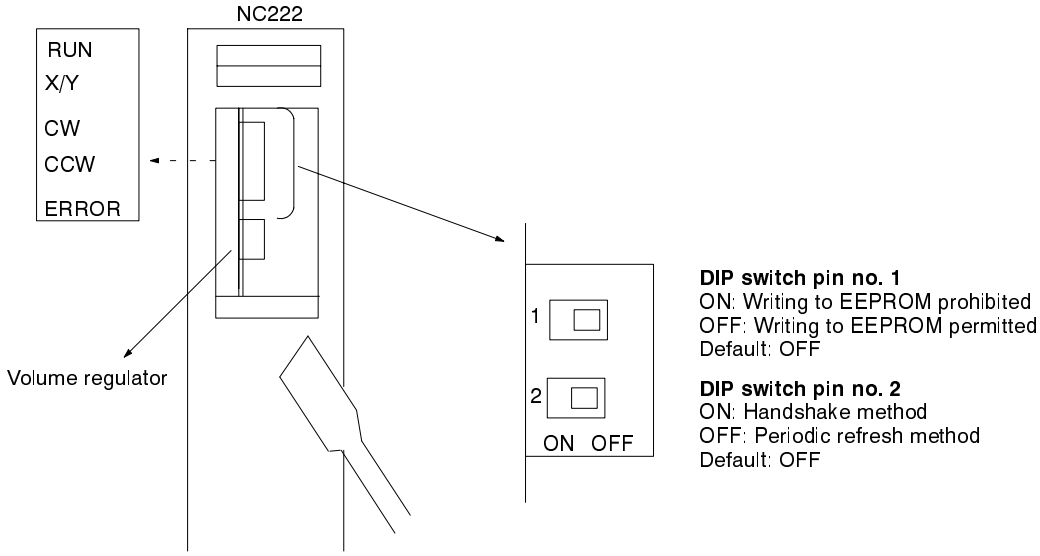


Refer to *6-2 Command Descriptions* for details on STORE and RESTR.

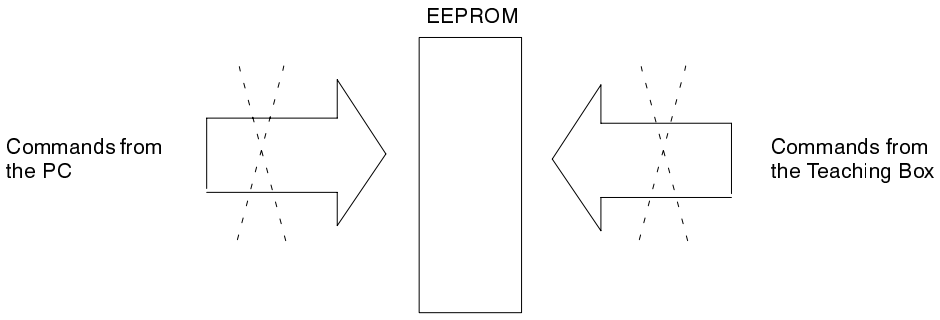
Caution STORE should not be executed more than 5,000 times.

4-3 EEPROM and RAM Settings

By means of internal NC222-E DIP switch settings, data can be prohibited from being written to the EEPROM and the method for refreshing status can be selected. To make the settings, first access the two DIP switch pins by removing the DIP switch cover with a flat-blade screwdriver as shown in the illustration below.



Setting pin no. 1 to ON prohibits data from being written to the EEPROM. Use this to protect data that must not be erased.

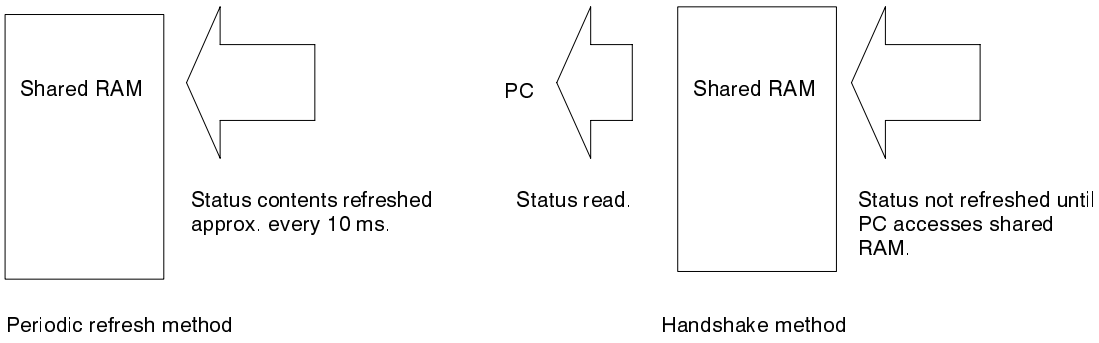


DIP switch pin no. 1: ON

Set pin no. 2 to select whether the handshake method or the periodic refresh method is to be used for refreshing the NC222-E internal status. The status contents are normally refreshed approximately every 10 ms, regardless of whether or not the PC is accessing the shared RAM. Therefore, the the status is changed at least every 10 ms. This is called the periodic refresh method.

With the handshake method, on the other hand, the status is not written to the shared RAM as long as the PC is not accessing it. This assures that sta-

tus changes will be received by the PC, but the time between status changes is longer than with the periodic refresh method.



Periodic refresh method

Handshake method

Caution The X-axis and Y-axis gain regulator and the zero volume regulator are located below the DIP switch. These regulators are factory set and paint locked. Be careful not to inadvertently change them.

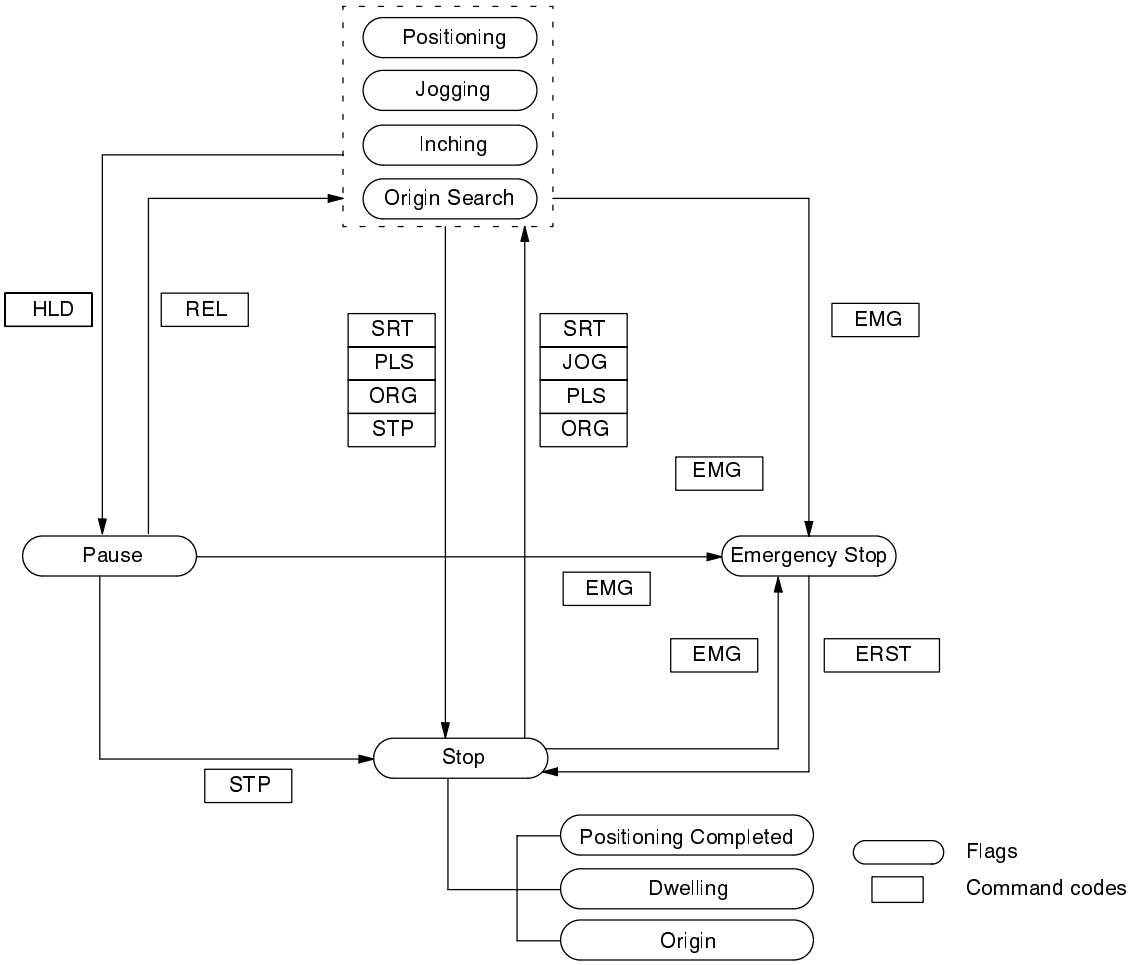
SECTION 5
Operating Status

This section describes the status information available from the PCU. This information is read into the PC by executing the Intelligent I/O Read instruction, READ(88). Also explained in this section is the relationship between certain PCU commands and the status information.

5-1 Flag Transitions and Types

Relationship between Flags and Commands

Flags and other status information will change as commands are executed. These changes are illustrated in the following illustration. When the commands along the arrow are executed, the flags given at the ends of the arrows turn ON. Refer to the command allocations table in *6-1 Command Format* for command code definitions.



IR Area Flags

Flags are assigned to the IN I/O word.

Wd / Bit	Word n+1 IN
00	(PCU Busy)*
01	(PCU Reading)*
02	(PCU Writing Completed)*
⋮	Not used by the user
15	

*These bits are used by READ(88) and WRIT(87) and are not designed to be accessed by the user.

Types of Flags

The Intelligent I/O Read instruction READ(88) is used to read blocks of flags and status data into a memory area in the PC. Their contents are as follows:

System status flags
Error codes
System error status flags
Error codes
Status flags
Current position
M code
Multiplier data
Current positioning action address
Current speed address
Override coefficient
Read data

5-2 Status Word Allocations

The PC uses the intelligent I/O Read instruction READ(88) to read status from the Position Control Unit. Refer to *4-2 PC Programs* for the READ(88) format. The NC222 adds several status words to those provided by the NC221.

- Servo-free
- Data Read Complete
- Teaching Box Protect
- External Input Protect
- Error Counter Overflow (X, Y)
- Synchronous Start Waiting (X, Y)
- Zone Flag Area
- Distribution Start
- Distribution End

The PC uses the Intelligent I/O Read instruction READ(88) to read status from the Position Control Unit. Refer to *4-2 PC Programs* for the READ(88) format. Data word allocations for the NC222 are summarized in the following table. (To compare these with the corresponding NC221 allocations, refer to *1-2-4 Changes in Status Word Allocations*.)

NC222 Status Word Allocations

	Wd \ Bit	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
X–Y common area	D+0	Speeds Cleared	PCU Ready	Teaching Box Ready	Teaching Box Connected	External Display Connected	Teaching Box Protect	External Input Protect	PC Communications Disabled	Interpolating Circular Arc	Interpolating Straight Line	Reading EEPROM	Writing EEPROM	EEPROM Write Completed	Error Counter Overflow (Y axis)	Data Read Complete	Error Counter Overflow (X axis)
		System status flags															
	D+1	Hardware Error	Communications Error	Y-axis System Error	X-axis System Error	System/data Processing Error	Interpolating Error	Y-axis Command Error	X-axis Command Error		Error code (10^1 digit)				Error code (10^0 digit)		
		Error code and system error status flags															
	D+2	Error-related OP code (leftmost digit)				Error-related OP code (middle digit)					Error-related OP code (rightmost digit)				Number of error-related OP codes		
		Error codes															
X-axis area	D+3	Parameters Enabled	Origin Set	Distribution Start	Distribution End	Home Shift	Override	Dwelling	Positioning Completed	Origin search	Inching	Jogging	Positioning	Stop	Pause	Sync Start Waiting	Current Position Sign
		Status flags (1)															
	D+4	CW Movement	CCW Movement	Accelerating	Constant Speed	Decelerating	In Position	Acceleration Zone	Deceleration Zone	Origin	OUT2 Output	OUT1 Output	CWLS Input	CCWLS Input	External Interrupt	External Servo-free Input	Origin Input
		Status flags (2)															
	D+5	BCD (10^7 digit)				BCD (10^6 digit)				BCD (10^5 digit)				BCD (10^4 digit)			
		Current position (leftmost digits)															
	D+6	BCD (10^3 digit)				BCD (10^2 digit)				BCD (10^1 digit)				BCD (10^0 digit)			
		Current position (rightmost digits)															
	D+7	Data Zone (480)	Data Zone (481)	Data Zone (482)	Data Zone (483)	Data Zone (484)	Data Zone (485)	Data Zone (486)	Data Zone (487)		M code (10^1 digit)				M code (10^0 digit)		
		M code															
	D+8	Pos. Data Cleared	Multiplier: 1, 2, 4			Current positioning action address (10^2 digit)					Current positioning action address (10^1 digit)				Current positioning action address (10^0 digit)		
		Multiplier/Current positioning action address															
	D+9	Current speed address (10^1 digit)				Current speed address (10^0 digit)					Override coefficient (10^1 digit)				Override coefficient (10^0 digit)		
		Current speed address/Override coefficient															

	Wd \ Bit	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Y-axis area	D + 10	Parameters Enabled	Origin Set	Distribution Start	Distribution End	Home Shift	Override	Dwelling	Positioning Completed	Origin search	Inching	Jogging	Positioning	Stop	Pause	Sync Start Waiting	Current Position Sign
		Status flags (1)															
	D + 11	CW Movement	CCW Movement	Accelerating	Constant Speed	Decelerating	In Position	Acceleration Zone	Deceleration Zone	Origin	OUT2 Output	OUT1 Output	CWLS Input	CCWLS Input	External Interrupt	External Servo-free Input	Origin Input
		Status flags (2)															
	D + 12	BCD (10^7 digit)				BCD (10^6 digit)				BCD (10^5 digit)				BCD (10^4 digit)			
		Current position (leftmost digits)															
	D + 13	BCD (10^3 digit)				BCD (10^2 digit)				BCD (10^1 digit)				BCD (10^0 digit)			
		Current position (rightmost digits)															
	D + 14	Zone Data (880)	Zone Data (881)	Zone Data (882)	Zone Data (883)	Zone Data (884)	Zone Data (885)	Zone Data (886)	Zone Data (887)	M code (10^1 digit)				M code (10^0 digit)			
		M code															
	D + 15	Pos. Data Cleared	Multiplier: 1, 2, 4			Current positioning action address (10^2 digit)				Current positioning action address (10^1 digit)				Current positioning action address (10^0 digit)			
		Multiplier/Current positioning action address															
	D + 16	Current speed address (10^1 digit)				Current speed address (10^0 digit)				Override coefficient (10^1 digit)				Override coefficient (10^0 digit)			
		Current speed address/Override coefficient															
X–Y common area	D + 17																
		Read Data Area															
		≀															
	D + 126																
		Read Data Area															

Note 1. When a READ(88) is executed, data values are placed in the Read Data Area. There are 110 words (17-126) set aside for this use.

2. During interpolation, the X-axis attributes and parameters are used for all shaded parameters above.

5-3 Status Word Details

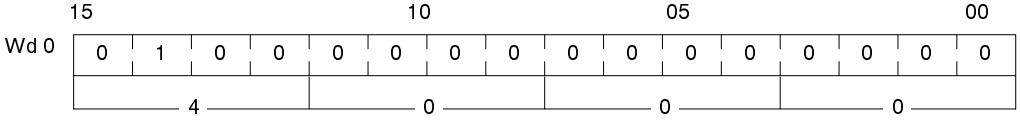
5-3-1 System Flags

Word D + 0

Bit	Name	Content	ON (1) condition	OFF (0) condition	Initial status	Wiring error status	System error status
00	X-axis Error Counter Overflow	Indicates whether error counter overflow has occurred.	When error counter overflow occurs.	When error reset or error counter reset is executed.	OFF (0)	No change	No change
01	Data Read Completed	Indicates that data has been successfully read to shared memory by means of data read command.	When data has been successfully read to shared memory the status of this bit either turns from OFF to ON or from ON to OFF, depending on its prior status.		OFF (0)	No change	No change
02	Y-axis Error Counter Overflow	Indicates whether error counter overflow has occurred.	When error counter overflow occurs.	When error reset or error counter reset is executed.	OFF (0)	No change	No change
03	EEPROM Write Completed	Indicates data has been successfully written to EEPROM.	When data has been successfully written to EEPROM.	When EEPROM write processing is again executed after writing is completed.	OFF (0)	No change	No change
04	Writing to EEPROM	Indicates that data is being written to EEPROM.	When data is being written to EEPROM.	When writing to EEPROM is complete (including when error occurs).	OFF (0)	No change	No change
05	Reading From EEPROM	Indicates that data is being read from EEPROM.	When data is being read from EEPROM.	When reading from EEPROM is complete.	OFF (0)	No change	No change
06	Interpolating Straight Line	Indicates that a straight-line interpolation is being executed.	During straight-line interpolation.	During single-axis positioning, during circular arc interpolation, and while stopped.	OFF (0)	OFF (0)	OFF (0)
07	Interpolating Circular Arc	Indicates that a circular arc interpolation is being executed.	During circular arc interpolation.	During single-axis positioning, during circular arc interpolation, and while stopped.	OFF (0)	OFF (0)	OFF (0)
08	PC Communications Disabled	Indicates that PC protect is in effect.	When PC protect is enabled from the Teaching Box or the PC.	When PC protect is not enabled from the Teaching Box or the PC.	OFF (0)	No change	No change
09	External Input Protect	Indicates that external input protect is in effect.	When external input protect is enabled from the Teaching Box or the PC.	When external input protect is not enabled from the Teaching Box or the PC.	OFF (0)	No change	No change

Bit	Name	Content	ON (1) condition	OFF (0) condition	Initial status	Wiring error status	System error status
10	Teaching Box Protect	Indicates that Teaching Box protect is in effect.	When the password is keyed in at the Teaching Box or when powering up.	When the password is keyed in at the Teaching Box.	ON (1)	No change	No change
11	External Display Connected	Indicates whether the External Display is connected.	When External Display connection is confirmed.	When External Display disconnection is confirmed.	Can be either ON or OFF.	No change	No change
12	Teaching Box Connected	Indicates whether the External Display is connected.	When Teaching Box connection is confirmed.	When Teaching Box disconnection is confirmed.	Can be either ON or OFF.	No change	No change
13	Teaching Box Ready	Indicates whether the Teaching Box is operable.	When the Teaching Box is connected and commands can be received.	When the Teaching Box is not connected or commands cannot be received.	Can be either ON or OFF.	No change	No change
14	PCU Ready	Indicates that PCU initialization was successfully completed after powering up.	When PCU initialization is completed	During initialization or when initialization fails.	Can be either ON or OFF.	No change	No change
15	Speeds Cleared	Indicates that all speeds have been cleared.	When CLR (the clear command) sets speeds to 0.	When one or more speeds are set to values other than 0.	Can be either ON or OFF.	No change	No change

Note The initial status settings are as shown below. The Teaching Box is not connected.



5-3-2 Error Code and System Error Flags

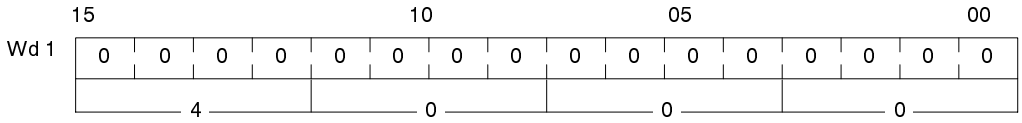
Refer to *Appendix C* for error codes.

Word D + 1

Bit	Name	Content	Set Condition	Reset Condition	Initial status	Wiring error status	System error status
0 to 3	Error Code	Indicates the rightmost digit of the error code that shows the cause of the error.	When a command error occurs.	When the next proper command is received.	0	No change	No change
4 to 7		Indicates the leftmost digit of the error code that shows the cause of the error.					

Bit	Name	Content	Set Condition	Reset Condition	Initial status	Wiring error status	System error status
8	X-Axis Command Error	Indicates command error affecting X-axis.	When error code of 32 to 35, 40, or 41 is generated for a servo control command.	When the next proper command is received.	0	No change	No change
9	Y-Axis Command Error	Indicates command error affecting Y-axis.	When error code of 32 to 35, 40, 41, or 59 to 61 is generated for a servo control command.	When the next proper command is received.	0	No change	No change
10	Interpolation Error	Indicates command error affecting interpolation.	When error code of 32 to 34, 36, 40, 41, or 59 to 61 is generated for a Start command.	When the next proper command is received.	0	No change	No change
11	System / Data Processing Error	Indicates command error affecting system or data processing.	When error code of 30 to 32, 54 to 58, 40, 41, or 80 is generated for a system or data processing command.	When the next proper command is received.	0	No change	No change
12	X-Axis System Error	Indicates system error affecting X-axis.	When error code of 10, 12, or 20 is generated.	When ERST (error reset) is processed.	0 or 1	No change	1
13	Y-Axis System Error	Indicates system error affecting Y-axis.	When error code of 11, 13, or 21 is generated.	When ERST (error reset) is processed.	0 or 1	No change	1
14	Communication s Error	Indicates communications error with Teaching Box or External Display.	When error code of 70 to 72 is generated.	When ERST (error reset) is processed.	0 or 1	No change	No change
15	Hardware Error	Indicates internal malfunction.	When error code of 00 to 02 is generated.	When ERST (error reset) is processed. Reset will not be possible for error codes of 01 or 02.	0 or 1	No change	No change

Note The initial status settings are as shown below. No errors are generated.

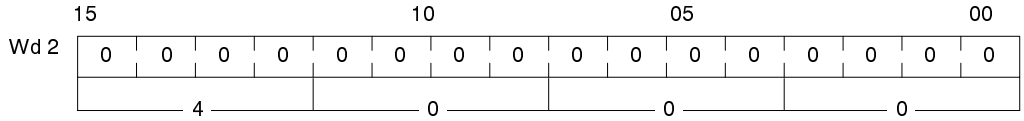


5-3-3 Error Op Codes

Word D + 2

Bit	Name	Content	Set Condition	Reset Condition	Initial status	Wiring error status	System error status
0 to 3	Error Op Codes	Indicates number of operands in BCD of preceding Op code.	When a command error occurs.	When the next proper command is received.	0	No change	No change
4 to 7		Indicates error-causing Op code rightmost digit in BCD.					
8 to 11		Indicates error-causing Op code middle digit in BCD.					
12 to 15		Indicates error-causing Op code leftmost digit in BCD.					

Note The initial status settings are as shown below. No errors are generated.



5-3-4 Status Flags (1)

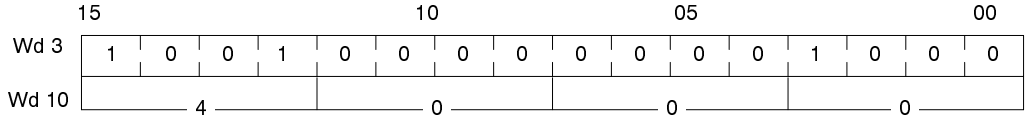
Command abbreviations are listed below the table (also see the beginning of *Section 6 Commands*). “X,” “Y,” and “I” indicate the X axis, Y axis, and interpolation and precede some commands. These prefixes are mostly dropped in the table because the flags are the same for the three different servo control modes.

X-Axis: Word D + 3
Y-Axis: Word D + 10

Bit	Name	Content	ON (1) condition	OFF (0) condition	Initial status	Wiring error status	System error status
00	Current Position Sign	Indicates current position as positive or negative.	When current position is negative (–).	When current position is zero (0) or positive (+), or when origin is not defined.	OFF (0)	OFF (0)	No change
01	Synchronous Start Waiting	Indicates that the second axis is waiting to start a synchronous operation after the first axis has started.	When a synchronous operation begins.	When one axis passes through the synchronous position; When external interrupt is received; When deceleration stop is implemented	OFF (0)	OFF (0)	OFF (0)
02	Pause	Indicates pause.	When HLD is received.	When REL, STP, or EMG is received, when external interrupt is received, or when system error occurs.	OFF(0)	OFF (0)	OFF (0)
03	Stop	Indicates positioning has stopped.	When there is no movement.	When SRT, JOG, ORG, or PLS is received.	ON (1)	ON (1)	OFF (0)

Bit	Name	Content	ON (1) condition	OFF (0) condition	Initial status	Wiring error status	System error status
04	Positioning	Indicates positioning.	When SRT is received.	When a terminating completion code is executed and positioning is completed, when a system error occurs, or when STP or external interrupt is completed.	OFF (0)	OFF (0)	OFF (0)
05	Jogging	Indicates jogging.	When JOG is received.	When STP or external interrupt completed or system error occurs.	OFF (0)	OFF (0)	OFF (0)
06	Servo-free	Indicates that servo-free is in effect.	When servo-free input is turned ON.	When servo-free input is turned OFF.	OFF (0)	OFF (0)	OFF (0)
07	Origin search	Indicates that origin search is in effect.	When ORG is received.	When origin search or STP is completed, or when a system error occurs.	OFF (0)	OFF (0)	OFF (0)
08	Positioning Completed	Indicates that positioning is completed.	After positioning ends and dwell time has expired.	When SRT is received or a system error occurs.	OFF (0)	OFF (0)	OFF (0)
09	Dwelling	Indicates that dwell time is active.	After positioning ends and dwell time starts.	When dwell time expires or emergency stop or system error occurs.	OFF (0)	OFF (0)	OFF (0)
10	Override	Indicates override coefficient other than 1.0.	When override command received is other than 1.0.	When 1.0 override command is received.	OFF (0)	No change	No change
11	Home Shift	Indicates home shift status.	When home shift enable is received.	When home shift disable is received.	OFF (0)	No change	No change
12	Distribution Completed	Indicates that a positioning operation has been completed.	The bit turns from OFF to ON or from ON to OFF, depending on its status before completion.		ON (1)	OFF (0)	No change
13	Distribution Started	Indicates that a positioning operation has been started.	The bit turns from OFF to ON or from ON to OFF, depending on its status before completion.		OFF (0)	OFF (0)	No change
14	Origin Set	Indicates that the origin has been established by positioning.	After ORG is completed, or when CCHG is received.	When there is a wiring error.	OFF (0)	OFF (0)	No change
15	Parameters Enabled	Indicates that all parameters are within established range.	When parameters are within established ranges.	When one or more parameters are outside established ranges.	Can be OFF (0) or ON (1).	No change	No change

Note The initial status settings are as shown below. Positioning is stopped, with the origin not yet established.



Command Codes

Prefixes: X = X axis, Y = Y axis, I = interpolation.

Main codes: SRT = start, STP = deceleration-stop, JOG = jogging, PLS = inching, ORG = origin search, OVR = override, HLD = pause, REL = pause release, and EMG = emergency stop.

Non-prefixing codes: END = command end, NOP = no operation, ERST = error reset, OUT = external output control, ACLR = all clear, CLR = clear, BCLR = block clear, STORE = EEPROM write (data save), RESTR = EEPROM read, READ = data read, MOV = data transfer, TEACH = teaching, CCHG = change current position, and HSFT = home shift.

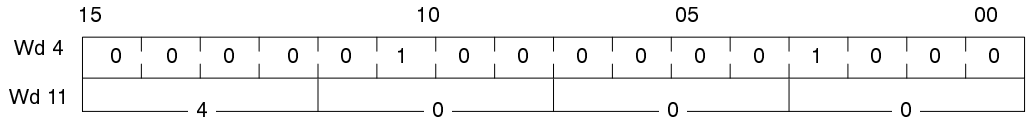
5-3-5 Status Flags (2)

X-Axis: Word D + 4
Y-Axis: Word D + 11

Bit	Name	Content	ON (1) Condition	OFF (0) Condition	Initial status	Error status
00	Origin Input	Indicates origin input status.	When origin input is ON.	When origin input is OFF.	0 or 1	No change
01	Servo-free Input	Indicates servo-free input status.	When servo-free input is ON (open).	When servo-free input is OFF.	0 or 1	No change
02	External Interrupt	Indicates external interrupt status.	When external interrupt input is ON.	When external interrupt input is OFF.	0 or 1	No change
03	CCWLS Input	Indicates CCW limit switch status.	When CCWLS input is ON (open).	When CCWLS input is OFF	0 or 1	No change
04	CWLS Input	Indicates CW limit switch status.	When CWLS input is ON (open).	When CWLS input is OFF.	0 or 1	No change
05	OUT1 Output	Indicates OUT1 status.	When OUT1 output is ON.	When OUT1 output is OFF.	0	No change
06	OUT2 Output	Indicates OUT2 status.	When OUT2 output is ON.	When OUT2 output is OFF.	0	No change
07	Origin	Indicates positioning at origin.	When stopped at zero.	When origin is not defined, when moving, when stopped at any point other than the origin, or when a system error occurs.	0	0
08	Deceleration Zone	Indicates position is within deceleration zone.	When current position and positioning destination differ by less than the set value.	When positioning or EMG is completed, or when a system error occurs.	0	0
09	Acceleration Zone	Indicates position is within acceleration zone.	When SRT or JOG is received.	When the starting position and current position differ by the set value, when STP is completed, or when a system error occurs.	0	0
10	In Position	Indicates the error counter status according to the set zone.	When error counter does not exceed in-position zone.	When error counter exceeds setting for in-position zone or when pulses are being input to counter.	0 or 1	No change

Bit	Name	Content	ON (1) Condition	OFF (0) Condition	Initial status	Error status
11	Decelerating	Indicates deceleration.	At the deceleration starting position.	When positioning action or STP ends.	0 or 1	0
12	Constant Speed	Indicates constant speed.	At acceleration end point.	At acceleration start point.	0	0
13	Accelerating	Indicates acceleration.	When SRT or JOG is received.	At constant speed point or deceleration point.	0	0
14	CCW Movement	Indicates CCW movement.	During CCW positioning actions.	When stopped, during CW positioning actions, or when movement is zero.	0	0
15	CW Movement	Indicates CW movement.	During CW positioning actions.	When stopped, during CCW positioning actions, or when movement is 0	0	0

Note The initial status settings are as shown below. The external inputs (CCWL, CWL, external interrupt, servo-free) are all properly connected. The external input status can be checked by the Teaching Box.



*See abbreviations list at the end of *5-3-4 Status Flags (1)*.

5-3-6 Current Position

X-Axis: Word D + 5
Y-Axis: Word D + 12

Leftmost Digits

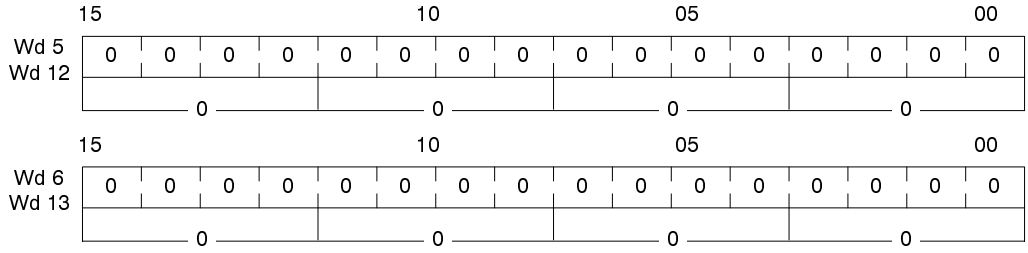
Bit	Function	Content	Updated	Cleared	Initially	On system error
0 1 2 3	Current position (leftmost 4 digits)	Designates current position in BCD (10^4 digit)	When the origin (either by ORG or CCHG) is established.	When wiring error occurs.	0	No change
4 5 6 7		Designates current position in BCD (10^5 digit)				
8 9 10 11		Designates current position in BCD (10^6 digit)				
12 13 14 15		Designates current position in BCD (10^7 digit)				

X-Axis: Word D + 6
Y-Axis: Word D + 13

Rightmost Digits

Bit	Function	Content	Updated	Cleared	Initially	On system error
0 1 2 3	Current position (rightmost 4 digits)	Designates current position in BCD (10^0 digit)	When the origin (either by ORG or CCHG) is established.	When wiring error occurs.	0	No change
4 5 6 7		Designates current position in BCD (10^1 digit)				
8 9 10 11		Designates current position in BCD (10^2 digit)				
12 13 14 15		Designates current position in BCD (10^3 digit)				

Note The initial status settings are as shown below. The present value indicates the value specified at the NC222-E, and not the feedback from the encoder.

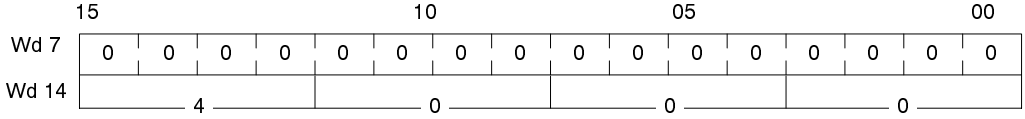


5-3-7 M Code

X-Axis: Word D + 7
Y-Axis: Word D + 14

Bit	Name	Content	Set condition	Reset condition	Initial status	System error
00 01 02 03	M code	Designates M code in BCD (10^0 digit)	When execution of a positioning action with a registered M code has been completed	When execution of a positioning action without an M code has been completed or when a system error occurs.	0	0
04 05 06 07		Designates M code in BCD (10^1 digit)				
08	Zone Execution Status	Indicates status for: (X: 487; Y: 887)	When within range: (X: 487; Y: 887)	When within range: (X: 487; Y: 887)	0	No change
09		Indicates status for: (X: 486; Y: 886)	When within range: (X: 486; Y: 886)	When within range: (X: 486; Y: 886)	0	No change
10		Indicates status for: (X: 485; Y: 885)	When within range: (X: 485; Y: 885)	When within range: (X: 485; Y: 885)	0	No change
11		Indicates status for: (X: 484; Y: 884)	When within range: (X: 484; Y: 884)	When within range: (X: 484; Y: 884)	0	No change
12		Indicates status for: (X: 483; Y: 883)	When within range: (X: 483; Y: 883)	When within range: (X: 483; Y: 883)	0	No change
13		Indicates status for: (X: 482; Y: 882)	When within range: (X: 482; Y: 882)	When within range: (X: 482; Y: 882)	0	No change
14		Indicates status for: (X: 481; Y: 881)	When within range: (X: 481; Y: 881)	When within range: (X: 481; Y: 881)	0	No change
15		Indicates status for: (X: 480; Y: 880)	When within range: (X: 480; Y: 880)	When within range: (X: 480; Y: 880)	0	No change

Note The initial status settings are as shown below. No positioning actions are executed.



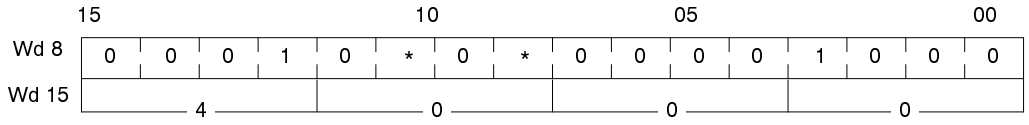
5-3-8 Multiplier and Current Positioning Action Address

X-Axis: Word D + 8
Y-Axis: Word D + 15

Bit	Name	Content	Set condition	Reset condition	Initial status	System error
0 1 2 3	Current Positioning Action Address	Designates current positioning action address in BCD (10^0 digit)	When power is turned on or when SRT is executed.	---	X: 100 Y: 500	No change
4 5 6 7		Designates current positioning action address in BCD (10^1 digit)				
8 9 10 11		Designates current positioning action address in BCD (10^2 digit)				

Bit	Name	Content	Set condition	Reset condition	Initial status	System error
12 13 14	Multiplier	Multiplier is designated 1, 2, or 4 in BCD.	When power is turned on or when the multiplier is changed.	---	Set value	No change
15	Positioning Action Clear	Indicates that all positioning actions are cleared.	When all positioning actions are cleared.	When even one positioning action is registered.	Can be OFF or ON.	No change

Note The initial status settings are as shown below. The asterisk (*) represents 1 for the X axis and 5 for the Y axis.

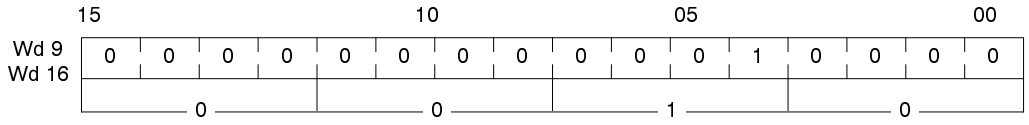


5-3-9 Current Speed Address and Override Coefficient

X-Axis: Word D + 9
Y-Axis: Word D + 16

Bit	Function	Content	Updated	Cleared	Initially	On system error
0 1 2 3	Override coefficient	Designates 10^{-1} digit of override coefficient in BCD.	When OVR is received.	---	10	No change
4 5 6 7		Designates 10^{0} digit of override coefficient in BCD.				
8 9 10 11	Current speed address	Designates current speed address in BCD (10^{0} digit).	When power is turned on or when a start command is received.	---	0	No change
12 13 14 15		Designates current speed address in BCD (10^{1} digits).				

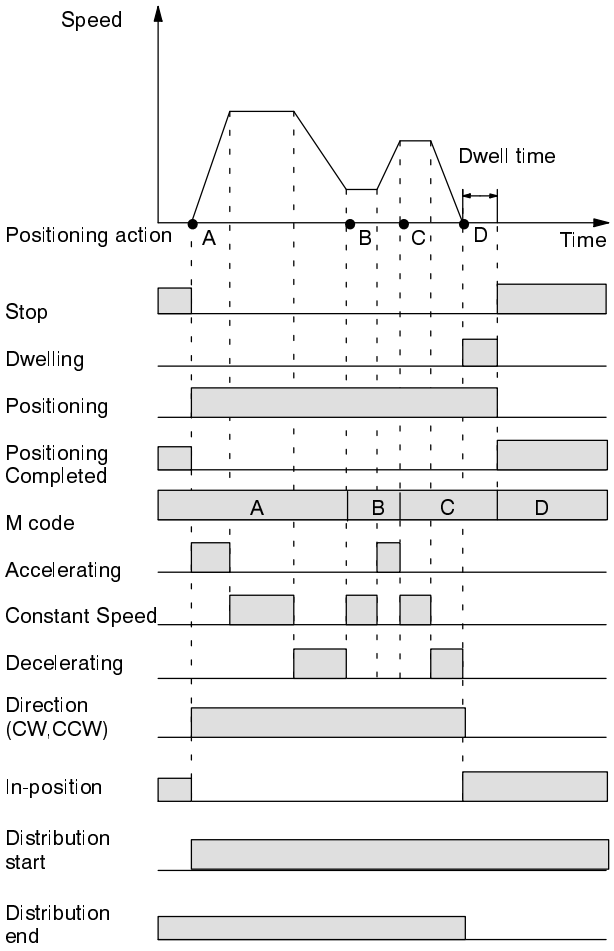
Note The initial status settings are as shown below. Override status ranges from 10% to 990%, in increments of 10%.



5-4 Flag Changes

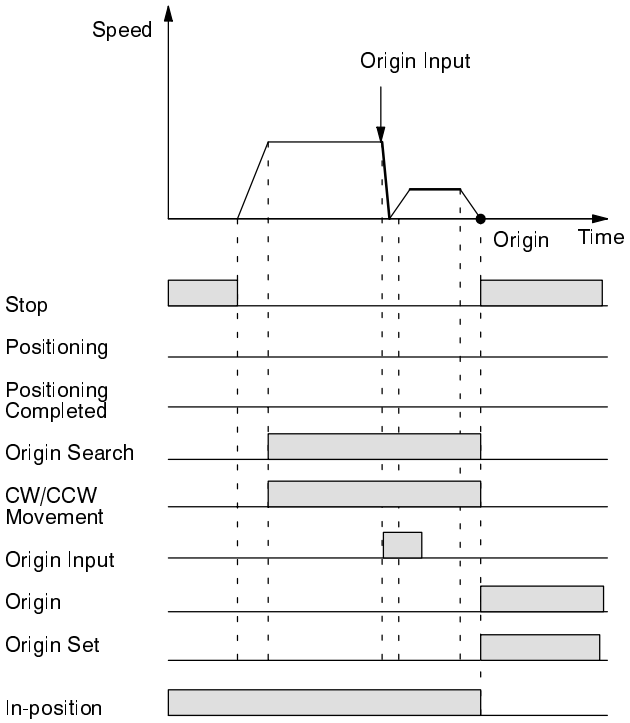
Flag Changes during Positioning

For ordinary positioning, flags change in the following manner, where the flags are set during the shaded times. The M codes for the positioning actions are indicated in this example with capital letters.



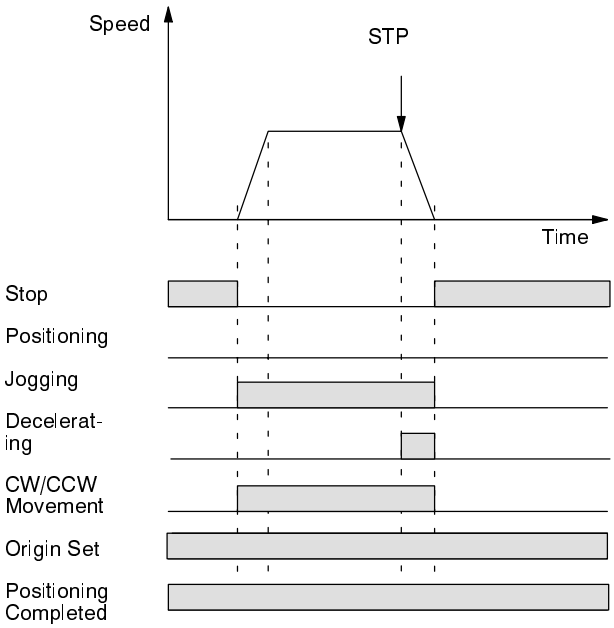
Flag Changes during Origin Search

During origin search, status flags change in the following manner. Flags are set during the shaded area.



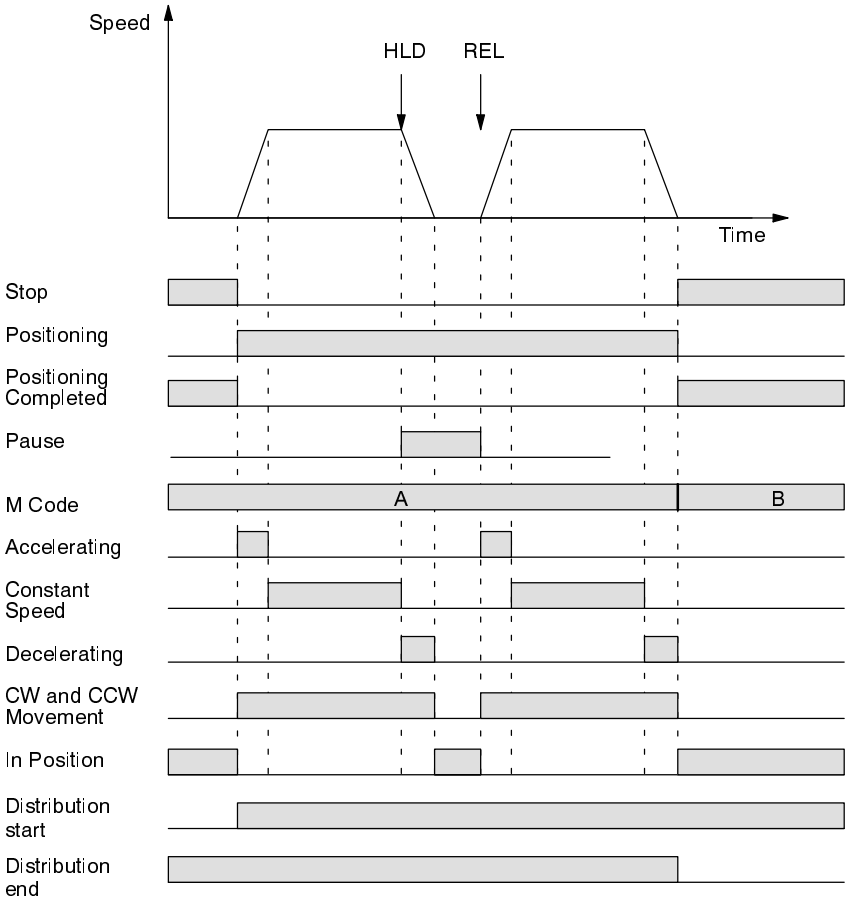
Flag Changes during JOG

During JOG operations, flags change in the following manner. Flags are set during the shaded areas.



Flag Changes for Pauses

Flags change in the following manner when HLD (Pause) and REL (Pause Release) are executed:



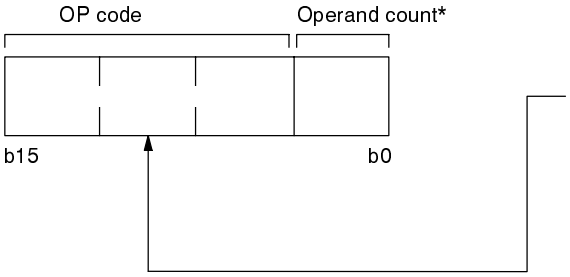
SECTION 6
Commands

This section describes the commands that are available to control PCU operation from the PC.

6-1 Command Format

There are three types of commands used. First, four system commands support other command processing. Second, the servo control commands operate the motors. Third, data processing commands handle data stored in the Position Control Unit.

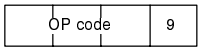
Each command comprises at least one data word with an OP code and an operand count. As the following layout shows, the OP code is unique for each command. The operand count usually designates the number (0-9) of additional data words assigned to the command. In this section, these accompanying data words are depicted below the OP code and operand word. If the number of additional data words exceeds 8, you enter 9 for the operand count, and an extra data word that follows provides the entry space for a larger operand count.

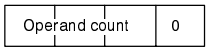


OP code

Contents		OP code	
		Leftmost digits	Rightmost digits
System commands		00	0-6
Servo control commands	X-axis	01	0-7
	Y-axis	02	0-7
	Interpolation	03	0-7
Data processing commands		04	0-6
		05	0-2

*Operand count equals value entered here if between 0 and 8. A “9” indicates that the following word contains the count, as follows:





In this case, the count must be between 9 and 125.

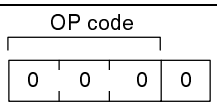
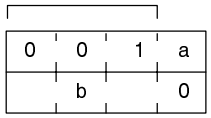
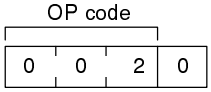
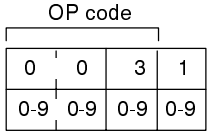
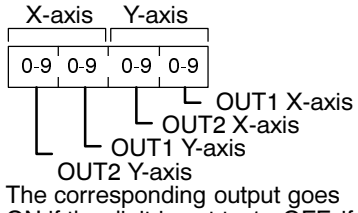
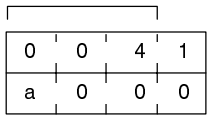
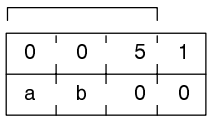
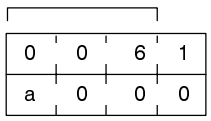
Command OP Code Allocations and Abbreviations

---			Rightmost digit									
Type		**Leftmost digits**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
System commands		00	END Command end	NOP No operation	ERST Error reset	OUT External output control	CREST Error count reset	SERVO Servo-free	WCHK Wiring check	---	---	---
Servo control commands	X-axis	01	XSRT Start	XSTP Deceleration stop	XJDG Jogging	XPLS Inching	XORG Origin search	XOVR Override	XHLD Pause	XREL Pause release	---	---
	Y-axis	02	YSRT Start	YSTP Deceleration stop	YJOG Jogging	YPLS Inching	YORG Origin search	YOVR Override	YHLD Pause	YREL Pause release	---	---
	Interpolation	03	ISRT Start	ISTP Deceleration stop	IJOG Jogging	IPLS Inching	IORG Origin search	IOVR Override	IHLD Pause	IREL Pause release	---	---
Data proceeding commands		04	ACLR All clear	CLR Clear	BCLR Block clear	STORE EEPROM write (data save)	RESTR EEPROM read	READ Data read	MOV Data transfer	---	---	---
		05	TEACH Teaching	CCHG Change current position	HSFT Home shift	---	---	---	---	---	---	---

6-2 Command Descriptions

6-2-1 System Commands

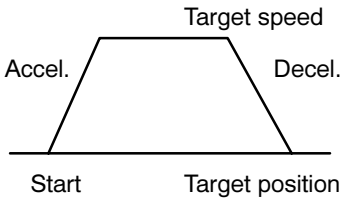
The following commands are used with WRITE(87) from the PC.

Name	Format	Function	Format explanation
Command end (END)		Indicates the end of a command train. For example, if this command is inserted in the middle of a group of commands, only the commands up to that point will be executed. This can be used to limit the use of commands.	
No operation (NOP)		Does not do anything, but can be used to skip commands by designating the number of words to be skipped. It can also be used to replace unnecessary commands in a group.	a.... Operand count: 0-9 b.... Extended operand count: 009 to 125 (when a is set to 9)
Error reset (ERST)		Clears error counter overflow and communications errors.	
External output control (OUT)		Designates external outputs ON or OFF.	 The corresponding output goes ON if the digit is set to 1 ; OFF, if set to 0 ; and unchanged, if 2-9.
Error counter reset (CREST)		Clears the error counter to 0, and sets the present value to 0. If an error counter overflow error occurs, it resets the error.	a....Axis selection 1: X-axis error counter reset 2: Y-axis error counter reset
Servo-free (SERVO)		Switches between servo-lock and servo-free.	a....X-axis servo-lock status 0: Servo-lock 1: Servo-free 2 to 9: Maintain existing status
Wiring check (WCHK)		Checks the designated axis for reversed or disconnected wiring, according to the parameter settings (419, 819). Execute this command while both axes are stopped. A command timing error will result if either axis is in operation.	a....Axis selection 1: X-axis error wiring check 2: Y-axis error wiring check

6-2-2 Servo Control Commands

The following commands are used with WRITE(87) for operations between the PC and PCU.

Start (XSRT, YSRT, ISRT)

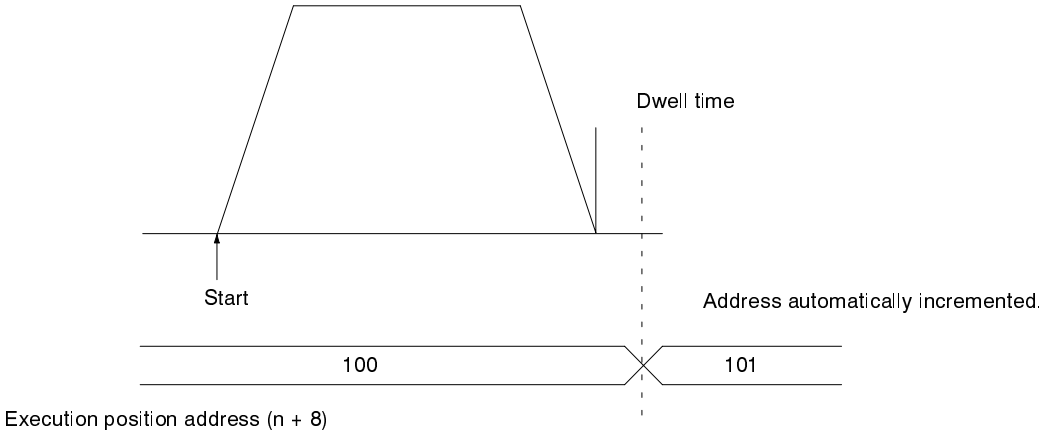
Name	Format	Function	Format explanation
Start (XSRT, YSRT, ISRT)	OP code 0 A 0 a 0 b 0 c 0 d 0 0	Positioning is executed according a positioning action as specified by the operand. 	A.....Axis designation 1: X-axis 2: Y-axis 3: Both axes a.....Operand number 0: Address specified according to internal address counter. 1 to 8: Operand number 9: Extension operand designation b.....Positioning action address (when a = 1 to 8) b.....Extension operand number 009 to 125 (when a = 9) c.....Synchronous positioning action address d.....Positioning action address

Application Example 1: Start Executed With No Operand (Operand Count = 0)

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	1	0	0

X-Axis Start

If the start is executed with no operand, then the positioning action indicated in word n + 8 will be executed. After execution, the address will be automatically advanced (i.e., auto-incremented).

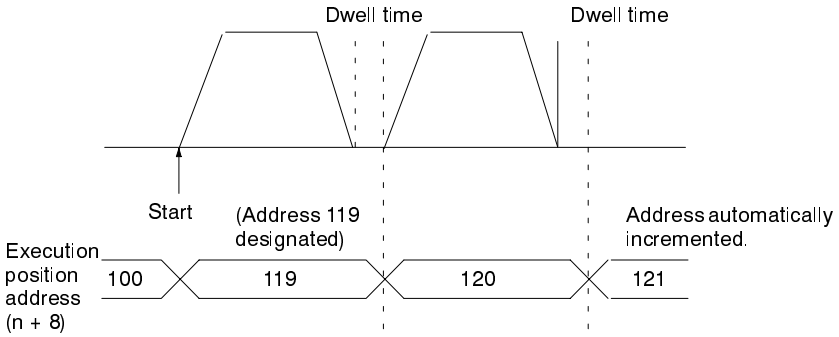


Application Example 1: Address Designated by Operands

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	1	0	2
n + 1	1	1	9	0
n + 2	1	0	7	0

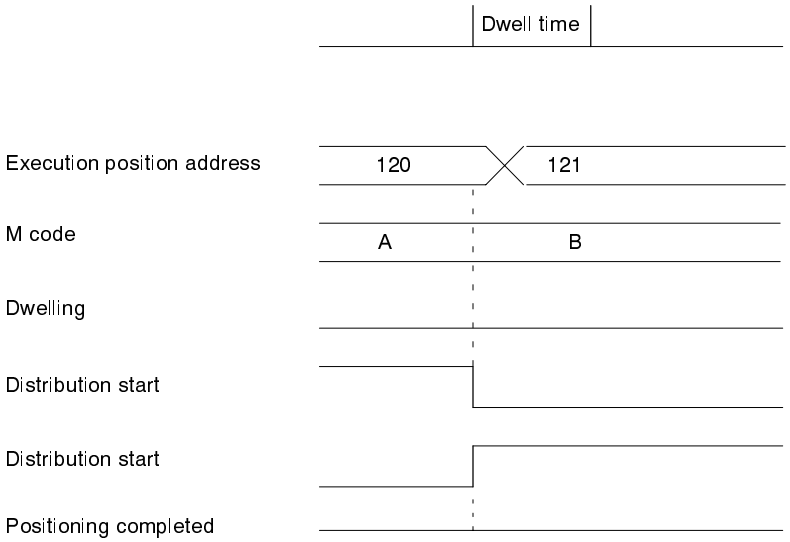
X-Axis Start

In this example, address 119 is designated for word n + 1, and address 107 is designated for word n + 2. When the start is executed in this case, i.e., with operands, the positioning actions designated by the operands will be executed without regard for the execution position address (n + 8). After the last address designated by an operand has been executed, the address will be automatically incremented.



(a) Positioning to the Same Position

When starting a positioning action with the same position indicated in the present value status (words n + 5 and n + 6), the dwell time will automatically be cancelled if one has been set. This also applies to increments of 0. In addition, the distribution start and end status bits will operate simultaneously.



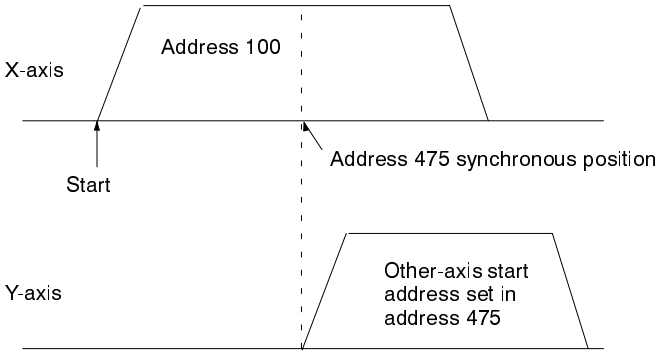
(b) Synchronous Starting

When a synchronous position is set in advance for a synchronous positioning action address, one axis will be started and the second axis will subsequently begin positioning while the first one is still operating.

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	1	0	1
n + 1	1	0	0	5

Because it has been entered in the X-axis start command, the Y-axis position action 475 will be indirectly designated. While positioning action 100 is still

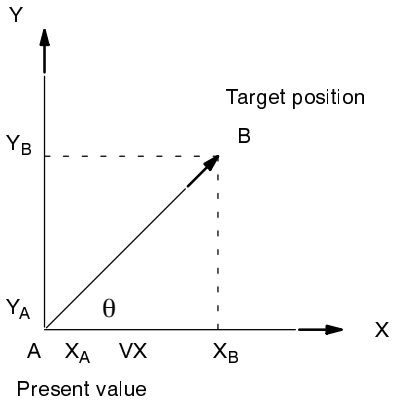
being executed along the X-axis, Y-axis positioning will be started from the address 475 synchronous position.



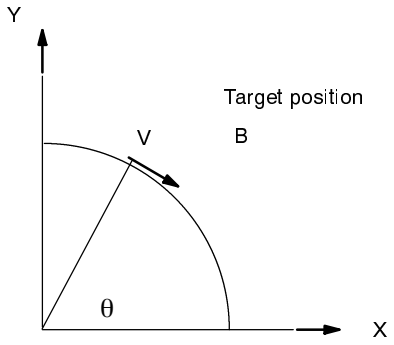
(c) Speed for Interpolation

The speed for interpolation is the speed for moving from A to B, which is registered for the X-axis in the interpolation data. The speeds for the X- and Y-axes are thus calculated as shown below, based on the relationship between the present value and the target position.

Straight Line Interpolation



Circular Arc Interpolation



X-axis speed: $VX = V\cos\theta$

Y-axis speed: $VY = V\sin\theta$

with

$$\tan\theta = \frac{\text{Y-axis (Target position – present value)}}{\text{X-axis (Target position – present value)}} = \frac{Y_A - Y_B}{Y_A - Y_B}$$

(d) Time from Reception of Start Command Until Output of Control Voltage

The time that elapses from when the NC222-E receives the start command to when it outputs the control voltage varies depending on the combination of positioning actions. In general, however, the following times can be considered fairly standard.

Start time / Pattern	Y-axis start with X-axis stopped	Y-axis start with X-axis operating	Both axes simultaneous start	Interpolation start
Pattern 0	30 to 35 ms	30 to 35 ms	35 to 40 ms	35 to 40 ms
Pattern 1 (No. of pos. actions ≤ 2)	30 to 35 ms	30 to 35 ms	35 to 40 ms	35 to 40 ms
Pattern 0 (No. of pos. actions ≥ 3)	35 to 40 ms	35 to 40 ms	35 to 40 ms	35 to 40 ms

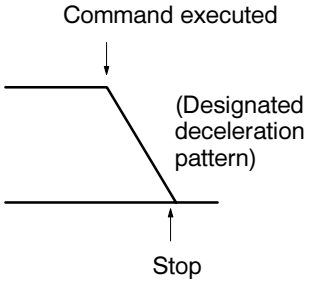
(e) Starting from the Teaching Box

When executing a start from the Teaching Box, the speed coefficient that has been set as a parameter is applied to the speeds that have been registered. Therefore positioning may be executed at speeds lower than those that have been registered.

Start speed from Teaching Box = Speed data x speed coefficient

In addition, positioning from the Teaching Box will only continue as long as the user continues to press the start key. When the key is released during positioning, the system will come to a deceleration stop.

Deceleration Stop (XSTP, YSTP, ISTP)

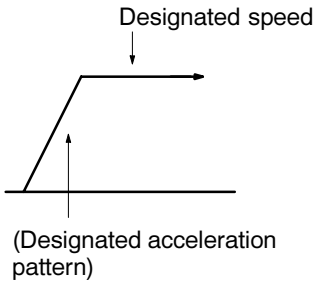
Name	Format	Function	Format explanation
Deceleration stop (XSTP, YSTP, ISTP)	OP code 0 A 0 a 0 0 a 0	Stops designated axes according to the designated acceleration and deceleration patterns. 	A.....Axis designation 1: X-axis 2: Y-axis 3: both axes a.....Acceleration and deceleration patterns: 0 to 9 X-axis addresses: 460 to 469 Y-axis addresses: 860 to 869

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	3	1	1
n + 1	0	0	2	0

Both axes are stopped by means of deceleration pattern 2 (X-axis address: 462; Y-axis address: 862).

Jogging (XJOG, YJOG, IJOG)

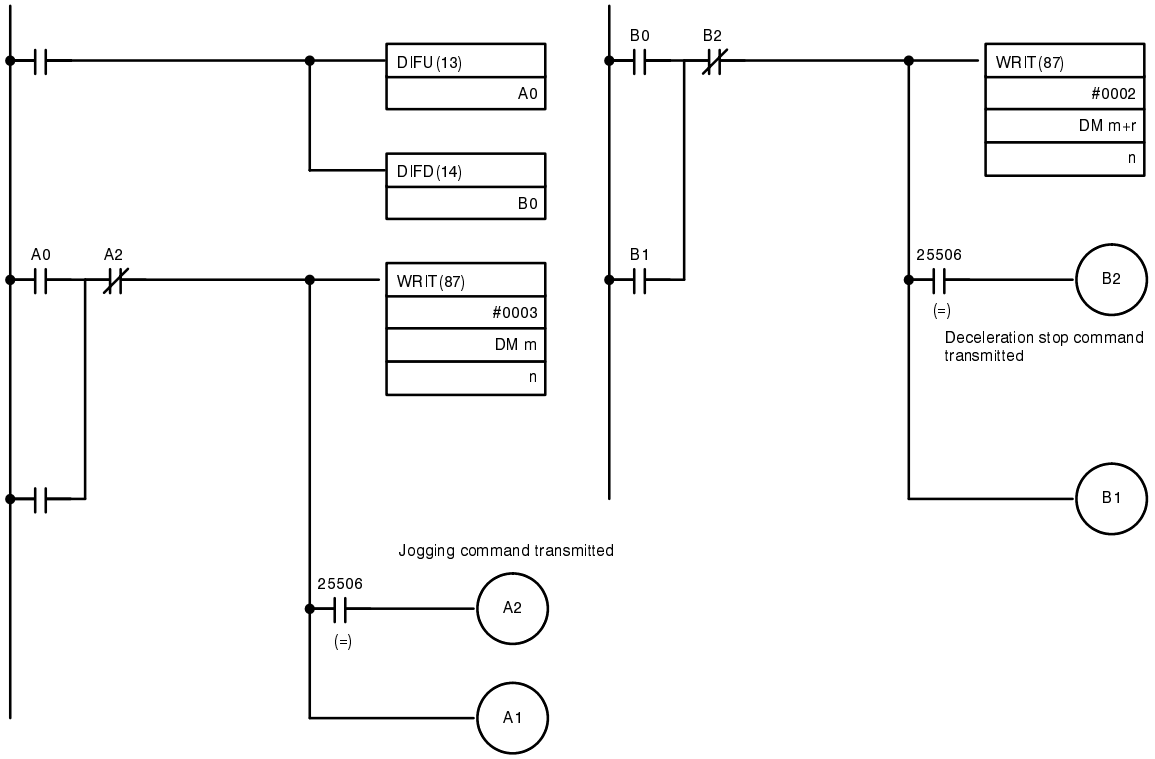
Name	Format	Function	Format explanation
Jogging (XJOG, YJOG, IJOG)	OP code 0 A 2 2 0 a b 0 0 c 0	Instructs jogging for designated axes. 	A.....Axis designation 1: X-axis 2: Y-axis 3: both axes a.....Acceleration and deceleration patterns: 0 to 9 X-axis addresses: 460 to 469 Y-axis addresses: 860 to 869

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	3	2	2
n + 1	0	1	2	0
n + 2	0	0	2	0

Jogging is executed along both axes at speed #12 (address 912) and acceleration/deceleration pattern 2 (X-axis address: 462; Y-axis address: 862).

When the jogging command is received, positioning will continue in the + direction at the designated speed as long as a stop instruction is not entered. To stop this operation, execute the deceleration stop command as shown below.



When executing jogging from the Teaching Box, jogging can be started and stopped by means of the direction keys after the data has been set. The jogging speeds and acceleration/deceleration patterns will be executed according to the parameter settings.

Inching (XPLS, YPLS, IPLS)

Name	Format	Function	Format explanation
Inching (XPLS, YPLS, IPLS)	OP code 0 A 3 1 a b	Moves the designated axis the designated number of pulses. All pulses are transmitted in one string. Number of pulses Inching	A.....Axis designation 1: X-axis 2: Y-axis 3: Both axes a.....Number of pulses (000 to 999) b.....Feeding direction 0: + direction 1: – direction

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	1	3	1
n + 1	1	0	0	0

The X-axis is moved for 100 pulses in the plus direction. When the Teaching Box is used for inching, the operation is carried out using the data registered in the parameters.

Origin Search (XORG, YORG, IORG)

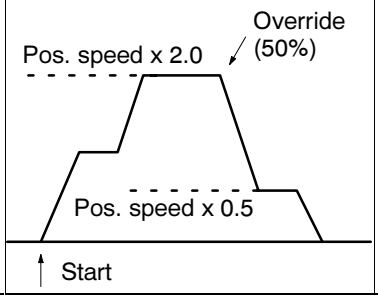
Name	Format	Function	Format explanation
Origin Search (XORG, YORG, IORG)	OP code 0 A 4 0	Performs origin search on designated axes. (For details, refer to *Section 7 Establishing the Origin.*)	A.....Axis designation 1: X-axis 2: Y-axis 3: Both axes

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	3	4	0

The origin is determined for both the X-axis and the Y-axis.

Override (XOVR, YOVR, IOVR)

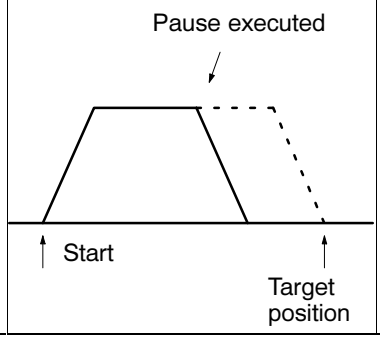
Name	Format	Function	Format explanation
Override (XOVR, YOVR, IOVR)	OP code 0 A 4 1 a	Designates the override coefficient for the positioning speed. Can be used to change the speed in the middle of a positioning action. Speeds can be changed within a range of 0.1% to 999.9% (in increments of 0.1%).  	A.....Axis designation 1: X-axis 2: Y-axis 3: Both axes a.....Override coefficient: 0001 to 9999 (0.1% increments)

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	2	5	1
n + 1	1	5	0	0

An override coefficient of 150% is executed for the Y-axis.

Pause (XHLD, YHLD, IHLD)

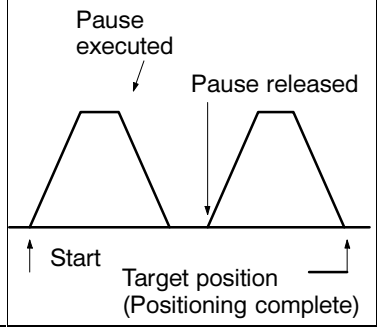
Name	Format	Function	Format explanation
Pause (XHLD, YHLD, IHLD)	OP code 0 A 6 0	Pauses positioning. 	A.....Axis designation 1: X-axis 2: Y-axis 3: Both axes

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	1	6	0

Positioning is paused on the X-axis.

Pause Release (XREL, YREL, IREL)

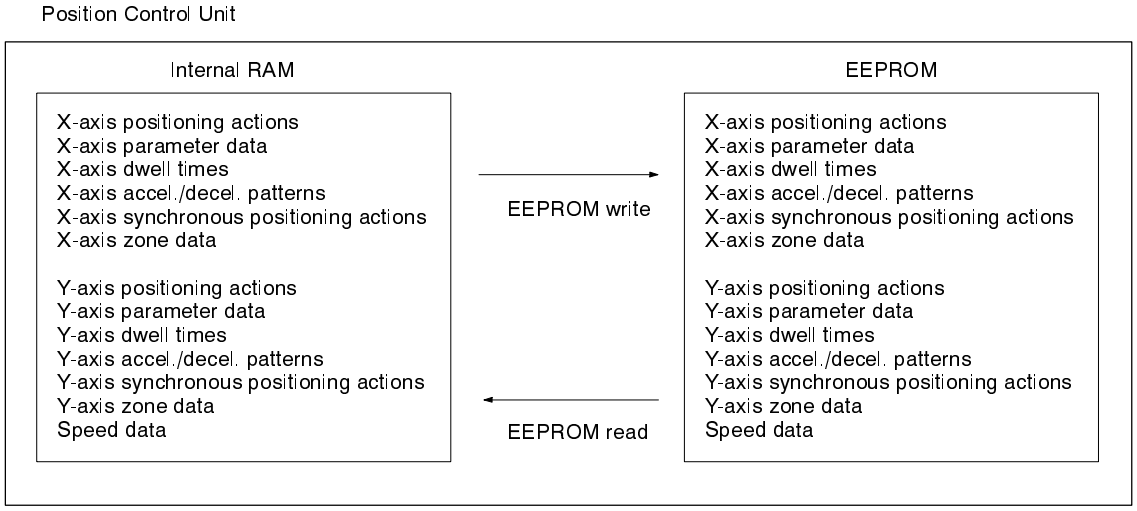
Name	Format	Function	Format explanation
Pause release (XREL, YREL, IREL)	OP code 0 A 7 0	Releases pause of positioning. 	A.....Axis designation 1: X-axis 2: Y-axis 3: Both axes

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	1	7	0

The pause is released on the X-axis.

6-2-3 Data Processing Commands



The following commands are used with WRITE(87) for operations within the PCU.

All Clear (ACLR)

Name	Format	Function	Format explanation
All clear (ACLR)	OP code 0 4 0 2 a b c d 0 e f g	Clears all or part of the internal RAM area data designated by the operand.	a.....Synchronous posit. actions b.....Speeds c.....Parameter data d.....Position actions e.....Zone data f.....Accel./decel. patterns g.....Dwell times Settings for all of the above: 0: Do not clear 1: Clear X-axis 2: Clear Y-axis 3: Clear both axes

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	4	0	2
n + 1	3	1	3	3
n + 2	0	3	3	3

All data in the internal RAM area is cleared.

Clear (CLR)

Name	Format	Function	Format explanation
Clear (CLR)	OP code 0 4 1 a b 0 c 0	Clears the data from the addresses designated by the operands.	a.....Operand count 1 to 8: Number of operands 9: Extended operand designation b.....Addresses to be cleared (when a = 1 to 8) c.....Addresses to be cleared or extended operand count: 009 to 125 (when a = 9)

When the operand count is set from 1 to 8, designate in words n + 1 onwards the addresses that are to be cleared. Designate the number of addresses that are specified in the operand count. For the extended operand designation, the range of settings is 009 to 125. From word n + 2 onwards, designate the addresses that are to be cleared. Designate the number of addresses that are specified in the extended operand count.

Addresses to be cleared:

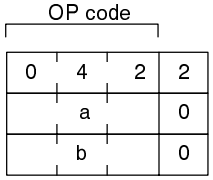
Positioning actions:	X-axis: 100 to 399	Y-axis: 500 to 799
Parameter data:	X-axis: 400 to 418	Y-axis: 800 to 818
Dwell time data	X-axis: 450 to 459	Y-axis: 850 to 859
Accel./decel. pattern data	X-axis: 460 to 469	Y-axis: 860 to 869
Synchronous pos. actions:	X-axis: 470 to 479	Y-axis: 870 to 879
Zone data:	X-axis: 480 to 489	Y-axis: 880 to 889
Speed data:	Both axes: 900 to 999	

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	4	1	2
n + 1	1	0	0	0
n + 2	5	0	0	0

The data for positioning action addresses 100 and 500 is cleared.

Block clear (BCLR)

Name	Format	Function	Format explanation
Block clear (BCLR)		Clears the data in the range of addresses designated by the operand (as long as the data is of the same type).	a.....Beginning address to be cleared b.....End address to be cleared

Range of addresses:

Positioning actions:	X-axis: 100 to 399	Y-axis: 500 to 799
Parameter data:	X-axis: 400 to 418	Y-axis: 800 to 818
Dwell time data	X-axis: 450 to 459	Y-axis: 850 to 859
Accel./decel. pattern data	X-axis: 460 to 469	Y-axis: 860 to 869
Synchronous pos. actions:	X-axis: 470 to 479	Y-axis: 870 to 879
Zone data:	X-axis: 480 to 489	Y-axis: 880 to 889
Speed data:	Both axes: 900 to 999	

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	4	2	2
n + 1	1	0	0	0
n + 2	3	9	9	0

All X-axis data (i.e., addresses 100 through 399) is cleared.

Write EEPROM (STORE)

Name	Format	Function	Format explanation
Write EEPROM (STORE)	OP code 0 4 3 2 a b c d 0 e f g	Writes data from internal RAM to EEPROM.	a.....Synchronous posit. actions b.....Speeds c.....Parameter data d.....Position actions e.....Zone data f.....Accel./decel. patterns g.....Dwell times Settings for all of the above: 0: Do not write 1: Write X-axis data 2: Write X-axis data 3: Write data for both axes

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	4	3	2
n + 1	1	3	1	1
n + 2	0	1	1	1

All X-axis data is written from RAM to EEPROM.

Read EEPROM (RESTR)

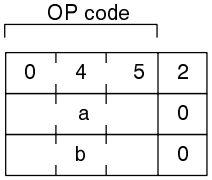
Name	Format	Function	Format explanation
Read EEPROM (RESTR)	OP code 0 4 4 2 a b c d 0 e f g	Reads data from EEPROM to internal RAM. This command executes automatically when power is turned on so that all data is read.	a.....Synchronous posit. actions b.....Speeds c.....Parameter data d.....Position actions e.....Zone data f.....Accel./decel. patterns g.....Dwell times Settings for all of the above: 0: Do not read 1: Read X-axis data 2: Read X-axis data 3: Read data for both axes

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	4	4	2
n + 1	2	3	2	2
n + 2	0	2	2	2

All Y-axis data is read from EEPROM to RAM.

Read Data (READ)

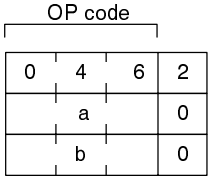
Name	Format	Function	Format explanation
Read data (READ)		Reads data from the designated data addresses to the status readout area (words 23 to 126). Does not read out the addresses themselves.	a.....Start address for read b.....Number of addresses to be read

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	4	5	2
n + 1	1	0	0	0
n + 2	0	1	0	0

The contents of X-axis positioning actions 100 to 109 are read (but not the addresses themselves).

Transfer Data (MOV)

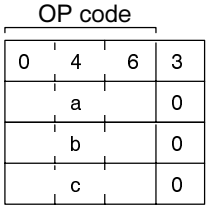
Name	Format	Function	Format explanation
Transfer data (MOV)		Transfers RAM data to another address. Transfer is not possible, however, between different types of data or between axes.	a.....Source address b.....Destination address

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	4	6	2
n + 1	1	0	0	0
n + 2	1	0	1	0

The contents of the X-axis positioning action at address 100 are transferred to address 101.

Block Transfer (BMOV)

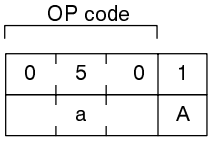
Name	Format	Function	Format explanation
Block transfer (BMOV)		Transfers multiple data words as blocks within RAM. Transfer is not possible, however, between different types of data or between axes.	a.....Source start address b.....Destination start address c.....Number of addresses to be moved

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	4	6	3
n + 1	1	0	0	0
n + 2	2	0	0	0
n + 3	0	1	0	0

Ten X-axis positioning actions, with addresses numbered from 100 to 109, are transferred to ten new addresses beginning with address 200.

Teaching (TEACH)

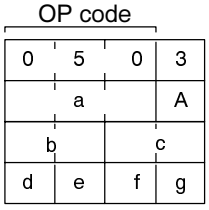
Name	Format	Function	Format explanation
Teaching (TEACH)		Stores the coordinates of the current position in a specified positioning action address on the designated axis. (When using interpolation, designate the address for the X-axis in a; the current position will also be set for the corresponding Y-axis.	a.....Position action address A.....Axis designation 1: X-axis 2: Y-axis 3: Both axes

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	5	0	1
n + 1	5	0	0	2

The current position is set to Y-axis address 500.

Data Teaching (DTEACH)

Name	Format	Function	Format explanation
Data teaching (DTEACH)		Stores current position for designated axis along with all non-position fields as a positioning action.	a.....Positioning action address A....Axis designation 1: X-axis 2: Y-axis 3: Interpolation b.....Speed address: 00 to 99 c.....M code: 00 to 99 d.....Dwell time address: 0 to 9 e.....Acceleration/deceleration pattern: 0 to 9 f.....Attributes: 0 to F g.....Positioning pattern: 0 to 7

Speed address 00 to 99: X-axis 900 to 949 and Y-axis 950 to 949

Dwell time addresses 0 to 9: X-axis 450 to 459 and Y-axis 850 to 859

Accel./decel. addresses 0 to 9: X-axis 460 to 469 and Y-axis 860 to 869

Attributes 0 to F:

Bit 4: Sign (0: Positive; 1: Negative)
Bit 5: Positioning method (0: ABS; 1: INC)
Bit 6: Interpolation data classification
00: No interpolation
01: Interpolation end point
10: Circular arc end point
11: Circular arc center point

Positioning pattern 0 to F:

Bit 0: Pattern (0: Pattern 0; 1: Pattern 1)
Bit 1: Circular arc interpolation method (0: CW; 1: CCW)
Bit 2: Positioning action enabled/disabled (0: Disabled; 1: Enabled)
Bit 3: Synchronous start enabled/disabled (0: Disabled; 1: Enabled)

Note Only ABS (absolute) can be used for the positioning method. Even if INC (incremental) is specified, it will be ignored.)

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	5	0	3
n + 1	1	0	0	3
n + 2	0	1	2	3
n + 3	2	0	4	0

The current position is stored to X-axis address 100 and Y-axis address 500, with the following settings: speed address 01; M code 23; dwell time address 2; acceleration/deceleration pattern address 0, ABS, interpolation end point, position pattern 0.

Change Current Position (CCHG)

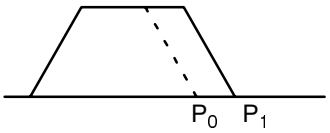
Name	Format	Function	Format explanation
Change current position (CCHG)	OP code 0 5 1 3 0 0 a A $x10^7$ $x10^6$ $x10^5$ $x10^4$ $x10^3$ $x10^2$ $x10^1$ $x10^0$	Changes the contents of the current position to the designated value for the designated axis.	a.....Direction digit 0: + 1: – A....Axis designation 1: X-axis 2: Y-axis

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	5	1	3
n + 1	0	0	0	1
n + 2	0	0	0	5
n + 3	0	0	0	0

The contents of the current position on the X-axis are changed to +50,000.

Home Shift (HSFT)

Name	Format	Function	Format explanation
Home shift (HSFT)	OP code 0 5 2 1 0 0 a b	When the digit in the designated data word field is 1, home shift is enabled for positioning that follows. Positioning is executed with the home shift data added to the positioning action data.  P_0: Positioning with home shift disabled. P_1: Positioning with home shift enabled.	a.....X-axis home shift 0: Disabled 1: Enabled 2 to 9: Maintains present condition b.....X-axis home shift Same as a.

Application Example

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	5	2	1
n + 1	0	0	1	1

Home shift is enabled for both axes.

6-3 Command Processing

Command Reception Conditions

The various commands can be received under the following conditions.

Command	Servo-lock	Servo-free
END NOP, OUT XOVR, YOVR, KIOVR	Reception is always possible.	Reception is always possible.
ERST	Can only be received when an error has been generated. At all other times it is ignored.	Can only be received when an error has been generated. At all other times it is ignored.
XHLD, YHLD, IHLD XSTP, YSTP, ISTP	Can only be received while Position Control Unit is operating. At all other times it is ignored.	The command is always ignored.
XREL, YREL, IREL	Can only be received while XHLD, YHLD, or IHLD is ON (i.e., during pause). At all other times it is ignored.	The command is always ignored.
XSRT, YSRT, ISRT	Can only be received while the PCU is stopped and when the origin setting has been completed.	A command error will result.
XJOG, YJOG, IJOG XPLS, YPLS, IPLS XORG, YORG, IORG	Can only be received while the PCU is stopped.	A command error will result.
TEACH, DTEACH	Can only be received while the PCU is stopped and when the origin setting has been completed.	Can only be received while the PCU is stopped and when the origin setting has been completed.
ACLR, CLR, BCLR STORE, RESTR READ, MOV CCHG HSFT CRESET SERVO	Can only be received while the PCU is stopped.	Can only be received while the PCU is stopped.
WCHK	Can only be received while the PCU is stopped.	The command is always ignored.

Command Completion Conditions

Command execution is completed when the following conditions are satisfied.

Command	Conditions for Completion of Command
END NOP, OUT XOVR, YOVR, KIOVR	---
ERST	When the error has been cleared, and the Wiring Error and Command Error status flags are OFF.
XSRT, YSRT, ISRT	When the target position has been reached (i.e., when the In-position Flag turns ON), and the dwell time is up. When a deceleration stop is executed, or when an over-traveling error is generated. When an error counter overflow occurs, or when an external interrupt is executed.

Command	Conditions for Completion of Command
XORG, YORG, IORG	When an origin search input has been entered, and origin search completed. When a deceleration stop is executed, or when an over-traveling error is generated. When an error counter overflow occurs, or when an external interrupt is executed.
XJOG, YJOG, IJOG	When a deceleration stop is executed, or when an over-traveling error is generated. When an error counter overflow occurs, or when an external interrupt is executed.
XPLS, YPLS, IPLS	When positioning has been carried out for the designated number of pulses. When an over-travelling error is generated, or when an error counter overflow occurs.
XSTP, YSTP, ISTP	When stopped (i.e., when the In-position and Stopped flags are ON). When an error counter overflow occurs, or when an external interrupt is executed.
XHLD, YHLD, IHLD	When the pause release command is executed. When a deceleration stop is executed, or when an over-traveling error is generated. When an error counter overflow occurs, or when an external interrupt is executed.
XREL, YREL, IREL	When the Pause Flag turns OFF and the operation that was in progress prior to the pause resumes.
STORE	When the EEPROM Write Completed Flag turns ON.
MOV	When the status of the Data Read Completed Flag is reversed.
TEACH, DTEACH ACLR, CLR, BCLR STORE, RESTR READ, MOV CCHG HSFT CRESET SERVO	---

Relationship between Flags and Commands

The following table shows which commands are valid when certain flags are ON. These are indicated as follows:

∅ Command acknowledged.
X Command ignored.
⊗ Command error results.

Condition / Command	Upon initialization	Stop	Deceleration Stop	Pause	Positioning	Origin Search	Jogging	Inching	Servo-free	Dwell Time
END	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅
NOP	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅
ERST	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅
OUT	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅
CRESET	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗
SERVO	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	X	⊗
SRT	⊗	∅	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
STP	X	X	∅	∅*1	∅	∅	∅	∅	X	∅
JOG	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
PLS	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
ORG	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
OVR	∅*2	∅*2	∅*2	∅*2	∅	∅	∅	∅	∅*2	∅*2
HLD	X	X	∅	X	∅	∅	∅	X	X	X

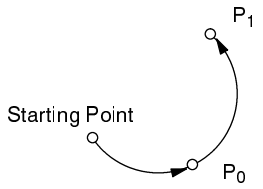
Condition / Command	Upon initialization	Stop	Deceleration Stop	Pause	Positioning	Origin Search	Jogging	Inching	Servo-free	Dwell Time
REL	X	X	X	∅	X	X	X	X	X	X
WCHK	∅	∅	X	X	X	⊗	⊗	⊗	⊗	⊗
ACLR	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗
CLR	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗
BCLR	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗
STORE	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗
RESTR	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗
READ	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅
MOV	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗
TEACH	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗
CCHG	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗
HSFT	∅	∅	⊗	⊗	⊗	⊗	⊗	⊗	∅	⊗

*1: Clears HLD and stops.
*2: The command is acknowledged, but is effective only from the next SRT.

6-4 Interpolation

For interpolated positioning, both X- and Y- motor axes operate together. Although the position field is used for both the X- and Y-axis positioning actions, all other positioning action parameters are taken from the X-axis fields only, and corresponding Y-axis fields are ignored.

For example, in the circular arc interpolation below the intermediate interpolation point P_0 and end point P_1 are selected.



Consider the command:

0	3	0	1	← Interpolation start with one operand
1	2	3	0	← Positioning action designating intermediate interpolation point

The OP code designates ISRT (interpolation start) with an operand count of 1 referring to the word for the single positioning action immediately below. The address 123 is an X-axis positioning action and assumed to be the intermediate interpolation point. The corresponding Y-axis positioning action is 523 (same last two digits). You must set the positioning action address with the circular arc interpolation command as the intermediate interpolation point.

The end point will automatically be searched in the address following the interpolation point address.

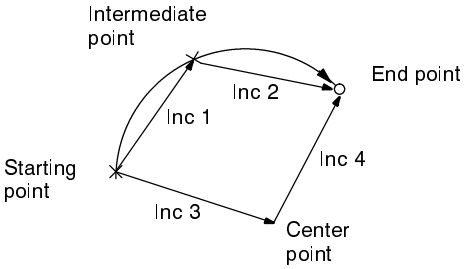
Position	Positioning action		X-axis data	Y-axis data	During interpolation	Remarks
P_0	Address		123	523	X=123 Y= 523	X-axis and Y-axis addresses automatically correspond through their last two digits.
	Position		P_0 (x)	P_0 (y)	X= P_0 (x) Y= P_0 (y)	Positive
	Speed		V_{0ad} (x)	V_{0ad} (y)	V_{0ad} (x)	100 <–> 500 101 <–> 501
	M code		M_0 (x)	M_0 (y)	There is no M code.	⋮
	Dwell time		DT_0 (x)	DT_0 (y)	Dwelling is disabled.	399 <–> 799
	Accel./decel. time		PT_0 (x)	PT_0 (y)	---	
	Attribute 1	Position field sign	Positive	Positive	Positive	
		Position type	ABS	ABS	ABS	
		Interpolation code	Intermediate point	No interpolation	Intermediate point	
	Attribute 2	Completion code	0	0	0	---
		Circular arc interpolation direction	CW	CCW	Automatically determined	
		Positioning action enable	Enabled	Enabled	Enabled	X and Y axes must both be enabled to avoid an error.
		Synchronous start enable	Disabled	Disabled	Disabled	---
P_1	Address		124	524	X=124 Y= 524	---
	Position		P_1 (x)	P_1 (y)	X=P_1 (x) Y=P_1 (y)	
	Speed		V_{1ad} (x)	V_{1ad} (y)	V_{0ad} (x)	
	M code		M_1 (x)	M_1 (y)	M_1 (x)	
	Dwell time		DT_1 (x)	DT_1 (y)	DT_1 (x)	
	Accel./decel. time		PT_1 (x)	PT_1 (y)	---	
	Attribute 1	Position field sign	Positive	Positive	Positive	
		Position type	ABS	ABS	ABS	
		Interpolation code	End point	Circular arc center	End point	

Position	Positioning action		X-axis data	Y-axis data	During interpolation	Remarks
P_1	Attribute 2	Completion code	0	0	0	---
		Circular arc interpolation direction	CW	CW	CW	
		Positioning action enable	Enabled	Enabled	Enabled	
		Synchronous start enable	Disabled	Disabled	Disabled	

Circular Arc Interpolation

Incremental Positions

When using incremental positions for circular arc interpolation, the increments for the intermediate or center point are measured from the starting point and the increments for the end point are measured from the intermediate or center point.



Program Example

The following table presents a short list of hypothetical positioning actions. For specific field entries, refer to *3-4 Setting Positioning Actions*.

Address	Position	Interpolation Code	Positioning Action Enable
123	P_0X	10*1	1 (Enabled)
124	P_1X	01*2	1 (Enabled)
125	P_2X	10*1	1 (Enabled)
126	P_3X	01*2	1 (Enabled)

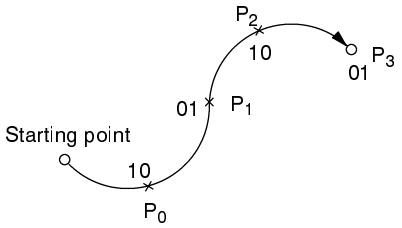
Completion code	Address	Position
1	523	P_0Y
1	524	P_1Y
0	525	P_2Y
0	526	P_3Y

*1: Circular arc intermediate point

*2: Interpolation end point

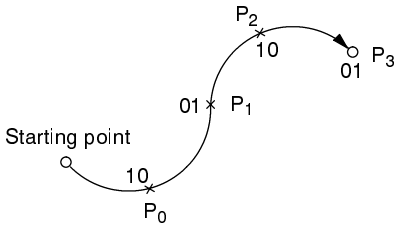
ISRT from Address 123

The figure below shows the resulting operation.



ISRT with Address 124 Disabled

In this case the positioning action of address 124 is processed normally since it is an end point; furthermore, address 123 remains enabled as an intermediate point. The entire operation proceeds normally.



ISRT with Improper Interpolation Codes

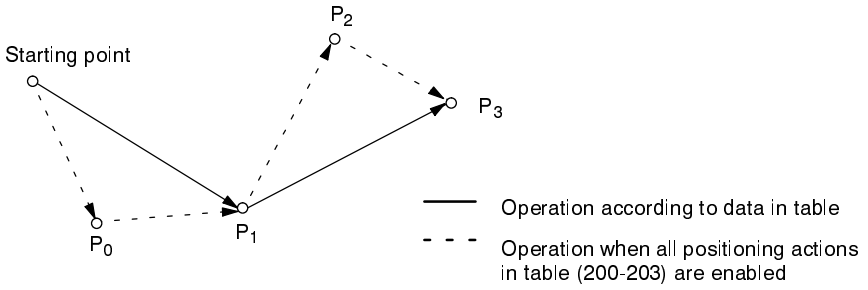
In this case a circular arc cannot be created with the designated positions, and a circular arc data error occurs. Remember, two consecutive positioning actions must comprise circular arc positioning. The first address must store the circular arc center (interpolation code 11) or circular arc intermediate point (interpolation code 10), and the second address must store the interpolation end point (interpolation code 01).

Straight-Line Interpolation

The following table presents a hypothetical list of positioning actions all with interpolation code 01 (as end points). The accompanying figure shows two interpolation routes. The solid line from the starting point to P_1 and then to P_3 obeys data in the table, because addresses 200 and 202 are disabled. If all addresses 200-203 were all enabled, positioning would follow the broken line in the figure.

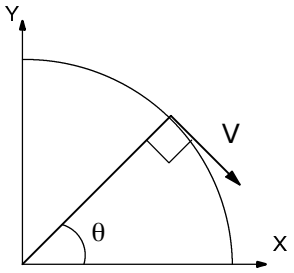
Address	Position	Interpolation Code	Positioning Action enabled
200	P_0X	01	Enabled
201	P_1X	01	Disabled
202	P_2X	01	Enabled
203	P_3X	01	Disabled

Completion code	Address	Position
1	600	P_0X
1	601	P_1X
1	602	P_2X
0	603	P_3X

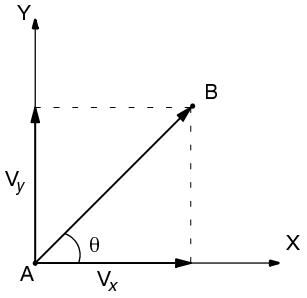


Interpolation Speeds

The speed set for the X-axis will be used for linear and circular interpolation. For circular arc interpolation, this speed will be the speed along the tangent to the arc, as shown below.



For linear interpolation, the speeds along the X- and Y-axes can be determined as follows:



$V_x = V\cos\theta$

$V_y = V\sin\theta$

6-5 Relation between SRT and Positioning Actions

The following table shows the positioning action fields pertinent to execution of XSRT, YSRT, and ISRT which initiate X-axis positioning, Y-axis positioning, and interpolated (both X- and Y-axes) positioning, respectively. If any pertinent fields have erroneous data, then a command error occurs. Designating XSRT or YSRT for interpolated positioning actions will refer only to the respective X or Y positioning actions. Only a single axis will operate.

Key. *: Data in this field is used. –: Data in this field unused. 0/1: Fixed data for the particular operation.

Axis	Field or field bit	X-axis positioning	Y-axis positioning	X-axis continuous positioning		Straight line interpolation	Continuous straight-line interpolation		Circular arc interpolation (using intermediate point)		Circular arc interpolation (using center)	
				First address	Next address		First address	Next address	First address	Next address	First address	Next address
X	Position	*		*	*	*	*	*	*	*	*	*
	Speed	*		*	*	*	*	*	*	-	*	-
	M code	*		*	*	*	*	*	-	*	-	*
	Dwell time	*		-	*	*	-	*	-	*	-	*
	Acceleration and deceleration time	*		*	*	*	*	*	-	-	-	-
	Interpolation code	00		00	00	01	01	01	10	01	11	01
	Position type	*		*	*	*	*	*	*	*	*	*
	Position field sign 1	*		*	*	*	*	*	*	*	*	*
	Synchronous start enable	*		*	*	-	-	-	-	-	-	-
	Positioning action enable	1		1	1	1	1	1	1	-	1	-
	Circular arc interpolation direction	-		-	-	-	-	-	-	-	*	-
	Completion code	0		1	0	0	1	0	0/1	-	0/1	-
Y	Position		*			*	*	*	*	*	*	*
	Speed		*			-	-	-	-	-	-	-
	M code		*			-	-	-	-	-	-	-
	Dwell time		*			-	-	-	-	-	-	-
	Acceleration and deceleration time		*			-	-	-	-	-	-	-
	Interpolation code		00			-	-	-	-	-	-	-
	Position type		*			*	*	*	*	*	*	*
	Position field sign		*			*	*	*	*	*	*	*
	Synchronous start enable		*			-	-	-	-	-	-	-
	Positioning action enable		1			1	1	1	1	-	1	-
	Circular arc interpolation direction		-			-	-	-	-	-	-	-
	Completion code		0			-	-	-	-	-	-	-

Example: Circular Arc Interpolation

In this example, the command is entered in word n and the interpolation midpoint is entered in word n + 2.

Wd \ Bits	12 to 15	08 to 11	04 to 07	00 to 03
n	0	3	1	1
n + 1	1	2	3	0

SECTION 7
Establishing the Origin

The section describes how to establish the origin, either by defining the current position as the origin or by using origin and limit inputs to establish the mechanical origin.

7-1 Changing Current Position (CCHG)

Before positioning, it is necessary to establish the origin as a reference point, by means of either CCHG (changing current position), CRESET (error count reset) or ORG (origin search). Use CCHG if it is difficult to establish the origin inputs mechanically or if you constantly need to re-establish the origin. Turn on the power, and move the workpiece to the desired origin position by jogging (JOG) or inching (PLS). Enter 0.0 with the CCHG command to establish the current position as the origin. CCHG is only effective when not positioning. During operation CCHG causes a command error.

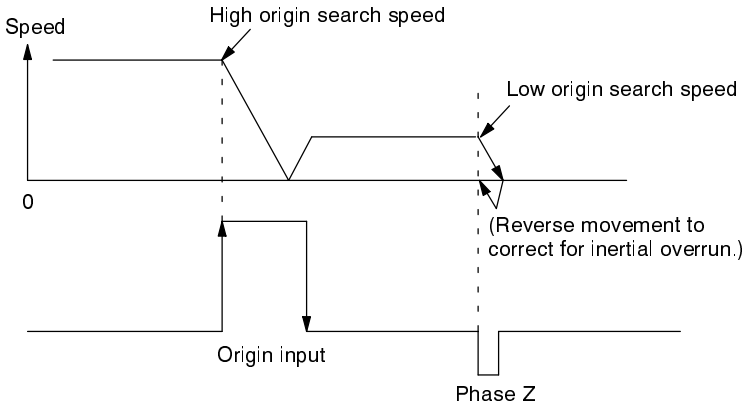
7-2 Error Count Reset (CRESET)

Like CCHG, this command sets the current position at 0.0, but it also sets the error count to 0.0. Also like CCHG, this command is valid only while positioning is stopped. Executing it during operation causes a command error.

7-3 Origin Search (XORG, YORG, IORG)

Origin search establishes the absolute mechanical origin with the origin search commands XORG, YORG or IORG by using the CW and CCW limits (Refer to *Section 6 Commands*). This function establishes the origin at the phase Z of the encoder based on the origin input.

When the origin search starts, the dog approaches the origin input at the high origin search speed (parameter stored at addresses 415 for the X-axis and 815 for the Y-axis). At the leading edge of the origin input, the speed slows and movement comes to a halt and then movement starts again at the low origin search speed (parameter stored at addresses 417 for the X-axis and 817 for the Y-axis). The motor axis (or axes) stops at the first phase Z pulse after the origin input goes OFF during the low origin search speed. Any movement beyond the edge due to inertia is corrected by reverse movement.



(First Z phase after origin input goes OFF during low origin search speed.)

For accurate origin search use a dog with a sufficient length to allow deceleration from the high origin search speed to the low origin search speed. If the dog is too short use a lower high origin search speed. In addition, if an override is executed during origin search, the low origin search speed may exceed 10,000 pps. This may prevent the Z phase signal from being picked up.

Search Patterns

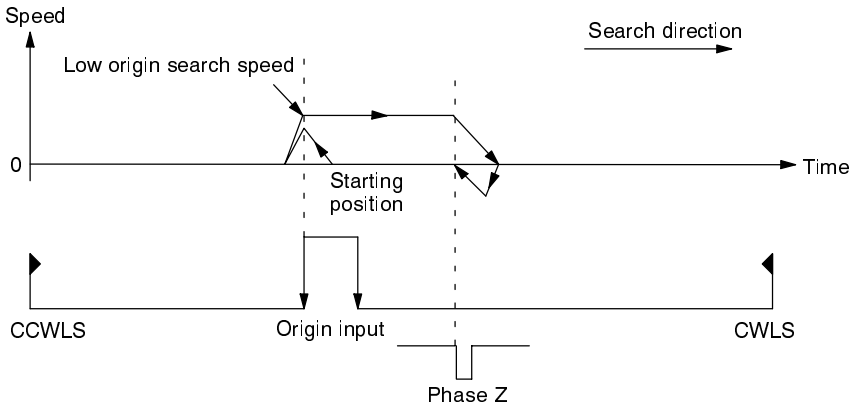
There are three origin search patterns possible according to the dog position at the start of the search and the search direction parameter. The following

examples all search clockwise. These three patterns are possible for counterclockwise searches as well.

Search Starting on Origin Input

1, 2, 3...

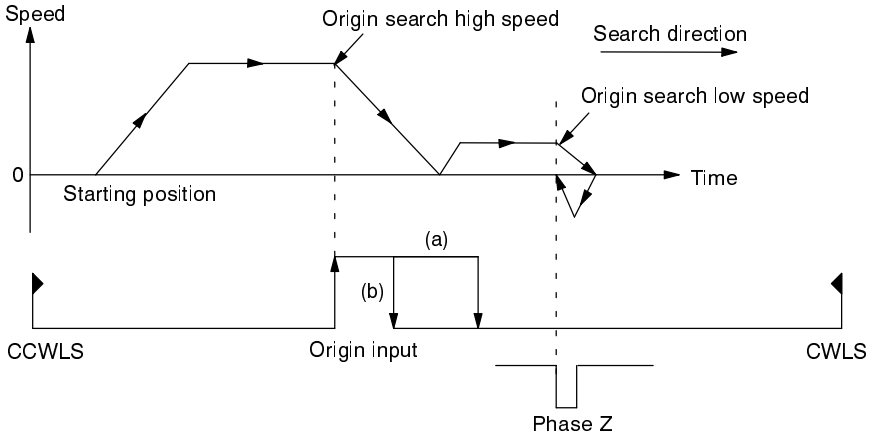
1. Movement starts in the direction opposite to the search direction at low origin search speed.
2. Movement stops and reverses direction at the trailing edge of the origin input.
3. The origin is established at the first phase Z pulse after the leading and trailing edges of the origin input.



Search Starting between CCW Limit Input and Origin Input

1, 2, 3...

1. Movement starts in the search direction at high origin search speed.
2. Movement slows to low origin search speed at the leading edge of the origin input.
3. The origin is established at the first phase Z pulse after the trailing edge of the origin input.

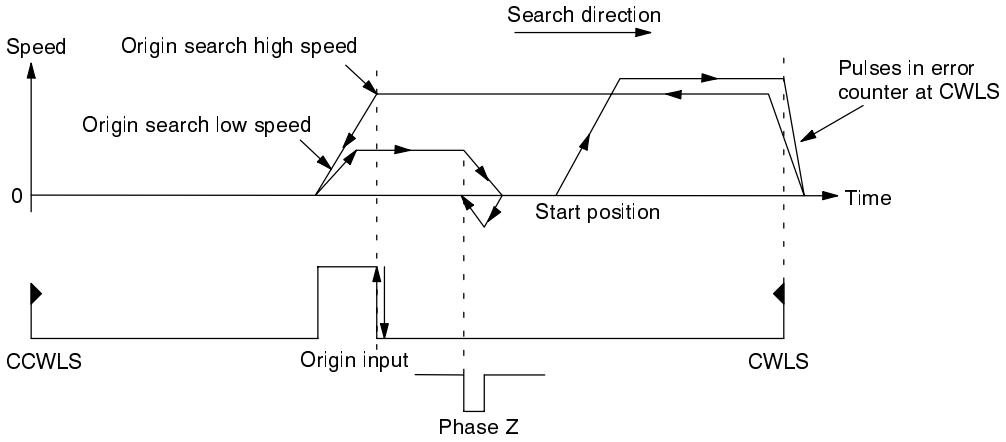


Search Starting between CW Limit Input and Origin Input

1, 2, 3...

1. Movement starts in the search direction at high origin search speed.
2. Movement stops and reverses direction at the CW limit input.
3. Movement stops at the leading edge of the origin input, reverses direction, and continues at low origin search speed.

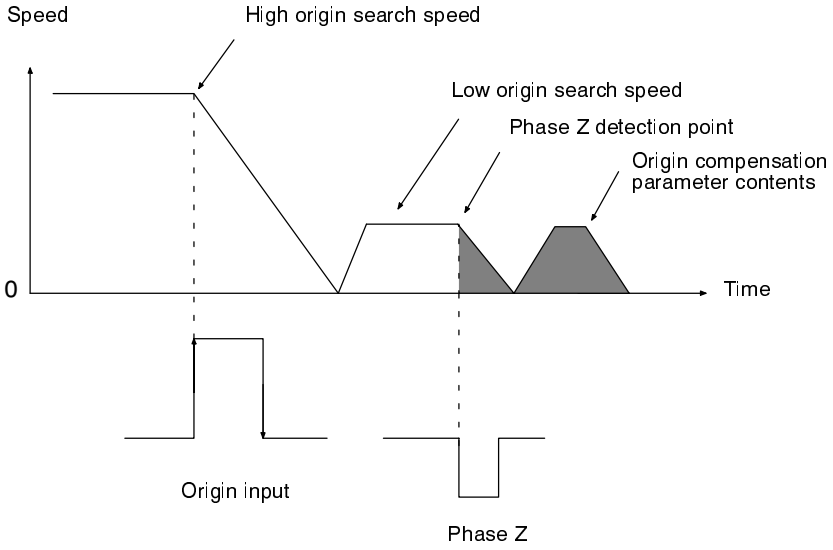
4. The origin is established at the first phase Z pulse after the trailing edge of the origin input.



Note When origin search is executed by the Teaching Box, after the origin search has been carried out, the distance between the origin input and the Z phase will be displayed. (When the pulse rate and the unit of conversion have been set, the unit will be converted for display.) Use the origin input and Z phase position adjustment.

7-4 Origin Compensation

The encoder phase Z position may not always designate the mechanical origin as desired. Sometimes the origin may be preferred a few pulses CW or CCW from the phase Z pulse. In order to correct the origin's position, set the origin compensation parameter (addresses 414 for the X-axis and 814 for the Y-axis) with the amount of compensation desired. Once the parameter is set, the origin is established according to the desired compensation from the phase Z pulse detected during origin search.



SECTION 8
Programming Examples

This section provides example PC programs along with the commands and sample data used to achieve various types of positioning actions.

8-1 Data Word Allocations

The lowercase letters j, k, l, m, and n designate the IR and DM area words for the programming examples in this section. The Position Control Unit is mounted on word n for output and word n+1 for input. The value n depends on the mounting position of the Position Control Unit. The following DM area entries for commands and positioning actions should be cross-referenced to programming examples that follow. Refer to the formats for commands *6-1 Command Format* and positioning actions *3-4 Setting Positioning Actions*.

Command DM Area (m-m+32)

Bit / DM No.	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0	Remarks
m	0	1	0	1	Positioning to point A (*8-3-1 Positioning to a Single Point (X Axis)*).
m+1	1	0	0	0	
m+2					
m+3	0	3	0	1	Straight-line interpolation to origin (*8-3-3 Straight-Line Interpolation to a Single Point (X/Y Axis)*).
m+4	1	0	2	0	
m+5					
m+6	0	3	0	1	Circular arc interpolation with center designation (*8-3-4 Circular Arc Interpolation (Center Designated)*).
m+7	1	0	3	0	
m+8					
m+9					
m+10	0	3	0	1	Circular arc interpolation with intermediate point designation (*8-3-5 Circular Arc Interpolation (Intermediate Point Designated)*)
m+11	1	0	5	0	
m+12					
m+13					
m+14					
m+15					
m+16	0	2	0	1	Positioning to point C via point B (*8-3-2 Positioning to a Single Point (Y Axis)*).
m+17	5	0	0	0	
m+18					
m+19					
m+20	0	3	0	3	Straight-line interpolation
m+21	1	0	2	0	Circular arc center
m+22	1	0	3	0	Circular arc intermediate point
m+23	1	0	4	0	Series of interpolation commands
m+24					Continuous interpolated positioning (*8-3-6 Continuous Positioning*)
m+25					
m+26					
m+27					
m+28					
m+29					
m+30					

Bit / DM No.	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0	Remarks
m+31					
m+32					

Positioning Actions in DM Area

Bit / DM No.	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0	Remarks
k	1	0	0	4	X-axis address 100, point A
k+1	0	0	0	1	
k+2	0	0	0	0	
k+3	0	2	1	0	
k+4	1	5	0	4	X-axis address 102, origin
k+5	1	0	2	4	(straight-line interpolation end point)
k+6	0	0	0	0	
k+7	0	0	0	0	
k+8	0	1	3	0	
k+9	1	5	4	4	
k+10	1	0	3	4	X-axis address 103,Point C (circular arc center)
k+11	0	0	0	1	
k+12	0	0	0	0	
k+13	0	2	0	0	
k+14	0	0	C	6	
k+15	1	0	4	4	X-axis address 104, (interpolation end point)
k+16	0	0	0	0	
k+17	0	0	0	0	
k+18	0	2	3	0	
k+19	1	5	4	4	
k+20	1	0	5	4	X-axis address 105, point D (interpolation end point)
k+21	0	0	0	0	
k+22	0	0	0	0	
k+23	0	2	0	0	
k+24	0	0	8	5	
k+25	1	0	6	4	X-axis address 106, point C
k+26	0	0	0	1	
k+27	0	0	0	0	
k+28	0	2	0	0	
k+29	1	5	4	5	
k+30	1	0	7	4	X-axis address 107, point A
k+31	0	0	0	1	
k+32	0	0	0	0	
k+33	0	0	0	0	
k+34	0	0	8	4	
k+35	1	0	8	4	X-axis address 108, origin

Bit / DM No.	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0	Remarks
k+36	0	0	0	0	
k+37	0	2	3	0	
k+38	0	2	3	0	
k+39	1	5	4	4	

Bit / DM No.	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0	Remarks
k+50	5	0	0	9	
k+51	0	0	9	0	
k+52	0	0	0	0	Y-axis address 500, point B
k+53	5	0	0	0	
k+54	0	3	2	0	
k+55	1	0	0	5	
k+56	0	0	0	1	Y-axis address 501, point C
k+57	0	0	0	0	
k+58	0	1	2	1	
k+59	1	1	0	4	
k+60	0	0	0	0	Y-axis address 502, origin (straight-line interpolation end point)
k+61	0	0	0	0	
k+62	0	2	3	0	
k+63	1	1	4	4	
k+64	0	0	0	1	Y-axis address 503, point C (circular arc center)
k+65	0	0	0	0	
k+66	0	2	0	0	
k+67	0	0	C	6	
k+68	0	0	0	0	Y-axis address 504, origin (interpolation end point)
k+69	0	0	0	0	
k+70	0	2	3	0	
k+71	1	5	4	4	
k+72	0	0	0	1	Y-axis address 505, point D (circular arc intermediate point)
k+73	0	0	0	0	
k+74	0	2	0	0	
k+75	0	0	8	5	
k+76	0	0	0	1	Y-axis address 506, point C
k+77	0	0	0	0	
k+78	0	2	0	0	
k+79	1	5	4	5	
k+80	0	0	0	0	Y-axis address 507, point A
k+81	0	0	0	0	

Bit / DM No.	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0	Remarks
k+82	0	2	0	0	
k+83	0	0	8	4	
k+84	0	0	0	0	Y-axis address 508, origin
k+85	0	0	0	0	
k+86	0	2	3	0	
k+87	1	5	4	4	

AR Area Reference

Bit / DM No.	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Subsection introduced
j	∅												∅	∅	∅	∅	*8-3-1*
j+1	∅	∅										∅	∅	∅	∅	∅	*8-3-2*
j+2	∅												∅	∅	∅	∅	*8-3-3*
j+3													∅	∅	∅	∅	*8-3-4*
j+4													∅	∅	∅	∅	*8-3-5*
j+5	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	*8-3-6*
j+6																	*8-2*
j+7																	*8-2*
j+8																	
j+9																	
j+10						∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	*8-4-1*
j+11				∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	∅	*8-4-2*

IR Area Flag Allocations

Refer to *5-2 Status Word Allocations*. The ladder diagrams and flowcharts in this section designate flags with the word number followed by bit number enclosed in parentheses. For example, I+3 (08) would be word 3, bit 08 in the tables of *5-2 Status Word Allocations*. Refer to the tables keeping in mind that all words begin with I (I+0 for word 0).

8-2 Data Transmission Program

The following describes the program that transfers positioning actions in the programming examples of *8-3 Basic Program Examples*. The same programs can be used to transfer parameters as long as data is consecutive in the DM area and as long as parameter addresses are specified. The basic program in *8-3 Basic Program Examples* uses parameters and speeds of the initial data in the memory when the Position Control Unit is shipped. For non-sequential transfers, the address field must be appended for every positioning action. For sequential transfers, the rightmost BCD digit in the address field of the first positioning action can be changed from 4, which states that four additional words follow the address as a positioning action, to 9. In this case you can set the total number of addresses involved in sequential transfer in the word that follows. Consequently, all address-field words except for the first become unnecessary. The maximum number of addresses for sequential transfer is 31.

DM Area Settings

The positioning actions (which consist of 5 words each) are written to DM words k to k+39 for the X axis and k+50 to k+87 for the Y axis. Review the Positioning Action DM Area table in *8-1 Data Word Allocations*. Each positioning action has fields for the address, position, speed, M code, dwell time, acceleration and deceleration time, and attributes. Refer to *3-4 Setting Positioning Actions* for further details.

X Axis

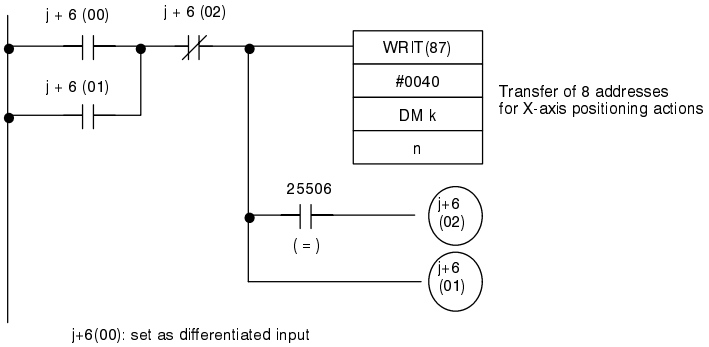
Address	Position (pulses)	Speed	M code	Dwell time	Acceleration and Deceleration time	Attribute 1	Attribute 2	Remarks
100	10,000	02	10	1	5	0	4	Point A
101	---	---	---	---	---	---	---	Empty address
102	0	01	30	1	5	4	4	Origin
103	10,000	02	00	0	0	C	6	Point C, arc center
104	10,000	02	30	1	5	4	4	Interpolation end point
105	0	02	00	0	0	8	5	Point D, arc intermediate
106	10,000	02	00	1	5	4	5	Point C
107	10,000	02	00	0	0	8	4	Point A
108	0	02	30	1	5	4	4	Origin

Y Axis

Address	Position (pulses)	Speed	M code	Dwell time	Acceleration and Deceleration time	Attribute 1	Attribute 2	Remarks
500	5,000	03	20	1	0	0	5	Point B
501	10,000	01	21	1	1	0	4	Point C
502	0	02	30	1	1	4	4	Origin (interpolation end point)
503	10,000	02	00	0	0	C	6	Point C, arc center
504	10,000	02	30	1	5	4	4	Interpolation end point
505	10,000	02	00	0	0	8	5	Point D, arc intermediate
506	10,000	02	00	1	5	4	5	Point C
507	0	02	00	0	0	8	4	Point A
508	0	02	30	1	5	4	4	Origin

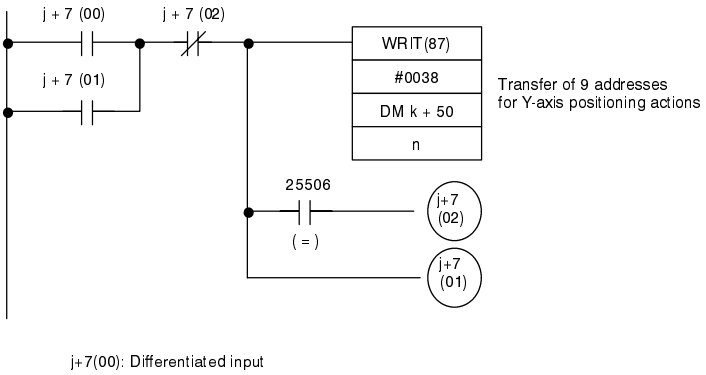
Transfer Program (1)

Transfers the 8 positioning actions for the X axis. Because address 101 is empty and has no data, the group of 8 addresses is considered non-sequential.



Transfer Program (2)

Transfers the 9 positioning actions of the Y axis. Without any empty addresses, the group of 9 positioning actions is considered sequential.

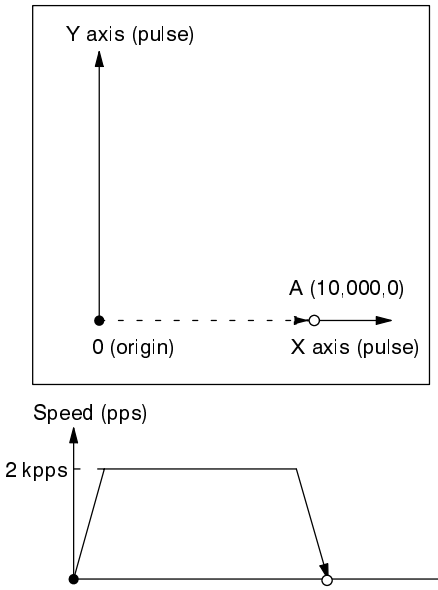


j+7(00): Differentiated input

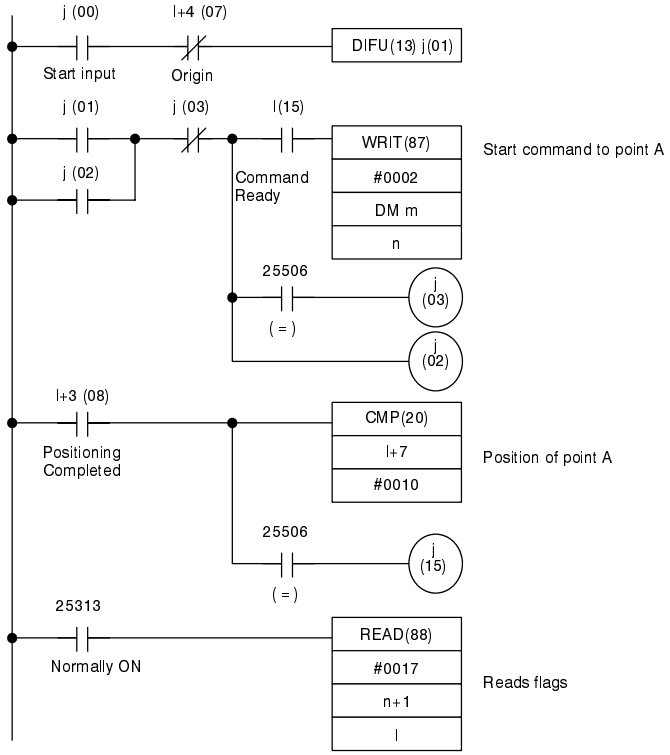
8-3 Basic Program Examples

8-3-1 Positioning to a Single Point (X Axis)

The following program positions to point A [10,000, 0 (pulses)] from the origin [0,0 (pulses)] at 2 kpps. At point A, bit J(15) turns ON to indicate completed positioning.

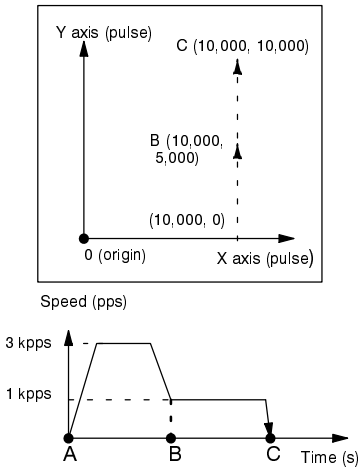


Ladder Diagram

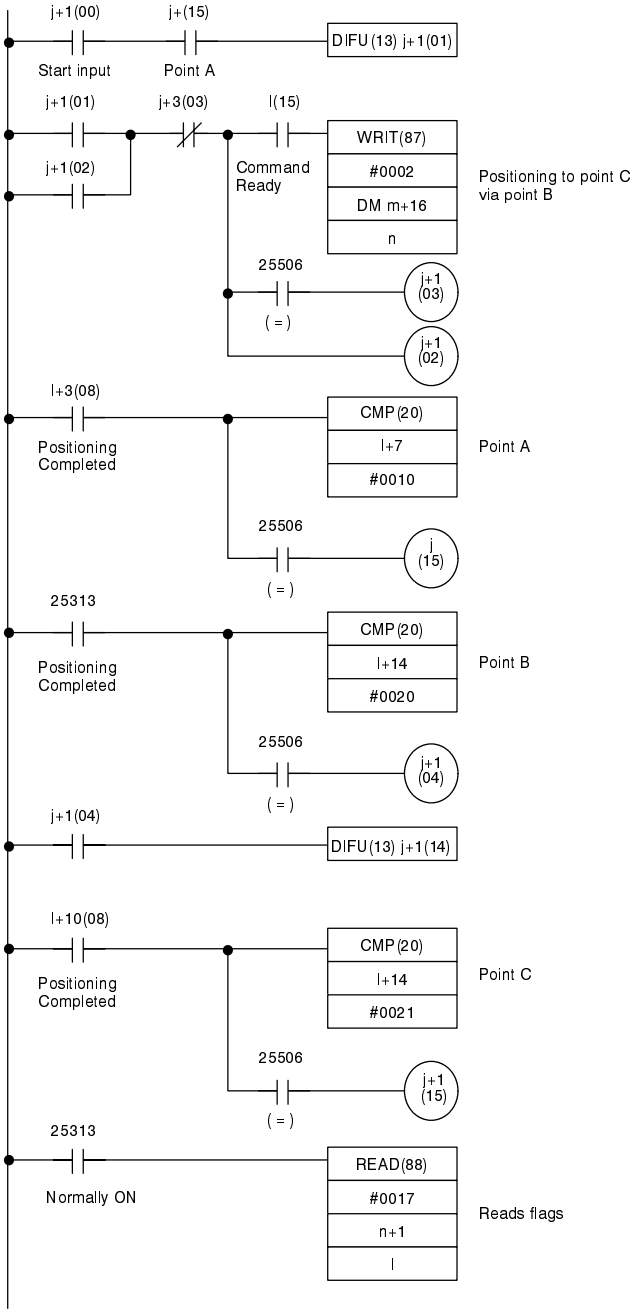


8-3-2 Positioning to a Single Point (Y Axis)

The following program positions to the origin [0, 0 (pulses)] from point C [10,000, 10,000 (pulses)] at 1 kpps. At the origin bit, j+2 (15) turns ON to indicate completed positioning. The speed registered in the X-axis speed field is used.

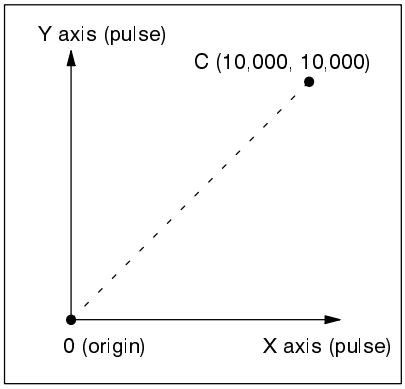


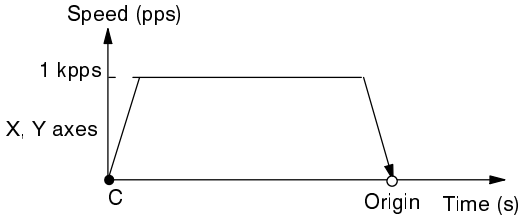
Ladder Diagram



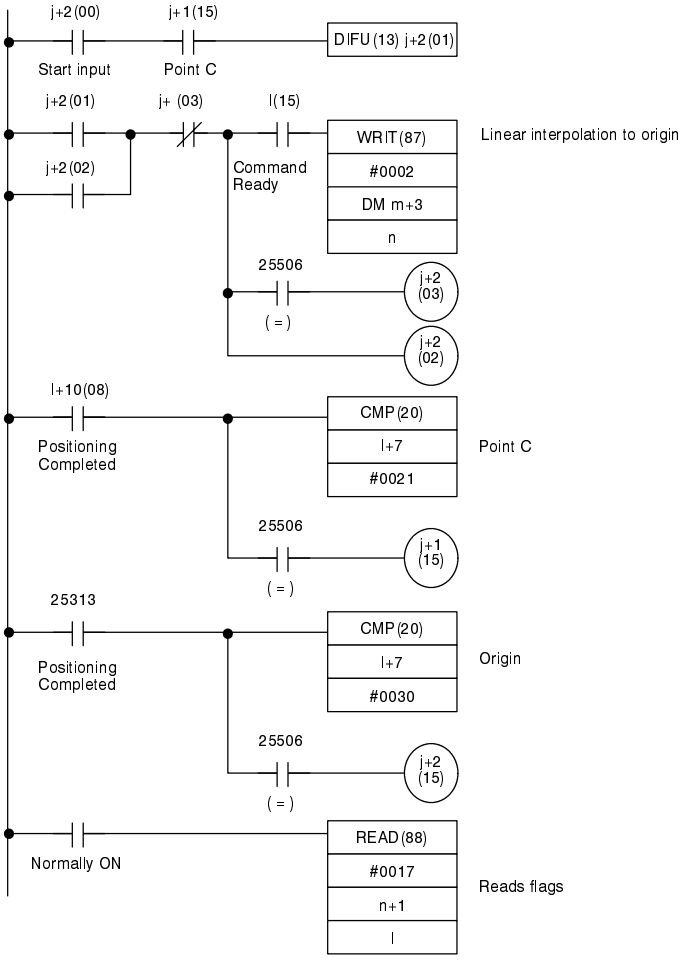
8-3-3 Straight-Line Interpolation to a Single Point (X/Y Axis)

The following program positions to point C [10,000, 10,000 (pulses)] from point A [10,000,0 (pulses)] via point B [10,000, 5,000 (pulses)]. Positioning starts at 3 kpps, but drops to 1 kpps at point B. At point B, bit j+1 (14) turns ON for one scan, and bit j(15) turns ON at point C to indicate completed positioning.



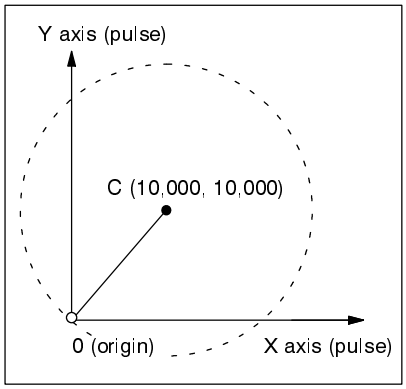


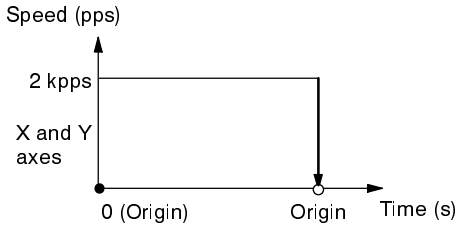
Ladder Diagram



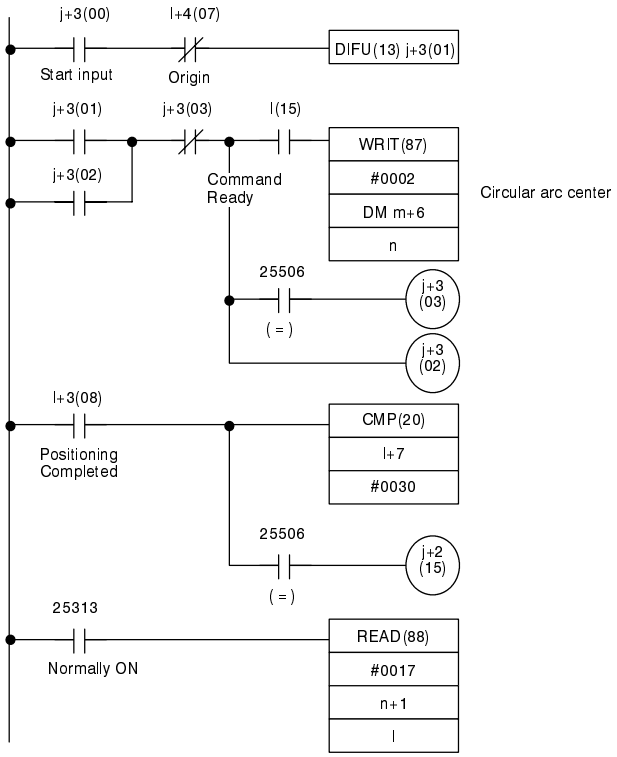
8-3-4 Circular Arc Interpolation (Center Designated)

The following program positions a circle counter-clockwise with point C [10,000, 10,000 (pulses)] as the center starting from the origin [0,0 (pulses)] at 2 kpps. At the origin, bit j+2 (15) turns ON to indicate completed positioning. For circular arc interpolation with a designated center, the starting point, center, and end point must be correctly assigned to avoid an error. An error occurs when the three points chosen cannot produce a circular arc. Computation in millimeter and inch units can generate rounding errors. Acceleration and deceleration times are not used.



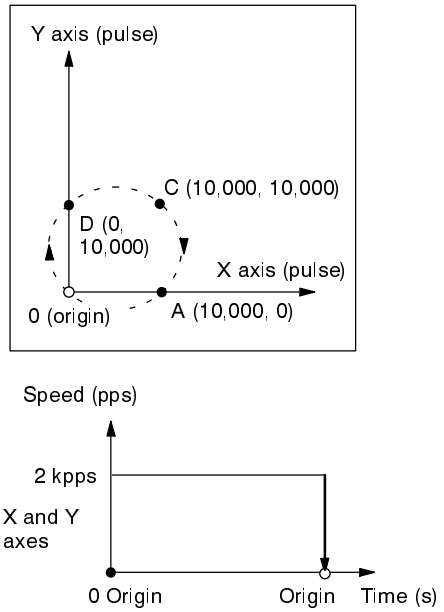


Ladder Diagram

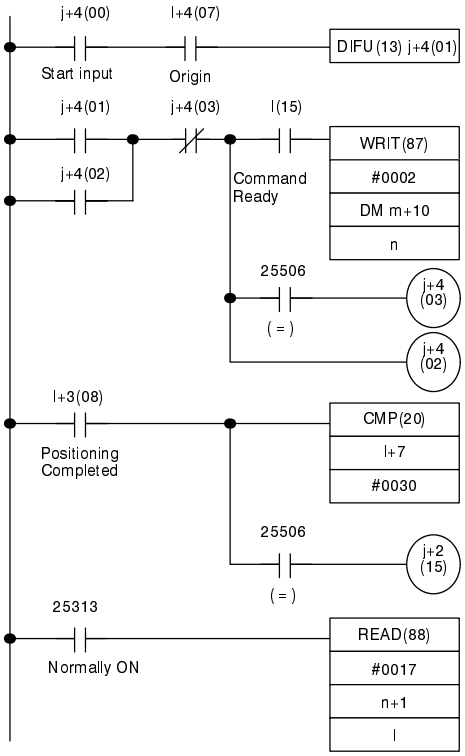


8-3-5 Circular Arc Interpolation (Intermediate Point Designated)

The following program positions a circle clockwise with point C [10,000, 10,000 (pulses)] as the intermediate point starting from the origin [0,0 (pulses)] at 2 kpps. With intermediate point D [0, 10,000 (pulses)] interpolation proceeds to point C at 2 kpps. Without stopping, interpolation completes at the origin via intermediate point A [10,000, 0 (pulses)]. At the origin, bit j+2 (15) turns ON to indicate completed positioning. For circular arc interpolation with a designated intermediate point, the entire circumference of a circle cannot be produced because the center cannot be computed. Again, acceleration and deceleration times are not used.



Ladder Diagram

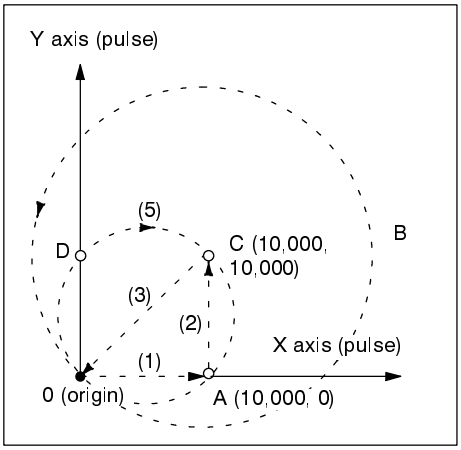


8-3-6 Continuous Positioning

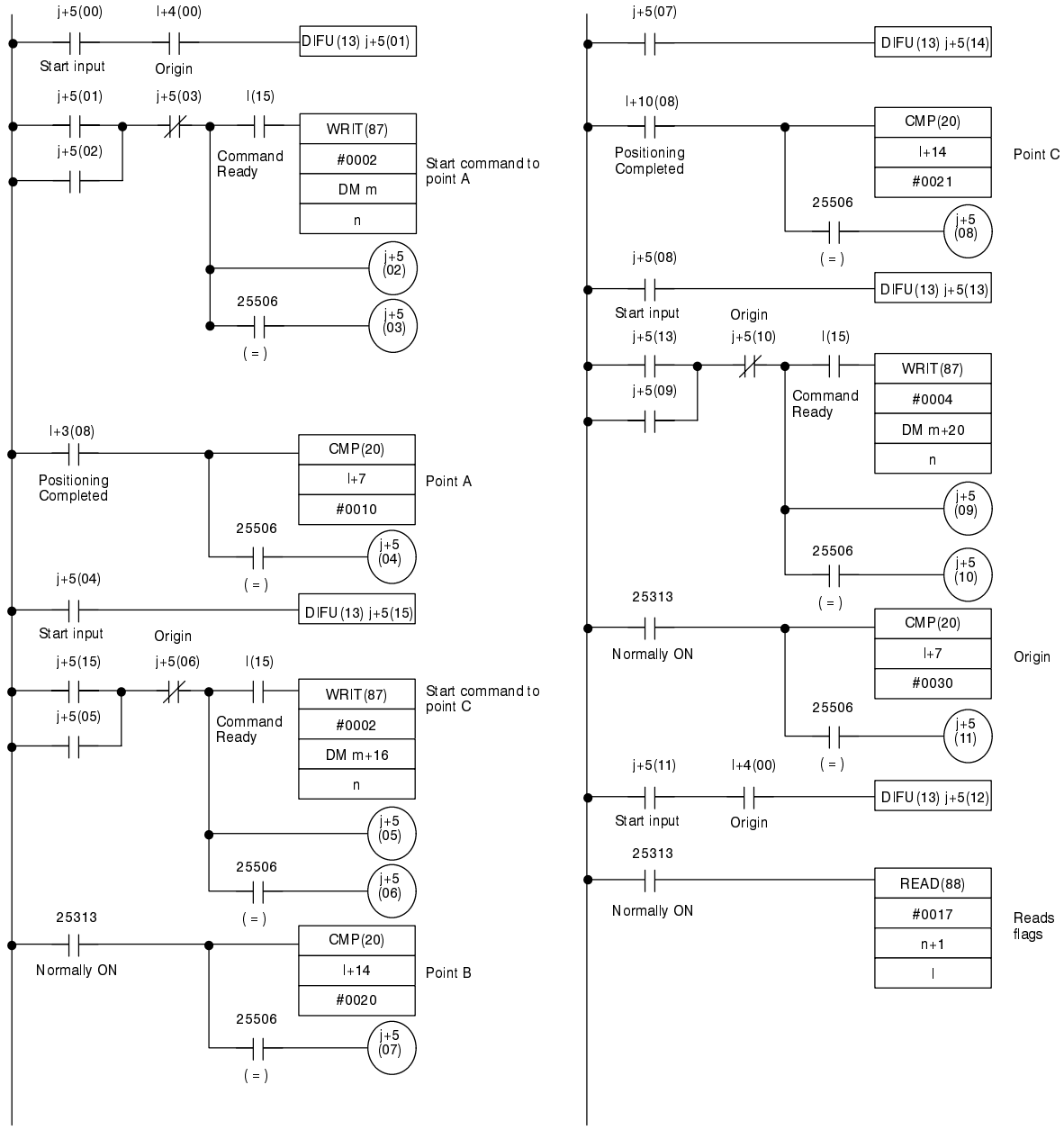
This program is a continuous program of all positioning from *8-3-1* through *8-3-5*. Positioning follows the order (1)-(5) as shown in the figure. However, at point A, bit j+5 (15) turns ON for one scan; at point B, bit j+5 (14) turns ON for one scan; at point C, bit j+5 (13) turns ON for one scan; and at the origin, bit j+5 (12) turn ON for one scan.

First, the X-axis motor moves independently to point A. At point A the X-axis M code is 10 and triggers (the integrated signal) the Y-axis motor to move via point B to point C. Next, the Y-axis M code (21) triggers the straight-line interpolation to the origin followed by two consecutive circular arc interpolations, one by designating the center and one by designating the intermediate point. The interpolation series of commands transfers as one command block. This is because only one SRT command for the same axis or axes can be allowed

in one command block. Since the last three interpolations all involve the same two axes, transferring together is allowed.



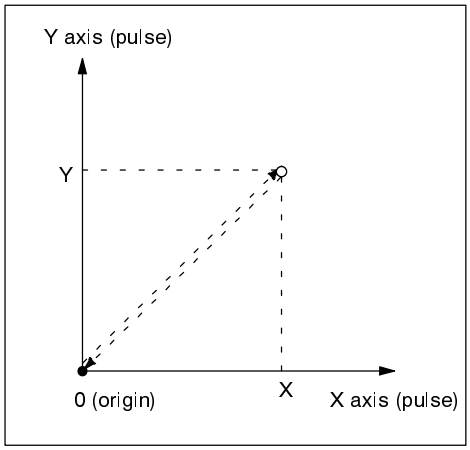
Ladder Diagram

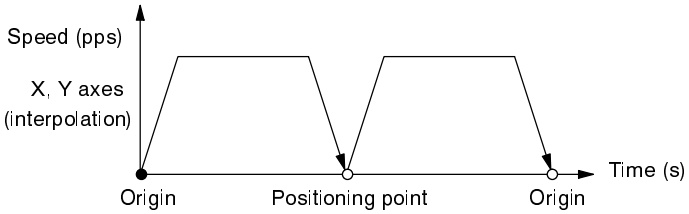


8-4 Application Program Examples

8-4-1 Digital Switch Positioning

With this program, you set X-axis coordinates, Y-axis coordinates, and speeds with digital switches. Positioning occurs at the set positions when the start switch is turned on. At the positioning point, the motors stop and the M code 55 is output. After stopping for 2 seconds, the axes automatically return to the origin.





AR Area Allocations

n	n+1	n+2	n+3	n+4	n+5	n+6	n+7	n+8	n+9
(OUT)	(IN)	(IN)	(IN)	(IN)	(IN)	(IN)	(IN)	(OUT)	(IN)
PCU		X-axis digital switch		Y-axis digital switch		Speed digital switch		M code output	Start input
		Left-most digits	Right-most digits	Left-most digits	Right-most digits	Left-most digits	Right-most digits		

Data Written to DM Area

Word l
Word l+1
:
Word l+16

Word (j+10) is part of the AR area.

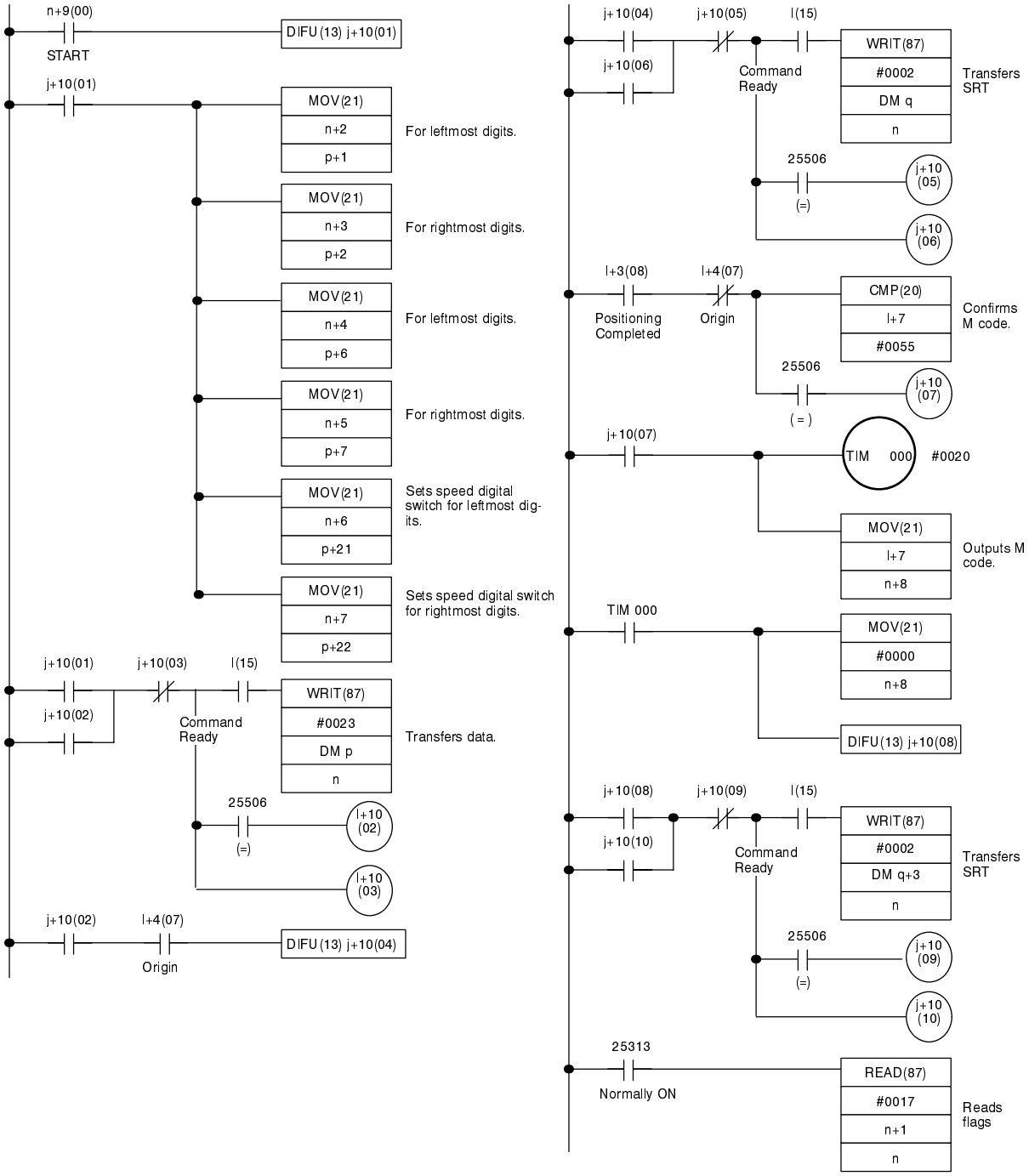
Data Written to DM Area

DM Wd	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0
p	1	0	0	4
p+1	X-axis position (leftmost digits)			
p+2	X-axis position (rightmost digits)			
p+3	1	0	5	5
p+4	0	1	4	4
p+5	5	0	0	4
p+6	Y-axis position (leftmost digits)			
p+7	Y-axis position (rightmost digits)			
p+8	1	0	5	5
p+9	0	1	4	4
p+10	1	0	1	4
p+11	0	0	0	0
p+12	0	0	0	0
p+13	1	0	0	0
p+14	0	1	4	4
p+15	5	0	1	4
p+16	0	0	0	0
p+17	0	0	0	0
p+18	1	0	0	0
p+19	0	1	4	4
p+20	9	1	0	2
p+21	0	0	Speed (leftmost digits)	
p+22	Speed (rightmost digits)			

Commands Written to DM Area

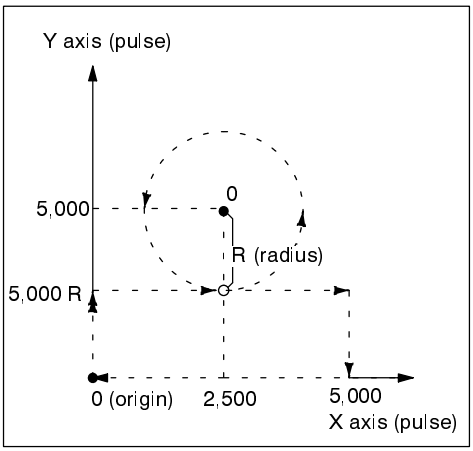
DM Wd	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0
q	0	3	0	1
q+1	1	0	0	0
q+2				
q+3	0	3	0	1
q+4	1	0	1	0
q+5				

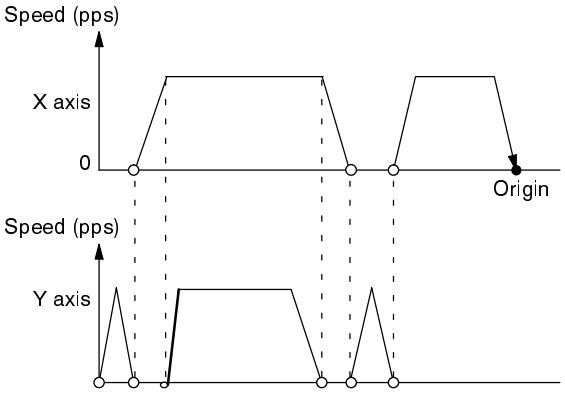
Ladder Diagram



8-4-2 Circular Arc Positioning

In this example, the center is already determined, but the digital switches determine the arc radius. The center has been determined at (2,500, 2,500). Set the radius with the digital switches. The axes then construct the prescribed circle starting at the origin and returning to the origin at a speed of 1 pps.





IR Area Allocations

n	n+1	n+2	n+5 n+3	n+4	
(OUT)	(IN)	(IN)	(IN)	(OUT)	(OUT)
PCU		Digital switch	Start input	M code output	Error output

AR Area Allocations

Word l
Word l+1
:
Word l+16

DM Area Command Allocations

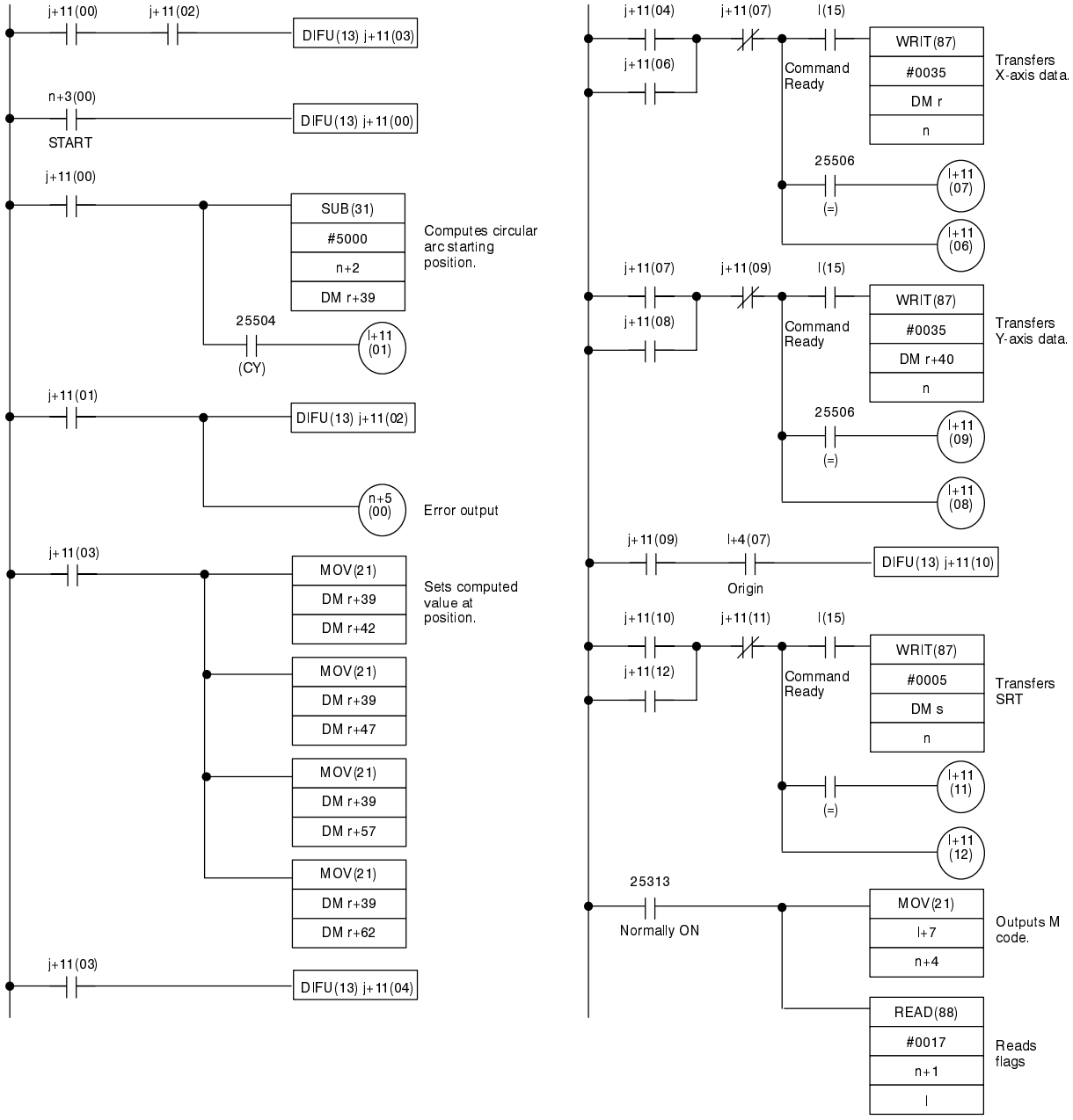
DM Wd	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0
s	0	3	0	4
s+1	1	0	0	0
s+2	1	0	1	0
s+3	1	0	5	0
s+4	1	0	6	0

DM Area Data Allocations

DM Wd	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0	
r	1	0	0	4	
r+1	0	0	0	0	
r+2	0	0	0	0	
r+3	0	1	7	7	
r+4	0	5	4	4	
r+5	1	0	1	4	
r+6	0	0	0	0	
r+7	2	5	0	0	
r+8	0	1	7	7	
r+9	0	5	4	5	
r+10	1	0	2	4	
r+11	0	0	0	0	Circular arc center
r+12	2	5	0	0	
r+13	0	1	7	7	
r+14	0	5	C	7	
r+15	1	0	3	4	
r+16	0	0	0	0	Circular arc end
r+17	2	5	0	0	
r+18	0	1	7	7	
r+19	0	5	4	5	
r+20	1	0	4	4	
r+21	0	0	0	0	
r+22	5	0	0	0	
r+23	0	1	0	0	
r+24	0	5	4	4	
r+25	1	0	5	4	
r+26	0	0	0	0	
r+27	5	0	0	0	
r+28	0	1	0	0	
r+29	0	5	4	4	
r+30	1	0	6	4	
r+31	0	0	0	0	
r+32	0	0	0	0	
r+33	0	1	0	0	
r+34	0	5	4	4	
r+35					
r+36					
r+37					
r+38					
r+39					

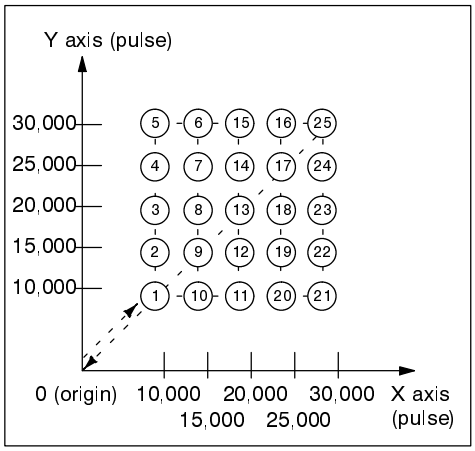
DM Wd	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0	
r+40	5	0	0	4	
r+41	0	0	0	0	
r+42					5000 R
r+43	0	1	7	7	
r+44	0	5	4	4	
r+45	5	0	1	4	
r+46	0	0	0	0	
r+47					5000 R
r+48	0	1	7	7	
r+49	0	5	4	5	
r+50	5	0	2	4	
r+51	0	0	0	0	
r+52	5	0	0	0	
r+53	0	1	7	7	
r+54	0	5	C	7	
r+55	5	0	3	4	
r+56	0	0	0	0	
r+57					5000 R
r+58	0	1	7	7	
r+59	0	5	4	5	
r+60	5	0	4	4	
r+61	0	0	0	0	
r+62					5000 R
r+63	0	1	0	0	
r+64	0	5	4	4	
r+65	5	0	5	4	
r+66	0	0	0	0	
r+67	0	0	0	0	
r+68	0	1	0	0	
r+69	0	5	4	4	
r+70	5	0	6	4	
r+71	0	0	0	0	
r+72	0	0	0	0	
r+73	0	1	0	0	
r+74	0	5	4	4	
r+75					
r+76					
r+77					
r+78					
r+79					

Ladder Diagram



8-4-3 Multiple Positioning

This program consecutively executes 25 positioning actions. At each position, an M code is output to indicate arrival. By turning ON the start switch, the motor axes follow the course along the broken lines in the figure below and perform 25 positioning actions. M codes 01-25 are respectively output at each position while the axes stop for 0.5 second. After the 25 positions, the motors return to the origin.



IR Area Allocations

n	n+1	n+2	n+3
(OUT)	(IN)	(OUT)	(IN)
PCU		M code output	Start input

AR Area Allocations

Word l
Word l+1
:
Word l+16

Word (j+12) is part of the AR area.

DM Area Allocations

Data Area

DM Wd	b_{15}-b_{12}	b_{11}-b_{8}	b_{7}-b_{4}	b_{3}-b_{0}
t	1	0	0	4
t+1	0	0	0	1
t+2	0	0	0	0
t+3	0	1	0	1
t+4	0	0	4	4
t+5	1	0	1	4
t+6	0	0	0	1
t+7	5	0	0	0
t+8	0	1	0	6
t+9	0	0	0	4
t+10	1	0	2	4
t+11	0	0	0	2
t+12	0	0	0	0
t+13	0	1	1	1
t+14	0	0	0	4
t+15	1	0	3	4
t+16	0	0	0	2
t+17	5	0	0	0
t+18	0	1	1	6
t+19	0	0	0	4
t+20	1	0	4	4
t+21	0	0	0	3
t+22	0	0	0	0
t+23	0	1	2	1
t+24	0	0	0	4
t+25	5	0	0	4
t+26	0	0	0	1
t+27	0	0	0	0
t+28	0	1	0	0
t+29	0	0	4	4
t+30	5	0	1	4
t+31	0	0	0	1
t+32	5	0	0	0
t+33	0	1	0	2
t+34	0	0	0	4
t+35	5	0	2	4
t+36	0	0	0	2
t+37	0	0	0	0
t+38	0	1	0	3
t+39	0	0	0	4
t+40	5	0	3	4
t+41	0	0	0	2
t+42	5	0	0	0
t+43	0	1	0	4
t+44	0	0	0	4
t+45	5	0	4	4
t+46	0	0	0	3
t+47	0	0	0	0
t+48	0	1	0	5
t+49	0	0	0	4
t+50	5	0	5	4

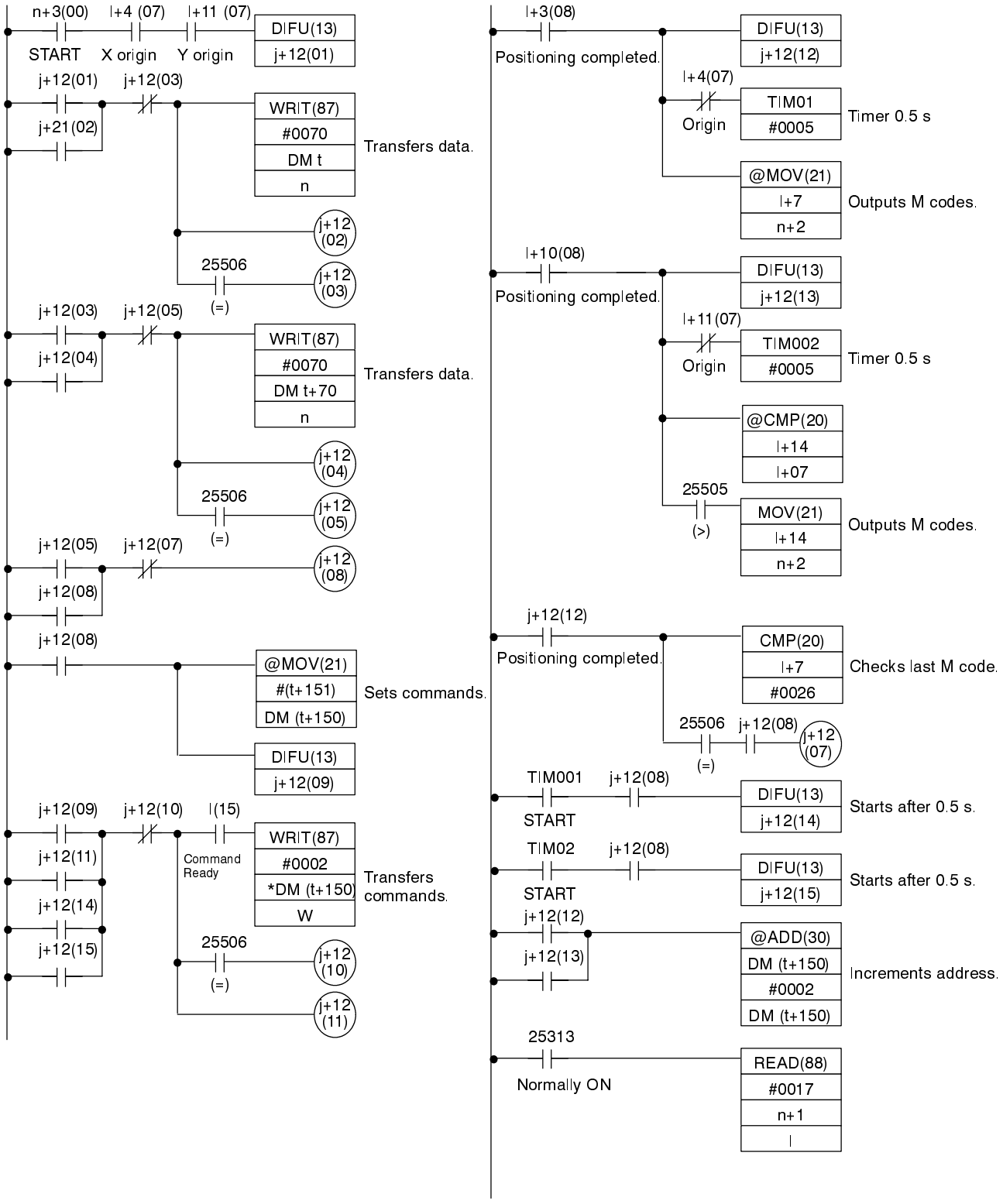
DM Wd	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0
t+51	0	0	0	2
t+52	5	0	0	0
t+53	0	1	0	7
t+54	0	0	0	4
t+55	5	0	6	4
t+56	0	0	0	2
t+57	0	0	0	0
t+58	0	1	0	8
t+59	0	0	0	4
t+60	5	0	7	4
t+61	0	0	0	1
t+62	5	0	0	0
t+63	0	1	0	9
t+64	0	0	0	4
t+65	5	0	8	4
t+66	0	0	0	1
t+67	0	0	0	0
t+68	0	1	1	0
t+69	0	0	0	4
t+70	5	0	9	4
t+71	0	0	0	1
t+72	5	0	0	0
t+73	0	1	1	2
t+74	0	0	0	4
t+75	5	1	0	4
t+76	0	0	0	2
t+77	0	0	0	0
t+78	0	1	1	3
t+79	0	0	0	4
t+80	5	1	1	4
t+81	0	0	0	2
t+82	5	0	0	0
t+83	0	1	1	4
t+84	0	0	0	4
t+85	5	1	2	4
t+86	0	0	0	3
t+87	0	0	0	0
t+88	0	1	1	5
t+89	0	0	0	4
t+90	5	1	3	4
t+91	0	0	0	2
t+92	5	0	0	0
t+93	0	1	1	7
t+94	0	0	0	4
t+95	5	1	4	4
t+96	0	0	0	2
t+97	0	0	0	0
t+98	0	1	1	8
t+99	0	0	0	4
t+100	5	1	5	4

DM Wd	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0
t+101	0	0	0	1
t+102	5	0	0	0
t+103	0	1	1	9
t+104	0	0	0	4
t+105	5	1	6	4
t+106	0	0	0	1
t+107	0	0	0	0
t+108	0	1	2	0
t+109	0	0	0	4
t+110	5	1	7	4
t+111	0	0	0	1
t+112	5	0	0	0
t+113	0	1	2	2
t+114	0	0	0	4
t+115	5	1	8	4
t+116	0	0	0	2
t+117	0	0	0	0
t+118	0	1	2	3
t+119	0	0	0	4
t+120	5	1	9	4
t+121	0	0	0	2
t+122	5	0	0	0
t+123	0	1	2	4
t+124	0	0	0	4
t+125	5	2	0	4
t+126	0	0	0	3
t+127	0	0	0	0
t+128	0	1	2	5
t+129	0	0	0	4
t+130	1	2	5	4
t+131	0	0	0	0
t+132	0	0	0	0
t+133	0	1	2	6
t+134	0	0	4	4
t+135	5	2	5	4
t+136	0	0	0	0
t+137	0	0	0	0
t+138	0	0	0	0
t+139	0	0	4	4

Command Area

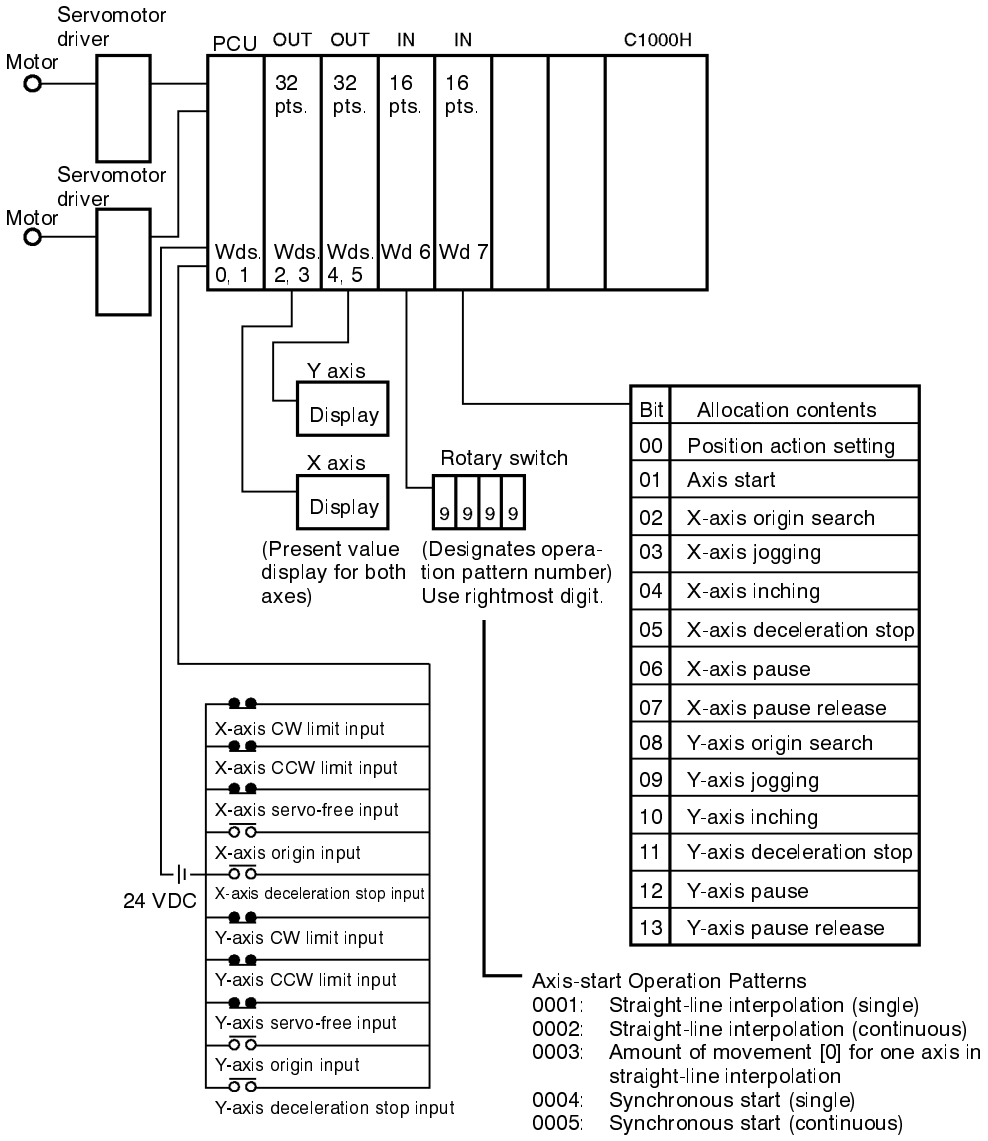
DM Wd	b_{15}-b_{12}	b_{11}-b_8	b_7-b_4	b_3-b_0
t+151	0	3	0	1
t+152	1	0	0	0
t+153	0	2	0	1
t+154	5	0	1	0
t+155	0	2	0	1
t+156	5	0	2	0
t+157	0	2	0	1
t+158	5	0	3	0
t+159	0	2	0	1
t+160	5	0	4	0
t+161	0	1	0	1
t+162	1	0	1	0
t+163	0	2	0	1
t+164	5	0	5	0
t+165	0	2	0	1
t+166	5	0	6	0
t+167	0	2	0	1
t+168	5	0	7	0
t+169	0	2	0	1
t+170	5	0	8	0
t+171	0	1	0	1
t+172	1	0	2	0
t+173	0	2	0	1
t+174	5	0	9	0
t+175	0	2	0	1
t+176	5	1	0	0
t+177	0	2	0	1
t+178	5	1	1	0
t+179	0	2	0	1
t+180	5	1	2	0
t+181	0	1	0	1
t+182	1	0	3	0
t+183	0	2	0	1
t+184	5	1	3	0
t+185	0	2	0	1
t+186	5	1	4	0
t+187	0	2	0	1
t+188	5	1	5	0
t+189	0	2	0	1
t+190	5	1	6	0
t+191	0	1	0	1
t+192	1	0	4	0
t+193	0	2	0	1
t+194	5	1	7	0
t+195	0	2	0	1
t+196	5	1	8	0
t+197	0	2	0	1
t+198	5	1	9	0
t+199	0	2	0	1
t+200	5	2	0	0
t+201	0	3	0	1
t+202	1	2	5	0

Ladder Diagram



8-4-4 Starting Positioning Actions

Configuration (With Wiring Simplified)



Word Allocation

Wd 0	Wd 1	Wd 2	Wd 3	Wd 4	Wd 5	Wd 6	Wd 7
(OUT)	(IN)	(OUT)	(OUT)	(OUT)	(OUT)	(IN)	(IN)
NC222-E		Y-axis current position output	Y-axis current position output	Y-axis current position output	Y-axis current position output	Start pattern input	Start switch for each command

AR Area Allocation

Bit no.	Contents
J + 13 (01)	Positioning action transfer begin bit
J + 13 (02)	Positioning action transfer self-maintenance auxiliary bit
J + 13 (03)	Positioning action transfer completed auxiliary bit
J + 13 (04)	Positioning action transfer self-maintenance auxiliary bit
J + 13 (05)	Positioning action transfer completed auxiliary bit

Bit no.	Contents
J + 13 (06)	Positioning action setting complete
J + 13 (07)	Positioning action setting complete clear
J + 13 (08)	Axis start operation pattern 1 detection bit
J + 13 (09)	Axis start operation pattern 2 detection bit
J + 13 (10)	Axis start operation pattern 3 detection bit
J + 13 (11)	Axis start operation pattern 4 detection bit
J + 13 (12)	Axis start operation pattern 5 detection bit
J + 13 (13)	Axis start begin bit
J + 13 (14)	Axis start self-maintenance auxiliary bit
J + 13 (15)	Axis start completed auxiliary bit
J + 14 (01)	X-axis origin search begin bit
J + 14 (02)	X-axis origin search self-maintenance auxiliary bit
J + 14 (03)	X-axis origin search completed auxiliary bit
J + 14 (04)	Y-axis origin search begin bit
J + 14 (05)	Y-axis origin search self-maintenance auxiliary bit
J + 14 (06)	Y-axis origin search begin bit
J + 14 (07)	X-axis jogging begin bit
J + 14 (08)	X-axis jogging self-maintenance auxiliary bit
J + 14 (09)	X-axis jogging completed auxiliary bit
J + 14 (10)	Y-axis jogging begin bit
J + 14 (11)	Y-axis jogging self-maintenance auxiliary bit
J + 14 (12)	Y-axis jogging completed auxiliary bit
J + 14 (13)	X-axis inching begin bit
J + 14 (14)	X-axis inching self-maintenance auxiliary bit
J + 14 (15)	X-axis inching completed auxiliary bit
J + 15 (01)	Y-axis inching begin bit
J + 15 (02)	Y-axis inching self-maintenance auxiliary bit
J + 15 (03)	Y-axis inching completed auxiliary bit
J + 15 (04)	X-axis deceleration stop begin bit
J + 15 (05)	X-axis deceleration stop self-maintenance auxiliary bit
J + 15 (06)	X-axis deceleration stop completed auxiliary bit
J + 15 (07)	Y-axis deceleration stop begin bit
J + 15 (08)	Y-axis deceleration stop self-maintenance auxiliary bit
J + 15 (09)	Y-axis deceleration stop completed auxiliary bit
J + 15 (10)	X-axis pause begin bit
J + 15 (11)	X-axis pause self-maintenance auxiliary bit
J + 15 (12)	X-axis pause completed auxiliary bit
J + 15 (13)	Y-axis pause begin bit
J + 15 (14)	Y-axis pause self-maintenance auxiliary bit
J + 15 (15)	Y-axis pause completed auxiliary bit
J + 16 (01)	X-axis pause release begin bit
J + 16 (02)	X-axis pause release self-maintenance auxiliary bit
J + 16 (03)	X-axis pause release completed auxiliary bit
J + 16 (04)	Y-axis pause release begin bit
J + 16 (05)	Y-axis pause release self-maintenance auxiliary bit
J + 16 (06)	Y-axis pause release completed auxiliary bit
Wd. I+ 16	Status read area

NC222-E Data Contents

The the initial factory-set parameter and speed data is used.

X-Axis Synchronous Positioning Actions

Address	Contents	Data
470	Synchronous positioning action #0	Position: ABS + 10,000 pulses; pattern 0; other-axis address: 600
471	Synchronous positioning action #1	Position: ABS + 10,000 pulses; pattern 1; next address: 2; other-axis address: 601
472	Synchronous positioning action #2	Position: ABS + 20,000 pulses; pattern 1; next address: 3; other-axis address: 602
473	Synchronous positioning action #3	Position: ABS + 30,000 pulses; pattern 1; next address: 4; other-axis address: 603
474	Synchronous positioning action #4	Position: ABS + 40,000 pulses; pattern 0; other-axis address: 604
475	Synchronous positioning action #5	---
476	Synchronous positioning action #6	---
477	Synchronous positioning action #7	---
478	Synchronous positioning action #8	---
479	Synchronous positioning action #9	---

Y-Axis Synchronous Positioning Actions

Address	Contents	Data
870	Synchronous positioning action #0	Position: ABS + 10,000 pulses; pattern 0; other-axis address: 200
871	Synchronous positioning action #1	Position: ABS + 10,000 pulses; pattern 1; next address: 2; other-axis address: 201
872	Synchronous positioning action #2	Position: ABS + 20,000 pulses; pattern 1; next address: 3; other-axis address: 202
873	Synchronous positioning action #3	Position: ABS + 30,000 pulses; pattern 1; next address: 4; other-axis address: 203
874	Synchronous positioning action #4	Position: ABS + 40,000 pulses; pattern 0; other-axis address: 204
875	Synchronous positioning action #5	---
876	Synchronous positioning action #6	---
877	Synchronous positioning action #7	---
878	Synchronous positioning action #8	---
879	Synchronous positioning action #9	---

X-Axis Positioning Actions

Address	Data
100	Coordinates: ABS + 10,000 pulses; speed address: 01; dwell time address: 1; acceleration/deceleration address: 0; M code: 01; straight-line interpolation; positioning pattern: 0; synchronous start disabled
101	Coordinates: ABS + 0 pulses; speed address: 00; dwell time address: 0; acceleration/deceleration address: 0; M code: 99; straight-line interpolation; positioning pattern: 0; synchronous start disabled
102	Coordinates: ABS + 10,000 pulses; speed address: 01; dwell time address: 0; acceleration/deceleration address: 0; M code: 02; straight-line interpolation; positioning pattern: 1; synchronous start disabled
103	Coordinates: ABS + 20,000 pulses; speed address: 02; dwell time address: 0; acceleration/deceleration address: 0; M code: 03; straight-line interpolation; positioning pattern: 1; synchronous start disabled
104	Coordinates: ABS + 30,000 pulses; speed address: 03; dwell time address: 0; acceleration/deceleration address: 0; M code: 04; straight-line interpolation; positioning pattern: 1; synchronous start disabled
105	Coordinates: ABS + 40,000 pulses; speed address: 04; dwell time address: 0; acceleration/deceleration address: 0; M code: 05; straight-line interpolation; positioning pattern: 1; synchronous start disabled
106	Coordinates: ABS + 50,000 pulses; speed address: 05; dwell time address: 1; acceleration/deceleration address: 0; M code: 06; straight-line interpolation; positioning pattern: 0; synchronous start disabled
107	Coordinates: ABS + 0 pulses; speed address: 00; dwell time address: 0; acceleration/deceleration address: 0; M code: 99; straight-line interpolation; positioning pattern: 0; synchronous start disabled
108	Coordinates: INC – 10,000 pulses; speed address: 06; dwell time address: 0; acceleration/deceleration address: 0; M code: 07; straight-line interpolation; positioning pattern: 1; synchronous start disabled
109	Coordinates: INC + 0 pulses; speed address: 07; dwell time address: 1; acceleration/deceleration address: 0; M code: 08; straight-line interpolation; positioning pattern: 0; synchronous start disabled
110	Coordinates: INC + 10,000 pulses; speed address: 00; dwell time address: 0; acceleration/deceleration address: 0; M code: 99; straight-line interpolation; positioning pattern: 0; synchronous start disabled
120	Coordinates: ABS + 20,000 pulses; speed address: 01; dwell time address: 0; acceleration/deceleration address: 0; M code: 10; single start; positioning pattern: 0; synchronous start enabled
121	Coordinates: ABS + 50,000 pulses; speed address: 02; dwell time address: 0; acceleration/deceleration address: 0; M code: 11; single start; positioning pattern: 0; synchronous start enabled
200	Coordinates: INC + 1,000 pulses; speed address: 01; dwell time address: 0; acceleration/deceleration address: 0; M code: 20; single start; positioning pattern: 0; synchronous start disabled
201	Coordinates: INC + 2,000 pulses; speed address: 01; dwell time address: 0; acceleration/deceleration address: 0; M code: 21; single start; positioning pattern: 0; synchronous start disabled
202	Coordinates: INC + 3,000 pulses; speed address: 02; dwell time address: 0; acceleration/deceleration address: 0; M code: 22; single start; positioning pattern: 0; synchronous start disabled
203	Coordinates: INC + 4,000 pulses; speed address: 03; dwell time address: 0; acceleration/deceleration address: 0; M code: 23; single start; positioning pattern: 0; synchronous start disabled
204	Coordinates: INC + 5,000 pulses; speed address: 03; dwell time address: 0; acceleration/deceleration address: 0; M code: 24; single start; positioning pattern: 0; synchronous start disabled

Y-Axis Positioning Actions

Address	Data
500	Coordinates: ABS + 10,000 pulses; speed address: 01; dwell time address: 1; acceleration/deceleration address: 0; M code: 01; straight-line interpolation; positioning pattern: 0; synchronous start disabled
501	Coordinates: ABS + 0 pulses; speed address: 00; dwell time address: 0; acceleration/deceleration address: 0; M code: 99; straight-line interpolation; positioning pattern: 0; synchronous start disabled
502	Coordinates: ABS + 10,000 pulses; speed address: 01; dwell time address: 0; acceleration/deceleration address: 0; M code: 02; straight-line interpolation; positioning pattern: 1; synchronous start disabled
503	Coordinates: ABS + 20,000 pulses; speed address: 02; dwell time address: 0; acceleration/deceleration address: 0; M code: 03; straight-line interpolation; positioning pattern: 1; synchronous start disabled
504	Coordinates: ABS + 30,000 pulses; speed address: 03; dwell time address: 0; acceleration/deceleration address: 0; M code: 04; straight-line interpolation; positioning pattern: 1; synchronous start disabled
505	Coordinates: ABS + 40,000 pulses; speed address: 04; dwell time address: 0; acceleration/deceleration address: 0; M code: 05; straight-line interpolation; positioning pattern: 1; synchronous start disabled
506	Coordinates: ABS + 50,000 pulses; speed address: 05; dwell time address: 1; acceleration/deceleration address: 0; M code: 06; straight-line interpolation; positioning pattern: 0; synchronous start disabled
507	Coordinates: ABS + 0 pulses; speed address: 00; dwell time address: 0; acceleration/deceleration address: 0; M code: 99; straight-line interpolation; positioning pattern: 0; synchronous start disabled
508	Coordinates: INC + 0 pulses; speed address: 06; dwell time address: 0; acceleration/deceleration address: 0; M code: 07; straight-line interpolation; positioning pattern: 1; synchronous start disabled
509	Coordinates: INC – 10,000 pulses; speed address: 07; dwell time address: 1; acceleration/deceleration address: 0; M code: 08; straight-line interpolation; positioning pattern: 0; synchronous start disabled
510	Coordinates: INC + 10,000 pulses; speed address: 00; dwell time address: 0; acceleration/deceleration address: 0; M code: 99; straight-line interpolation; positioning pattern: 0; synchronous start disabled
520	Coordinates: ABS + 20,000 pulses; speed address: 01; dwell time address: 0; acceleration/deceleration address: 0; M code: 12; single-axis start; positioning pattern: 0; synchronous start enabled
521	Coordinates: ABS + 50,000 pulses; speed address: 02; dwell time address: 0; acceleration/deceleration address: 0; M code: 13; single-axis start; positioning pattern: 0; synchronous start enabled
600	Coordinates: INC + 1,000 pulses; speed address: 01; dwell time address: 0; acceleration/deceleration address: 0; M code: 30; single start; positioning pattern: 0; synchronous start disabled
601	Coordinates: INC + 2,000 pulses; speed address: 01; dwell time address: 0; acceleration/deceleration address: 0; M code: 31; single start; positioning pattern: 0; synchronous start disabled
602	Coordinates: INC + 3,000 pulses; speed address: 02; dwell time address: 0; acceleration/deceleration address: 0; M code: 32; single start; positioning pattern: 0; synchronous start disabled
603	Coordinates: INC + 4,000 pulses; speed address: 03; dwell time address: 0; acceleration/deceleration address: 0; M code: 33; single start; positioning pattern: 0; synchronous start disabled
604	Coordinates: INC + 5,000 pulses; speed address: 03; dwell time address: 0; acceleration/deceleration address: 0; M code: 34; single start; positioning pattern: 0; synchronous start disabled

DM Area Allocation

DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00	DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00
u	4	7	0	4	u+41	0	0	0	3
u+1	0	0	0	1	u+42	0	0	0	0
u+2	0	0	0	0	u+43	2	0	3	1
u+3	6	0	0	0	u+44	4	0	0	4
u+4	0	0	0	4	u+45	0	0	0	0
u+5	4	7	1	4	u+46	0	0	0	0
u+6	0	0	0	1	u+47	0	0	0	0
u+7	0	0	0	0	u+48	2	0	4	0
u+8	6	0	1	1	u+49	0	0	0	4
u+9	2	0	0	4	u+50	1	0	0	4
u+10	4	7	2	4	u+51	0	0	0	1
u+11	0	0	0	2	u+52	0	0	0	0
u+12	0	0	0	0	u+53	0	1	0	1
u+13	6	0	2	1	u+54	1	0	4	4
u+14	3	0	0	4	u+55	1	0	1	4
u+15	4	7	3	4	u+56	0	0	0	0
u+16	0	0	0	3	u+57	0	0	0	0
u+17	0	0	0	0	u+58	0	0	9	9
u+18	6	0	3	1	u+59	0	0	4	4
u+19	4	0	0	4	u+60	1	0	2	4
u+20	4	7	4	4	u+61	0	0	0	1
u+21	0	0	0	4	u+62	0	0	0	0
u+22	0	0	0	0	u+63	0	1	0	2
u+23	6	0	4	0	u+64	0	0	4	5
u+24	0	0	0	4	u+65	1	0	3	4
u+25	8	7	0	4	u+66	0	0	0	2
u+26	0	0	0	1	u+67	0	0	0	0
u+27	0	0	0	0	u+68	0	2	0	3
u+28	2	0	0	0	u+69	0	0	4	5
u+29	0	0	0	4	u+70	1	0	4	4
u+30	8	7	1	4	u+71	0	0	0	3
u+31	0	0	0	1	u+72	0	0	0	0
u+32	0	0	0	0	u+73	0	3	0	4
u+33	2	0	1	1	u+74	0	0	4	5
u+34	2	0	0	4	u+75	1	0	5	4
u+35	8	7	2	4	u+76	0	0	0	4
u+36	0	0	0	2	u+77	0	0	0	0
u+37	0	0	0	0	u+78	0	4	0	5
u+38	2	0	2	1	u+79	0	0	4	5
u+39	3	0	0	4	u+80	1	0	6	4
u+40	8	7	3	4	u+81	0	0	0	5

DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00	DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00
u+82	0	0	0	0	u+123	0	1	2	1
u+83	0	5	0	6	u+124	0	0	2	4
u+84	1	0	4	4	u+125	2	0	2	4
u+85	1	0	7	4	u+126	0	0	0	0
u+86	0	0	0	0	u+127	3	0	0	0
u+87	0	0	0	0	u+128	0	2	2	2
u+88	0	0	9	9	u+129	0	0	2	4
u+89	0	0	4	4	u+130	2	0	3	4
u+90	1	0	8	4	u+131	0	0	0	0
u+91	0	0	0	1	u+132	4	0	0	0
u+92	0	0	0	0	u+133	0	3	2	3
u+93	0	6	0	7	u+134	0	0	2	4
u+94	0	0	7	5	u+135	2	0	4	4
u+95	1	0	9	4	u+136	0	0	0	0
u+96	0	0	0	0	u+137	5	0	0	0
u+97	0	0	0	0	u+138	0	3	2	4
u+98	0	7	0	8	u+139	0	0	2	4
u+99	1	0	6	4	u+140	5	0	0	4
u+100	1	1	0	4	u+141	0	0	0	1
u+101	0	0	0	1	u+142	0	0	0	0
u+102	0	0	0	0	u+143	0	1	0	1
u+103	0	0	9	9	u+144	1	0	4	4
u+104	0	0	6	4	u+145	5	0	1	4
u+105	1	2	0	4	u+146	0	0	0	0
u+106	0	0	0	2	u+147	0	0	0	0
u+107	0	0	0	0	u+148	0	0	9	9
u+108	0	1	1	0	u+149	0	0	4	4
u+109	0	0	0	C	u+150	5	0	2	4
u+110	1	2	1	4	u+151	0	0	0	1
u+111	0	0	0	5	u+152	0	0	0	0
u+112	0	0	0	0	u+153	0	1	0	2
u+113	0	2	1	1	u+154	0	0	4	5
u+114	0	0	0	C	u+155	5	0	3	4
u+115	2	0	0	4	u+156	0	0	0	2
u+116	0	0	0	0	u+157	0	0	0	0
u+117	1	0	0	0	u+158	0	2	0	3
u+118	0	1	2	0	u+159	0	0	4	5
u+119	0	0	2	4	u+160	5	0	4	4
u+120	2	0	1	4	u+161	0	0	0	3
u+121	0	0	0	0	u+162	0	0	0	0
u+122	2	0	0	0	u+163	0	3	0	4

DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00	DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00
u+164	0	0	4	5	u+205	6	0	0	4
u+165	5	0	5	4	u+206	0	0	0	0
u+166	0	0	0	4	u+207	1	0	0	0
u+167	0	0	0	0	u+208	0	1	3	0
u+168	0	4	0	5	u+209	0	0	2	4
u+169	0	0	4	5	u+210	6	0	1	4
u+170	5	0	6	4	u+211	0	0	0	0
u+171	0	0	0	5	u+212	2	0	0	0
u+172	0	0	0	0	u+213	0	1	3	1
u+173	0	5	0	6	u+214	0	0	2	4
u+174	1	0	4	4	u+215	6	0	2	4
u+175	5	0	7	4	u+216	0	0	0	0
u+176	0	0	0	0	u+217	3	0	0	0
u+177	0	0	0	0	u+218	0	2	3	2
u+178	0	0	9	9	u+219	0	0	2	4
u+179	0	0	4	4	u+220	6	0	3	4
u+180	5	0	8	4	u+221	0	0	0	0
u+181	0	0	0	0	u+222	4	0	0	0
u+182	0	0	0	0	u+223	0	3	3	3
u+183	0	6	0	7	u+224	0	0	2	4
u+184	0	0	6	5	u+225	6	0	4	4
u+185	5	0	9	4	u+226	0	0	0	0
u+186	0	0	0	1	u+227	5	0	0	0
u+187	0	0	0	0	u+228	0	3	3	4
u+188	0	7	0	8	u+229	0	0	2	4
u+189	1	0	7	4	u+230	---	---	---	---
u+190	5	1	0	4	u+231	---	---	---	---
u+191	0	0	0	1	u+232	---	---	---	---
u+192	0	0	0	0	u+233	---	---	---	---
u+193	0	0	9	9	u+234	---	---	---	---
u+194	0	0	6	4	u+235	---	---	---	---
u+195	5	2	0	4	u+236	---	---	---	---
u+196	0	0	0	2	u+237	---	---	---	---
u+197	0	0	0	0	u+238	---	---	---	---
u+198	0	1	1	2	u+239	---	---	---	---
u+199	0	0	0	C	u+240	---	---	---	---
u+200	5	2	1	4	u+241	---	---	---	---
u+201	0	0	0	5	u+242	---	---	---	---
u+202	0	0	0	0	u+243	---	---	---	---
u+203	0	2	1	3	u+244	---	---	---	---
u+204	0	0	0	C	u+245	---	---	---	---

DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00	DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00
u+246	---	---	---	---	---	---	---	---	---
u+247	---	---	---	---	---	---	---	---	---
u+248	---	---	---	---	---	---	---	---	---
u+249	---	---	---	---	---	---	---	---	---
u+250	---	---	---	---	---	---	---	---	---

Command Area

DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00	DM	Bits 15 to 12	Bits 11 to 08	Bits 07 to 04	Bits 03 to 00
u+251	See Note	See Note	See Note	See Note	u+280	---	---	---	---
u+252	See Note	See Note	See Note	See Note	u+281	---	---	---	---
u+253	See Note	See Note	See Note	See Note	u+282	---	---	---	---
u+254	---	---	---	---	u+283	---	---	---	---
u+255	0	1	4	0	u+284	---	---	---	---
u+256	0	2	4	0	u+285	---	---	---	---
u+257	---	---	---	---	u+286	---	---	---	---
u+258	0	1	2	2	u+287	---	---	---	---
u+259	0	0	1	0	u+288	---	---	---	---
u+260	0	0	0	0	u+289	---	---	---	---
u+261	0	2	2	2	u+290	---	---	---	---
u+262	0	0	1	0	u+291	---	---	---	---
u+263	0	0	0	0	u+ 292	---	---	---	---
u+264	---	---	---	---	u+293	---	---	---	---
u+265	0	1	3	1	u+294	---	---	---	---
u+266	0	0	1	0	u+295	---	---	---	---
u+267	0	2	3	1	u+296	---	---	---	---
u+268	0	0	1	0	u+297	---	---	---	---
u+269	---	---	---	---	u+298	---	---	---	---
u+270	0	1	1	1	u+299	---	---	---	---
u+271	0	0	0	0	u+300	---	---	---	---
u+272	0	2	1	1	u+301	---	---	---	---
u+273	0	0	0	0	u+302	---	---	---	---
u+274	---	---	---	---					
u+275	0	1	6	0					
u+276	0	2	6	0					
u+277	---	---	---	---					
u+278	0	1	7	0					
u+279	0	2	7	0					

Note Axis Start command area.

Operation

By selecting axis start, origin search, jogging, inching, deceleration stop, pause, or pause release by means of a switch, the respective command is executed. In addition, axis start can be executed with any of five operation patterns which are selected by means of a rotary switch setting

Operation patterns:

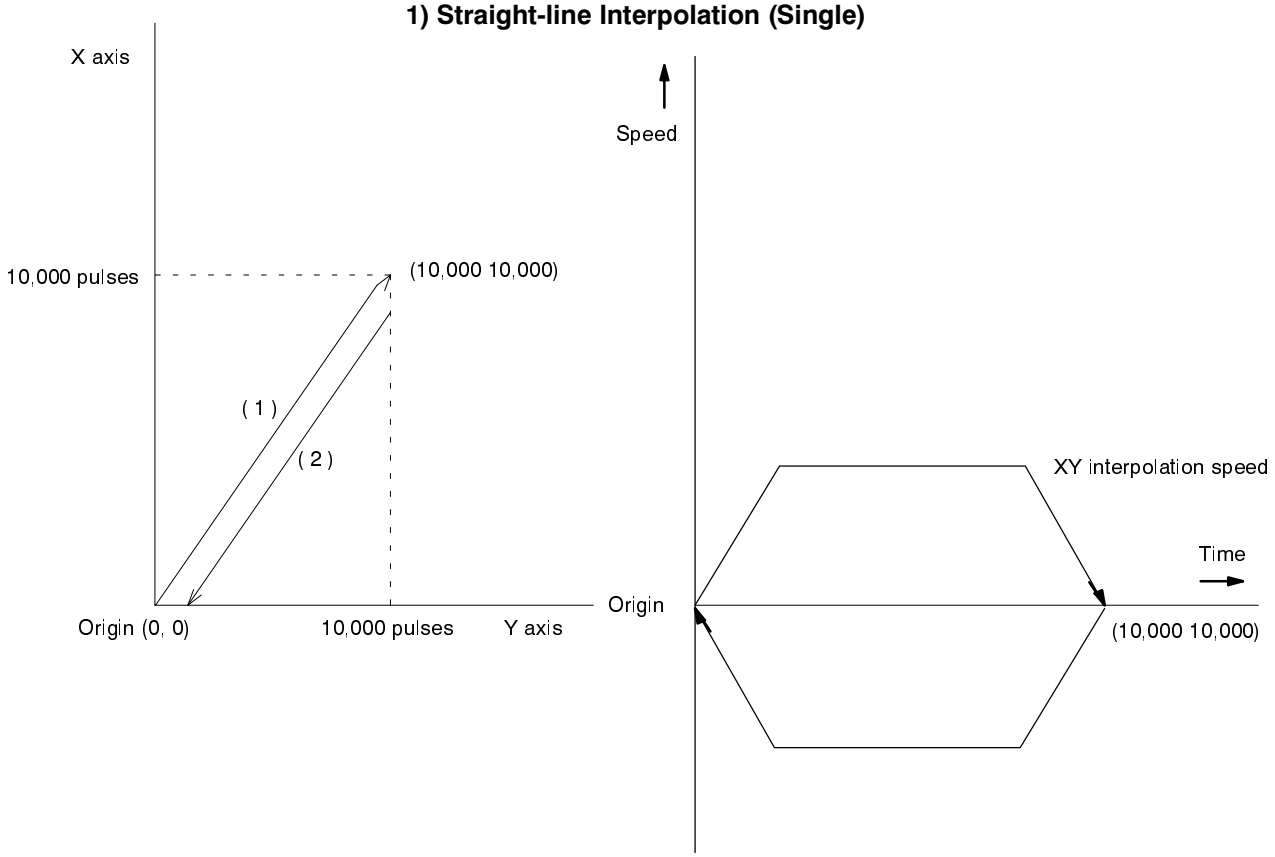
1: Straight-line interpolation (single)
2: Straight-line interpolation (continuous)
3: Straight-line interpolation for amount of single-axis movement [0]
4: Synchronous start (single)
5: Synchronous start (continuous)

The X-axis and Y-axis current positions are always output to the Output Unit.

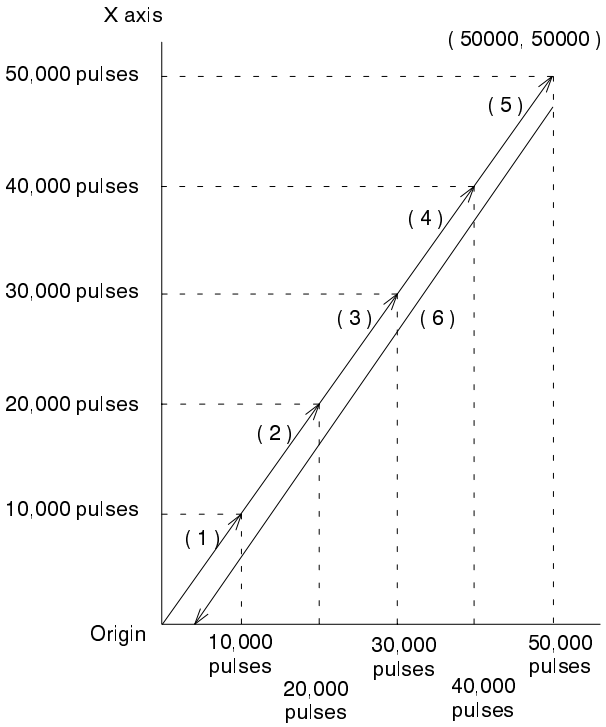
Operation Patterns

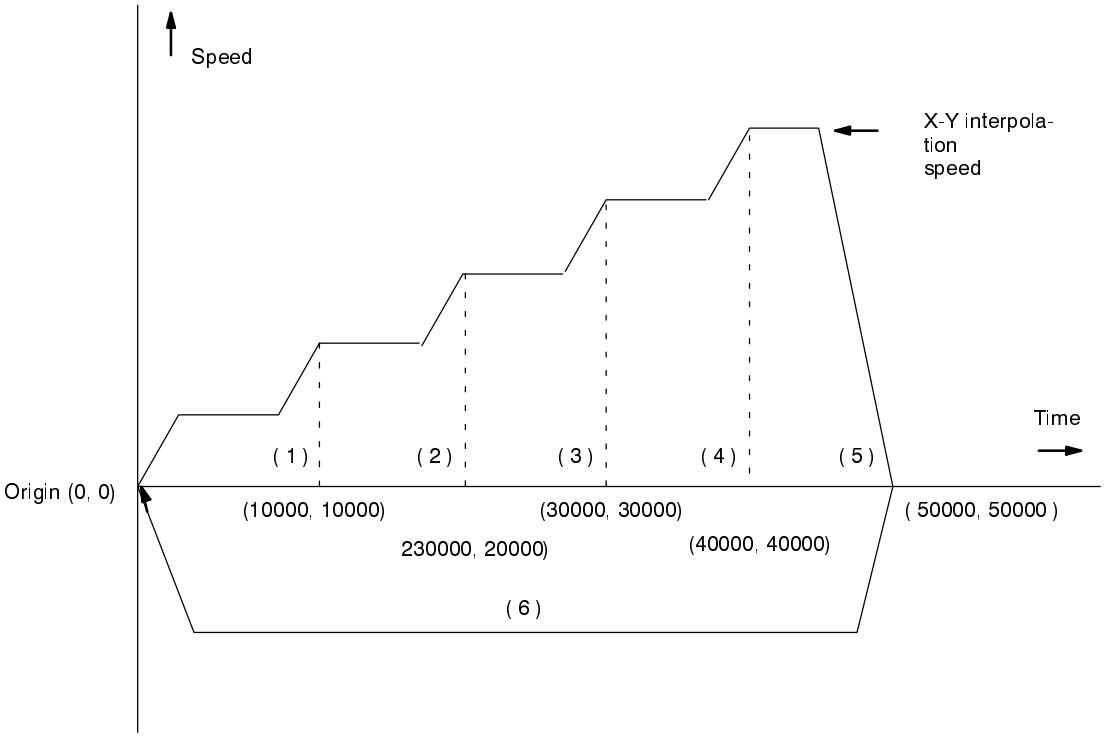
The five operation operation patterns are illustrated below and on the following pages.

1) Straight-line Interpolation (Single)

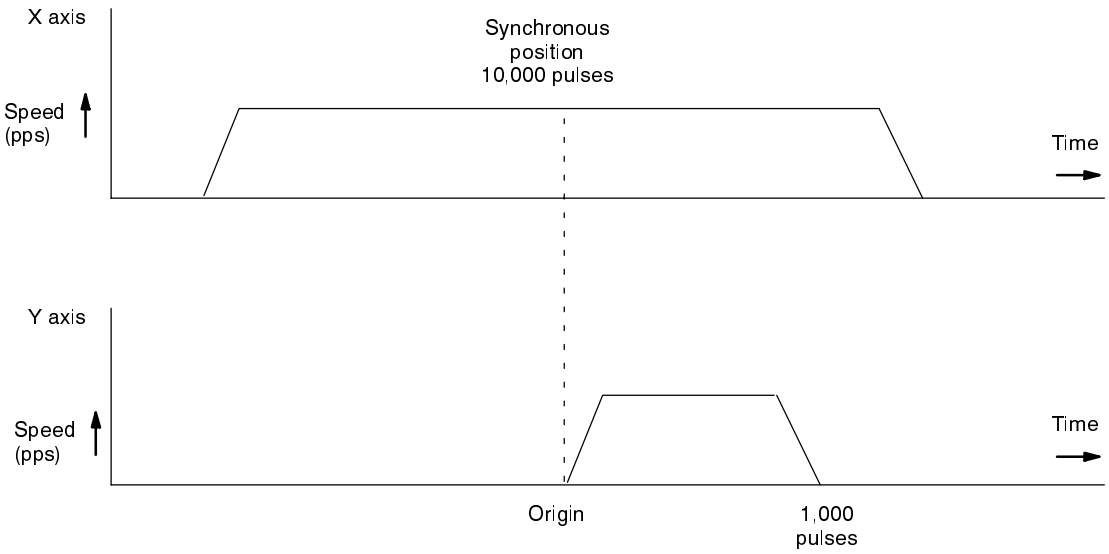


2) Straight-line Interpolation (Continuous)

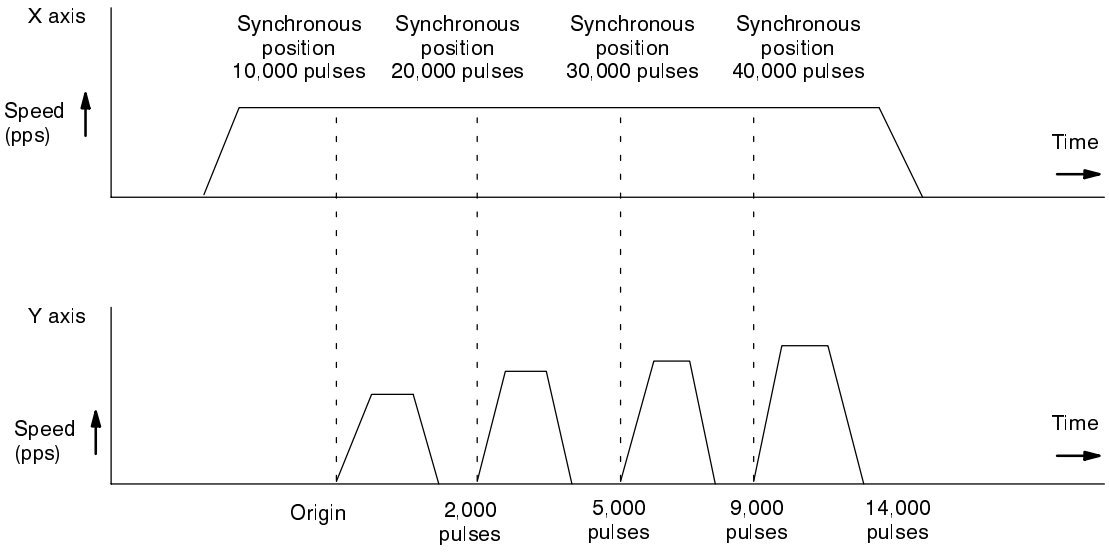




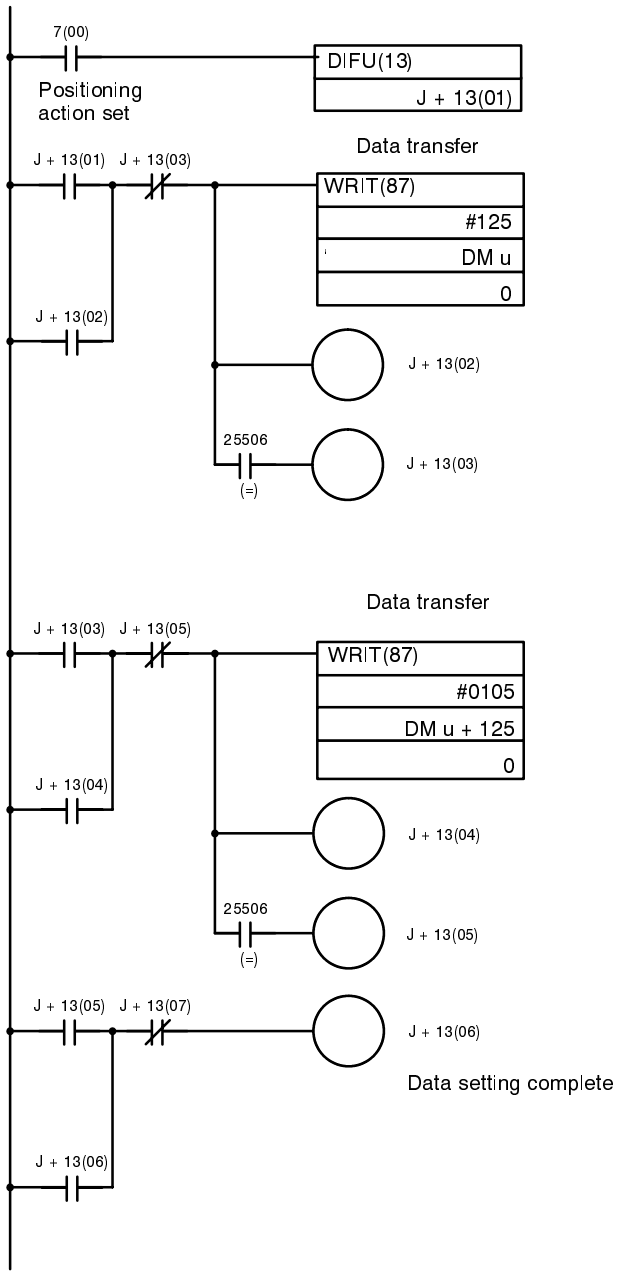
4) Synchronous Start (Single)

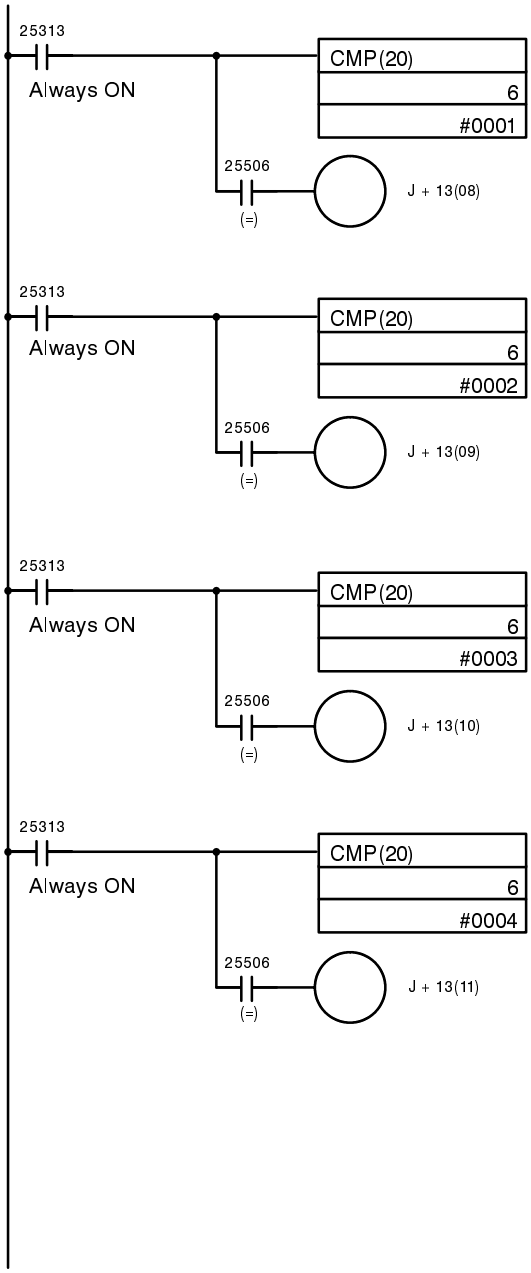


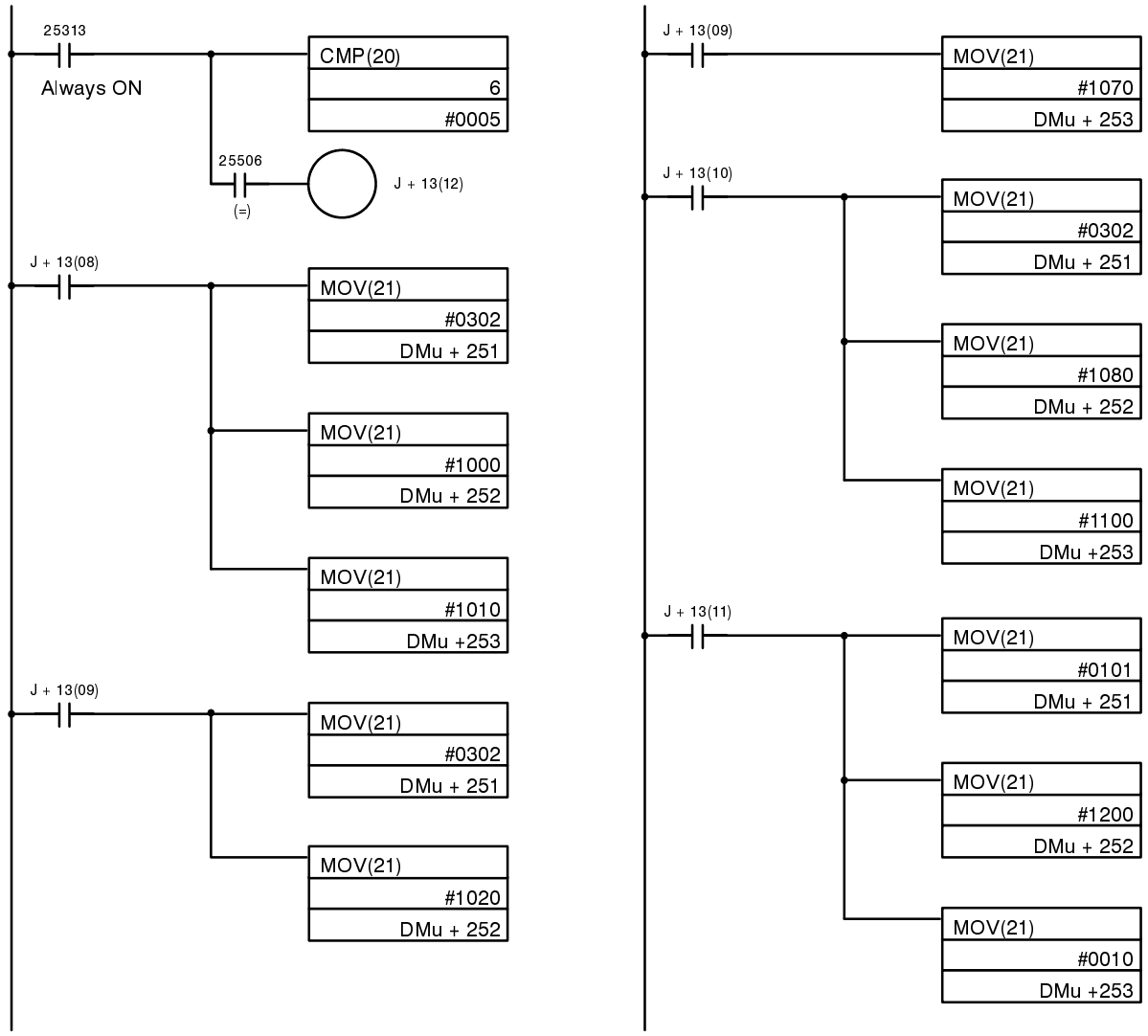
4) Synchronous Start (Continuous)

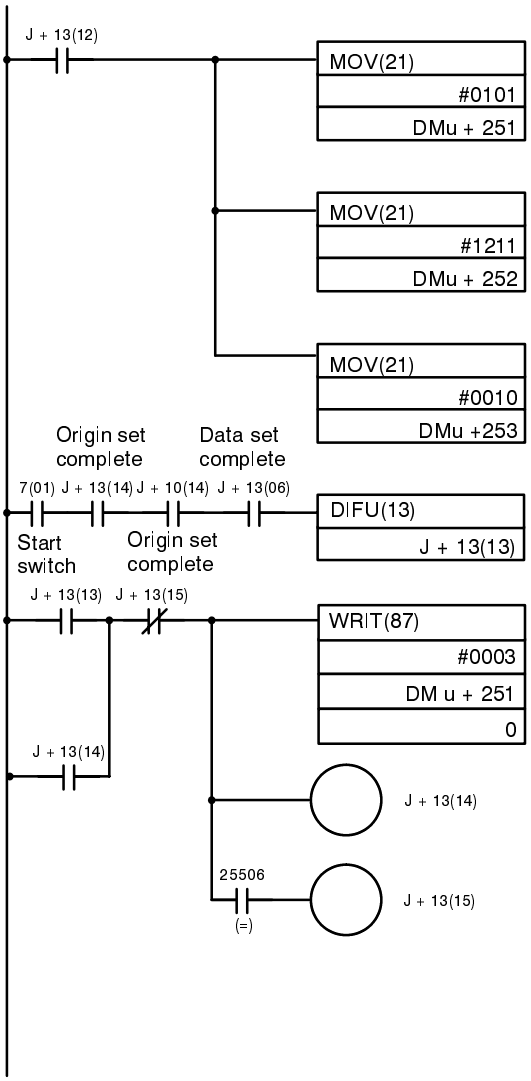


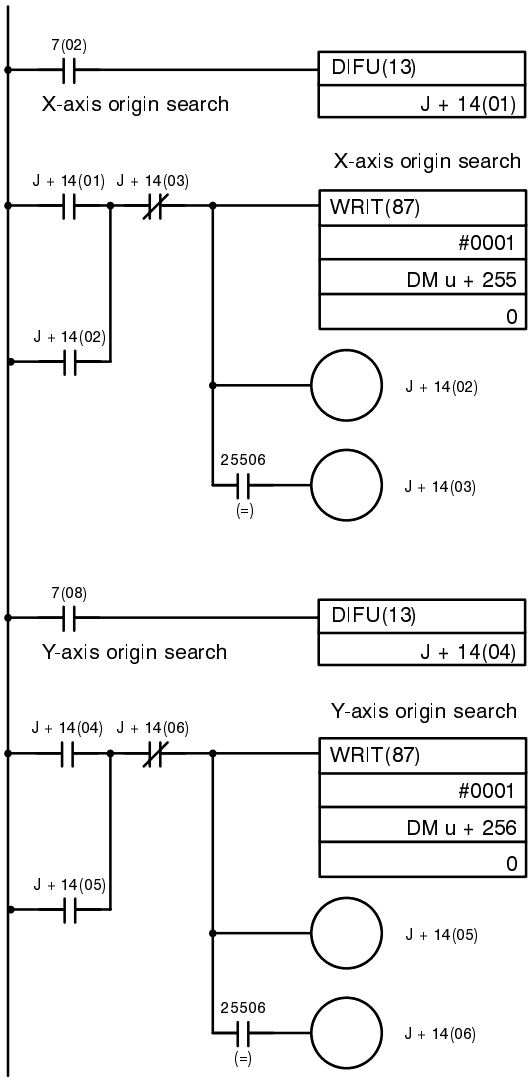
Ladder Program Examples (C1000H, C2000H)

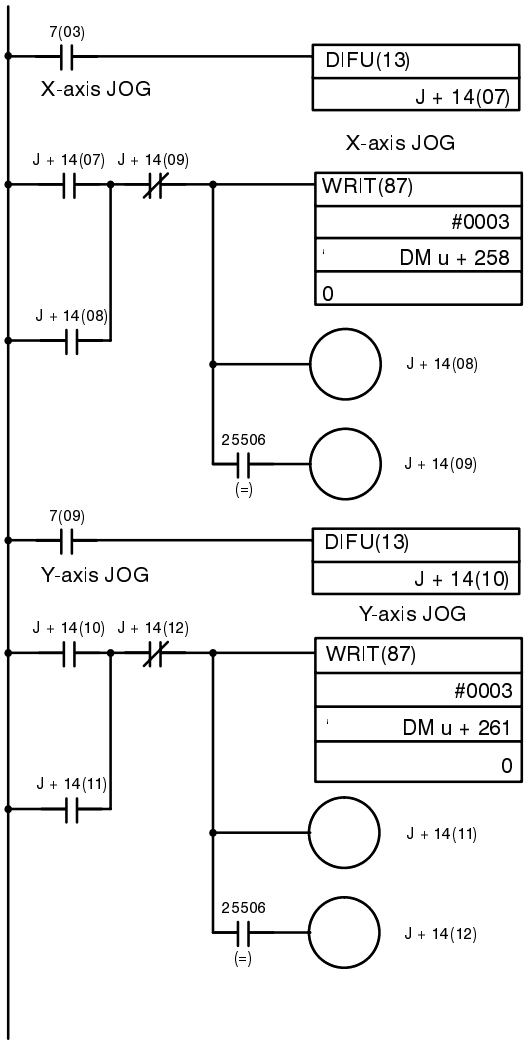


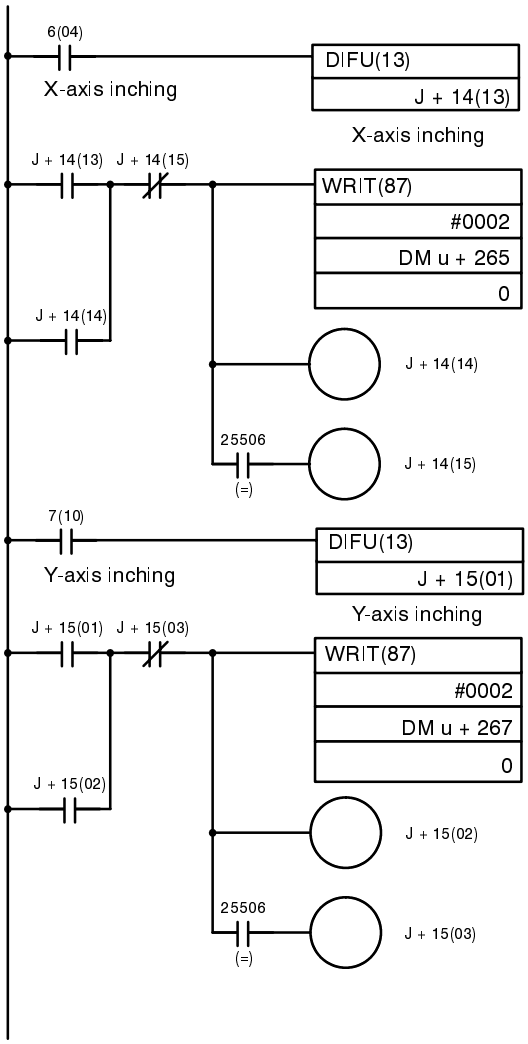


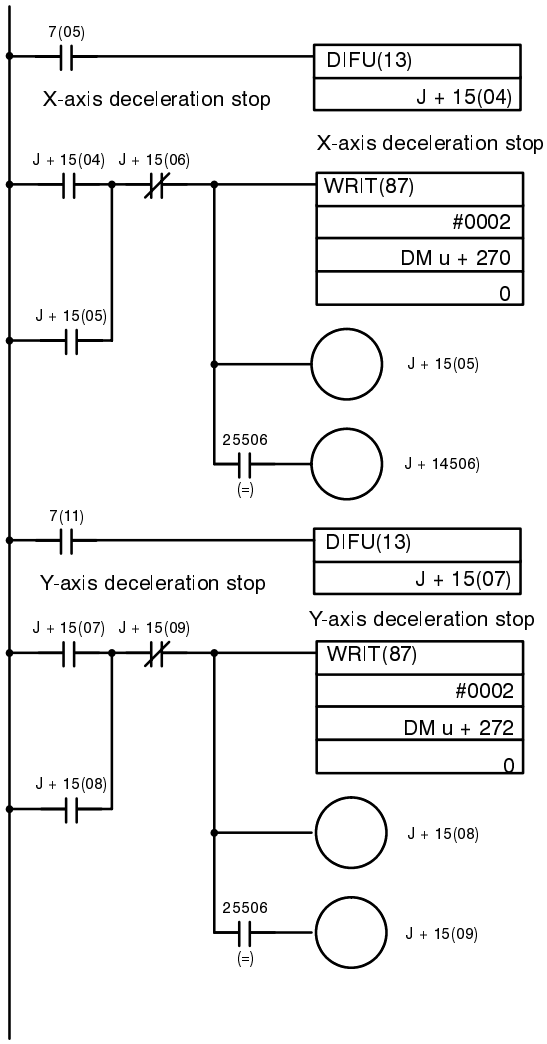

25313
Always ON
CMP(20)
6
#0005
25506
(=)
J + 13(12)
J + 13(08)
MOV(21)
#0302
DMu + 251
MOV(21)
#1000
DMu + 252
MOV(21)
#1010
DMu +253
J + 13(09)
MOV(21)
#0302
DMu + 251
MOV(21)
#1020
DMu + 252
J + 13(09)
MOV(21)
#1070
DMu + 253
J + 13(10)
MOV(21)
#0302
DMu + 251
MOV(21)
#1080
DMu + 252
MOV(21)
#1100
DMu +253
J + 13(11)
MOV(21)
#0101
DMu + 251
MOV(21)
#1200
DMu + 252
MOV(21)
#0010
DMu +253

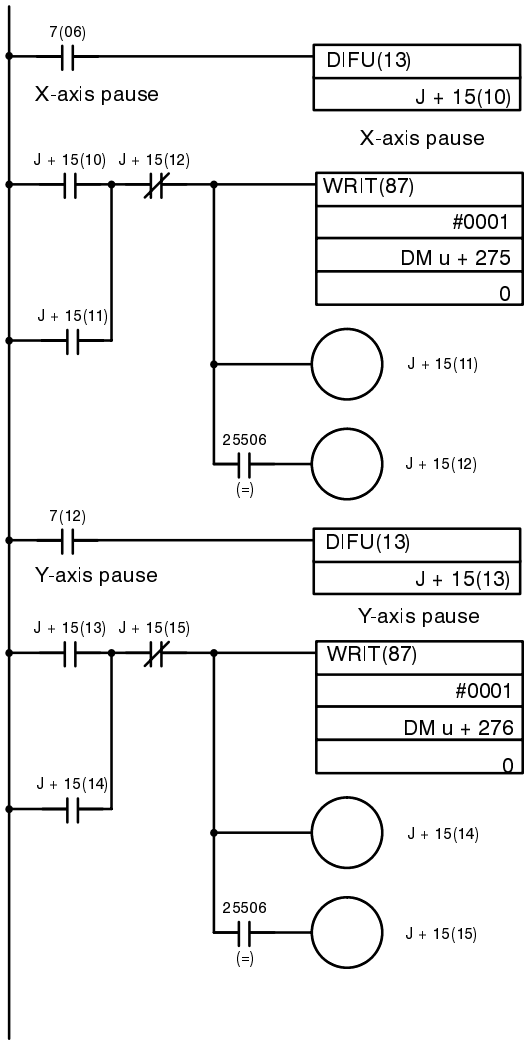

J + 13(12)
MOV(21)
#0101
DMu + 251
MOV(21)
#1211
DMu + 252
MOV(21)
#0010
DMu +253
Origin set complete
Data set complete
7(01) J + 13(14) J + 10(14) J + 13(06)
DIFU(13)
J + 13(13)
Start switch
Origin set complete
J + 13(13) J + 13(15)
WRIT(87)
#0003
DM u + 251
0
J + 13(14)
J + 13(14)
25506
(=)
J + 13(15)

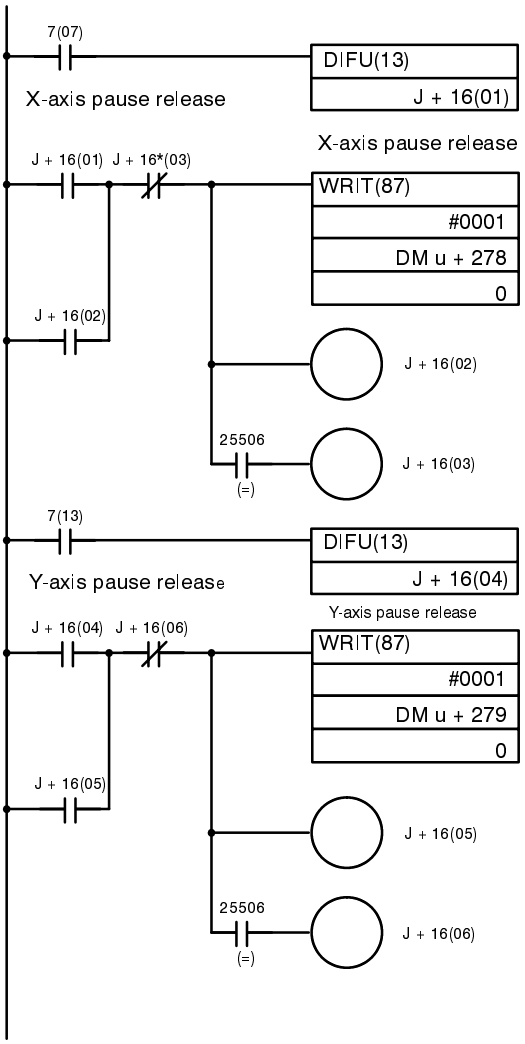

7(02)
DIFU(13)
X-axis origin search
J + 14(01)
X-axis origin search
J + 14(01) J + 14(03)
WRIT(87)
#0001
DM u + 255
0
J + 14(02)
J + 14(02)
25506
(=)
J + 14(03)
7(08)
DIFU(13)
Y-axis origin search
J + 14(04)
Y-axis origin search
J + 14(04) J + 14(06)
WRIT(87)
#0001
DM u + 256
0
J + 14(05)
J + 14(05)
25506
(=)
J + 14(06)

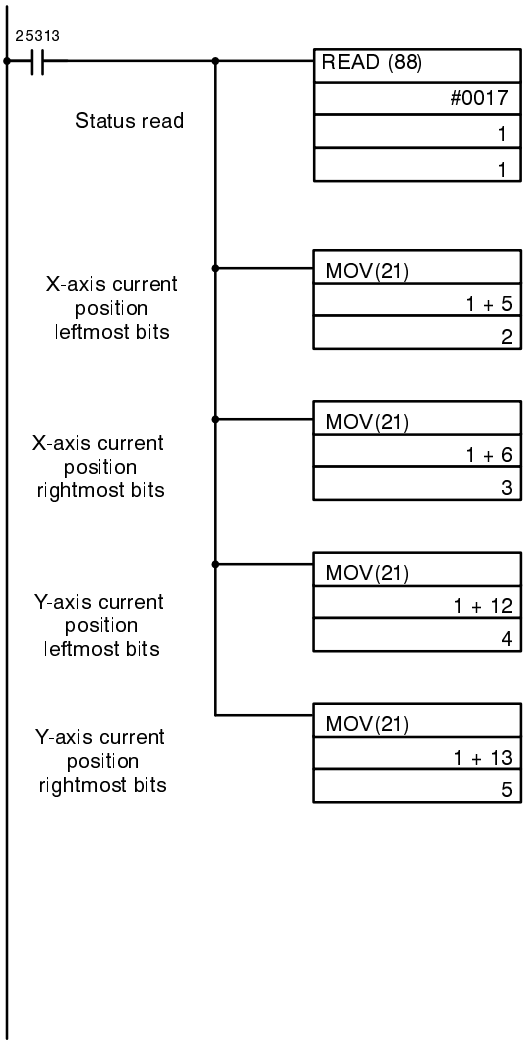

7(03)
X-axis JOG
DIFU(13)
J + 14(07)
X-axis JOG
J + 14(07)
J + 14(09)
WRIT(87)
#0003
DM u + 258
0
J + 14(08)
J + 14(08)
25506
(=)
J + 14(09)
7(09)
Y-axis JOG
DIFU(13)
J + 14(10)
Y-axis JOG
J + 14(10)
J + 14(12)
WRIT(87)
#0003
DM u + 261
0
J + 14(11)
J + 14(11)
25506
(=)
J + 14(12)


6(04)
X-axis inching
DIFU(13)
J + 14(13)
X-axis inching
J + 14(13)
J + 14(15)
WRIT(87)
#0002
DM u + 265
0
J + 14(14)
J + 14(14)
25506
(=)
J + 14(15)
7(10)
Y-axis inching
DIFU(13)
J + 15(01)
Y-axis inching
J + 15(01)
J + 15(03)
WRIT(87)
#0002
DM u + 267
0
J + 15(02)
J + 15(02)
25506
(=)
J + 15(03)


7(05)
DIFU(13)
J + 15(04)
X-axis deceleration stop
X-axis deceleration stop
J + 15(04)
J + 15(06)
WRIT(87)
#0002
DM u + 270
0
J + 15(05)
J + 15(05)
25506
(=)
J + 14506)
7(11)
DIFU(13)
J + 15(07)
Y-axis deceleration stop
Y-axis deceleration stop
J + 15(07)
J + 15(09)
WRIT(87)
#0002
DM u + 272
0
J + 15(08)
J + 15(08)
25506
(=)
J + 15(09)


7(06)
DIFU(13)
J + 15(10)
X-axis pause
X-axis pause
J + 15(10)
J + 15(12)
WRIT(87)
#0001
DM u + 275
0
J + 15(11)
J + 15(11)
25506
(=)
J + 15(12)
7(12)
DIFU(13)
J + 15(13)
Y-axis pause
Y-axis pause
J + 15(13)
J + 15(15)
WRIT(87)
#0001
DM u + 276
0
J + 15(14)
J + 15(14)
25506
(=)
J + 15(15)


7(07)
DIFU(13)
J + 16(01)
X-axis pause release
X-axis pause release
J + 16(01)
J + 16*(03)
WRIT(87)
#0001
DM u + 278
0
J + 16(02)
J + 16(02)
25506
(=)
J + 16(03)
7(13)
DIFU(13)
J + 16(04)
Y-axis pause release
Y-axis pause release
J + 16(04)
J + 16(06)
WRIT(87)
#0001
DM u + 279
0
J + 16(05)
J + 16(05)
25506
(=)
J + 16(06)

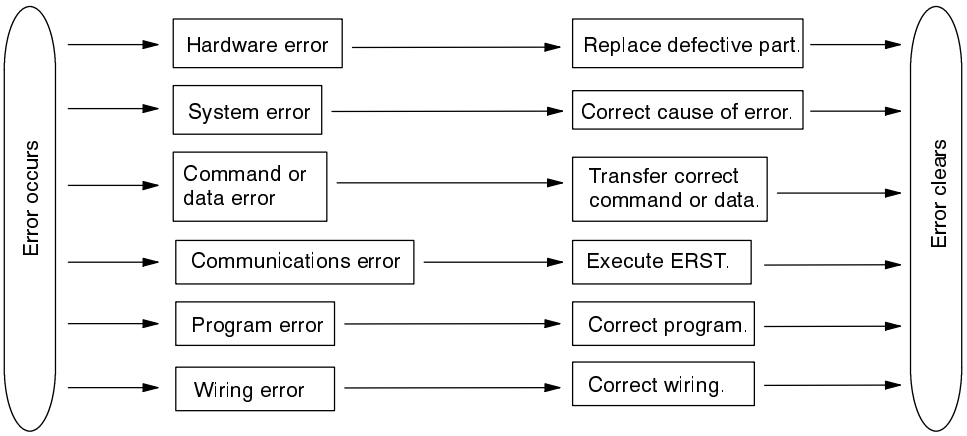

25313
READ (88)
#0017
1
1
Status read
X-axis current position leftmost bits
MOV(21)
1 + 5
2
X-axis current position rightmost bits
MOV(21)
1 + 6
3
Y-axis current position leftmost bits
MOV(21)
1 + 12
4
Y-axis current position rightmost bits
MOV(21)
1 + 13
5

SECTION 9
Error Processing

This section covers error processing and describes the different error processing steps. The six types of errors, (hardware, system, command/data, communications, program, and wiring errors) and their unique error codes are discussed in detail.

9-1 Procedure

Error processing is facilitated by the ERROR indicator on the Position Control Unit. The following figure describes the different error processing steps. The six types of errors (hardware errors, system errors, command/data errors, communications errors, program errors, and wiring errors) are further classified by their unique error codes (Refer to *Appendix C*). In addition, the ERROR indicator on the Position Control Unit lights when there is a system error or command error and flashes when there is a communications error. When a hardware error occurs, the RUN indicator turns off or all four of the indicators flash.



9-2 Basic Troubleshooting

If an error occurs, the following general procedure should be used.

1, 2, 3...

1. Check the indicator status on the Position Control Unit front panel and the flag status.
2. If possible, determine the cause of the error. Check the error code.
3. Correct the cause of the error.
4. Reset the Position Control Unit (ERST).

9-3 Hardware Errors

Caused by defective components or electrical noise within the NC222-E. Hardware errors are assigned error codes 00 through 03 (See *Appendix C*). They include RAM errors, common RAM errors, gate array errors, COMB errors, bus errors, EEPROM verification errors, and watchdog timer errors. When a hardware error occurs, correct any wiring problems that produce electrical noise, or replace the defective components.

9-4 System Errors

Caused by factors such as servo selection, problems during operation, and so on. System errors are assigned error codes 10 through 13 (See *Appendix C*). Possible problem areas include the workpiece travelling beyond the CW or CCW limit switch or error counter overflow. These errors are cleared by correcting the cause of the problem.

9-5 Wiring Errors

Caused by faulty wiring such as reversed or disconnected wiring. Wiring errors are assigned error codes 20 through 23. These errors are cleared by correcting the faulty wiring.

9-6 Command/Data Errors

Caused by PC commands. Command errors are further classified as OP code errors with codes 30 through 36, operand errors with codes 40 and 41, and data errors with codes 50 through 61 (See *Appendix C*). Possible problem areas include incorrect command or data format, commands received at the wrong time (e.g., SRT before ORG), and undefined data.

9-7 Communications Errors

Caused by abnormal data communications with Peripheral Devices such as the Teaching Box. Communication errors are assigned error codes 70 through 79 (See *Appendix C*). Problem areas are parity errors, framing errors, and overrun errors. These errors are cleared by ERST.

9-8 Program Errors

Caused by errors in the PC program, such as the number of words transferred by WRIT(87) exceeding 127. The error code is 80. A program error can be cleared by correcting the program.

SECTION 10
Teaching Box Operations

This section covers Teaching Box operations, including key operations, PC contents and permitted settings, and error codes are discussed in detail.

10-1 Features and System Configuration

10-1-1 Features

Versatile Message Display

The C500-TU002 Teaching Box displays 32 characters on two lines, 16 characters per line. Two axes are displayed at the same time for two-axis control.

Conversational Type

The C500-TU002 Teaching Box is a user-friendly, conversational type model. Anyone can operate the Teaching Box by following the menus.

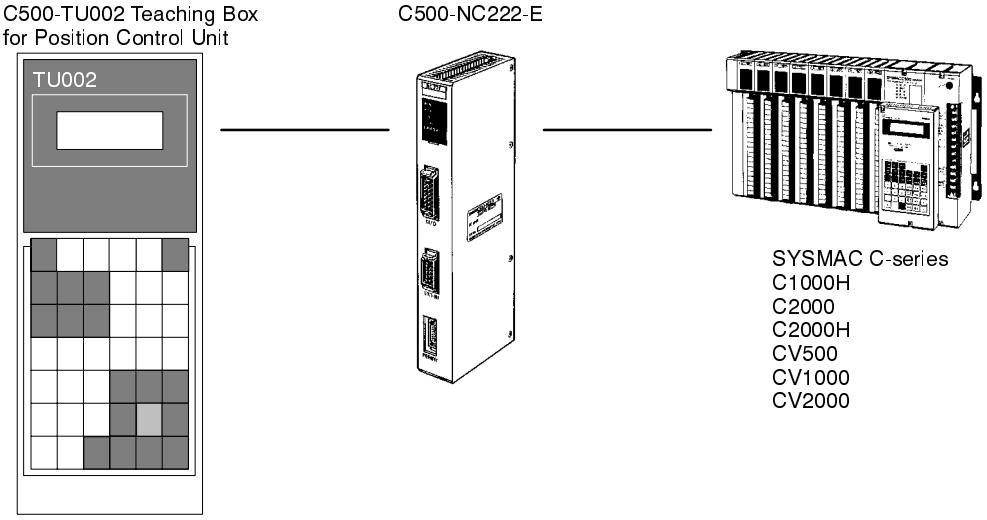
Easy-to-see Error Indicator

The C500-TU002 Teaching Box displays error codes for operational errors such as a hardware error, program setting error, etc., thus minimizing operational mistakes.

Connecting to a Variety of Position Control Units

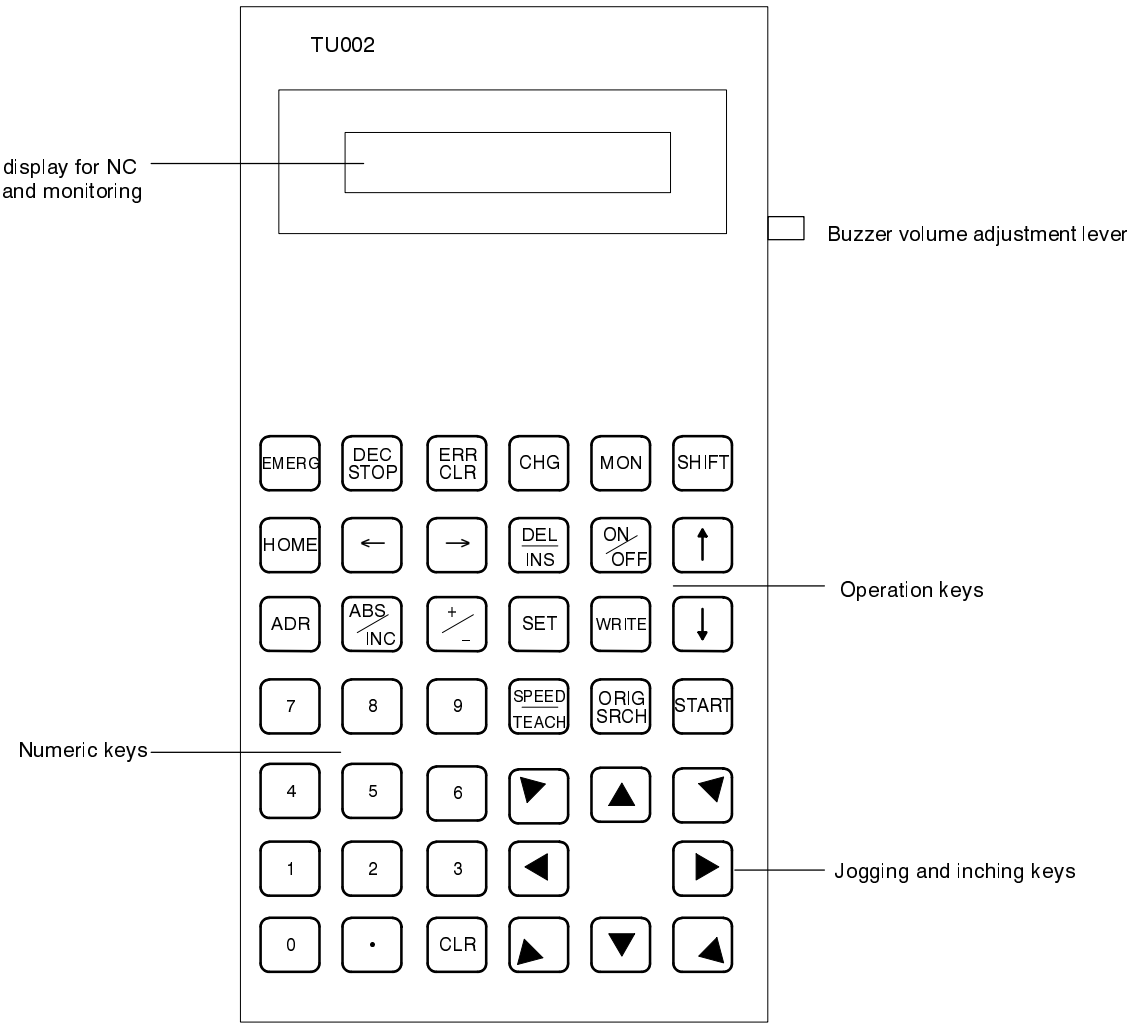
The C500-TU002 Teaching Box connects to the C500-NC222, C500-NC221, C500-NC111(-V1), C500-NC103, and C500-NC121 Position Control Units by setting the pins of the DIP switch on the rear panel of the C500-TU002 Teaching Box.

10-1-2 System Configuration



10-2 Nomenclature and Functions

10-2-1 Nomenclature



10-2-2 Key Functions

Key	Function
EMERG	Stops positioning immediately.
DEC STOP	Stops positioning gradually.
ERR CLR	Resets to clear the error status of the NC221 or NC222.
CHG	Changes positioning data to the present value.
MON	Monitors axis operation.
SHIFT	Used in combination with another key to change functions.
HOME	Returns to the initial display.
Right and Left	Moves the cursor.
DEL/INS	Inserts or deletes positioning data.
ON/OFF	Turns control output signals ON or OFF.
+/–	Sets the + or – of the coordinate of positioning data.
SET	Sets a mode under a menu.
WRITE	Writes data that has been set.
Up and Down	Scrolls the screen.
SPEED/TEACH	Sets speed data.
	Executes teaching.
ORG SRCH	Moves an axis to the origin.
START	Starts positioning for the specified address.
CLR	Clears NC data that has been set.
Numeral	Sets data.
Arrow	Executes jogging and inching in the specified direction.

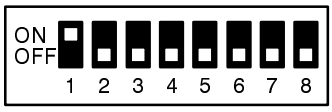
Note The EMERG Key of the C500-NC221-E and that of the C500-NC222-E are different in function. The EMERG Key of the C500-NC221-E stops positioning by making the voltage output of the C500-NC221-E to be 0 and the present value will be lost. On the other hand, the EMERG Key of the C500-NC222-E stops by discharging the accumulated value of the deflection counter of the C500-NC222-E and the present value will not be lost.

10-3 Teaching Box Operations

10-3-1 Operational Flow

Before operating axes with the Teaching Box with the C500-NC222-E, follow the procedure below.

1, 2, 3... 1. Set pin 1 of the internal DIP switch to ON and pins 2 through 8 to OFF.



2. Connect the Teaching Box to the C500-NC222-E and turn on the Teaching Box.
3. Input a password.
4. Select the Operating mode.
5. Clear the previous data.
6. Input new data.
7. Establish the origin (origin search or current position setting)
8. Start operation.

Note The main menu and the DIP switch settings of the C500-NC222-E are the same as those of the C500-NC221-E.

10-3-2 DIP Switch Settings

Refer to the following table for the settings of the DIP switch.

Pin	Setting
1	Set to ON when connecting the Teaching Box to the C500-NC221-E or C500-NC222-E.
2	Set to ON when connecting the Teaching Box to the C500-NC111-EV1.
3	Set to ON when connecting the Teaching Box to the C500-NC103-E.
4	Set to OFF.
5, 6	Not used.
7, 8	For system use. Be sure to set these pins to OFF.

Note
1. If more than one pin out of pins 1 to 4 is set to ON, only the setting of the pin with the smallest number is effective.
2. The initial screen of the Teaching Box for the C500-NC222-E and that for the C500-NC221-E are the same. If the C500-NC222-E is used, press the CLR key after the initial screen appears and continue Teaching Box operations.

10-3-3 Password Input

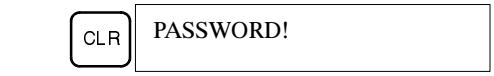
The Teaching Box has a password function to insure safe operation. The password function prevents the Teaching Box from being operated by accident. It also prevents the operation of the Teaching Box by a third person.

It is necessary to input the user's own password into the Teaching Box before any key operation when the Teaching Box is turned on, is installed, or when the Teaching Box is in Protect mode.

Operational Flow

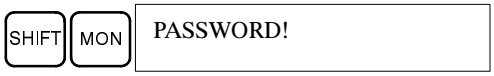
The following main menu appears when the Teaching Box is turned on.

Press the CLR key and input the password.



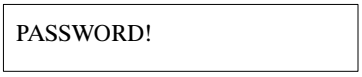
Teaching Box Protect Setting

Press the SHIFT key and then MON key and input the password.



Teaching Box Protect Cancel

Input the password.

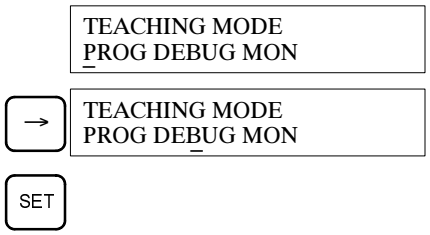


10-3-4 Initial Operation (Mode Selection)

Before setting a value with the Teaching Box, select the Teaching mode. The Program, Debug, or Monitor mode can be selected after selecting the Teaching mode.

Operation Description

Move the cursor with the Left or Right key and select the mode to be set.



Values can be set in Program mode.

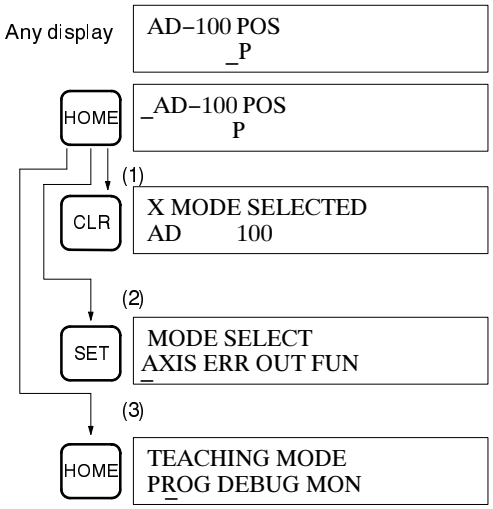
Modes and Functions

Mode	Function	PC commands
Program	All operations are enabled.	All commands are enabled.
Debug	Only debugging is enabled.	All commands are enabled until PC Protect turns ON.
Monitor	Monitors axis operations.	All commands are enabled.

10-3-5 Returning to Main Menus

To return to one of the main menus from any other display, follow the procedure below.

Key Operation and Displays



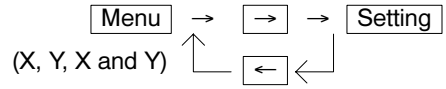
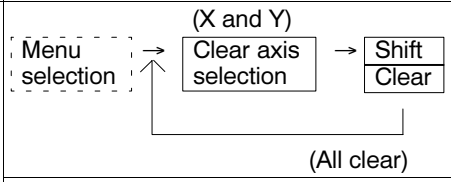
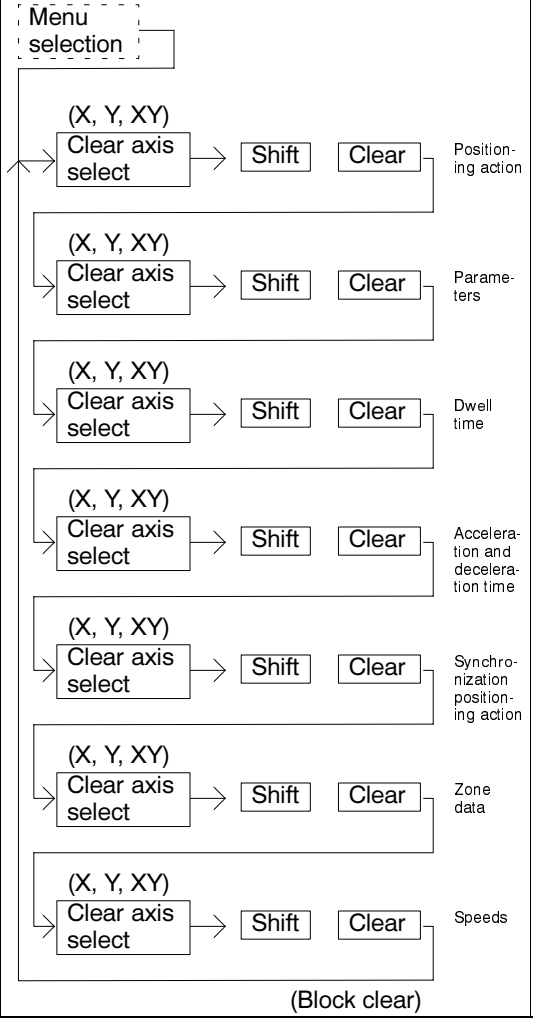
Operation Description

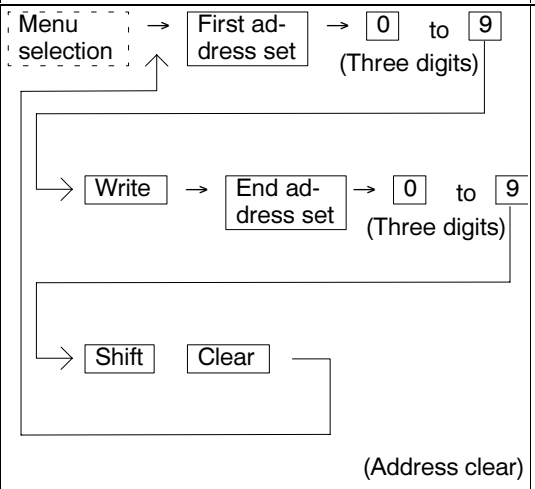
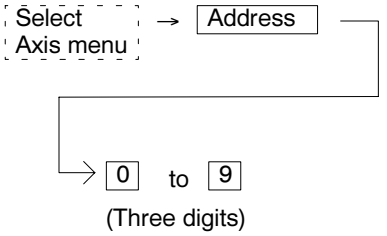
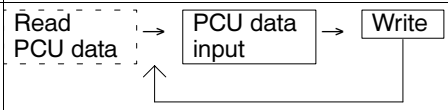
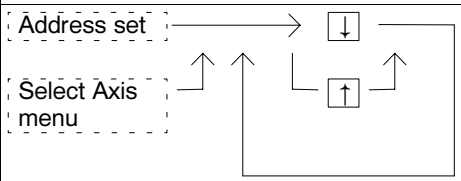
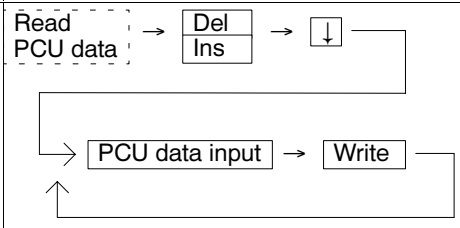
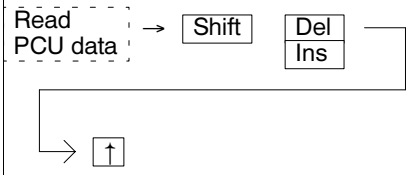
1, 2, 3...

1. Move to the Edit (X mode) menu by pressing the HOME key followed by the CLR key.
2. Move to the Operating mode (mode select) menu by pressing the HOME key following by the SET key.
3. Move to the initial (Teaching mode) display by pressing the HOME key twice.

10-4 Table of Operations

The following table summarizes operations described in detail in the following pages. Each term enclosed in a dotted box indicates the operation prior to the key sequence shown. When inputting numerical data, 0's for the leftmost digits do not need to be entered, e.g., to input the number 00002, press the "2" key only.

Operation name	Function	Available mode			Basic Operating Procedure	Page
		Debug	Monitor	Program		
Axis selection	Selects X axis, Y axis, or X and Y axes from a menu.	No	No	Yes		203
Data all clear	Clears all data selected.	No	No	Yes		203
	Clears a block of X- and Y-axes parameters, positioning actions, dwell time, acceleration/deceleration times, synchronization positioning actions, and zone data.					

Operation name	Function	Available mode			Basic Operating Procedure	Page
		Debug	Monitor	Program		
Data clear	Clears the data in a range between designated start and end addresses.	No	No	Yes		203
Address settings	Sets a designated address.	No	No	Yes		207
Writing PCU data	Writes PCU data to the PCU memory.	No	No	Yes		207
Reading PCU data	Reads the contents of the PCU memory.	No	No	Yes		225
Inserting positioning actions	Writes a positioning action to a designated address and moves the prior positioning actions written at and beyond that address successively back one address each.	No	No	Yes	 The DEL/INS key is effective for inputting and displaying the first positioning action.	233
Deleting positioning actions	Deletes the positioning action at a designated address and shifts prior positioning actions past that address successively up toward the designated address.	No	No	Yes	 The DEL/INS key is effective for displaying the first positioning action.	235

Operation name	Function	Available mode			Basic Operating Procedure	Page
		Debug	Monitor	Program		
Jogging and inching	Jogging and inching are executed on the axis selected in Axis mode.	No	No	Yes	Select Axis menu → Shift →	236 and 237
Teaching	Writes a position designated through a JOG operation to the designated positioning action address.	No	No	Yes	Set address → Learning → Jogging Pulse feed Write ↑ / ↓ → Data set Write	239
Origin search	Moves an axis to the origin.	No	No	Yes	Select Axis menu → Origin search Origin search is not possible while the ERR, OUT, or FUN menu is selected.	241
Start, home shift start	Performs positioning for a designated address.	No	No	Yes	Select Axis menu → Start Shift + Start (Home shift) Start home shift is not possible while the ERR, OUT, or FUN menu is selected.	242
Monitor and override	Monitors the current position, current address, M code, and dwell time speed override and performs override changes.	No	No	Yes	Select Axis menu → Monitor → ↓ ↑ (At the time of override display) Write → 0 to 9 Write (override) Override is effective in Program mode only.	244
Change current position	Changes the current position to the input value.	No	No	Yes	Select Axis menu → Change Present value input → Write	246
Deceleration stop	Decelerates to a stop for axes selected under the Axis menu.	No	No	Yes	Select Axis menu → Start operation → Deceleration stop	248

Operation name	Function	Available mode			Basic Operating Procedure	Page
		Debug	Monitor	Program		
Emergency Stop	Immediately stops the axes selected in Axis mode.	No	No	Yes	Any display → Start operation → Immediate stop	248
Setting OUT1 and OUT2 Outputs	Outputs OUT1 and OUT2.	No	No	Yes	Select OUT menu → Select OUT1/OUT2 menu (OUT1, OUT2) → ON/OFF	249
Writing PCU data to EEPROM and reading PCU data from EEPROM	Writes positioning actions, parameters, and speeds to the EEPROM and reads these values from the EEPROM.	No	No	Yes	Select FUN menu → Select EEPROM (Memory clear, servo, EEPROM) → READ/WRITE → Setting	249 and 250
Error displays	Displays the contents of the PCU's error.	No	Yes	Yes	Select FUN menu An error message is automatically displayed when an error results.	251
Resetting	The PCU's error is reset.	Yes	Yes	Yes	Error results → Resetting → Clear	252
PC protect	PC and external inputs are protected.	Yes	No	No	Select mode → Select debugging mode (PC, EXT, trace) → ON/OFF	252
Command tracing	The I/O statuses of the X and Y axes and the OP code are displayed.	Yes	No	No	Select mode → Select debugging mode (PC, trace) → ↓ - - - → ↓	253
Servomotor free	Sets a designated axis to servomotor lock or servomotor free.	No	No	Yes	Select FUN menu → Servo selected (Memory clear, servo EEPROM) → Select Axis menu (X, Y) → Select servomotor (Free, lock) → Set	255

Note To change the values that have been already set, execute a reading PCU data operation, press the CLR key to clear the displayed items, and input new values.

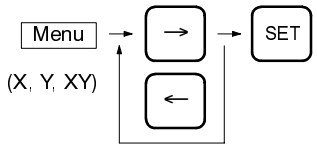
10-5 Axis Selection

It is necessary to select the X axis, Y axis, or X and Y axes under the Axis menu before setting PCU data or positioning.

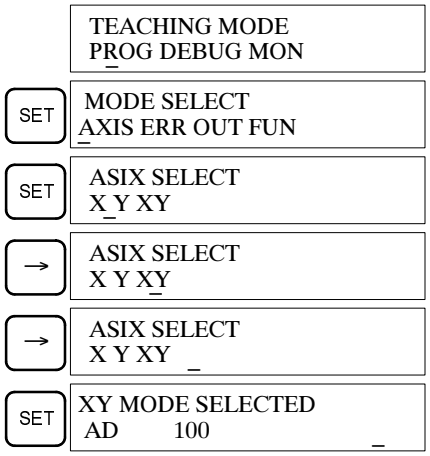
Available Modes

Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure



Key Operations and Display changes



Use the Right or Left keys to select the X axis, Y axis, or X and Y axes from the menu. If the X axis is selected, only data settings for the X axis can be made. If the Y axis is selected, only data settings for the Y axis can be made. If the X and Y axes are selected, both X and Y axes' data settings can be made.

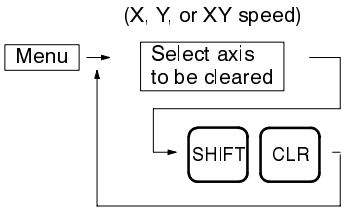
10-6 Data Clear

Data clear operations includes all clear, block clear, and address clear operations. To correct values already set or to write new values to the Position Control Unit's RAM, do the following.

Available Mode

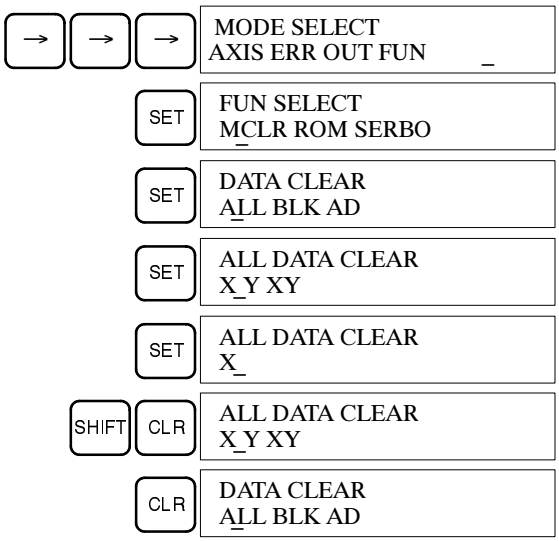
Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure



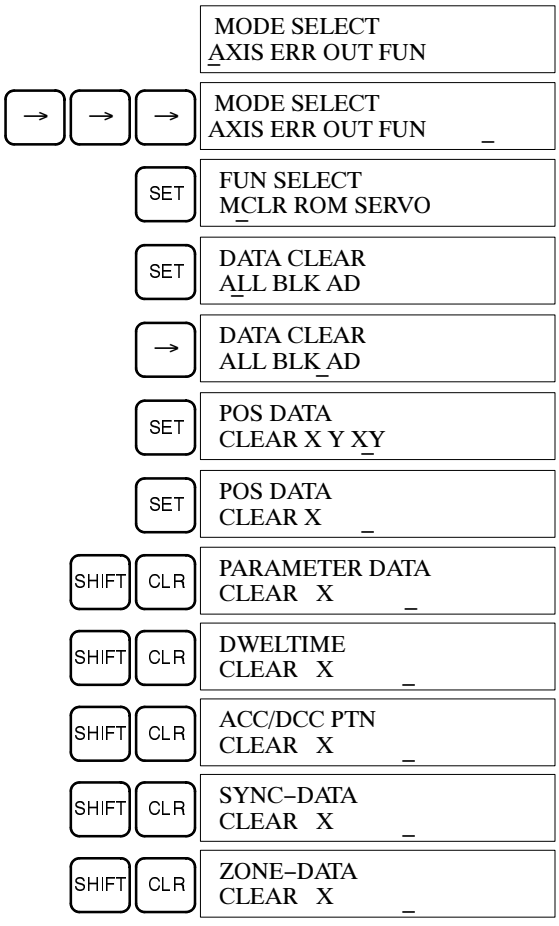
Key Operation and Displays

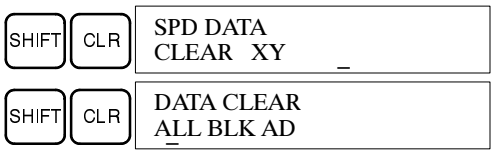
All Clear



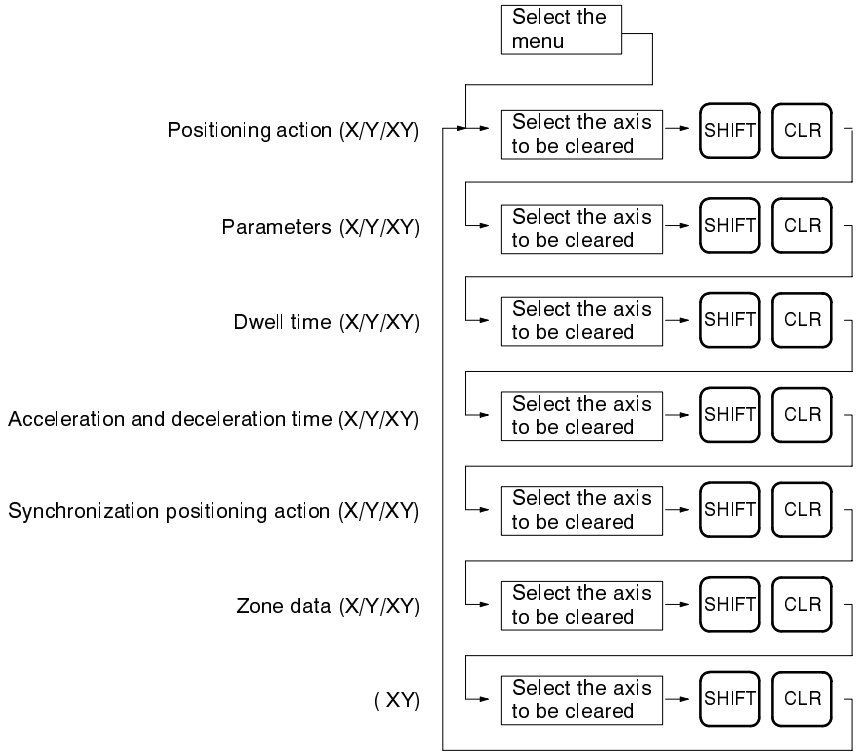
- The all clear operation clears the contents of positioning actions, parameters, dwell times, acceleration and deceleration times, synchronization positioning actions, zone data, and speeds for the X axis or the contents of positioning actions, parameters, dwell times, acceleration and deceleration times, synchronization positioning actions, zone data, and speeds for the Y axis of the PCU.
- Use the Right or Left keys to select the axis whose data items are to be cleared and press the SET key to execute.

Block Clear





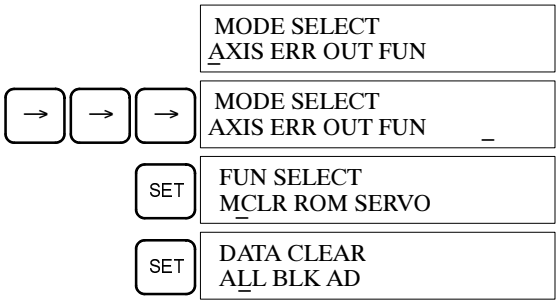
Basic Operating Procedure

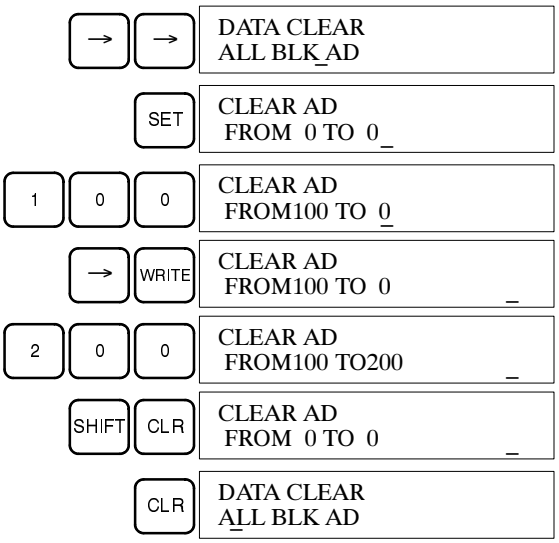


Operation Description

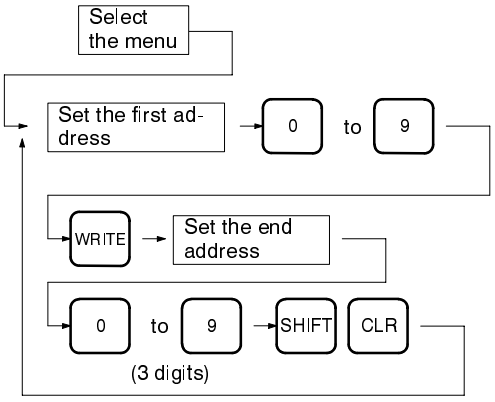
- The block clear operation clears a block of positioning actions, parameters, dwell times, acceleration and deceleration times, synchronization positioning actions, zone data, speeds of the X axis, the positioning actions, parameters, dwell times, acceleration and deceleration times, synchronization positioning actions, zone data of the Y axis, and common speeds of X and Y axes.
- By pressing the Down key, the next value will be displayed without clearing the previous value.
- To clear an axis, select the axis with the Right or Left keys and press the SET key to execute.
- If the X axis is selected, the parameters, dwell times, acceleration and deceleration times, synchronization positioning actions, and zone data of only the X axis can be cleared.
- Similarly, if the Y axis or XY axis is selected, the values of only the selected axis or axes can be cleared.

Address Clear





Basic Operating Procedure



Operation Description

- By inputting the first address and end address both in three digits, the values existing between the first address and end address will be cleared.
- In the above example, the values existing between addresses 100 and 200 are cleared.
- Refer to the following table for data items that can be cleared and the available address ranges of the data items.

Axis / Data item	X axis	Y axis
Positioning action	100 to 399	500 to 799
Parameter	400 to 420	800 to 820
Dwell time	450 to 459	850 to 859
Acceleration and deceleration time	460 to 469	860 to 869
Synchronization positioning action	470 to 479	870 to 879
Zone data	480 to 487	880 to 887
Speed	900 to 999	

Note An error will result if a improper address range is designated.

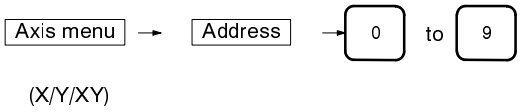
10-7 Address Settings

Address settings are required for writing, reading, inserting, or deleting values.

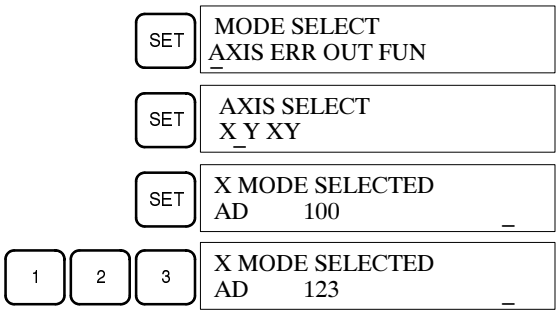
Available Mode

Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure



Key Operation and Displays



Operation Description

- Select the axis from the Axis menu with which the address desired will be set.
- When the address is input in three digits, the address is displayed.
- No value is displayed by only setting the address. Press the Down key to display the value of the address that has been set.

Note PCU data settings must start from address 100.

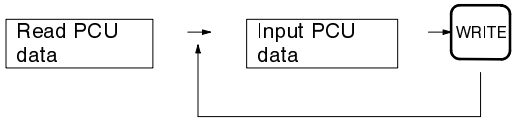
10-8 Writing PCU Data

This operation is used to write to the memory the contents of parameters, positioning actions, dwell times, acceleration and deceleration times, synchronization positioning actions, and zone data for the X axis and the contents of parameters, positioning actions, dwell times, acceleration and deceleration times, synchronization positioning actions, zone data, and speeds for the Y axis.

Available Mode

Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure

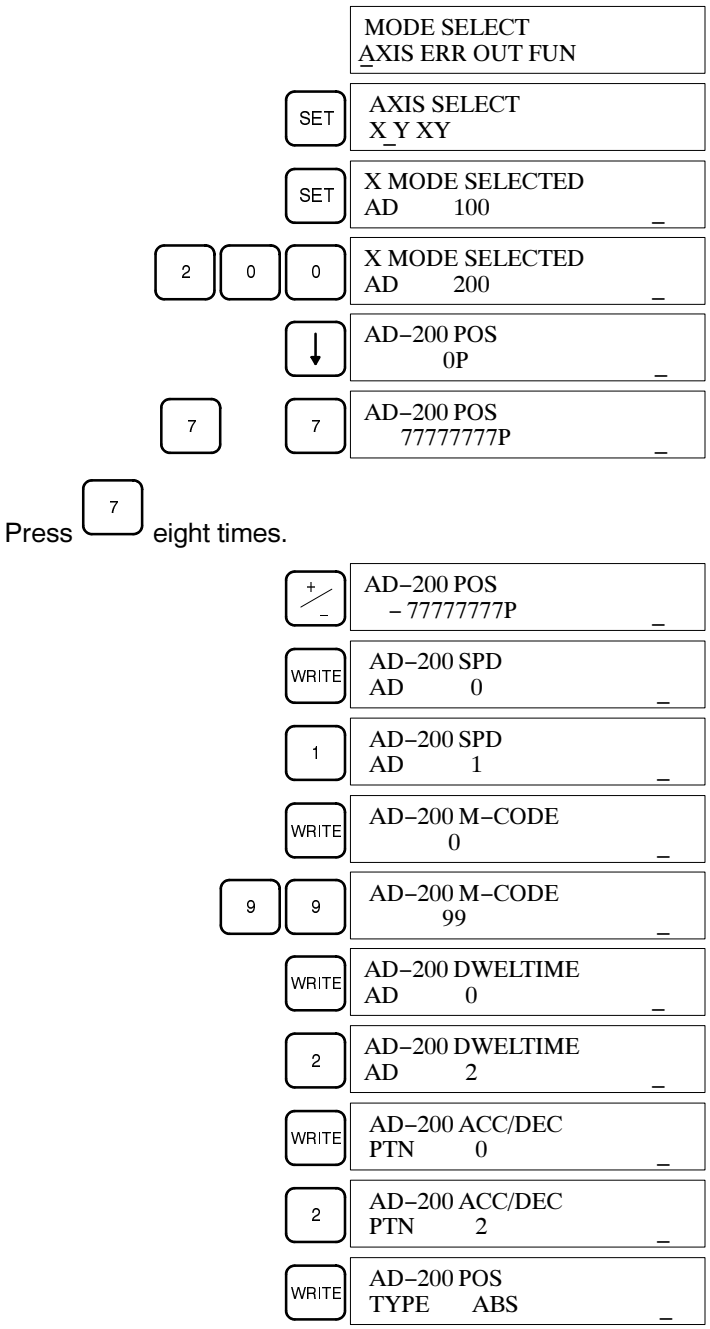


Example of X-axis Data with No Interpolation

Address	Data	
200	Positioning action	–77777777
	Speed address	01
	M code	99
	Dwell time address	2
	Acceleration and deceleration address	2
	Positioning action type	ABS
	Positioning pattern	1
	Positioning enabled/disabled	1
	Synchronization start enabled/disabled	0

Key Operation and Displays

Positioning Action of X Axis

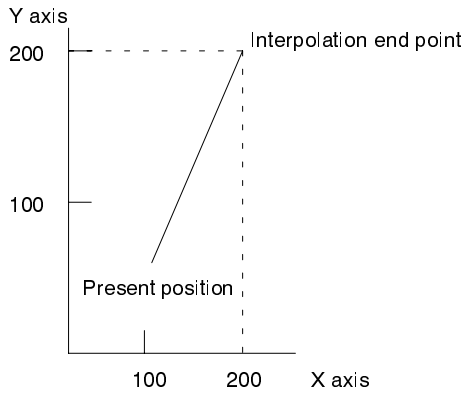


WRITE	AD–200 INTERPOL 0:NO 1:YES 0 _
WRITE	AD–200 POS PTN 0 _
1	AD–200 POS PTN 1 _
WRITE	AD–200 POS 0:NOP 1:OP 0 _
1	AD–200 POS 0:NOP 1:OP 1 _
WRITE	AD–200 SYNC–STA 0:NOP 1:OP 0 _
WRITE	AD–201 POS 0P _

Operation Description

- After setting addresses or reading data from the addresses set, data can be written to the addresses. When writing data to the addresses for the first time, execute data all clear, select the axis, set the addresses, and start writing the data.
- Write a single positioning data value per address. The single positioning data includes a positioning action, speed address, M code, dwell time address, acceleration and deceleration address, positioning action type, positioning pattern, positioning action, positioning action enable or disable, synchronization start enable or disable.
- When changing the values that has been already written, press the CLR key so that the values will be cleared.
- If the positioning action is set to disabled, the positioning action in the designated addresses will be treated as NOP and the values in the designated addresses cannot be used for positioning.
- In the above example, the X axis' positioning action is written. The corresponding Y axis' positioning action can be written in the same way.
- Refer to *10-30 PCU Data Contents and Permitted Settings* for the contents of the X and Y axes positioning action and setting ranges.
- The above key operation display is in pulse units.

Example of Straight Line Interpolation Positioning Action Write



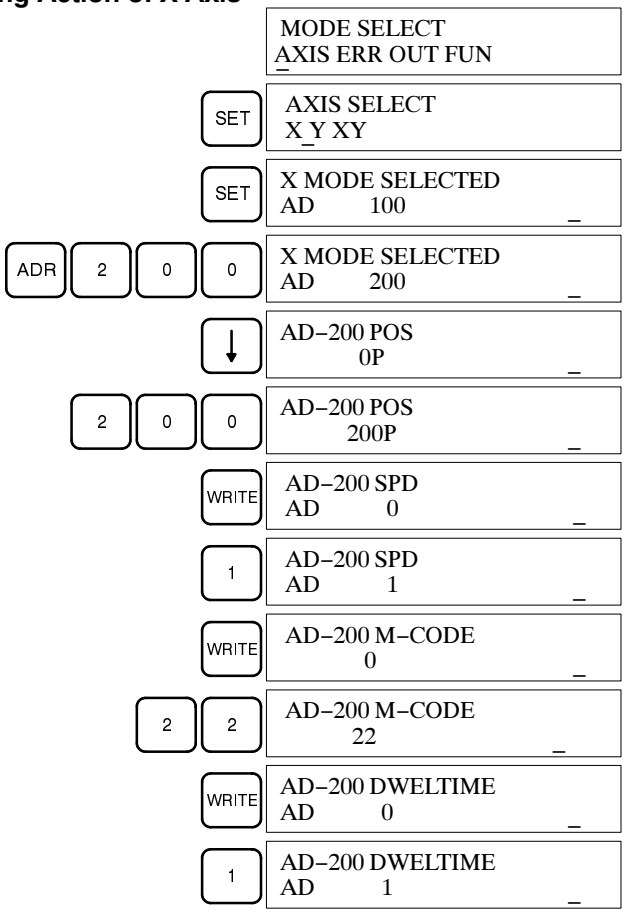
X-axis address	Data		Y-axis address	Data	
200	Positioning action	200	600	Positioning action	200
	Speed address	01		Speed address	---
	M code	22		M code	---
	Dwell time address	1		Dwell time address	---
	Acceleration and deceleration address	1		Acceleration and deceleration address	---
	Positioning data type	ABS		Positioning data type	ABS
	Positioning pattern	0		Positioning pattern	---
	Interpolation positioning action Interpolation end point			Interpolation positioning action Interpolation end point	

The following table lists enabled and disabled fields for corresponding X- and Y-axis's positioning actions during straight line interpolation. Disabled data items will be ignored.

Field	Positioning action of X axis	Positioning action of Y axis
Positioning action	Enabled	Enabled
Speed address	Enabled	Disabled
M code	Enabled	Disabled
Dwell time address	Enabled	Disabled
Acceleration and deceleration data address	Enabled	Disabled
Positioning data type	Enabled	Enabled
Positioning pattern	Enabled	Disabled

Key Operation and Displays

Straight Line Interpolation Positioning Action of X Axis

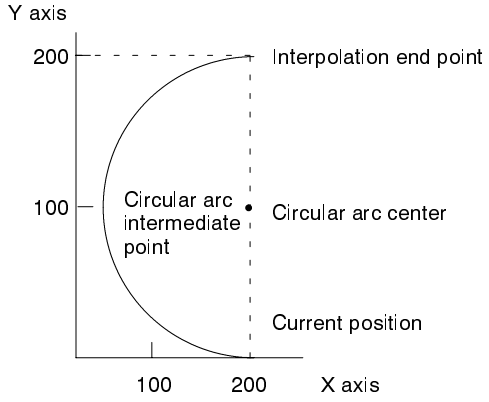


WRITE	AD–200 ACC/DEC PTN 0 _
1	AD–200 ACC/DEC PTN 1 _
WRITE	AD–200 POS TYPE ABS _
WRITE	AD–200 INTERPOL 0:NO 1:YES 0 _
1	AD–200 INTERPOL 0:NO 1:YES 1 _
WRITE	AD–200 INTERPOL 0:END 1:CIRC 0 _
WRITE	AD–200 POS PTN 0 _
WRITE	AD–200 POS 0:NOP 1:OP 0 _
1	AD–200 POS 0:NOP 1:OP 1 _
WRITE	AD–201 POS 0P _

Operation Description

- After setting addresses or reading data from the addresses set, data can be written to the addresses.
- Specify address 200 of the X axis to write a straight line interpolation positioning action.
- In the above example, the X axis' positioning action is written. The corresponding Y axis' positioning action can be written in the same way.
- If straight line interpolation positioning action is written to the address of the X axis, the same data must be written to the corresponding address of the Y axis, otherwise an error will result when starting the axes.
- The above key operation display is in pulse units.
- No synchronization start enabled/disabled setting is possible for interpolation positioning actions.

Example of Circular-arc Interpolation Positioning Action Write



Specifying Circular-arc Center

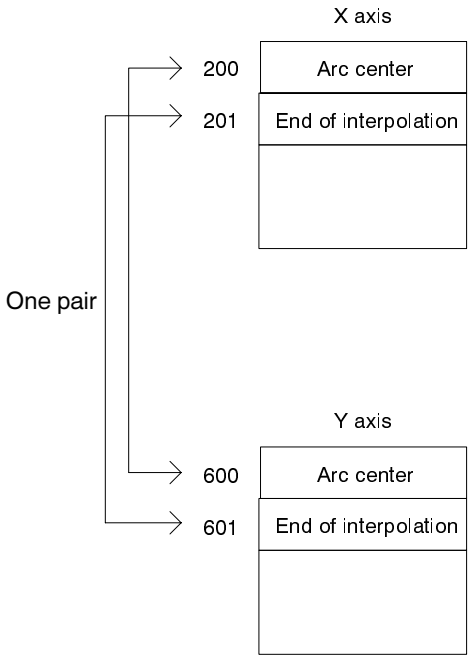
Kind of data	X-axis address	Field		Y-axis address	Field	
Data of arc center	200	Positioning action	200	600	Positioning action	100
		Speed address	01		Speed address	---
		M code	---		M code	---
		Dwell time address	1		Dwell time address	---
		Acceleration and deceleration address	---		Acceleration and deceleration address	---
		Positioning data type	ABS		Positioning data type	ABS
		Positioning pattern	---		Positioning pattern	---
		Interpolation positioning action	Circular arc center		Interpolation positioning action	Interpolation center
		Arc direction	CW		Arc direction	---
Data of interpolation end	201	Positioning action	200	601	Positioning action	200
		Speed address	01		Speed address	---
		M code	22		M code	---
		Dwell time address	1		Dwell time address	---
		Acceleration and deceleration address	1		Acceleration and deceleration address	---
		Positioning data type	ABS		Positioning data type	ABS
		Positioning pattern	0		Positioning pattern	---
		Interpolation positioning action	Interpolation center		Interpolation positioning action	Interpolation end

Starting with Circular-arc Intermediate Point

Kind of data	X-axis address	Field		Y-axis address	Field	
Data of arc center	200	Positioning action	100	600	Positioning action	100
		Speed address	02		Speed address	---
		M code	---		M code	---
		Dwell time address	---		Dwell time address	---
		Acceleration and deceleration address	2		Acceleration and deceleration address	---
		Positioning action type	ABS		Positioning action type	ABS
		Positioning pattern	---		Positioning pattern	---
		Interpolation positioning action	Interpolation intermediate point		Interpolation positioning action	Interpolation center
Data of interpolation end	201	Positioning action	200	601	Positioning action	200
		Speed address	---		Speed address	---
		M code	22		M code	---
		Dwell time address	---		Dwell time address	---
		Acceleration and deceleration address	1		Acceleration and deceleration address	---
		Positioning action type	ABS		Positioning action type	ABS
		Positioning pattern	0		Positioning pattern	---
		Interpolation positioning action	interpolation end point		Interpolation positioning action	interpolation end point

- The interpolation positioning action of a circular arc can be designated with either the arc's center and its interpolated end point or the arc's intermediate point and its interpolated end point.
- The addresses of the circular-arc center and its interpolated end point data are designated with the following formula.
  Y axis address = X axis address + 400

Specify the arc's center first and then the interpolated end point or the arc's intermediate point first and then its interpolated end point.

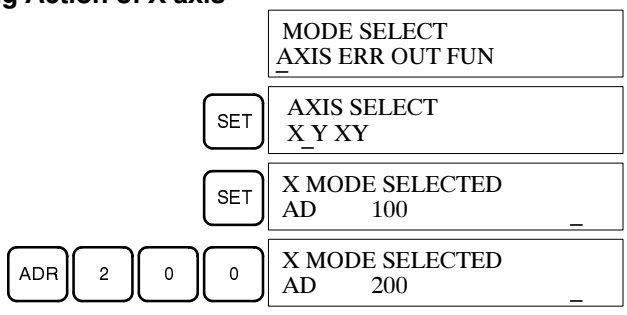


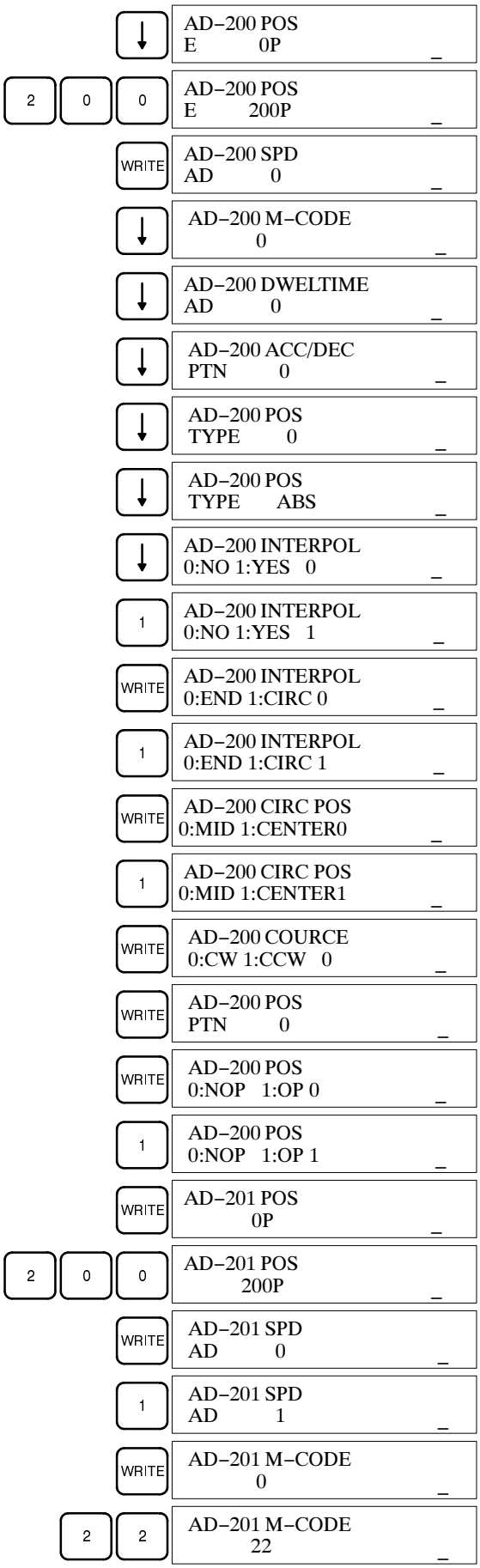
The following table lists enabled and disabled fields for corresponding X- and Y-axes' positioning actions during arc interpolation. Disabled data items will be ignored.

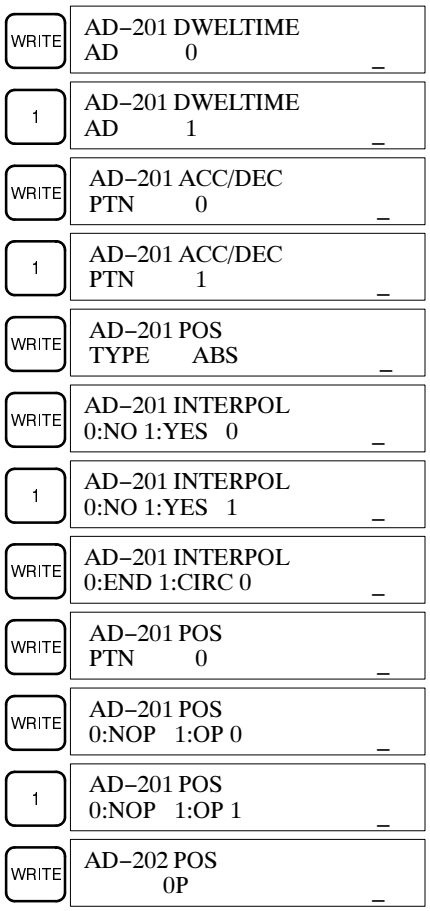
Field	Positioning action of X axis			Positioning action of Y axis		
	Circular-arc center	Circular-arc intermediate point	Interpolated end point	Circular-arc center	Circular-arc intermediate point	Interpolated end point
Positioning action	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled
Speed address	Disabled	Enabled	Enabled	Disabled	Disabled	Disabled
M code	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled
Dwell time address	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled
Acceleration and deceleration data address	Disabled	Enabled	Enabled	Disabled	Disabled	Disabled
Positioning data type (ABS/INC)	Enabled	Enabled	Enabled	Enabled	Enabled	Enabled
Positioning pattern (Pattern 0/1)	Disabled	Disabled	Enabled	Disabled	Disabled	Disabled
Arc direction (CW/CCW)	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled

Key Operation and Displays

Circular-arc Interpolation Positioning Action of X axis




↓
AD–200 POS
E 0P
2 0 0
AD–200 POS
E 200P
WRITE
AD–200 SPD
AD 0
↓
AD–200 M–CODE
0
↓
AD–200 DWELTIME
AD 0
↓
AD–200 ACC/DEC
PTN 0
↓
AD–200 POS
TYPE 0
↓
AD–200 POS
TYPE ABS
↓
AD–200 INTERPOL
0:NO 1:YES 0
1
AD–200 INTERPOL
0:NO 1:YES 1
WRITE
AD–200 INTERPOL
0:END 1:CIRC 0
1
AD–200 INTERPOL
0:END 1:CIRC 1
WRITE
AD–200 CIRC POS
0:MID 1:CENTER0
1
AD–200 CIRC POS
0:MID 1:CENTER1
WRITE
AD–200 COURCE
0:CW 1:CCW 0
WRITE
AD–200 POS
PTN 0
WRITE
AD–200 POS
0:NOP 1:OP 0
1
AD–200 POS
0:NOP 1:OP 1
WRITE
AD–201 POS
0P
2 0 0
AD–201 POS
200P
WRITE
AD–201 SPD
AD 0
1
AD–201 SPD
AD 1
WRITE
AD–201 M–CODE
0
2 2
AD–201 M–CODE
22



Operation Description

- After setting addresses or reading data from set addresses, data can be written to the addresses.
- Specify address 200 of the X axis to write circular-arc center data.
- Write the arc's interpolated end point data to address 201 of the X axis.
- In the above example, the X axis' positioning action is written. The corresponding Y axis' positioning action can be written in the same way.
- If arc center data or arc intermediate point data is written to the address of the X axis, the same data must be written to the corresponding address of the Y axis, otherwise an error will result when starting the axes.
- The above key operation display is in pulse units.

Example of X-axis Parameter Data

Address	Data	
400	Unit setting	pulse
401	Pulse rate	1
402	Rotation direction	+
403	Encoder type	–, –, x4
404	Gain	24
405	In-position	10
406	Backlash compensation	100
407	Stroke limit (+)	9999
408	Stroke limit (–)	9999
409	Zone setting	100, 100
410	Home shift	1000
411	Maximum speed, speed coefficient	10000, 5
412	Teaching Box speed	1, 1, 1000
413	Search direction	0
414	Origin compensation	10
415	High origin search speed	2000
416	Origin search acceleration and deceleration	1
417	Low origin search speed	1000
418	External deceleration stop	1, 1, 100
419	Wiring check	1, 10, 100
420	Error counter capacity	0, 0, 512

- After setting addresses or reading data from the addresses set, data can be written to the addresses.
- Refer to *10-30 PCU Data Contents and Permitted Settings* for the contents of the X and Y axes parameter data and setting ranges.
- In the above example, the X axis' positioning action is written. The corresponding Y axis' positioning action can be written in the same way.
- The following positioning actions will be displayed if MM or INCH is selected as the unit.

MM

```
+10000.000M
```

INCH

```
+10000.000I
```

- The following speed data will be displayed if MM or INCH is selected as the unit.

MM

```
10000.000MS
```

INCH

```
10000.000IS
```

Note Overflow data causes the following display.

```
OVER M
```

```
OVER I
```

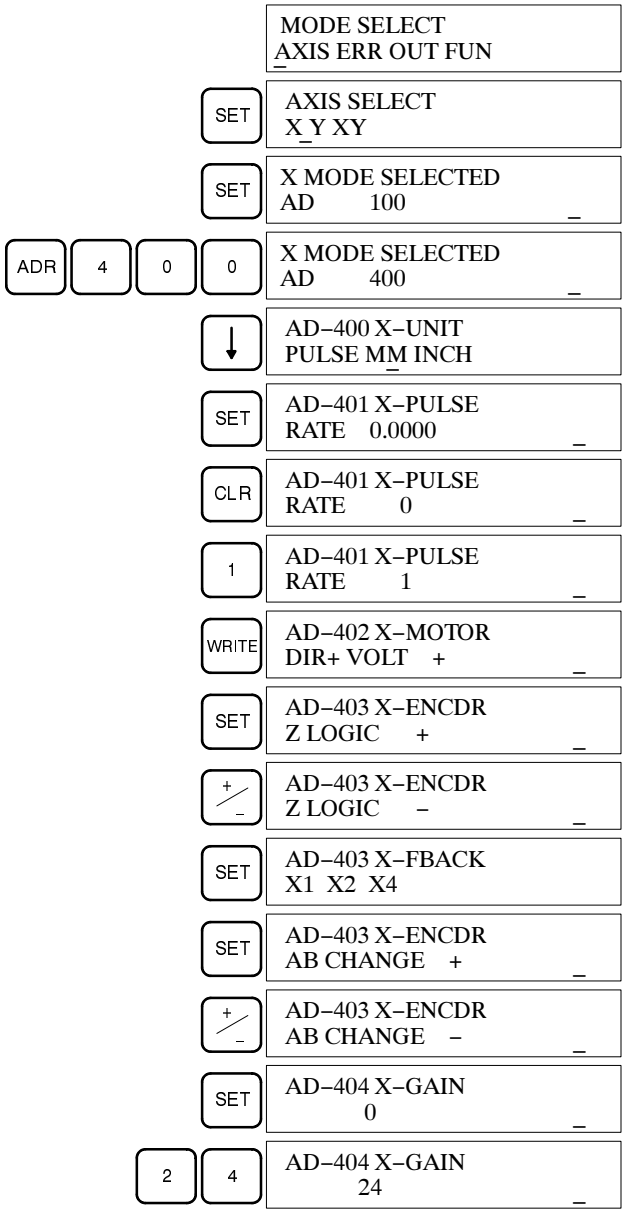
To change the values that have been already set, execute a reading PCU data operation, press the CLR key and clear the displayed items, and input new values.

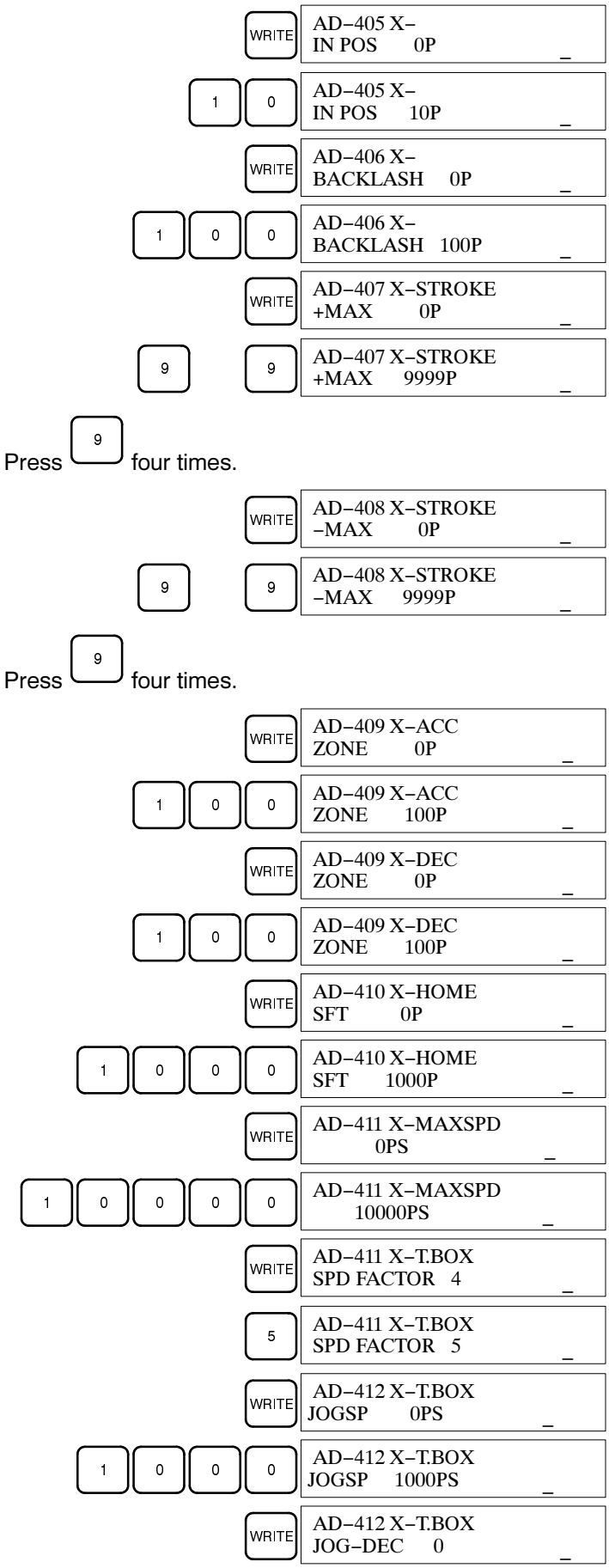
Key Operation and Displays

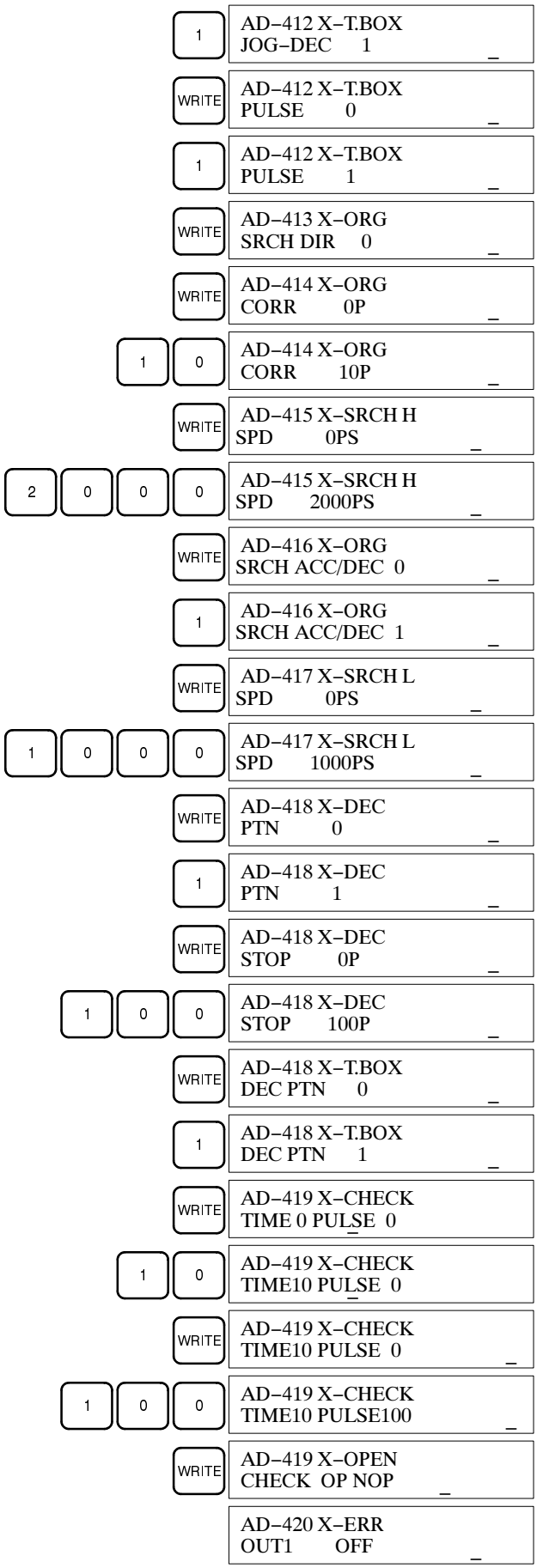
X-axis Parameter Data

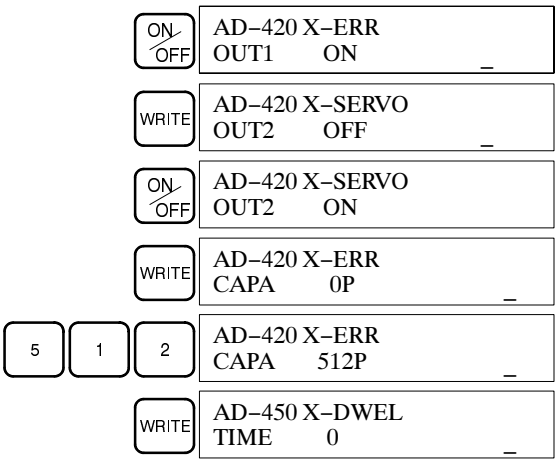
The following data items can be set in pulses, millimeters, or inches as X-axis parameters.

- Stroke limit (+)
- Stroke limit (–)
- Home shift
- Maximum speed
- Teaching Box speed
- Origin compensation
- Origin search high speed
- Origin search low speed
- Number of deceleration stop pulses
- Zone setting (in pulses only)
- Backlash compensation (in pulses only)
- In-position (in pulses only)
- Error counter (in pulses only)




WRITE
AD−405 X−
IN POS 0P
1
0
AD−405 X−
IN POS 10P
WRITE
AD−406 X−
BACKLASH 0P
1
0
0
AD−406 X−
BACKLASH 100P
WRITE
AD−407 X−STROKE
+MAX 0P
9
9
AD−407 X−STROKE
+MAX 9999P
Press 9 four times.
WRITE
AD−408 X−STROKE
−MAX 0P
9
9
AD−408 X−STROKE
−MAX 9999P
Press 9 four times.
WRITE
AD−409 X−ACC
ZONE 0P
1
0
0
AD−409 X−ACC
ZONE 100P
WRITE
AD−409 X−DEC
ZONE 0P
1
0
0
AD−409 X−DEC
ZONE 100P
WRITE
AD−410 X−HOME
SFT 0P
1
0
0
0
AD−410 X−HOME
SFT 1000P
WRITE
AD−411 X−MAXSPD
0PS
1
0
0
0
0
AD−411 X−MAXSPD
10000PS
WRITE
AD−411 X−T.BOX
SPD FACTOR 4
5
AD−411 X−T.BOX
SPD FACTOR 5
WRITE
AD−412 X−T.BOX
JOGSP 0PS
1
0
0
0
AD−412 X−T.BOX
JOGSP 1000PS
WRITE
AD−412 X−T.BOX
JOG−DEC 0


1
AD–412 X–T.BOX
JOG–DEC 1
WRITE
AD–412 X–T.BOX
PULSE 0
1
AD–412 X–T.BOX
PULSE 1
WRITE
AD–413 X–ORG
SRCH DIR 0
WRITE
AD–414 X–ORG
CORR 0P
1 0
AD–414 X–ORG
CORR 10P
WRITE
AD–415 X–SRCH H
SPD 0PS
2 0 0 0
AD–415 X–SRCH H
SPD 2000PS
WRITE
AD–416 X–ORG
SRCH ACC/DEC 0
1
AD–416 X–ORG
SRCH ACC/DEC 1
WRITE
AD–417 X–SRCH L
SPD 0PS
1 0 0 0
AD–417 X–SRCH L
SPD 1000PS
WRITE
AD–418 X–DEC
PTN 0
1
AD–418 X–DEC
PTN 1
WRITE
AD–418 X–DEC
STOP 0P
1 0 0
AD–418 X–DEC
STOP 100P
WRITE
AD–418 X–T.BOX
DEC PTN 0
1
AD–418 X–T.BOX
DEC PTN 1
WRITE
AD–419 X–CHECK
TIME 0 PULSE 0
1 0
AD–419 X–CHECK
TIME10 PULSE 0
WRITE
AD–419 X–CHECK
TIME10 PULSE 0
1 0 0
AD–419 X–CHECK
TIME10 PULSE100
WRITE
AD–419 X–OPEN
CHECK OP NOP
AD–420 X–ERR
OUT1 OFF

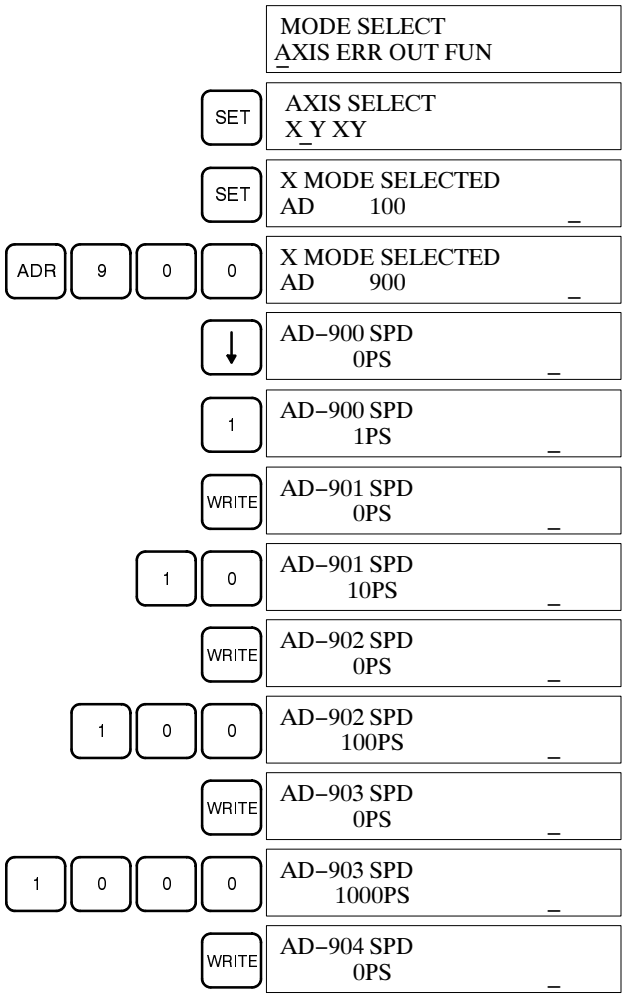


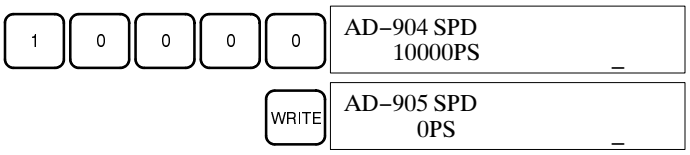
Example of Speed Data Write

Address	Data	
900	Speed	1
901	Speed	10
902	Speed	100
903	Speed	1000
904	Speed	10000

Key Operation and Displays

Speed Data





Operation Description

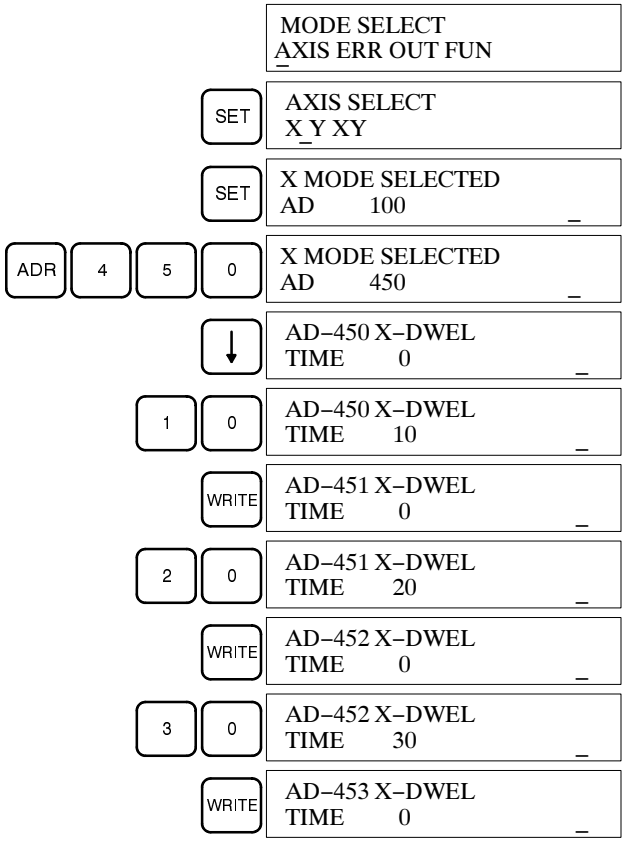
- After setting addresses or reading data from set addresses, data can be written to the addresses.
- Refer to *10-30 PCU Data Contents and Permitted Settings* for the contents of the X and Y axes speed data and setting ranges.
- The above key operation display is in pulse units.
- To amend the values that have been already set, execute a reading PCU data operation, press the CLR key to clear the displayed items, and input new values.

Example of X-axis Dwell Time Data

Address	Data
450	Dwell time 0 100 ms
451	Dwell time 1 200 ms
452	Dwell time 2 300 ms

Key Operation and Displays

X-axis Dwell Time Data



Operation Description

- After setting addresses or reading data from set addresses, data can be written to the addresses.
- Refer to *10-30 PCU Data Contents and Permitted Settings* for the contents of the X and Y axes' dwell time data and setting ranges.
- Dwell time data must be input in units of 10 ms.

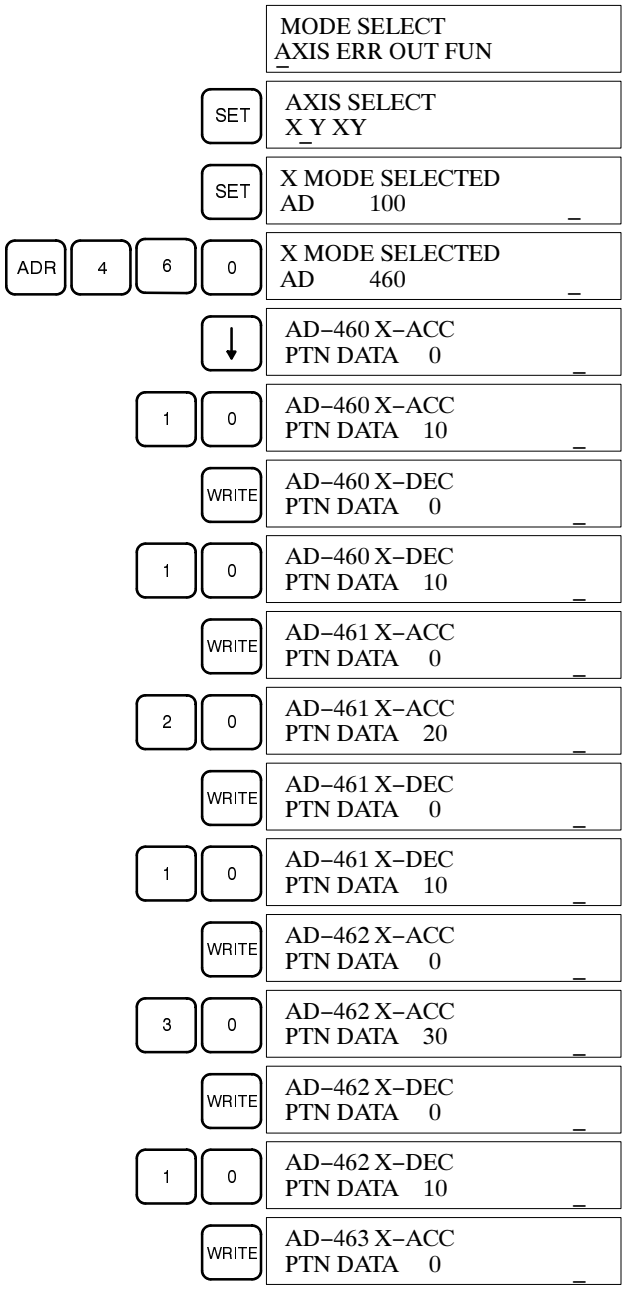
- To amend the values that have been already set, execute a reading PCU data operation, press the CLR key to clear the displayed items, and input new values.

Example of X-axis Acceleration and Deceleration Time Write

Address	Data
460	Acceleration and deceleration time #0, 100-ms acceleration, and 100-ms deceleration
461	Acceleration and deceleration time #1, 200-ms acceleration, and 100-ms deceleration
462	Acceleration and deceleration time #2, 300-ms acceleration, and 100-ms deceleration

Key Operation and Displays

X-axis Acceleration and Deceleration Time



Operation Description

- After setting addresses or reading data from set addresses, data can be written to the addresses.

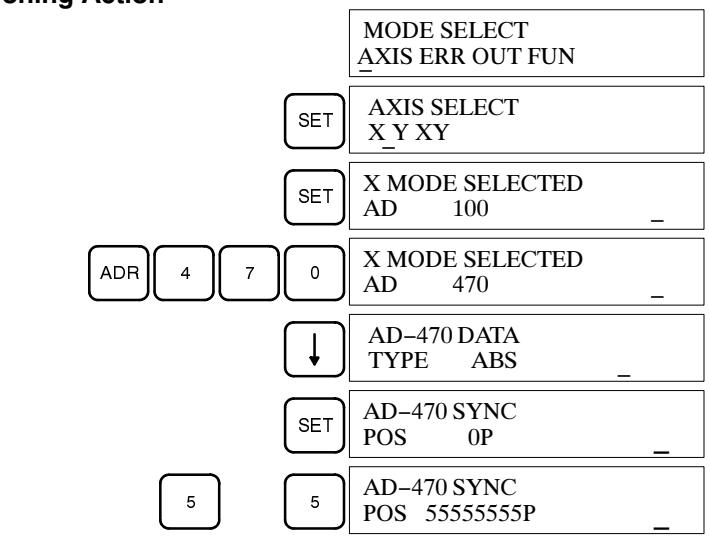
- Refer to *10-30 PCU Data Contents and Permitted Settings* for the contents of the X and Y axes' acceleration and deceleration times and setting ranges.
- Acceleration and deceleration times must be input in units of 10 ms. Thus, for example, entering "10" sets 100 ms.
- To amend the values that have been already set, execute a reading PCU data operation, press the CLR key to clear the displayed items, and input new values.

Example of X-axis Synchronization Positioning Action Write

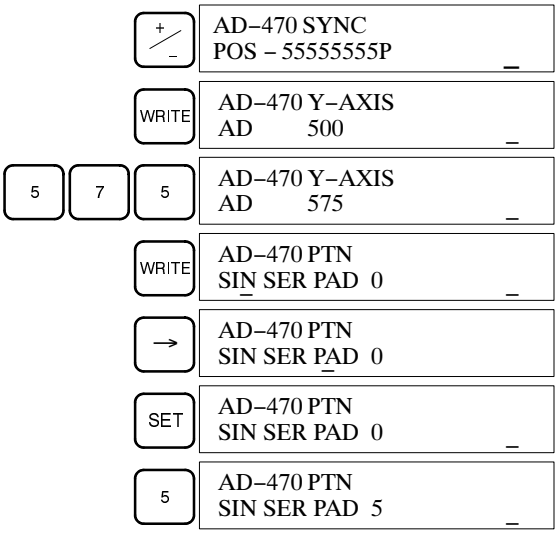
Address	Data	
470	Data type	ABS
	Synchronization position	–55555555
	Y axis address	575
	Synchronization pattern	SER
	Next address designation	5
	Synchronization positioning action enabled/disabled	1

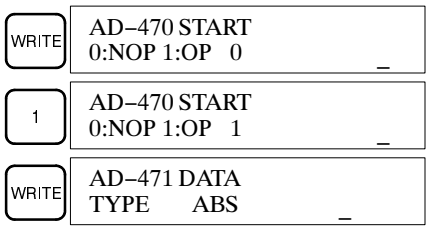
Key Operation and Displays

X-axis Synchronization Positioning Action



Press 5 eight times.





Operation Description

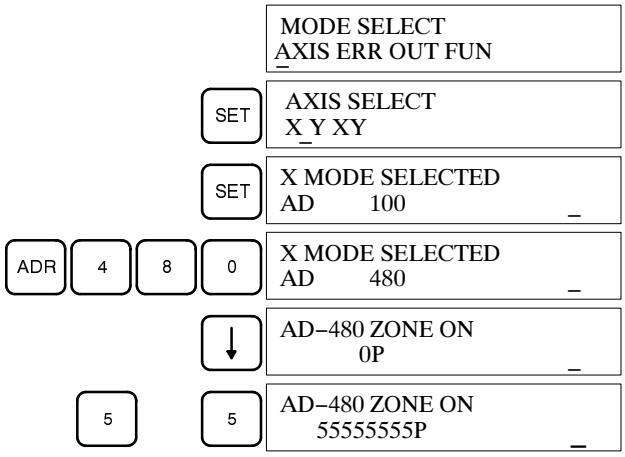
- After setting addresses or reading data from set addresses, data can be written to the addresses.
- Refer to *10-30 PCU Data Contents and Permitted Settings* for the contents of the X and Y axes' speed data and setting ranges.
- The above key operation display is in pulse units.
- To amend the values that have been already set, execute a reading PCU data operation, press the CLR key to clear the displayed items, and input new values.

Example of X-axis Zone Setting Data Write

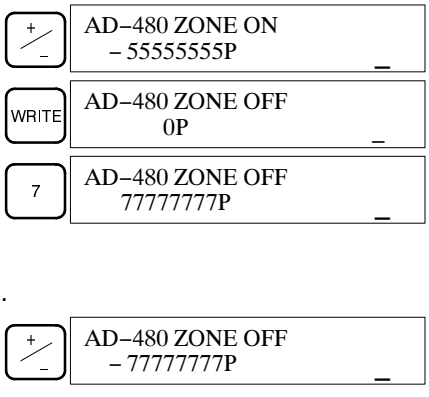
Address	Data	
480	ON positioning action	–55555555P
	OFF positioning action	–77777777P
	Data enabled/disabled	1
	External output ON/OFF	1
	External output designation OUT1	ON
	External output designation OUT2	OFF

Key Operation and Displays

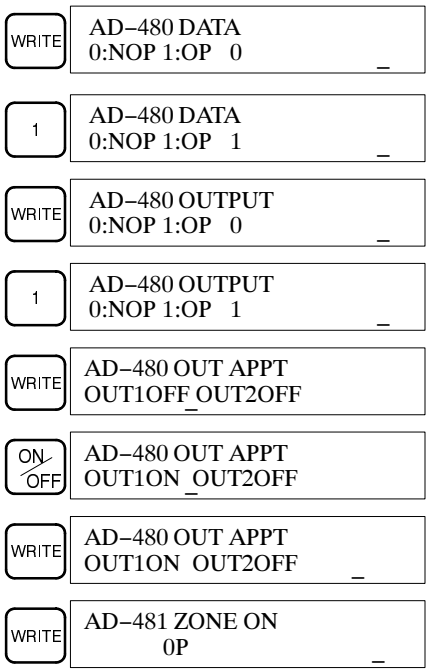
X-axis Zone Setting Data



Press 5 eight times.



Press 7 eight times.



Operation Description

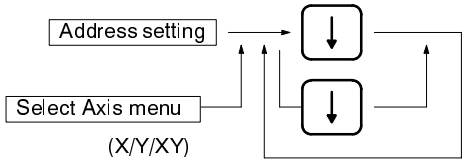
- After setting addresses or reading data from the addresses set, data can be written to the addresses.
- Refer to *10-30 PCU Data Contents and Permitted Settings* for the contents of the X and Y axes' speed data and setting ranges.
- The above key operation display is in pulse units.
- To amend the values that have been already set, execute a reading PCU data operation, press the CLR key to clear the displayed items, and input new values.

10-9 Reading PCU Data

This operation is used to read from the memory the contents of parameters, positioning actions, dwell times, acceleration and deceleration times, synchronization positioning actions, and zone data for the X axis and the contents of parameters, positioning actions, dwell times, acceleration and acceleration patterns, synchronization positioning actions, zone data, and speeds for the Y axis.

Available Mode

Monitor	Debug	Program
No	No	Yes

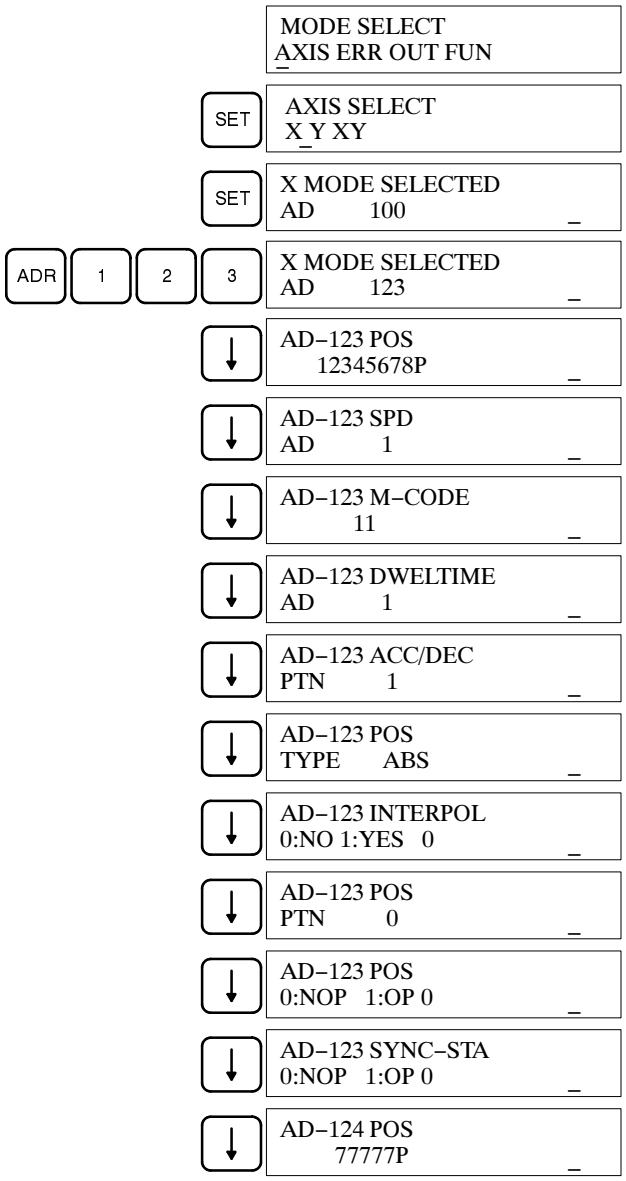


Example of X-axis Data with No Interpolation

Address	Data	
123	Positioning action	+12345678
	Speed address	01
	M code	11
	Dwell time address	1
	Acceleration and deceleration address	1
	Positioning action type	ABS
	Positioning pattern	0
	Positioning enabled/disabled	1
	Synchronization start enabled/disabled	0

Key Operation and Displays

X-axis Positioning Action



Operation Description

- A single positioning data value is stored in each address. After setting the addresses, press the Down key to read the first data item in the current address.

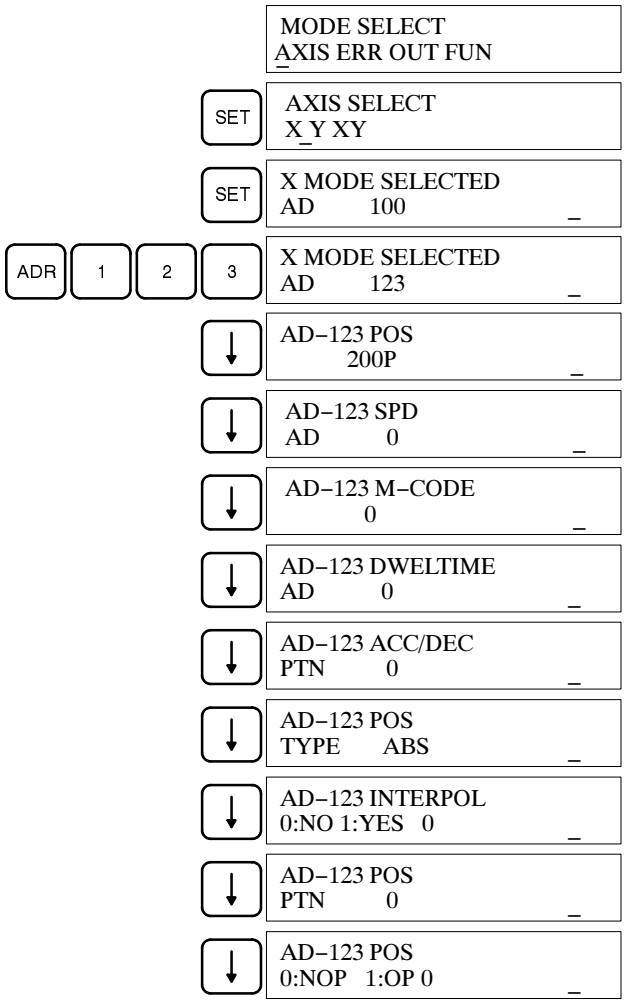
- Press the Down key so that the data item in the next address will be displayed. Press the Up key so that the data item in the previous address will be displayed.
- Press the Up key while the first data item of an address is displayed so that the last data item of the previous address will be displayed.
- Press the Down key while the last data item of an address is displayed so that the first data item of the next address will be displayed.
- In the above example, the X axis' positioning action is read. The Y axis' corresponding positioning action can be read in the same way.

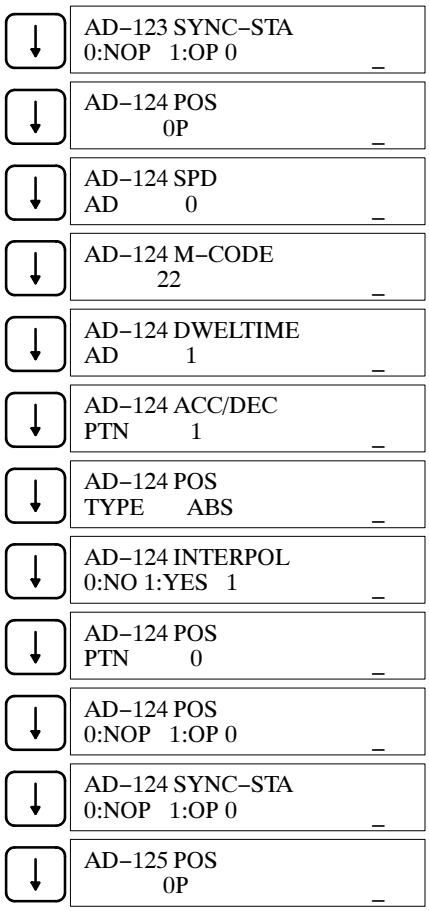
Example of X-axis Interpolation Positioning Action

Address	Data		Address	Data	
123	Positioning action	100	124	Positioning action	200
	Speed address	---		Speed address	01
	M code	---		M code	22
	Dwell time address	---		Dwell time address	1
	Acceleration and deceleration address	---		Acceleration and deceleration address	1
	Positioning action type	ABS		Positioning action type	ABS
	Positioning pattern	---		Positioning pattern	0
	Interpolation completion data	---		Interpolation completion data	End point
	Circular-arc direction	CW			

Key Operation and Displays

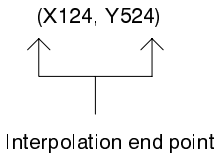
X-axis Interpolation Positioning Action





Operation Description

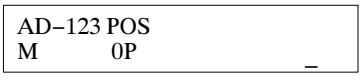
- If the type of positioning action is an interpolation positioning action, interpolation attributive data will be displayed.
- The Teaching Box indicates whether positioning action is at the interpolated end point, circular arc intermediate point, or circular arc center.
- The interpolated end point indicates that the data in the current address is at the straight line interpolation end point or circular arc interpolation end point.



- If the center of a circular arc is selected, the rotation direction of the circular arc (CW or CCW) will be displayed.
- In the above example, the X axis' positioning action is read. The Y axis' corresponding positioning action can be read in the same way.

1, 2, 3... 1. The Teaching Box displays whether the data read is at the interpolated end point, circular arc intermediate point, or circular arc center. If the data is at the interpolated end point, the following will be displayed.

2. If the data is at the circular arc intermediate point, the following will be displayed.



3. If the data is at the circular arc center, the following will be displayed.

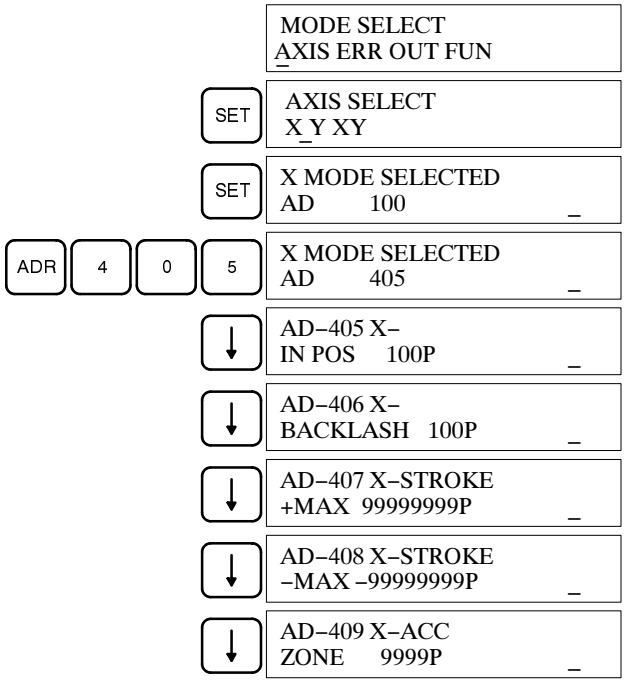
```
AD−123 POS
C        0P                _
```

Example of X-axis Parameter Data

Address	Data	
405	In positioning zone	100
406	Backlash compensation	100
407	Stroke limit (+)	99999999
408	Stroke limit (+)	99999999
409	Zone setting	9999

Key Operation and Displays

X-axis Parameter Data



Operation Description

- A single parameter data value is stored in each address. After setting the addresses, press the Down key to read the first data in the current address.
- Press the Down key so that the data in the next address will be displayed. Press the Up key so that the data in the previous address will be displayed.
- In the above example, the X axis' positioning action is read. The Y axis' corresponding positioning action can be read in the same way.

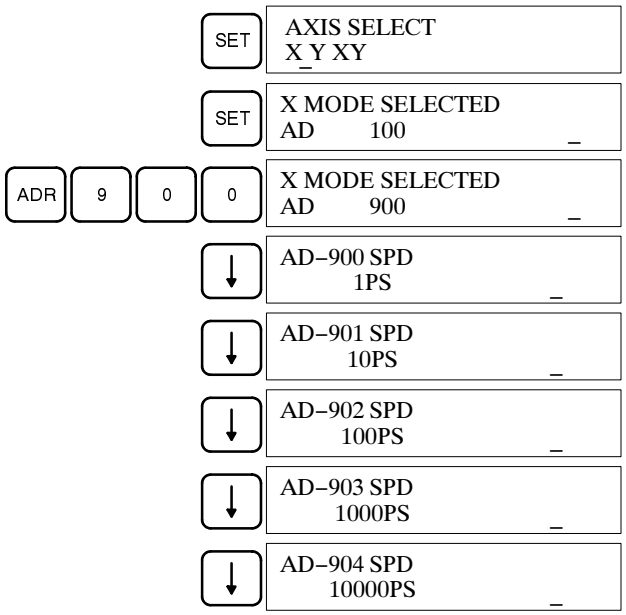
Speed Data Example

Address	Data	
900	Speed	1 pps
901	Speed	10 pps
902	Speed	100 pps
903	Speed	1000 pps
904	Speed	10000 pps

Key Operation and Displays

Speed Data

```
MODE SELECT
AXIS ERR OUT FUN
```



Operation Description

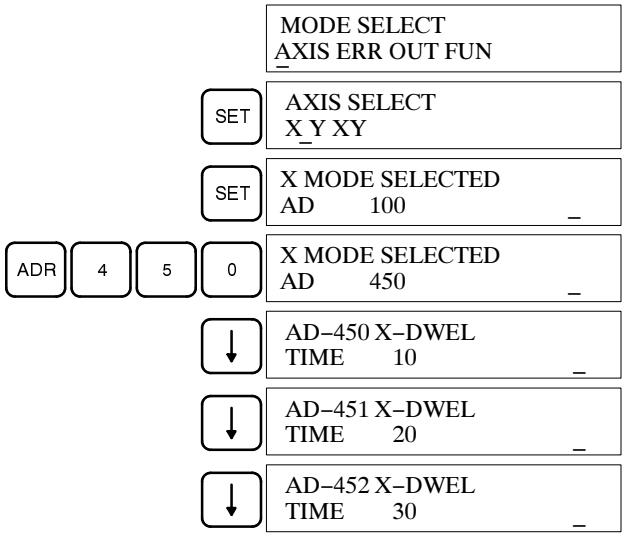
- A single speed data value is stored in each address. After setting the addresses, press the Down key to read the first data in the current address.
- Press the Up key while the first data item of an address is displayed so that the last data item of the previous address will be displayed.
- Press the Down key while the last data item of an address is displayed so that the first data item of the next address will be displayed.

Example of X-axis Dwell Time Data

Address	Data	
450	Dwell time 0	10
451	Dwell time 1	20
452	Dwell time 2	30

Key Operation and Displays

X-axis Dwell Time



Operation Description

- A single dwell time data value is stored in each address. After setting the addresses, press the Down key to read the first data item in the current address.

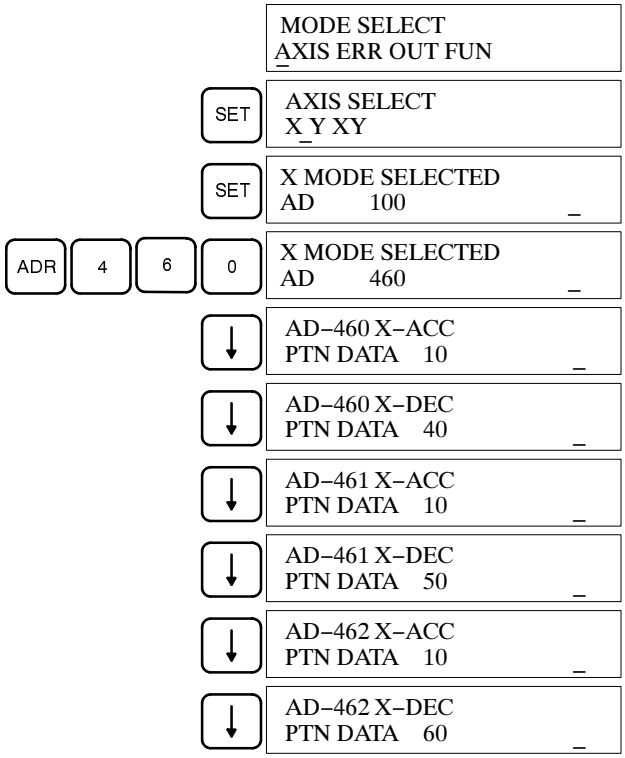
- Press the Up key while the first data item of an address is displayed so that the last data item of the previous address will be displayed.
- Press the Down key while the last data item of an address is displayed so that the first data item of the next address will be displayed.

X-axis Acceleration and Deceleration Time

Address	Data
460	Acceleration and deceleration time #0, acceleration 10, and deceleration 40
461	Acceleration and deceleration time #1, acceleration 10, and deceleration 50
462	Acceleration and deceleration time #2, acceleration 10, and deceleration 60

Key Operation and Display Changes

X-axis Acceleration and Deceleration Time



Operation Description

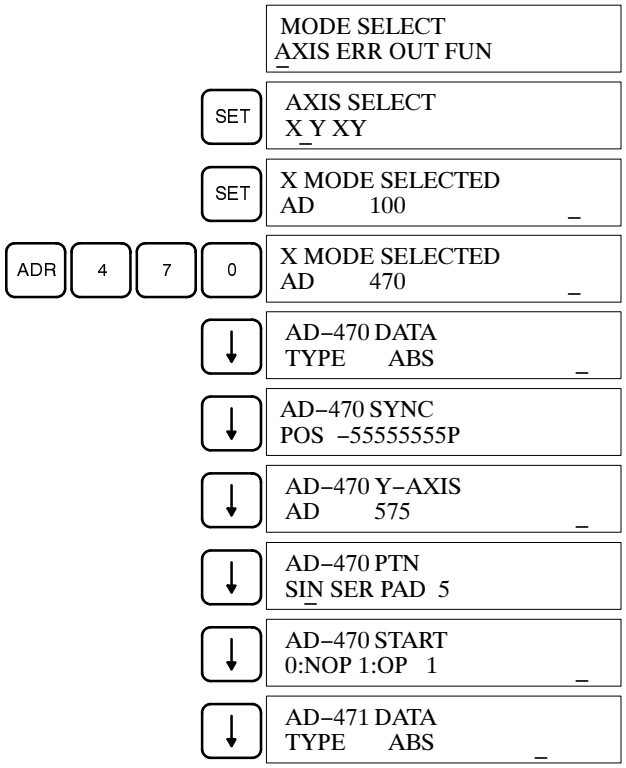
- A single acceleration and deceleration time data value is stored in each address. After setting the addresses, press the Down key to read the first data item in the current address.
- Press the Up key while the first data item of an address is displayed so that the last data item of the previous address will be displayed.
- Press the Down key while the last data of an address is displayed so that the first data item of the next address will be displayed.

Example of X-axis Synchronization Positioning Action

Address	Data	
470	Data type	ABS
	Synchronization position	–55555555
	Y-axis address	575
	Synchronization pattern	SER
	Next address designation	5
	Synchronization positioning action enabled/disabled	1

Key Operation and Displays

X-axis Synchronization Positioning Action



Operation Description

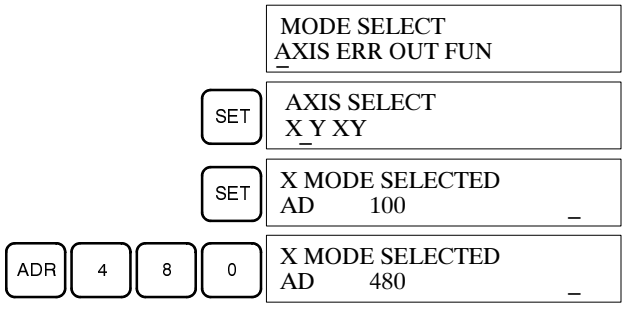
- A single synchronization positioning action is stored in each address. After setting the addresses, press the Down key to read the first data in the current address.
- Press the Up key while the first data item of an address is displayed so that the last data item of the previous address will be displayed.
- Press the Down key while the last data item of an address is displayed so that the first data item of the next address will be displayed.

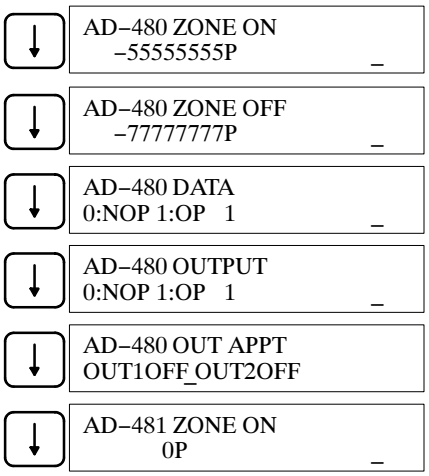
Example of X-axis Zone Setting Data

Address	Data	
480	ON positioning action	−55555555P
	OFF positioning action	−77777777P
	Data enabled/disabled	1
	External output ON/OFF	1
	External output designation OUT1	ON
	External output designation OUT2	OFF

Key Operation and Displays

X-axis Zone Setting Data





Operation Description

- A single zone setting data value is stored in each address. After setting the addresses, press the Down key to read the first data in the present address.
- Press the Up key while the first data of an address is displayed so that the last data of the previous address will be displayed.
- Press the Down key while the last data of an address is displayed so that the first data of the next address will be displayed.

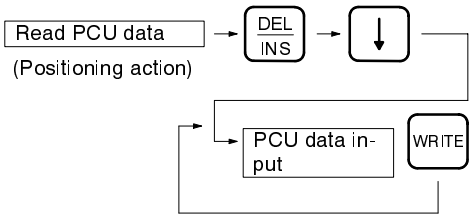
10-10 Inserting Positioning Actions

This operation is used to insert a positioning action at a designated address and move the prior positioning actions written at and beyond that address successively back one address each.

Available Mode

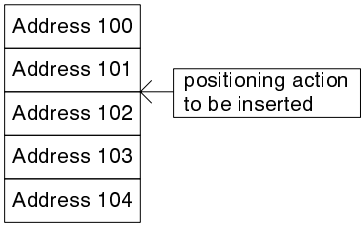
Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure



The DEL/INS key is effective for displaying the last positioning action.

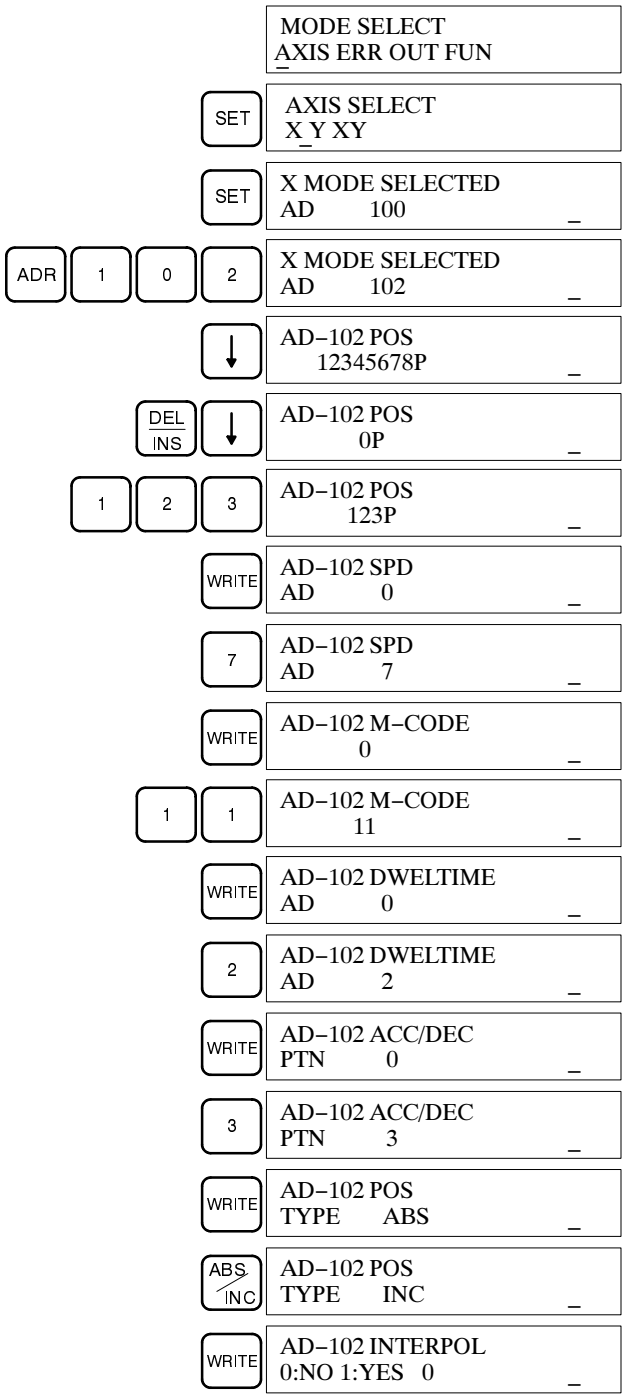
Example of Insertion of Positioning Action

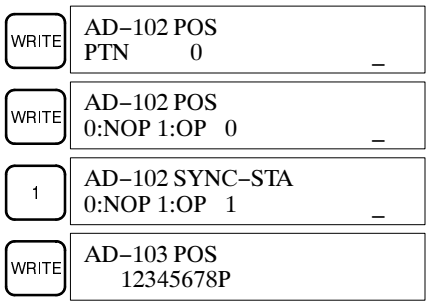


Data to Be Inserted

Address	Data	
102	Positioning action	123
	Speed address	07
	M code	11
	Dwell time address	02
	Acceleration and deceleration address	03
	Positioning action type	INC
	Positioning pattern	0
	Interpolation positioning action	---

Key Operation and Displays





Operation Description

- The positioning action is inserted immediately before the positioning action at the designated address.
- Insertion is impossible if the last address allocated for positioning actions is filled.
- Insertion is not allowed for parameters and speeds.
- The DEL/INS key is enabled when inputting or displaying the first field of a positioning action.
- Insert positioning actions separately for the X and Y axes. Inserting to the X axis does not automatically move back Y-axis positioning actions.
- The above key operation display is in pulse units.

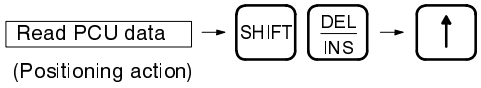
10-11 Deleting Positioning Actions

This operation is used to delete a positioning action at a designated address and shift prior positioning actions past that address.

Available Mode

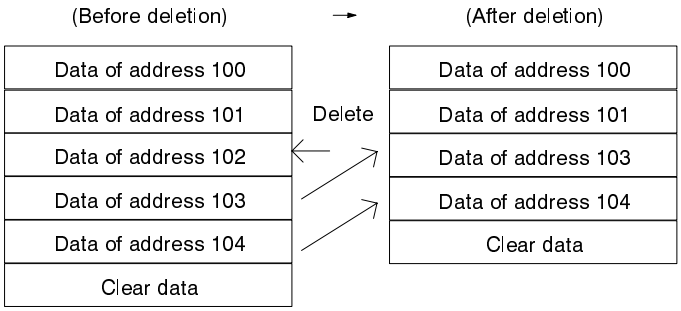
Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure

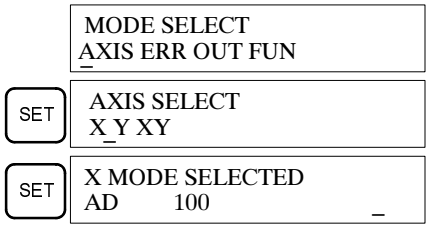


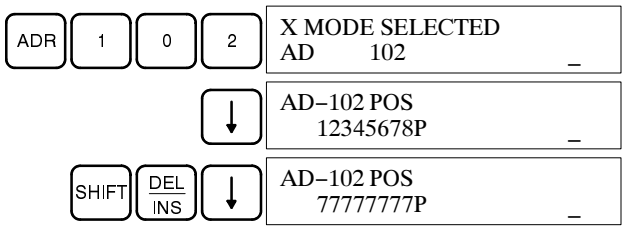
Press the Shift and DEL/INS keys for the display of the first data.

Example of Deleting Positioning Action



Key Operation and Displays





Operation Description

- Deletion is not allowed for parameters and speeds.
- By pressing the Shift and DEL/INS keys, the positioning action prior to the deleted positioning action moves up, and the address where the last positioning action previously resided is cleared.
- The positioning action in the last address will be cleared.
- Delete positioning actions separately for the X and Y axes. Deleting an X-axis positioning action does not automatically delete the Y-axis' corresponding positioning action.

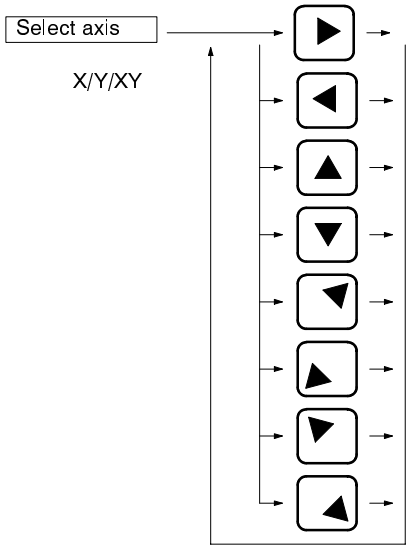
10-12 Jogging

Jogging is performed for the axis or axes (X, Y, or XY) selected under the Axis menu.

Available Mode

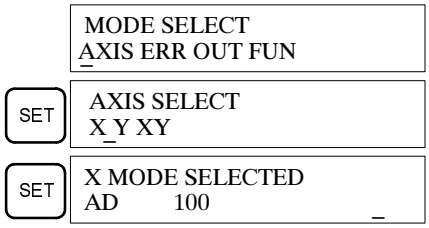
Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure



Key Operation and Displays

Jogging



The current position is displayed.

The current position in operation is displayed.

The current position in operation is displayed.

Operation Description

- Jogging moves values in the X and Y directions at Jogging speed.
- Jogging is activated by pressing jogging keys. Jogging continues operating while jogging keys are input.
- Stop jogging with the ON/OFF key.
- Jogging is effective on the axis selected by the Axis menu. Refer to the following table for details.

Axis	Key	Operation
X	▶	X-axis clockwise
	◀	X-axis counterclockwise
Y	▲	Y-axis clockwise
	▼	Y-axis counterclockwise
XY	◀	X-axis and Y-axis clockwise
	▲	X-axis and Y-axis counterclockwise
	▶	X-axis CCW movement and Y-axis clockwise
	◀	X-axis CW movement and Y-axis counterclockwise

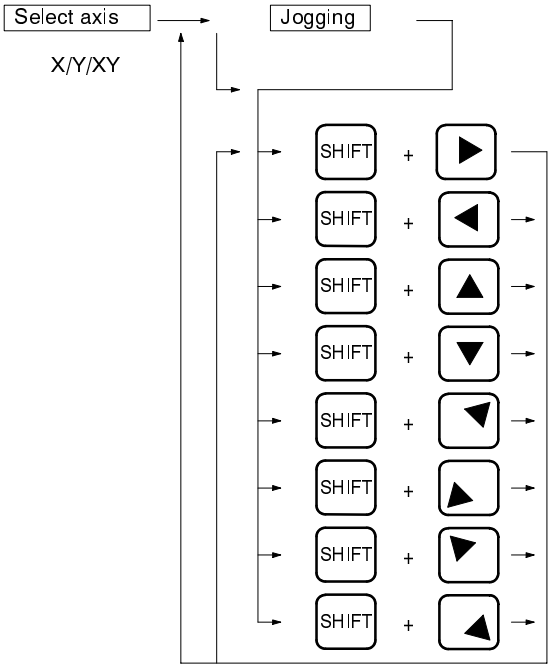
10-13 Inching

Inching proceeds according to the set number of pulses in the directions permitted by pressing the keys for the axis or axes (Y, Y, and XY) selected.

Available Mode

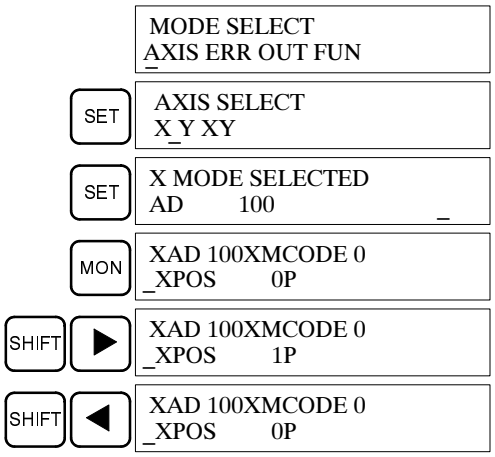
Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure



Key Operation and Displays

Inching



Operation Description

- Inching moves values in the designated X, Y, or XY direction.
- Inching is activated for a single pulse operation by pressing any one of the key combinations shown in the following table.
- Inching is effective on the axis selected by the Axis menu.

Axis	Key	Operation
X	SHIFT + ▶	X-axis clockwise
	SHIFT + ◀	X-axis counterclockwise
Y	SHIFT + ▲	Y-axis clockwise
	SHIFT + ▼	Y-axis counterclockwise
XY	SHIFT + ◤	X-axis and Y-axis clockwise
	SHIFT + ◥	X-axis and Y-axis counterclockwise
	SHIFT + ◣	X-axis counterclockwise and Y-axis clockwise
	SHIFT + ◢	X-axis clockwise and Y-axis counterclockwise

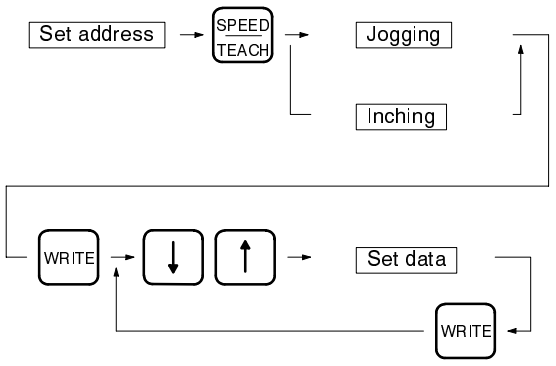
10-14 Teaching

Teaching is used to write a position reached by jogging or inching as the position for a positioning action.

Available Mode

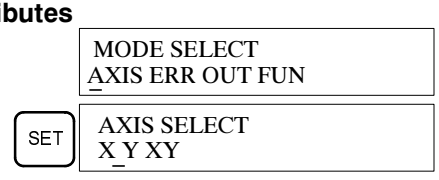
Monitor	Debug	Program
No	No	Yes

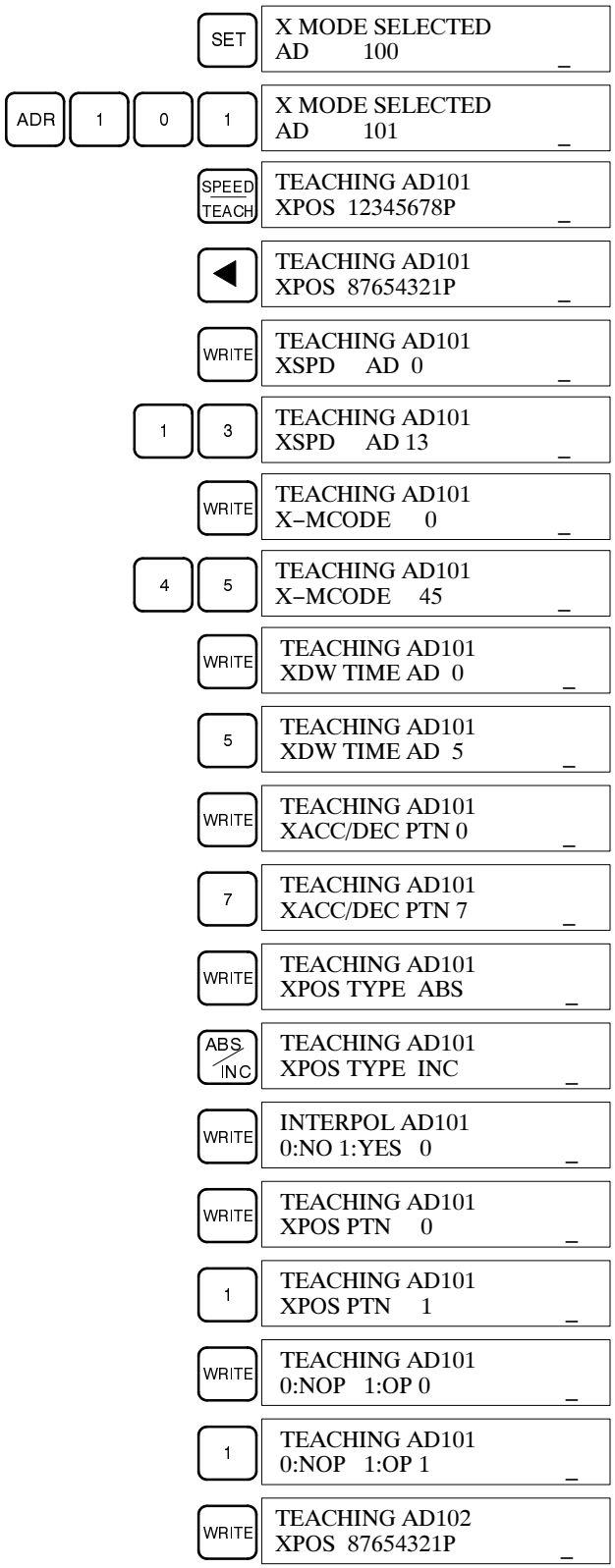
Basic Operating Procedure



Key Operation and Displays

Teaching of Data Including Positioning Action Attributes





Operation Description

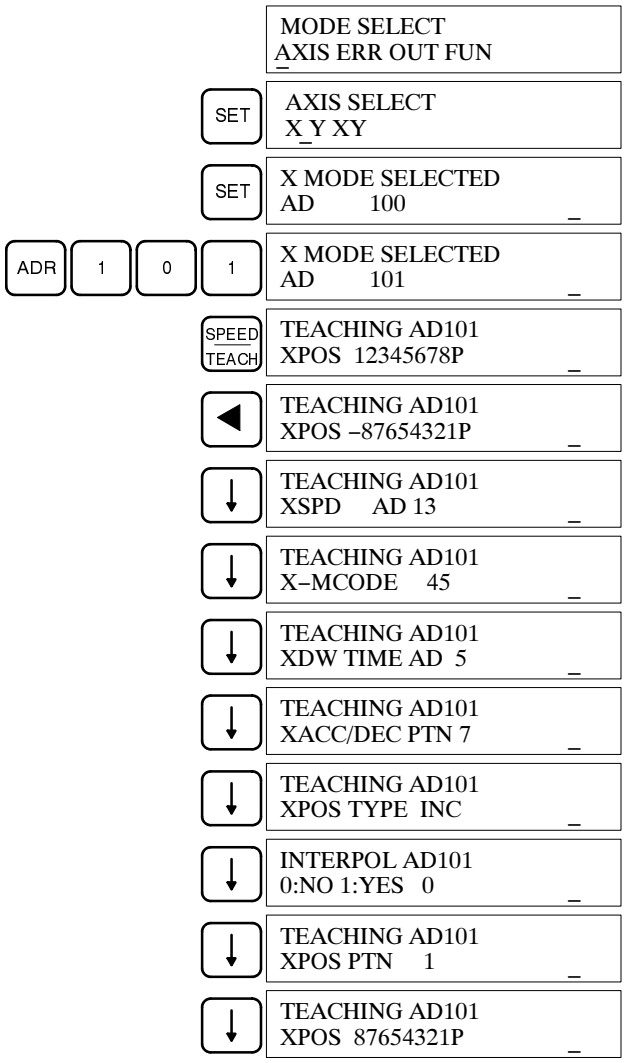
- After setting the address, move the desired position using the following keys and teach the position.

◀ ▶

- The above key operation display is in pulse units.

Key Operation and Displays

Teaching Position Only



Operation Description

- After setting the address, move to the desired position using the following keys and teach the position. Then scroll through the remaining fields with the Up and Down keys.

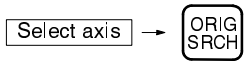
10-15 Origin Search

Origin Search is used to find the origin for the axis or axes (X, Y, and XY) selected in Axis mode.

Available Mode

Monitor	Debug	Program
No	No	Yes

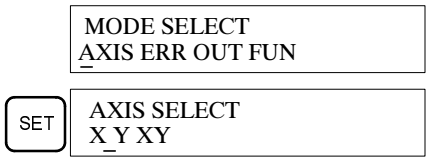
Basic Operating Procedure



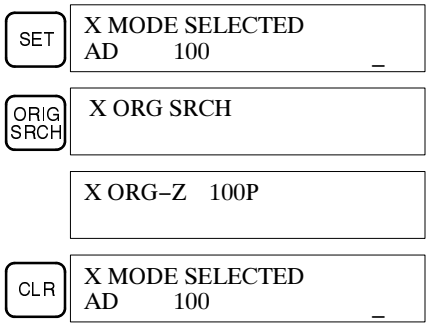
The ORIG SRCH key is enabled when ERR, OUT, or FUN is selected.

Key Operation and Displays

When X Axis Is Selected

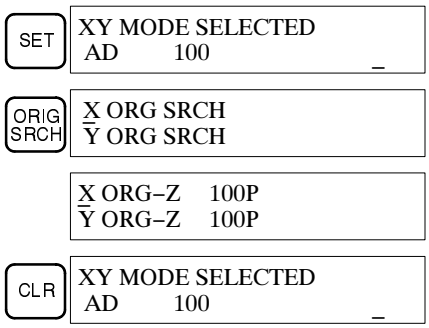


Select X for the X axis.



When X and Y Axes Are Selected

Select XY for the X and Y axes.



Operation Description

- Origin Search moves an axis to the origin at the speed specified by the origin search speed set in the parameters (addresses 416 for the X axis and 816 for the Y axis).
- The origin is designated according to the axes selected in Axis mode.
- After the origin is designated, the distance between the rising edge of the origin input signal to phase Z will be displayed.
- By pressing the CLR key, the initial display will appear.

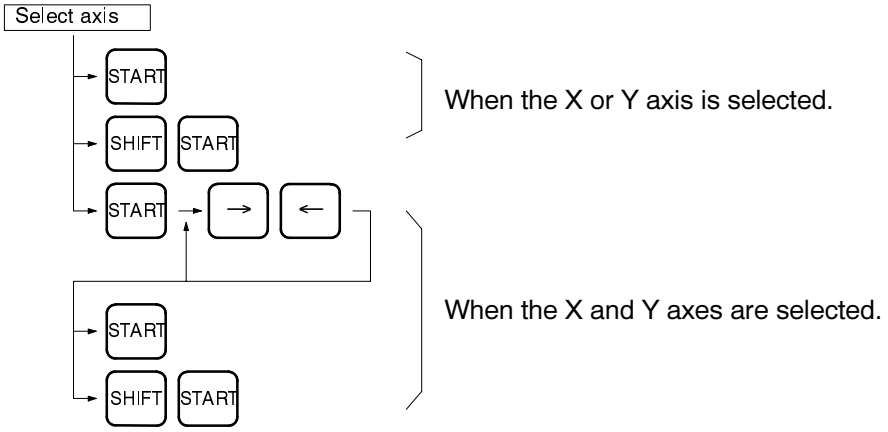
10-16 Start, Home Shift Start

Either Start or Home Shift Start executes positioning from the set address for the axes (X, Y, and XY) selected.

Available Mode

Monitor	Debug	Program
No	No	Yes

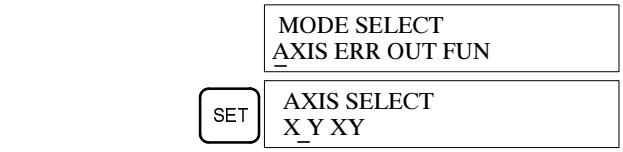
Basic Operating Procedure



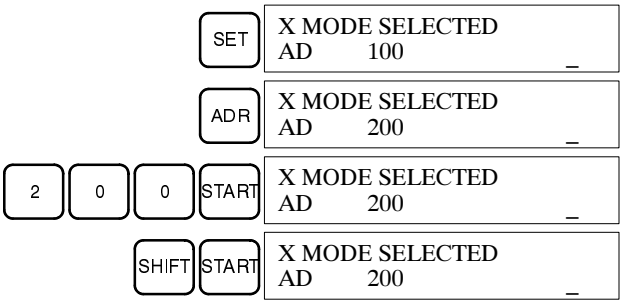
Start or Home Shift Start is disabled if ERR, OUT, or FUN is selected.

Key Operation and Displays

Start



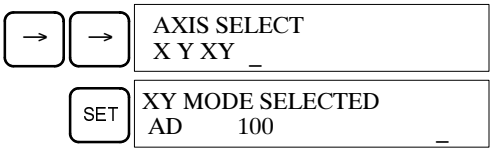
Select X for the X axis and Y for the Y axis. Selecting both X and Y axes allows independent operation as well as simultaneous and interpolated operations.

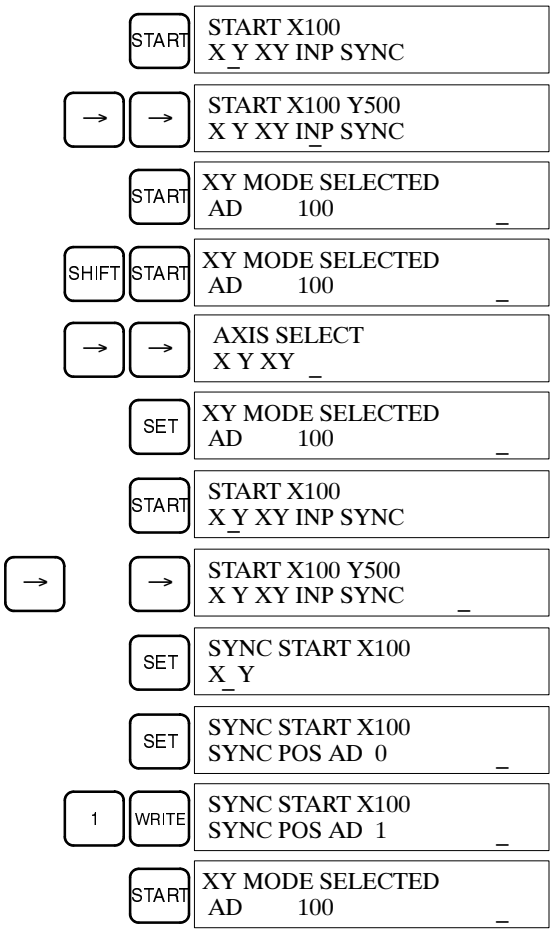


Operation Description

- Positioning proceeds according to the speed designated by the positioning action.
- Start or Home Shift Start is effective only after establishing the origin.
- Start or Home Shift Start is executed on the axis designated in Axis mode.
- Home shift adds a set number of pulses stored in the Home Shift parameter (addresses 410 for the X axis and 810 for the Y axis) to the position designated for the positioning action.
- Start is effective while the START key is pressed. When the Start key is released, the Teaching Box decelerates and stops. The deceleration pattern is determined by the value set with the positioning action.
- The user need not continue pressing the START key, because the START key is used to select the kind of start operation when the X and Y axes are selected.

Start with X and Y Axes Selected





Operation Description

- For this start, select the type of operation (X-axis independent, Y axis independent, simultaneous, interpolation, or synchronization) with the Left and Right Keys after pressing the START Key. Press the START key afterwards once more.

10-17 Monitor and Override

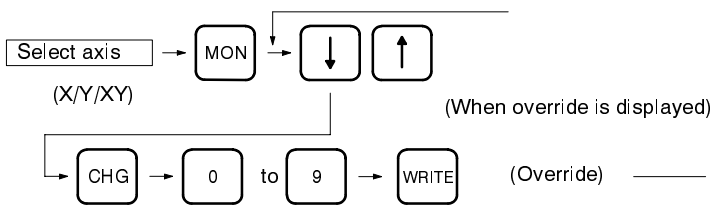
Monitor is used in monitoring motor movement conditions such as the current address, M code, current position, speed, dwel time, origin signal, limit input signal, rotation direction, override coefficient, and error counter value while refreshing them. Monitor is also used to change override instructions.

Available Mode

Monitor	Debug	Program
Yes	No	Yes

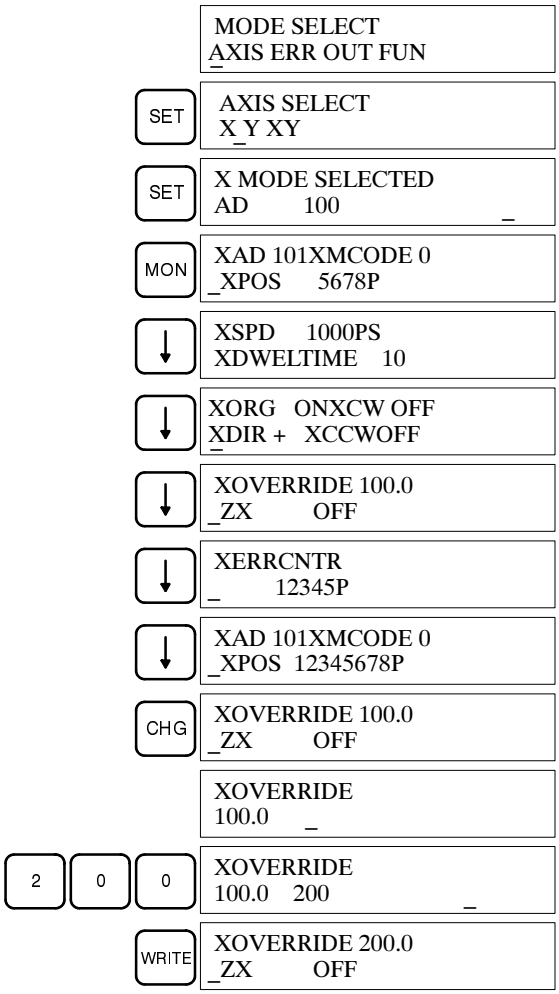
Note Override is effective in Program mode.

Basic Operating Procedure



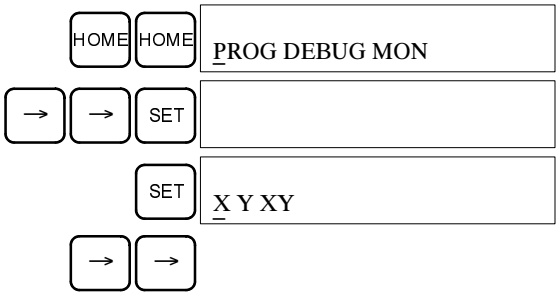
Key Operation and Displays

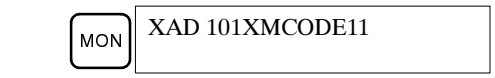
Monitor



Operation Description

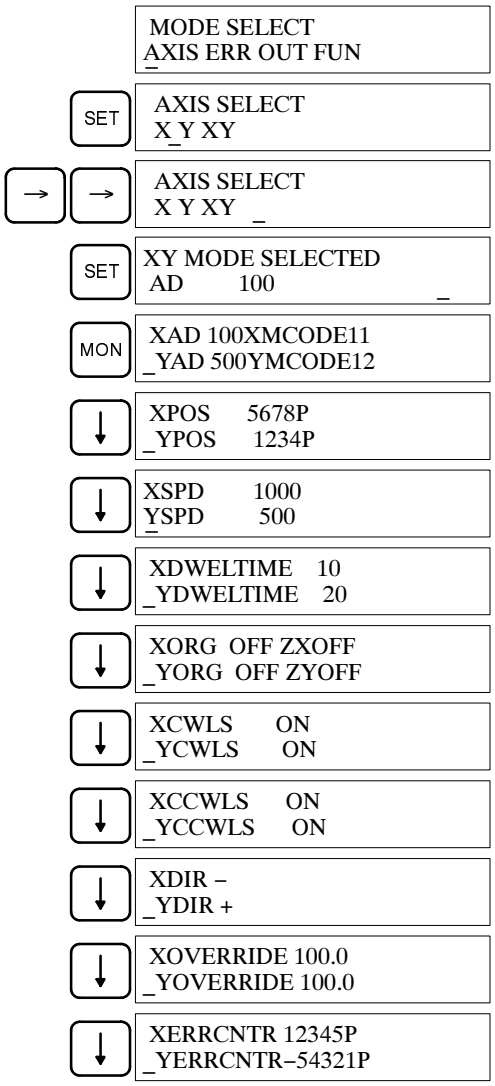
- After selecting the axes, press the MON key to monitor. Press the Up and Down keys to move between displays for the current address, M code, current position, speed, dwell time, origin signal, limit input signal, rotation direction, override coefficient, and error counter value.
- Set the override within the range of 0.1% to 999.9% in 0.1% increments.
- The above key operation display is in pulse units.
- Speed monitor displays the speed set in the positioning action of the axis in operation.
- The origin, CW limit, and CCW limit are displayed as ON or OFF according to the external I/O contact conditions.
- When Monitor is selected as the Teaching mode, operate the keys as follows:





Key Operation and Display Changes

When X and Y Axes Are Selected



Operation Description

- After selecting the axes, press the MON key to monitor. Press the Up and Down keys to move between displays for the current address, M code, current position, speed, dwell time, origin signal, limit input signal, rotation direction, override coefficient, and error counter value.
- Set the override within the range of 0.1% to 999.9% in 0.1% increments.
- When the X and Y axes are set, override can be set after moving the cursor with the Right and Left keys.

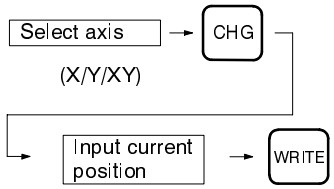
10-18 Change Current Position

Changes the current position to the input value. Positioning after the current position is changed is executed according to the new value.

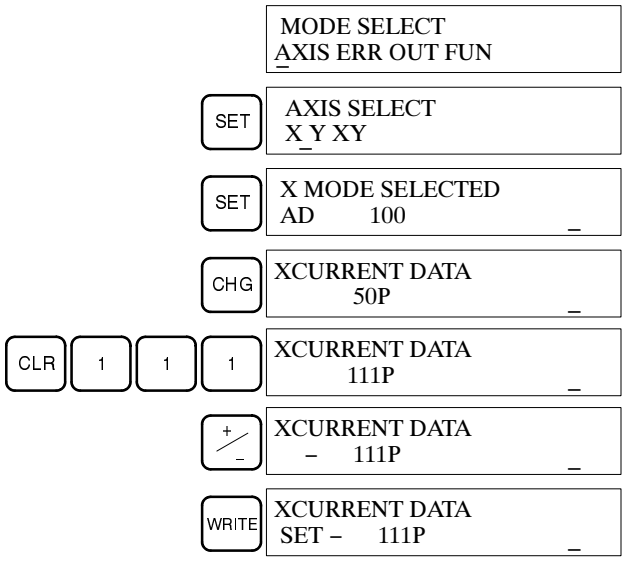
Available Mode

Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure

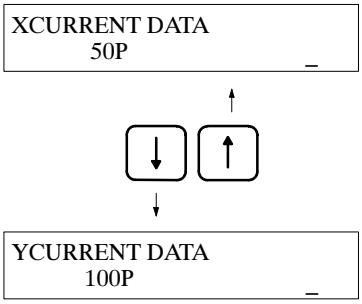


Key Operation and Displays

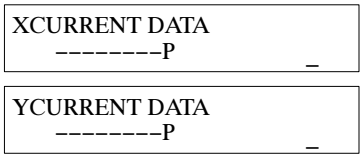


Operation Description

- The example above changes the current position from 50 to −111.
- When both the X and Y axes are selected, press the CHG key and then use the Up and Down keys to toggle between the current position displays for the X and Y axes.
- After the axis on which the current position is changed, change the current value as follows:



If no origin is designated, the following will be displayed.

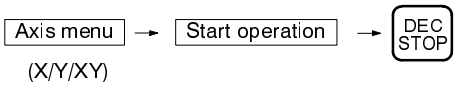


10-19 Deceleration Stop

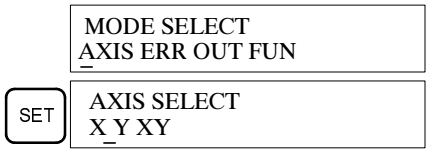
This operation is used to decelerate to a stop for axes selected under the Axis menu.

Available Mode

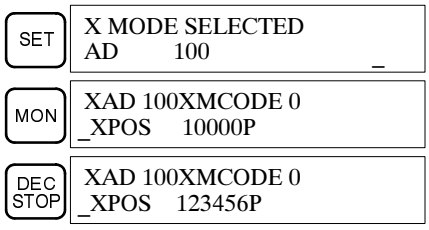
Monitor	Debug	Program
Yes	Yes	Yes



Key Operation and Displays



Select X to decelerate and stop the X axis, Y to decelerate and stop the Y axis, and XY to decelerate and stop both the X and Y axes simultaneously.



Operation Description

- Axes in operation selected under the Axis menu will be decelerated and stopped by pressing the DEC/STOP key.
- Deceleration Stop is effective during any key operation after the Axis menu is selected.
- When the Teaching Box is operating, the DEC/STOP key cannot be pressed.

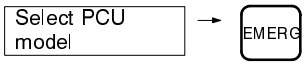
10-20 Emergency Stop

Emergency Stop will stop axes selected under the Axis menu while the axes are in operation. The axes will be stopped by turning OFF the START Key when operating the Teaching Box. While operating the Teaching Box, the EMERG Key cannot be pressed.

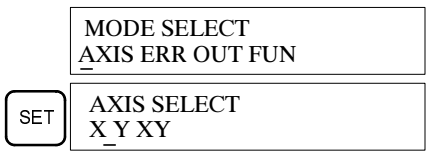
Available Mode

Monitor	Debug	Program
Yes	Yes	Yes

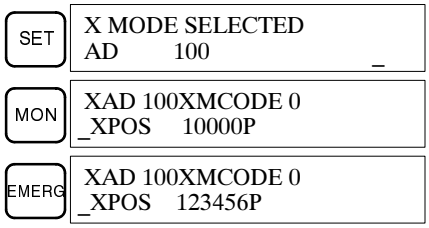
Basic Operating Procedure



Key Operation and Displays



Select X to stop the X axis, Y to stop the Y axis, and XY to stop both the X and Y axes simultaneously.



Operation Description

- The operation of axes selected under the Axis menu will be stopped immediately after the EMERG key is pressed.
- Emergency Stop is effective during any key operation after the Axis menu is selected.
- When the Teaching Box is operating, the EMERG key cannot be pressed.

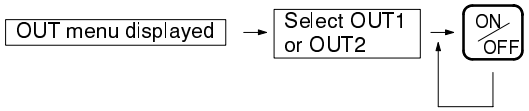
10-21 Setting OUT1 and OUT2 Outputs

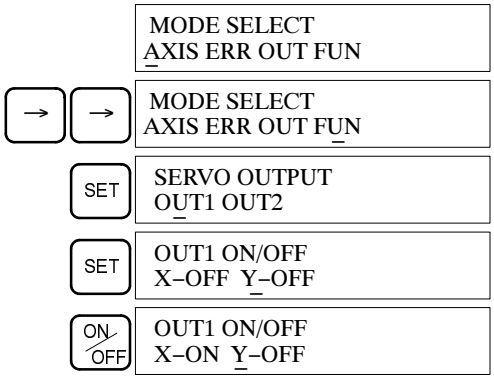
OUT1 and OUT2 to the servomotor driver can be turned ON or OFF from the PCU.

Available Mode

Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure





Operation Description

- Select the OUT menu, and turn the control output signal ON or OFF for the X and Y axes with the ON/OFF key.
- Signals are output whenever the ON/OFF key is input.
- Toggle between the X and Y axes with the Right and Left keys.

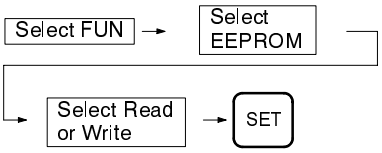
10-22 Writing PCU Data to EEPROM

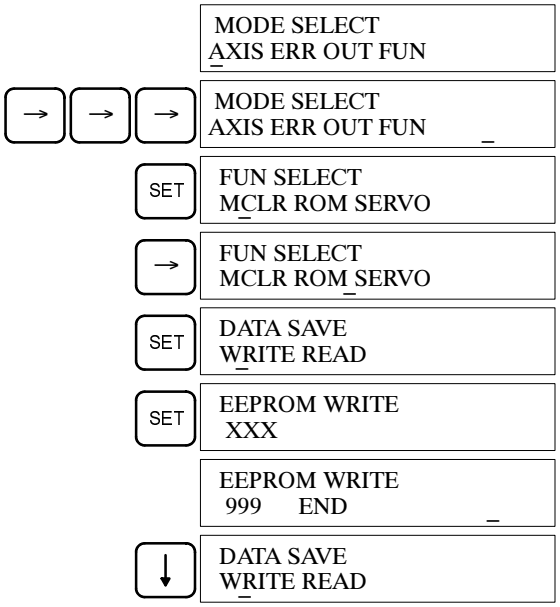
Positioning actions, parameters, speeds, dwell times, and acceleration and deceleration times can be written to the EEPROM.

Available Mode

Monitor	Debug	Program
No	No	Yes

Basic Operating Procedure





Operation Description

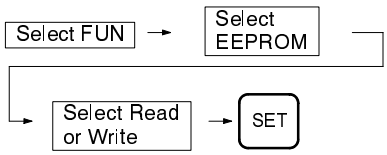
- All the data of the X and Y axes is transferred to the EEPROM.
- After selecting the FUN menu and then the EEPROM menu, select the desired menu items with the Left and Right keys, and execute them with the SET key.
- While writing, the display shows the number of addresses being written.

10-23 Reading PCU Data from EEPROM

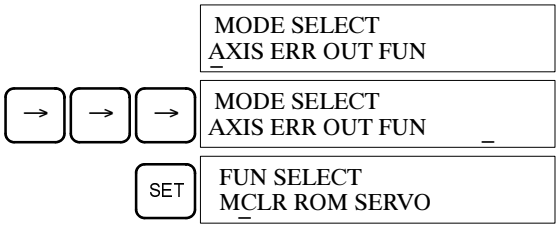
Positioning actions, parameters, speeds, dwell times, and acceleration and deceleration times can be read from the EEPROM.

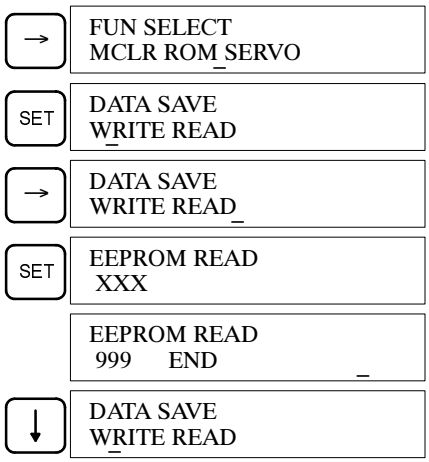
Available Mode

Monitor	Debug	Program
No	No	Yes



Key Operation and Displays





Operation Description

- All data of the X and Y axes is transferred from the EEPROM.
- After selecting the FUN menu and EEPROM menu, select the desired menu items with the Left and Right keys, and execute them with the SET key.
- While reading, the display shows the number of addresses being read.

10-24 Error Displays

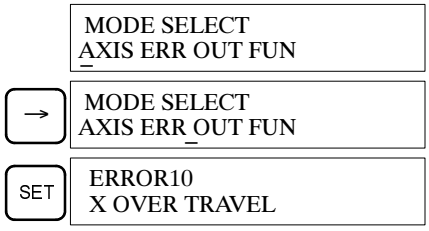
The contents of errors that have occurred on the PCU can be displayed.

Available Mode

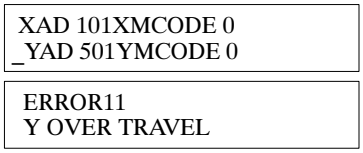
Monitor	Debug	Program
Yes	No	Yes

Key Operation and Displays

Reading Errors



Automatic Error Message



An overtravel error occurred on the Y axis.

Operation Description

- The above example shows a bus error.
- The first time any error occurs, an error message is displayed automatically. Clear the display with the CLR key, and the display before the error occurred returns. Automatic error message displays are enabled after selecting either the Axis, OUT, or FUN menu.
- The CLR key clears the display only, not the error itself.

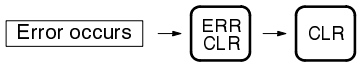
10-25 Resetting

Resetting is used to clear errors on the PCU.

Available Mode

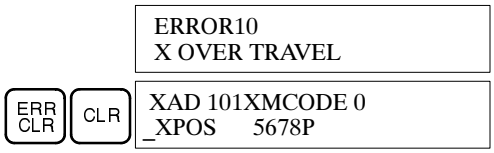
Monitor	Debug	Program
Yes	Yes	Yes

Basic Operating Procedure

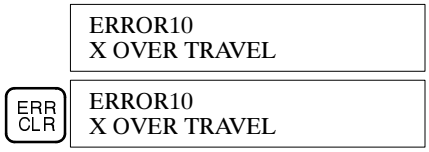


Key Operation and Displays

Error Clearable



Error Not Clearable



Operation Description

- After an error occurs, clear the error with the ERR CLR key.
- The CLR key is enabled during an error display and while editing data.

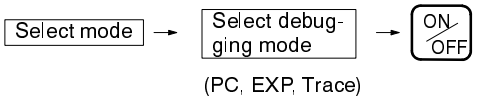
10-26 PC Protect

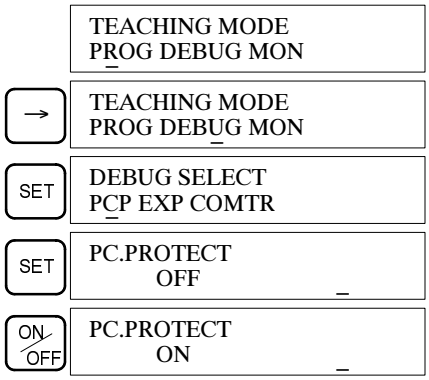
PC instructions are ignored when PC Protect is turned ON, and only Teaching Box and external inputs remain enabled.

Available Mode

Monitor	Debug	Program
No	Yes	No

Basic Operating Procedure





Operation Description

- By turning PC Protect ON, the PCU can be operated externally only. By turning PC Protect OFF, PC instructions are enabled.

• Toggle between ON and OFF with the ON/OFF key.

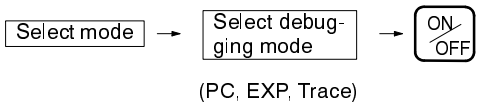
10-27 External Input Protect

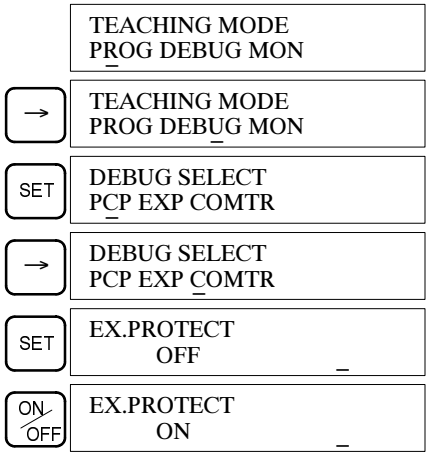
External inputs are ignored when External Input Protect is ON.

Available Mode

Monitor	Debug	Program
No	Yes	No

Basic Operating Procedure





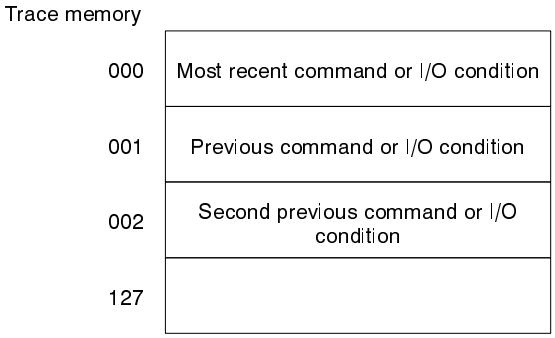
Operation Description

• By turning External Input Protect ON, external inputs are ignored. By turning External Input Protect OFF, external inputs are enabled.

• Toggle between ON and OFF with the ON/OFF key.

10-28 Command Tracing

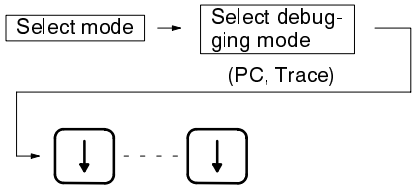
The trace memory records up to 128 previous steps of external I/O conditions and commands which may be traced. Both PC and Teaching Box commands are stored in the trace memory.



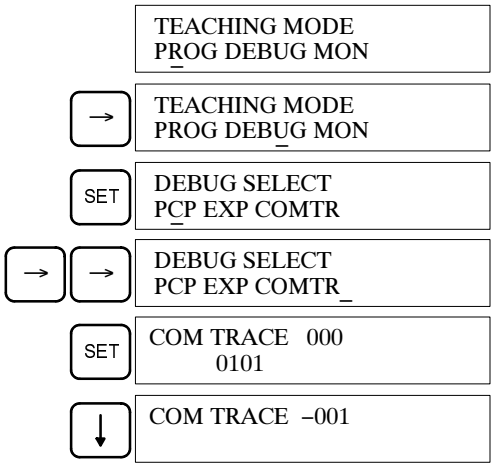
Available Mode

Monitor	Debug	Program
No	Yes	No

Basic Operating Procedure



Key Operation and Displays



Operation Description

- The I/O conditions of the X and Y axes are displayed from the trace memory as OP codes.
- The codes may be successively viewed by pressing the Down key.
- The above example shows the OP code “0101” at the most recent trace memory location 000, and X- and Y-axis I/O conditions at the previous memory location –001.
- Refer to the *C500-NC221-E Position Control Unit Operation Manual (W138)* for details on OP codes.
- When the OP code exceeds 1,000, the upper three digits indicate that data has been written to the positioning action.

X-axis I/O Assignments

b_{14}	b_{13}	b_{12}	b_{11}	b_{10}	b_9	b_8
OUT2 output	OUT1 output	CW LS input	CCW LS input	External interrupt input	External emergency stop input	Origin input

Y-axis I/O Assignments

b_6	b_5	b_4	b_3	b_2	b_1	b_0
OUT2 output	OUT1 output	CW LS input	CCW LS input	External interrupt input	External emergency stop input	Origin input

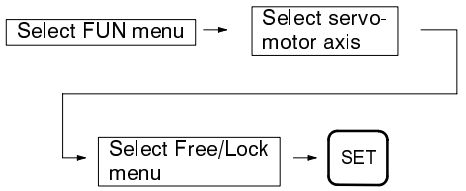
10-29 Servomotor Free

Servomotor Free sets the axis selected to servomotor free or servomotor lock.

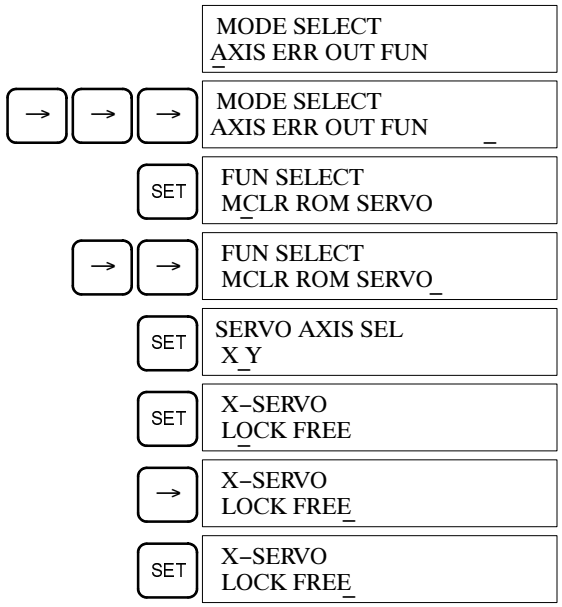
Basic Operating Procedure

Monitor	Debug	Program
No	No	Yes

Operation Description



Key Operation and Displays



Operation Description

- After selecting the Axis menu, press the Left or Right key to select servomotor free or servomotor lock, and press the SET key to execute.
- Toggle between the X and Y axes with the Right and Left keys.

10-30 PCU Data Contents and Permitted Settings

Item	Address range	Field		Permitted settings
Positioning actions	100	X-axis position		0 to 99,999,999 in pulse 0 to 99,999.000 in mm 0 to 9,999.0000 in inch
		Speed		0 to 99
		M code, dwell time		0 to 99, 0 to 9
		Acceleration and deceleration time		0 to 9
		Positioning action type		ABS/INC
		Interpolation positioning action		0, 1 (1: yes 0: no)
		Interpolation positioning action type		0, 1 (1: circular arc 0: end point)
		Circular arc data type		0, 1 (1: intermediate point 0: circular arc center)
		Circular arc direction		0, 1 (1:CW 0:CCW)
		Positioning pattern		0, 1
		Position action enable/disable		0, 1 (1: enable 0: disable)
	101 to 399	Same as above		Same as above
X-axis parameters	400	Unit		Pulse, mm, inch
	401	Pulse rate		0.0001 to 1.0
	402	Rotation direction		0, 1
	403	Encoder type	Multiplication	x1, x2, x4
			A- and B-phases polarity change	+, –
	404	Gain		(1 to 999) x 10 μV/p
	405	In-position zone		1 to 999 pulses
	406	Backlash compensation		0 to 9,999 pulses
	407	Stroke limit (+)		1 to 99,999,999 pulses 0.001 to 99,999.00 mm 0.0001 to 9,999.0000 inches
	408	Stroke limit (–)		1 to 99,999,999 pulses 0.001 to 99,999.00 mm 0.0001 to 9,999.0000 inches
	409	Zone setting		0 to 9,999 pulses
	410	Home shift		0 to ±999,999 pulses 0 to ±99,999.0 mm 0 to ±9,999.00 inches
	411	Maximum speed		1 to 300000 pps 0.001 to 9999.000 mm/s 0.0001 to 999.000 inch/s
		Teaching Box speed coefficient		1 to 9
	412	Teaching Box jogging speed		1 to 300000 pps 0.001 to 9999.000 mm/s 0.0001 to 999.0000 inch/s
		Teaching Box jogging acceleration and deceleration time		0 to 9
		Number of Teaching Box pulses		1 to 9 pulses

Item	Address range	Field	Permitted settings
X-axis parameters	413	Origin search direction	0, 1
	414	Origin compensation	0 to ±999,999 pulses 0 to ±99,999.0 mm 0 to ±9,999.00 inches
	415	High origin search speed	1 to 300,000 pps 0.001 to 9,999.000 mm/s 0.0001 to 999.0000 inch/s
	416	Origin search acceleration and deceleration	0 to 9
	417	Low origin search speed	1 to 10,000 pps 0.001 to 9,999.000 mm/s 0.0001 to 999.0000 inch/s
	418	External deceleration-stop pattern	0 to 9
		Number of deceleration-stop pulses	1 to 10,000 pulses 0.001 to 9,999.000 mm 0.0001 to 999.0000 inches
		Deceleration key deceleration pattern	0 to 9
	419	Disconnection check	0, 1
		Check time	0 to 990 ms
		Number of check pulses	0 to 999 pulses
	420	Error counter capacity	10 to 32,768 pulses
		External output 1 designation	0, 1
		External output 2 designation	0, 1
Dwell times	450 to 459	X-axis dwell times #0 to #9	0 to 9990 ms
Acceleration and deceleration times	460 to 469	X-axis acceleration and deceleration times #0 to #9	10 to 4990 ms
X-axis synchronization positioning data	470	X-axis synchronization positioning action	0 to ±99,999,999 pulses 0 to ±99,999.000 mm 0 to ±9,999.0000 inches
		Y-axis start address	500 to 799
		Synchronization pattern	0, 1
		Continuous pattern next address	0 to 9
		Data type	ABS/INC
		Data enable/disable	0, 1 (1: enable 0: disable)
	471 to 479	Same as above	Same as above
X-axis zone setting data	480	X-axis zone ON data	0 to ±99,999,999 pulses 0 to ±99,999.000 mm 0 to ±9,999.0000 inches
		X-axis zone OFF data	0 to ±99,999,999 pulses 0 to ±99,999.000 mm 0 to ±9,999.0000 inches
		Data enable/disable	0, 1 (1: enable 0: disable)
		External output ON/OFF	0, 1 (1: yes 0: no)
		External output designation OUT1	0, 1 (1: designated 0: not designated)
		External output designation OUT2	0, 1 (1: designated 0: not designated)
	481 to 489	Same as above	Same as above

Item	Address range	Field		Permitted settings
Positioning actions	500	Y-axis position		0 to 99,999,999 in pulse 0 to 99,999.000 in mm 0 to 9,999.0000 in inch
		Speed		0 to 99
		M code, dwell time		0 to 99, 0 to 9
		Acceleration and deceleration time		0 to 9
		Positioning action type		ABS/INC
		Interpolation positioning action		0, 1 (1: yes 0: no)
		Interpolation positioning action type		0, 1 (1: Circular arc 0: end point)
		Circular arc data type		0, 1 (1: intermediate point 0: circular arc center)
		Circular arc direction		0, 1 (1:CW 0:CCW)
		Positioning pattern		0, 1
		Positioning action enabled/disable		0, 1 (1: enable 0: disable)
	501 to 799	Same as above		Same as above
Y-axis parameters	800	Unit		Pulse, mm, inch
	801	Pulse rate		0.0001 to 1.0
	802	Rotation direction		0, 1
	803	Encoder type	Multiplication	x1, x2, x4
			A- and B-phase polarity change	+, –
	804	Gain		(1 to 999) x 10 μV/p
	805	In-position zone		1 to 999 pulses
	806	Backlash compensation		0 to 9,999 pulses
	807	Stroke limit (+)		1 to 99,999,999 pulses 0.001 to 99,999.00 mm 0.0001 to 9,999.0000 inches
	808	Stroke limit (–)		1 to 99,999,999 pulses 0.001 to 99,999.00 mm 0.0001 to 9,999.0000 inches
	809	Zone setting		0 to 9,999 pulses
	810	Home shift		0 to ±999,999 pulses 0 to ±99,999.0 mm 0 to ±9,999.00 inches
	811	Maximum speed		1 to 300000 pps 0.001 to 9999.000 mm/s 0.0001 to 999.0000 inch/s
		Teaching Box speed coefficient		1 to 9
	812	Teaching Box jogging speed		1 to 300000 pps 0.001 to 9999.000 mm/s 0.0001 to 999.0000 inch/s
		Teaching Box jogging acceleration and deceleration time		0 to 9
		Number of Teaching Box pulses		1 to 9 pulses
	813	Origin search direction		0, 1
	814	Origin compensation		0 to ±999,999 pulses 0 to ±99,999.0 mm 0 to ±9,999.00 inches

Item	Address range	Field	Permitted settings
Y-axis parameters	815	High origin search speed	1 to 300000 pps 0.001 to 9999.000 mm/s 0.0001 to 999.0000 inch/s
	816	Origin search acceleration and deceleration	0 to 9
	817	Low origin search speed	1 to 10000 pps 0.001 to 9999.000 mm/s 0.0001 to 999.0000 inch/s
	818	External deceleration-stop pattern	0 to 9
		Number of deceleration-stop pulses	1 to 10,000 pulses 0.001 to 9,999.000 mm 0.0001 to 999.0000 inches
		Deceleration key deceleration pattern	0 to 9
	819	Disconnection check	0, 1
		Check time	0 to 99
		Number of check pulses	0 to 999 pulses
	820	Error counter capacity	10 to 32,768 pulses
		External output 1 designation	0, 1
		External output 2 designation	0, 1
Dwell times	850	Y-axis dwell time #0	0 to 9990 ms
	851 to 859	Y-axis dwell times #1 to #9	0 to 9990 ms
Acceleration and deceleration times	860	Y-axis acceleration and deceleration time #0	10 to 4990 ms
	861 to 869	Y-axis acceleration and deceleration times #1 to #9	1 to 4990 ms
Y-axis synchronization positioning data	870	Y-axis synchronization positioning action	0 to ±99,999,999 pulses 0 to ±99,999.000 mm 0 to ±9,999.0000 inches
		X-axis start address	100 to 399
		Synchronization pattern	0, 1
		Continuous pattern next address	0 to 9
		Data type	ABS/INC
		Data enabled/disabled	0, 1 (1: enabled 0: disabled)
	871 to 879	Same as above	Same as above
X-axis zone setting data	880	Y-axis zone ON data	0 to ±99,999,999 pulses 0 to ±99,999.000 mm 0 to ±9,999.0000 inches
		Y-axis zone OFF data	0 to ±99,999,999 pulses 0 to ±99,999.000 mm 0 to ±9,999.0000 inches
		Data enable/disable	0, 1 (1: enable 0: disable)
		External output ON/OFF	0, 1 (1; yes 0: no)
		External output designation OUT1	0, 1 (1: designated 0: not designated)
		External output designation OUT2	0, 1 (1: designated 0: not designated)
	881 to 889	Same as above	Same as above
XY-axis speed data	900	Data 0	1 to 300000 pps 0.001 to 9999.000 mm/s 0.0001 to 999.0000 inch/s

Item	Address range	Field	Permitted settings
XY-axis speed data	901	Data 1	1 to 300000 pps 0.001 to 9999.000 mm/s 0.0001 to 999.0000 inch/s
	902 to 999	Data 2 to data 99	Same as above

10-30-1 Error Code Displays and Error Processing on NC222

Error	Error code display	Cause of error	Remedy
Hardware errors	ERROR01 BUS ERROR	An abnormality was found in bus hardware when accessing the bus.	Replace the bus hardware.
	ERROR02 EEPROM VERIFY	An abnormality was found in the EEPROM when executing the STORE command.	Replace the EEPROM.
	ERROR03 WDT ERROR	The reset hangs because of circuit problems or because the reset clearing signal does not arrive.	Check signal routing from the CPU of the PC (CPU, Backplane, I/O interface Unit, Expansion I/O Racks). If no problems exist in the routing then the error is in the PCU, and cannot be corrected by the user. Replace the PCU.
System errors	ERROR10 X OVER TRAVEL	The CW or CCW limit input turned ON for the X axis when the operation was not an origin search.	Press the ERR CLR key (error clear). This does not erases the stored origin, so jogging and origin search operations are enabled.
	ERROR11 Y OVER TRAVEL	The CW or CCW limit input turned ON for the Y axis when the operation was not an origin search.	Press the ERR CLR key (error clear). This does not erases the stored origin, so jogging and origin search operations are enabled.
	ERROR12 X ERR CNTR OVER	The X-axis error counter overflowed.	The error counter count exceeded its maximum value when a workpiece got caught on or bumped into an obstruction. Remove the obstruction, clear the error, and reestablish the origin.
	ERROR13 Y ERR CNTR OVER	The Y-axis error counter overflowed.	
Wiring errors	ERROR20 X REVERCE WIRE	Phase-difference signals (phases A and B signals) from the X-axis encoder are reversed.	Turn off the power and interchange phases A and B or change the parameter data to change phases A and B.
	ERROR21 Y REVERCE WIRE	Phase-difference signals (phases A and B signals) from the Y-axis encoder are reversed.	
	ERROR22 X SNAP OF WIRE	The positioning loop wire of the X axis is disconnected.	Connect the positioning loop wire.
	ERROR23 Y SNAP OF WIRE	The positioning loop wire of the Y axis is disconnected.	

Error	Error code display	Cause of error	Remedy
OP code errors	ERROR30 XXXX ILLEGAL COMMAND	An undefined OP code was sent as a command	Correct the command and retransmit.
	ERROR31 XXXX OPERAND LENGTH	Operands longer or shorter than the defined length are attached to the command.	
	ERROR32 XXXX COMMAND TIMING1	A command valid only when the motor is stopped was received when the motor was operating, or a command valid only when the motor is operating was received when the motor was stopped.	Consider the PC program timing, and correct the command transfer timing.
	ERROR33 XXXX COMMAND TIMING2	A synchronization start command and normal start command are transmitted together.	Consider the PC program timing, and correct the command transfer timing.
	ERROR34 XXXX COMMAND TIMING3	A servomotor control command was transmitted when during servomotor free.	Consider the PC program timing, and correct the command transfer timing.
	ERROR35 XXXX CMD IN INTERPOL	A command for a single axis was received during interpolation.	Consider the PC program timing, and correct the command transfer timing.
	ERROR36 XXXX CMD IN SINGLE	An interpolation control command was transmitted during a single axis operation.	Consider the PC program timing, and correct the command transfer timing.
Operand errors	ERROR40 XXXX ILLEGAL OPERAND	An undefined operand was received.	Correct the operand and retransfer the command.
	ERROR41 XXXX ILLEGAL OPERAND	The operand format is incorrect.	
Data errors	ERROR50 XXXX INTERPOL DATA	Data designated by interpolation start command was not interpolation positioning action.	Correct the data and retransfer the command.
	ERROR51 XXXX INTERPOL DATA	Among interpolation positioning action, data for one axis is disabled.	
	ERROR52 XXXX CIRCULAR DATA	The center or intermediate point is the same as the end point; an arc cannot be produced.	
	ERROR53 XXXX CIRCULAR DATA	No interpolation end point data followed the center or intermediate point data.	
Data errors	ERROR54 XXXX DATA ADDRESS	Data beyond the defined range was transferred.	Correct the data and retransfer the command.
	ERROR55 XXXX DATA LENGTH	The data length did not fit the defined range.	
Data errors	ERROR56 XXXX DATA TIMING	Data transfer occurred during operation.	Data cannot be transferred during operation. Transfer data while the axes are stopped.

Error	Error code display	Cause of error	Remedy
Data errors	ERROR57 XXXX ILLEGAL DATA	Data beyond the defined range was transferred.	Correct the data and retransfer.
	ERROR58 XXXX ILLEGAL DATA	The data format did not fit the defined range.	Correct the data and retransfer.
	ERROR59 XXXX SOFT LIMIT	The position of the positioning action exceeded the positive and negative limit parameters.	Check the positioning value to be executed or check the limit parameters.
	ERROR60 XXXX SPEED 0	The speed called in the positioning action was 0.	Check the speeds or speed fields of the positioning actions.
	ERROR61 XXXX SEARCH INCOMP	Origin search incomplete.	Establish the origin with Origin Search or Changing Current Position Operation.
Communication errors	ERROR70 PARITY ERROR	Parity check uncovered an abnormality.	Clear the error with ERST, and perform the following steps. If the error does not clear, there may be a hardware problem that is not user serviceable; replace the PCU. 1. Check for faulty cable connections. 2. Exchange the external display for the Teaching Box or the Teaching Box itself. 3. Replace the cables of the peripheral equipment (C200H-CN-222 or C200H-CN-422). 4. Replace the PCU.
	ERROR71 FRAMING ERROR	Data format broke down during transfer.	
	ERROR72 OVER RUN ERROR	Handshake abnormality	
	ERROR80 XXXX TRANS CH OVER	The number of channels transferred exceeded the maximum permissible number.	Change the PC program so the number of channels transferred remains within the permissible number.

10-30-2 Coding Sheet for NC222

Address			Field	Setting range	Data
		0	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	
			Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	
			Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	
			Circular arc data type	1: circular arc center 0: intermediate point	
			Circular arc direction	CCW=1, CW=0	
			Positioning action	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	
		1	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	
			Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	
			Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	
			Circular arc data type	1: circular arc center 0: intermediate point	
			Circular arc direction	CCW=1, CW=0	
			Positioning pattern	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	
		2	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	
			Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	

Address			Field	Setting range	Data
		2	Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	
			Circular arc data type	1: circular arc center 0: intermediate point	
			Circular arc direction	CCW=1, CW=0	
			Positioning pattern	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	
		3	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	
			Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	
			Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	
			Circular arc data type	1: circular arc center 0: intermediate point	
			Circular arc direction	CCW=1, CW=0	
			Positioning pattern	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	
		4	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	
			Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	
			Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	
			Circular arc data type	1: circular arc center 0: intermediate point	
		4	Circular arc direction	CCW=1, CW=0	
			Positioning pattern	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	

Address			Field	Setting range	Data
		5	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	
			Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	
			Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	
			Circular arc data type	1: circular arc center 0: intermediate point	
			Circular arc direction	CCW=1, CW=0	
			Positioning pattern	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	
		6	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	
			Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	
			Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	
			Circular arc data type	1: circular arc center 0: intermediate point	
			Circular arc direction	CCW=1, CW=0	
			Positioning pattern	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	
		7	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	

Address			Field	Setting range	Data
		7	Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	
			Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	
			Circular arc data type	1: circular arc center 0: intermediate point	
			Circular arc direction	CCW=1, CW=0	
			Positioning pattern	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	
		8	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	
			Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	
			Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	
			Circular arc data type	1: circular arc center 0: intermediate point	
			Circular arc direction	CCW=1, CW=0	
			Positioning pattern	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	
		9	Position	0 to 99,999,999 pulses	
				0 to 99,999.000 mm	
				0 to 9,999.0000 inches	
			Speed	0 to 99	
			M code	0 to 99	
			Dwell time	0 to 9	
			Acceleration and deceleration time	0 to 9	
			Positioning action type	ABS, INC	
			Interpolation positioning action	1: yes 0: no	
			Interpolation positioning action type	1: circular arc 0: end point	

Address			Field	Setting range	Data
		9	Circular arc data type	1: circular arc center 0: intermediate point	
			Circular arc direction	CCW=1, CW=0	
			Positioning pattern	0, 1	
			Positioning action enable/disable	1: enable 0: disable	
			Synchronization start	1: enable 0: disable	

Parameter Data

Item	Address	Field		Setting range	Data
X-axis parameter data	400	Unit		Pulse, mm, inch	
	401	Pulse rate		0.0001 to 1.0	
	402	Rotation direction		0, 1	
	403	Encoder type	Multiplication	x1, x2, x4	
			A- and B-phases polarity change	+, –	
	404	Gain		(1 to 999) x 10 μV/p	
	405	In-position zone		1 to 999 pulses	
	406	Backlash compensation		0 to 9,999 pulses	
	407	Stroke limit (+)		1 to 99,999,999 pulses	
				0.001 to 99,999.00 mm	
				0.0001 to 9,999.0000 inches	
	408	Stroke limit (–)		1 to 99,999,999 pulses	
				0.001 to 99,999.00 mm	
				0.0001 to 9,999.0000 inches	
	409	Zone setting		0 to 9,999 pulses	
	410	Home shift		0 to ±999,999 pulses	
				0 to ±99,999.0 mm	
				0 to ±9,999.00 inches	
	411	Maximum speed		1 to 300000 pps	
				0.001 to 9999.000 mm/s	
				0.0001 to 999.0000 inch/s	
		Teaching Box speed coefficient		1 to 9	
	412	Teaching Box jogging speed		1 to 300000 pps	
				0.001 to 9999.000 mm/s	
				0.0001 to 999.0000 inch/s	
		Teaching Box jogging acceleration and deceleration time		0 to 9	
		Number of Teaching Box pulses		1 to 9	
	413	Origin search direction		0, 1	
	414	Origin compensation		0 to ±999,999 pulses	
				0 to ±99,999.0 mm	
				0 to ±9,999.00 inches	
	415	High origin search speed		1 to 300000 pps	
				0.001 to 9999.000 mm/s	
				0.0001 to 999.0000 inch/s	
	416	Origin search acceleration and deceleration		0 to 9	
	417	Low origin search speed		1 to 10000 pps	
				0.001 to 9999.000 mm/s	
				0.0001 to 999.0000 inch/s	

Item	Address	Field		Setting range	Data
X-axis parameter data	418	External deceleration-stop pattern		0 to 9	
		Number of deceleration-stop pulses		1 to 10,000 pulses	
				0.001 to 9,999.000 mm	
				0.0001 to 999.0000 inches	
		Deceleration key deceleration pattern		0 to 9	
	419	Disconnection check		0, 1	
		Check time		0 to 99	
		Number of check pulses		0 to 999 pulses	
	420	Error counter capacity		10 to 32,768 pulses	
		External output 1 designation		0, 1	
		External output 2 designation		0, 1	
Y-axis parameter data	800	Unit		Pulse, mm, inch	
	801	Pulse rate		0.0001 to 1.0	
	802	Rotation direction		0, 1	
	803	Encoder type	Z phase	+, –	
			Multiplication	x1, x2, x4	
			A- and B-phases polarity change	+, –	
	804	Gain		(1 to 999) x 10^{-2} x 305 μV/ms	
	805	In-position zone		1 to 999 pulses	
	806	Backlash compensation		0 to 9,999 pulses	
	807	Stroke limit (+)		1 to 99,999,999 pulses	
				0.001 to 99,999.00 mm	
				0.0001 to 9,999.0000 inches	
	808	Stroke limit (–)		1 to 99,999,999 pulses	
				0.001 to 99,999.00 mm	
				0.0001 to 9,999.0000 inches	
	809	Zone setting		0 to 9,999 pulses	
	810	Home shift		0 to ±999,999 pulses	
				0 to ±99,999.0 mm	
				0 to ±9,999.00 inches	
	811	Maximum speed		1 to 300000 pps	
				0.001 to 9999.000 mm/s	
				0.0001 to 999.0000 inch/s	
		Teaching Box speed coefficient		1 to 9	
	812	Teaching Box jogging speed		1 to 300000 pps	
				0.001 to 9999.000 mm/s	
				0.0001 to 999.0000 inch/s	
		Teaching Box jogging acceleration and deceleration time		0 to 9	
		Number of Teaching Box pulses		1 to 9	
	813	Origin search direction		0, 1	
	814	Origin compensation		0 to ±999,999 pulses	
				0 to ±99,999.0 mm	
				0 to ±9,999.00 inches	

Item	Address	Field	Setting range	Data
Y-axis parameter data	815	High origin search speed	1 to 300000 pps	
			0.001 to 9999.000 mm/s	
			0.0001 to 999.0000 inch/s	
	816	Origin search acceleration and deceleration	0 to 9	
	817	Low origin search speed	1 to 10000 pps	
			0.001 to 9999.000 mm/s	
			0.0001 to 999.0000 inch/s	
	818	External deceleration-stop pattern	0 to 9	
		Number of deceleration-stop pulses	1 to 10,000 pulses	
			0.001 to 9,999.000 mm	
			0.0001 to 999.0000 inches	
		Deceleration key deceleration pattern	0 to 9	
	819	Disconnection check	0, 1	
		Check time	0 to 99	
		Number of check pulses	0 to 999 pulses	
	820	Error counter capacity	10 to 32,768 pulses	
		External output 1 designation	0, 1	
		External output 2 designation	0, 1	

Synchronization Positioning Action

Address	Field	Setting range	Data
	Synchronization position	0 to ±99,999,999 pulses	
		0 to 99,999.000 mm	
		0 to 9,999.0000 inches	
	Other axis address	X axis: 100 to 399 Y axis: 500 to 799	
	Synchronization pattern	0, 1	
	Continuous pattern next address	0 to 9	
	Data type	ABS, INC	
	Data enable/disable	0, 1	
	Synchronization position	0 to ±99,999,999 pulses	
		0 to 99,999.000 mm	
		0 to 9,999.0000 inches	
	Other axis address	X axis: 100 to 399 Y axis: 500 to 799	
	Synchronization pattern	0, 1	
	Continuous pattern next address	0 to 9	
	Data type	ABS, INC	
	Data enable/disable	0, 1	

Address	Field	Setting range	Data
	Synchronization position	0 to ±99,999,999 pulses	
		0 to 99,999.000 mm	
		0 to 9,999.0000 inches	
	Other axis address	X axis: 100 to 399 Y axis: 500 to 799	
	Synchronization pattern	0, 1	
	Continuous pattern next address	0 to 9	
	Data type	ABS, INC	
	Data enable/disable	0, 1	
	Synchronization position	0 to ±99,999,999 pulses	
		0 to 99,999.000 mm	
		0 to 9,999.0000 inches	
	Other axis address	X axis: 100 to 399 Y axis: 500 to 799	
	Synchronization pattern	0, 1	
	Continuous pattern next address	0 to 9	
	Data type	ABS, INC	
	Data enable/disable	0, 1	
	Synchronization position		
	Other axis address		
	Synchronization pattern	0, 1	
	Continuous pattern next address	0 to 9	
	Data type	ABS, INC	
	Data enable/disable	0, 1	

Zone Setting Data

Address	Field	Setting range	Data
	Zone ON data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	Zone OFF data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	External output ON/OFF	0, 1	
	External output designation OUT1	0, 1	
	External output designation OUT2	0, 1	
	Data enable/disable	0, 1	

Address	Field	Setting range	Data
	Zone ON data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	Zone OFF data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	External output ON/OFF	0, 1	
	External output designation OUT1	0, 1	
	External output designation OUT2	0, 1	
	Data enable/disable	0, 1	
	Zone ON data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	Zone OFF data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	External output ON/OFF	0, 1	
	External output designation OUT1	0, 1	
	External output designation OUT2	0, 1	
	Data enable/disable	0, 1	
	Zone ON data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	Zone OFF data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	External output ON/OFF	0, 1	
	External output designation OUT1	0, 1	
	External output designation OUT2	0, 1	
	Data enable/disable	0, 1	
	Zone ON data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	Zone OFF data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	External output ON/OFF	0, 1	
	External output designation OUT1	0, 1	
	External output designation OUT2	0, 1	
	Data enable/disable	0, 1	

Address	Field	Setting range	Data
	Zone ON data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	Zone OFF data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	External output ON/OFF	0, 1	
	External output designation OUT1	0, 1	
	External output designation OUT2	0, 1	
	Data enable/disable	0, 1	
	Zone ON data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	Zone OFF data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	External output ON/OFF	0, 1	
	External output designation OUT1	0, 1	
	External output designation OUT2	0, 1	
	Data enable/disable	0, 1	
	Zone ON data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	Zone OFF data	0 to ±99,999,999 pulses	
		0 to ±99,999.000 mm	
		0 to ±9,999.0000 inches	
	External output ON/OFF	0, 1	
	External output designation OUT1	0, 1	
	External output designation OUT2	0, 1	
	Data enable/disable	0, 1	

Dwell Times

Address	Field	Data (0 to 9,990 ms)
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		

Acceleration and Deceleration Times

Address	Field	Data (0 to 4,990 ms)
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		

Speed (1 to 300,000 PPS, 0.001 to 9,999.0 MPS, 0.0001 to 999.0 IPS)

Address	Field	Data
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		

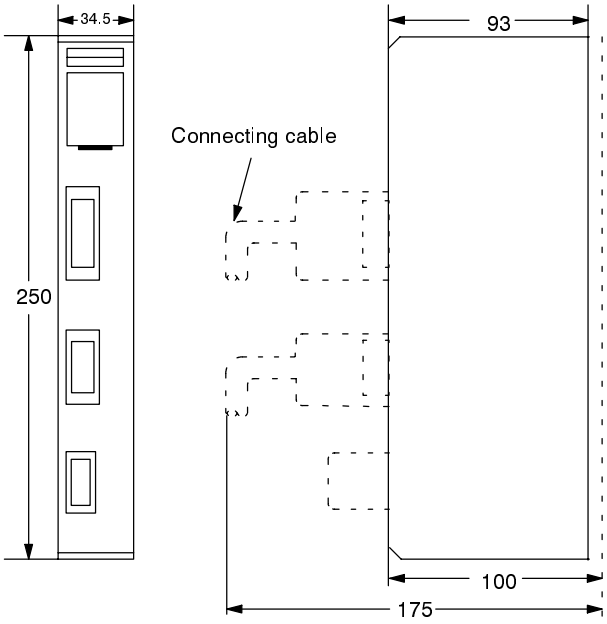
Appendix A
Position Control Unit Specifications

General Specifications

Item	Specification
Power supply voltage	5 VDC (for PCU)
	24 VDC (for external power)
Voltage fluctuation tolerance	4.75-5.25 VDC (for PCU)
	21.6-26.4 VDC (for external unit power)
DC current consumption	950 mA or less for 5 VDC
	50 mA or less for 24 VDC
Dielectric strength	Between all external terminals and frame ground: 500 VAC for 1 minute at 50/60 Hz
Noise resistance	Power (100 VAC) (a) Normal mode: 1.2 kV (b) Common mode: 1.2 kV I/O (24 VDC) (a) Normal mode: 600 V (b) Common mode: 600 V Conditions: Pulse width 1 μs, rise time 1 ns.
Vibration resistance	10-54.8 Hz for 20 minutes each in X, Y, and Z directions with 0.5-mm double amplitude
Operating ambient temperature	0 to 55 °C (one Unit used); 0 to 50 °C (multiple Units used) (see note)
Operating humidity	35% to 85% (no condensation)
Operating atmosphere	No corrosive gases
Storage temperature	–20 to 65 °C
Grounding	Ground at a resistance of less than 100 Ω
Weight	700 grams or less (excluding connectors)
Dimensions	250.0 (H) x 34.5 (W) x 93.0 (D) mm

Note If the Position Control Unit is mounted between two Units (such as the C500-IA___or C500-ID___) which produce high temperatures, or if several Position Control Units are mounted next to each other, then the maximum ambient operating temperature must be reduced by 5°C to 50°C. If the Position Control Unit must be used in an environment with an ambient temperature higher than 50°C, then install a fan or take other measures to cool the Position Control Unit.

Dimensions (Unit: mm)



I/O Electrical Specifications – Inputs

Item	Specification
Input types	Origin, external interrupt, CW limit, CCW limit, external servo-free
Input voltage	24 VDC + 10%
Input current	8 mA
ON voltage	12V min.
OFF voltage	4V max.
ON delay time	2 ms or less
OFF delay time	2 ms or less
Phase inputs	A, B, Z
Phase input voltage	5 VDC + 5%
Rated phase input current	10 mA
ON voltage for phase inputs	2.5V max.
Response frequency	A, B phase: 300 kHz max. (50% duty ratio) Z phase: 10 kHz max.

I/O Electrical Specifications – Outputs

Item	Specification
Output types	OUT1, OUT2
Maximum open/close capacity	Open collector 40 mA at 24 VDC
Leak current	0.1 mA or less
Residual voltage	1.1 V or less
External power supply voltage	24 VDC ± 10%
Output type	Speed voltage
Output voltages	−10 to 10 VDC
Output current	10 mA (approx. 1-kΩ impedance)

Performance Specifications

Item		Specification
Control method		Semi-closed loop with incremental encoder
Number of control axes		Two
Number of points used for I/O		32 points (2 words)
Peripheral devices		Teaching Box
Positioning actions	Settings	(1) From the Teaching Box (2) From the PC with sequence programs
	Position types	Incremental or absolute
	Maximum input	±99,999,999 pulses, with conversion to millimeters and inches on the Teaching Box.
	Data capacity	300 positions per axis
	Interpolation settings	Straight-line interpolation(end point) Circular arc interpolation (arc center and end point, or arc intermediate and end points)
Speeds	Capacity	100 for both axes
	Range	1 to 300,000 pps (in 1 pps increments)
Parameters	Acceleration/Deceleration method	Automatic trapezoidal acceleration/deceleration curve
	Acceleration/Deceleration pattern	10 separate acceleration/deceleration times per axis.
	Acceleration/Deceleration times	10 to 4,999 ms (with 10-ms increments)
	Backlash compensation	0 to 9,999 pulses
	Home shift	To modify positioning actions: 0 to ±999,999 pulses.
	Gain control	1 to 9.990 μV/pulse
	Zone settings	Settings possible for any of eight points per axis.
Functions	Origin search	Settings for search directions, high and low search speeds, and origin compensation (±999,999 pulses)
	Synchronous startup	Either axis can be preset to start operation when the other axis reaches a specified point during operation.
	Jogging	Jogging or inching can be executed by means of instructions from the PC or the Teaching Box.

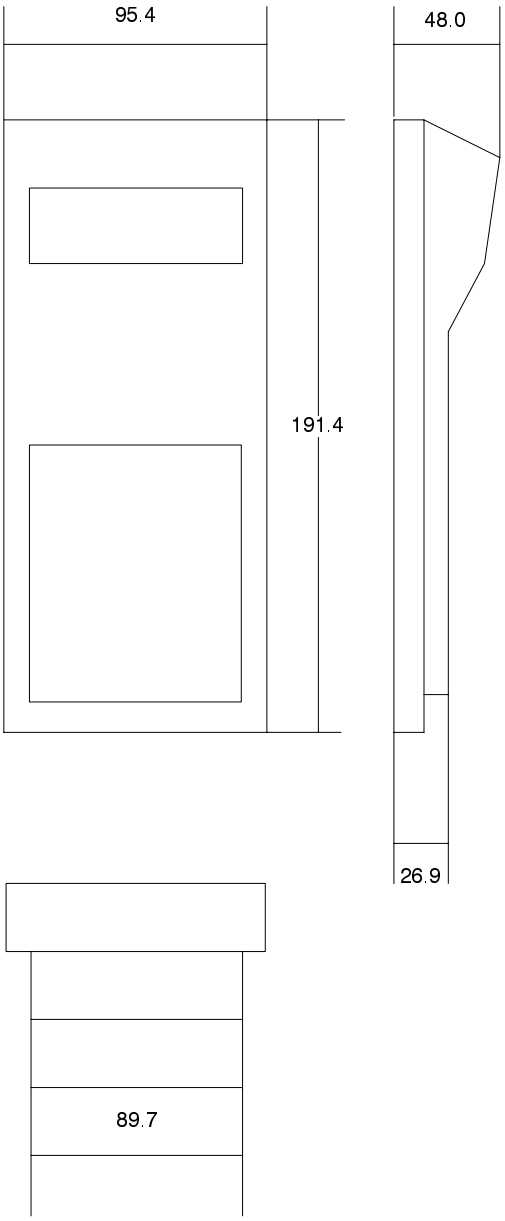
Item		Specification
Functions	Teaching	The present position can be registered as position data by means of an instruction from the PC or the Teaching Box.
	Servo-lock/servo-free	It is possible to switch between servo-lock and servo-free from either the PC or the Teaching Box.
	M functions	M code outputs: 01-99 (99 types)
	Dwell timer	Ten types can be set, within a range of 0 ms to 9990 ms (in 10-ms increments).
	Present position display	The present position can be displayed at either the PC or the Teaching Box.
	Error count display	The contents of the error counter can be output to the Teaching Box, or output as status to the PC. The error counter can be reset and the capacity can be set.
	Override	0.1% to 999.9%, in increments of 0.1%
	External interrupt (deceleration stop)	Positioning can be stopped, at a specified deceleration time, either from the PC or externally.
	External servo-free input	Stopping is possible due to the natural discharge of the error counter, by means of the Teaching Box.
	Data storage	Data is stored by means of EEPROM and is read automatically at the time of powering up.
Error checking functions	Error code output	Error codes indicating the causes of errors are output to the PC and the Teaching Box.
	Error counter overflow output	External output of error counter overflow can be be set to ON or OFF.
	Protect functions	PC protect, external input protect, and Teaching Box protect can all be set.
	Command trace	Commands and external inputs can all be traced through the past 128 steps, and displayed at the Teaching Box.
	Disconnected wiring check	Checks, when the wiring check command is executed, whether the position table is created.
	Faulty wiring check	When the wiring check command is executed, transmits a small number of pulses and checks for faulty wiring.

Appendix B
Teaching Box Specifications

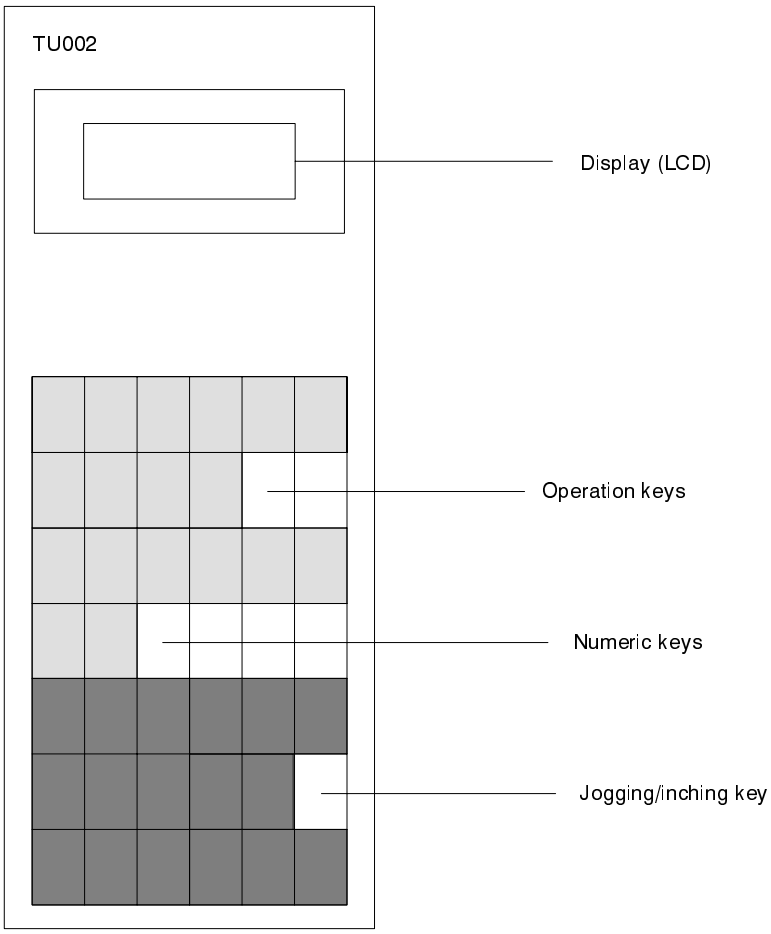
Item		Specifications
Power supply voltage		5 VDC (from Position Control Unit)
Voltage fluctuation tolerance		4.75 to 5.25 VDC
Internal current consumption		300 mA or less for 5 VDC
Noise resistance		Power supply: 5 VDC (a) Normal mode: 12E (b) Common mode: 12E (E: Power supply voltage) Pulse width: 1 μs Rise time: 1 ns Cable winding: 1 kv
Vibration resistance	Mechanical durability	25 Hz for 2 hrs each in X, Y, and Z directions with 2-mm double amplitude
	Malfunction durability	55 Hz for 10 minutes each in X, Y, and Z directions with 0.4-mm double amplitude
Shock resistance		10 G; three times each in X, Y, and Z directions.
Ambient operating temperature		0 to 45 °C
Ambient operating humidity		35% to 85% (no condensation)
Ambient operating atmosphere		No corrosive gases
Ambient storage temperature		–20 to 65 °C
Cable	NC221-E; NC222-E	C200H-CN222 (2 m); C200H-CN422 (4 m); C500-CN132 (10 m)
	NC103-E; NC111-V1	C500-CN422 (4 m)
Weight		400 grams or less
Dimensions		192 (H) x 96 (W) x 48.4 (D) mm

Note Use the internal DIP switch to select the type of model.

External Dimensions (Unit: mm)

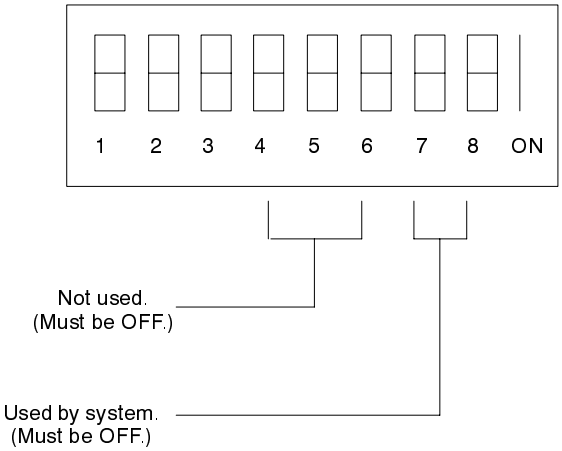


Nomenclature and Functions



Internal DIP Switch Settings

Use these DIP switch settings to select the Position Control Unit. If more than one of these pins are set to ON, then the smallest numbered pin will be given priority. Use the same setting (pin no. 1) for the NC222-E as for the NC221-E.



Pin no.	Setting
1	ON for connecting to NC221-E and NC222-E.
2	ON for connecting to NC111-EV1.
3	ON for connecting to NC103-E.

Performance Specifications

Item	Specifications	
Applicable models	C500-NC221-E; C500-NC222-E; C500-NC103-E; C500-NC111-EV1	
Display	Liquid crystal display (16 characters x 2 rows)	
Command functions	Immediate stop	Key in emergency stop to stop positioning immediately.
	Deceleration stop	Key in deceleration stop to stop positioning gradually.
	Error reset	Key in error reset to clear error status.
	PV change	The present value can be changed to any value.
	Start	Starts with specified positioning actions.
	Origin search	Determines the origin.
	Jogging	Jogging can be executed by means of the arrow keys.
	Writing data	Positioning, parameter, and speed data can be written.
	Inserting, deleting data	Positioning actions can be inserted or deleted.
	Clearing data	Positioning, parameter, and speed data can be cleared.
	Teaching	Positioning actions can be taught.
Monitoring functions	The present value, M code, dwell time, origin input, Z phase, CW limit input, CCW limit input, override status, error counter contents, positioning action address, direction, and speed data address can all be monitored.	
Data storage	Reading data from, and writing data to EEPROM are possible by means of key input.	
Debugging operations	Error code output	The error code showing the cause of an error can be displayed.
	Command trace	Commands received can be traced for up to 128 steps.
	PC protect	Commands from the PC can be temporarily prohibited.
	External input protect	The NC222 can be operated with no external inputs provided.
	Z-phase position check	After origin search has been completed, the space between the Z phase and the origin sensor is diplayed.
Safety features	Teaching Box protect	The Teaching Box can be set so that a password must be keyed in before operation.
	Startup	Positioning continues while the key is held down, and stops when it is released.
	Positioning speed	It is possible to preset a positioning speed coefficient and start conduct positioning at a speed lower than the actual set speed.

Appendix C
Error Code List

Hardware Errors

Error Code	Error Type		Time checked	Cause of abnormalities and status	Correction
00	Hardware error	RAM error	At power up.	Hardware-related abnormality in RAM.	If the problem is noise-related, then correct the wiring and consider applying noise countermeasures such as installation of a surge killer. If the problem is not noise-related, then it cannot be corrected by the user. Please replace any defective components.
		Common RAM error		Hardware-related abnormality in shared RAM.	
		Gate array error		Hardware-related abnormality in gate array.	
		COMB error		Abnormality in peripheral LSIs (PIAs, timer ICs).	
01		Bus error	When the bus is accessed.	Hardware-related abnormality in bus.	
02		EEPROM verification error	When STORE is executed.	Hardware-related abnormality in EEPROM.	
03		Watchdog timer error	Always checked.	Normal software execution is prevented by noise or other external causes.	

System Errors

Error Code	Error Type		Time checked	Cause of abnormalities and status	Correction
10	X axis	Over-travelling error	Always checked.	The CW or CCW limit input turned ON when the operation was not an origin search.	Perform a JOG operation to move the workpiece away from the CW or CCW limit switch, and then enter ERST (error reset). This erases the stored origin, so the origin must then be re-established.
11	Y axis				

Error Code	Error Type		Time checked	Cause of abnormalities and status	Correction
12	X axis	Error counter overflow	Always checked.	The count of the error counter exceeded the maximum value.	Check for any obstructions to workpiece positioning that may be causing the count of the error counter to increase abnormally. Adjust the servomotor driver and improve motor follow-up, so that the count of the error counter does not increase. Lengthen the acceleration time or lower the speed. Execute ERST.
13	Y axis				

Wiring Errors

Error Code	Error Type		Time checked	Cause of abnormalities and status	Correction
20	X axis	Reversed wiring error	When the command is transferred.	The wiring is connected in reverse.	Change the A and B phases at the power supply. Switch the A and B phases by means of the encoder A/B phase switch data.
21	Y axis				
22	X axis	Disconnected wiring error		The wiring is disconnected or broken.	Repair the place where the position loop is broken. Then turn on the power again.
23	Y axis				

Command and Data Errors

Error Code	Error Type		Time checked	Cause of abnormalities and status	Correction
30	OP code errors	Undefined error	When commands are transferred.	An undefined OP code was sent as a command.	Correct the OP code and re-transmit the command.
31		Operand count error		Operands differing from the number defined are attached to the commands.	
32		Transmission timing error (1)	When commands are executed.	A command valid when positioning is stopped was transferred for an axis while that axis was in operation.	Consider the PC program timing, and correct the command transfer timing.
33		Transmission timing error (2)	When commands are executed.	A synchronous start command and a normal start command were transferred together.	
34		Transmission timing error (3)	When commands are executed.	A servo control command was transferred while servo-free was in effect.	

Error Code	Error Type		Time checked	Cause of abnormalities and status	Correction
35	OP code errors	Transmission error during interpolation	When interpolation commands are executed.	A command for a single axis was received during interpolation.	Consider the PC program timing, and correct command transfer during interpolation.
36		Transmission error during single-axis operation	When single-axis commands are executed.	An interpolation control command was received during single-axis operation.	
40	Operand errors	Undefined error	When commands are transferred.	An undefined operand was received.	Correct the operand and re-transmit the command.
41		Format error		The operand format is incorrect.	
50	Data errors	Interpolation data error (1)	When ISRT is transferred.	Data designated by ISRT is not interpolation data.	Correct the data and re-transmit the data.
51		Interpolation data error (2)		Among interpolation data, data for one axis is disabled.	
52		Circular arc data error (1)		The center or intermediate point is the same as the end point; arc cannot be produced.	
53		Circular arc data error (2)		No interpolation end point data following the center or intermediate point data.	
54		Data address error	When data is transferred (WRIT (87)).	Data addressed beyond the defined range was transferred.	Correct the data and re-transmit the data.
55		Data length error		The data length did not fit the defined range.	
56		Data setting timing error		Data transfer occurred during axis operation.	Data cannot be transferred during operation. Transfer data while the axes are stopped.
57		Undefined error		Data beyond the defined range was transferred.	Correct the data and re-transmit the data.
58		Format error		The data format did not fit the defined range.	
59		Stroke limit error	When XSRT, YSRT, or ISRT is transferred.	The position field of the positioning action exceeded the stroke limit (+) or (–) parameter.	Check the position you wish to execute or check the stroke limit parameters.
60		Speed 0 error	When SRT, ORG, or JOG is transferred.	The speed called in the positioning action was 0.	Check the speeds or speed fields of the positioning action.
61		Set origin incomplete error	When SRT is transferred.	SRT was transferred before the origin was established.	Establish the origin.

Communication Errors

Error Code	Error Type	Time checked	Cause of abnormalities and status	Correction
70	Parity error	Constant	Parity check uncovered an abnormality.	Clear the error with ERST, and follow the steps below. If the error does not clear, there may be a hardware problem which is not user serviceable. (1) Check cable connections.
71	Framing error		Data format broke down during transfer.	(2)Exchange the External Display with the Teaching Box or vice-versa to check peripheral equipment. (3) Replace the cables of the peripheral equipment (C200H-CN222 or C200H-CN422).
72	Overrun error		Handshake abnormality	(4) Replace the PCU.
80	Transfer word count overflow (data error)	When data is transferred.	The number of words transferred with WRIT (87) exceeded 127.	Change the PC program so the number of words transferred remains within 127.

Program Errors

Error Code	Error Type	Time checked	Cause of abnormalities and status	Correction
80	Transfer word count overflow (data error)	When data is transferred.	The number of words transferred with WRIT (87) exceeded 127.	Change the PC program so the number of words transferred remains within 127.

Appendix D
Data Memory Coding Sheets

DM Wd	15↔00				Function	DM Wd	15↔00				Function	DM Wd	15↔00				Function
		0	0	1	Unit: 0 to 2			1	6	1	Origin search accel./decel. speed: 0 to 9			6	1	2	Acceleration/ deceleration time #1
	0	0	0				0	0	0				0				
		0	1	2	Pulse rate: 1.0 to 0.001			1	7	2	Low origin search speed 1 to 10,000		0				
	0	0					0	0	0					6	2	2	Acceleration/ deceleration time #2
													0				
		0	2	1	Rotation direction: 0.1			1	8	2	Deceleration stop (pulses) 1 to 10,000 0 to 9; 0 to 9		0				
	0	0	0				0							6	3	2	Acceleration/ deceleration time #3
		0	3	1	Encoder type: 0–1, 0–1, 1, 2,4								0				
	0							1	9	2	Discon. wiring chk. enable: 0.1 Time: 00 to 99 Puls: 000–999		0				
		0	4	1	Gain: 1 to 999									6	4	2	Acceleration/ deceleration time #4
	0								0	0			0				
		0	5	1	In-position zone:1 to 999			2	0	2	Error count capacity: 0 to 32,768 p Ext. output: 0–1		0				
	0								0					6	5	2	Acceleration/ deceleration time #5
		0	6	1	Backlash compensation: 0 to 9,999								0				
								5	0	1	Dwell time #0: 0 to 9990		0				
		0	7	2	Stroke limit (+): 0 to 99,999,999									6	6	2	Acceleration/ deceleration time #6
								5	1	1	Dwell time #1		0				
		0	8	2	Stroke limit (–): 0 to 99,999,999								0				
								5	2	1	Dwell time #2			6	7	2	Acceleration/ deceleration time #7
		0	9	2	Zones: 0–9,999 (decel) 0–9,999 (accel)								0				
								5	3	1	Dwell time #3		0				
														6	8	2	Acceleration/ deceleration time #8
		1	0	2	Home shift: ±999,999			5	4	1	Dwell time #4		0				
													0				
								5	5	1	Dwell time #5			6	9	2	Acceleration/ deceleration time #9
		1	1	2	Maximum speed: 1 to 300,000								0				
		0						5	6	1	Dwell time #6		0				
														7	0	4	Synchronous positioning action #0
		1	2	2	Teaching Box speed: 1 to 300,000 0 to 9; 1 to 9			5	7	1	Dwell time #7						
								5	8	1	Dwell time #8						
		1	3	1	Origin search direction: 0.1												
	0	0	0					5	9	1	Dwell time #9			7	1	4	Synchronous positioning action #1
		1	4	2	Origin compensation: 0 to ±999,999												
		0						6	0	2	Acceleration/ deceleration time (pattern) #0: 1 to 499						
							0										
		1	5	2	High origin search speed 1 to 300,000		0										
		0									---						---
											---						---
		7	2	4	Synchronous positioning action #2												Positioning action #2
								8	1	5	Zone setting #1						

DM Wd	15↔00	Function	DM Wd	15↔00	Function	DM Wd	15↔00	Function
	7 3 4	Synchronous positioning action #3						Positioning action #3
				8 2 5	Zone setting #2			
	7 4 4	Synchronous positioning action #4						Positioning action #4
				8 3 5	Zone setting #3			
	7 5 4	Synchronous positioning action #5						Positioning action #5
				8 4 5	Zone setting #4			
	7 6 4	Synchronous positioning action #6						Positioning action #6
				8 5 5	Zone setting #5			
	7 7 4	Synchronous positioning action #7						Positioning action #7
				8 6 5	Zone setting #6			
	7 8 4	Synchronous positioning action #8						Positioning action #8
				8 7 5	Zone setting #7			
	7 9 4	Synchronous positioning action #9						Positioning action #9
					Positioning action #1			
	8 0 5	Zone setting #0						Positioning action #10

					Positioning action #19			
		Positioning action #11						Positioning action #28
					Positioning action #20			
		Positioning action #12						Positioning action #29
					Positioning			

DM Wd	15↔00	Function	DM Wd	15↔00	Function	DM Wd	15↔00	Function
					action #21			
		Positioning action #13						Positioning action #30
					Positioning action #22			
		Positioning action #14					2	Speed #0 (1 to 300,000)
							0 0	
					Positioning action #23		2	Speed #1
							0 0	
		Positioning action #15					2	Speed #2
							0 0	
					Positioning action #24		2	Speed #3
		Positioning action #16					0 0	
							2	Speed #4
					Positioning action #25		0 0	
		Positioning action #17					2	Speed #5
							0 0	
					Positioning action #26		2	Speed #6
							0 0	
		Positioning action #18					2	Speed #7
							0 0	
					Positioning action #27		2	Speed #8
		---					0 0	
					---			---
	2	Speed #9		2	Speed #23		2	Speed #37
	0 0			0 0			0 0	
	2	Speed #10		2	Speed #24		2	Speed #38
	0 0			0 0			0 0	
	2	Speed #11		2	Speed #25		2	Speed #39
	0 0			0 0			0 0	
	2	Speed #12		2	Speed #26		2	Speed #40
	0 0			0 0			0 0	
	2	Speed #13		2	Speed #27		2	Speed #41
	0 0			0 0			0 0	
	2	Speed #14		2	Speed #28		2	Speed #42

DM Wd	15↔00				Function	DM Wd	15↔00				Function	DM Wd	15↔00				Function
	0	0					0	0					0	0			
				2	Speed #15					2	Speed #29					2	Speed #43
	0	0					0	0					0	0			
				2	Speed #16					2	Speed #30					2	Speed #44
	0	0					0	0					0	0			
				2	Speed #17					2	Speed #31					2	Speed #45
	0	0					0	0					0	0			
				2	Speed #18					2	Speed #32					2	Speed #46
	0	0					0	0					0	0			
				2	Speed #19					2	Speed #33					2	Speed #47
	0	0					0	0					0	0			
				2	Speed #20					2	Speed #34					2	Speed #48
	0	0					0	0					0	0			
				2	Speed #21					2	Speed #35					2	Speed #49
	0	0					0	0					0	0			
				2	Speed #22					2	Speed #36					2	Speed #50
	0	0					0	0					0	0			

Glossary

absolute position	A position given in respect to the origin rather than in respect to the present position.
attribute	One of several types of data that define positioning actions. Attributes include settings such as interpolation code, interpolation point, and completion code.
backlash compensation	Compensation for the amount of mechanical play, or "looseness," present in gears. Such play can create positioning inaccuracy when the direction of positioning changes.
BCD	An acronym for binary-coded decimal. This is used to code decimal numbers in binary.
circular arc center	An interpolation point which can be defined, along with the interpolation end point, to enable circular arc interpolation. Taking these points as known values, the Position Control Unit can position in a circular arc pattern.
circular arc intermediate point	An interpolation point which can be defined, along with the interpolation end point, to enable circular arc interpolation. Taking these points as known values, the Position Control Unit can position in a circular arc pattern.
circular arc interpolation	Dual-axis positioning in a circular pattern from the present position to a point designated as the interpolation end point. In addition to the interpolation end point, it is necessary to designate either a circular arc center or a circular arc intermediate point.
completion code	A positioning action attribute that determines, upon completion of a given positioning action, whether positioning stops or whether the next positioning action is executed immediately, without a break.
continuous (completion)	The completion code that causes the next positioning action to be executed immediately upon completion of the current one.
CW and CCW	Abbreviations for clockwise (CW) and counterclockwise (CCW). CW and CCW are defined for a motor shaft in reference to a viewer facing the shaft on the end of the motor from which the shaft extends from the motor for connection.
CW/CCW limits	Limits on the CW and CCW sides of the origin which can be internally set to restrict rotation of the shaft.
data area	A memory storage area in the PC. Different types of memory blocks, with differing functions, are stored in the various data areas of the PC. These blocks of memory are built up from single units, or bits, which are grouped into 16-bit words. Commands used to control the Position Control Unit are transferred from a data area in the PC.
distributed control	An automation concept in which each portion of an automated system is located near the devices actually being controlled. In other words, control is decentralized and "distributed" over the system. Distributed control is a concept basic to PC systems.
DM area	A PC data area in which general operating parameters, speeds, and positions for positioning actions are stored.
dwell time	A setting that specifies the period of time during which positioning will stop before execution of the next positioning action.
error code	A four-digit code which is output to the PC and the External Display to identify the type of error which has occurred.
error counter	A device used to ensure positioning accuracy when positioning via pulse trains. The error counter receives a target position as a specific number of pulses in a pulse train from the Position Control Unit and outputs analog speed voltages to drive a servomotor accordingly. The specified number of pulses in the error counter is counted down by feedback from an encoder measuring actual motor shaft movement, causing voltage output to stop when the number of pulses equals zero, i.e., when the target position has been reached.
external interrupt	A function whereby positioning may be stopped or speed may be changed, during operation, in response to an external signal.
feedback	The return of a portion of the output of a circuit or device to its input. It is used in servocontrol systems to help bring actual values closer to target values.

flag A bit that is turned ON and OFF automatically by the system to provide status information.

gain The increase in signal power produced by an amplifier.

hunting The tendency, in servosystems, to overcompensate when the system's momentum carries it past the target position.

inching Manual feeding wherein positioning is executed one pulse at a time.

incremental position A position given in respect to the present position, rather than in respect to the origin.

initial position The present position when a start command is executed.

interpolation The mathematical calculation of missing values between known values. The Position Control Unit uses interpolation when positioning along both axes simultaneously. There are two types of interpolation possible: straight-line and circular arc.

interpolation code A setting which determines whether or not a positioning action uses interpolation, and, if so, defines the type of interpolation.

interpolation end point The point which is defined as the final point for interpolated positioning. The three types of interpolation points are: interpolation end point, circular arc intermediate point, and circular arc center.

M code An abbreviation for machine code. The user can set various M codes for various positions so that each M code will be output when the workpiece passes its respective position.

NC contacts Normally-closed contacts. A pair of contacts on a relay that open when the relay is energized.

NO contacts Normally-open contacts. A pair of contacts on a relay that close when the relay is energized.

op code An abbreviation for operation code. This code is used to designate the DM area address for each command.

open-loop system A control system in which operations are carried out according to programmed instructions, but in which feedback is not provided for automatic adjustments.

origin The point which is designated as 0 at any given time.

origin compensation A parameter used to correct the origin from the position determined according to the origin input signal.

origin proximity signal A signal input to indicate when the position is near the origin to enable shifting to a lower speed.

origin proximity The region near the origin. When positioning enters this region, a proximity switch may output a signal for deceleration.

output code User-defined codes output following completion of a positioning action.

parameters Data which determines limits and other conditions under which an operation will be carried out.

positioning action The fundamental unit of positioning. A particular positioning action moves the workpiece along one or both axes in a direction, at a speed, and to a position determined by the data which has been set as part of the positioning action.

present position The numeric value in pulses defined as being the "location" of the positioning system at any one point in time. The present position position is not absolute, but rather can be redefined as required by positioning operations.

pulses Discrete signals sent at a certain rate. The Position Control Unit outputs pulses, each of which designates a certain amount of movement. Such pulses are converted to an equivalent control voltage in actual positioning.

pulse rate The distance moved the motor shaft divided by the number of pulses required for that movement.

pulse train A series of pulses output together.

semiclosed-loop system A control system in which a PC controls an external process without human intervention. This system provides feedback (via a tachogenerator and a rotary encoder) so that actual values (of positions, speeds, and so on) are continuously adjusted to bring them more closely in line with target values.

servolock An operation whereby a rotary encoder is used to maintain the position of a motor while it is stopped. Whenever the motor axis moves, the rotary encoder sends a feedback pulse to an error counter, causing a rotation voltage to be generated in the reverse direction so that the motor rotates back to its original position.

Special I/O Unit A dedicated Unit, such as a Position Control Unit, High-Speed Counter Unit, or Analog Timer Unit, which is used for a special purpose.

straight-line interpolation Dual-axis, linear positioning from the present position to a point designated as the interpolation end point.

target position A parameter for a positioning action that designates what position is to be reached at the completion of the action.

teaching Writing the present position into memory, via the Teaching Box, as the target position for the designated positioning action.

terminating (completion) A completion code that causes positioning to stop upon completion of the current positioning action.

trapezoidal acceleration/deceleration Accelerating and decelerating in a stepwise pattern such that a trapezoidal figure is formed.

zone A range of positions or values which can be defined so that flags are turned ON whenever the present position is within the range.

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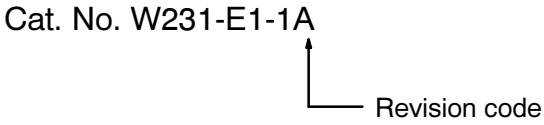
Revision History

A manual revision code appears as a suffix to the catalog number on the front cover of the manual.



The following table outlines the changes made to the manual during each revision. Page numbers refer to the previous version.

Revision code	Date	Revised content
1	January 1994	Original production
1A	January 1995	**Page 59:** Output 1 setting in the diagram for External Output Control corrected. **Page 78:** Settings for addresses 470 to 479 corrected. **Page 81:** Settings for address 870 to 879 corrected. **Pages 175, 176:** The bit data from u + 48 to u + 123 was shifted down by one row to u + 49 to u 124. Bit data for u + 48 was then added. **Page 212:** Data in both tables corrected.