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Cat. No. W86-E1-1A

OMRON USER'S MANUAL

Position Control Unit

(for SYSMAC-C series)

Type

3G2A5-NC103-E

OMRON Corporation

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APPENDIX A-1

Chapter 1 Features

The position control unit is a special I/O unit for the SYSMAC-C500 and -C2000. The position control unit functions in response to positioning commands sent from the PC to issue either pulse strings or voltage output to control drivers for either stepping motors or servomotors.

Applicable motors

Because the position control unit can output either pulse strings or voltages, it can be easily connected to the driver for either a stepping motor or any type of servomotor. Moreover, it can be connected to 5 V and 12 V motor drivers. This selection is made by an internal DIP switch. Therefore, the unit can be connected to almost all commercially available drivers.

Stop functions

The position control unit is provided with various stop functions such as "emergency stop", "immediate stop", "pause", and "interrupt" functions so that the operation of the unit can be stopped at any time required.

Number of controlled axes and controlled parameters

The position control unit performs single-axis control of such parameters as pulse rate, speed, acceleration/deceleration, dwell time, etc., according to specified set values.

Compensation function

The position control unit is provided with backlash and origin correction functions to perform precision positioning.

Diagnostic function

In case an error occurs in the position control unit, it sends an error code identifying its nature to the PC to facilitate smooth and speedy troubleshooting.

Feedback pulse multiplication function

The feedback pulse number can be multiplied by two or four if so specified by the built-in DIP switch.

Data backup

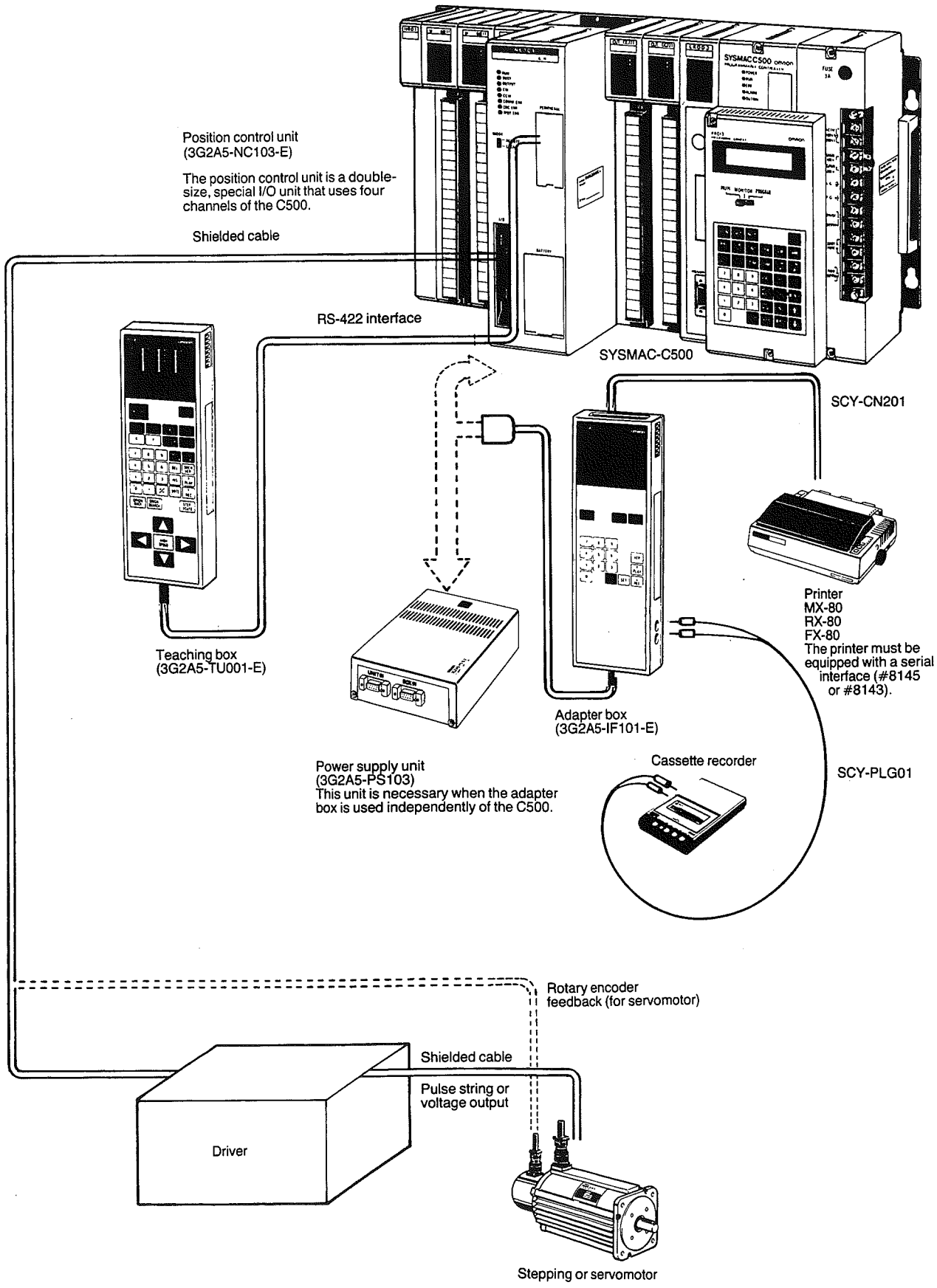
The set data (such as parameter data, speed data, and position data) are registered backed up by a battery. Therefore, they are retained even during a power failure.

Teaching box connection

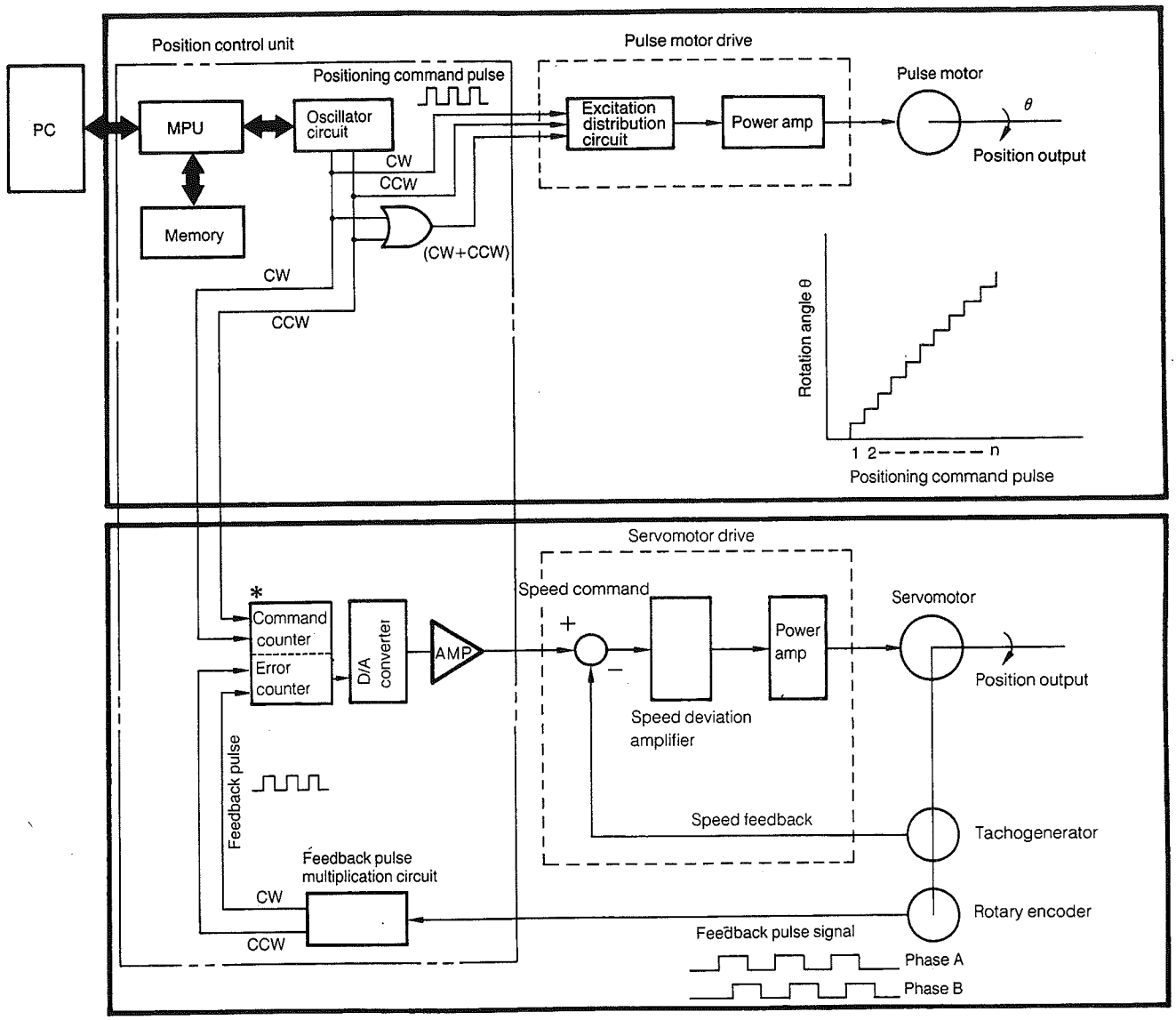
By connecting the teaching box, operations such as read/write of position data, manual operation, teaching, etc., can be performed independently of the PC.

Data save and reference

By connecting the position control unit to the adapter box, operations such as saving data to a cassette tape, outputting hard copies from a printer, etc., can be performed.


Position control unit
(3G2A5-NC103-E)
The position control unit is a double-size, special I/O unit that uses four channels of the C500.
Shielded cable
RS-422 interface
SYSMAC-C500
SCY-CN201
Printer
MX-80
RX-80
FX-80
The printer must be equipped with a serial interface (#8145 or #8143).
Teaching box
(3G2A5-TU001-E)
Adapter box
(3G2A5-IF101-E)
Power supply unit
(3G2A5-PS103)
This unit is necessary when the adapter box is used independently of the C500.
Cassette recorder
SCY-PLG01
Rotary encoder
feedback (for servomotor)
Shielded cable
Pulse string or
voltage output
Driver
Stepping or servomotor

2.1 Control system configuration



* The command counter constantly stores the positioning command value; by reading this counter, the logical present value can be obtained.
The error counter is the deviation counter for the servo system. The volume of the movement is first set in this counter and then the feedback count is subtracted to perform the positioning action.

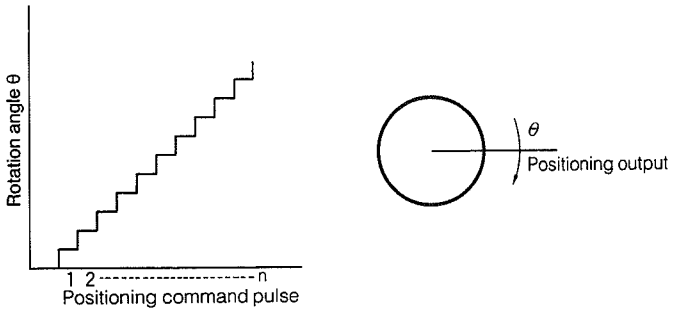
This diagram shows control system envisaged for the position control unit. Thus,

- the pulse motor is controlled by an open loop system.
- the servomotor is controlled by a semiclosed loop system.

2.2 Principles of control system

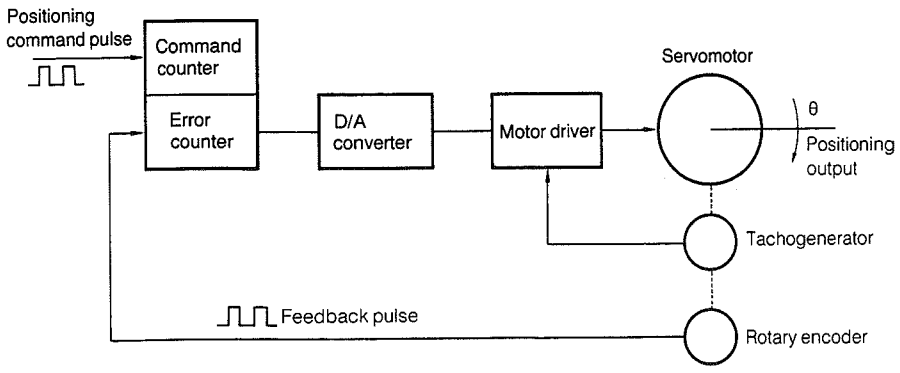
OPEN LOOP SYSTEM

In the open loop control system, the position control unit outputs pulse strings as specified by the programmed data to control the rotation angle of a motor (usually, a pulse motor). This differs from the semi-closed system described below in that there is no feedback signal. The pulse motor rotates a fixed angle for each pulse signal supplied to the motor driver. Thus the number of rotations of the motor is proportional to the number of pulses supplied from the position control unit and the rotation speed of the motor is proportional to the frequency of the pulse train.



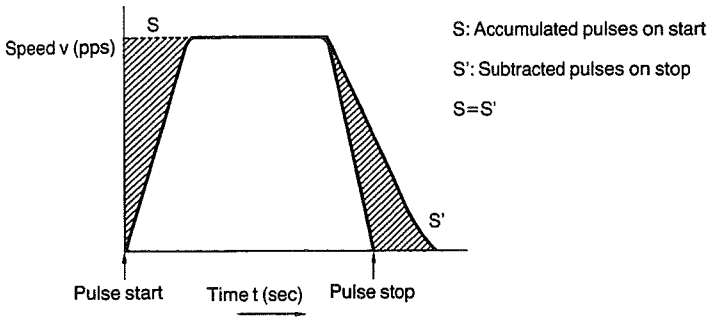
SEMI-CLOSED LOOP SYSTEM

Most of the servomechanisms used in industrial-application positioners use the semi-closed loop system. In this method, the movement of the mechanism in relation to the command value is detected as the rotation of the motor, and this value is fed back to compute the deviation between the command and the actual movement. Adjustment is then performed to eliminate the detected error.



The following is a description of the internal operation of the position control unit in a semi-closed loop system.

First a command (including a direction parameter) pulse string is supplied, after passing through the command counter, to the error counter. In the error counter the pulses are integrated, using the direction parameter to indicate addition or subtraction. The pulses accumulated in this way are then converted to an analog voltage by a D/A converter and then output to the motor driver as a speed command voltage. At the same time, the rotary encoder connected to the motor shaft generates a feedback pulse proportional to the rotation angle of the motor. This feedback pulse is returned to the error counter where it is subtracted from the current value of the error counter.



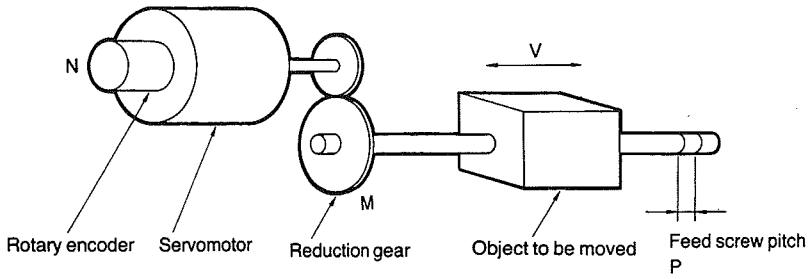
As the command pulses are continuously input to the error counter, the error counter retains a fixed amount of pulses and continues to drive the motor.

When the supply of command pulses stops, the accumulated value in the error counter is decremented and the rotation of the motor continues until the value of the error counter reaches zero. When the motor has stopped moving, the delayed feedback pulse in the feedback loop causes the motor shaft to move back and forth within a range of ±1 pulse. This condition is known as servolock and maintains the position of the shaft.

This method is similar to the open loop method in that the rotation speed of the motor is proportional to the frequency of the command pulse string and the number of rotations is proportional to the number of command pulses.

2.3 Simplified positioning system design

The following diagram shows a simplified positioning system and the parameters required to calculate the positioning accuracy.



● Positioning accuracy formula

$$\text{Positioning accuracy} = \frac{\text{Feed screw pitch}}{\text{Number of encoder pulses} \times \text{Reduction ratio}}$$

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

where,

N: Rotary encoder pulses (pulses/revolution)
M: Reduction ratio
V: Feed velocity of object to be moved (mm/s)
P: Feed screw pitch (mm/revolution)

This value is referred to as the pulse rate of the position control unit.

The number of encoder pulses required to maintain the proper balance of the positioning accuracy and feedback is obtained by the following formula:

$$\text{Number of pulses} = \frac{\text{Feed velocity}}{\text{Positioning accuracy}}$$

$$= \frac{\text{V (mm/s)}}{\text{Positioning accuracy (mm/pulse)}}$$

$$= \frac{\text{V} \times \text{N} \times \text{M}}{\text{P}} \text{ (pulse/s)}$$

Note: The system configuration should maintain the required number of pulses at 100K pps or less, as this is the maximum number of feedback pulses that can be accepted by the position control unit from the rotary encoder.

Chapter 3 Specifications and internal configuration



3.1 Ratings

The ratings of the position control unit conform to the ratings of the other products of the SYSMAC C-series.

3.2 Characteristics

Control function	No. of axes	Single-axis control
Positioning command	Input command units	0.0001 to 1 mm/pulse, inch/pulse, degree/pulse, degree/s, or pulse/pulse
	Max. command value	±999999 x unit
	Data capacity	200 points
Speed command	Speed command	Seven-step speed control for return, origin search, and manual operation; arbitrary speed setting possible; units of mm/s, inch/s, degree/s, pulse/s
	Acceleration/ deceleration	Automatic trapezoidal acceleration/ deceleration function
	Max. speed	100K pps (requires minimum encoder Zero index pulse width of 2 ms)
Origin return	Origin search	Speed settable
	Origin return	Speed settable
Compensation	Backlash	0 to 9999 x unit
	Near-zero	255 x unit
	Origin correction	±(0 to 9999) x unit
Acceleration/ deceleration	Acceleration time	0.4 to 99.99 s
Teaching function	Manual operation	Single-axis operation
	Playback	PTP data teaching
	Step execution	Stepwise (per position data) execution possible

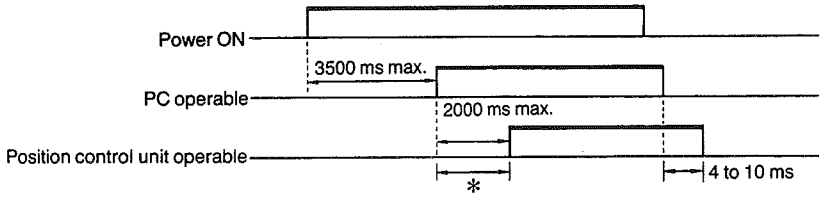
.3 Power ratings

Power for the position control unit is supplied from the power supply unit of the host PC via the base unit. The power supplies that can be used for the C500 are 3G2A5-PS221-E and 3G2A5-PS222-E.

Supply voltage	5 VDC
Operating voltage range	4.75 to 5.25 VDC
DC current consumption	900 mA max.

Power supply timing chart

The following timing chart shows the basic timing requirements for the power supply sequence.



* The user should not attempt to operate the position control unit during this interval. Although the PC is operable during this period, the position control unit is not. For this reason, even if special auxiliary relay 6115 (initial cycle ON flag), is used on power application, it is ignored.

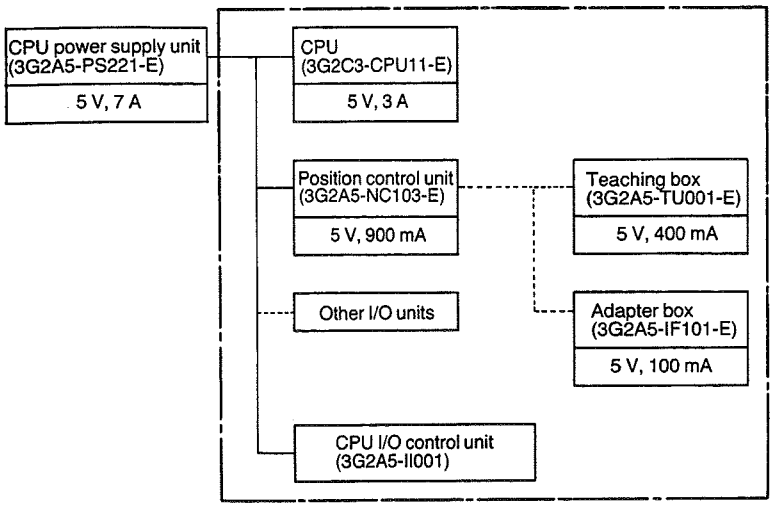
3.4 Power consumption

The power consumption of the position control unit and its peripherals is shown below.

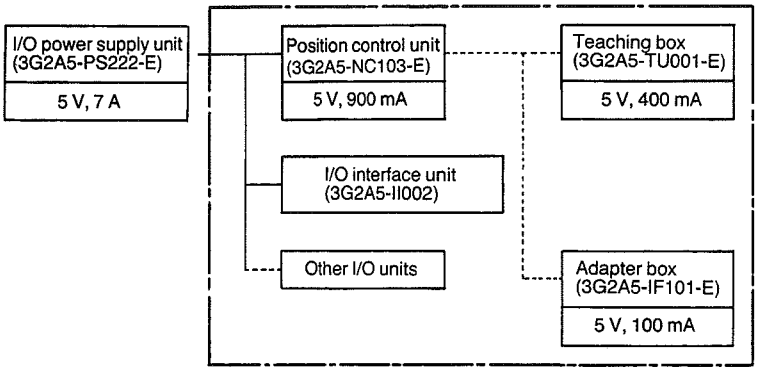
Position control unit (3G2A5-NC103-E)	5 VDC, 900 mA max.
Adapter box (3G2A5-IF101-E)	5 VDC, 100 mA max.
Teaching box (3G2A5-TU001-E)	5 VDC, 400 mA max.

The design of the control system should of course take the power consumption into consideration. Example systems and their power consumptions are shown below. Both of these systems use a 5 V, 7 A power supply and must be configured so that the total current consumption for the devices enclosed within the broken lines does not exceed 7 A.

CPU power supply

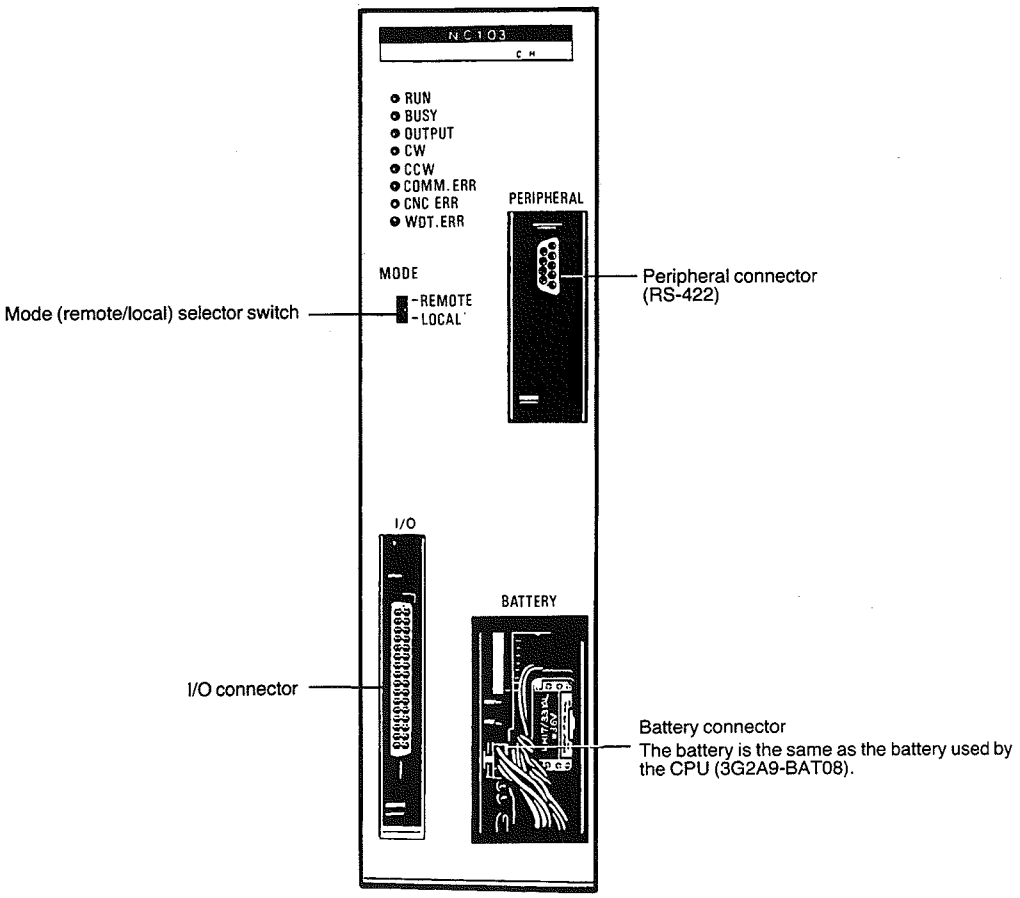


I/O power supply



3.5 Operation panel and indicators

Operation panel



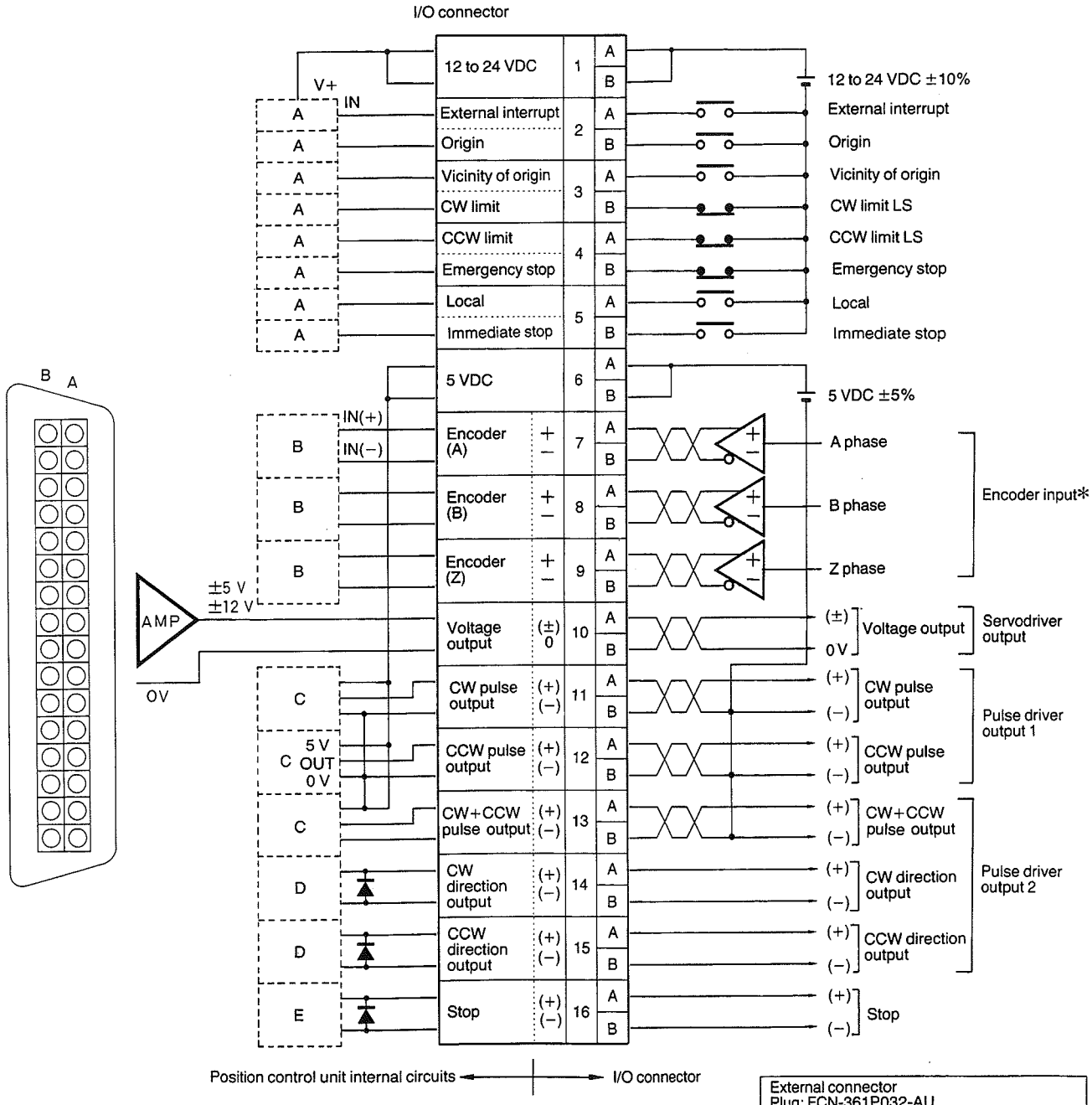
Operation panel

Mode selector switch	Performs remote/local mode setting
Peripheral connector	RS-422 connector used to connect the teaching box and the adapter box
Battery connector	Battery connector for the RAM backup battery (battery must be replaced within 5 minutes of being removed)
I/O connector	Provides the output for the motor driver, input from all external switches, encoder input, etc.

Indicators

RUN	Lights during remote mode operation; blinks when battery voltage drop is detected.
BUSY	Lights during the positioning operation; blinks at the time of emergency stop and immediate stop
OUTPUT	Lights when the control pulse string is being output
CW	Lights when positioning is being performed in the CW (clockwise) direction
CCW	Lights when positioning is being performed in the CCW (counter-clockwise) direction
COMM. ERR	Lights when a communication error occurs between the position control unit and the PC or a peripheral.
CNC ERR	Lights if the cause of the error exists in the unit during operation.
WDT ERR	Lights when there is a watchdog timer error

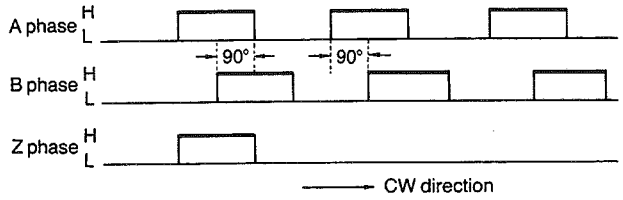
4.1 Position control unit I/O interface



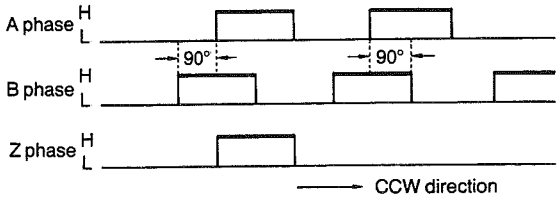
* The use of line driver type encoders is assumed for the encoder inputs.

ROTARY ENCODER CONNECTION

The signals used to connect the rotary encoder (phase A, phase B, CW, and CCW) are defined as shown below.

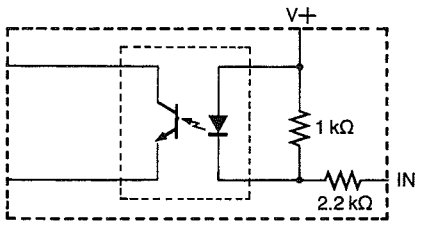


Rotation direction: CW



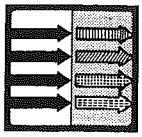
Rotation direction: CCW

Detailed description of parts marked A in interface diagram on page 4-1



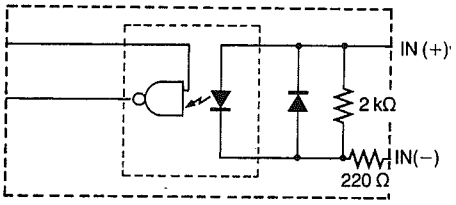
Rated input voltage (Vcc)	12 to 24 VDC
Rated input current	10 mA (at 24 VDC)
Permissible voltage range	±10%
ON-delay time (Note 1)	1 ms max.
OFF-delay time (Note 1)	1 ms max.
ON voltage	10 V min.
Number of circuits	8
Response frequency (Note 2)	10 Hz min.

Names of signals		
2	A	External interrupt
	B	Origin
3	A	Vicinity of origin
	B	CW limit LS (Note 3)
4	A	CCW limit LS (Note 3)
	B	Emergency stop (Note 3)
5	A	Local (Note 4)
	B	Immediate stop (Note 3)



Note:
1. The values for ON- and OFF-delay times are hardware values and do not indicate processing speed of the system software.
2. The response frequency indicates the frequency at which the process can be performed by the system.
3. When the CW, CCW, emergency stop, and immediate stop signals are not supplied externally, these terminals should be shorted to 0 V.
4. The Local signal has priority over the mode control switch on the position control unit.

Detailed description of parts marked B in interface diagram on page 4-1

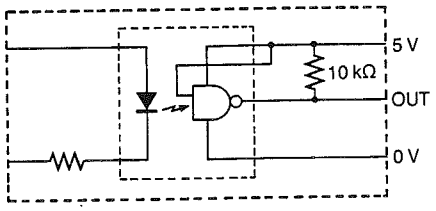


Rated input voltage (Vcc)	5 VDC
Rated input current	15 mA
Permissible voltage range	±5%
ON-delay time (Note 1)	5 μs max.
OFF-delay time (Note 1)	5 μs max.
ON voltage	2.5 V min.
Number of circuits	3
Response frequency (Note 2)	A, B phase: 100 kHz min.
	Z phase: 500 Hz min.

Names of signals		
7	A	A phase (+)
	B	A phase (–)
8	A	B phase (+)
	B	B phase (–)
9	A	Z phase (+)
	B	Z phase (–)

Note:
1. The values for ON- and OFF-delay times are hardware values and do not indicate processing speed of the system software.
2. The response frequency indicates the frequency at which the process can be performed by the system.

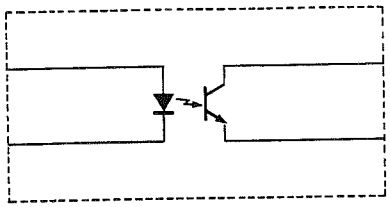
Detailed description of parts marked C in interface diagram on page 4-1



Rated output voltage	5 VDC
Rated output current	10 mA
Permissible output voltage range	±5%
Residual voltage	0.6 V max.
Leakage current	100 μA max.
ON-delay time	5 μs max.
OFF-delay time	5 μs max.
Number of circuits	3
External supply voltage	5 VDC ±5%

Names of signals		
11	A	Pulse output CW (+)
	B	Pulse output CW (–)
12	A	Pulse output CCW (+)
	B	Pulse output CCW (–)
13	A	Pulse output CW+CCW (+)
	B	Pulse output CW+CCW (–)

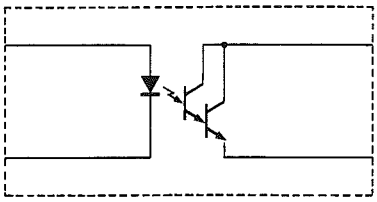
Detailed description of parts marked D in interface diagram on page 4-1



Rated output voltage	5 to 24 VDC
Rated output current	5 mA
Permissible output voltage range	±10%
Residual voltage	0.6 V max.
Leakage current	100 μA max.
ON-delay time	1 ms max.
OFF-delay time	1 ms max.
Number of circuits	2
External supply voltage	5 to 24 VDC ±10%

Names of signals		
14	A	Direction output CW (+)
	B	Direction output CW (–)
15	A	Direction output CCW (+)
	B	Direction output CCW (–)

Detailed description of parts marked E in interface diagram on page 4-1

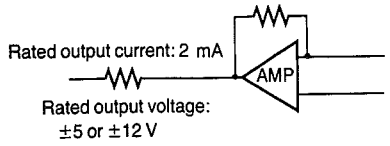


Rated output voltage	5 to 24 VDC
Rated output current	40 mA
Permissible output voltage range	±10%
Residual voltage	1.2 V max.
Leakage current	100 μA max.
ON-delay time	1 ms max.
OFF-delay time	1 ms max.
Number of circuits	1
External supply voltage	5 to 24 VDC ±10%

Names of signals		
16	A	Stop (+)*
	B	Stop (–)*

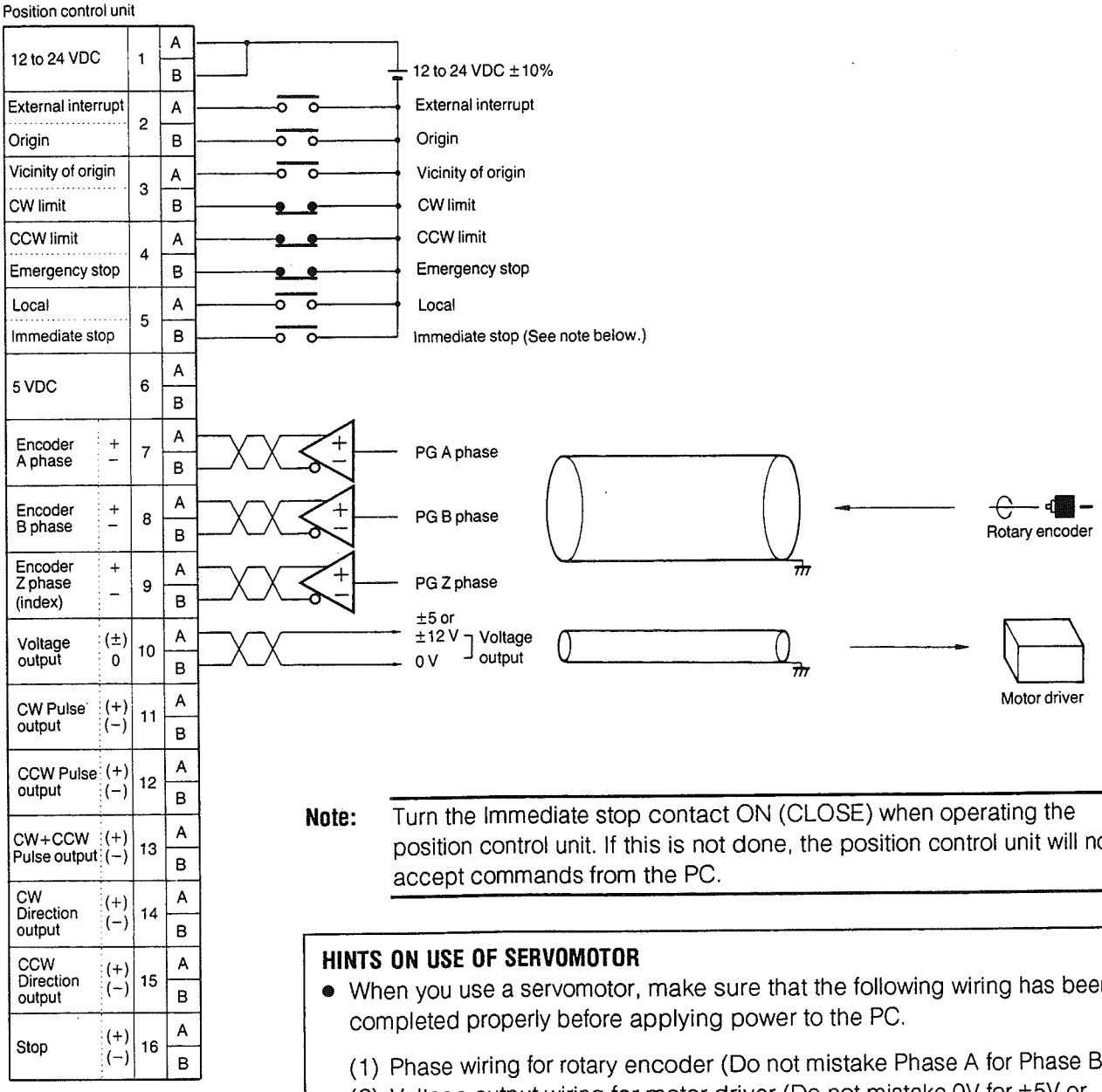
* If the user PC program turns the stop relay (bit 15 of CHn+1) ON, the stop output of the I/O interface turns ON (conducts).

Analog voltage output



4.2 Motor driver connection

Servomotor



Note: Turn the Immediate stop contact ON (CLOSE) when operating the position control unit. If this is not done, the position control unit will not accept commands from the PC.

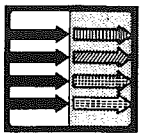
HINTS ON USE OF SERVOMOTOR

- When you use a servomotor, make sure that the following wiring has been completed properly before applying power to the PC.

  (1) Phase wiring for rotary encoder (Do not mistake Phase A for Phase B.)
  (2) Voltage output wiring for motor driver (Do not mistake 0V for ±5V or ±12V.)

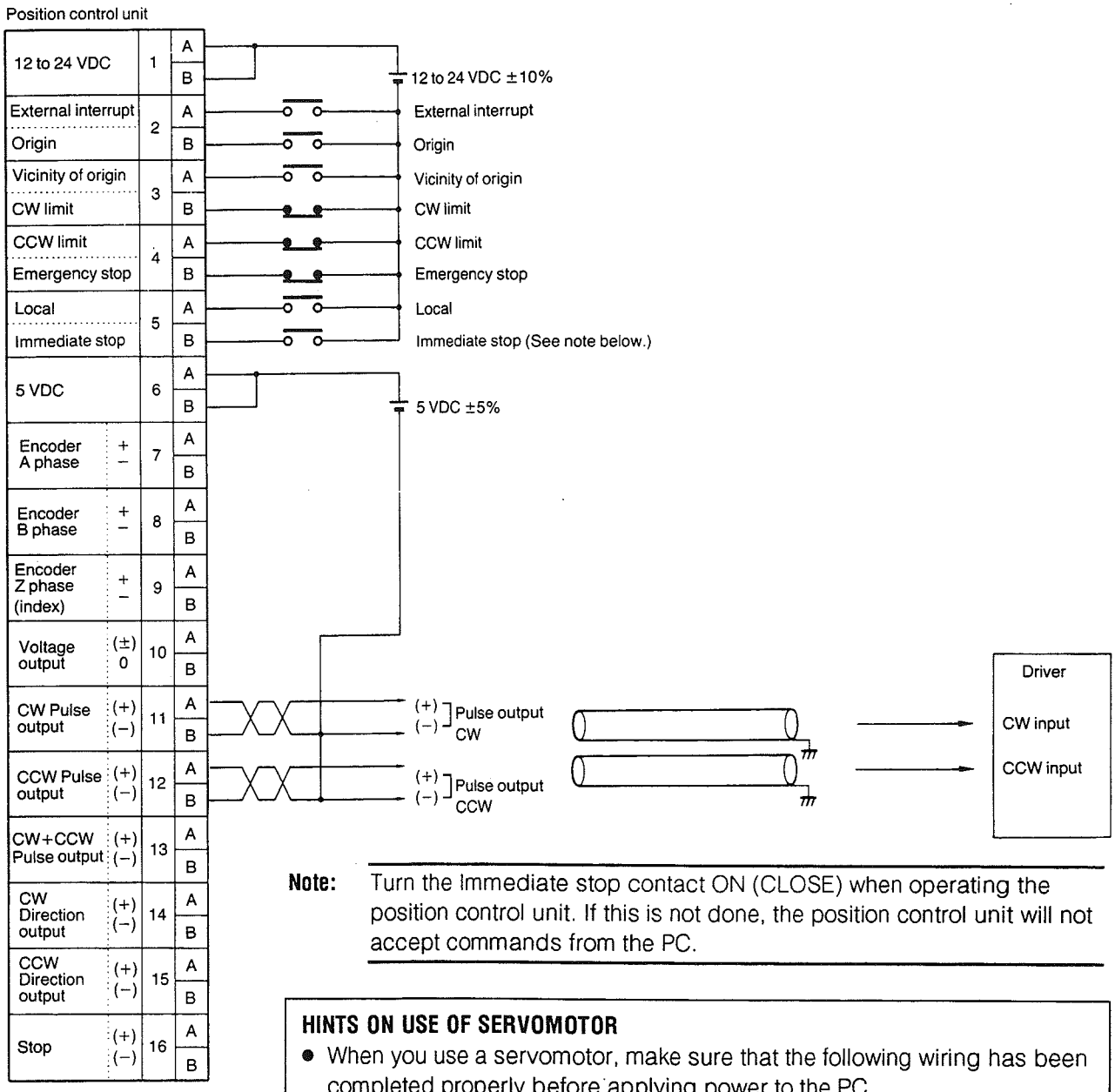
  If power is applied to the PC with improper motor driver connections, the servomotor will be forced to revolve suddenly in one direction, which is very dangerous.

- When you apply power to the PC for the first time after completing the required interface connections, pay adequate attention to the above point. To prevent unexpected accidents, recommend that power be applied to the PC without connecting any load to the motor.



Pulse motor

This example assumes the use of a driver with separate inputs for the CW and CCW directions.



Note: Turn the Immediate stop contact ON (CLOSE) when operating the position control unit. If this is not done, the position control unit will not accept commands from the PC.

HINTS ON USE OF SERVOMOTOR

- When you use a servomotor, make sure that the following wiring has been completed properly before applying power to the PC.

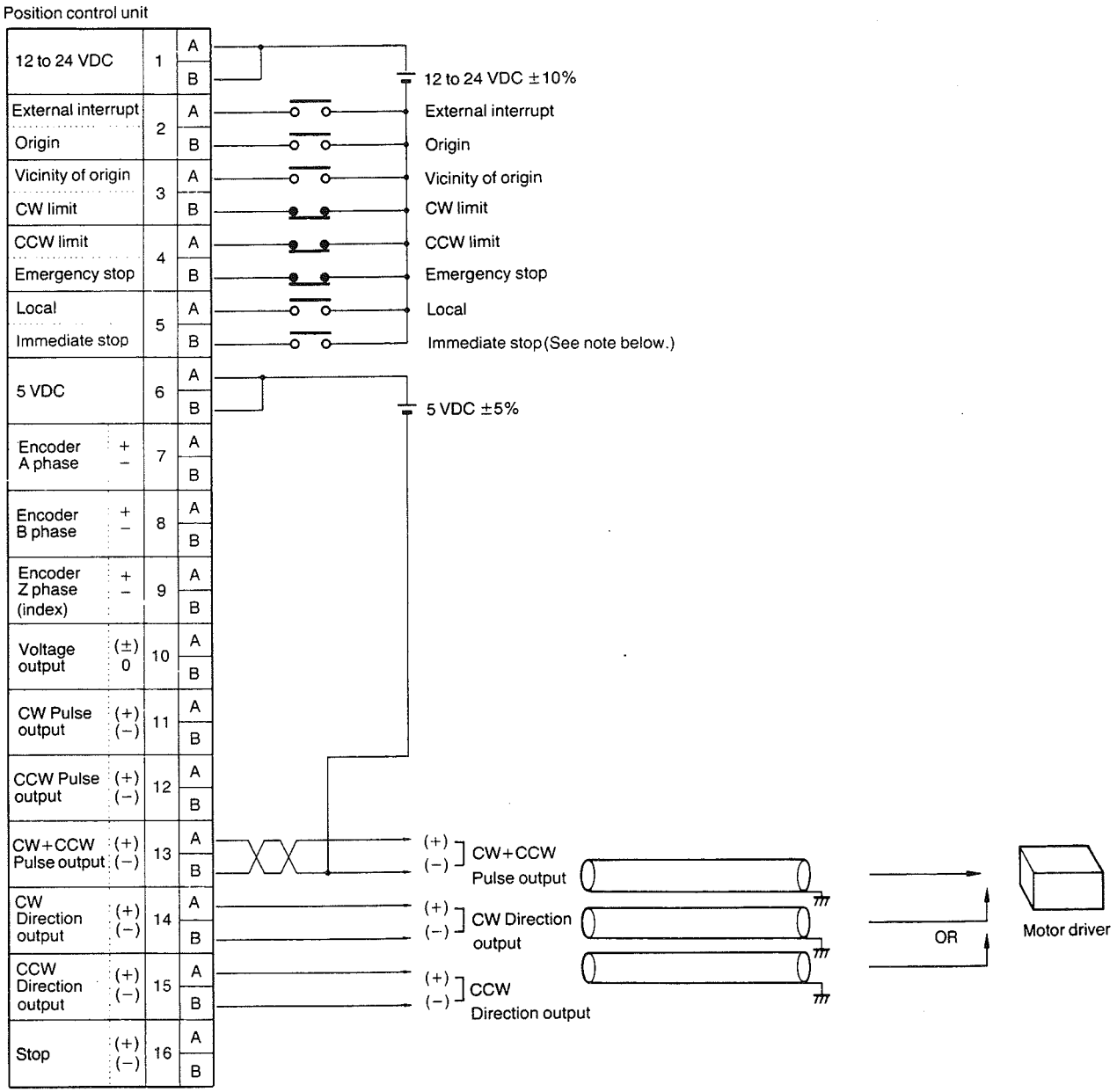
  (1) Phase wiring for rotary encoder (Do not mistake Phase A for Phase B.)
  (2) Voltage output wiring for motor driver (Do not mistake 0V for ±5V or ±12V.)

  If power is applied to the PC with improper motor driver connections, the servomotor will be forced to revolve suddenly in one direction, which is very dangerous.

- When you apply power to the PC for the first time after completing the required interface connections, pay adequate attention to the above point. To prevent unexpected accidents, recommend that power be applied to the PC without connecting any load to the motor.

Position control unit interface

This example assumes the use of a driver with an input terminal for both CW and CCW directions.



Note: Turn the Immediate stop contact ON (CLOSE) when operating the position control unit. If this is not done, the position control unit will not accept commands from the PC.

HINTS ON USE OF SERVOMOTOR

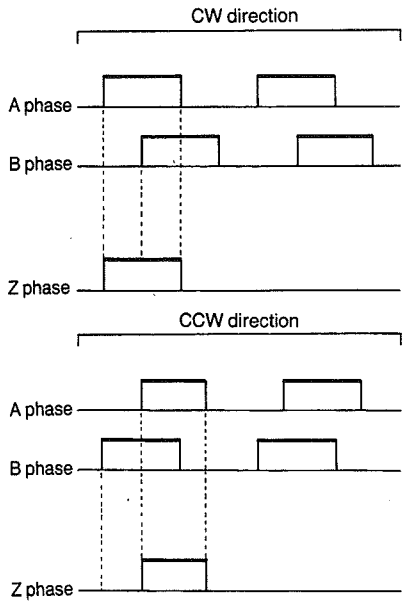
- When you use a servomotor, make sure that the following wiring has been completed properly before applying power to the PC.
  (1) Phase wiring for rotary encoder (Do not mistake Phase A for Phase B.)
  (2) Voltage output wiring for motor driver (Do not mistake 0V for ±5V or ±12V.)
  If power is applied to the PC with improper motor driver connections, the servomotor will be forced to revolve suddenly in one direction, which is very dangerous.
- When you apply power to the PC for the first time after completing the required interface connections, pay adequate attention to the above point. To prevent unexpected accidents, recommend that power be applied to the PC without connecting any load to the motor.

4.3 Rotary encoder connection

The design of the position control unit assumes that it will be used in a system that includes rotary encoder for position detection (number of motor rotations and angle). There are two coding methods normally used in rotary encoders: incremental and absolute. For the position control unit, the use of a reversible type rotary encoder adopting the incremental method is recommended.

Reversible type incremental encoder

This is a rotary encoder that outputs a serial pulse train corresponding to the amount of rotation of the motor shaft. This type of encoder outputs only while the motor shaft is rotating and does not output any signals during the motor rest state.



A reversible type rotary encoder is one which is provided with both an A phase and a B phase output signal and is capable of detecting the forward or reverse direction of the shaft. There are also types that output an index (zero signal or Z phase) for each rotation of the shaft.

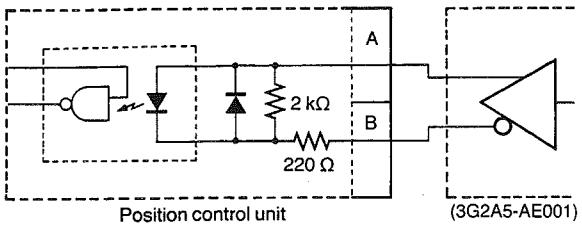
In addition, these two types of output circuits are employed in rotary encoders.

- line driver
- open collector

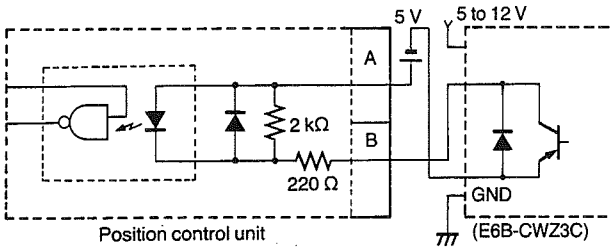
Although the position control unit can be connected to and will function with either type of output circuit, the open collector type is very vulnerable to noise and this imposes severe limits on the length of tranmission cable that can be used. For this reason, the use of a line driver type is recommended.

Line driver output connection example

Connecting to encoder adapter (3G2A5-AE001)



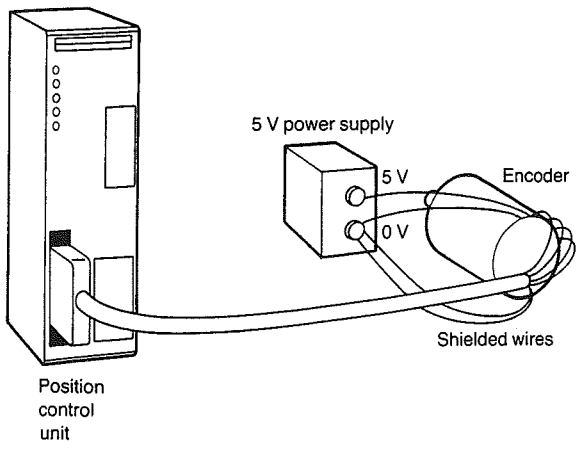
Open collector output connection example

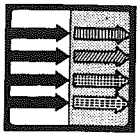


The maximum distance between the encoder and the position control unit is as follows, depending on the type of output driver used.

Line driver	25 m max.
Open collector	1 m max.

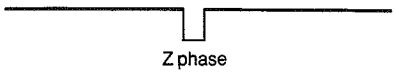
Shielding between the position control unit and the rotary encoder should be provided by connecting the shielded wires of the encoder to the 0 V terminal of the 5 V power supply.



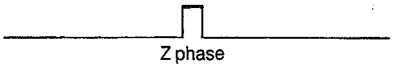


Note that the high and low levels of the Z phase are reversed for line driver and open collector type encoders.

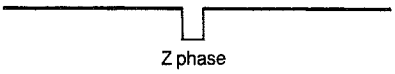
For open collector outputs, the Z phase is normally high and only goes low when the index is detected (active "L").



Also, generally, in the case of line driver outputs, the Z phase is normally low and only goes high when the index is detected (active "H").



Note that the output configuration of the encoder may differ depending on the type.
Example: Some line driver outputs are normally at high level but go low at the Z phase.



When the Z phase is used for origin determination, pin No.4 of position control unit DIP switch 1 should be set to select the type of output.

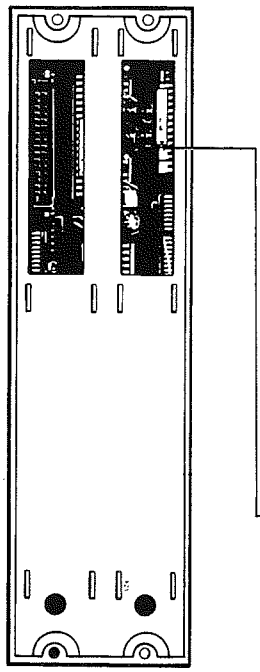
For a detailed description of the function of each of the DIP switches, refer to Section 4.4, DIP switch settings.

4.4 DIP switch settings

SETTING METHOD

For pulse motor

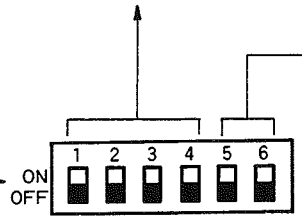
When the position control unit is used with a pulse motor, the DIP switch 1 on the rear of the unit must be set as follows.



Rear panel of position control unit

DIP pin switch No.	ON/OFF	Function
1	ON	No encoder index signal (Z phase)
	*OFF	Encoder index signal (Z phase)
2	ON	Parameter data write inhibit
	*OFF	Parameter data write enable
3	ON	Servomotor
	*OFF	Pulse motor
4	ON	Active "L" (Z phase)
	*OFF	Active "H" (Z phase)

* Indicates the selected function.



Multiplicand	DIP switch bit No. 5	6
x1	OFF	OFF
x2	ON	OFF
x4	OFF	ON
x0	ON	ON

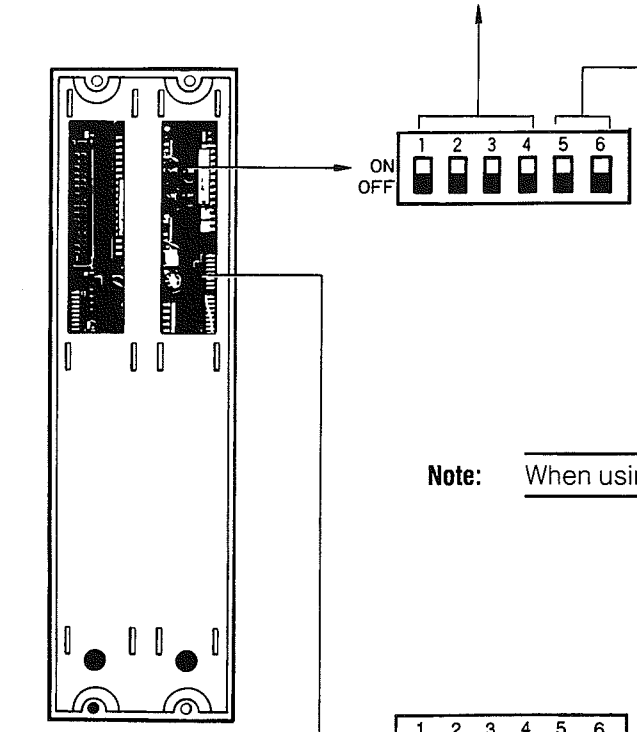
Note: When using a pulse motor, set the multiplicand to 0.

For servomotor

When the position control unit is used with a servomotor, the DIP switches on the rear panel of the position control unit must be set as follows.

DIP pin switch No.	ON/OFF	Function
1	ON	No encoder index signal (Z phase)
	OFF*	Encoder index signal (Z phase)
2	ON	Parameter data write inhibit
	OFF*	Parameter data write enable
3	ON	Servomotor
	OFF*	Pulse motor
4	ON	Active "L" (Z phase)
	OFF*	Active "H" (Z phase)

* Indicates the selected function.



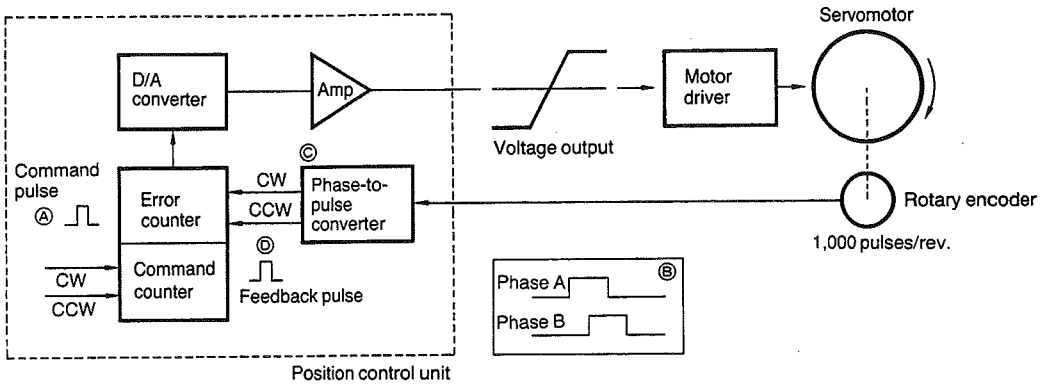
Multiplicand	DIP switch bit No. 5	6
x1	OFF	OFF
x2	ON	OFF
x4	OFF	ON
x0	ON	ON

Note: When using a pulse motor, set the multiplicand to 0.

Driver type	Position loop gain	DIP switch pin number 1	2	3	4	5	6
12 V driver	x 1	ON	ON	OFF	OFF	OFF	ON
	x 2	ON	OFF	OFF	OFF	OFF	ON
	x 4	OFF	OFF	OFF	OFF	OFF	ON
5 V driver	x 1	ON	ON	ON	ON	ON	ON
	x 2	ON	OFF	ON	ON	ON	ON
	x 4	OFF	OFF	ON	ON	ON	ON

4.5 Feedback pulse multiplication function

Although the number of command pulses are always equal to the number of feedback pulses in the semiclosed loop control system, with this function, the number of feedback pulses that is obtained can be increased.

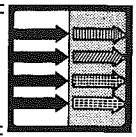


In the above figure, when one command pulse Ⓐ is input to the error counter via the command counter, the D/A converter converts the pulse into a voltage equivalent to one command pulse and then outputs it. This voltage output then causes the motor to revolve and the encoder, which is fixed to the motor shaft, thus starts revolving. When the encoder starts revolving, it outputs to the position control unit a feedback signal whose phase A is different from phase B as shown in Fig. Ⓑ.

Inside the position control unit, the phase-to-pulse converter recognizes the direction in which the encoder (i.e., motor shaft) is revolving and the encoder revolution displacement by checking the number of pulses and the phase difference of the feedback signal. The converter then returns the feedback pulses Ⓓ to the error counter. (Note that either of two kinds of feedback pulses (CW and CCW) is returned at this time depending on the direction in which the encoder is revolving.)

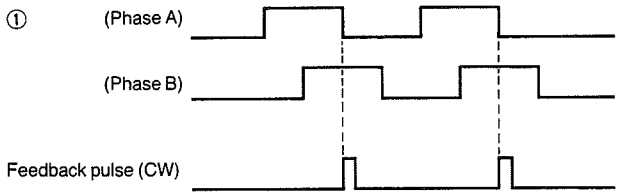
The error counter, in response, checks whether the returned number of pulses and direction are in agreement with the number of pulses and the direction of command pulse Ⓐ. If the returned number of pulses and direction match are found to be as designated by the command pulse, the error counter outputs 0. As a result, the voltage output issued by the D/A converter also becomes 0 and thus the motor stops.

In this manner, command pulse Ⓐ and feedback pulse Ⓓ correspond to each other on a one-to-one basis. Therefore, if an encoder attached to the motor outputs 1,000 pulses per revolution, one command pulse Ⓐ causes a 1/1,000 revolution of the motor shaft.

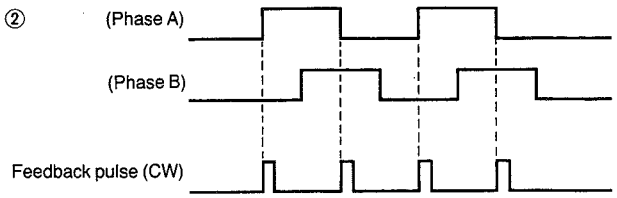


However, depending on the method of obtaining feedback pulses Ⓓ from feedback signal Ⓑ, the number of feedback pulses that is obtained from the pulse with the same phase as that of the feedback pulse can be changed.

For example, in figure Ⓑ, only two feedback pulses can be obtained as shown in Fig. ①.

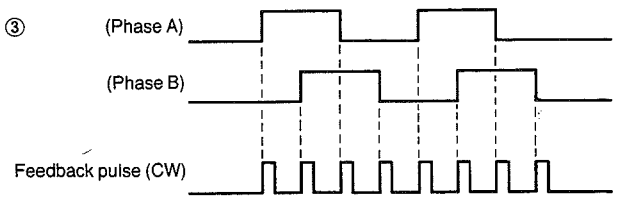


However, by modifying the phase-to-pulse converter Ⓒ, the number of the feedback pluses can be doubled even with the same revolution displacement as shown in Fig. ②.



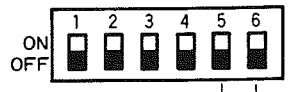
By using the feedback pulse multiplication function, therefore, even when, for example, an encoder that outputs 1,000 pulses per revolution is attached to the motor, one command pulse Ⓐ can cause the motor shaft to revolve by 1/2,000 revolution.

Similarly, the number of the feedback pulses can be quadrupled as indicated by Fig. ③, and thereby revolve the motor shaft by 1/4,000 revolution with one command pulse Ⓐ even when a 1,000-pulse-per-revolution encoder is attached to the motor.



Therefore, by using this function, the positioning accuracy can be enhanced by controlling the number of feedback pulses that is obtained from the pulses of phases A and B that are input by the encoder.

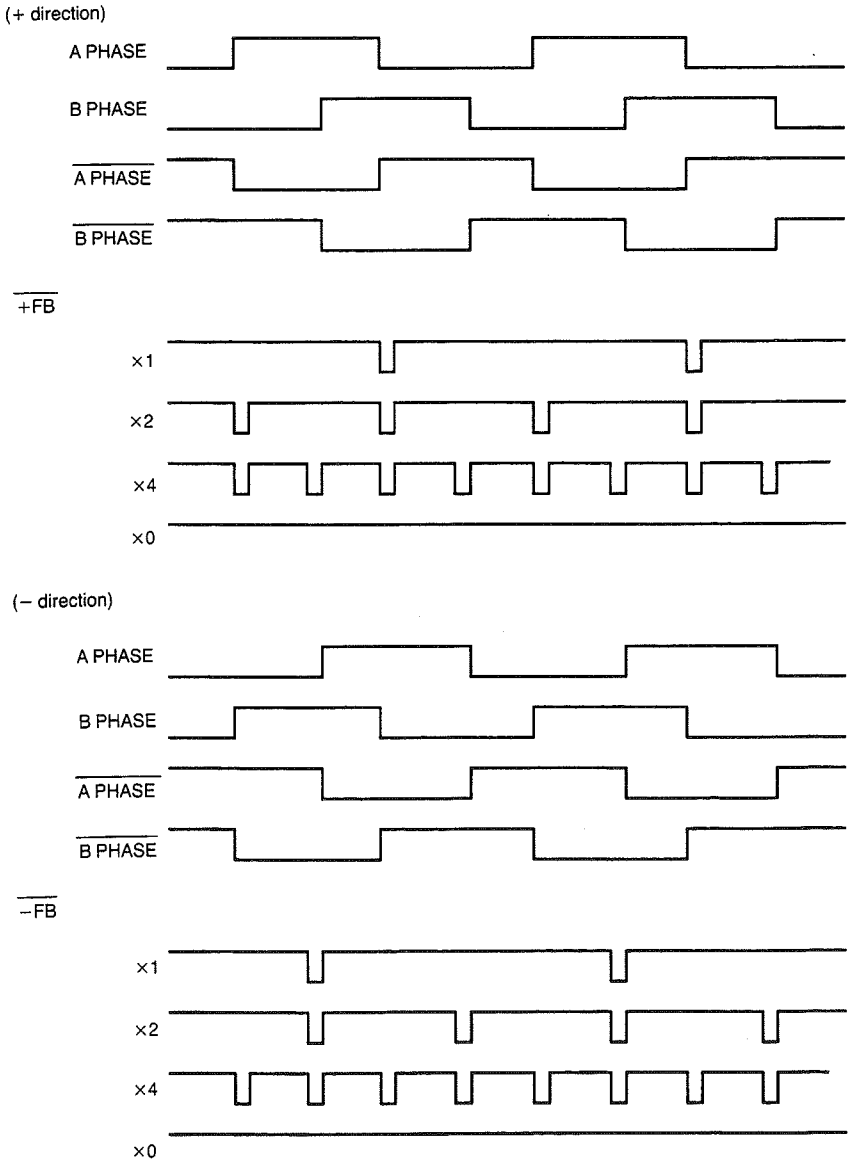
This position control unit is provided with a built-in DIP switch with which to select the multiplicand by which the number of feedback pulses is multiplied.



Multiplicand	DIP switch bit No. 5	6
x1	OFF	OFF
x2	ON	OFF
x4	OFF	ON
x0	ON	ON

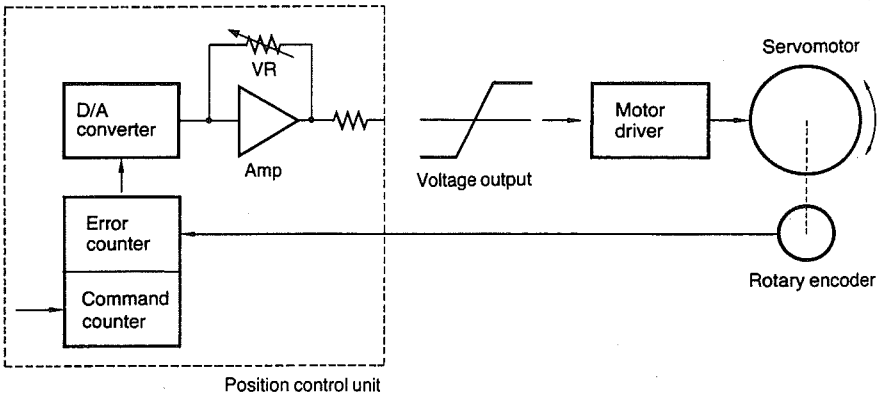
Note: When using a pulse motor, set the multiplicand to 0.

The following are the timing charts of phases A and B pulses input from the encoder and feedback pulses.



4.6 Loop gain

When the position controller is connected to a servomotor, it is necessary to determine the position loop gain. In the position control unit, position loop gain is defined as shown in the following figure.



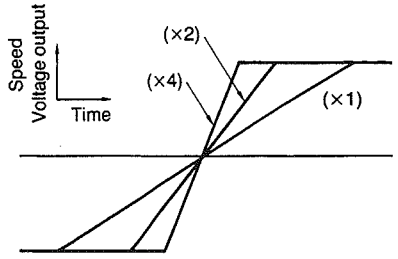
The position loop gain value expresses the response characteristic of the servo system.

$$\text{Position loop gain} = \frac{\text{Response speed}}{\text{Position deviation (error counter value)}}$$

Because the response speed varies with the speed command voltage response characteristic, the NC101 is so designed that this relation is established.

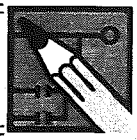
Position loop gain ∝ Response speed ∝ Speed command voltage response characteristic

As shown in the figure above, by changing the resistance used in the internal amp (×1, ×2, or ×4), the response characteristic (in this case, the rise time can be changed,) enabling control of the loop gain.



If the position loop gain is too high, this will cause oscillation; if it is too low, this will increase the servo amplitude, making the positioning operation unstable. The optimum value for position loop gain will vary with the type of mechanical system used. Start with a ×1 gain, and then step up to ×2 or ×4 as required.

Chapter 5 User data



5.1 Types of user data

The types of user data and the range of defined values for each type are shown in the following table.

User data	Address	Item	Setting values
Position data	1000 (1999	Position command data	Coordinates (0 to 999999) [pulse] Speed (0 to 9) Pattern (1: continue, 0: terminate) INC/ABS (1:INC) +/– (1:–) Bank end/non end (1: bank end)
	1200	Home shift data	Coordinates (0 to 999999) +/– (1:–)
Parameter data (Note 1)	2000	Dimension	mm, inch, deg, pulse, (1 to 4)
	2001	Pulse rate	0.0001 to 1.0000
	2002	CW limit zone	0 to 999999 [pulse]
	2003	CCW limit zone	0 to 999999 [pulse]
	2004	Backlash correction	0 to 9999 [pulse]
	2005	Maximum speed	0, 20 to 100000 [pulses/s]
	2006	Start speed	0, 20 to 100000 [pulses/s]
	2007	Acceleration/deceleration time	0.40 to 99.99 [s]
	2008	Near-zero	0 to 255 [pulse]
	2009	Dwell time	0 to 99.99 [s]
	2010	Origin search direction and current position indication format	Error counter (1: used, 0: not used) (1: CW, 0: CCW)
	2011	Origin correction	± (0 to 9999) [pulse]
Speed data	4000	*0 Origin return speed (manual high speed)	20 to 100000 [pulses/s]
	4001	*1 Origin search high speed	20 to 100000 [pulses/s]
	4002	*2 Manual low speed (origin search low speed)	20 to 100000 [pulses/s]
	4003	*3	20 to 100000 [pulses/s]
	4004	*4	20 to 100000 [pulses/s]
	4005	*5	20 to 100000 [pulses/s]
	4006	*6	20 to 100000 [pulses/s]
	4007	*7	20 to 100000 [pulses/s]
	4008	*8	20 to 100000 [pulses/s]
	4009	*9	20 to 100000 [pulses/s]

Note: 1. All parameter data should be set.
2. Manual speeds should be set to be slower than origin return or origin search speed.
3. The speed data can be set within the range of ϕ [pulse/s] and 20 to 100,000 [pulse/s] but cannot be set within the range of 1 to 19 [pulse/s].

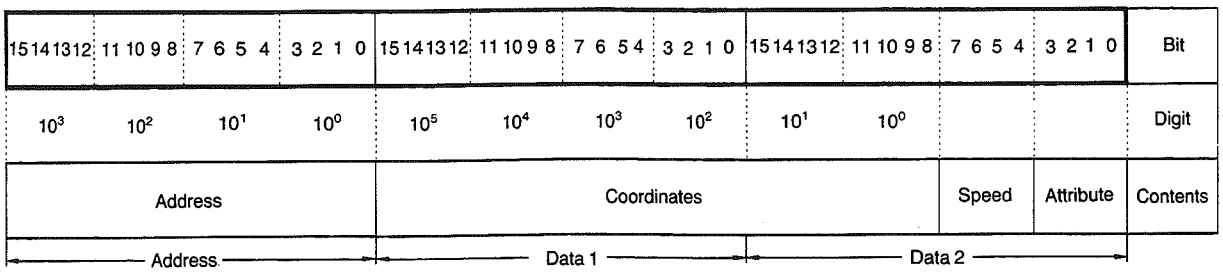
* Set the parameter data, speed data, and position data in this sequence.

5.2 User data configuration

The user data consists of up to three words depending upon the communication procedure between the PC and position control unit.

5.3 Position data

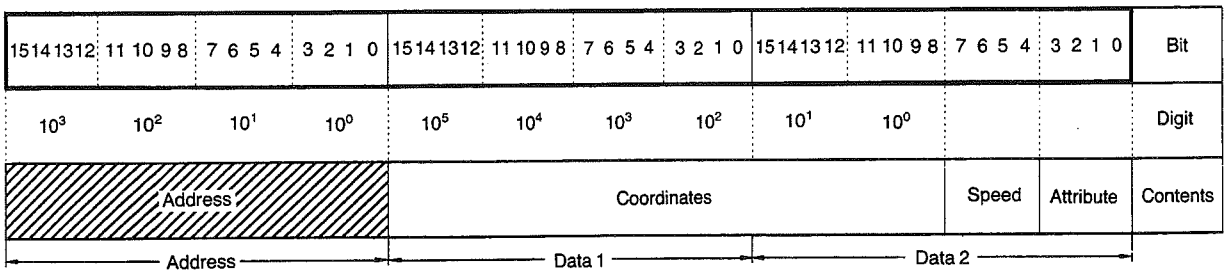
The position data consists of four fields: address, coordinate, speed, and attribute.



Note: Assign significances 8, 4, 2 and 1 to the respective bits of each digit, from the most significant bit toward the least. For example, the four bits (bits 15, 14, 13, and 12) of digit 10^5 are assigned the significances as follows:

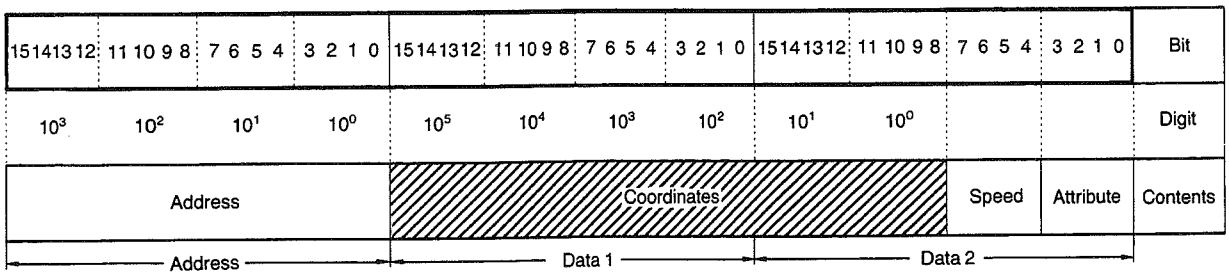
Bit 15: 8
Bit 14: 4
Bit 13: 2
Bit 12: 1

Address field



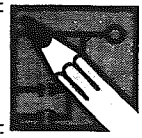
A maximum of 200 items of position data can be registered in the position control unit. To this data, addresses 1000 to 1199 are assigned. The address field of position data is made up of four digits: digits, 10^3, 10^2, 10^1, and 10^0. Address 1200 is assigned to the home shift data.

Coordinate field

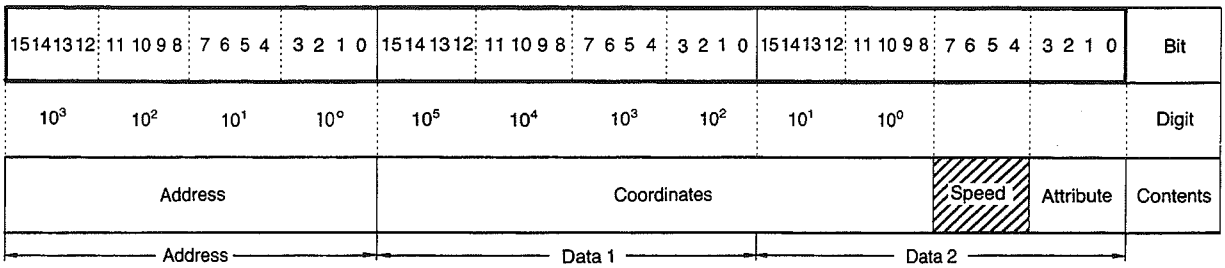


The coordinates with which the position control unit performs the positioning operation is set in the coordinate field of data, using six digits. The coordinate can be 000000 to 999999.
When using the teaching box to set the position data, the unit can be [mm], [inch], [degree], or [pulse]. Do not set the data so that the value [pulse] converted with the pulse rate exceeds the set range.

$$\frac{\text{(Data set by teaching box) [mm, inch, degree, or pulse]}}{\text{(Pulse rate) [mm, inch, degree, pulse/pulse]}} \leqslant 999999$$



Speed field



This field is used to set speed data number (from 0 to 9) to register the speed at which the controlled system is moved to the destination.

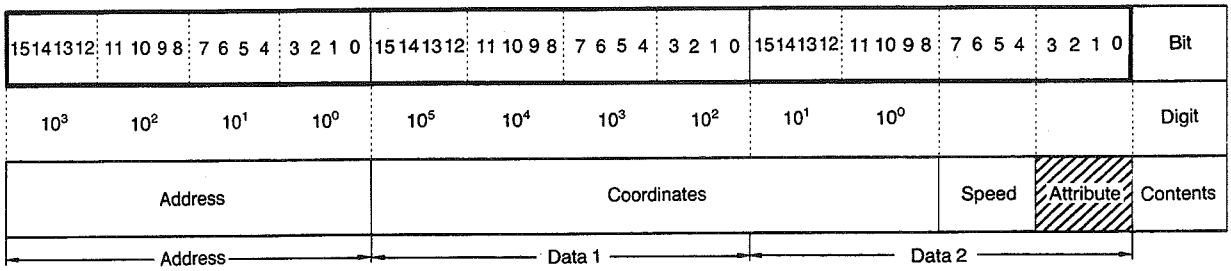
As shown, this field consists of four bits (7, 6, 5, and 4) in data 2. Using these four bits, you can specify the least significant digit of a 4-digit speed data address, which can be 4000 to 4009. (For speed data, refer to 5.5.)

For example, if "5" is specified by these four bits of the speed field by clearing bits 7 and 5 to 0 and setting bits 6 and 4 to 1, speed data address 4005 is specified.

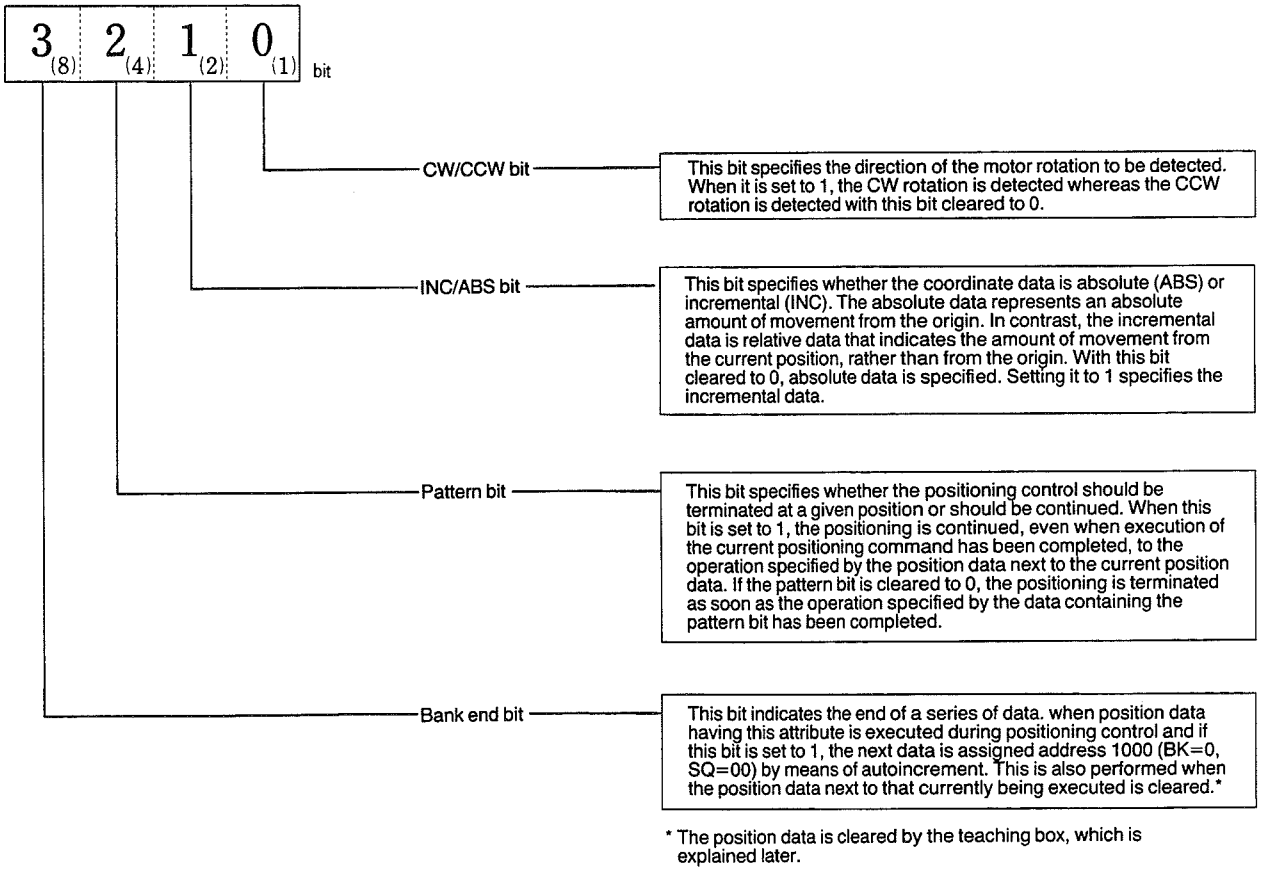
The following table lists the 10 speed data addresses and corresponding bit settings.

Bit				Speed data address
7	6	5	4	
0	0	0	0	4000 (origin return) (manual high speed)
0	0	0	1	4001 (origin search high speed)
0	0	1	0	4002 (manual low speed) (origin search low speed)
0	0	1	1	4003
0	1	0	0	4004
0	1	0	1	4005
0	1	1	0	4006
0	1	1	1	4007
1	0	0	0	4008
1	0	0	1	4009

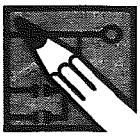
Attribute field



The attribute field includes four bits and specifies the nature of the position data.



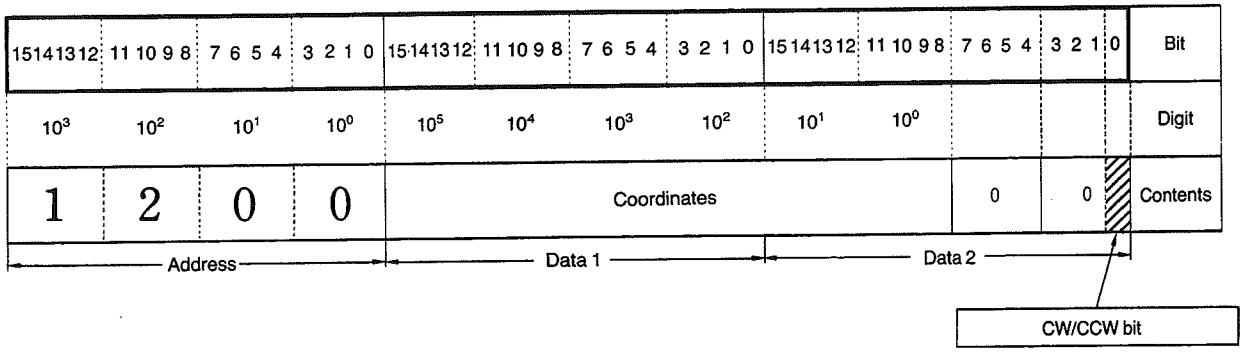
* The position data is cleared by the teaching box, which is explained later.



Home shift data

When the home shift relay in the PC is turned ON, the current position data becomes the sum of the set coordinates and the home shift data. When the home shift relay is OFF, positioning is performed using the set coordinates only.

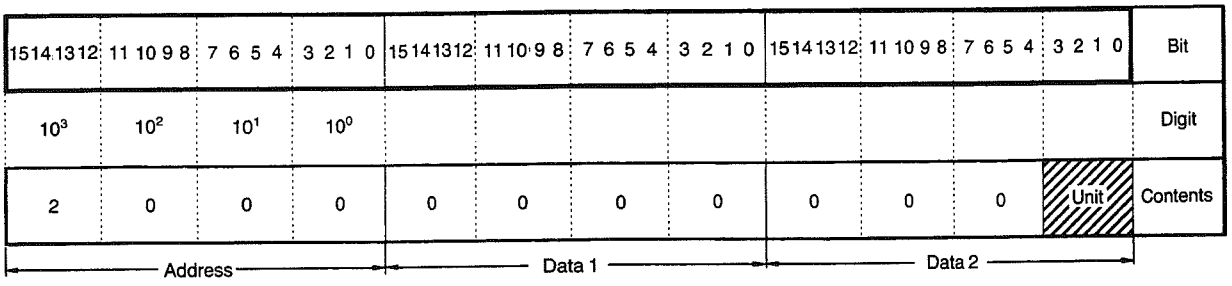
To determine whether home shift is valid or not, check if the home shift relay is ON or OFF when the shaft starts rotating. In other words, if the relay is ON when the shaft starts rotating, the home shift data will still be valid even if the relay is turned OFF.



5.4 Parameter data

Dimension unit parameter (address 2000)

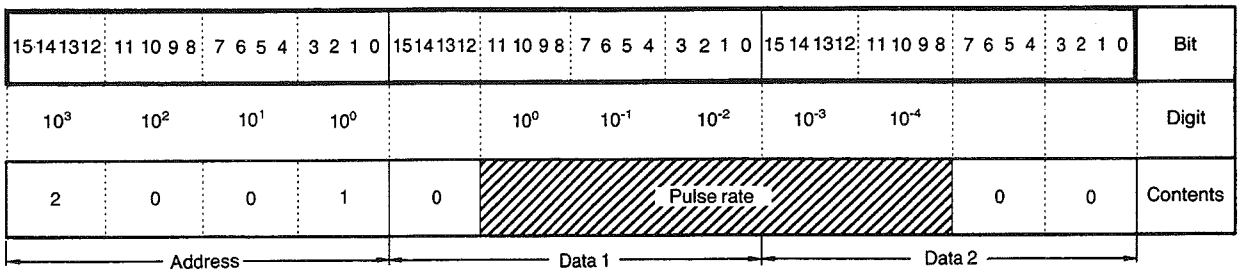
The least significant 4 bits of data2 are used to specify the units for the positioning operation. The following four operations are available:



Decoded value of DATA2, bits 0 to 3)	Dimension
1	mm
2	inch
3	deg (angle)
4	pulse

Pulse rate (address 2001)

This parameter determines the amount of movement for each command pulse. This is a 5 digit BCD data uses the high-order 2 digits of data2 and the low-order 3 digits of data1.



The pulse rate may be set in the range 0.0001 to 1.0000 (units/pulse).

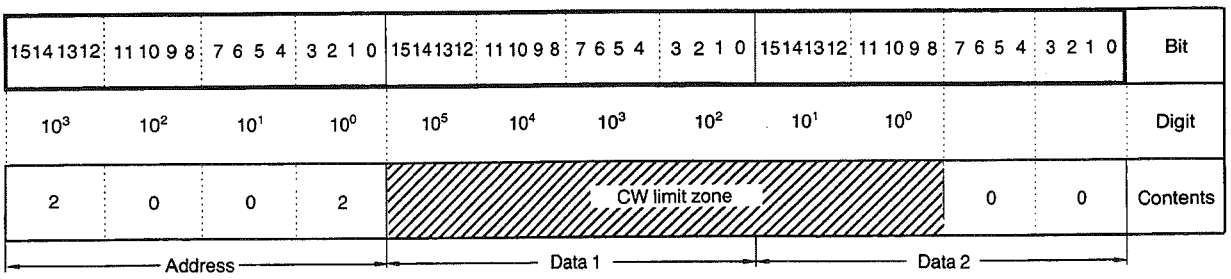
Note: The dimension and parameter are set as parameters as described above. When user data is to be input using the teaching box, however, numerical values based on these parameters must be set.

For example, when the dimension is set to 1 mm and the pulse rate to 0.5, the position data, say, 1,000 mm should be set to 1,000 by teaching box. However, to transfer data from the PC to position control unit, the unit must be converted into pulses. Therefore, the position data set in this example, 1,000 mm, is converted into 2,000 pulses.

CW limit zone (address 2002)

This parameter specifies from software the limit of movement in the CW direction.

This is a 6 digit BCD data.



This parameter may be set in the range 0 to 999999 (pulses).

Note: When the teaching box is connected, this is performed in units.

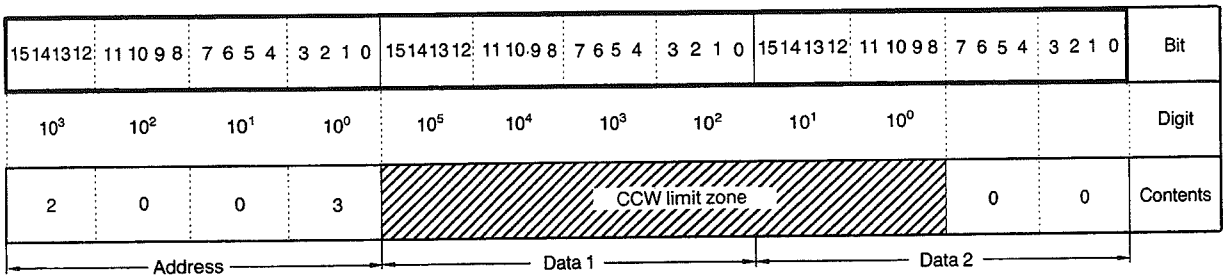
When using the teaching box to set the position data, the unit can be [mm], [inch], [degree], or [pulse]. Do not set the data so that the value [pulse] converted with the pulse rate exceeds the set range.

$$\frac{\text{(Data set by teaching box) [mm, inch, degree, or pulse]}}{\text{(Pulse rate) [mm, inch, degree, pulse/pulse]}} \leqslant 999999$$

CCW limit zone (address 2003)

This parameter specifies from software the limit of movement in the CCW direction.

This is a 6 digit BCD data.



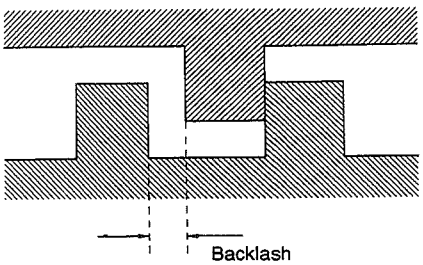
This parameter may be set in the range 0 to 999999 (pulses).

Note: When the teaching box is connected, this setting is performed in units.

When using the teaching box to set the position data, the unit can be [mm], [inch], [degree], or [pulse]. Do not set the data so that the value [pulse] converted with the pulse rate exceeds the set range.

$$\frac{\text{(Data set by teaching box) [mm, inch, degree, or pulse]}}{\text{(Pulse rate) [mm, inch, degree, pulse/pulse]}} \leqslant 999999$$

Backlash compensation (address 2004)



This parameter specifies the amount of compensation required to correct the kind of mechanical error shown in the figure below (the backlash shown in this figure requires compensation in the CCW [left] direction). Normally, this parameter is required for changing the direction of the motor shaft rotations.

This is a 4 digit BCD data.

15141312	11 10 9 8	7 6 5 4	3 2 1 0	15141312	11 10 9 8	7 6 5 4	3 2 1 0	15141312	11 10 9 8	7 6 5 4	3 2 1 0	Bit
10^3	10^2	10^1	10^0			10^1	10^0	10^{-1}	10^{-2}			Digit
2	0	0	4	0	0	Backlash correction				0	0	Contents
Address				Data 1				Data 2				

This parameter may be set in the range 0 to 9999 (pulses)

Note: When the teaching box is connected, this setting is performed in units.

When using the teaching box to set the position data, the unit can be [mm], [inch], [degree], or [pulse]. Do not set the data so that the value [pulse] converted with the pulse rate exceeds the set range.

$$\frac{\text{(Data set by teaching box) [mm, inch, degree, or pulse]}}{\text{(Pulse rate) [mm, inch, degree, pulse/pulse]}} \leqslant 9999$$

Maximum speed (address 2005)

This parameter specifies the maximum movement speed. The data format is the same as that for the CW and CCW limit zones.

This is a 6 digit BCD data.

15141312	11 10 9 8	7 6 5 4	3 2 1 0	15141312	11 10 9 8	7 6 5 4	3 2 1 0	15141312	11 10 9 8	7 6 5 4	3 2 1 0	Bit
10^3	10^2	10^1	10^0	10^5	10^4	10^3	10^2	10^1	10^0			Digit
2	0	0	5	Maximum speed						0	0	Contents
Address				Data 1				Data 2				

This parameter may be set in the range 0 or 20 to 100000 (pulses/s).

Note:
1. When the teaching box is connected, this setting is performed in units.
2. The data cannot be set within the range of 1 to 19 [pulses/s].

When using the teaching box to set the position data, the unit can be [mm], [inch], [degree], or [pulse]. Do not set the data so that the value [pulse] converted with the pulse rate exceeds the set range.

$$\frac{\text{(Data set by teaching box) [mm, inch, degree, or pulse]}}{\text{(Pulse rate) [mm, inch, degree, pulse/pulse]}} \leqslant 100000$$



Starting speed (address 2006)
Although servomotors must start operation from speed 0, pulse motors may start from any speed within the range of the self starting frequency.

The starting speed should be set so that it is within this range and does not cause an overdrive to occur. The data format is the same as that for the CW and CCW limit zones.

15141312	11 10 9 8	7 6 5 4	3 2 1 0	15141312	11 10 9 8	7 6 5 4	3 2 1 0	15141312	11 10 9 8	7 6 5 4	3 2 1 0	Bit
10^3	10^2	10^1	10^0	10^5	10^4	10^3	10^2	10^1	10^0			Digit
2	0	0	6	Starting speed						0	0	Contents
Address				Data 1				Data 2				

This parameter may be set in the range 0 or 20 to 100000 (pulses/s).

Note:
1. When the teaching box is connected, this setting is performed in units.
2. The data cannot be set within the range of 1 to 19 [pulses/s].

When using the teaching box to set the position data, the unit can be [mm], [inch], [degree], or [pulse]. Do not set the data so that the value [pulse] converted with the pulse rate exceeds the set range.

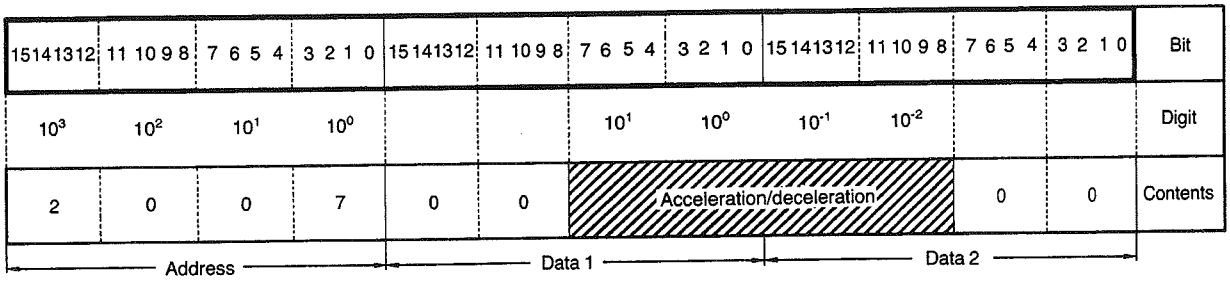
$$\frac{\text{(Data set by teaching box) [mm, inch, degree, or pulse]}}{\text{(Pulse rate) [mm, inch, degree, pulse/pulse]}} \leqslant 100000$$

When the position control unit is used to drive a servomotor, this value should be set to 0.

Acceleration/deceleration (address 2007)

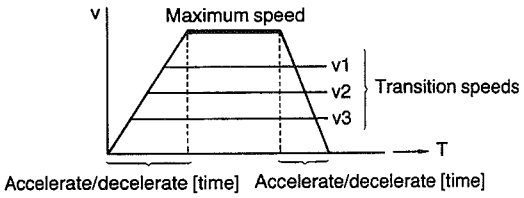
This parameter specifies the rate at which the movement will accelerate and decelerate between the starting and the maximum speed. This value, which is the same for both acceleration and deceleration, controls all changes of positioning speed.

This is a 4 digit BCD data.



This parameter may be set in the range 0.40 to 99.99 (s) in units of 0.01 s.

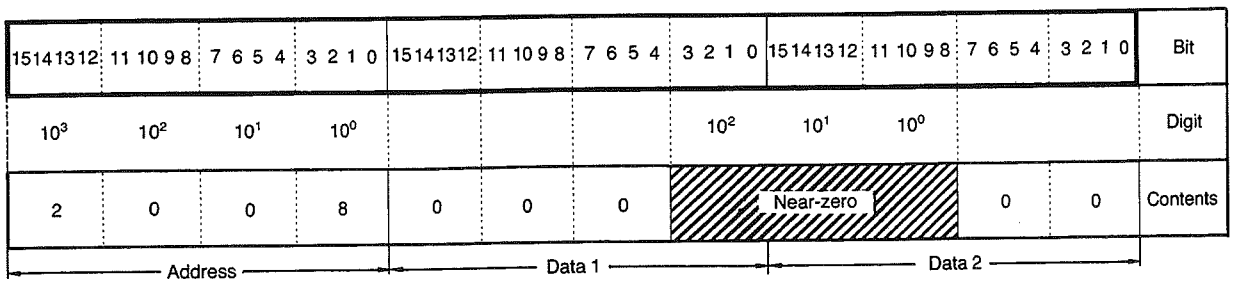
Example (servomotor)



Near-zero (address 2008)

When the value in the error counter falls within the set range, the near-zero relay (Bit 14 of CHn+3) turns ON. This user data sets the near-zero value.

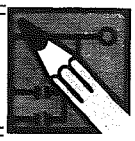
This is a 3 digit BCD data.



This parameter may be set in the range 0 to 255 (pulses).

Note:

1. This value is effective only when the position control unit is used to control the operation of a servomotor, and is ignored in the case of a pulse motor.
2. The unit is also in pulse when the teaching box is used.



Dwell time (address 2009)

With servomotors, there may be a period of hunting after the destination is reached. This parameter serves to reduce the effect of this hunting. After the destination has been reached, the position control unit outputs the positioning complete signal a certain period later. This is known as the dwell time and is set by this parameter.

This is a 4 digit BCD data.

15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0	15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0	15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0	Bit
10^3	10^2	10^1	10^0			10^1	10^0	10^{-1}	10^{-2}			Digit
2	0	0	9	0	0	Dwell time				0	0	Contents
Address				Data 1				Data 2				

This parameter may be set in the range 0.00 to 99.99 (s).

Note: This parameter is valid whether the motor being driven is a pulse motor or a servomotor. However, it is not normally used for pulse motors.

Origin search and current value display method (address 2010)

Origin search locates the mechanical origin before performing the positioning operation.

This parameter sets the direction of the search operation and selects the display method for the current postion value.

15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0	15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0	15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0	Bit
10^3	10^2	10^1	10^0									Digit
2	0	1	0	0	0	0	0	0	0	0	Origin search	Contents
Address				Data 1				Data 2				

This parameter uses the least significant 2 bits of DATA2.

Bit 1	Bit 0	Selected function
0	0	CCW direction origin search Displays command counter contents as current value*
0	1	CW direction origin search Displays command counter contents as current value
1	0	CCW direction origin search Displays command and error counter contents as current value
1	1	CW direction origin search Displays command and error counter contents as current value**

* The current value of the position specified by a command value is displayed. For example, when the positioning is performed to the origin, the present value is fixed to 0.000 and the origin bit remains turned ON.

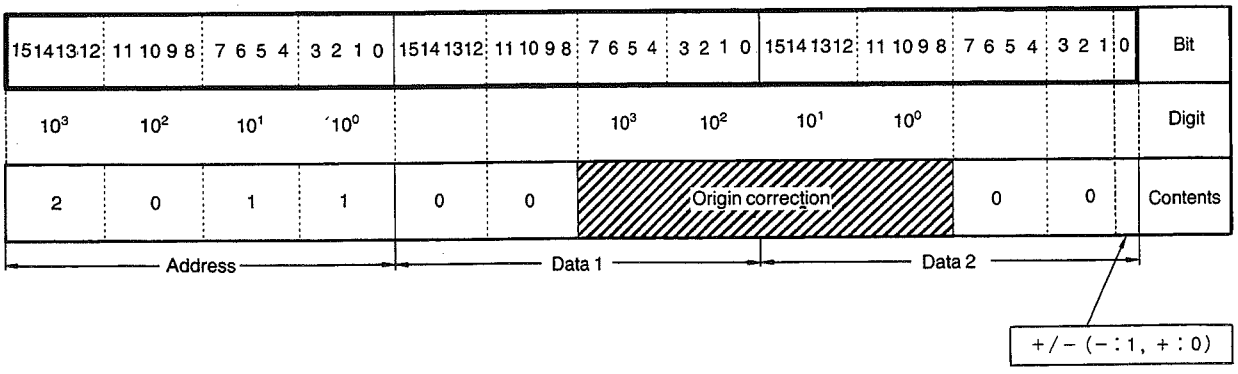
** The current value of the position including the fluctuation in the error counter value is output. For example, when the positioning is performed to the origin, the present value fluctuates around the origin and becomes −1.0, 0.0, or 1.0. In accordance with this, the origin bit is repeatedly turned ON and OFF. This output method is invalid when the panel monitor is used.

Origin correction (2011)

This function is used to compensate for any minor errors that may occur when origin search is performed. This is used to compensate for any slippage betweent the origin and the Z phase of the encoder.

This is a 4 bit BCD data.

The LSB of DATA2 functions as a sign bit [to specify the direction of the correction]



This parameter may be set in the range 0 to 9999 (pulses).

Note: When the teaching box is connected, this setting is performed in units.

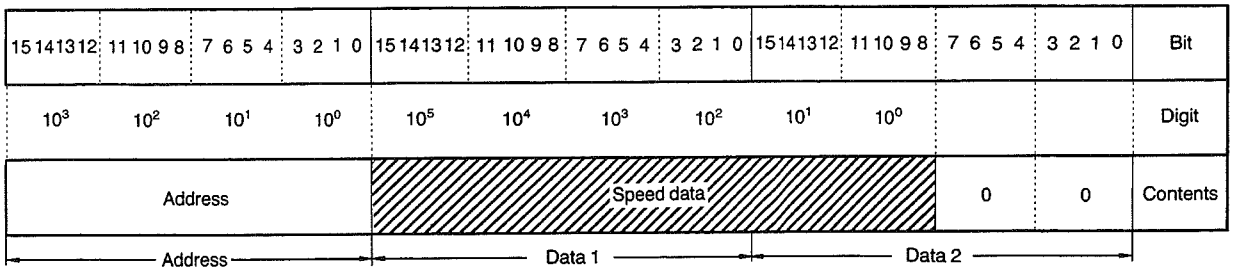
When using the teaching box to set the position data, the unit can be [mm], [inch], [degree], or [pulse]. Do not set the data so that the value [pulse] converted with the pulse rate exceeds the set range.

$$\frac{\text{(Data set by teaching box) [mm, inch, degree, or pulse]}}{\text{(Pulse rate) [mm, inch, degree, pulse/pulse]}} \leqslant 9999$$

5.5 Speed data

Address

The speed data is allocated to the 10 addresses 4000 to 4009.



Address	Description
4000	No. 0 Origin return speed (manual high speed)
4001	No. 1 Origin search high speed
4002	No. 2 Origin search low speed (manual low speed)
4003	No. 3
4004	No. 4
4005	No. 5
4006	No. 6
4007	No. 7
4008	No. 8
4009	No. 9

This parameter may be set in the range 0 to 999999 (pulses/s).

Note: The unit is in unit/s when the teaching box is used.

Both the origin return speed and manual high speed are allocated as speed data No. 0 (to address 4000).

The origin search speed is allocated as speed data No. 1 (to address 4001).

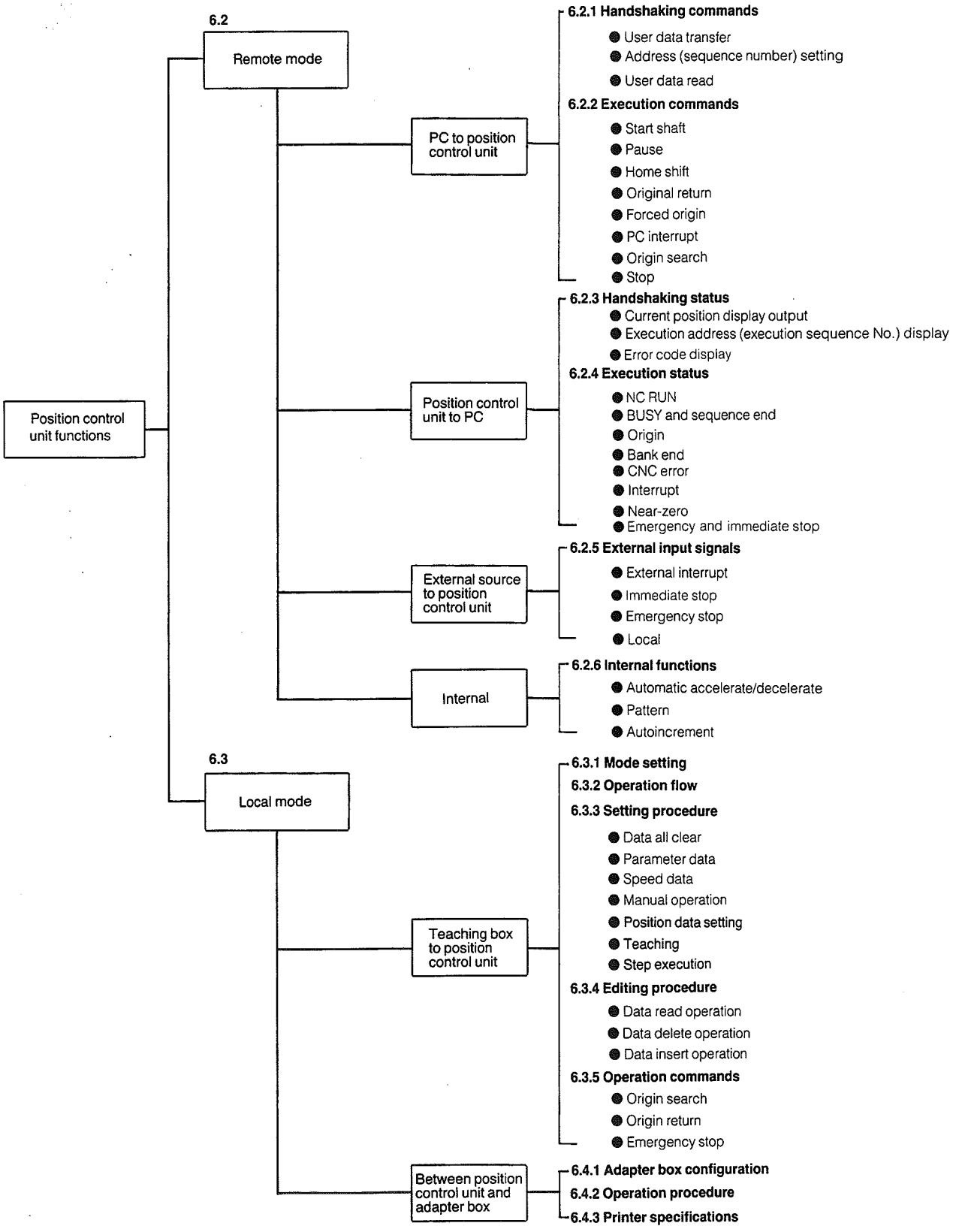
The origin search low speed and manual low speed are allocated as speed data No. 2 (to address 4002).

When using the teaching box to set the position data, the unit can be [mm], [inch], [degree], or [pulse]. Do not set the data so that the value [pulse] converted with the pulse rate exceeds the set range.

$$\frac{\text{(Data set by teaching box) [mm, inch, degree, or pulse]}}{\text{(Pulse rate) [mm, inch, degree, pulse/pulse]}} \leqslant 999999$$

6.1 Operating mode [2]

The position control unit has two operating modes in which these functions can be effected.



The position control unit has two operating modes: remote and local. Normally, the local mode, in which the position control unit operates under the direct control of the teaching box, is used first to set all necessary data and parameters as well as to test the task program operation. After the task operation has been fully confirmed and debugged, operation is transferred to the remote mode. In remote mode, the operation of the position control unit is controlled by the host PC (continuous run) to perform the position control operation.

In local mode, the following features of the teaching box enable easy task program development and debugging:

- data is set in the units (mm, pulse, inch, or degree) that are actually used for the position control operation
- data reference is simplified, allowing the program data to be easily confirmed
- a manual operation mode is provided that allows tasks to be moved from one location to another; all existing data will then be valid at the new location.
- execution of a series of position data can be performed
- all of the set data can be cleared

In remote mode, the position control unit performs the following functions:

- data transfer between the position control unit and the host PC
- execution of control operations in response to commands sent from the host PC

6.2 Remote mode

In remote mode, since the position control unit operates under the control of the host PC, the interface protocol between the position control unit and the host PC must be established. The assignment of each bit of the four channels (expressed generically as CHn to CHn+3) occupied by the position control unit is described below.

Another important difference with the local mode is that in remote mode all data transfer operations are performed in pulse units.

Relay assignment and bit description

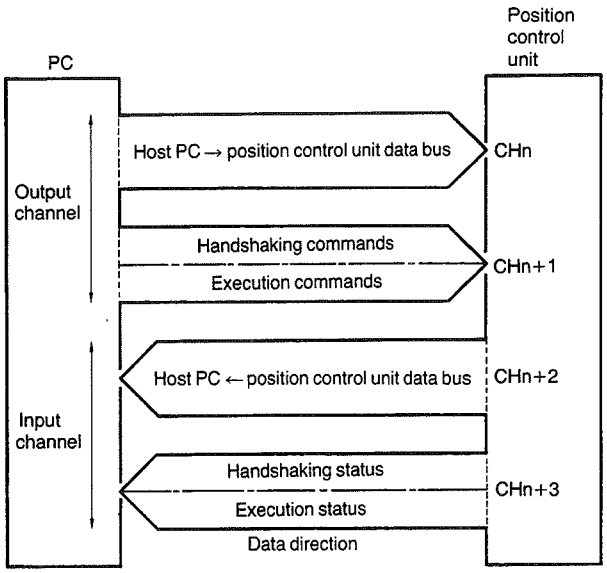
In the standard communication protocol used between the position control unit and the host PC, I/O channel CHn is used as a data bus for data from the PC to the position control unit, CHn+1 serves to communicate handshaking and execution commands from the PC, CHn+2 is the data bus from the position control unit to the PC, and CHn+3 transmits the handshaking and execution statuses from the position control unit to the PC. The format for all data transfers is BCD.

Channel	Bit	Description
n	0 to 15	Host PC → position control unit data bus
n+1	0	Address write
	1	DATA1 write
	2	DATA2 write
	3	Program data read command
	4	Scan clock
	5	Address (sequence No.) set
	6	Handshaking error release
	7	Operation mode
	8	Start shaft
	9	Pause
	10	Origin return
	11	Forced origin
	12	Home shift
	13	PC interrupt
	14	Origin search
	15	Stop

Output channels

Channel	Bit	Description
n+2	0 to 15	Host PC ← position control unit data bus
n+3	0	ACK (handshaking BUSY)
	1	DATA1 receive
	2	DATA2 receive
	3	Program data receive
	4	NC RUN
	5	Handshaking error
	6	Current position data receive
	7	Execution address (execution sequence No.) receive
	8	BUSY (positioning operation)
	9	Sequence end
	10	Origin
	11	Bank end
	12	CNC error
	13	Interrupt
	14	Near-zero position
	15	Emergency and immediate stop

Input channels



The terms "input" and "output" are as seen from the host PC

Bits 0 to 7 of CHn+1: Handshaking commands
Bits 8 to 15 of CHn+1: Execution commands
Bits 0 to 7 of CHn+3: Handshaking statuses
Bits 8 of 15 of CHn+3: Execution statuses

Note: The ACK signal is returned from the position control unit in response to the following handshaking commands:

- address write
- DATA1 write
- DATA2 write
- program data read command
- address (sequence no.) set

The output format for CHn+1 (handshaking and execution commands) are as follows:

- bits 0 to 3, 5, 8, 10, 11, and 14 are active rising edge
- bits 6, 9, 12, 13, and 15 are level sensitive (active HIGH)
- bit 4 is the clock signal
- bit 7 (operation mode) is always ON
- with the exceptions of bits 4 and 7, the control program should ensure that only one of these signals is ON at any given time.

CHn
This channel functions as the data bus to transfer user data (position, parameter, and speed data) from the host PC to the position control unit.

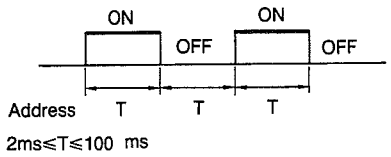
CHn+1
Bit 0 .... Address write
All user data is sent in groups of 3 words each. Data sent from the host PC to the position control unit is therefore broken into 3 words each 16 bits long. This bit functions to indicate that the current word is the first word, i.e., the address.

Bit1 .... Data1 write
This bit functions in the same way as bit 0 above but signals that the current word is the second word, i.e., DATA1.

Bit2 .... Data2 write
This bit functions in the same way as bits 0 and 1 above but signals that the current word is the third word, i.e., DATA2.

Bit3 .... Program read command
This bit is used when the host PC reads user data stored in the position control unit. When the first word (address) is output, this relay is turned on and the remaining two words (DATA1 and DATA2) can be read by the PC from the position control unit.

Bit4 .... Scan clock
This is the basic clock signal required to provide the timing for data transfer between the PC and the position control unit. The PC user program must include provision for generation of this signal in the cycle shown below:



2ms≤T≤100 ms

Bit5 .... Address (sequence no.) set
This bit specifies position data within the position control unit. When the PC outputs the first word (address) of the position data and turns this relay ON, the specified address becomes the address for position control unit. This bit is used when performing positioning using position data stored in a specific address.

Bit6 .... Handshaking error release
During data transmission from the PC to the position control unit, the handshaking error relay (CHn+3, bit5) is set and transmission is aborted if a value exceeding the defined limits is detected, or if there is a protocol error in the position control unit. This relay is used to release such errors from the PC side and to restart the transmission process. (In this case, however, transmission must be restarted from the first word (address) of the user data.)

Bit7 .... Operation mode
This bit informs the position control unit that the host PC is in either run or monitor mode. This signal must be supplied by a normally ON relay (relay 6113 for example) in the user program.
If the operation mode bit is off:

- during data transmission, turning this relay ON to restart transmission may cause an error.
- during positioning, this will result in the same process as for a PC interrupt

Bit8 .... Shaft start
When this relay turns ON, the positioning operation begins. This bit is not required, however, for origin search or origin return operations.

Bit9 .... Pause
If this relay is turned ON during the positioning operation, the operation will stop, and enter a wait state. The positioning operation will be resumed at the speed defined in the acceleration/deceleration table when this relay is turned OFF.

Bit10 .... Origin return
When this relay is turned ON, the shaft is returned to the position stored in the position control unit's memory as the origin. The speed at this time will be the speed stored in address 4000 (*0) and the operation will follow the procedure defined in the acceleration/deceleration table.

Bit11 .... Forced origin
When this relay turns ON, the current position is stored as the origin in the memory of the position control unit. At this time, both the command and the error counters are cleared. Note, however, that this relay is valid only during stop [when the stop or pause signal has been input].

Bit12 .... Home shift
This bit enables the home shift operation. When this bit is ON, positioning is performed after adding the home shift data to the position data. When this relay is OFF, normal positioning is performed.



Bit13 .... PC interrupt
When this relay is turned ON during the positioning operation, the operation stops and will not be resumed even if this relay is turned back OFF. In other words, this relay causes a forced cancel of the positioning operation. To restart the positioning operation, CHn, bit8 (shaft start) must be set to ON. In this case the address will be automatically incremented and the destination will be next destination after the one that was interrupted.

Bit14 .... Origin search
When this relay is turned ON, the position control unit will begin to search for the mechanical origin as defined by the origin limit switch and the origin vicinity limit switch.

Bit15 .... Stop
This relay is used to connect and disconnect the motor and the driver. This bit is used, for example, to turn the servocontrol ON and OFF for moving the shaft manually. Note, however, that this relay is not used internally by the position control unit; the signal input to this relay is output unchanged to an external connector.

CHn+2
This channel functions as the data bus to transfer user data (position, parameter, and speed data) as well as current position data from the position control unit to the host PC. The format for all data transfers is BCD.

CHn+3
The bits of this channel are used to inform the host PC of the handshaking and command execution status.

Bit0 .... ACK (handshaking BUSY)
During data transmission between the host PC and the position control unit, this relay outputs a signal to acknowledge reception of commands and data from the host PC. If this acknowledge protocol is not performed, a handshaking error occurs.

Bit1 .... DATA1 transmit
When user or current position data is sent from the position control unit to the host PC, it is broken into 3 words each 16 bits long. This bit functions to inform the PC that the second of these 3 words (DATA1) is being sent.

Bit2 .... DATA2 transmit
This bit functions in the same way as bit 1 above but signals that the current word is the third word, i.e., DATA2.

Bit3 .... Program data transmit
This relay turns ON when data in the position control unit is read by the host PC.

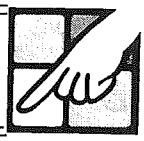
Bit4....NC RUN
This relay turns ON when the position control unit is in the operable status and remote mode.

Bit5 .... Handshaking error
During data transmission from the the position control unit to the PC, this relay turns ON and transmission is aborted if a value exceeding the defined limits is detected, or if there is a protocol error. Handshaking error release (CHn+1, bit6) signal must be used to restart the transmission.

Bit6 .... Current position data transmit
This relay turns ON to inform the host PC that the current position data is being sent from the position control unit to the PC.

Bit7 .... Execution address (execution sequence no.) transmit
This relay turns ON when the address of the positioning operation currently being executed is sent from the position control unit to the host PC.

Bit8 .... BUSY (positioning operation)
This relay turns and remains ON while position control unit is performing the positioning operation; it turns OFF when the operation completes and remains OFF until the next positioning operation begins.



Bit9 .... Sequence end
This relay turns on when a series of positioning operations has completed and the dwell time has elapsed and turns OFF at the start of next positioning operation.

Note: In remote mode, this bit turns ON after origin search or origin return. In local mode, however, it remains OFF after these operations.

Bit10 .... Origin
This relay turns ON when the shaft stops at the position that is stored in the memory of the position control unit as the origin (but not when this point is passed). This relay also turns ON when the forced origin relay turns ON.

Bit11 .... Bank end
This relay turns ON when the last position data of a continuous series stored in the memory of the position control unit is executed or when data with the "bank end" attribute is executed.

Bit12 .... CNC error
This relay turns ON in the following cases:

- when one of the left or right limit switches has turned ON
- when one of the software limits (parameters 2002 and 2003) has turned ON
- when there is no feedback from the encoder, or when the return signal from the encoder is delayed and the value of the error counter exceeds the defined limits

Bit13 .... Interrupt
This relay turns ON when a PC or external interrupt is generated.

Bit14 .... Near-zero
This bit turns on when the value of the error counter falls within a predefined range (parameter 2008).

Bit 15....Emergency and immediate stop
This relay turns ON when an emergency stop signal or immediate stop signal has been input.

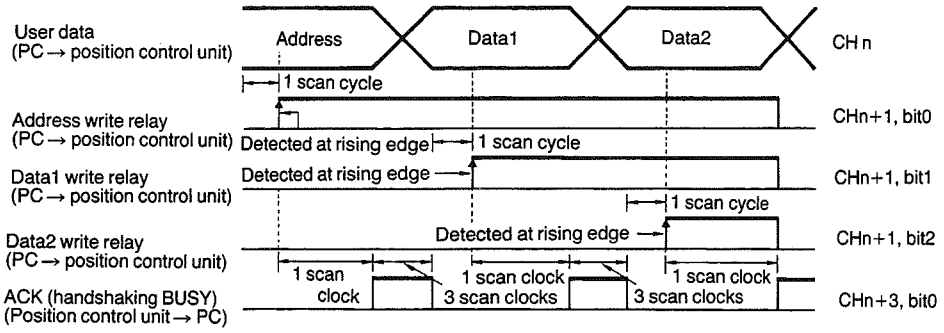
6.2.1 HANDSHAKING COMMANDS

User data transfer (PC → position control unit)

The following describes the protocol for transferring user data (position, parameter, and speed data) from the host PC to the position control unit.

Timing chart

This is a reference timing chart for the handshaking commands. The times indicated by such expressions as "1 scan clock", etc., are for reference only and will vary in actual applications.



Data transfer sequence

[1] The host PC places the address data on the PC → position control unit data bus (CHn).

[2] The PC waits for at least one scan clock after the address data has become stable and sends the address write command to the position control unit by turning the relay at CHn+1, bit0 ON.

[3] The position control unit reads the address data, performs a format check, and then outputs an ACK signal (CHn+3, bit0) to acknowledge that the address data has been received. If a format error is detected at this time, the handshaking error bit (CHn+3, bit5) will turn ON. Once the position control unit has output this ACK signal, the address write relay may be turned OFF.

[4] When the ACK signal is returned, the PC outputs Data1 to the PC → position control unit bus (CHn).

[5] The PC waits for at least one scan clock after Data1 has become stable and then sends the Data1 write command by turning the relay at CHn+1, bit1 ON.

[6] The position control unit reads Data1, performs a format check, and then outputs an ACK signal (CHn+3, bit 0) to acknowledge that DATA1 has been received.
Once the position control unit has output this ACK signal, the Data1 write relay may be turned OFF.

[7] When the ACK signal is returned, the PC outputs Data2 to the PC → position control unit bus (CHn).

[8] The PC waits for at least one scan clock after Data2 has become stable and then sends the Data2 write command by turning the relay at CHn+1, bit2 ON.

[9] The position control unit reads Data2, performs a format check, and then outputs an ACK signal (CHn+3, bit0) to acknowledge that Data2 has been received.
Once the position control unit has output this ACK signal, the Data2 write relay may be turned OFF.

Example program

The following is an example program for user data transfer. Here, data memories DM001 to DM030 store the program and DM000, CH15, and CH30 are used as a work area.

This program uses bits 0, 1, 2, 4, and 7 of channel n+1; bit0 of channel n+3.

● Relay assignment for position control unit

CH / Bit	0	1	2	3
0	PC → position control unit data bus	Address write	Position control unit → PC data bus	ACK handshake (BUSY)
1		Data1 write		
2		Data2 write		
3				
4		Scan clock		
5				
6				
7		Operation mode		
8				
9				
10				
11				
12				
13				
14				
15				

This example assumes that the position control unit is mounted to the channels 0 to 3 of the PC.

● Relay assignment

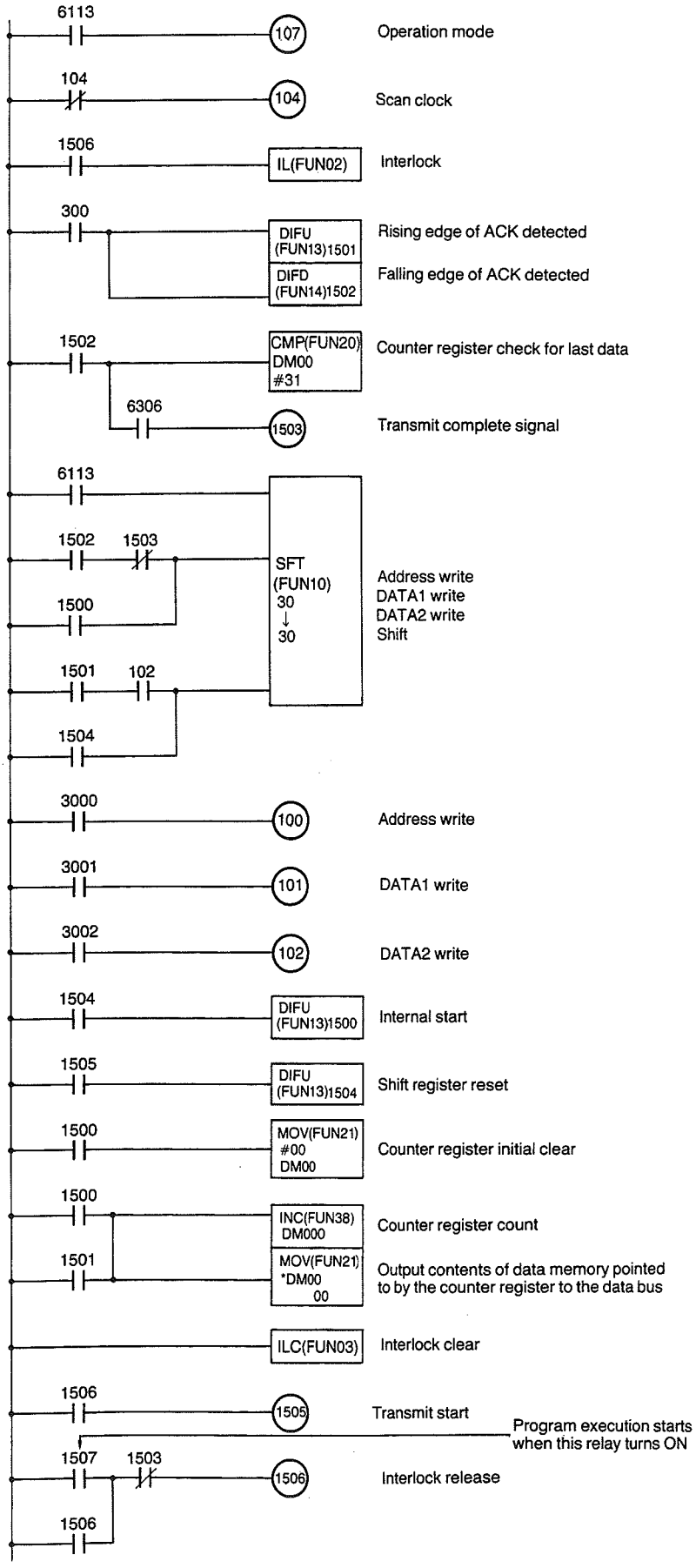
Bit	CH15	CH30
0	Start data transfer rising edge differential relay	Handshaking command auxiliary relay
1	ACK rising edge differential relay	Handshaking command auxiliary relay
2	ACK falling edge differential relay	Handshaking command auxiliary relay
3	Transfer complete auxiliary relay	
4	SFT reset auxiliary relay	
5	IL internal start auxiliary relay	
6	IL auxiliary relay	Note: This channel, CH30, is used for shift register and should not be used by any other signals.
7	Start data transfer auxiliary relay	
8		
9		
10		
11		
12		
13		
14		
15		

● Data memory assignment

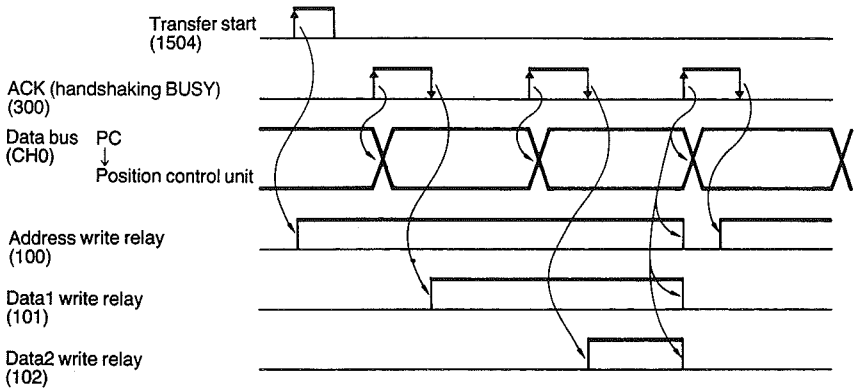
In this program, 10 groups of 3-word user data are stored in data memories DM001 to DM030. DM000 is used as a counter register for the memory relay numbers.

	Data memory	Description
	DM000	Memory No. counter register
User data1	DM001	Address data
	DM002	Data1
	DM003	Data2
User data2	DM004	Address data
	DM005	Data1
	DM006	Data2
	⋮	⋮
User data10	DM028	Address data
	DM029	Data1
	DM030	Data2

Transferred program



The following timing chart shows the timing for the example program.



The condition of the position control unit data bus and handshaking channel (CH02, CH03) during data transmission from the PC is shown ir the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	User data	0000
CHn+3	0	ACK (handshaking BUSY)	ON ↔ OFF	ON
	1	DATA1 receive	OFF	OFF
	2	DATA2 receive	OFF	OFF
	3	Program data receive	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data receive	OFF	OFF
	7	Execution address receive	OFF	OFF
	8	BUSY (positioning operation)	OFF	OFF
	9	Sequence end	ON or OFF*	ON or OFF*
	10	Origin	ON or OFF	ON or OFF
	11	Bank end	ON or OFF	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero position	ON	ON
	15	Emergency and immediate stop	OFF	OFF

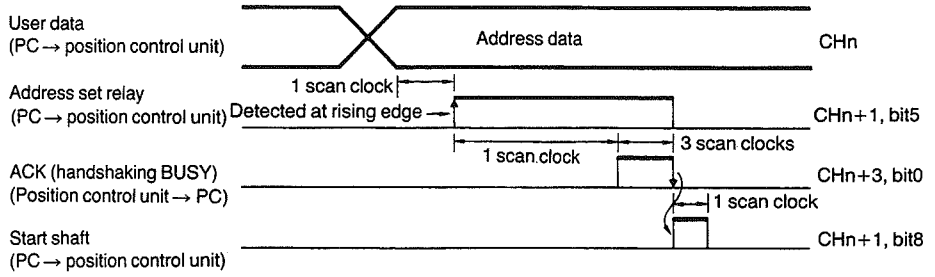
* Bit 9 is OFF before the origin is determined and ON after it has been determined.

Address (sequence number) setting

The following is a description of the operations required to set the position data in the desired address. After this setting has been performed, turning the start shaft relay ON will cause the positioning operation to be executed starting from the set address.

Timing chart

This is a reference timing chart for address setting. The times indicated by such expressions as "1 scan clock", etc., are for reference only and will vary in actual application.



Address setting sequence

[1] The host PC places the address data on the PC → control unit data bus (CHn).

[2] The PC waits for at least one scan clock after the address data has become stable and sends the address setting command to the position control unit by turning the relay at CHn+1, bit5 ON.

[3] The position control unit reads the address data, performs a format check, and then outputs an ACK signal (CHn+3, bit0) to acknowledge that the command has been received.
At this point the address is set in the position control unit and the address setting command may be turned OFF. If a format error is detected, the handshaking error bit (CHn+3, bit5) will turn ON.

[4] As for the timing of the start shaft command (CHn+1, bit8), this command should be performed at or after the falling edge of the ACK signal.

The following is a user data transfer example program. This program uses CH15 as the working area; the handshaking signals used are CH1, bits 4, 5, 7, and 8; CH3, bit0.

Relay assignment for position control unit

CH / Bit	0	1	2	3
0	PC → position control unit data bus		Position control unit → PC data bus	ACK (handshake BUSY)
1				
2				
3				
4		Scan clock		
5		Address setting		
6				
7		Operation mode		
8		Start shaft		
9				
10				
11				
12				
13				
14				
15				

This example assumes that the position control unit is mounted to the channels 0 to 3 of the PC.

● Relay assignment

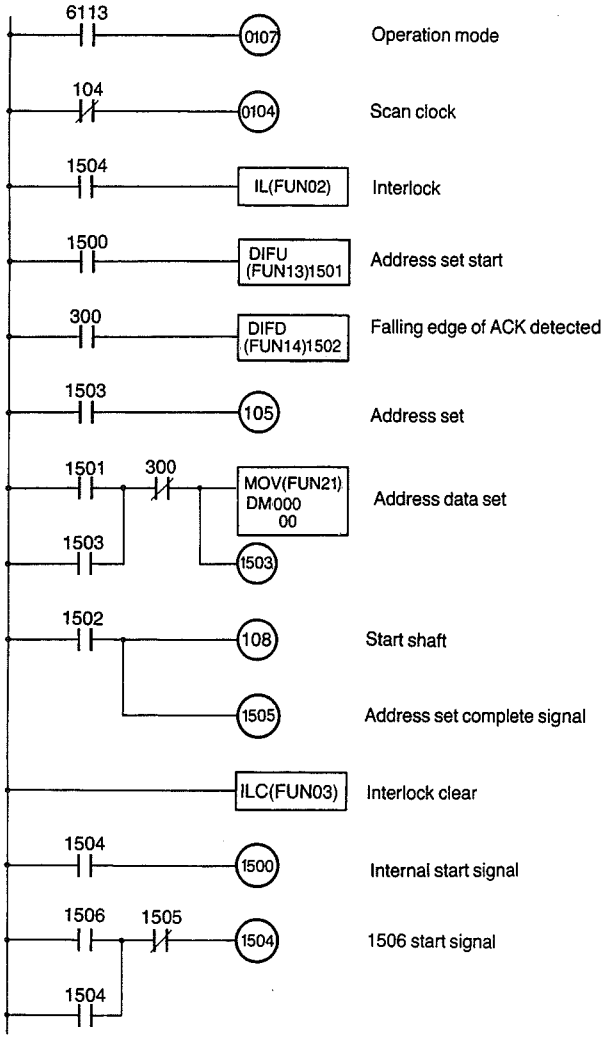
Bit	CH15
0	Address set start auxiliary relay
1	Address set auxiliary relay
2	Address set auxiliary relay
3	Address set auxiliary relay
4	IL auxiliary relay
5	Address set complete signal
6	Address set start signal
7	
8	
9	
10	
11	
12	
13	
14	
15	

● Data memory assignment

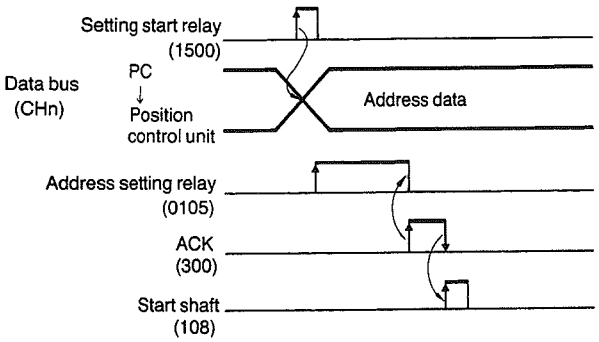
Memory relay No.	Description
DM000	Address data

Example program

The following program sets the data in DM000 as the next address to be executed.



The timing for the example program is shown in the following timing chart.



The condition of the position control unit data bus and handshaking channel (CHn+2, CHn+3) during data transmission from the PC is shown in the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Address data	0000
CHn+3	0	ACK (handshaking BUSY)	ON ↔ OFF	ON
	1	DATA1 transmit	OFF	OFF
	2	DATA2 transmit	OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	OFF	OFF
	7	Execution address transmit	OFF	OFF
	8	BUSY (positioning operation)	OFF	OFF
	9	Sequence end	ON or OFF*	ON or OFF*
	10	Origin	ON or OFF	ON or OFF
	11	Bank end	ON or OFF	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero position	ON	ON
	15	Emergency and immediate stop	OFF	OFF

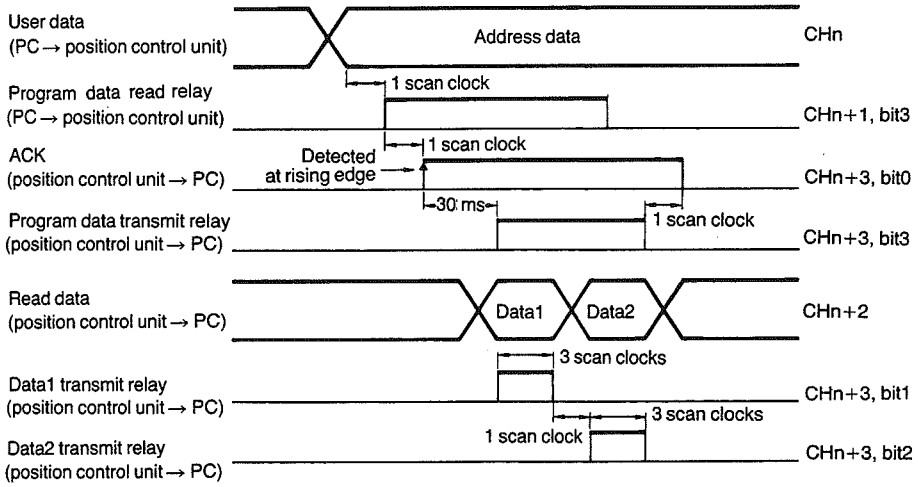
* Bit 9 is OFF before the origin is determined and ON after it has been determined.

User data read

The following is a description of the operations required to read the contents of any desired address in the position control unit's memory.

Timing chart

This is a reference timing chart for reading user data. The times indicated by such expressions as "1 scan clock", etc., are for reference only and will vary in actual application.



Data read sequence

[1] The host PC places the address data on the PC → position control unit data bus (CHn).

[2] The PC waits for at least one scan clock after the address data has become stable and then issues the data read command by turning the relay at CHn+1, bit5 ON.

[3] The position control unit reads the address data, performs a format check, and then outputs an ACK signal (CHn+3, bit0) to acknowledge that the command has been received.
At this point the address is set in the position control unit and the address setting command may be turned OFF.
If a format error is detected, the handshaking error bit (CHn+3, bit5) will turn ON.

[4] The position control unit waits approximately 30 ms after returning the ACK signal and then turns the program data transmit relay (CHn+3, bit3) ON. At the same time, the position control unit also outputs Data1 to the position control unit → PC data bus (CHn+2).

[5] Once Data1 has become stable, the position control unit turns the Data1 transmit signal (CHn+3, bit1) ON.

[6] After Data1 has been output long enough to ensure that it has been read by the PC, Data2 is next placed on the bus.

[7] Once Data2 has become stable, the position control unit turns the Data2 transmit signal (CHn+3, bit2) ON.

[8] After DATA2 has been output long enough to ensure that it has been read by the PC, the Data2 transmit relay is turned OFF. At the same time, the program data transmit relay is turned OFF and Data2 changes to the next data.

The interface signals used by this sequence are CH1, bits 3, 4, and 7; CH3, bits 0 to 3.

● Relay assignment for position control unit

Bit \ CH	0	1	2	3
0	PC → Position control unit data bus		Position control unit → PC data bus	ACK (handshake BUSY)
1				Data1 transmit
2				Data2 transmit
3		Program read command		Program data transmit
4		Scan clock		
5				
6				
7		Operation mode		
8				
9				
10				
11				
12				
13				
14				
15				

● Relay assignment

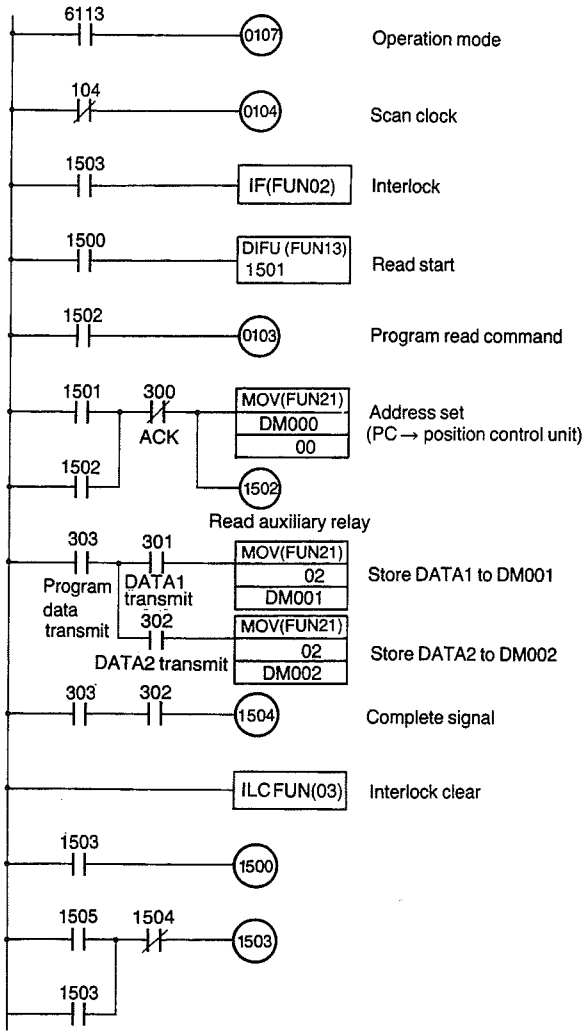
Bit	CH15
0	Read start relay
1	Read auxiliary relay
2	Read auxiliary relay
3	IL auxiliary relay
4	User data read complete signal
5	User data read start signal
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

● Data memory assignment

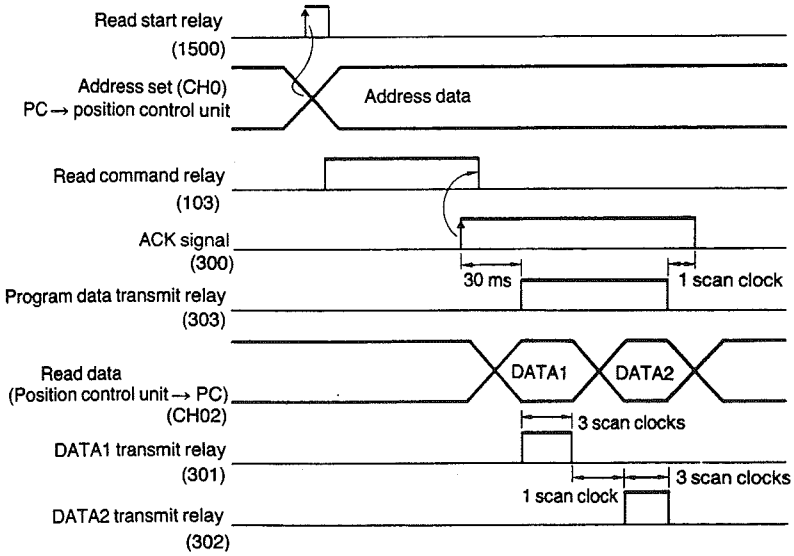
Data memory No.	Description
DM000	Address data
DM001	Data1
DM002	Data2

Example program

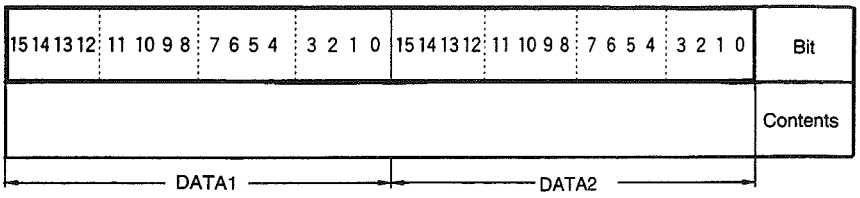
In the program that follows, the PC reads the user data addressed by the value stored in DM000, and stores this data in DM001 (DATA1) and DM002 (DATA2).



The timing chart for the example program is shown below.



● Data format (position control unit → PC)



● Data memory assignment

The format for DATA1 and DATA2 depends on the type of user data in the address specified by the PC. The type of data stored in each range of memory is as shown below.

Address	Description
1000 to 1200	Position data
2000 to 2011	Parameter data
4000 to 4009	Speed data

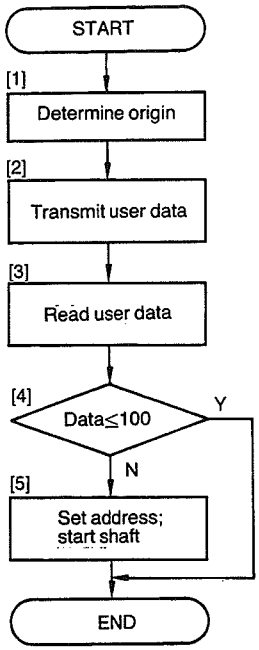
The condition of the position control unit data bus and handshaking channel (CH02, CH03) during user data read is shown in the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	User data	0000
CHn+3	0	ACK (handshaking BUSY)	ON ↔ OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	ON ↔ OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	OFF	OFF
	7	Execution address transmit	OFF	OFF
	8	BUSY (positioning operation)	OFF	OFF
	9	Sequence end	ON or OFF*	ON or OFF*
	10	Origin	ON or OFF	ON or OFF
	11	Bank end	ON or OFF	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero position	ON	ON
	15	Emergency and immediate stop	OFF	OFF

* Bit 9 is OFF before the origin is determined and ON after it has been determined.

Complete operation flow

The handshaking commands described thus far can be used together to perform the complete positioning action shown in the following flowchart.



[1] The origin is determined using either origin search or forced origin. This will cause the origin bit (CHn+3, bit10) to be set, starting the program.

[2] The necessary user data (parameter, speed, and positioning data) is sent from the PC to the position control unit.

[3] The address 1005 positioning data is read and stored in data memory DM200.

[4] The program tests for data less than 100, if the data value is less than 100, program execution is terminated.

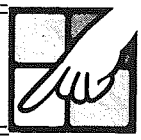
[5] If the read data is greater than 100, the execution address is set to 1000 and the shaft movement is started to perform the positioning operation.

● Relay assignments

Bit \ CH	0	1	2	3
0	PC → Position control unit data bus		Position control unit → PC data bus	ACK (handshake BUSY)
1				
2				
3				
4		Scan clock		
5				
6				
7		Operation mode		
8				
9				
10				Origin
11				
12				
13				
14				
15				

The interface signals used by this program are CH1, bits 4, and 7; CH3, bits 0 and 10. This program assumes that the user has set the following data in the memory of the position control unit.

DM001 to DM036 Parameter data
DM037 to DM066 Speed data
DM067 to DM096 Positioning data



●Data memory

Parameter data

Memory No.	Description
DM000	Memory number counter register
DM001	Address data
DM002	Data1
DM003	Data2
	⋮
DM034	Address data
DM035	Data1
DM036	Data 2

Speed data

Memory No.	Description
DM037	Address data
DM038	DATA1
DM039	DATA2
	⋮
DM064	Address data
DM065	DATA1
DM066	DATA2

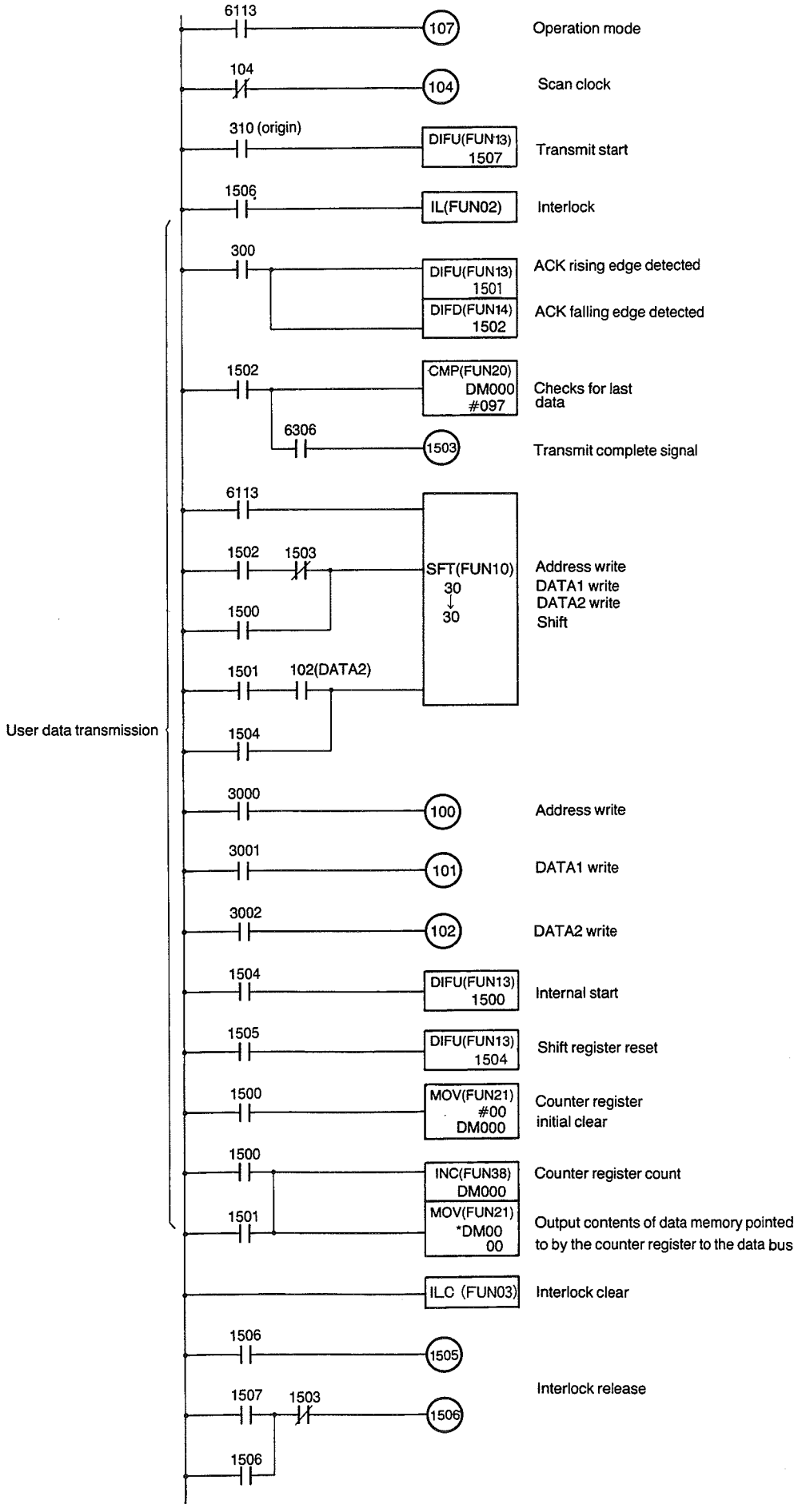
Position data

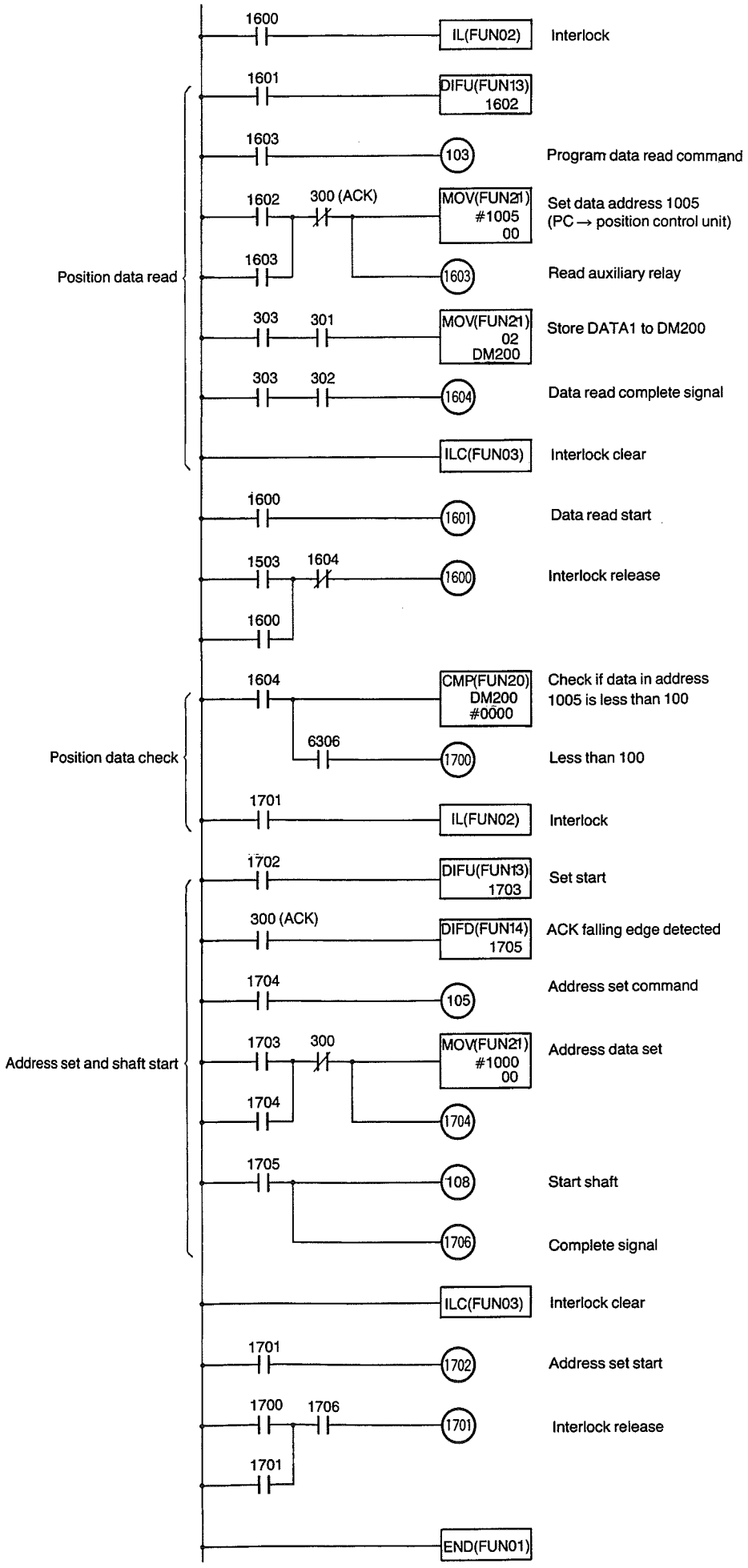
Memory No.	Description
DM067	Address data
DM068	DATA1
DM069	DATA2
	⋮
DM094	Address data
DM095	DATA1
DM096	DATA2
DM200	Read data storage area

● Auxiliary relay assignment

Bit	CH15	CH16	CH17	CH30
0	Start data transmit rising edge differential relay	IL auxiliary relay	Address set start auxiliary relay	Handshaking command auxiliary relay
1	ACK rising edge differential relay	Data read start	IL auxiliary relay	Handshaking command auxiliary relay
2	ACK falling edge differential relay	Data read start rising edge differential relay	Internal auxiliary relay	Handshaking command auxiliary relay
3	Transfer complete auxiliary relay	Internal auxiliary relay	Address set rising edge differential relay	
4	SFT reset auxiliary relay	Data read complete auxiliary relay	Internal auxiliary relay	
5	IL internal start auxiliary relay		ACK falling edge differential relay	
6	IL auxiliary relay		Address set complete signal	
7	Start data transmit auxiliary relay			
8				
9				
10				
11				
12				
13				
14				
15				

The bits of CH30 are used for a shift register and should not be used for any other purpose.

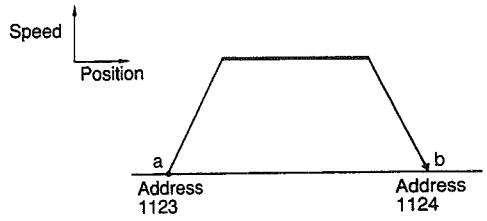

6113
107
Operation mode
104
104
Scan clock
310 (origin)
DIFU(FUN13)
1507
Transmit start
1506
IL(FUN02)
Interlock
300
DIFU(FUN13)
1501
ACK rising edge detected
DIFD(FUN14)
1502
ACK falling edge detected
1502
CMP(FUN20)
DM000
#097
Checks for last data
6306
1503
Transmit complete signal
6113
1502
1503
1500
SFT(FUN10)
30
30
Address write
DATA1 write
DATA2 write
Shift
1501
102(DATA2)
1504
User data transmission
3000
100
Address write
3001
101
DATA1 write
3002
102
DATA2 write
1504
DIFU(FUN13)
1500
Internal start
1505
DIFU(FUN13)
1504
Shift register reset
1500
MOV(FUN21)
#00
DM000
Counter register initial clear
1500
INC(FUN38)
DM000
Counter register count
1501
MOV(FUN21)
*DM00
00
Output contents of data memory pointed to by the counter register to the data bus
ILC (FUN03)
Interlock clear
1506
1505
Interlock release
1507
1503
1506
1506


1600
IL(FUN02)
Interlock
1601
DIFU(FUN13)
1602
1603
103
Program data read command
1602
300 (ACK)
MOV(FUN21)
#1005
00
Set data address 1005
(PC → position control unit)
Position data read
1603
1603
Read auxiliary relay
303
301
MOV(FUN21)
02
DM200
Store DATA1 to DM200
303
302
1604
Data read complete signal
ILC(FUN03)
Interlock clear
1600
1601
Data read start
1503
1604
1600
Interlock release
1600
1604
CMP(FUN20)
DM200
#0000
Check if data in address
1005 is less than 100
Position data check
6306
1700
Less than 100
1701
IL(FUN02)
Interlock
1702
DIFU(FUN13)
1703
Set start
300 (ACK)
DIFD(FUN14)
1705
ACK falling edge detected
1704
105
Address set command
Address set and shaft start
1703
300
MOV(FUN21)
#1000
00
Address data set
1704
1704
1705
108
Start shaft
1706
Complete signal
ILC(FUN03)
Interlock clear
1701
1702
Address set start
1700
1706
1701
Interlock release
1701
END(FUN01)

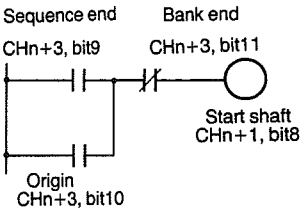
6.2.2 EXECUTION (RUN) COMMAND

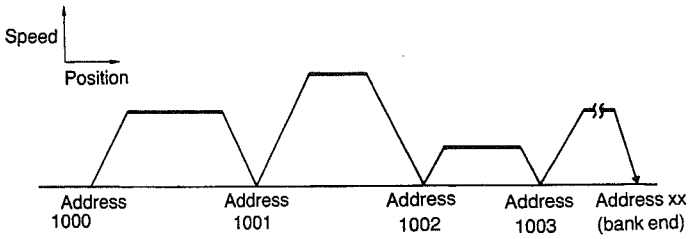
Start shaft

When the start shaft relay is turned ON, the positioning operation will begin from the indicated address; the address is autoincremented when the positioning operation finishes.

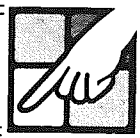


If the start shaft relay is turned ON at point a (after the positioning operation specified by the contents of address 1123 has completed and the address has been incremented), the shaft will move to point b at th speed specified by the speed data ancillary to position data.
A relay circuit to perform this function is shown below.





In the above figure, the series of positioning data is executed once after first performing origin search, forced origin, or origin return.



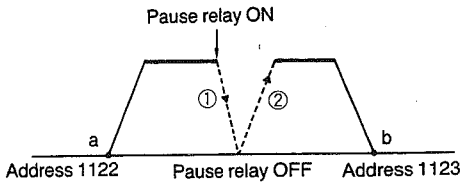
The condition of the position control unit data bus and handshaking channel (CHn+2, CHn+3) during positioning (after the start shaft signal has been applied) is shown in the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	User data	0000
CHn+3	0	ACK (handshaking BUSY)	OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	ON ↔ OFF	OFF
	7	Execution address transmit	ON ↔ OFF	OFF
	8	BUSY (positioning operation)	ON	ON
	9	Sequence end	OFF*	OFF*
	10	Origin	OFF	OFF
	11	Bank end	OFF	OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero position	ON or OFF	ON or OFF
	15	Emergency and immediate stop	OFF	OFF

* Bit 9 is OFF before the origin is determined and ON after it has been determined.

Pause

The pause relay is used to effect a temporary halt in the positioning operation.



In the above figure, the pause relay turns ON during a positioning operation between points a (address 1122) and b (address 1123) causing the shaft to decelerate and then stop. When the pause relay is turned OFF, the operation continues toward the predetermined destination.

Since the pause state is considered to be a part of the positioning operation, the BUSY signal remains ON.

Note:

- If the pause relay is turned ON during origin search, the search operation will be aborted. To continue the origin search, the origin search relay must be turned ON again after first turning the pause relay OFF.
- Pause can be effected during origin return.

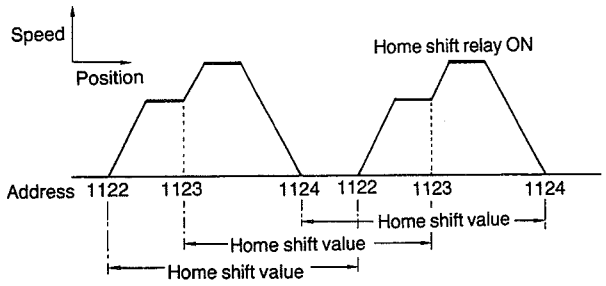
The condition of the position control unit data bus and handshaking channel (CH02, CH03) during the pause state is shown in the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Current position data; execution address	0000
CHn+3	0	ACK	OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	ON ↔ OFF	OFF
	7	Execution address transmit	ON ↔ OFF	OFF
	8	BUSY	ON	ON
	9	Sequence end	OFF*	OFF*
	10	Origin	OFF	OFF
	11	Bank end	OFF	OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero	ON	ON
	15	Emergency and immediate stop	OFF	OFF

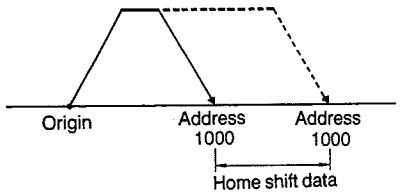
* Bit 9 is OFF before the origin is determined and ON after it has been determined.

Home shift

The home shift relay (CHn+1, bit12) is used to move a series of positioning operations to a new location. While the home shift relay is ON, the home shift data (set in address 1200) will be added to the position data and the actual positioning operation is performed using the resulting sum. In the following figure, when the home shift relay is ON, the series of positioning operations (addresses 1122 to 1124) is shifted by the home shift value.



Note that the origin position does not change even if the home shift relay is ON. The current position (position control unit → PC) is raised by the home shift value. For example, if the address 1000 position data is 500 and the home shift value is 200, the current position will be 500 when the home shift relay is OFF, and 700 (500 + 200) when the home shift relay is ON.

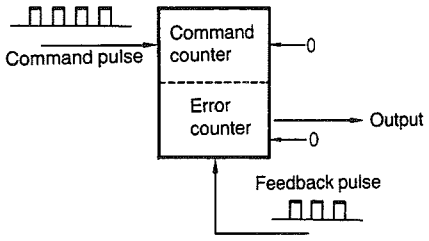


Origin return

Origin return is described in detail in Chapter 8, Origin determination.

Forced origin

When this relay is turned ON, both the error and the command counter are cleared and the current position becomes the origin.



Note, however, that forced origin is effective only during the stop state.

Forced origin is used:

- when the positioning range is narrow and there is not enough space between the origin and the origin vicinity to set a positioning value
- to permanently move the origin in order to perform positioning operations from the new origin
- after power has been applied, to perform preparatory positioning before the origin is actually determined

Note that this signal is recognized at the rising edge.

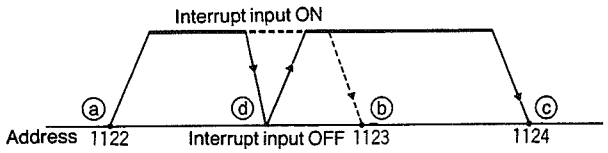
The condition of the position control unit data bus and handshaking channel (CH02, CH03) after completion of the forced origin operation is shown in the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Current position data; execution address	0000
CHn+3	0	ACK	OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	ON ↔ OFF	OFF
	7	Execution address transmit	ON ↔ OFF	OFF
	8	BUSY	OFF	OFF
	9	Sequence end	ON*	ON*
	10	Origin	ON	ON
	11	Bank end	ON or OFF	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero	ON	ON
	15	Emergency and immediate stop	OFF	OFF

* Bit 9 is OFF before the origin is determined and ON after it has been determined.

PC interrupt

This command is similar to the pause command in that it causes the positioning operation to halt. However, it differs from the pause command in that, when the start shaft signal is applied a second time, instead of continuing from where the previous positioning operation stopped, the address of the aborted operation is incremented and the new address is taken as the destination.



As can be seen in the above figure, the positioning operation begins from position ⓐ when the start shaft signal is input. Before the destination (position ⓑ, dotted line) can be reached, however, an interrupt is input causing the shaft to decelerate and stop at point ⓓ. When the interrupt is cleared and the start shaft signal is again input, the positioning operation will start again, taking point ⓒ (address 1124) as the destination. In other words, this function cancels the current positioning operation.

The PC interrupt function can be also used to cancel an emergency stop signal. When the emergency stop relay is turned ON, the emergency and immediate stop relay (CHn+3, bit15) is also turned ON. By turning ON the PC interrupt relay after turning OFF the emergency stop relay, the emergency stop signal can be canceled.

There are two kinds of interrupts that can be input to the position control unit: a PC interrupt from the host PC and an external interrupt. These two interrupt inputs are ORed together so that an interrupt will occur if the signal from either source is received and the interrupt can only be cleared when both sources are OFF.

Note that if the PC interrupt is turned ON during the origin search, the search is aborted. To continue the search, the origin search relay must be turned ON again after removing the PC interrupt input. Also note that the PC interrupt is valid during origin return.

The condition of the position control unit data bus and handshaking channel (CH02, CH03) after an interrupt has been received is shown in the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Current position data; execution address	0000
CHn+3	0	ACK	OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	ON ↔ OFF	OFF
	7	Execution address transmit	ON ↔ OFF	OFF
	8	BUSY	OFF	OFF
	9	Sequence end	ON*	ON*
	10	Origin	OFF	OFF
	11	Bank end	ON or OFF	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	ON	ON
	14	Near-zero	ON	ON
	15	Emergency and immediate stop	OFF	OFF

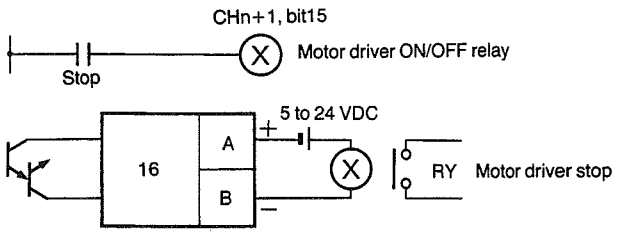
* Bit 9 is OFF before the origin is determined and ON after it has been determined.

Origin search

Origin search is described in detail in Chapter 8, Origin determination.

Stop

Because this relay only conveys commands from the host PC to the motor driver, and does not affect the functions of the position control unit in any way, the stop function can be used for a wide range of applications. For example, the relay can be used to stop the motor driver or to permit manual rotation of the shaft.



This relay can also be used as a switch for a variety of other purposes.

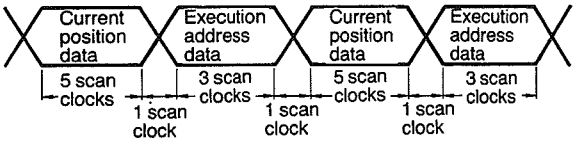
Note that this relay is used to control the driver from the PC; the operation of the position control unit is continuous.

6.2.3 HANDSHAKING STATUS

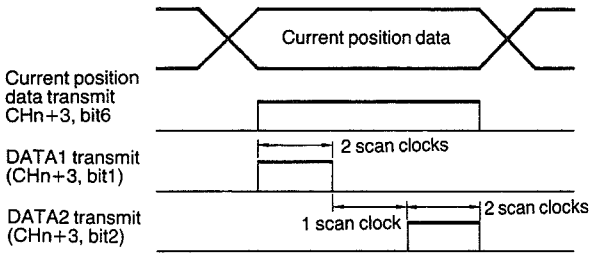
Current position display output

The position control unit constantly outputs the current position data, alternating this output with that of the execution address data; the data is output even during the positioning operation (BUSY) or in the stop state.

The format and reference timing for this output are as shown in the following figure.



[1] The current position data transmit relay (CHn+3, bit6) turns ON while the current position data is being output to the position control unit → PC data bus. While the DATA1 transmit relay (CHn+3, bit1) is ON, DATA1 of the current position data is output.
[2] Next DATA2 of the current position data is output to the data bus. This is indicated by the DATA2 transmit status signal (CHn+3, bit2) turning ON.
[3] Finally, the current position data transmit relay and the DATA2 transmit relay turn OFF together.



Example program

The following is an example program for outputting the current position display data.

This program uses the scan clock and operation mode signals from the PC → position control unit bus (CHn+1) and the DATA1 transmit, DATA2 transmit and current position data transmit signals of the position control unit → PC handshaking bus (CHn+3).

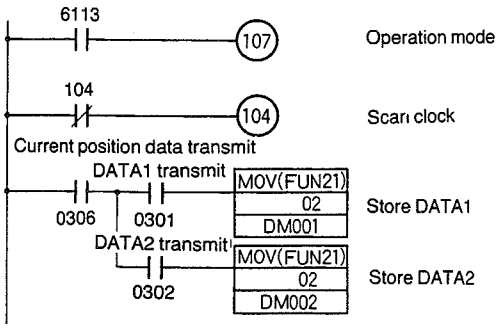
● Relay assignment for position control unit

Bit \ CH	0	1	2	3
0	PC → Position control unit data bus		Position control unit → PC data bus	
1				Data1 transmit
2				Data2 transmit
3				
4		Scan clock		
5				
6				Current position data transmit
7		Operation mode		
8				
9				
10				
11				
12				
13				
14				
15				

● Data memory assignment

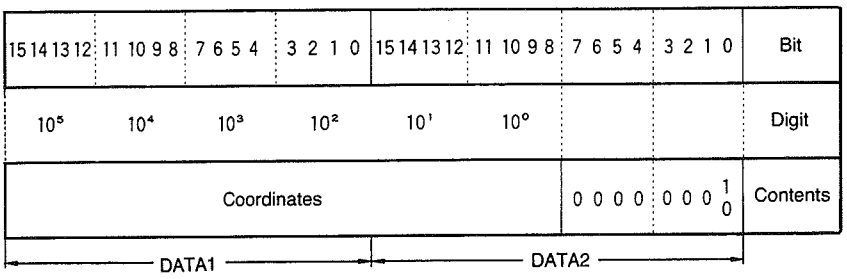
Data memory No.	Description
DM001	Current position Data1
DM002	Current position Data2

The following program reads the current position information output from the position control unit and stores it in DM001 (Data1) and DM002 (Data2).



Note that whether the current movement mode is incremental or absolute, the current position data is always output as absolute coordinates expressed in BCD format with a sign (+ or −) bit. At this time, all other attributes and speed bits are fixed at 0.

Data format (position control unit → PC)



The condition of the position control unit data bus and handshaking channel (CH02, CH03) during transmission of the current position is shown in the following table.

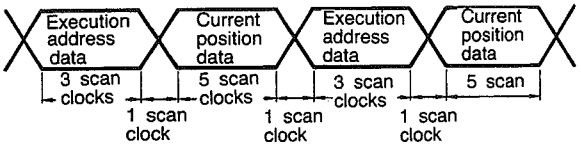
CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Current position data	0000
CHn+3	0	ACK	OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	ON	OFF
	7	Execution address transmit	OFF	OFF
	8	BUSY	ON or OFF	ON or OFF
	9	Sequence end	ON or OFF*	ON or OFF*
	10	Origin	ON or OFF	ON or OFF
	11	Bank end	ON or OFF	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	ON or OFF	ON or OFF
	14	Near-zero	ON or OFF	ON or OFF
	15	Emergency and immediate stop	OFF	OFF

* Bit 9 is OFF before the origin is determined and ON after it has been determined.

Execution address (execution sequence No.) display

The position control unit constantly outputs the execution address data, alternating this output with that of the current position data; this data is output even during the positioning operation (BUSY) or in the stop state.

The format and reference timing for this output are as shown in the following figure.



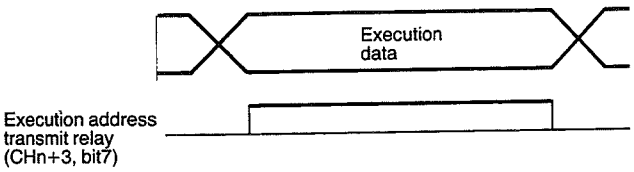
Execution address display sequence

[1] The execution address data is output to the position control unit → PC data bus (CHn+2) and at the same time the execution address transmit (CHn+3, bit7) relay turns ON.

[2] The execution address data continues to be output to the data bus while this relay is ON.

[3] When the execution address transmit relay turns OFF, the execution address data is removed from the bus.

The timing for this is shown below.



This sequence uses the scan clock and operation mode signals from the PC → position control unit bus (CHn+1) and the execution address transmit signal of the position control unit → PC handshaking bus (CHn+3).

Example program

The following is an example program for displaying execution address (execution sequence No.).

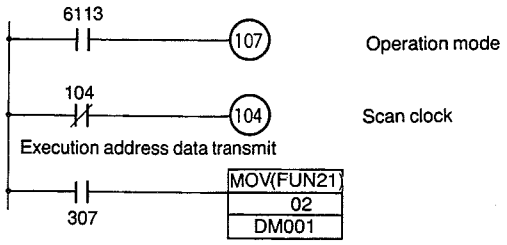
Bit \ CH	0	1	2	3
0	PC → Position control unit data bus		Position control unit → PC data bus	
1				
2				
3				
4		Scan clock		
5				
6				
7		Operation mode		Execution address transit
8				
9				
10				
11				
12				
13				
14				
15				

● Data memory assignment

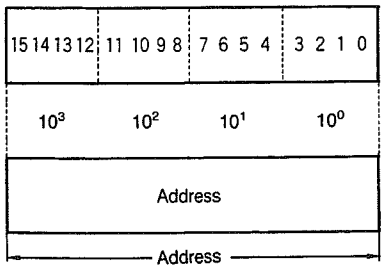
Data memory No.	Description
DM001	Execution address data

Example program

The following program reads the execution address data output from the position control unit and stores it in DM001.



● Data format (position control unit → PC)



Error code display

The position control unit is provided with a function that sends, if an error occurs, the error code identifying the nature of the error to the PC. For details, refer to Chapter 9.

The condition of the position control unit data bus and handshaking channel (CH02, CH03) during transmission of the execution address is shown in the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Execution address (sequence No.) data	0000
CHn+3	0	ACK	OFF	ON
	1	Data1 transmit	OFF	OFF
	2	Data2 transmit	OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position transmit	OFF	OFF
	7	Execution address transmit	ON	OFF
	8	BUSY	ON or OFF	ON or OFF
	9	Sequence end	ON or OFF*	ON or OFF*
	10	Origin	ON or OFF	ON or OFF
	11	Bank end	ON or OFF	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	ON or OFF	ON or OFF
	14	Near-zero	ON or OFF	ON or OFF
	15	Emergency and immediate stop	OFF	OFF

* Bit 9 is OFF before the origin is determined and ON after it has been determined.

6.2.4 EXECUTION STATUS

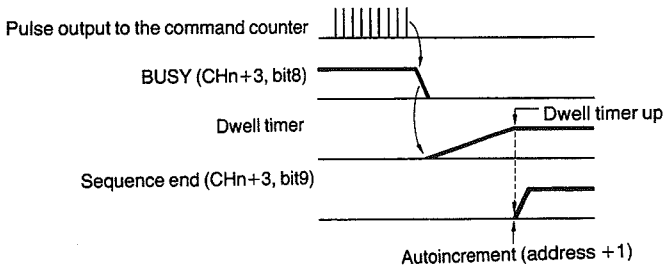
NC RUN

The NC RUN relay (CHn+3, bit4) turns ON when the position control unit is in the operable status. Specifically, it turns ON when the position control unit is in the remote mode and is ready to receive execution commands.

BUSY and sequence end

The BUSY signal is output to indicate that the position control unit is performing a positioning operation. The sequence end signal is output to indicate the completion of the positioning operation.

The relation between these two signals is shown in the following figure.



● Sequence of operations

[1] When the output of command pulses to the command counter ends, the BUSY signal relay (CHn+3, bit8) turns OFF.
[2] When the BUSY signal goes low, the dwell timer is activated.
[3] When the count of the dwell timer is up, the autoincrement function increments the address (+1).
[4] Once the address has been incremented, the sequence end relay turns ON.

Note: At the end of the origin search or origin return operation, the sequence end relay turns ON, but when the forced origin signal goes from OFF to ON, the sequence end signal does not turn ON.

Origin

This relay turns ON to show that the current position (where the shaft movement has stopped) is the origin.

This relay turns ON:

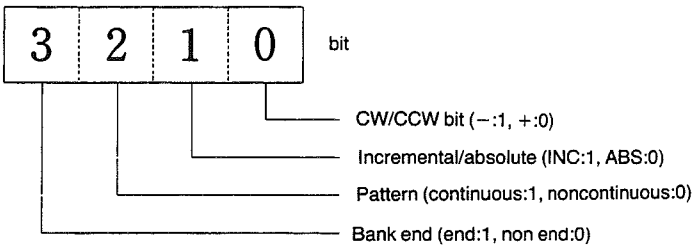
- when the forced origin relay has been turned ON
- when origin return has been executed
- when origin positioning operation (including origin search) has been executed

Bank end

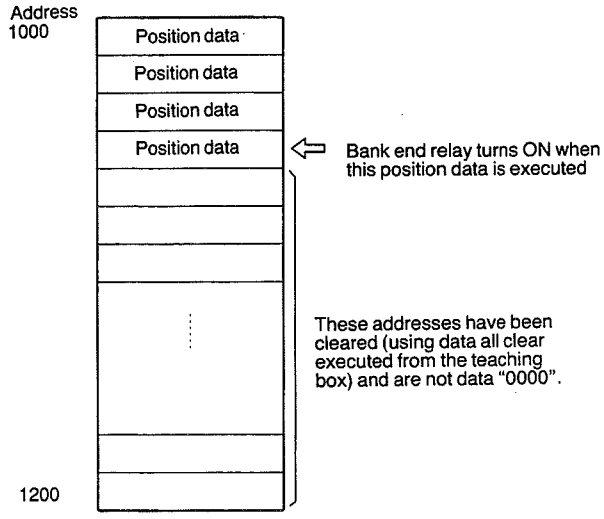
The bank end relay (CHn+3, bit11) turns ON in either of the two cases described below.

● When the bank end attribute of the position data is 1

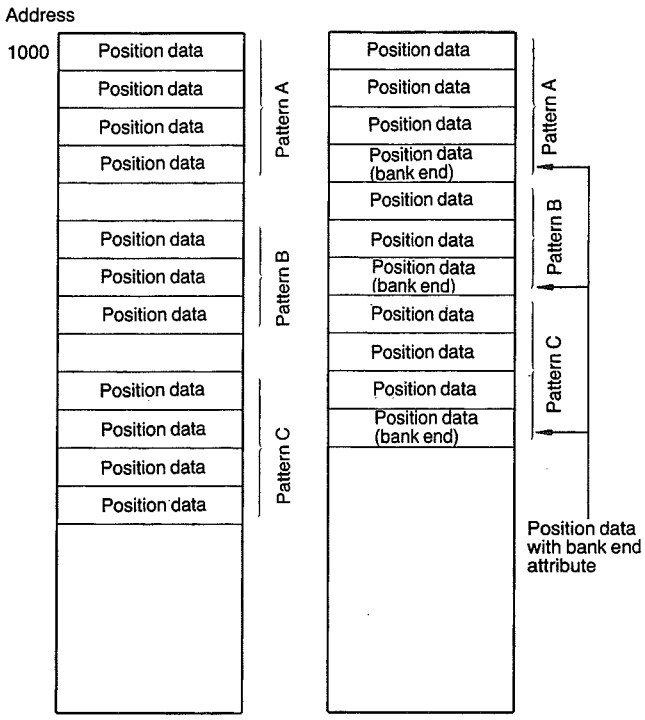
Attribute



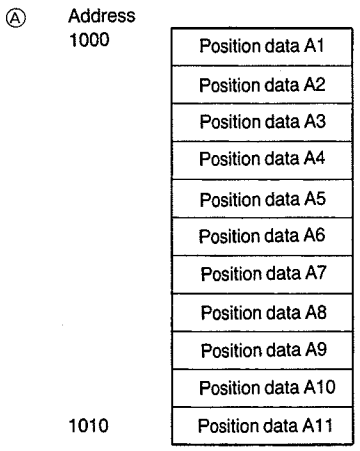
● When the last position data stored in the memory of the position contrc unit is executed



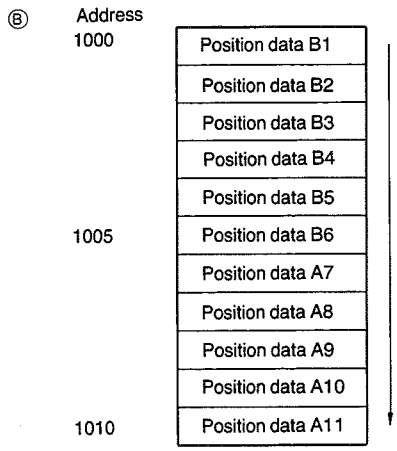
The bank end signal is used when different types of position data patterns have been stored in the memory of the position control unit. Examples of this are shown below.



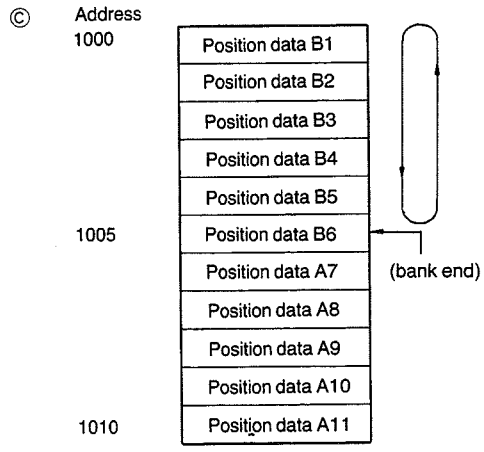
The bank end attribute is also used when writing position data.



In this example, it is assumed that position data A1 to A11 are stored in addresses 1000 to 1010. The position control unit cannot clear all of the position data using a command sent from the PC. Therefore, when rewriting the data stored in addresses 1000 to 1005, for example, the bank end attribute should be specified for the position data in address 1005. If it is not, execution will continue through to position data A11.



It would of course be possible to have the PC user program manage the execution addresses but this would increase the user program burder The normal practice is therefore to use position data with the bank end attribute to specify the range of addresses to be executed.



CNC error

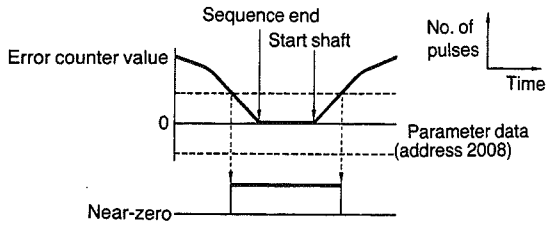
For details on the CNC error relay (CHn+3, bit12) refer to Chapter 9, Error processing.

Interrupt

This relay (CHn+3, bit13) turns ON when either the external interrupt or the PC interrupt (CHn+1, bit13) turns ON. Because the external interrupt and the PC interrupt are ORed together, this relay will turn ON if either of the interrupt sources turns ON and will only turn OFF when both of them are OFF.

Near-zero

This relay (CHn+3, bit14) turns ON when the current value of the error counter falls within the number of pulses specified by the near-zero parameter data (address 2008). Once this relay turns ON, it remains ON both during and after the positioning operation.



Note that when positioning is performed at low speeds, the value of the error counter will always be within the value specified by the near-zero parameter and consequently this relay will always be ON.

Emergency and immediate stop

For details of the emergency and immediate stop relays (CHn+3, bit15), refer to Chapter 9.

6.2.5 EXTERNAL INPUT SIGNALS

External interrupt

The function of this interrupt is the same as that of the PC interrupt. This input is ORed together with the PC interrupt input so an interrupt will occur if either of these interrupt sources is received and the interrupt will only be removed when both of these inputs turn OFF.

Immediate stop

This is an external input signal that enables or disables the position control unit to operate. When this signal is turned ON, the unit can operate, whereas when it is OFF, the unit cannot operate.
If this signal is turned OFF while the position control unit is not operating, the display remains unchanged and the unit accepts no command such as the shaft start and transfer. To enable the position control unit to receive the commands, the immediate stop signal should be turned ON again.

When this signal is turned OFF while the position control unit is operating, the positioning operation is immediately stopped. Also, when the pulse motor is used, a CNC error occurs. For how to clear the CNC error, refer to Chapter 9.

Emergency stop

This function is used differently when a servomotor is used from when a pulse motor is used.

When servomotor is used
This emergency stop signal drops the voltage output of the position control unit to 0 V and, at the same time, makes the feedback loop invalid. However, since the position control unit continues receiving input of the feedback pulse from the encoder, it can resume its operation after the emergency stop signal has been cleared. At this time, the emergency and immediate stop relay (CHn+3, bit15) turns ON.

When pulse motor is used
The emergency stop signal causes the position control unit to stop outputting the pulses and the CNC error (CHn+3, bit12) and emergency and immediate stop relays (CHn+3, bit15) are turned ON. Therefore, the position control unit stops operating even if its positioning operation is under execution.

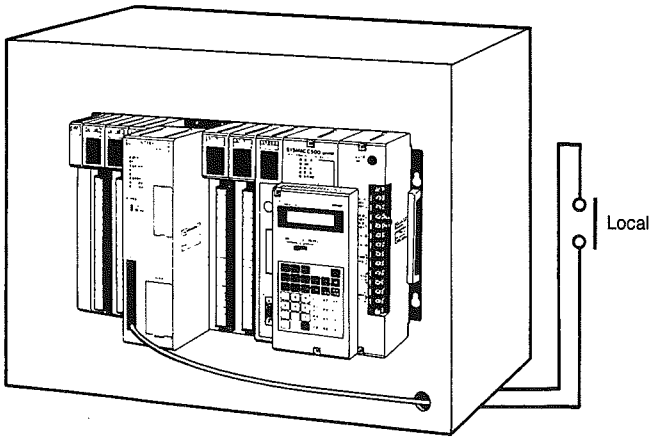
Canceling emergency stop

When servomotor is used
The effect of the emergency stop signal can be canceled by turning ON the PC interrupt relay (CHn+1, bit13) or an external interrupt signal. It can also be canceled by turning ON an external interrupt signal or the CLR key while the teaching box is being used.

When pulse motor is used
When power is turned ON, the emergency stop signal can be canceled by turning OFF power once and then back ON. It can also be canceled by changing the mode selector switch position from the REMOTE to LOCAL, and then back to REMOTE.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	0000	0000
CHn+3	0	ACK	OFF	ON
	1	DATA1 transmit	OFF	OFF
	2	DATA2 transmit	OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	OFF	OFF
	7	Execution address transmit	OFF	OFF
	8	BUSY	OFF	OFF
	9	Sequence end	OFF	OFF
	10	Origin	OFF	OFF
	11	Bank end	OFF	OFF
	12	CNC error	ON	ON
	13	Interrupt	OFF	OFF
	14	Near-zero	OFF	OFF
	15	Emergency and immediate stop	ON	OFF

Local
This external input is ORed with the local side of the remote/local select switch on the front panel of the position control unit. Remote mode can therefore not be entered unless the remote/local selector switch is at the remote position and the external local input is OFF. This is provided so that local mode can be selected from outside the control panel for error clear, teaching box operation, etc.



The differences between the remote and local modes (as seen from the PC) are summarized in the following table. The condition of each signal is when origin search has been performed after power application.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Current position data; execution address	0000
CHn+3	0	ACK	OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	ON ↔ OFF	OFF
	7	Execution address transmit	ON ↔ OFF	OFF
	8	BUSY	OFF	OFF
	9	Sequence end	ON*	ON*
	10	Origin	ON	ON
	11	Bank end	ON or OFF	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero position	ON	ON
	15	Emergency and immediate stop	OFF	OFF

* Bit 9 is OFF before the origin is determined and ON after it has been determined.

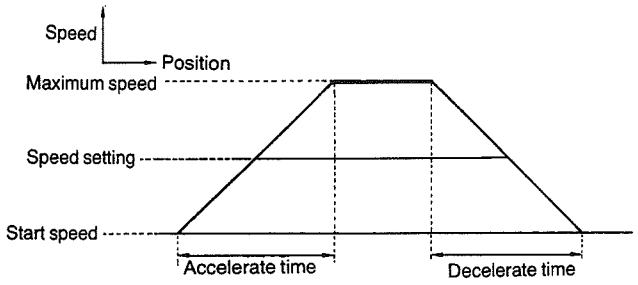
6.2.6 INTERNAL FUNCTIONS

Automatic accelerate/decelerate

The acceleration/deceleration is determined by the following parameter data:

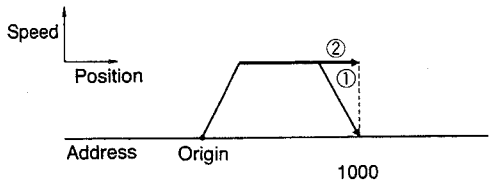
Start speed (Address 2006)
Maximum speed (Address 2005)
Acceleration time (Address 2007)

Note that the accelerate and decelerate times are always the same.



As shown in the figure above, acceleration and deceleration between the start speed and the maximum speed is performed automatically. In normal positioning operations, the acceleration/deceleration to the set speed is performed automatically.

Pattern

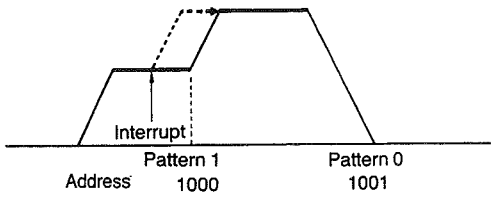


When the start shaft relay is turned ON, the movement of the shaft accelerates as specified by the three parameters described above and moves to the destination. At this time the type of movement performed follows one of the two patterns shown in the above figure.

With pattern data 0 (terminal), the speed of the shaft drops to 0 when the destination is reached. In pattern 1, the action is part of a series of positioning actions so the speed does not decelerate but maintains a constant speed after reaching the destination. Note that it is not possible to change directions while the shaft is still moving. Any attempt to change direction when the pattern data is not 0 will cause a CNC error.

Interrupts received during pattern 1 data

When an interrupt is received during pattern 1, the position data at that time is canceled and the next position data (shown by the dot arrow and in this case, address 1001; pattern 0) is executed.

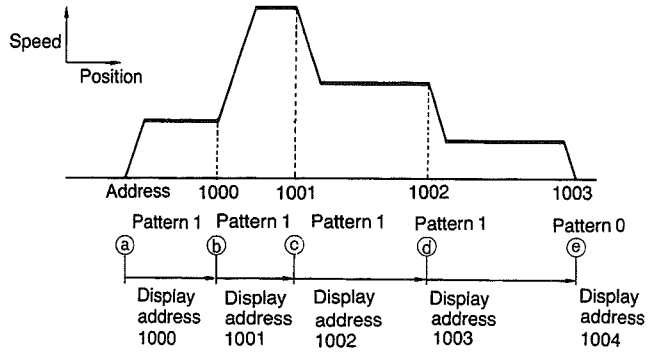


Autoincrement

Whether during operation or during stop, the position control unit constantly sends the execution address and the current position data to the PC. The format of the address display, however, is different during the positioning operation and during stop.

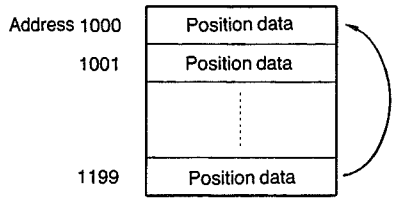
During the positioning operation, the execution address output by the position control unit is the address of the destination toward which the shaft is moving. In other words, the displayed address is one address ahead of the actual position of the shaft.

The following figure shows a series of positioning actions (data pattern 1) and the execution address output for each "leg" of the journey.



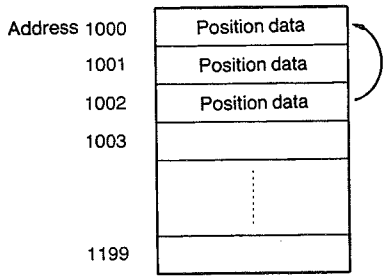
Note that when the shaft arrives at point e, the execution address is automatically incremented to 1004. This is so that when the next start shaft command is applied, the positioning action can start immediately from address 1004. If this were not done, it would be necessary to perform address setting followed by a start shaft command each time it was desired to execute a series of positioning operations. This function is called the autoincrement function. Note that in the following three cases, the autoincrement returns to 1000.

- When the last position data, address 1199, is executed

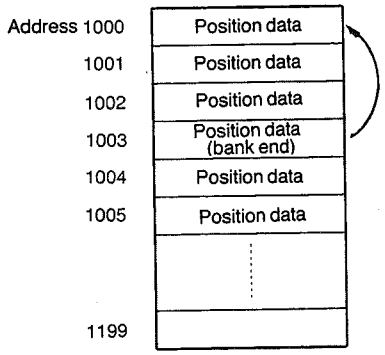


● When the position data up to a certain address is executed, and there is no more data following that in memory

Note: The expression "no more data" does not refer to the condition in which there is only data 0000 following the last address, but to the condition after memory all clear has been executed from the teaching box.

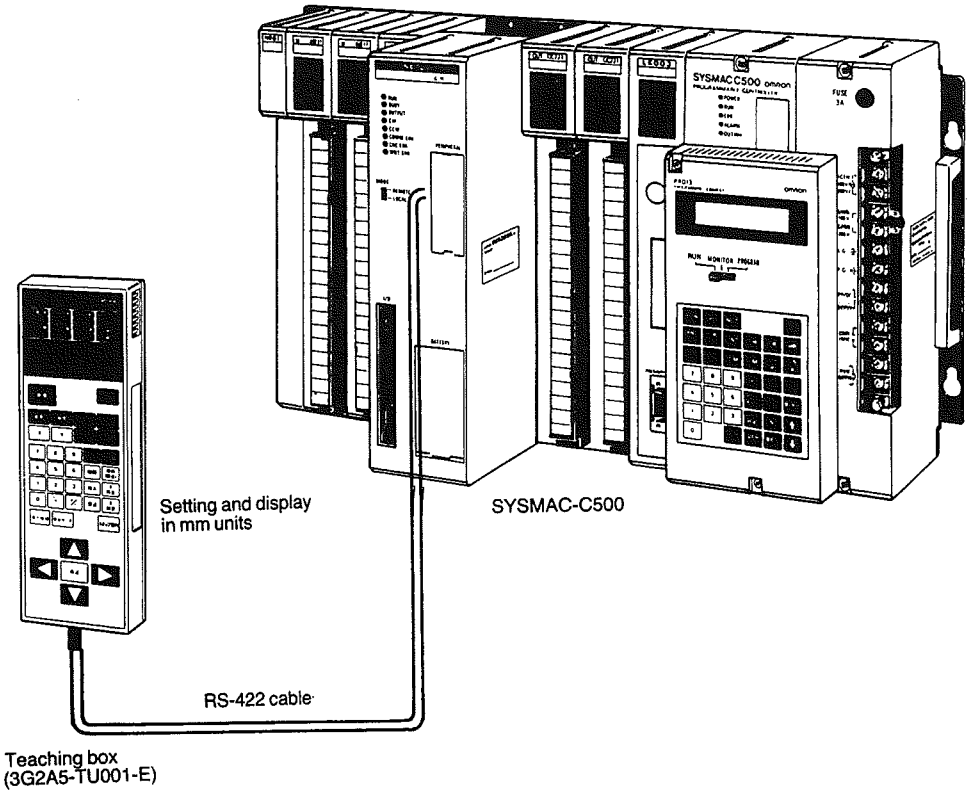


● When position data with the bank end attribute has been executed



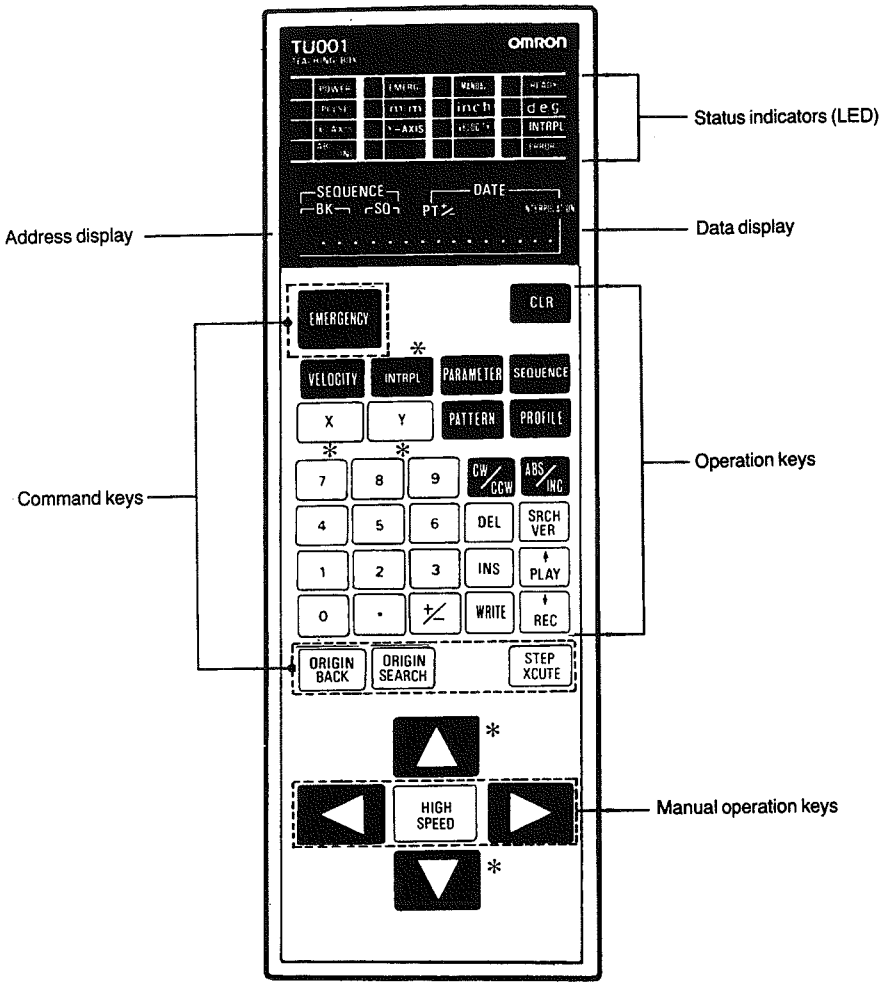
6.3 Local mode

In this mode, the position control unit is functionally detached from the PC and operates under the control of the teaching box. Also, in this mode, setting and display are performed by the teaching box in mm units.



Note: If local mode is entered from remote mode during data transmission from the PC to the position control unit, there is a chance that a transmission error will occur when operation returns to remote mode and transmission from the PC to the position control unit is resumed. If local mode is entered from remote mode during the positioning operation, the shaft movement will decelerate/stop, and the current positioning sequence will be halted (the operation at this time is the same as interrupt processing).

Teaching box

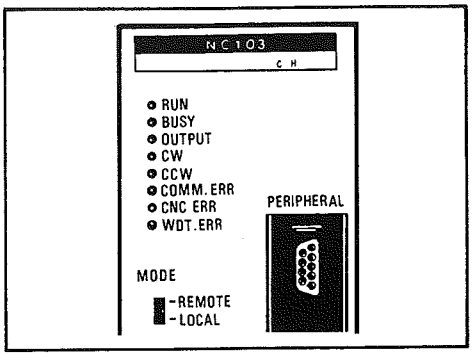


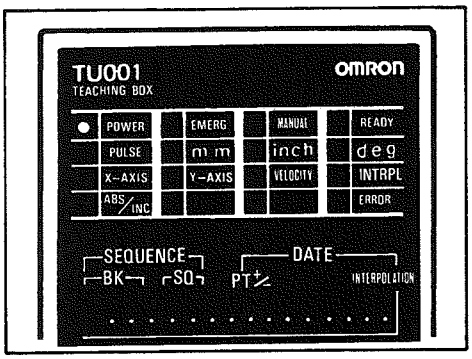
* INTRPL X Y ▲ ▼ These keys cannot be used with the position control uni.

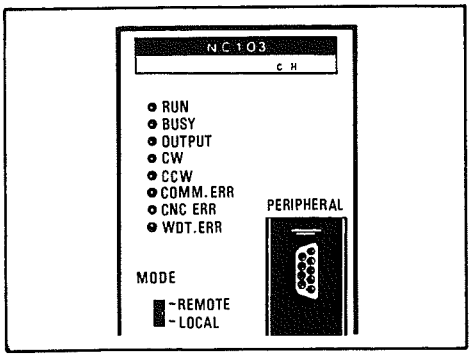
Address display	Displays the address of the user data (4 digits)
Data display	Displays the user and current position data (6 digits)
Status indicators	Display the current status (power, units, error, etc.)
Operation keys	Used for input and editing of user data
Command keys	Used to execute commands
Manual operation (high speed) keys	Used for manual control of the positioning operation

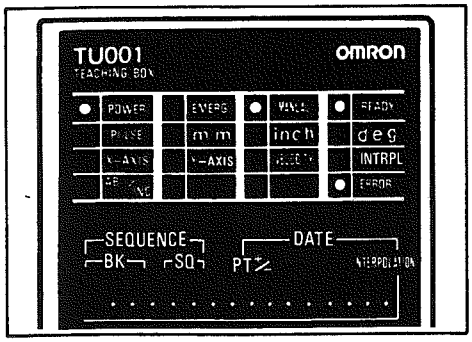
6.3.1 MODE SETTING

The teaching box should be set to local mode when operation is started.









Confirm that the local/remote select switch on the front panel of the position control unit is set to the "remote" position, then connect the teaching box

If the teaching box is operating normally, the POWER LED will illuminate

Set the local/remote select switch on the position control unit to "local" and start operation

If there is an error, the ERROR LED will illuminate

If there is no error, the POWER, MANUAL, and READY LEDs will illuminate

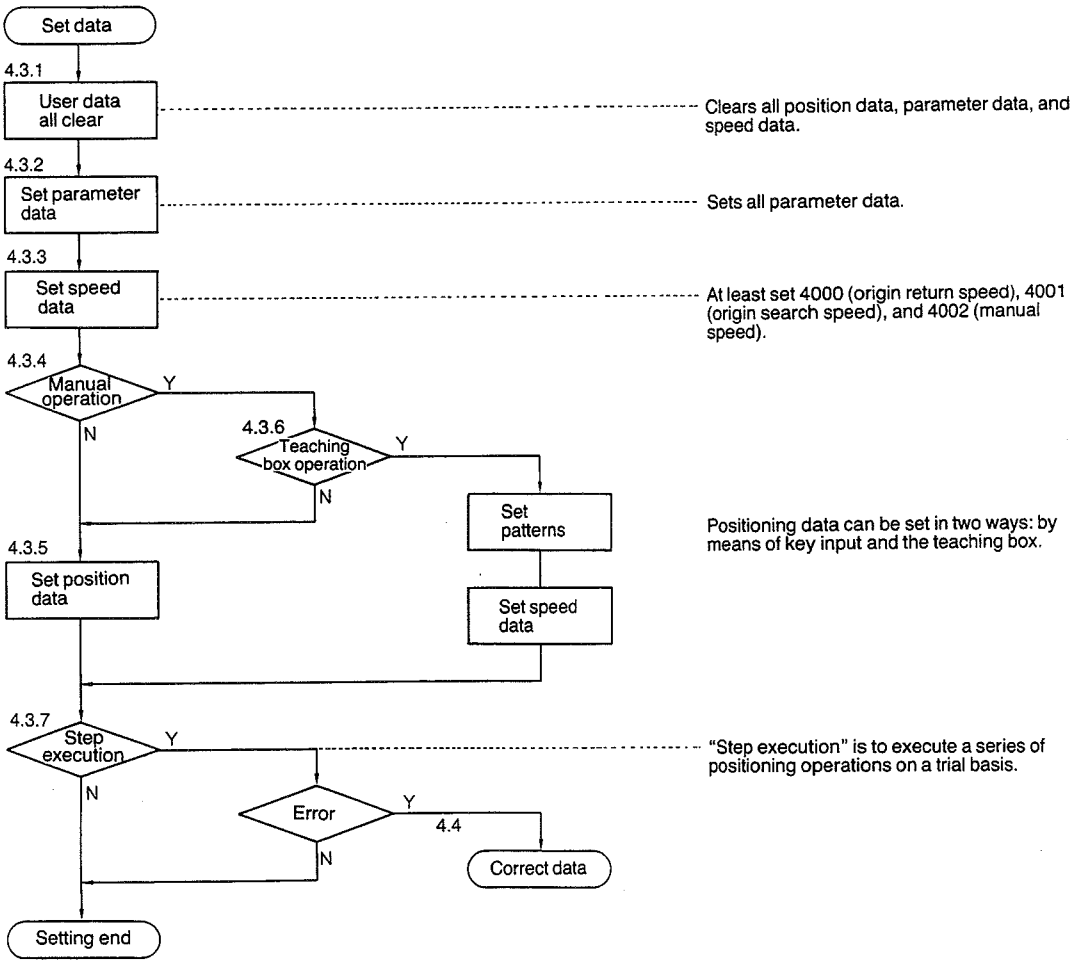
Confirm the setting of the position control unit's emergency stop external input

If the position control unit cannot be operated from the teaching box, check if the Ready contact is OFF or if the limit zone limit switch is ON

Note: If the remote/local select switch of the position control unit is set to the "local" mode when the teaching box is not connected, the ERROR LED will illuminate and the RUN LED will blink. Should this happen, the error can be cleared by first connecting the teaching box and then switching the remote/local switch from local to remote and then back to local.

6.3.2 OPERATION FLOW

Setting and correcting data is done according to the following procedure.

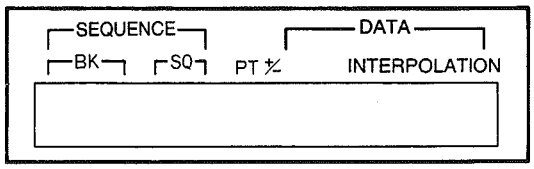


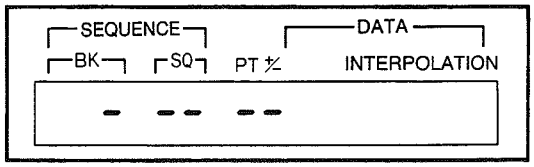
6.3.3 SETTING PROCEDURE

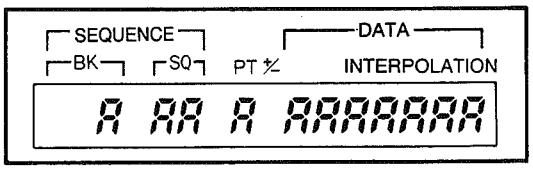
Data all clear

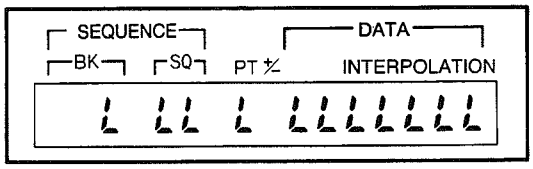
This operation clears all of the user data stored in the position control unit's RAM.



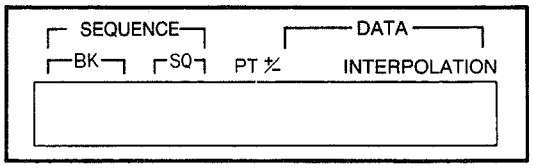






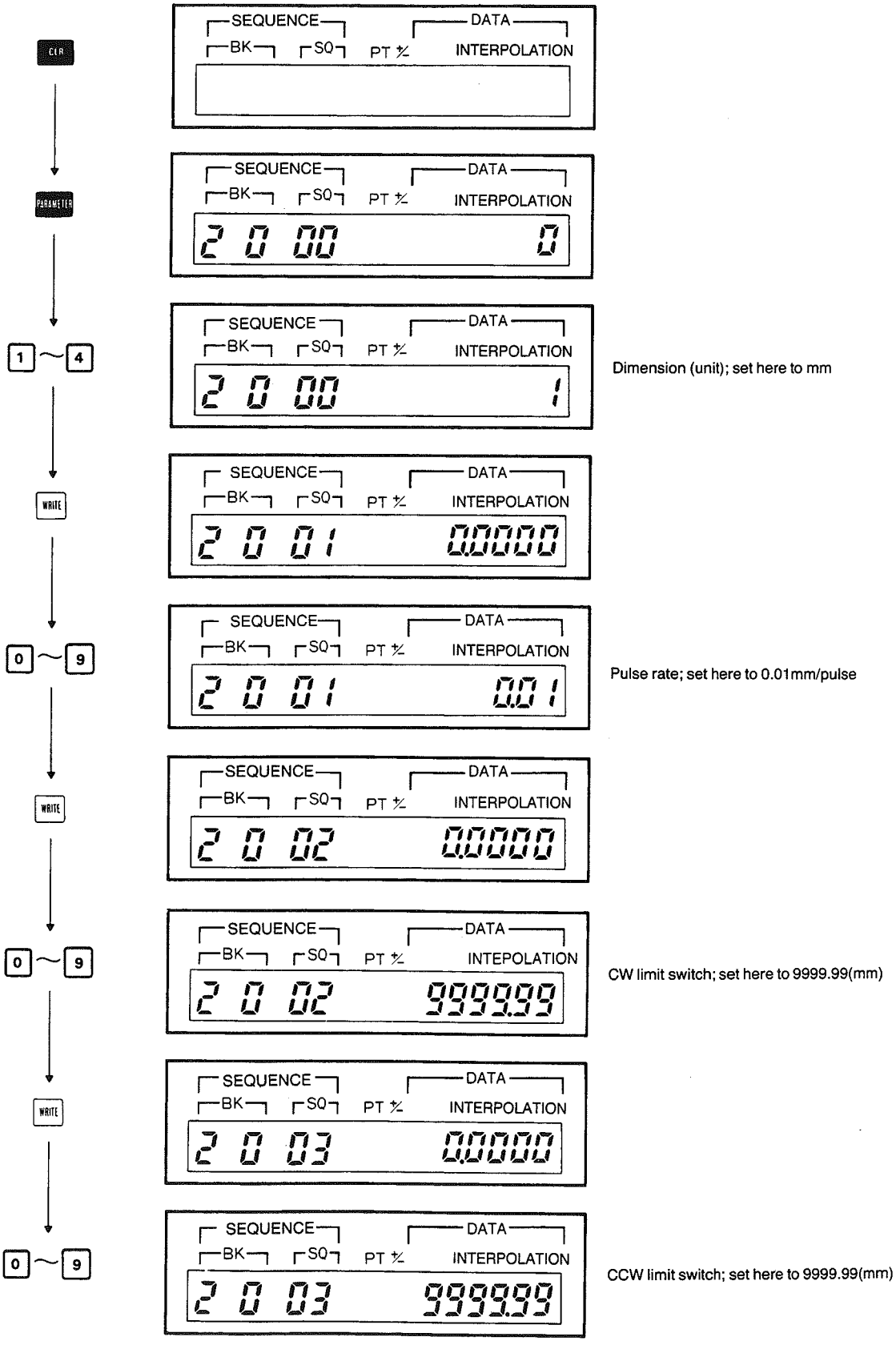


After 0.5 s



The CLR key is used to correct input errors or to cancel input.

Parameter data

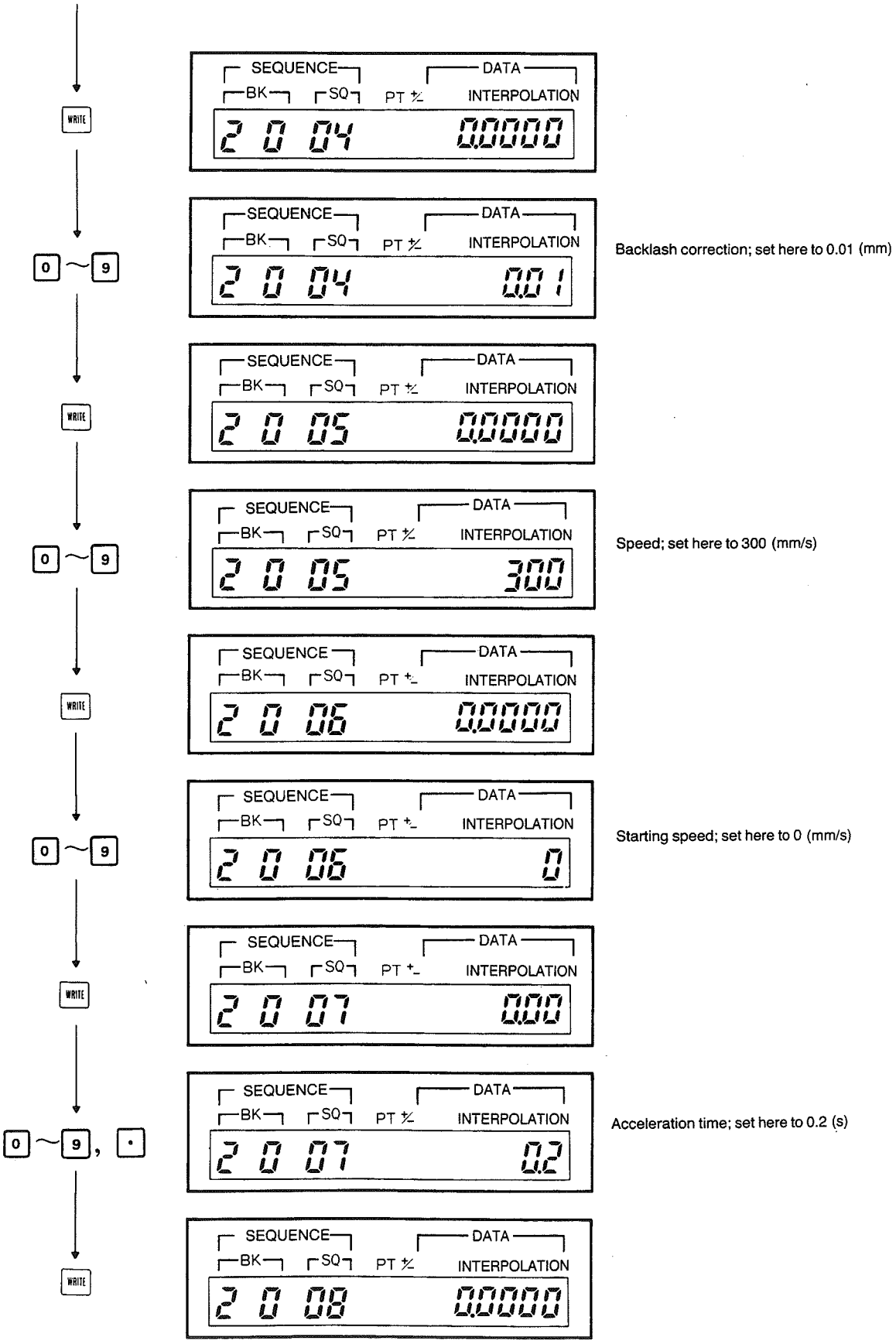


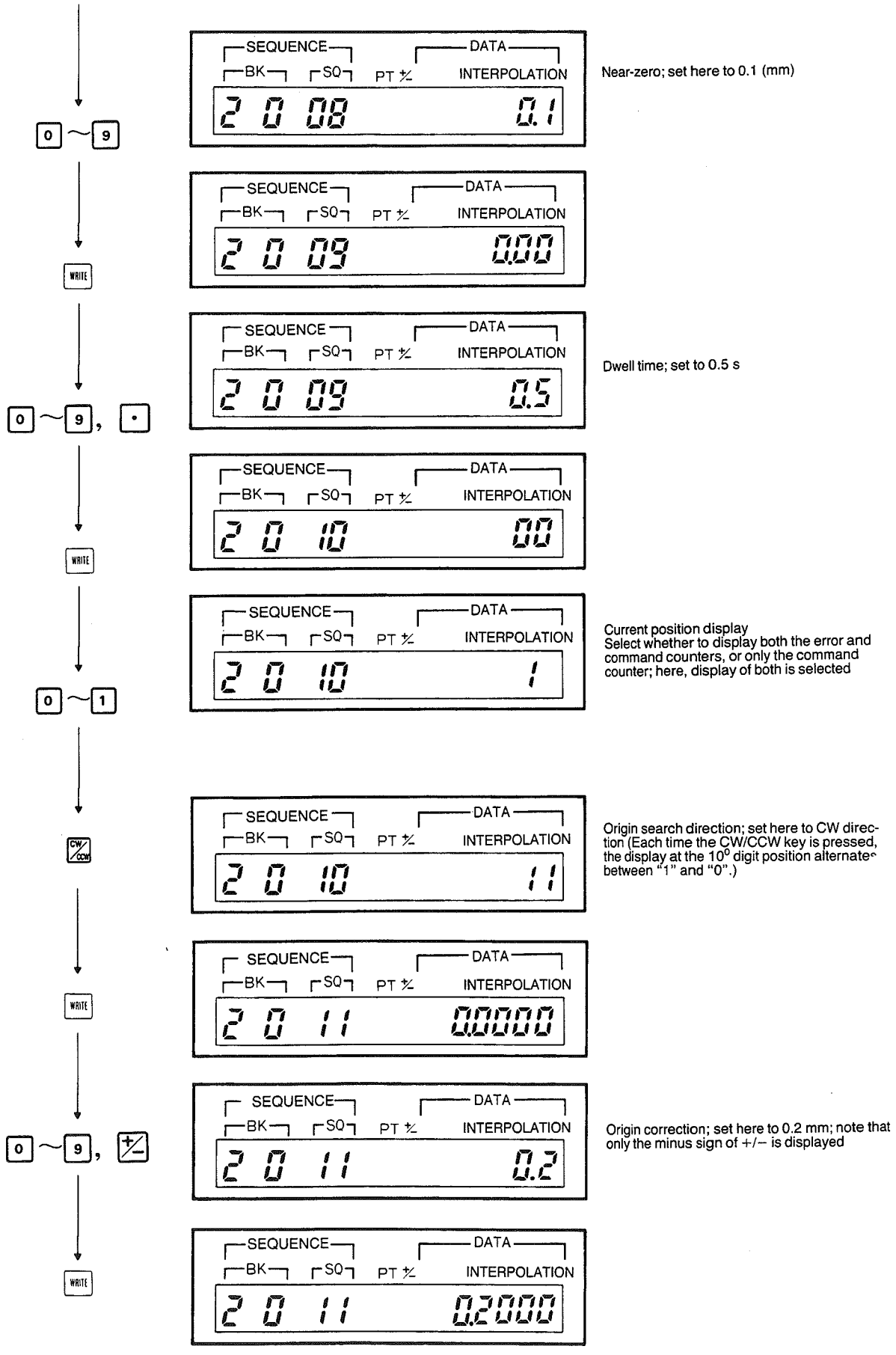
Dimension (unit); set here to mm

Pulse rate; set here to 0.01mm/pulse

CW limit switch; set here to 9999.99(mm)

CCW limit switch; set here to 9999.99(mm)


SEQUENCE
BK
SQ
PT +/-
DATA
INTERPOLATION
2 0 04 0.0000
WRITE
0 ~ 9
2 0 04 0.01
Backlash correction; set here to 0.01 (mm)
WRITE
2 0 05 0.0000
0 ~ 9
2 0 05 300
Speed; set here to 300 (mm/s)
WRITE
2 0 06 0.0000
0 ~ 9
2 0 06 0
Starting speed; set here to 0 (mm/s)
WRITE
2 0 07 0.00
0 ~ 9, .
2 0 07 0.2
Acceleration time; set here to 0.2 (s)
WRITE
2 0 08 0.0000



Near-zero; set here to 0.1 (mm)

Dwell time; set to 0.5 s

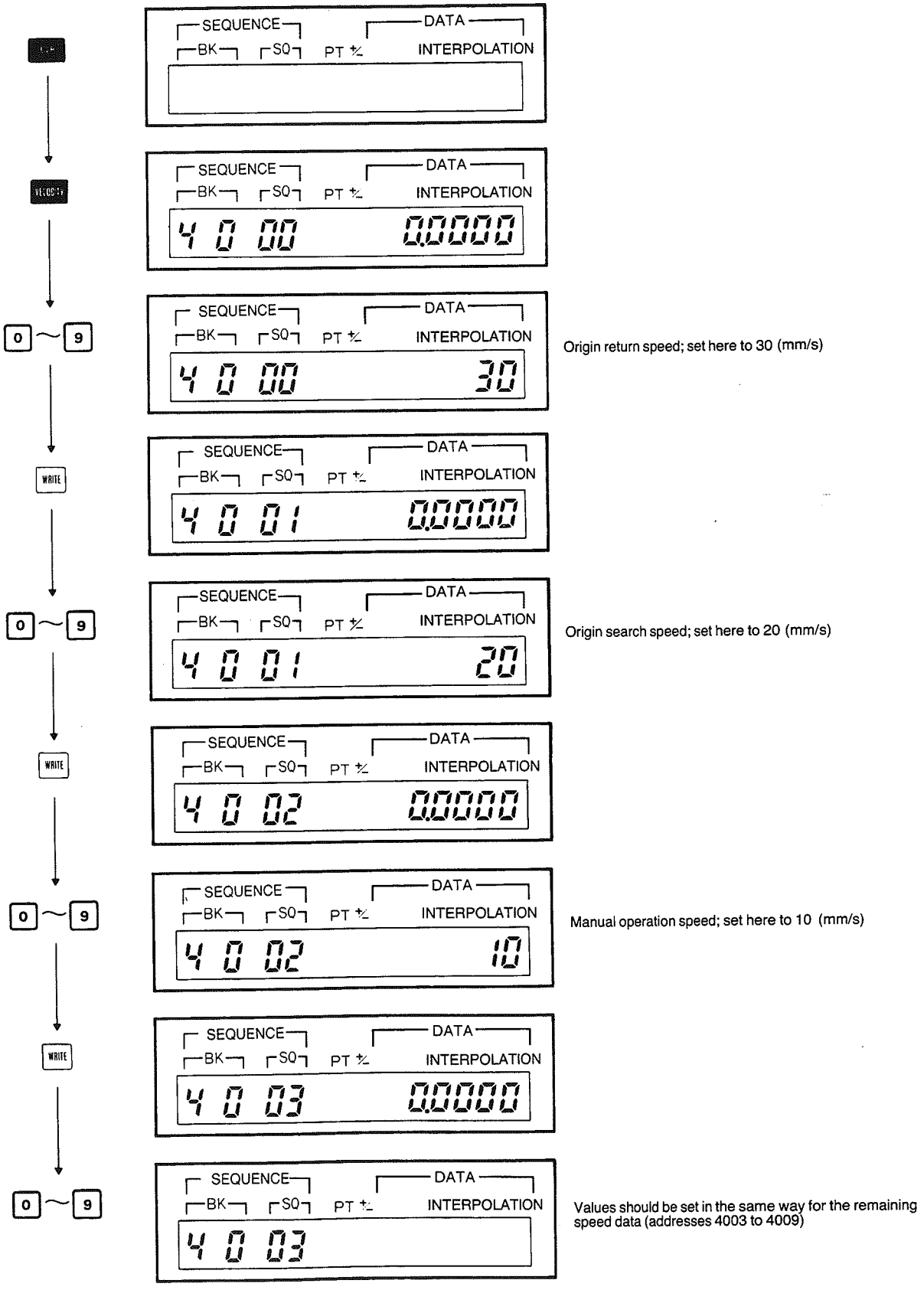
Current position display
Select whether to display both the error and command counters, or only the command counter; here, display of both is selected

Origin search direction; set here to CW direction (Each time the CW/CCW key is pressed, the display at the 10^0 digit position alternates between "1" and "0".)

Origin correction; set here to 0.2 mm; note that only the minus sign of +/− is displayed

Speed data

Note that in the following examples, mm are assumed as the unit.



Origin return speed; set here to 30 (mm/s)

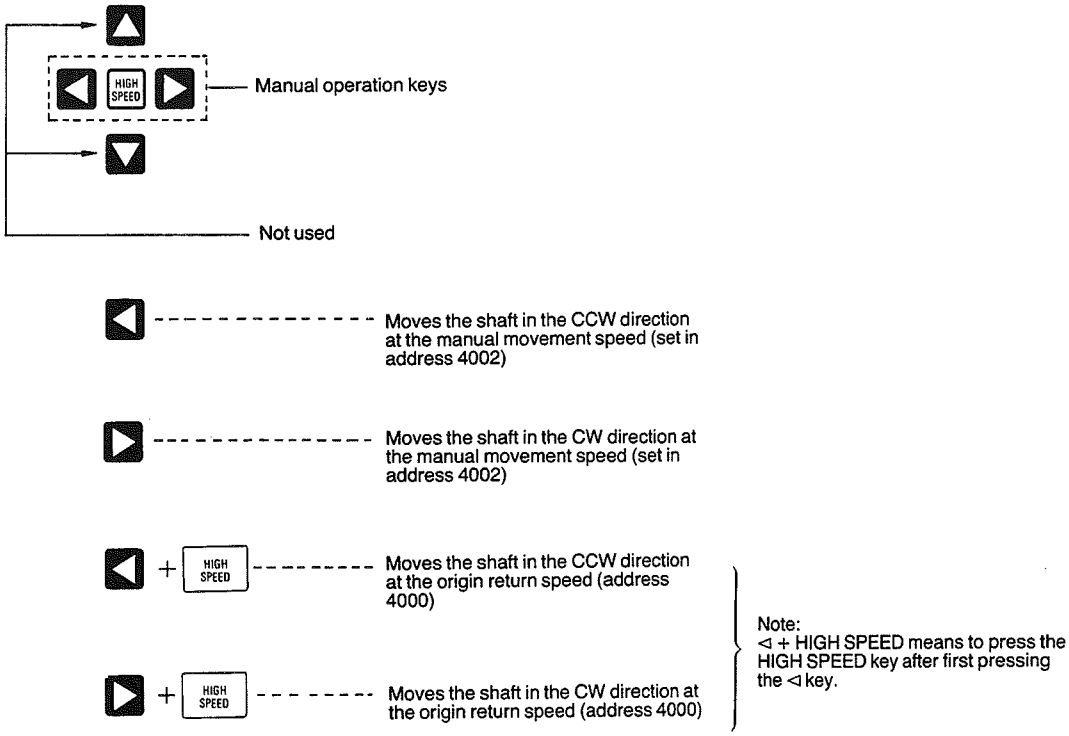
Origin search speed; set here to 20 (mm/s)

Manual operation speed; set here to 10 (mm/s)

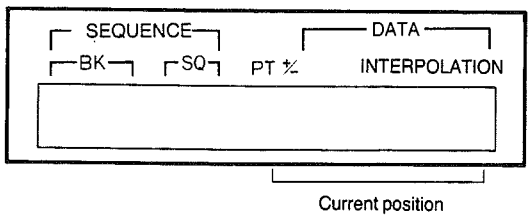
Values should be set in the same way for the remaining speed data (addresses 4003 to 4009)

Manual operation

The manual operation mode of the position control unit uses the arrow keys on the lower half of the teaching box to move the shaft to the desired position.



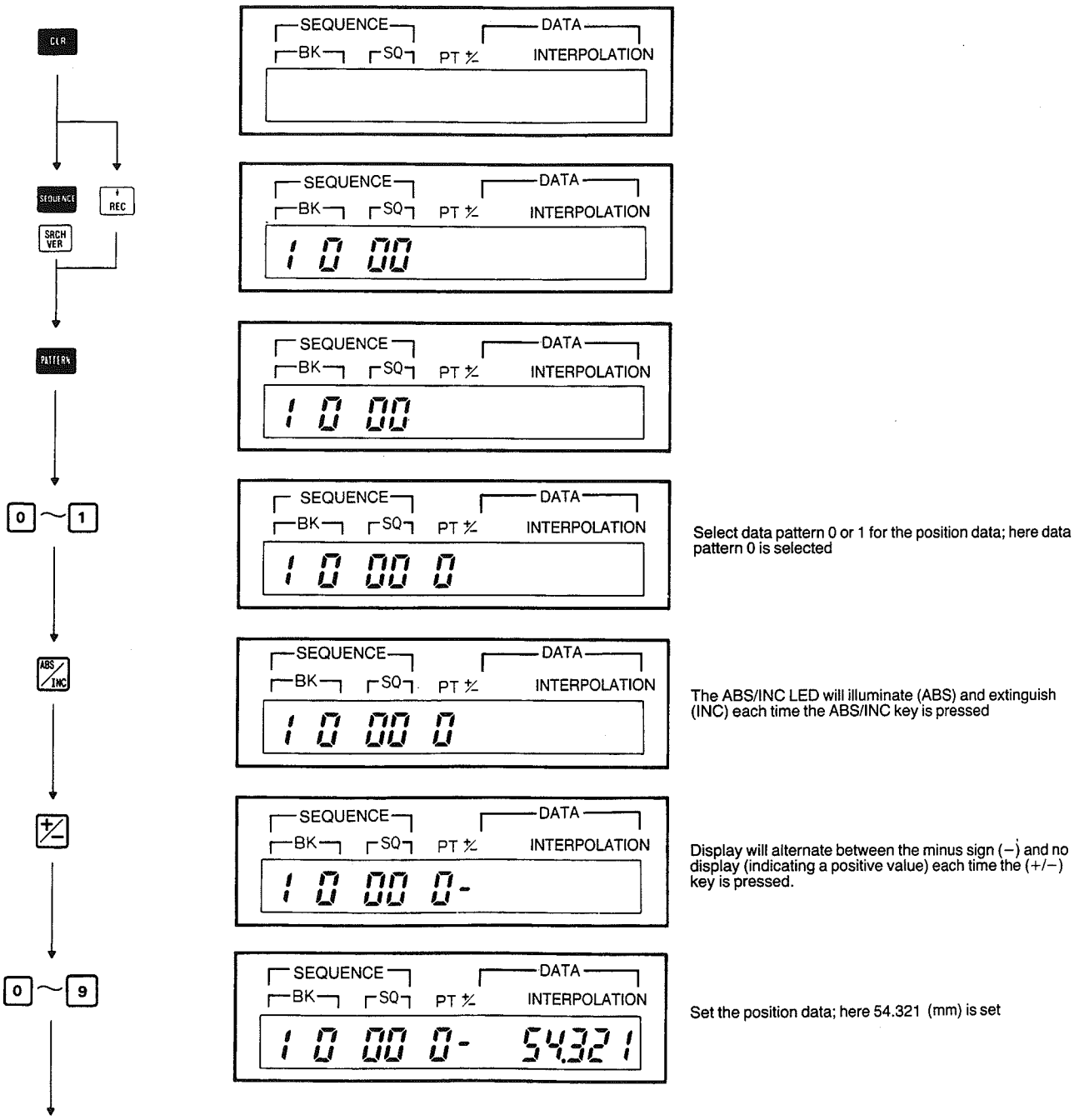
In manual operation mode, if the origin has been set, the current position will be displayed.



Depending on the parameter data in address 2010, the current position display will be either that for both the error and command counters, or for the command counter only.

When both are displayed, the condition of the error counter is always displayed, so the constantly changing current value is displayed. When only the command counter is displayed, a fixed theoretical value is displayed.

Position data setting

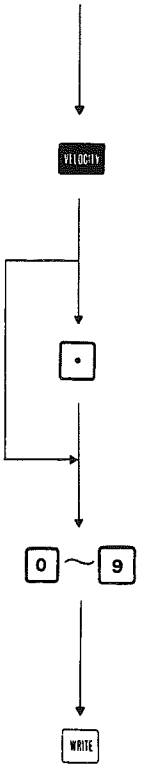


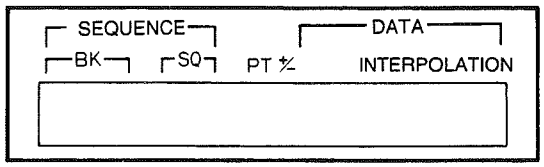
Select data pattern 0 or 1 for the position data; here data pattern 0 is selected

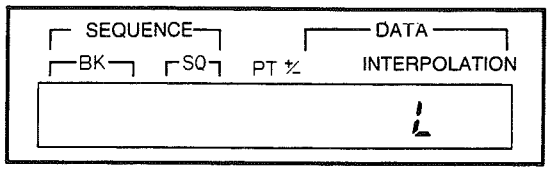
The ABS/INC LED will illuminate (ABS) and extinguish (INC) each time the ABS/INC key is pressed

Display will alternate between the minus sign (−) and no display (indicating a positive value) each time the (+/−) key is pressed.

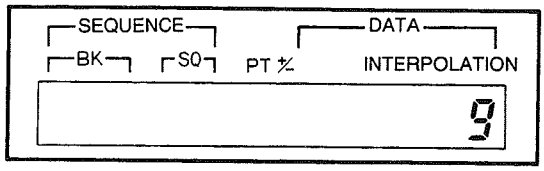
Set the position data; here 54.321 (mm) is set



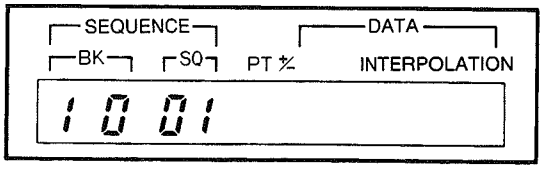




Display will alternate between "L" (indicating bank end) and no display each time the bank end key(.) is pressed.



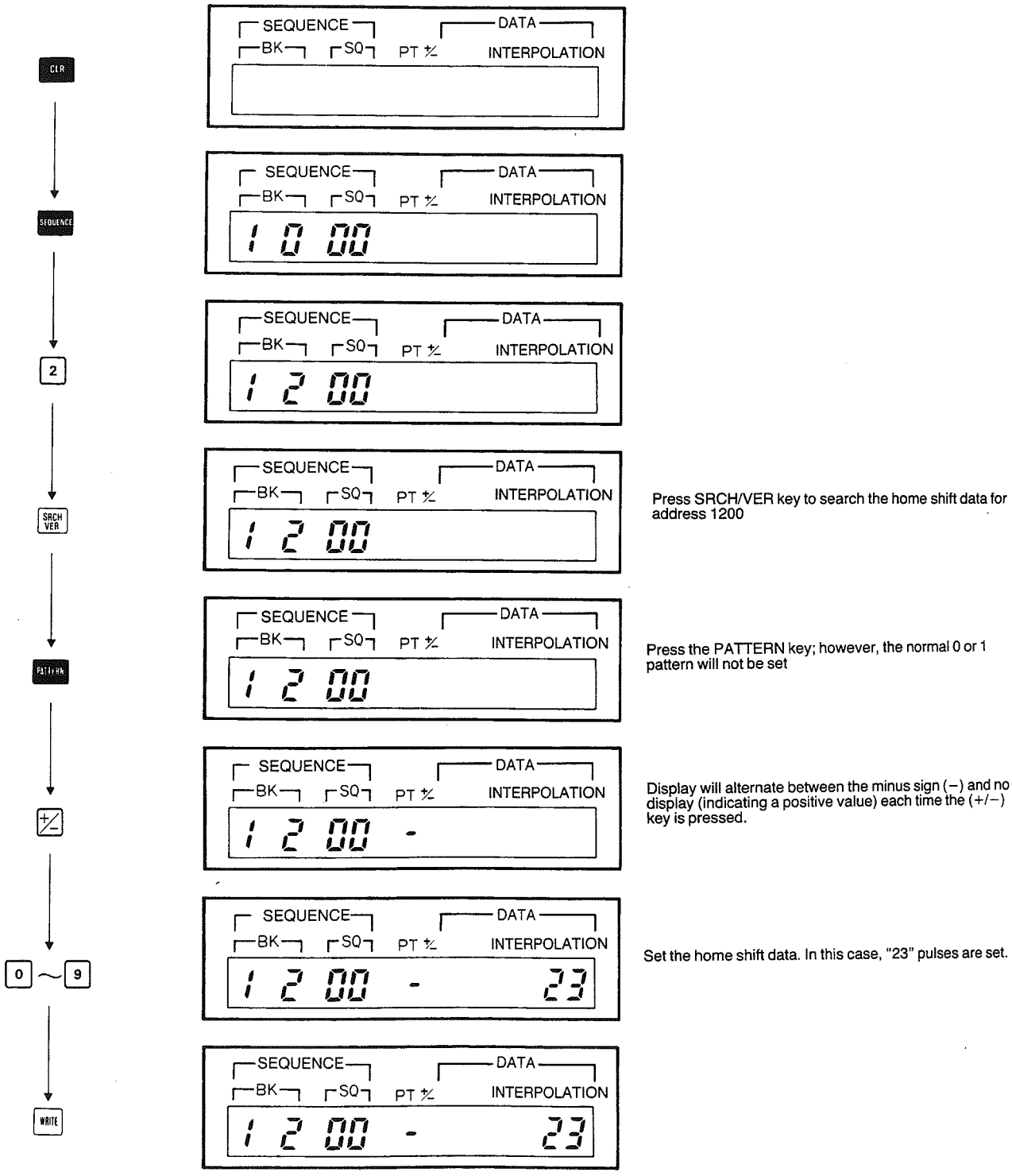
Speed setting; here the speed data set in address 4009 is selected



Pressing the WRITE key causes the address to be automatically incremented; it also causes the data input after input of the PATTERN key to be written to the memory of the position control unit.

Home shift data setting

Note that the procedure for setting the home shift data is different from that for setting normal positioning data.



Press SRCH/VER key to search the home shift data for address 1200

Press the PATTERN key; however, the normal 0 or 1 pattern will not be set

Display will alternate between the minus sign (−) and no display (indicating a positive value) each time the (+/−) key is pressed.

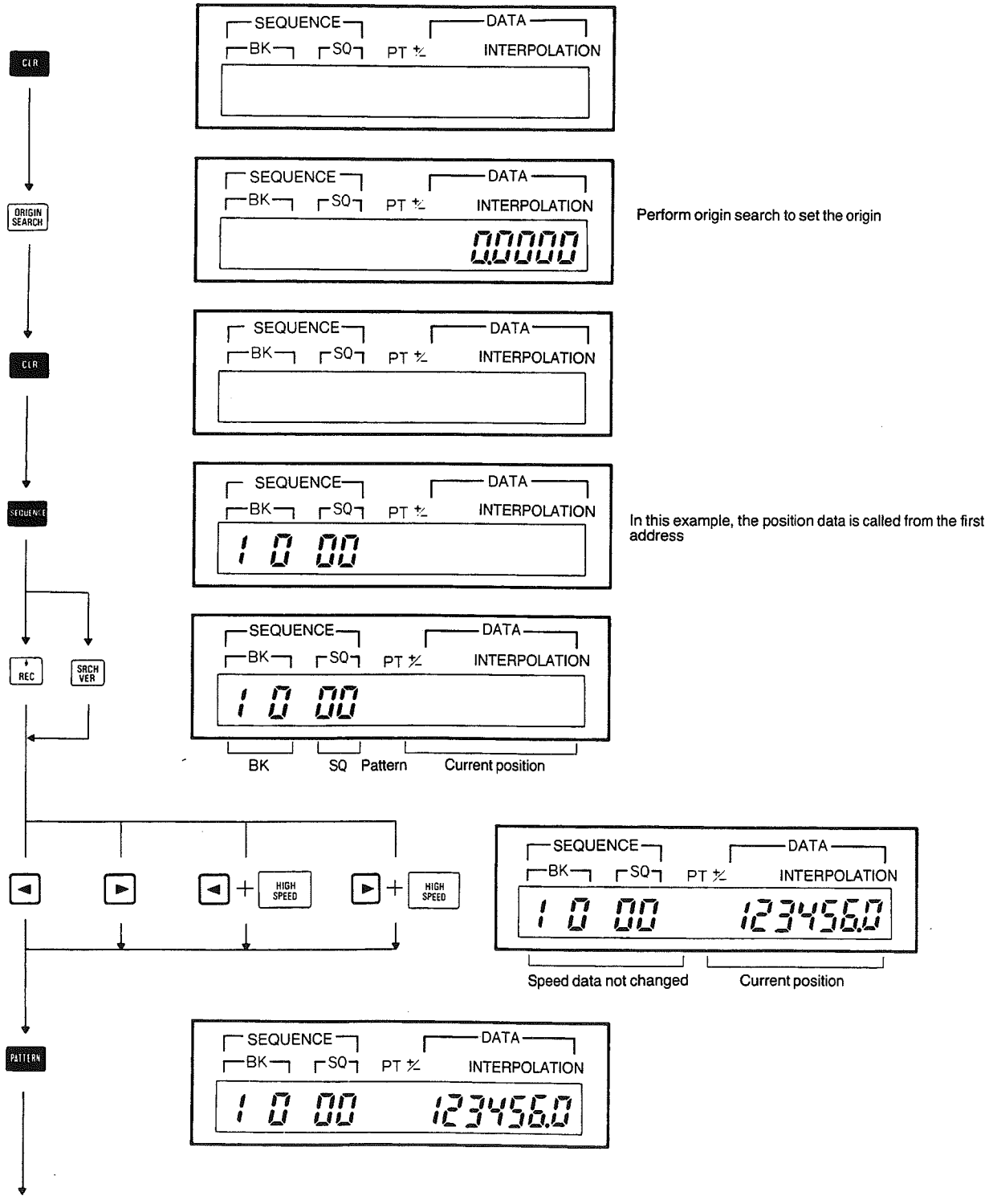
Set the home shift data. In this case, "23" pulses are set.

Note that home shift data must always be set in pulse units.

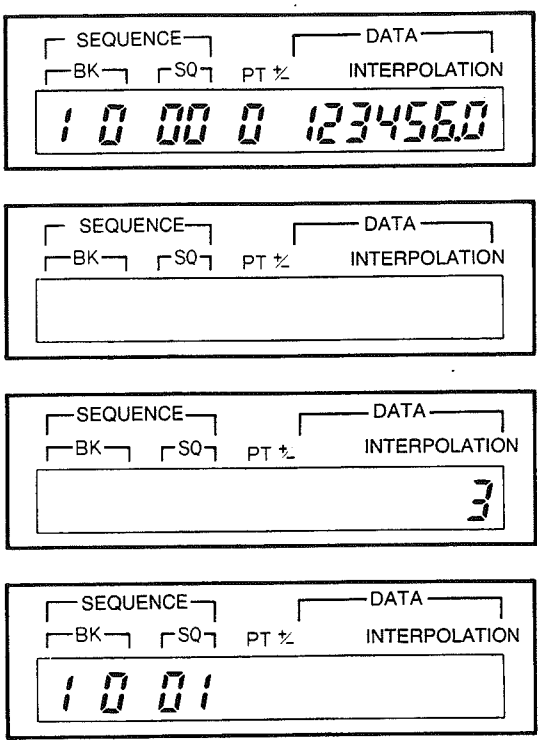
Teaching

Teaching refers to a process whereby the addresses in which data is to be stored are first called; the shaft is moved to the desired position by manual operation and this position data is registered and stored in the called address. Note that before this operation can be performed, the origin must first be determined, either by origin search or forced origin.

● First teaching





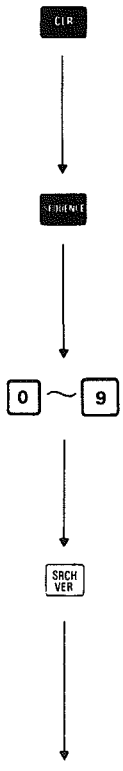


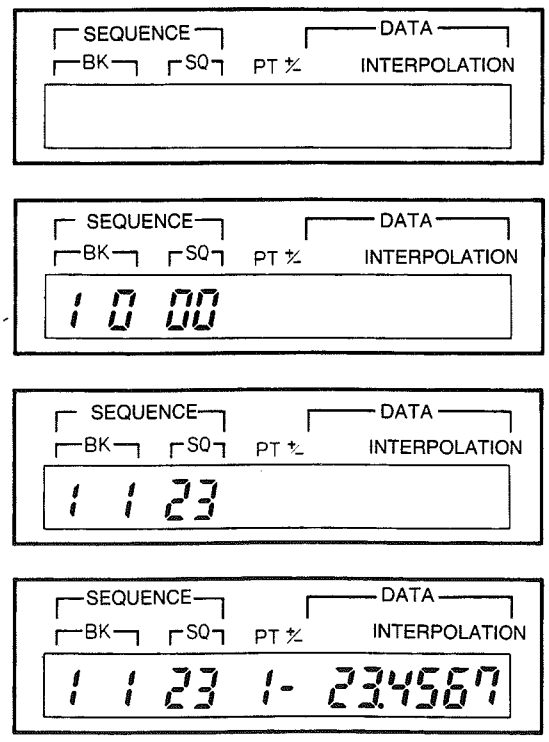
In this example, the data is set as pattern 0

In this example, the speed data set in address 4003 is selected

This operation sets the data in address 1000 to pattern 0, speed 3 and position data 123456

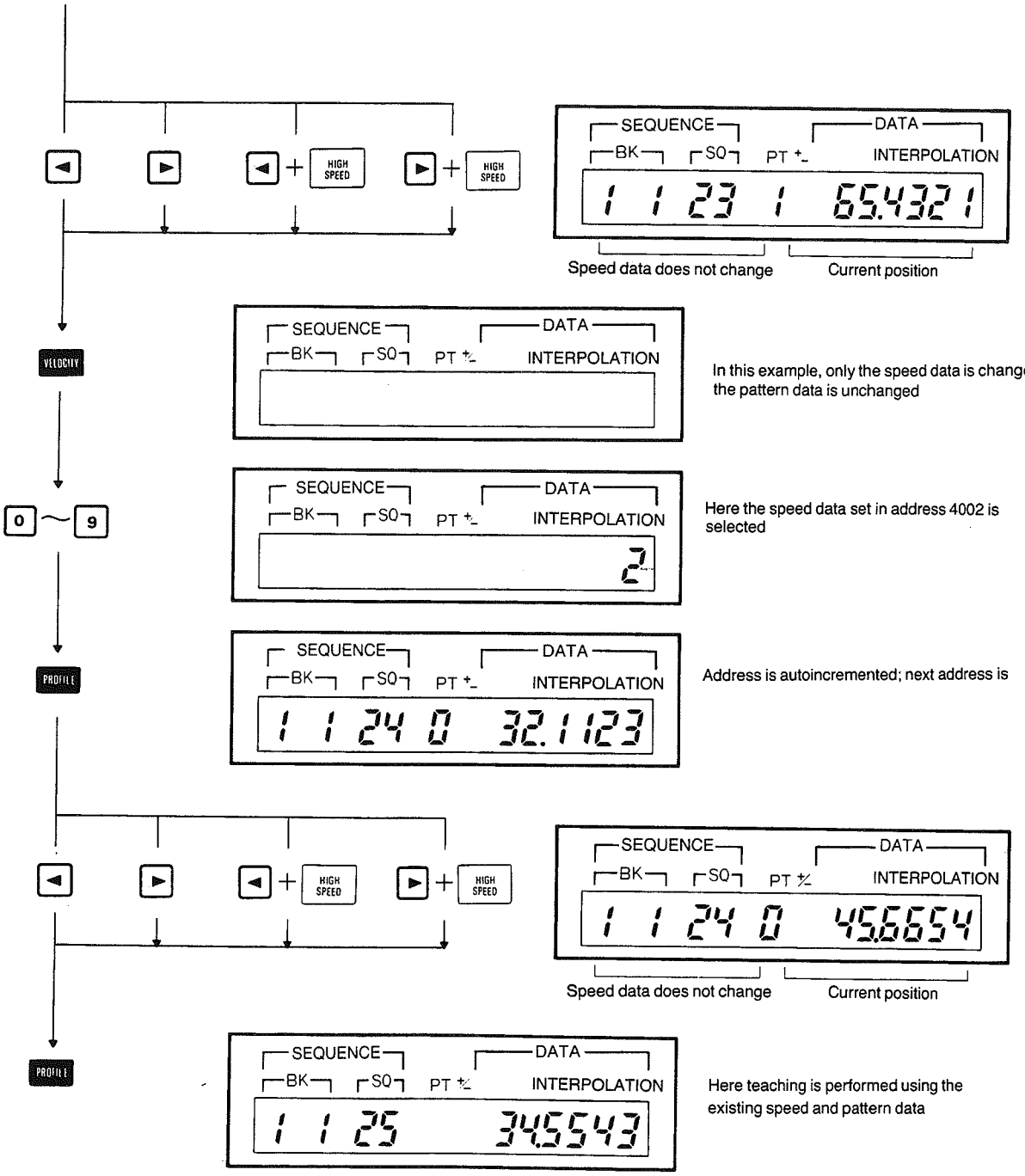
● When origin search operation has already completed and the position data has been entered





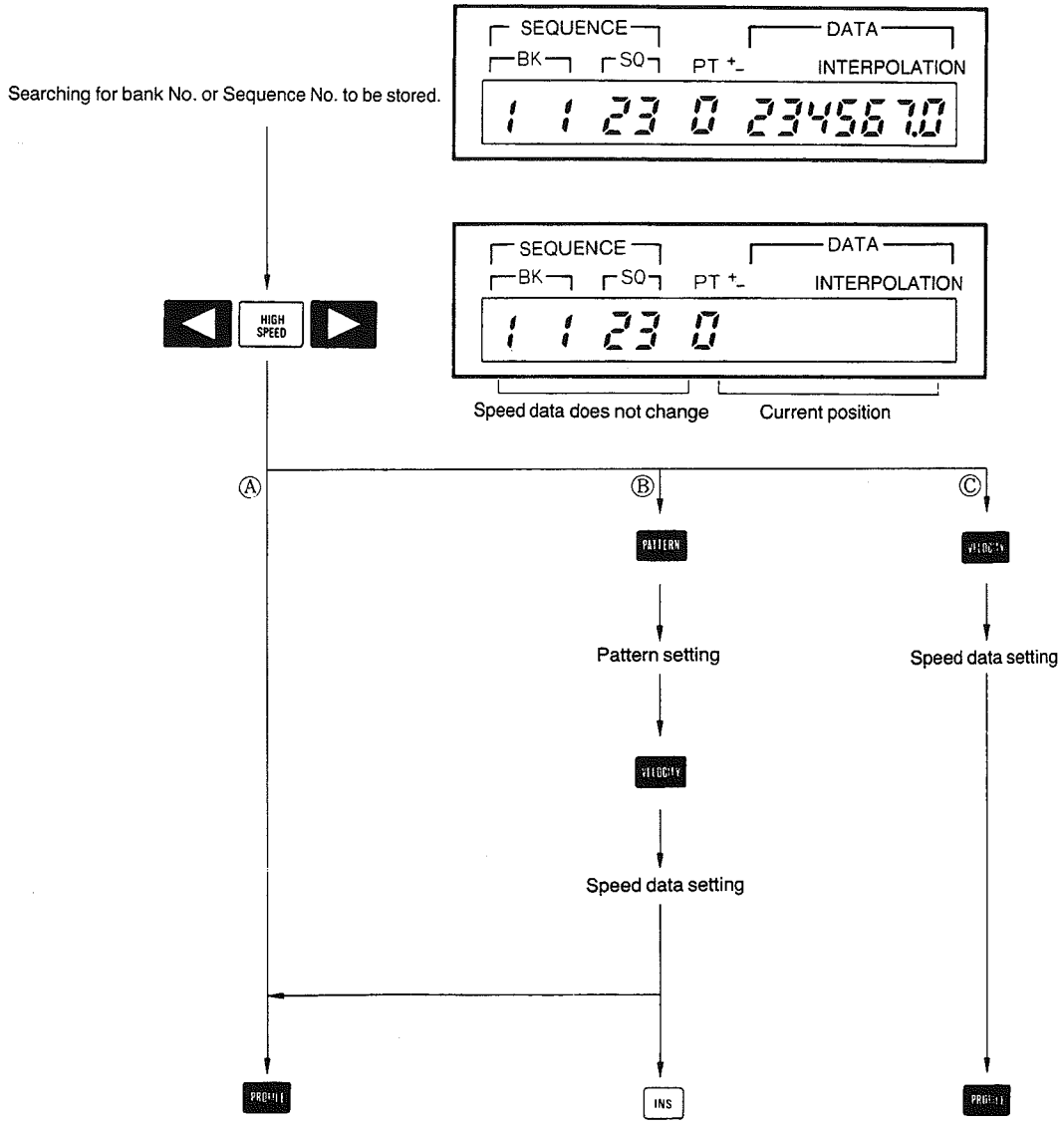
The address to be called is displayed in the BK and SQ fields of the display; here, address 1123 is set

Press the SRCH/VER key to call the contents of address 1123


◄
►
◄ + HIGH SPEED
► + HIGH SPEED
SEQUENCE
DATA
BK
SQ
PT +-
INTERPOLATION
1 1 23 1 65.4321
Speed data does not change
Current position
VELOCITY
In this example, only the speed data is changed; the pattern data is unchanged
0 ~ 9
2
Here the speed data set in address 4002 is selected
PROFILE
1 1 24 0 32.1123
Address is autoincremented; next address is
1 1 24 0 45.6654
Speed data does not change
Current position
1 1 25 34.5543
Here teaching is performed using the existing speed and pattern data

- Summary of steps for teaching

The steps for teaching are summarized below.



ⒶPattern and speed data are unchanged; teaching performed for position data only

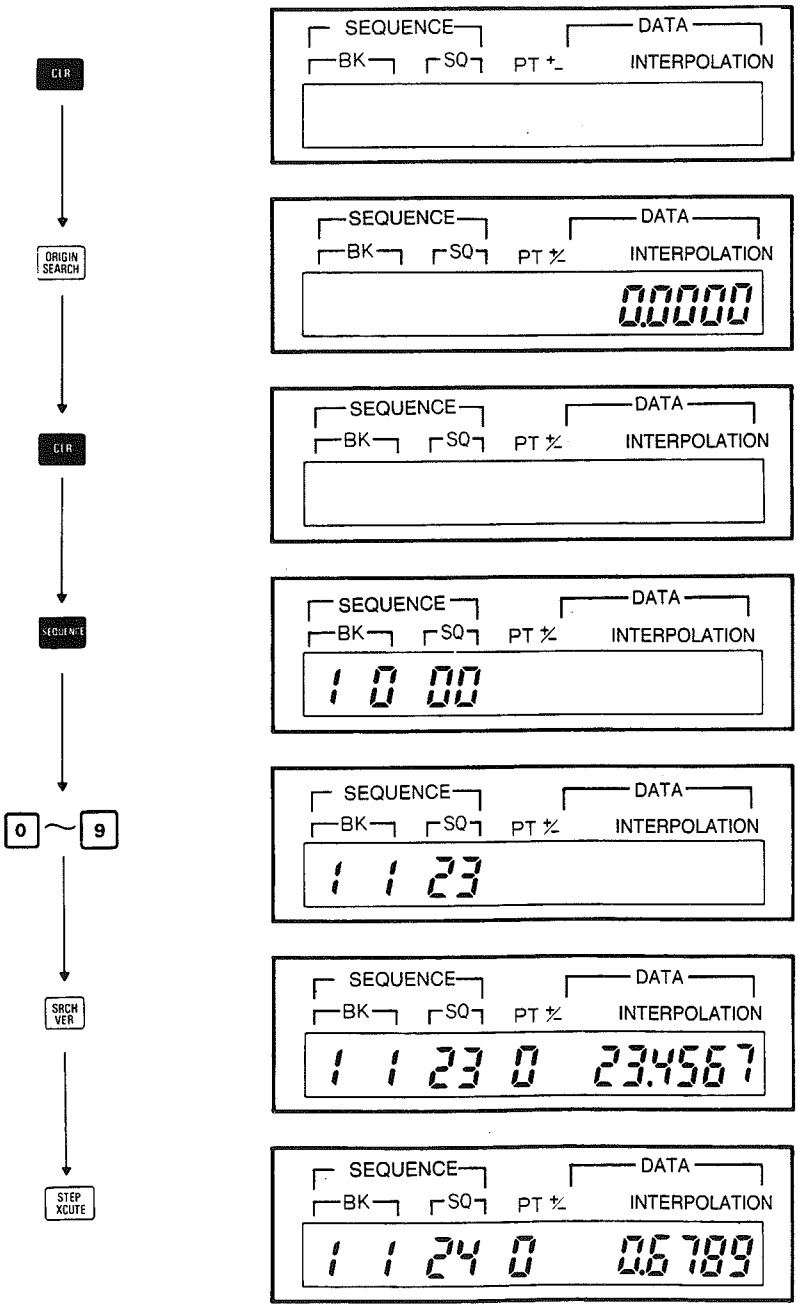
ⒷTeaching performed for position, pattern, and speed data

ⒸTeaching performed for position and speed data only

Step execution

Step execution performs positioning to the desired position. Note that before this operation can be performed, the origin must first be determined, either by origin search or forced origin.

● First step execution
Starting from the very beginning



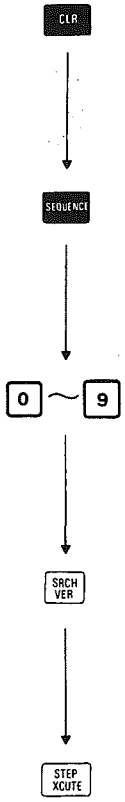
Perform origin search to set the origin

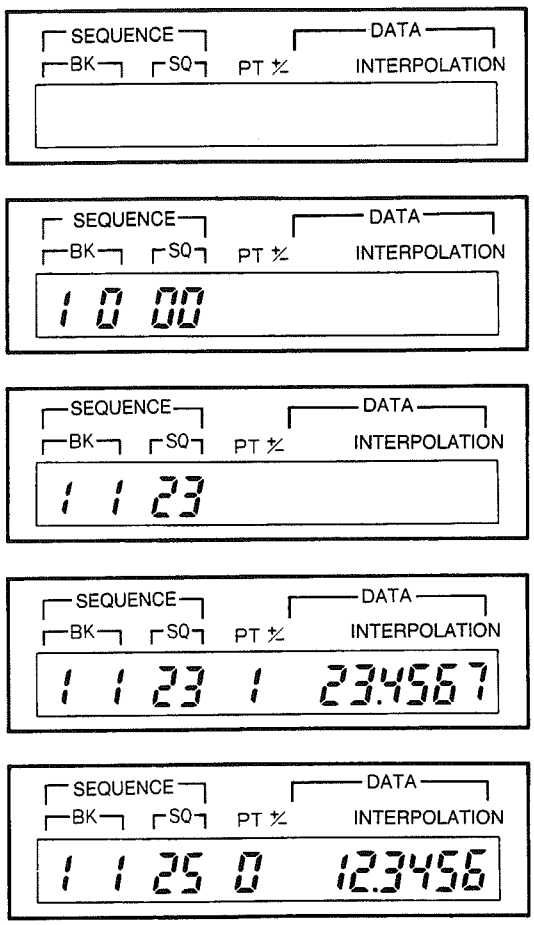
The address to be called is displayed in the BK and SQ fields of the display; here BK=11 and SQ=23 (address 1123).

Press the SRCH/VER key to call the contents of address 1123

Use the STEP/XCUTE key to move the shaft to the address 1123 position; once the shaft has been moved to this position, the address is autoincremented and the data for address 1124 is displayed

● When the origin search is completed and the search data is pattern 1





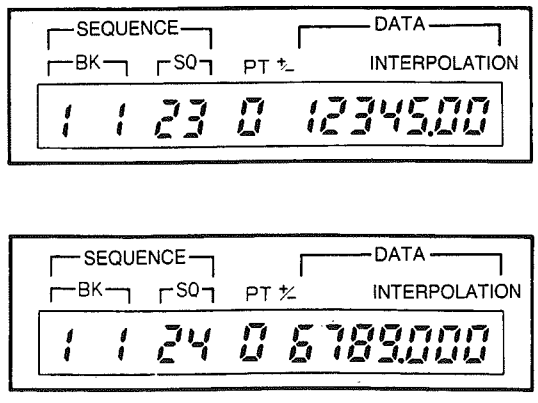
The address to be called is displayed in the BK and SQ fields of the display; here BK=11 and SQ=23 (address 1123)

Press the SRCH/VER key to call the contents of address 1123; the data is pattern 1

● The pattern for the data in address 1124 is 0. Because the pattern for the data at address 1123 is 1, the positioning action continues to address 1124. The figure above shows the display after positioning for address 1124 has been performed and autoincrement has been performed.

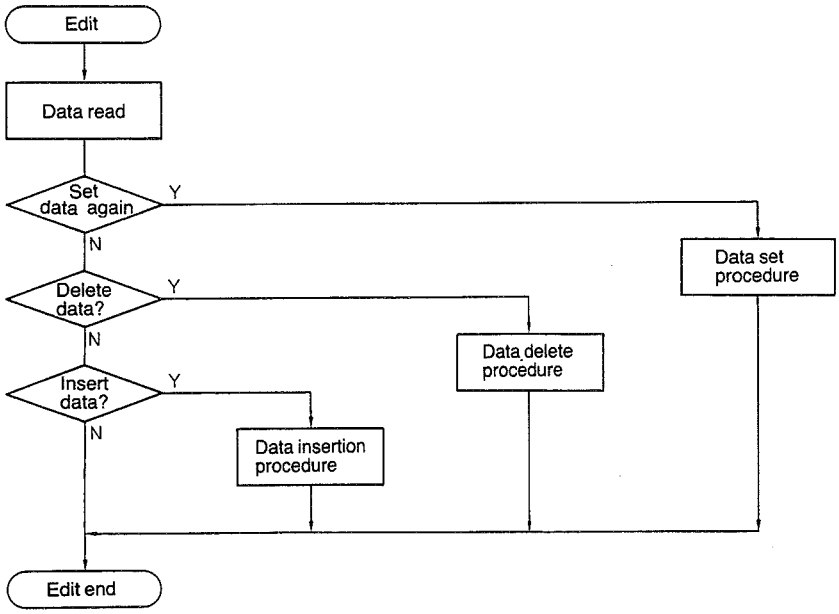
● Step execution summary
The procedure for step execution is summarized below.





6.3.4 EDITING PROCEDURE

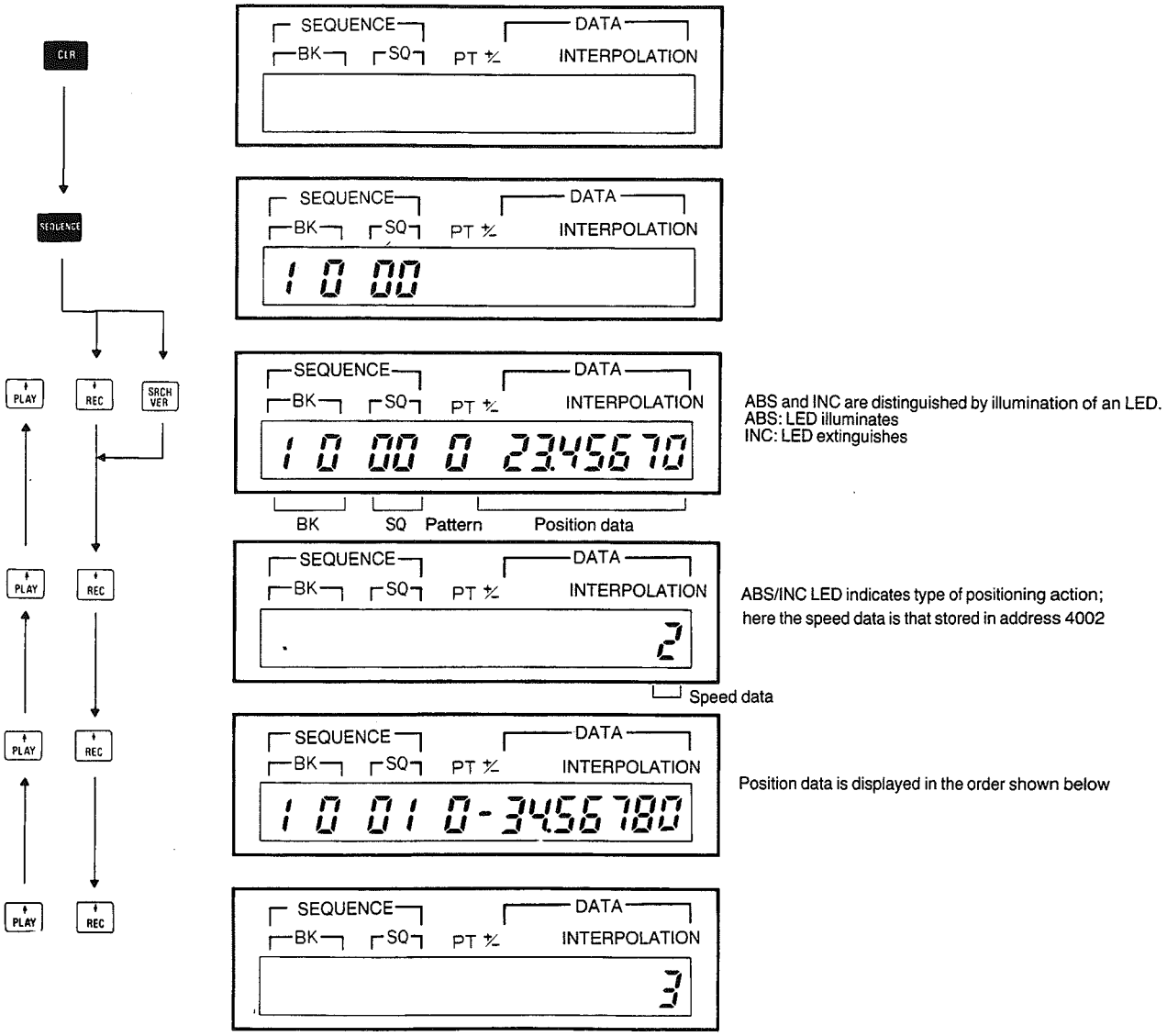
Select the appropriate steps for editing data using the flowchart shown below.



Insertion and deletion can only be performed for position data.

Data read operation

● Reading position data

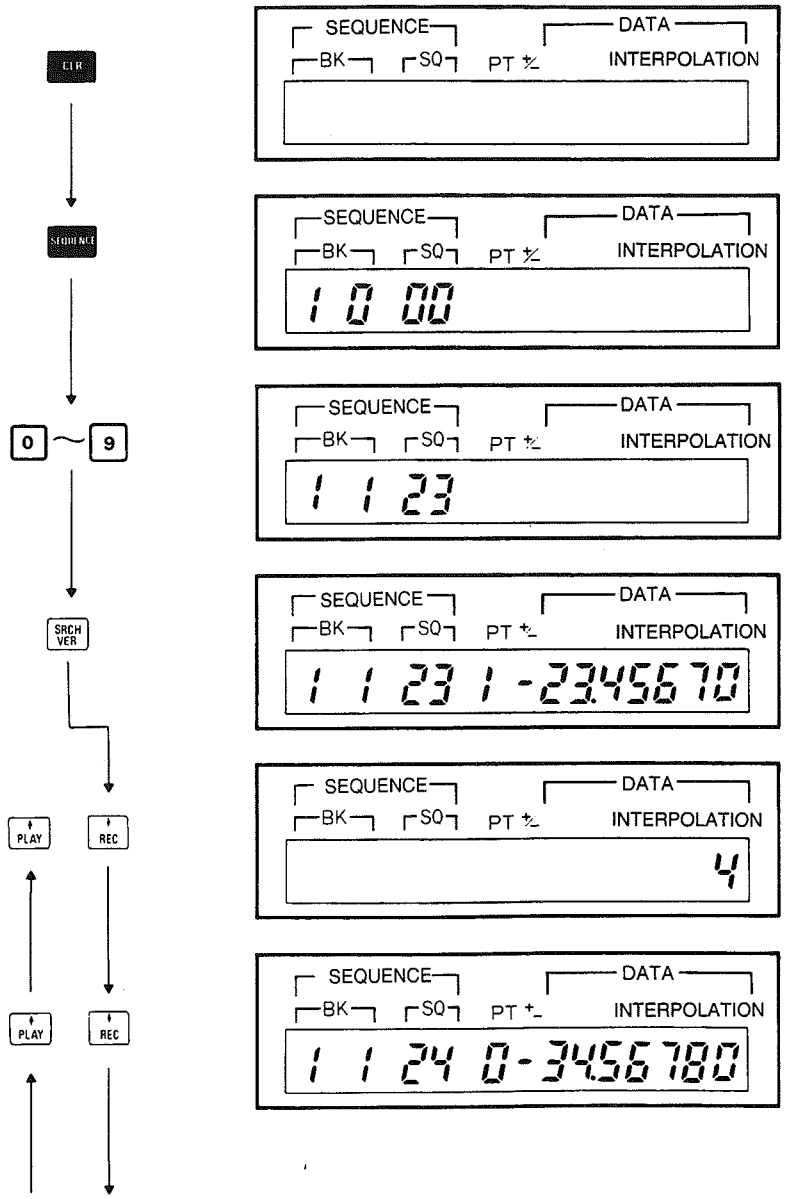


ABS and INC are distinguished by illumination of an LED.
ABS: LED illuminates
INC: LED extinguishes

ABS/INC LED indicates type of positioning action;
here the speed data is that stored in address 4002

Position data is displayed in the order shown below

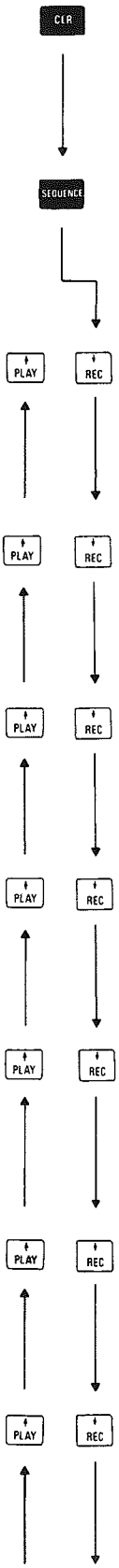
● Reading arbitrary position data

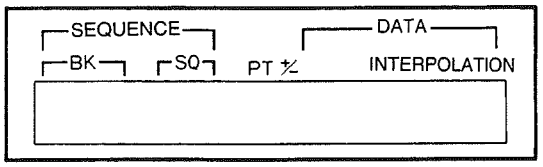


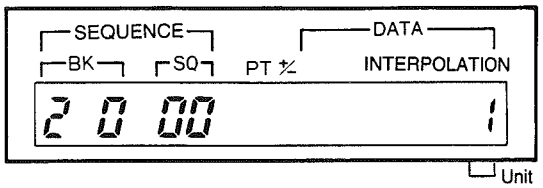
The address to be called is displayed in the BK and SQ fields of the display; here address 1123 is displayed

Press the SRCH/VER key to call the contents of address 1123

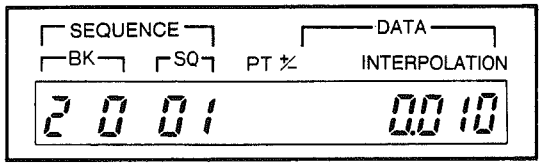
● Reading parameter data



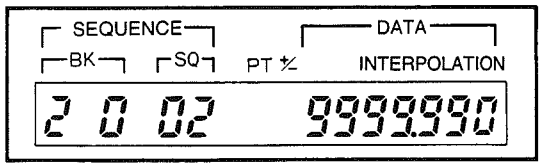




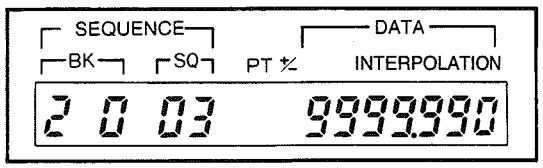
Units (address 2000) are mm



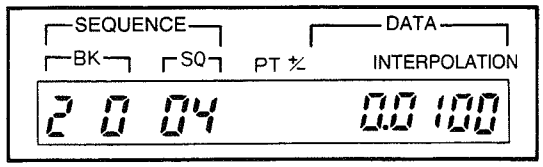
Pulse rate (address 2001) is 0.01 (mm/pulse)



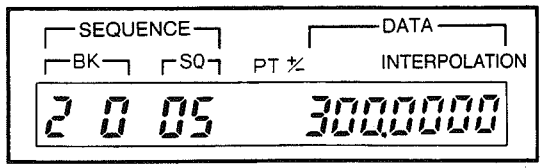
CW limit zone (address 2002) is 9999.99 (mm)



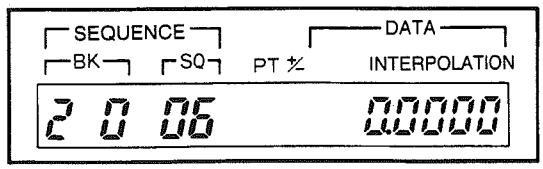
CCW limit zone (address 2003) is 9999.99 (mm)



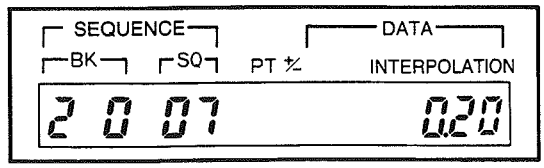
Backlash correction (address 2004) is 0.01 (mm)



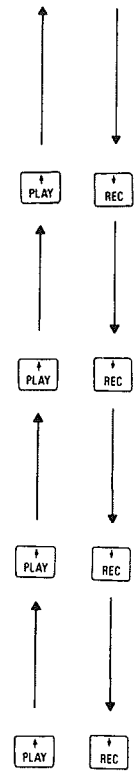
Maximum speed (address 2005) is 300 (mm/s)

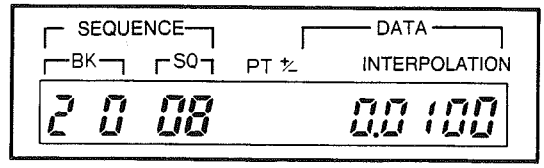


Starting speed (address 2006) is 0 (mm/s)

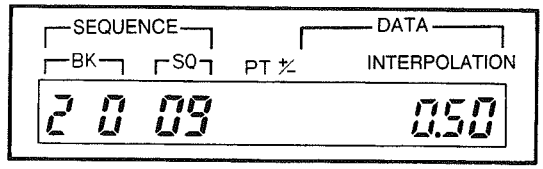


Acceleration/deceleration time (address 2007) is 0.2 (s)

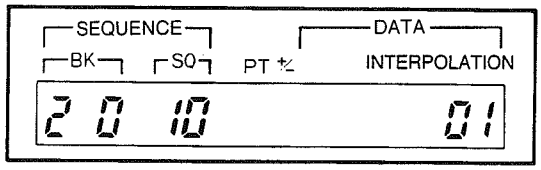




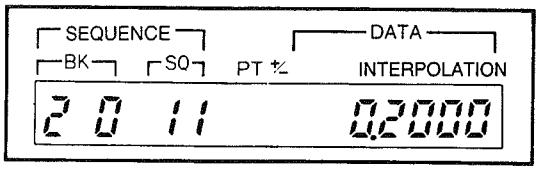
Near-zero parameter (address 2008) is 0.01 (mm)



Dwell time (address 2009) is 0.5 (s)

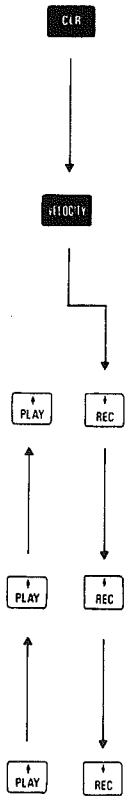


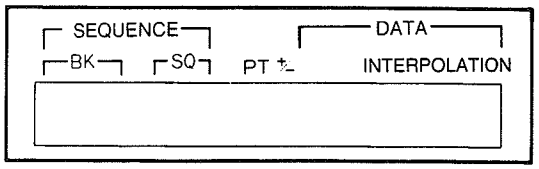
Origin search direction (address 2010) is CW; only the contents of the command counter are displayed

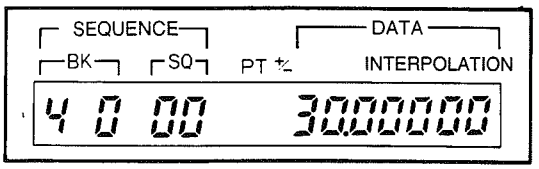


Origin correction (address 2011) is 0.2 (mm)

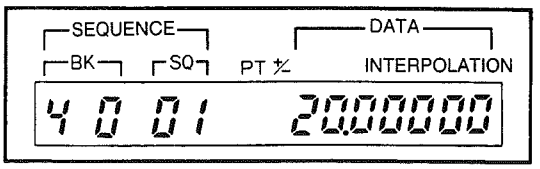
● Reading speed data



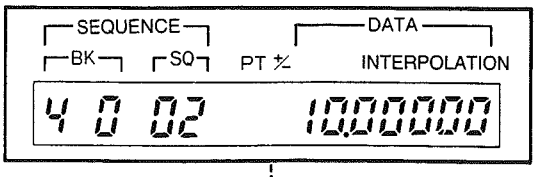




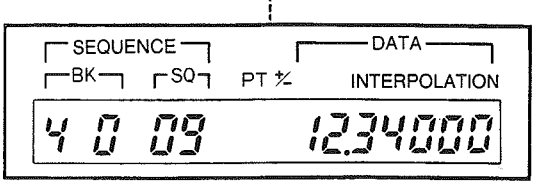
Origin return speed (address 4000) is 30.0 (mm/s)



Origin search speed (address 4001) is 20.0 (mm/s)



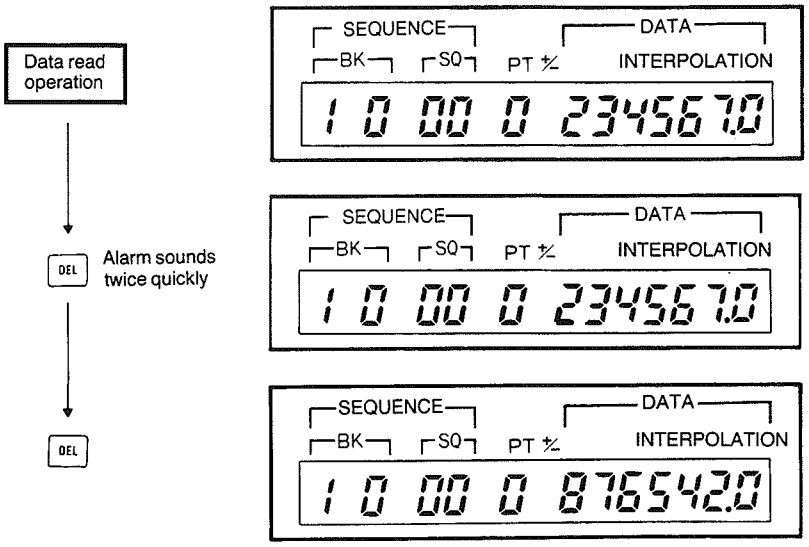
Manual operation speed (address 4002) is 10.0 (mm/s)



Speed (address 4009) is 12.34 (mm/s)

Data delete operation

Position data is the only type of data that can be deleted. The procedure for deleting position data is described below.

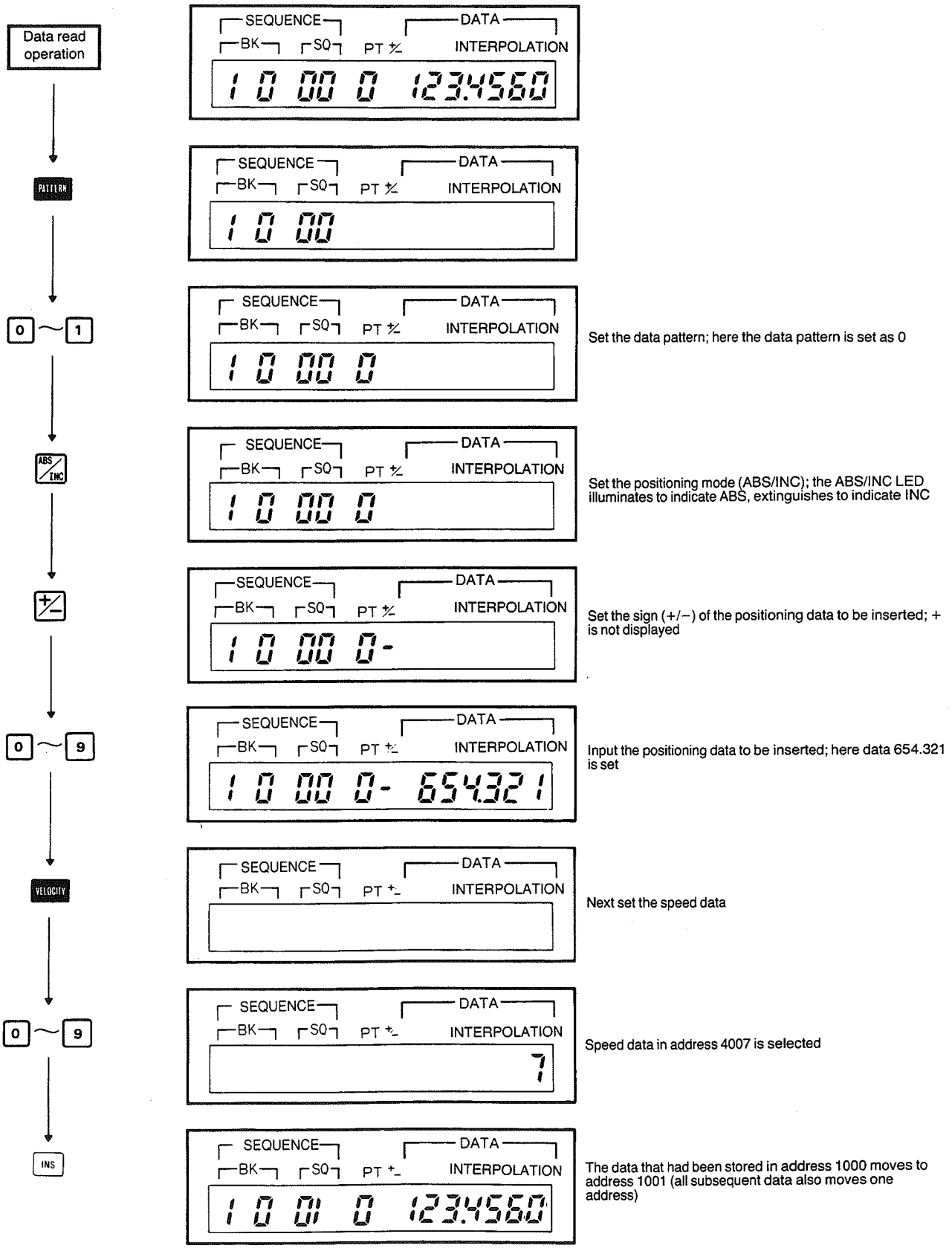


The data that had been stored in address 1000 is deleted; the data in address 1001 (and in all subsequent addresses) shifts up one address

When successive addresses of position data are deleted, the alarm sounds only for the first deletion. After that, data can be deleted simply by pressing the DEL key.

Data insert operation

As with deletion, position data is the only type of data that can be inserted.



- The procedure for inserting data is the same as for writing data; the only difference is that at the end of the procedure the INS key is pressed instead of the WRITE key.
- After position data as been inserted, the subsequent data in memory is all pushed back the number of addresses occupied by the inserted data.

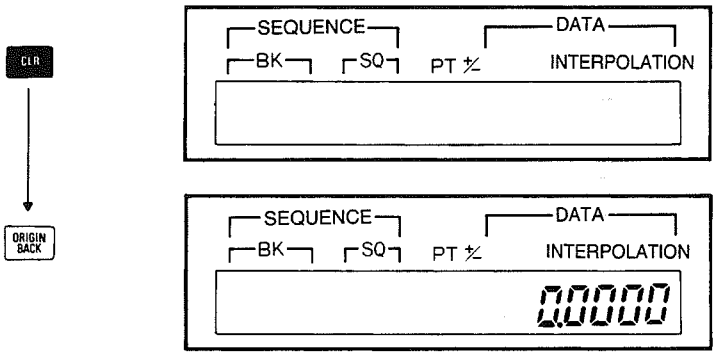
6.3.5 OPERATION COMMANDS

The teaching box, in addition to the data setting and editing functions described thus far, also includes the operation commands described below.

Origin search

Origin search can be performed by pressing the ORIGIN SEARCH key on the teaching box.

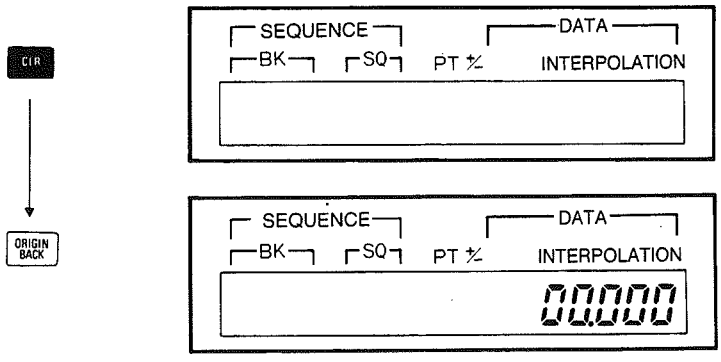
- When the origin search function completes, data 0.0000 is displayed.



Origin return

Origin return can be performed by pressing the ORIGIN BACK key on the teaching box.

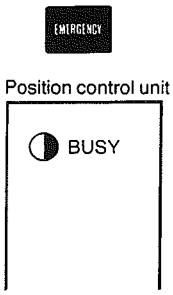
- When the origin return function completes, data 0.0000 is displayed.



Note: Origin return should be performed after the origin has been determined by first executing either origin search or forced origin.

Emergency stop

This function is used when it is necessary to stop the positioning operation immediately and is valid during origin search, origin return, manual operation, step execution, etc.



To effect an emergency stop, press the EMERGENCY key on the teaching box. When this is done, the voltage output is internally lowered to 0 V and the emergency and immediate stop relay (CHn+3, bit15) is turned ON. The emergency stop of the position control unit is indicated by blinking of the BUSY LED indicator. To cancel the emergency stop, the following four methods are available.

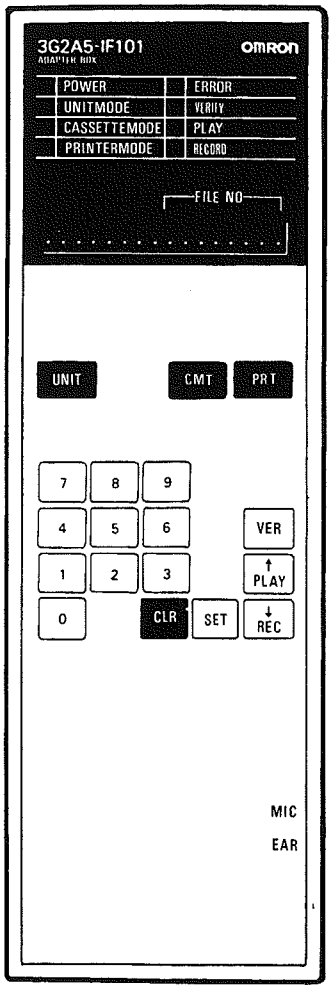
- Set the mode selector switch on the front panel from the LOCAL to the REMOTE position and then back to the LOCAL position.
- Set the REMOTE mode from the LOCAL mode and then back to the LOCAL mode, using the external LOCAL contact.
- Turn on power and then turn it off. Then turn it back on.
- Either turn ON the PC interrupt relay (CHn+1, bit13) or turn ON the interrupt signal of the external I/O connector.

When the position control unit is in the LOCAL mode, there are the following two methods to cancel the emergency stop status.

- Press the CLR key on the teaching box keyboard.
- Turn ON the interrupt signal of the external I/O connector.

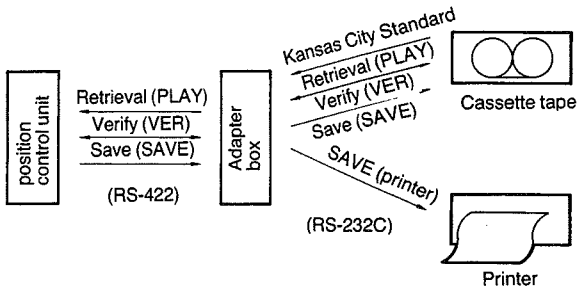
6.4 Data save and reference

The adapter box (3G2A5-IF101-E) can be connected to the position control unit to enable data save and reference operations to external memories.

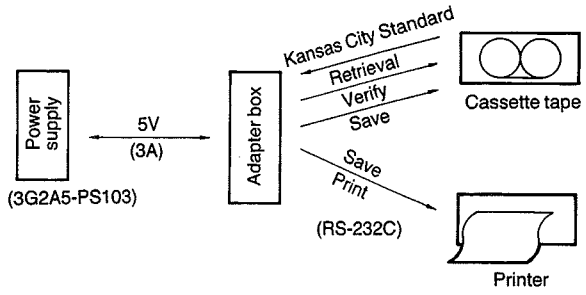


6.4.1 ADAPTER BOX CONFIGURATION

● When the adapter box is connected on-line with the position control unit



● When the adapter box is off-line

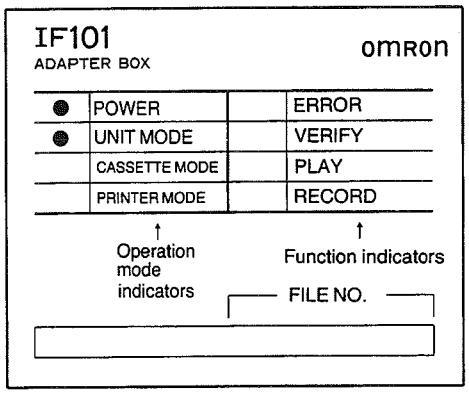


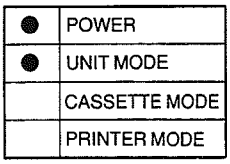
Note: When the adapter box is operated off-line, the internal RAM of the adapter box is backed up by a capacitor, so data can only be retained for about 2 hours. When the adapter box is used independent of the position control unit, it should be connected to a power supply unit (3G2A5-PS103).

6.4.2 OPERATION PROCEDURE

Power application

Confirm that the power supply is functioning properly and that it is set to the position control unit operation mode. (At this time there should be no display in the FILE NO. field.) The adapter box has three different operation modes that are selected by operating the function keys shown in the figure in 6.4.1, Adapter box configuration. These modes are:
Unit mode
Printer mode
Cassette mode
The corresponding LED will light to indicate the selected mode.





Unit mode

This is the default mode, that is, this mode is automatically selected when power is applied. If the adapter box is set in another mode, unit mode can be selected by pressing the UNIT key.
The functions of the adapter box can be executed by pressing the PLAY, REC, or VER keys.

REC Sends the user data (position, parameter, and speed data) in the RAM of the position control unit to the RAM of the adapter box

PLAY Sends the user data in the RAM of the adapter box to the RAM of the position control unit

VER Verifies the contents of the adapter box RAM against the contents of the position control unit RAM

●	POWER
	UNIT MODE
	CASSETTE MODE
●	PRINTER MODE

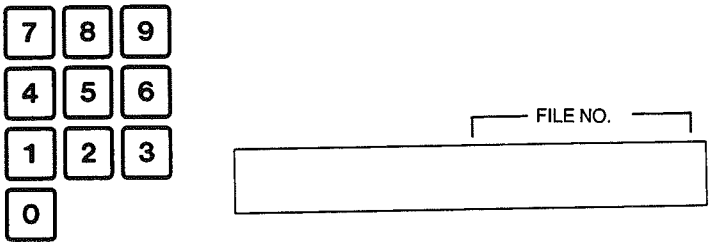
Printer mode

This mode is selected by pressing the PRT key. Operation begins when the REC key is pressed. The user data in the RAM of the adapter box is printed out in the predetermined format. At this time the user data is checked and if any error is found, the appropriate message is included in the printout.

●	POWER
	UNIT MODE
●	CASSETTE MODE
	PRINTER MODE

Cassette mode

This mode is selected by pressing the CMT key. Operation begins when the file number is input from the numeric keypad.

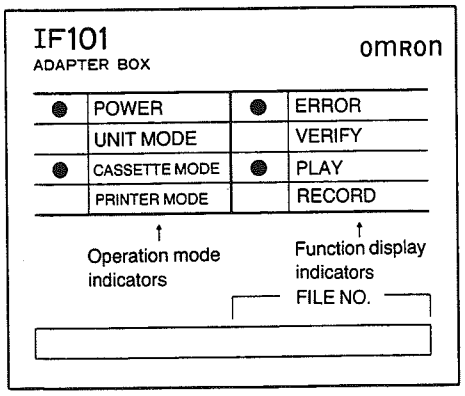


Note: When the file number is not set, 00000000 is assumed. If you have forgotten the file number, pressing the 0 and SET keys will cause the file number to be ignored and allows the user to move to the following procedures.
This setting, however, is reset when the cassette mode is left.

REC Saves the user data in the RAM of the adapter box to the cassette tape
PLAY Loads the contents of the tape to the RAM of the adapter box
VER Verifies the contents of the tape against the contents of the adapter box RAM

Error

There are two types of errors that can occur in each operation mode.
● Run, transmission errors, etc., during operation
● Syntax errors in the user data detected during output to the printer
In the first case, the nature of the error can be ascertained by examining which LED(s) (error, function, and operation) is illuminated. For example, if a framing error occurs during the PLAY operation in cassette mode, operation will halt and the display at this time will be as shown below.



During printout of the user data, checks are performed for the following three types of syntax errors. The messages printed at this time and their meanings are as follows:

V. OVER
- The starting speed exceeds the maximum speed
- The maximum speed exceeds the limit values
- The set speed exceeds the maximum speed

POS OVER
- The position data is outside the limit zone

PATTERN
- The combination of position patterns is erroneous

CLR key

This key has two different functions.
- During operation, pressing this key will abort the operation and cause the adapter box to enter a wait state for input of the REC, PLAY, or VER key.

- If an error has occurred, to clear the error and extinguish the corresponding LED display; the adapter box enters wait state for input of REC, PLAY, or VER key.

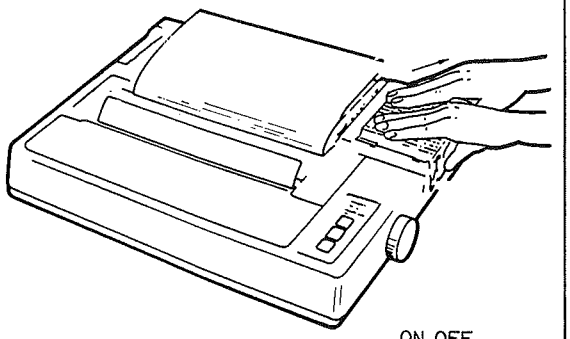
6.4.3 PRINTER SPECIFICATIONS (EXAMPLES WITH EPSON PRINTERS)

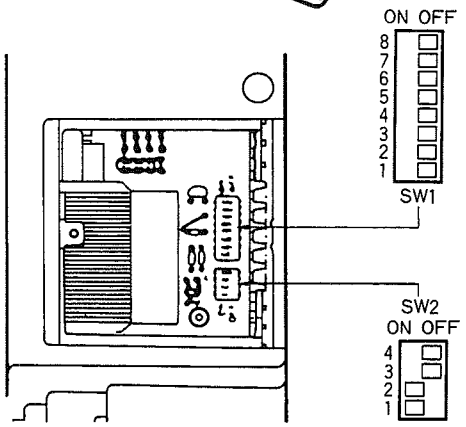
The following Epson printers can be connected to the adapter box. Because the serial interface has options for all of these printers, the interfaces listed below must be installed in the printer before they can be used.

Printer	Interface board
FX-80	#8145 or #8143
RX-80	#8145 or #8143
MX-80 (TYPE III)	#8145
MX-80 (TYPE II)	#8145

The DIP switch settings for the serial interface board and the printer are shown below.

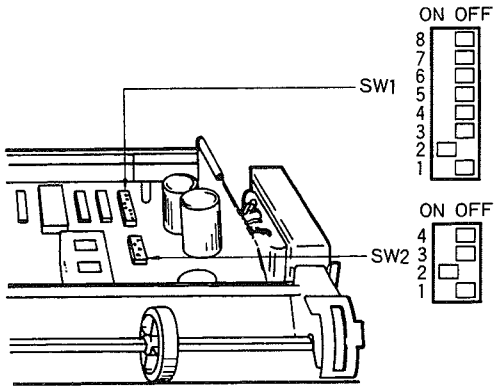
For the FX-80 printer



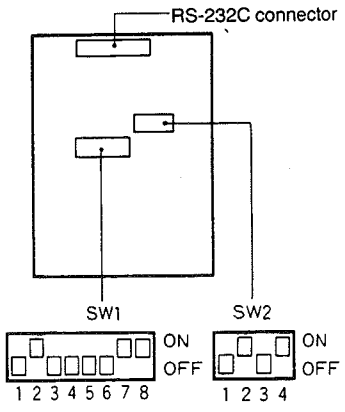


For the RX-80 printer

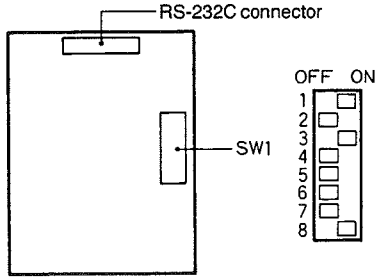
Removal method for the printer casing is described in the user's manual of the RX-80.



For serial interface #8145



For serial interface #8143





Printout example

ADDRESS		POSITION DATA			
BANK	SEQUENCE	PATTERN	POSITION	VELOCITY	ERROR
@10	00	1	+200	*0	
10	01	1	+300	*0	
10	02	1	+400	*0	
10	03	0	+500	*0	
10	04	0	+50	*0	
10	05	1	+60	*1	
⋮					
11	92	1	*−70	*9	
11	93	1	*−70	*0	
11	94	1	*−70	*9	
11	95	0	*−70	*0	
11	96	1	0	*9	
11	97	0	*+70	*0	
11	98	0	*+70	*9	
11	99	0	0	*0	
12	00		+ 5		

Note: Position data marked with an asterisk (*) is incremental data. In the BANK field, the unit price sign (@) indicates that the position data has a bank end attribute.

PARAMETER DATA				
ADDRESS	PARAMETER	DATA	DIMENSION	ERROR
2000	DIMENSION	1	mm	
2001	PULSE RATE	1.0000	mm/pulse	
2002 2003	LIMIT ZONE	+9999x1.0000 −9999x1.0000	mm	
2004	BACKLASH	1x1.0000	mm	
2005	MAX. VELOCITY	10000x1.0000	mm/sec	
2006	START VELOCITY	0x1.0000	mm/sec	
2007	DATA FOR ACCELERATION AND DECELERATION	0.02	SEC	
2008	NEAR ZERO	5x1.0000	pulse	
2009	DWELL TIME	0.01	SEC	
2010	SEARCH DIRECTION	1	CW	
2011	ORIGIN CORRECTION	0x1.0000	mm	

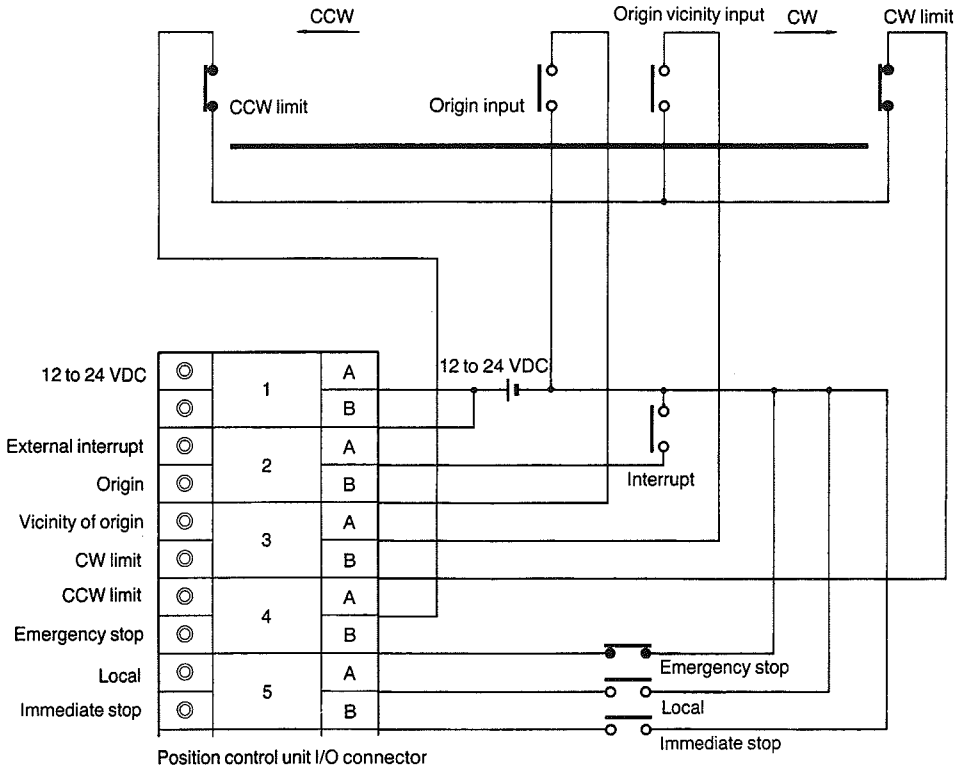
VELOCITY SET DATA					
ADDRESS	KEY NO	DATA	DIMENSION	NOTE	ERROR
4000	*0	0.1000	mm/sec	RETURN	
4001	*1	0.2000	mm/sec	SEARCH	
4002	*2	0.3000	mm/sec	MANUAL	
4003	*3	0.4000	mm/sec		
4004	*4	0.5000	mm/sec		
4005	*5	0.6000	mm/sec		
4006	*6	0.7000	mm/sec		
4007	*7	0.8000	mm/sec		
4008	*8	0.9000	mm/sec		
4009	*9	1.0000	mm/sec		

*** ERROR GUIDE***
1. V.OVER : START VELOCITY > LIMIT VELOCITY
   : MAX VELOCITY > LIMIT VELOCITY
   : SET VELOCITY > MAX VELOCITY
2. POS OVER : POSITION > LIMIT ZONE
3. PATTERN : ARRANGEMENT PATTERN ERROR

Chapter 7 Connecting external input

7.1 External inputs

The design of the position control unit assumes that the external inputs shown below will be connected.

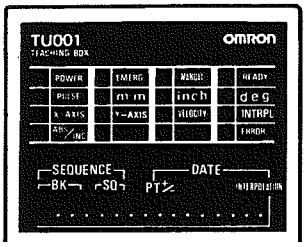
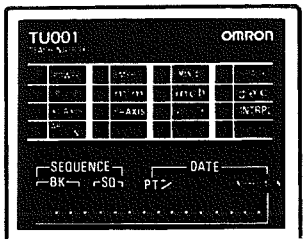


Connecting external input

The external inputs must be in the conditions described below in order for position control unit to perform positioning.

Emergency stop	NC; OFF (closed)
READY	NO; ON (closed)
CW limit LS	NC; OFF (closed)
CCW limit LS	NC; OFF (closed)

If these conditions are not established, the position control unit and the teaching box will indicate this with the following displays.

Condition	Position control unit display	Teaching box display
Emergency stop relay is open	BUSY BUSY LED blinks	 EMERGENCY LED lights
Immediate stop relay is open	RUN (Remote mode) RUN (Local mode) Display is same as during normal operation	 Display is same as during normal operation; if attempt is made to operate position control unit ERROR LED will light

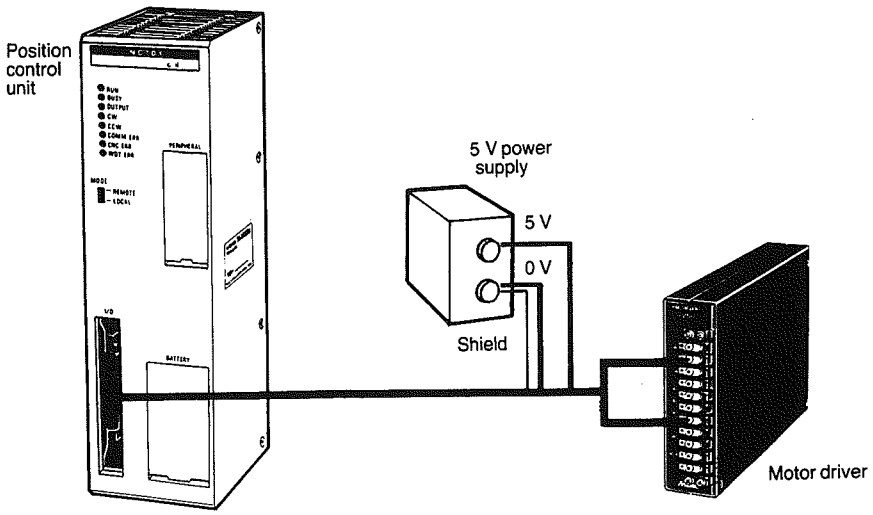
Note: Power supply for external inputs should be turned ON either at the same time or before power is applied to the position control unit.

GROUNDING

The following schemes are recommended for connecting the grounds of the shielded wires for a pulse motor or a servomotor.

Pulse motor

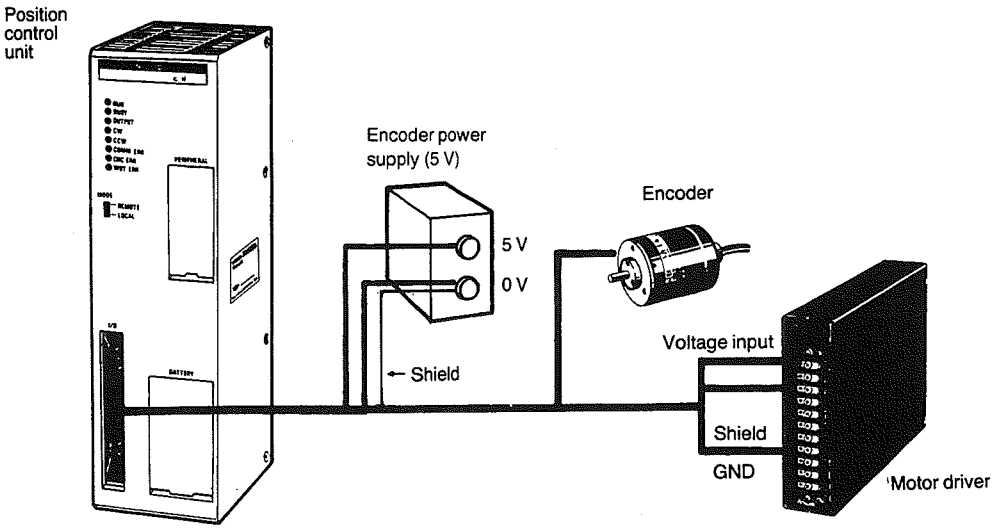
The shield of the cable between the position control unit and the pulse motor driver should be connected to 0 V terminal of the external power supply.



Servomotor

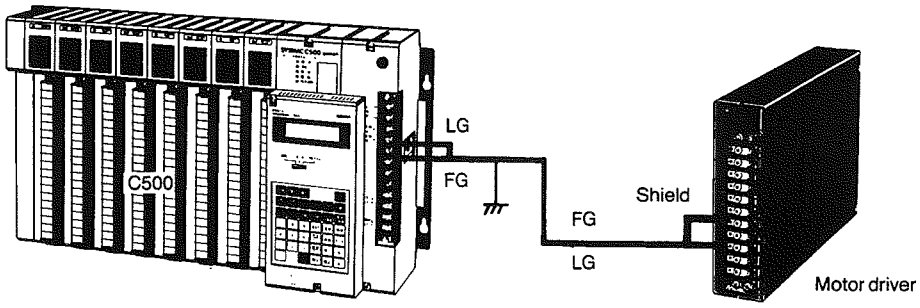
The shield of the cable used to carry the voltage output from the position control unit to the servomotor driver should be connected to the GND (LG and FG) terminals of the driver.

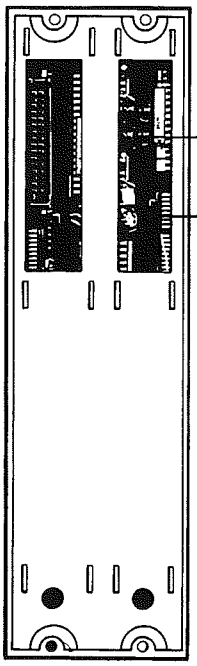
The shield of the cable used to transmit the feedback pulse from the rotary encoder to the position control unit should be connected to the 0 V terminal of the encoder power supply (5 V).



Connecting external input

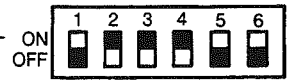
● When necessary, it is also possible to connect the GND of the driver to the LG and FG of the C500 power supply.





The two sets of DIP switches (6 bits each) on the rear panel of the position control unit should also be set according to the conditions under which positioning is to be performed.

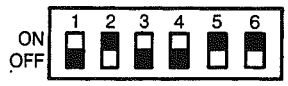
● **For use with a pulse motor**



1 No encoder Z phase	ON
2 Parameter write enable	OFF
3 Pulse motor	OFF
4 Z phase active "H"	OFF
5, 6 Multiple: ×0	ON, ON

● **For use with a servomotor**

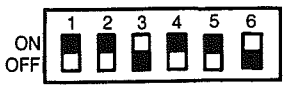
When the encoder Z phase is not used and the encoder output is active "L":



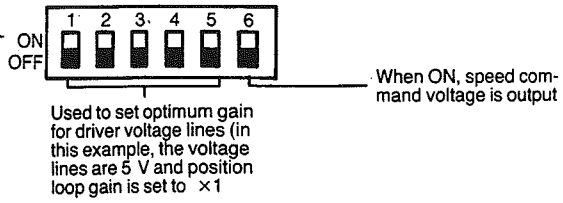
1 No encoder Z phase	ON
2 Parameter write enable	OFF
3 Servomotor	ON
4 Z phase active "L"	ON
5, 6 Multiple: ×1	OFF, OFF

● **For use with a servomotor**

When the encoder Z phase is used and the encoder output is active "H":



1 Encoder Z phase	OFF
2 Parameter write enable	OFF
3 Servomotor	ON
4 Z phase active "H"	OFF
5, 6 Multiple: ×4	OFF, ON

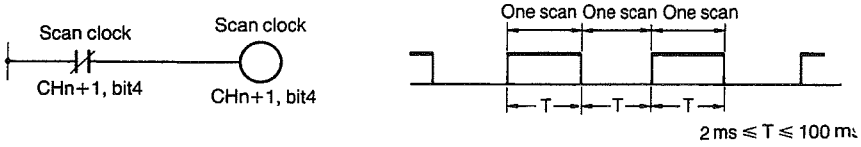


7.2 Internal setting

The internal settings are those settings that must be performed by the user program before positioning can be performed.

Scan clock

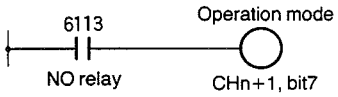
The scan clock is required to establish timing for data communications between the PC and the position control unit. The scan clock relay is CHn+1, bit4 so typical programs to provide this clock are as shown below.



Note: Ensure that scan time T does not exceed 100 ms.

Operation mode

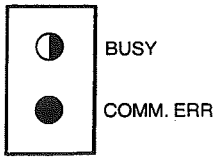
This input is required to inform the position control unit of the current mode of the PC. The position control unit determines from the ON or OFF state of this relay whether the PC is in run (RUN or MONITOR) or program mode. The operation mode relay is CHn+1, bit7 so a typical program to provide this signal is as shown below.



- If the scan clock is not set, the position control unit will accept only execution commands sent from the PC. These commands are:

  Start shaft
  Pause
  Origin return
  Forced origin
  Home shift
  PC interrupt
  Origin search
  Stop

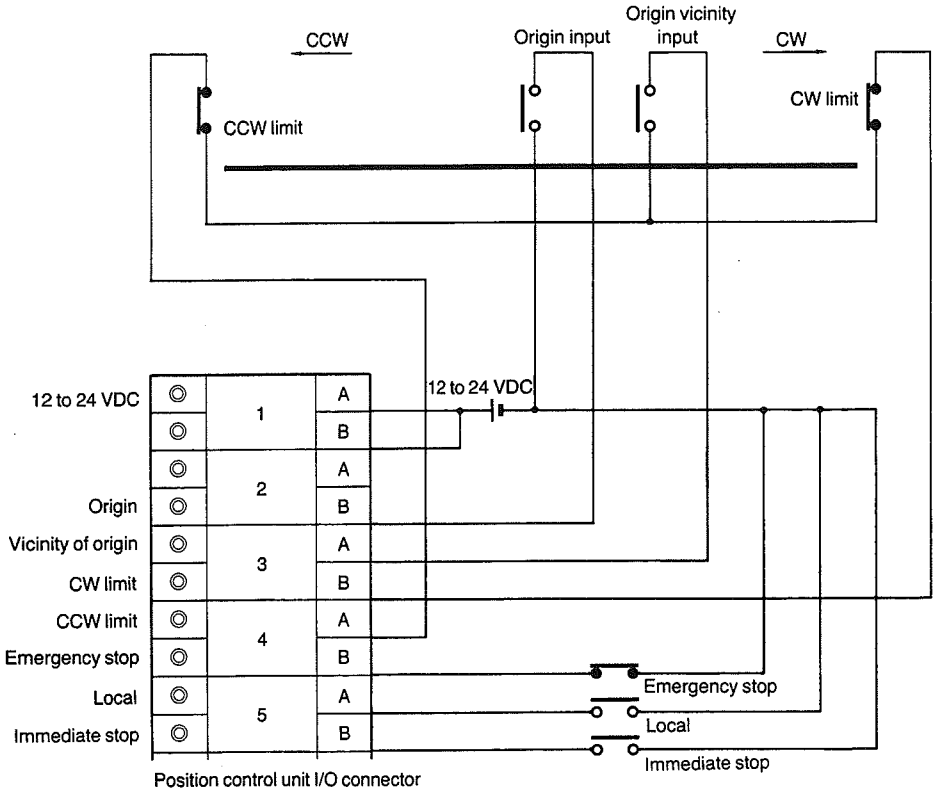
- If operation mode is not set, the position control unit will assume that the PC is in program mode and will only function in local mode. If the teaching box is not connected in local mode, the BUSY LED will blink and the COMM. ERROR LED will illuminate.



Chapter 8 Origin determination

Before positioning can be performed, it is first necessary to fix the origin, which serves as a reference position for all subsequent operations.

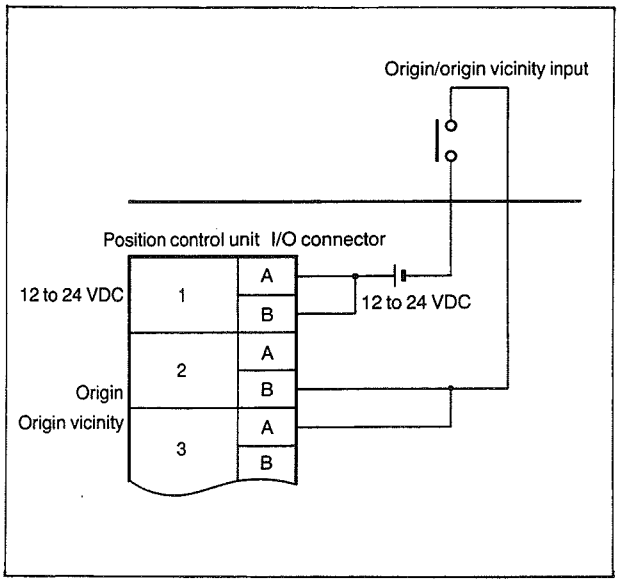
8.1 Origin/origin vicinity input

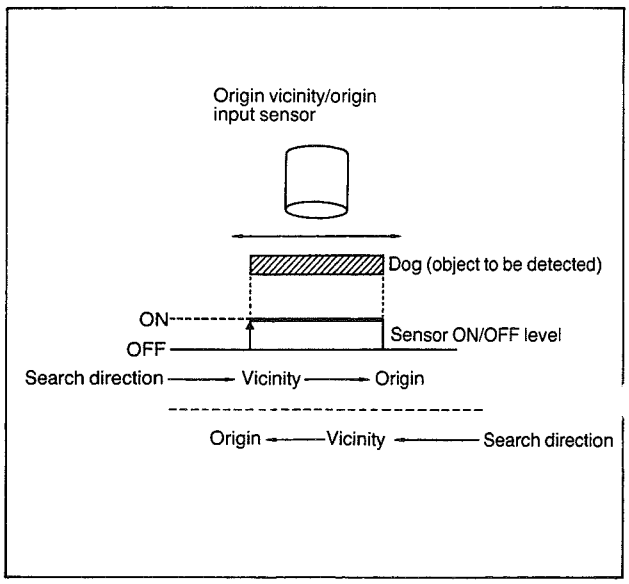


Note: The immediate stop relay should be ON when the position control unit can perform positioning.

ORIGIN/ORIGIN VICINITY INPUT

An example for inputting the origin and origin vicinity signals are shown below.





In this example, the origin/origin vicinity input turns ON when the dog is detected and this becomes the origin vicinity input. When this input turns OFF, the origin signal is input.

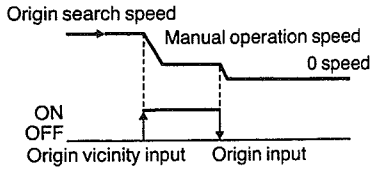
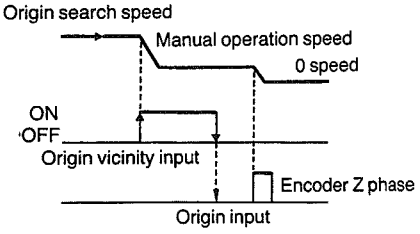
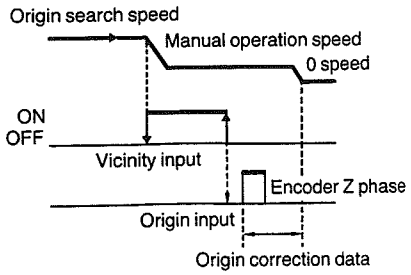
For the sensor, use of a device with no chattering, such as a photoelectric or proximity switch, is recommended. (For the CW and CCW limit inputs, a limit switch may be used with no difficulty.)

The timing with which the origin and origin vicinity inputs are input is as shown below.

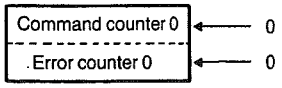
Origin vicinity input	NO contact	ON OFF OFF	Origin vicinity input is recognized at the rising edge (OFF → ON) of the input.
		Signal level 12 to 24 VDC 0 V 0 V	When the voltage is monitored at the 3A terminal of the position control unit I/O connector, the input timing is as shown on the left, with the falling edge active.
Origin input	NO contact	ON OFF OFF	Origin input is recognized at the falling edge (ON → OFF) of the input.
		Signal level 12 to 24 VDC 12 to 24VDC 0 V 0 V	When the voltage is monitored at the 2B terminal of the position control unit I/O connector, the input timing is as on the left with the rising edge active.

8.2 Origin search (CHn+1, bit14)

Origin search is used to determine the absolute mechanical origin. If this input is shared with the origin and origin vicinity inputs described earlier, the following three methods exist for determining the origin.

Conditions	Input state	Remarks
• The servomotor does not use the Z phase of the rotary encoder • A rotary encoder is not used for the control of the pulse motor		The shaft rotates toward the origin at the origin search speed; when the vicinity input goes ON, the speed changes to the manual operation speed that controls this movement; the origin is the location where the origin vicinity input turns OFF.
• The servomotor uses the Z phase of the rotary encoder Note: The pulse width of the encoder Z phase must be at least 2 ms. The manual operation speed must be reduced enough to maintain this pulse width.		The shaft rotates toward the origin at the origin search speed; when the vicinity input goes ON, the speed changes to the manual operation speed; the vicinity input turns OFF and the first encoder Z phase input after that is taken as the origin.
• The origin correction parameter data (address 2011) has been set Note: The origin correction data is used when mechanical factors make it impossible to obtain a precise location for the origin, for example if there is a difference between the mechanical origin and the Z phase output of the encoder.		The shaft rotates toward the origin at the origin search speed; when the vicinity input goes ON, the speed changes to the manual operation speed; the vicinity input turns OFF; after the first encoder Z phase is input, the shaft continues to move the amount specified by the origin correction data; the location where the shaft movement stops is taken as the origin.

The examples above show how origin search can be used to determine the origin. At the mechanical location determined as the origin, both the command and the error counter are cleared and the location is stored in memory.

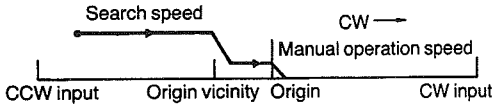
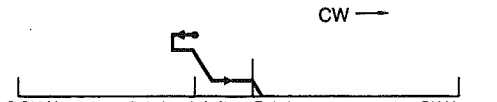
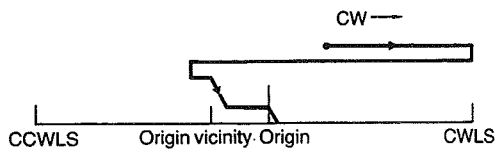


All positioning operations performed thereafter will refer to this location as the origin.

Note: The transition from origin search to manual operation speed is controlled by the acceleration/deceleration table. The vicinity location should therefore be set so that there is enough time to decelerate to the manual operation speed before the origin input is received.

Origin determination

Origin search is performed as shown below depending on the position of the shaft before origin search.

Conditions	1. Original vicinity and origin inputs are shared. 2. In the parameter data, the origin search direction is specified as CW. 3. The encoder Z phase input is present	
Position before origin search	Origin search operation	Remarks
Between the CCW input and and origin vicinity input		The shaft, rotating in the CW direction, approaches the origin at origin search speed; when the vicinity input goes ON, the speed changes to manual operation speed; the shaft stops when the first encoder Z phase is received after the vicinity input.
When the origin vicinity input is ON		The shaft movement proceeds at origin search speed in the opposite direction (CCW) of the search direction; the shaft passes the origin vicinity once and then reverses direction when the shaft passes the origin vicinity again (this time in the CW direction); the speed changes to manual operation speed and stops with input of the first encoder Z phase after the vicinity input turns OFF.
Between the origin and the CW input (including the origin)		The shaft movement proceeds at origin search speed in the CW direction; when the CWLS turns ON, the movement reverses direction; the movement passes the origin vicinity and reverses direction again; this time when the origin is passed in the search (CW) direction, speed is reduced to manual operation speed; the shaft movement stops with input of the first encoder Z phase after the vicinity input turns OFF.

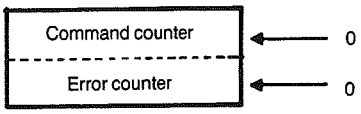
The condition of the position control unit data bus and handshaking channel (CHn+2, CHn+3) after completion of origin search is shown in the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Current position data; execution address	0000
CHn+3	0	ACK	OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	ON ↔ OFF	OFF
	7	Execution address transmit	ON ↔ OFF	OFF
	8	BUSY	OFF	OFF
	9	Sequence end	ON	ON
	10	Origin	ON	ON
	11	Bank end	ON or OFF	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero position	ON	ON
	15	Emergency and immediate stop	OFF	OFF

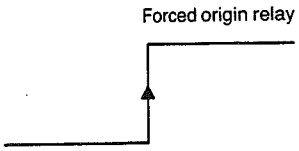
8.3 Forced origin (CHn+1, bit11)

Origin determination should be performed by the forced origin in the following cases:

- when there is not enough space between the origin and the origin vicinity to permit the shaft to decelerate to manual operation speed
- to frequently move the origin in order to perform positioning operations from the new origin



When this relay turns ON (rising edge active), both the command and the error counters are cleared to 0 and the position at that time is recorded as the origin location. Note that forced origin is effective only when the shaft movement is stopped.

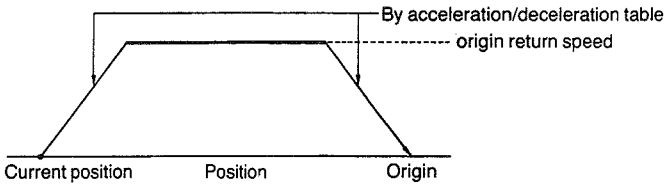


The condition of the position control unit data bus and handshaking channel (CHn+2, CHn+3) after completion of forced origin is shown in the following table.

CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Current position data; execution address	0000
CHn+3	0	ACK	OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	ON ↔ OFF	OFF
	7	Execution address transmit	ON ↔ OFF	OFF
	8	BUSY	OFF	OFF
	9	Sequence end	ON	ON
	10	Origin	ON or OFF	ON
	11	Bank end	ON	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero position	ON	ON
	15	Emergency and immediate stop	OFF	OFF

8.4 Origin return

This function causes the shaft to return from any position to the origin (as determined by origin search or forced origin). Origin return is performed either when the origin return relay is turned ON from the PC or when the origin return command is keyed in from the teaching box.



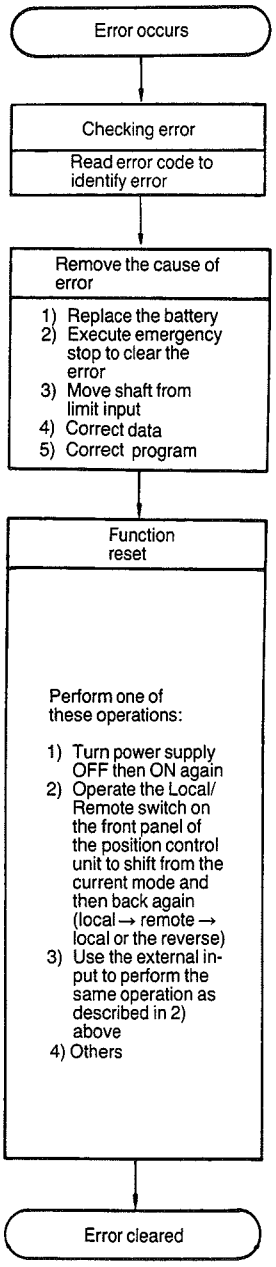
Note: Interrupt and pause inputs are accepted during origin return. During origin search however, these two commands only cause the search operation to abort and do not fulfill their original functions.

The condition of the position control unit data bus and handshaking channel (CHn+2, CHn+3) after completion of origin search is shown in the following table.

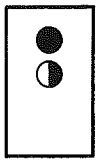
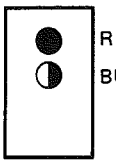
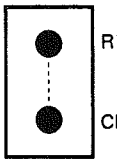
CH	Bit	Description	Remote mode	Local mode
CHn+2	0 to 15	Position control unit → PC data bus	Current position data; execution address	0000
CHn+3	0	ACK	OFF	ON
	1	DATA1 transmit	ON ↔ OFF	OFF
	2	DATA2 transmit	ON ↔ OFF	OFF
	3	Program data transmit	OFF	OFF
	4	NC RUN	ON	OFF
	5	Handshaking error	OFF	OFF
	6	Current position data transmit	ON ↔ OFF	OFF
	7	Execution address transmit	ON ↔ OFF	OFF
	8	BUSY	OFF	OFF
	9	Sequence end	ON	ON
	10	Origin	ON or OFF	ON
	11	Bank end	ON	ON or OFF
	12	CNC error	OFF	OFF
	13	Interrupt	OFF	OFF
	14	Near-zero position	ON	ON
	15	Emergency and immediate stop	OFF	OFF

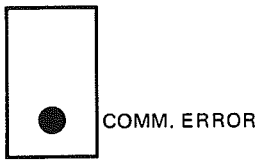
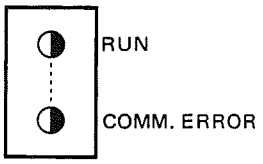
Chapter 9 Error processing

The position control unit issues warnings for the errors described on the following pages. The basic flowchart for troubleshooting errors is as shown below.



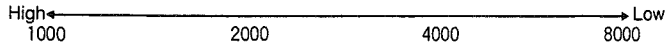
9.1 Error list

Error		Cause	Display	Remedy
Emergency stop (1000)		The emergency stop external input is OPEN or emergency stop has been input from the teaching box.	The RUN LED lights up and the BUSY LED blinks at intervals of 0.5 s; emergency and immediate stop relay (CHn+3, bit 15) turns ON. However, the RUN LED goes off in the local mode. 	Close the external emergency input and turn ON external input or PC interrupt relay (CHn+1, bit 13). In the local mode, press the CLR key on the teaching box or turn ON external interrupt input to clear the emergency stop input. However, when the pulse motor is used, a CNC error occurs. Refer to the description of the CNC error below.
Immediate stop (1100)		The immediate stop external input is OPEN while the position control unit is performing positioning.	The RUN LED lights up and the BUSY LED blinks at intervals of 1.0 s; the emergency and immediate stop (CHn+3, bit 15) relay turns ON. However the RUN LED goes off in the local mode. 	Close the external immediate stop input. However, when the pulse motor is used, a CNC error occurs. Refer to the description of the CNC error below.
CNC error	Error counter overflow (2000)	The input from the encoder is too slow and the error counter value overflows	The RUN and CNC LEDs light up; CNC error (CHn+3, bit 12) relay turns ON. 	a) Remove the cause of the error • Move the work away from the CW or CCW LS. • Remove the cause of the overflow error. • Correct the position data. • Correct the attribute. • Check the speed data. • Close the emergency stop. • Close the immediate stop. b) Turn OFF power. c) Turn ON power. Perform origin search and resume positioning. b') Operate the Local/Remote switch or local switch of the external input. c') Perform origin search and resume positioning.
	Limit LS ON (2100)	The work has turned on the CW or CCW LS		
	Software limit value overflow (2200)	A position value that exceeds the software limits has been set.		
	Pattern error 1 (2300)	An attempt has been made to reverse the movement direction with data having attribute of pattern 1.		
	Pattern error 2 (2400)	An attempt has been made to reverse the movement direction with the end bank and data having attribute of pattern 1.		
	Data setting error 1 (2500)	Position data and speed data do not exist in the address having attribute of pattern 1.		
	Data setting error 2 (2600)	Position data and speed data do not exist in the address having attribute of pattern 0.		
	Emergency and immediate stop (2700)	The emergency or immediate stop signal is input when a pulse motor is used.		
	Data setting error 3 (2800)	The origin return speed, origin search speed, and manual speed are not set.		

Error		Cuase	Display	Remedy
COMM. error	BCD error 1 (4000)	The address of the data transferred from the PC to NC is not in BCD.	The COMM. LED lights up; handshake error relay (CHn+3, bit 5) turns ON. 	a) Read the second word of the error code to check the cause of the error. b) Review the timing of the user program. c) Turn ON a relay (CHn+1, bit 6) to clear the handshake error. d) Restart connumication from the beginning of the user data.
	BCD error 2 (4100)	The first word of the data transferred from the PC to NC is not in BCD.		
	BCD error 3 (4200)	The second word of the data transferred from the PC to the NC is not in BCD.		
	Timer check error (4300)	The intervals between PC-to-NC communication is too long (e.g., when transferring three-word data, the second word is not transferred even after the first word has been received).		
	Data setting error 1 (4400)	The data in the address is not in accordance with the predetermined rules.		
	Data setting error 2 (4500)	Pattern 1 is set with the end bank.		
	Data setting error 3 (4600)	An attempt is made to set a value exceeding the preset maximum value.		
	Data setting error 4 (4700)	An attempt is made to set a value falling below the preset minimum value.		
	Parameter write disable (4800)	An attempt is made to write a parameter when parameter write is disabled by the DIP switch.		
Battery low (8000)		The supply voaltage of the backup battery drops.	The RUN and COMM. LEDs blink. 	a) Turn OFF power and replace the battery. b) Set the user data in the position control unit again. c) Perform origin search to determine the origin and resume the positioning.

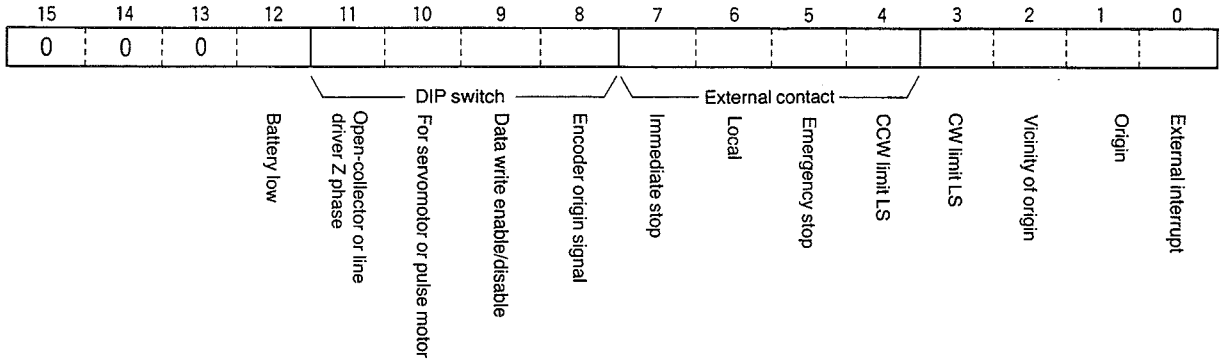
9.2 Priority of error codes

If two or more errors occur at the same time, the priority by which one error takes precedence over the other when transferred from the position control unit to the PC is as follows:



9.3 Second data of error code

9.3.1 EMERGENCY STOP, IMMEDIATE STOP, CNC ERROR, BATTERY LOW



Note: Opening and closing of an external contact are represented by "0" and "1", respectively. However, the OFF and ON positions of a DIP switch are respectively expressed as "0" and "1".

9.3.2 HANDSHAKE ERROR

In case of an error, the position control unit transfers the data in which the error has occurred as is to the PC, along with the error code.

For example, if an attempt is made to transfer this three-word data, the error code will be as follows:

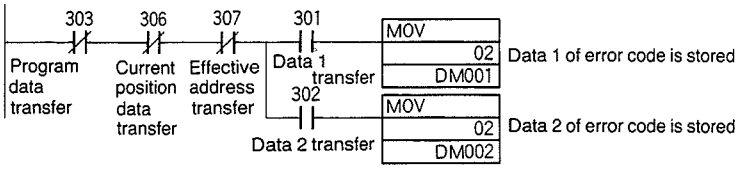
				Error code	
				1st word	2nd word
1000	990A	0020	→	4100	990A

In the above example, of the address, the first data, and the second data, the second data is not in BCD. Therefore, the position control unit transfers to the PC the error code "4100" followed by the second data "990A" which has caused the BCD error to occur.

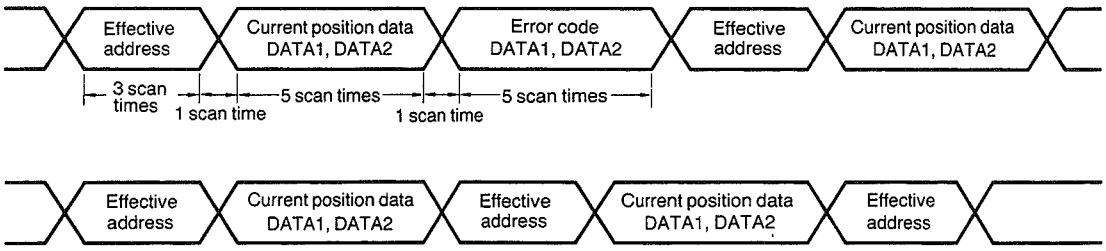
9.4 Error code transfer

In case an error occurs, the position control unit transfers the error code to the PC to inform the user of the occurrence and cause of the error.

9.4.1 PROGRAM EXAMPLE TO TRANSFER ERROR CODE TO PC

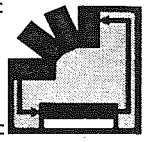


9.4.2 ERROR CODE TRANSFER



Note: If no error occurs, the position control unit transfers no error code.

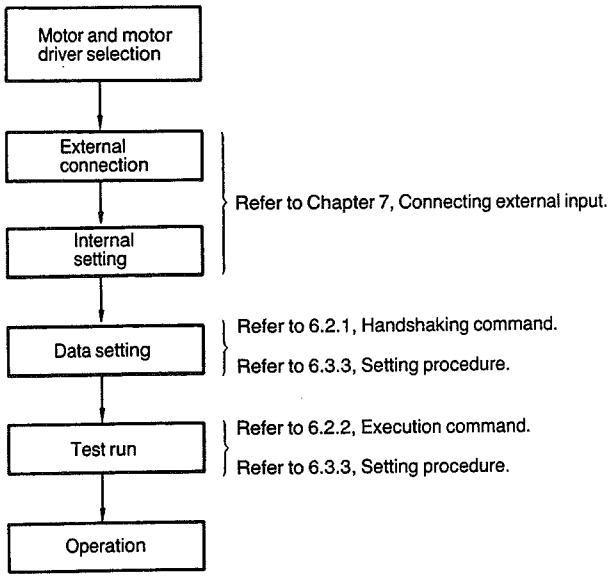
Chapter 10 Application examples



This chapter describes the operations of the position control unit as well as the programming procedure of the programming console in actual applications, taking a specific example for when a pulse motor and when a servomotor is used.

10.1 Operating procedure

This flowchart shows the procedure for using the position control unit.



10.2 Pulse motor driving

10.2.1 PULSE MOTOR AND DRIVER SELECTION

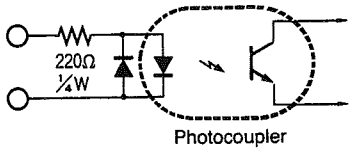
Next an application example is shown when the controlled system is a pulse motor. The specifications of the pulse motor are:

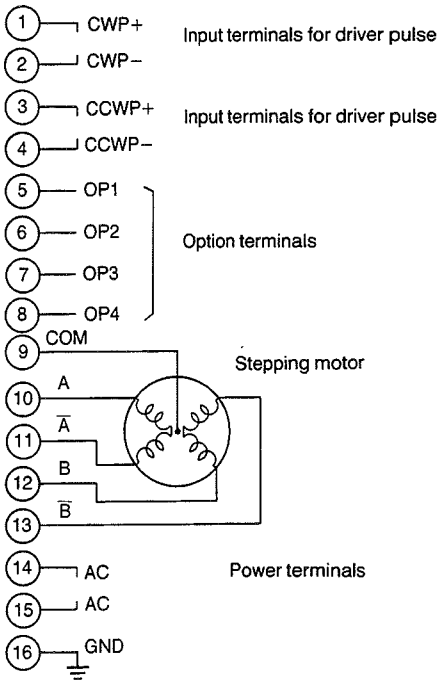
4.7 VDC 1.8 A
1.8 deg/step

These are the conditions under which pulses are input from the input device (in this example, photo microsensors) to the position control unit:

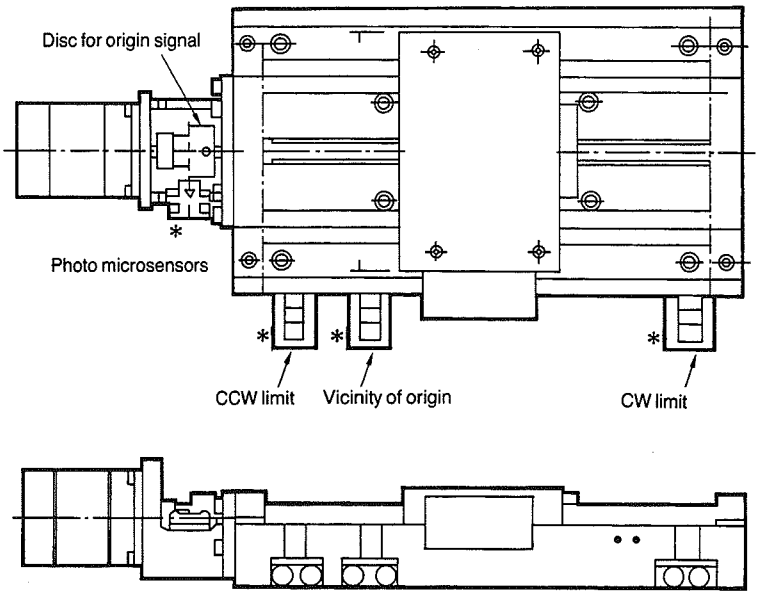
Pulse voltage: +3 to +5 V (for true signal),
0 to +0.5 V (for false signal)
Internal resistance: 220Ω
Pulse width: 20 µs min.
Rise time: 2 µs max.

The following diagram shows the terminal arrangement of the position control unit.



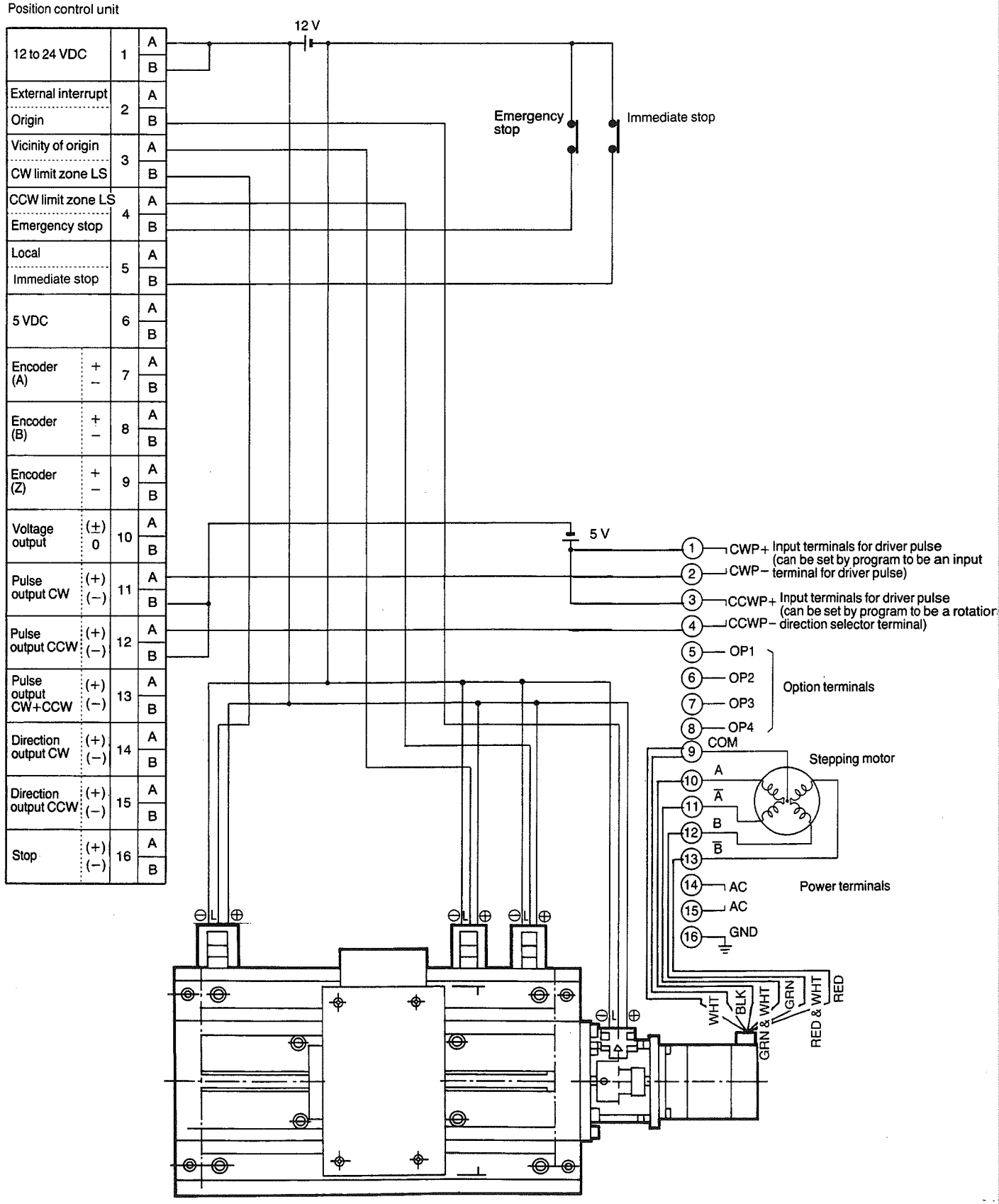


Next a single-shaft work table is shown whose motor is to be controlled by the position control unit. In this example, Type EE-SG3M (OMRON) photo microsensors are used.



10.2.2 EXTERNAL INPUT CONNECTION

This figure shows the wiring between the terminals of the position control unit and the terminals of the motor driver.

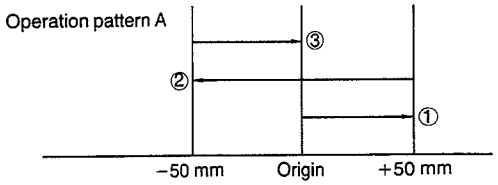


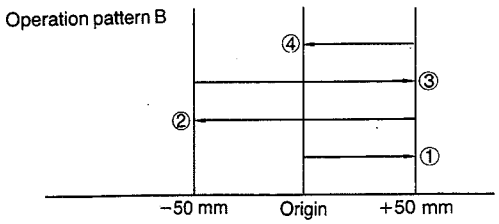
10.2.3 INTERNAL SETTING

Now that the object to be controlled has been outlined, attention is turned to the programming used for the control. The program in this application example will perform the following operations.

- Upon power application, it transfers the parameter data and speed data stored in the PC's data memory to the position control unit (i.e., data transfer).
- It sets the position of the motor shaft upon power application as the origin (forced origin setting).
- When either of external switches A and B is operated, it transfers a series of position data to the position control unit in accordance with which the unit performs positioning (until the switch is turned OFF).

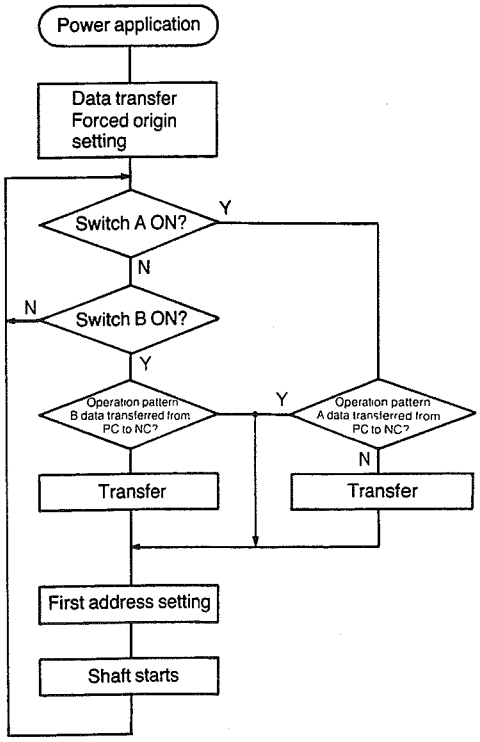
The following charts illustrate the operation of the position control unit.



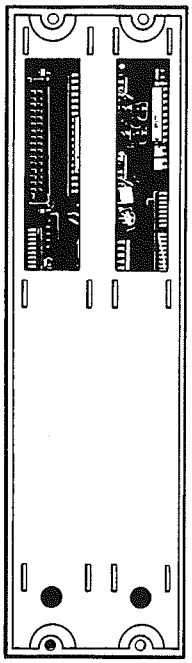


Note that the position data is specified by the position control unit.

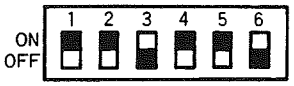
The operations performed by this program follow this flowchart:



Because a pulse motor is to be controlled in this example, set the DIP switches on the rear of the position control unit as follows:



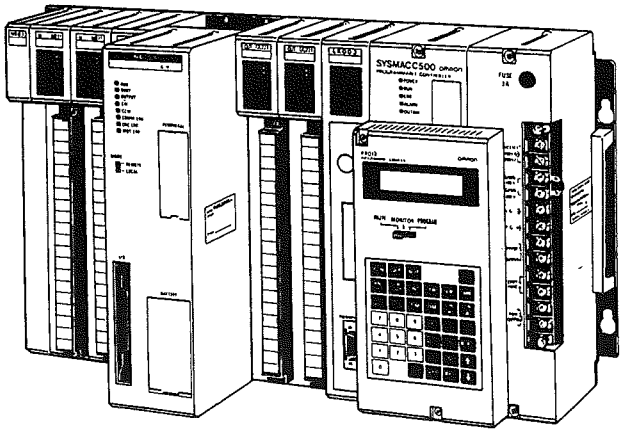
Rear view of position control unit



Bit No.	ON/OFF	Description
1	ON	No encoder Z phase
2	OFF	Parameter write enable
3	OFF	Pulse motor
4	OFF	Z phase active "H"
5	ON	Multiple (x0)
6	ON	

Programming

When the necessary wiring has been done, the program must be written into the PC's memory through the programming console. To do so, first mount the position control unit to the CPU rack of the SYSMAC-C500 (used for this example) as shown below. The following figure shows the position control unit mounted to channels 5 to 8 of the CPU rack.



SYSMAC-C500 CPU rack

Then apply power to the C500.

```
<PROGRAM>
PASSWORD!
```

```
<MONITOR>
```

```
0000
```

Upon power application, the POWER LED indicator of the C500 illuminates. At this time, the operating mode of the PC is displayed on the programming console, enclosed by < >. Therefore, if the C500 is in program mode at the time of power application, you'll see this display on the programming console.

To enable programming console operation, press CLR, MONTR, CLR.

CLR → MONTR → CLR

```
0000
```

```
0000
FUN(??)
```

```
MEMORY ERR.
```

or "NO END INSTR"

```
I/O VER.ERR.
```

Note that the message MEMORY ERR and I/O VERIFY ERR may be displayed respectively at the first and second depressions of the CLR key. If that happens, you need to identify and correct the error. To read the error, press

CLR → FUN → MONTR → MONTR

```
0000
```

```
0000
```

```
0000
```

```
0000MEMORY CLR ?
   HR CNT DM
```

```
0000MEMORY CLR
END HR CNT DM
```

If the message MEMORY ERR is consequently displayed, press these keys to clear all memory contents.

CLR → PLAY/SET → NOT → REC/RESET → MONTR

```
0000
```

```
0000
FUN(??)
```

```
0000
FUN(0?)
```

```
0000
END(01)
```

```
0001
NOP(??)
```

If the problem was a NO END INSTR, write the END instruction this way at the end of the program already in the memory.

CLR → FUN → 0 → 1 → WRITE

```
0000
```

```
0000
FUN(??)
```

```
0000I/OTBL?
   ?-?U=
```

If I/O VERIFY ERR message appears, the I/O numbers must be assigned by generating an I/O table. Do this as follows:

CLR → FUN → SHIFT → CH/X → CHG → 9 7 1 3 → WRITE

```
0000I/OTBL WRITE
            ????
```

```
0000I/OTBL WRITE
            9713
```

```
0000I/OTBL WRITE
OK
```

```
0000
```

```
0000
CHANNEL DM    000
```

```
0000
CHANNEL DM    001
```

```
D001
0000
```

```
0000PRES VAL?
D001  0000  ????
```

```
0000PRES VAL?
D001  0000  2000
```

```
D001
2000
```

If no error is present upon power application, or after the error has been corrected, the parameter, speed, and position data must be written to the data memories of the C500. The data to be written are listed on the table below.

As an example, the following operation sequence illustrates how to write constant 200 to DM001. (Note that the data memory area must be cleared in advance.)




```
0000
```

```
0000
CHANNEL DM     00
```

```
0000
CHANNEL DM    100
```

```
      D100 MONTR
0000010101010101
```

```
      D100 CHG?
■0000101010101010
```

```
      D100 CHG?
1■000101010101010
```

```
      D100 CHG?
10■00101010101010
```

```
      D100 CHG?
100■0101010101010
```

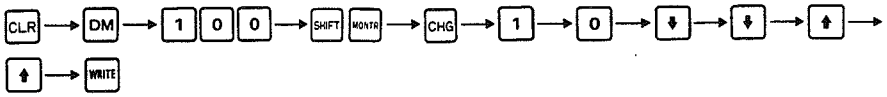
```
      D100 CHG?
1000■1010101010101
```

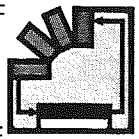
```
      D100 CHG?
100■0101010101010
```

```
      D100 CHG?
10■00101010101010
```

```
      D100 MONTR
1000010101010101
```

Data can be written to the data memory in binary numbers instead of decimal numbers. The following shows an example for this.





DM assignment

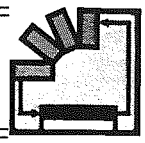
DM No.	Data	Remarks
000	0000	Data register clear
001	2000	Dimension address
002	0000	
003	0001	Unit mm setting
004	2001	Pulse rate address
005	0010	0.1 mm/pulse
006	0000	
007	2002	CW limit zone address
008	9999	999999 pulses
009	9900	
010	2003	CCW limit zone address
011	9999	999999 pulses
012	9900	
013	2004	Backlash correction address
014	0000	Backlash = 0
015	0000	
016	2005	Max. speed address
017	0025	Max. speed (2,500 pulses/s)
018	0000	
019	2006	Start speed address
020	0000	Start speed (0 pulse/s)
021	0000	
022	2007	Acceleration/deceleration time address
023	0000	
024	1000	Acceleration/deceleration time (0.1 s)
025	2008	Near-zero address
026	0000	
027	0300	Near-zero (3 pulses)
028	2009	Dwell time address
029	0001	
030	0000	Dwell time (1 s)
031	2010	Origin search direction address
032	0000	
033	0000	Origin search CCW direction
034	2011	Origin correction address
035	0000	
036	0000	Origin correction (0)
037	4000	Speed data first address
038	0005	
039	0000	Origin return speed (500 pulses/s)
040	4001	Origin search speed address
041	0010	
042	0000	Origin search speed (1,000 pulses/s)
043	4002	Manual speed address
044	0015	
045	0000	Manual speed (1,500 pulses/s)

DM No.	Data	Remarks
046	4003	Speed data No. 3 address
047	0020	
048	0000	Speed data No. 3 (2,000 pulses/s)
049	4004	Speed data No. 4 address
050	0025	
051	0000	Speed data No. 4 (2,500 pulses/s)
052	4005	Speed data No. 5 address
053	0000	
054	0000	Speed data No. 5 (0 pulse/s)
055	4006	Speed data No. 6 address
056	0000	
057	0000	Speed data No. 6 (0 pulse/s)
058	4007	Speed data No. 7 address
059	0000	
060	0000	Speed data No. 7 (0 pulse/s)
061	4008	Speed data No. 8 address
062	0000	
063	0000	Speed data No. 8 (0 pulse/s)
064	4009	Speed data No. 9 address
065	0000	
066	0000	Speed data No. 9 (0 pulse/s)
067	0000	—
068	1000	Position data address
069	0005	
070	0032	SWA position data + 500 pulses
071	1001	Position data address
072	0010	
073	0033	SWA position data — 1,000 pulses
074	1002	Position data address
075	0005	
076	003A	SWA position data + 500 pulses
077	0000	
078	0000	
079	0000	
080	0000	—
081	1000	Position data address
082	0005	
083	0042	SWB position data + 500 pulses
084	1001	Position data address
085	0010	
086	0043	SWB position data — 1,000 pulses
087	1002	Position data address
088	0010	
089	0042	SWB position data + 1,000 pulses
090	1003	Position data address
091	0005	
092	004B	SWB position data — 500 pulses

CH / Bit	5	6	7	8
0	PC → position control unit data bus	Address write	Position control unit → PC data bus	ACK (handshake BUSY)
1		Data1 write		Data1 transmit
2		Data2 write		Data2 transmit
3		Program read command		Program data transmit
4		Scan clock		NC RUN
5		Address setting		Handshake error
6		Handshake error clear		Current position data transmit
7		Operation mode		Execution address transmit
8		Start shaft		BUSY (positioning under way)
9		Pause		Sequence end
10		Origin return		Origin
11		Forced origin		Bank end
12		Home shift		CNC error
13		PC interrupt		Interrupt
14		Origin search		Near-zero
15		Stop		Emergency and immediate stop

CH / Bit	15
0	Transmit start (handshake BUSY)
1	ACK (handshake BUSY) rise
2	ACK (handshake BUSY) fall
3	Program start command
4	Program stop command
5	IL auxiliary relay
6	Transmit start auxiliary relay
7	Transmit end
8	Internal auxiliary relay
9	SWA rise
10	SWB rise
11	Parameter and speed data transmit end
12	Data transmit end when SWA ON
13	Data transmit end when SWB ON
14	
15	

CH / Bit	16
0	Address setting IL auxiliary relay
1	Address setting start auxiliary relay
2	Internal auxiliary relay
3	Internal auxiliary relay
4	Internal auxiliary relay
5	Internal auxiliary relay
6 to 15	

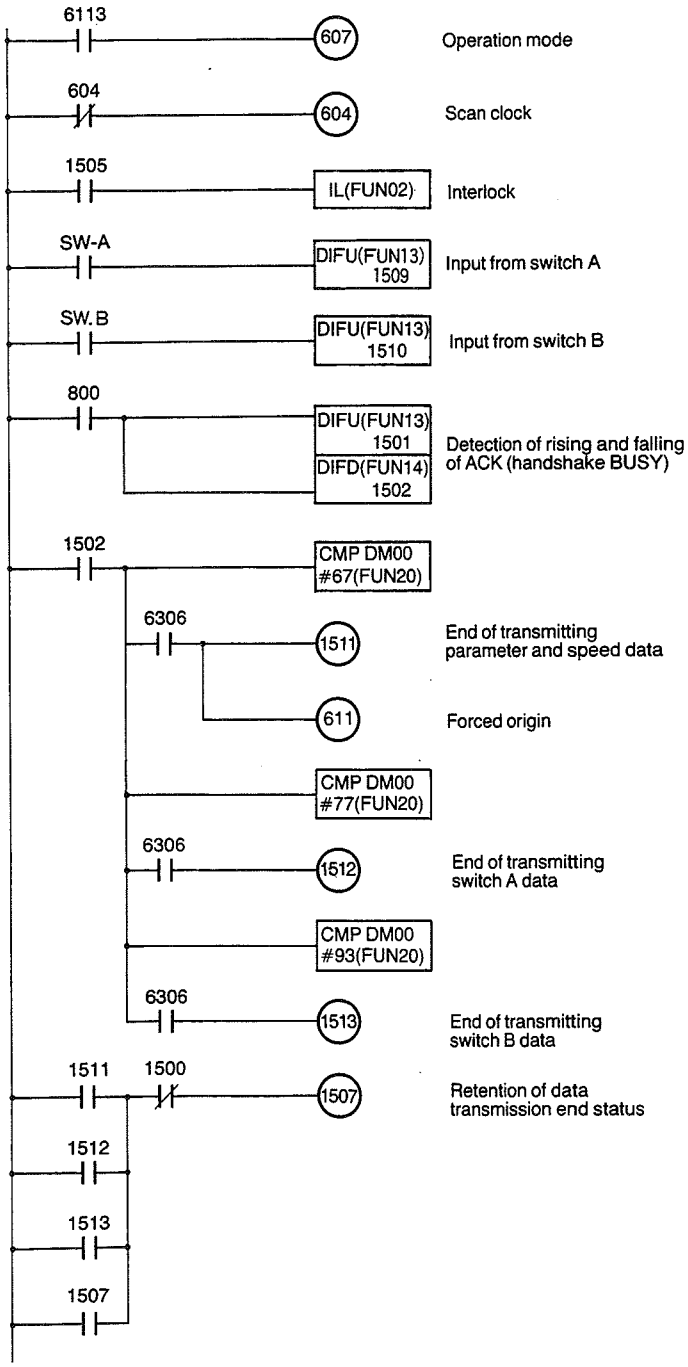


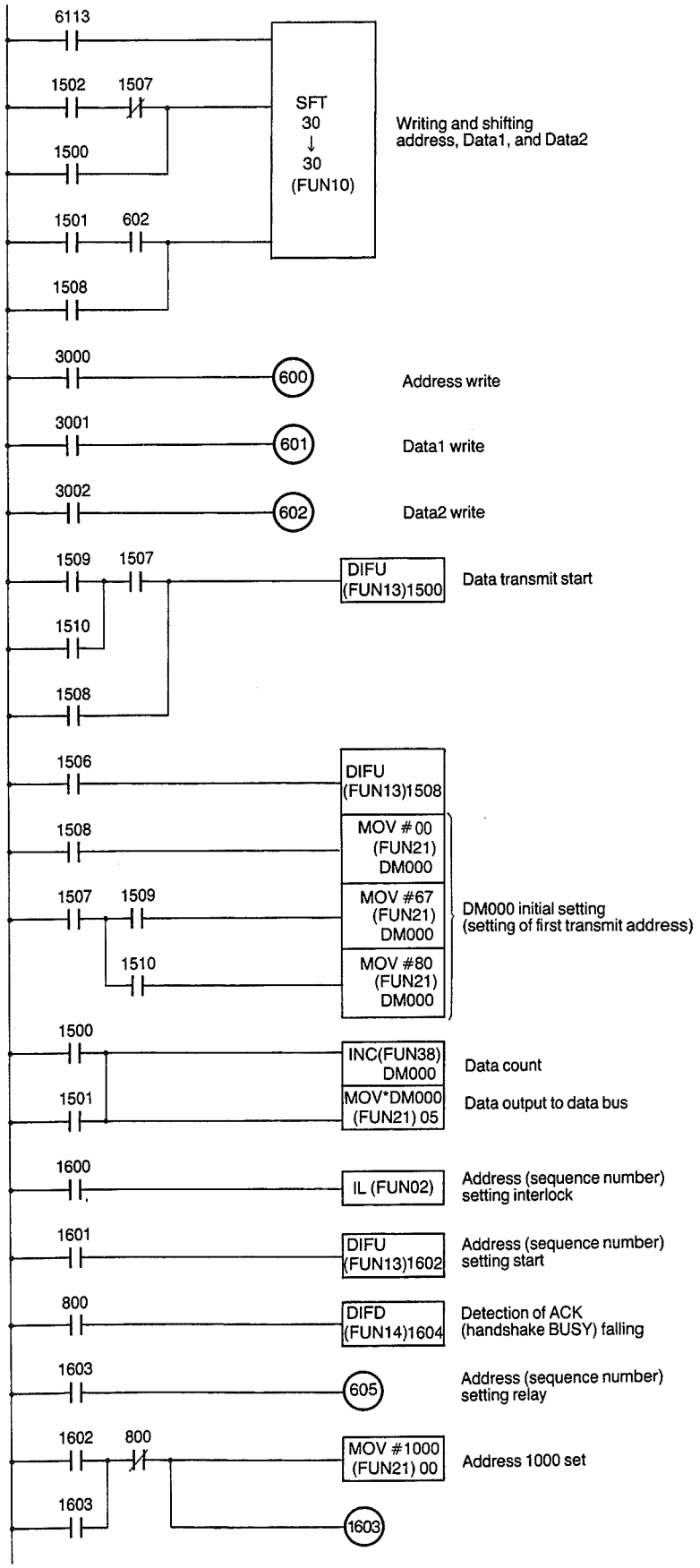
Bit \ CH	30
0	Address write auxiliary relay
1	Data1 write auxiliary relay
2	Data2 write auxiliary relay
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

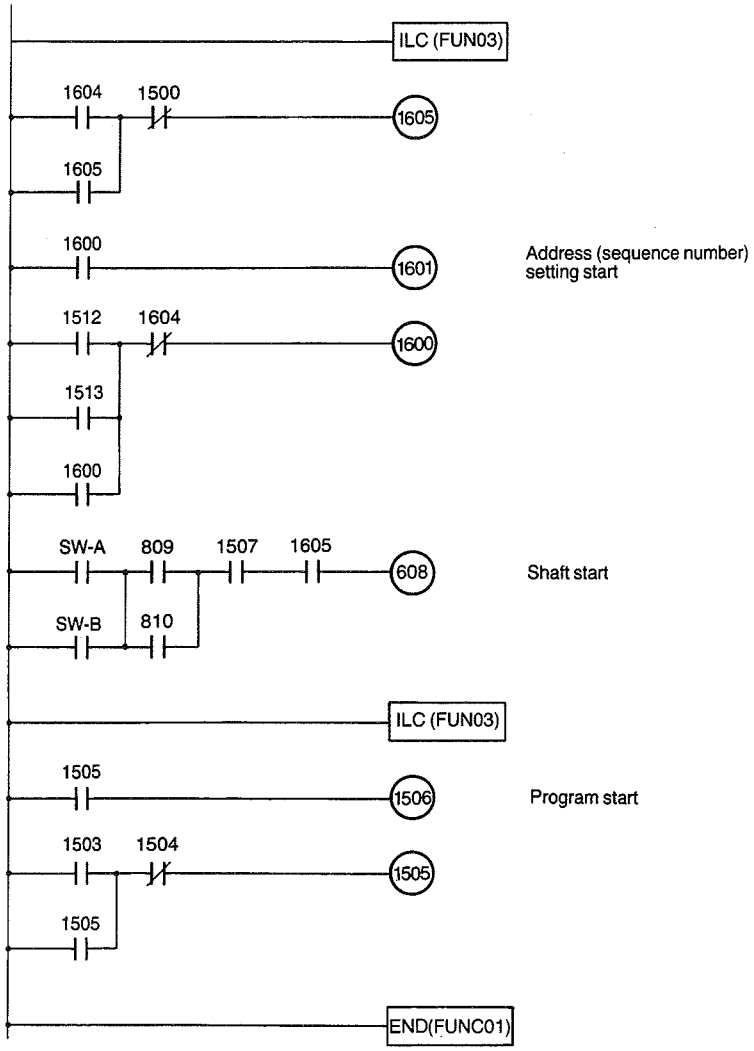
10.2.4 DATA SETTING

Once you have completed the preparations given on the last several pages, write the following program to the PC memory using the programming console. Note that the PC must be in program mode when writing a program.

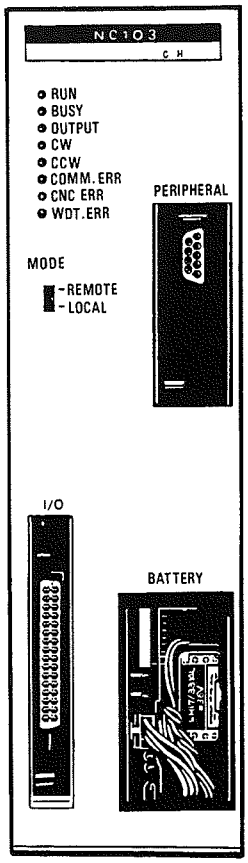
When this program is executed, the data stored in the data memories are sequentially transmitted from the PC to the position control unit.

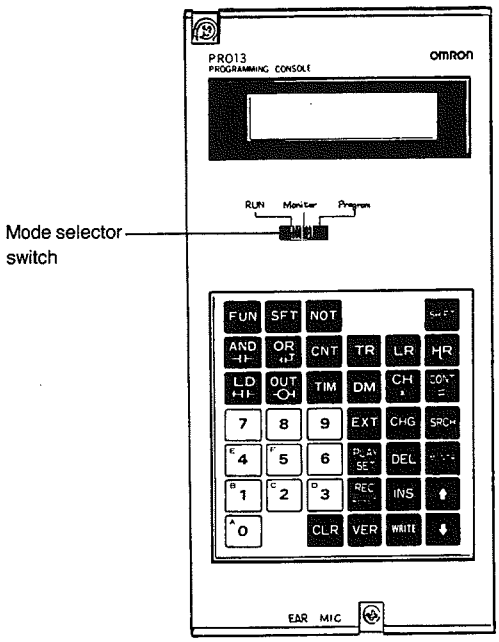



6113
1502
1507
1500
SFT
30
↓
30
(FUN10)
Writing and shifting address, Data1, and Data2
1501
602
1508
3000
600
Address write
3001
601
Data1 write
3002
602
Data2 write
1509
1507
1510
1508
DIFU (FUN13)1500
Data transmit start
1506
DIFU (FUN13)1508
1508
MOV #00 (FUN21) DM000
1507
1509
MOV #67 (FUN21) DM000
1510
MOV #80 (FUN21) DM000
DM000 initial setting (setting of first transmit address)
1500
INC(FUN38) DM000
Data count
1501
MOV*DM000 (FUN21) 05
Data output to data bus
1600
IL (FUN02)
Address (sequence number) setting interlock
1601
DIFU (FUN13)1602
Address (sequence number) setting start
800
DIFD (FUN14)1604
Detection of ACK (handshake BUSY) falling
1603
605
Address (sequence number) setting relay
1602
800
MOV #1000 (FUN21) 00
Address 1000 set
1603
1603


ILC (FUN03)
1604
1500
1605
1605
1600
1601
Address (sequence number) setting start
1512
1604
1600
1513
1600
SW-A
809
1507
1605
608
Shaft start
SW-B
810
ILC (FUN03)
1505
1506
Program start
1503
1504
1505
1505
END(FUNC01)

Remember – the position control unit must be in remote mode when it is being controlled by the PC. Consequently, it is always a good practice after programming to check that the position control unit is in remote mode. Then set the PC to either monitor or run mode using the mode selector switch on the programming console. When you do that, the RUN indicator on the position control unit illuminates and the work starts to move.

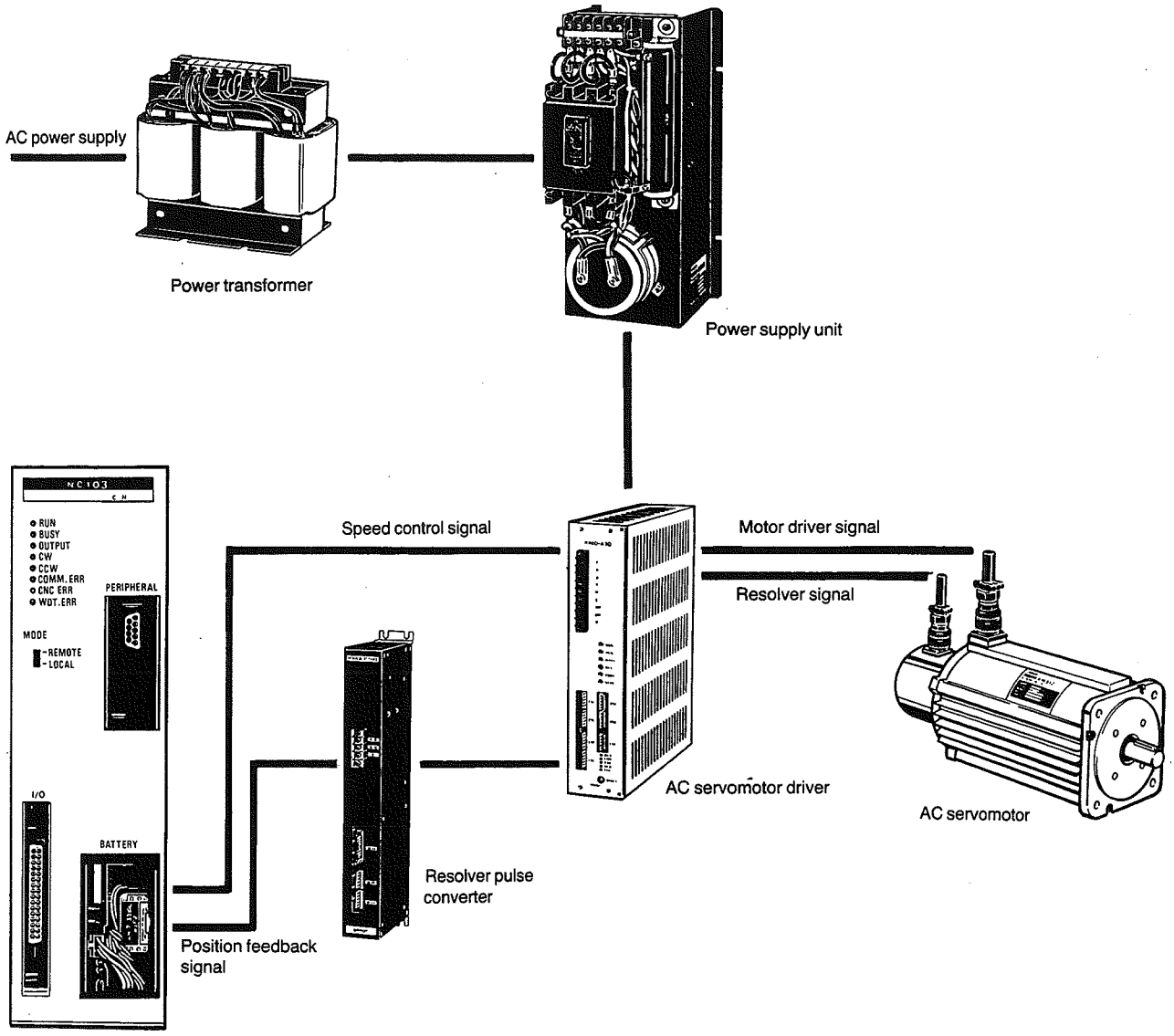


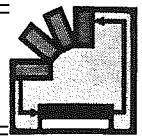


10.3 Servomotor driving

10.3.1 SERVOMOTOR AND DRIVER SELECTION

Let's look at another application example for the position control unit. This time an AC servomotor is used. This is how the control system might be configured:





Here are the specifications of the AC servomotor, servomotor driver, power supply unit, and resolver pulse converter.

AC servomotor

Output (W)	200
Torque (kg.cm)	7.8
No. of revolutions (rpm)	2,500
Rated voltage (V)	115
Rated current (A)	3.0
Max. momentary torque (kg.cm)	31
Max. number of revolutions (rpm)	3,500
Power rate (kW/s)	1.06
Rotor inertia (kg.cm.s^2)	0.0056
No. of resolver poles	2
Weight (kg)	7.0
Insulation	F2
Applicable power transformer (single-shaft) (VA 3ϕ)	300

AC servodriver

Applicable servomotor capacity		200 W max.	
Control method		3 frequency control, transistor PWM method	
Main power source		DC power from power supply unit	
Max. momentary output current		±10 A	
Continuous output current		±5 A	
Current range		0 to ±10 A	
Servo ridigity		4 A/mV	
Speed control range		5000:1	
Speed variation	Load variation	0.01% (at 0 to 100% load)	
	Current variation	0.01% (at 90 to 110% of supply voltage)	
	Temperature variation	0.05% (at 0 to 50°C)	
Speed command input	Rated command voltage	−7 VDC (CCW)/+7 VDC (CW)	
	Input resistance	20 to 30 kΩ	
Current-limiting input	Control input voltage	0 to +5 VDC (maximum current at 0 V and zero output current at 5 V)	
	Input resistance	15 kΩ ±10%	
Speed feedback		Resolver speed detection method	
Built-in speed command power supply		±15 VDC ±2% (output impedance: 1 kΩ)	
Speed voltage output		4.2 V (2 poles: 2,000 rpm/4 poles: 1,000 rpm)	
Control input	Driver command	RUN	15 V, 10 mA contact input
	Error input	ALMI	15 V, 3 mA contact input
	Gain reduction	MING	15 V, 10 mA contact input
Protective function	Main power source over voltage	Effected when the main power supply outputs 360 VDC	
	Radiator fin overheat	Effected when the radiator fin is at 90°±5°C	
	Speed amp. saturation	Effected 3 to 5 s after the speed amp. is saturated	
	Servomotor control power supply failure	Effected when the built-in power supply output exceeds or falls below ±10% of ±15 V	
Alarm output		SPST-NC contact output (opens when a failure occurs) 200 VAC/48 VDC, 0.5 A	
Weight		6.2 kg	

Resolver pulse converter

Item	Signal name		
No. of resolver pulses		2	4
Max. number of output pulses (per revolution)	CW CCW	1,000	2,000
	CHA, A CHB, B	250	500
No. of origin pulses (per revolution)	CHZ, Z	1	1
Max. output pulse rate (K pps)	CW CCW	100	
	CHA, A CHB, B	25	
Output format and capacity	CW CCW CHA CHB CHZ	Open-collector output (7406 output) Applied voltage: 30 V max. Sink current: 40 mA max. Residual voltage: 0.7 V max. (at 50 mA)/ 0.4 V max. (at 16 mA)	
	A B Z	Bipolar output (by line driver SN75113). Must be received by SN75115 or equivalent	
Power supply output	E5 ELG	+5 V, 100 mA max.	

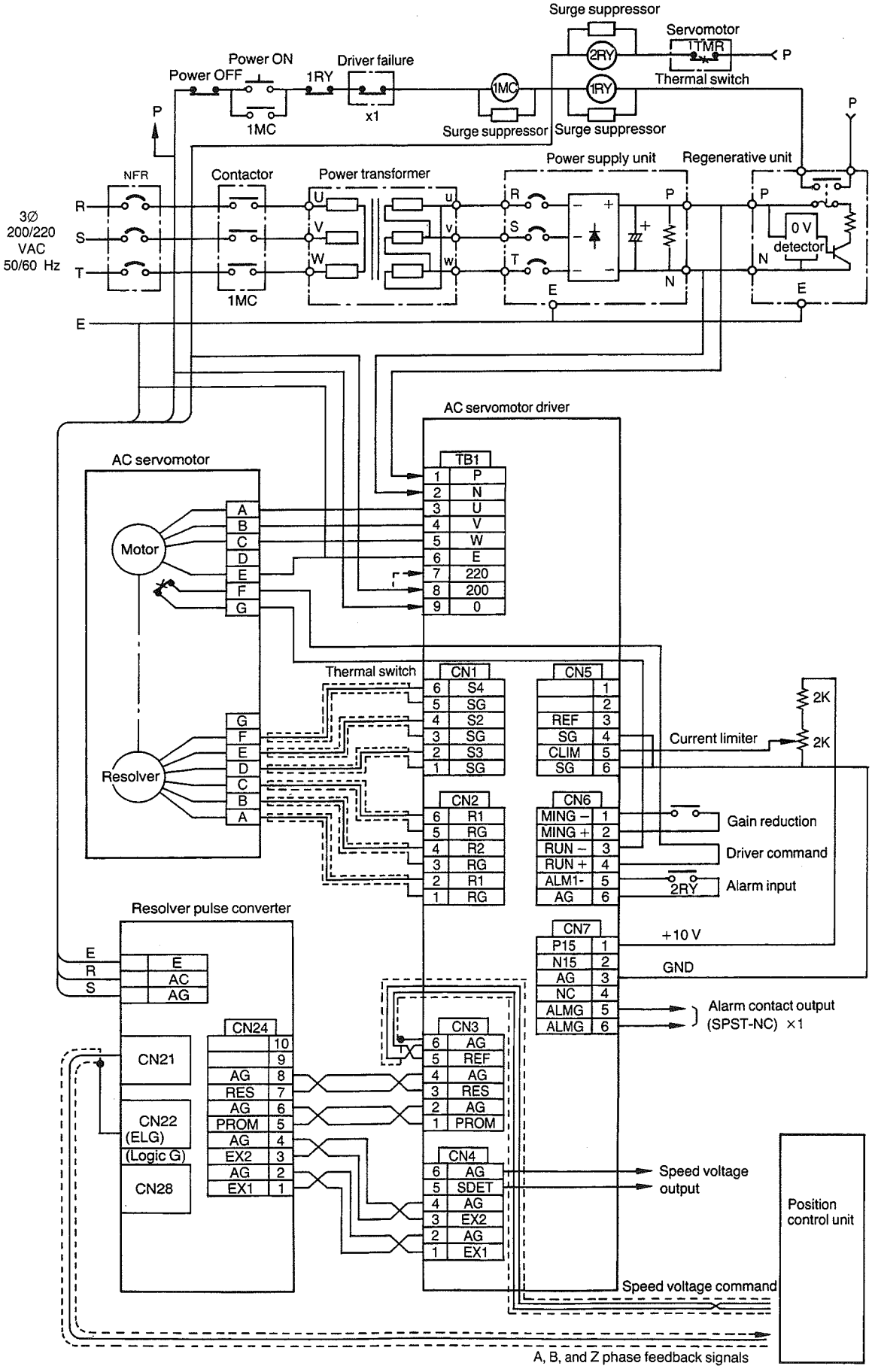
Power supply unit

● 250 VDC output type

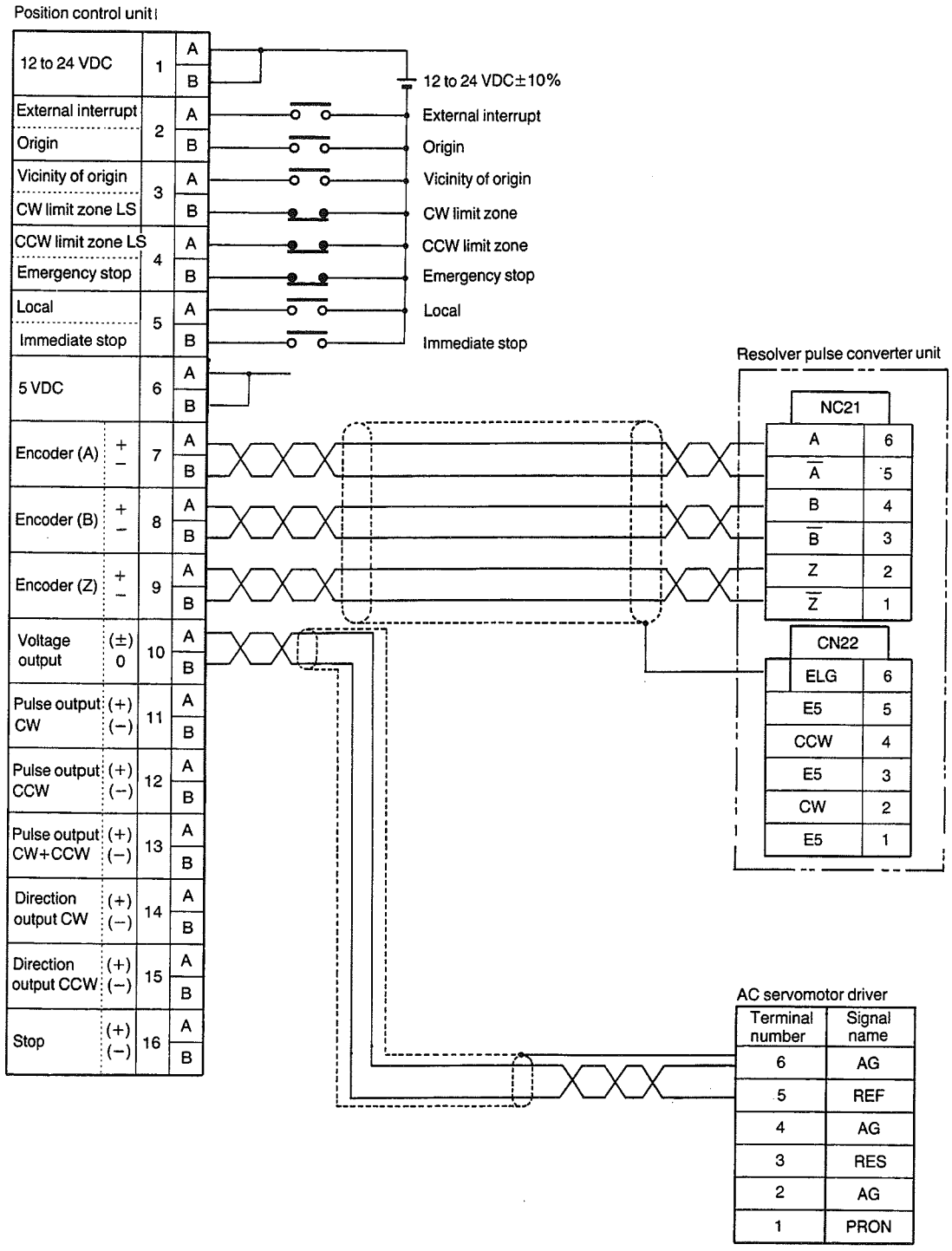
No. of input power source phases	Single
Max. output voltage	250 VDC
Max. output current	15 A
Weight	3.5 kg
Max. AC input current	12 A

10.3.2 EXTERNAL INPUT CONNECTION

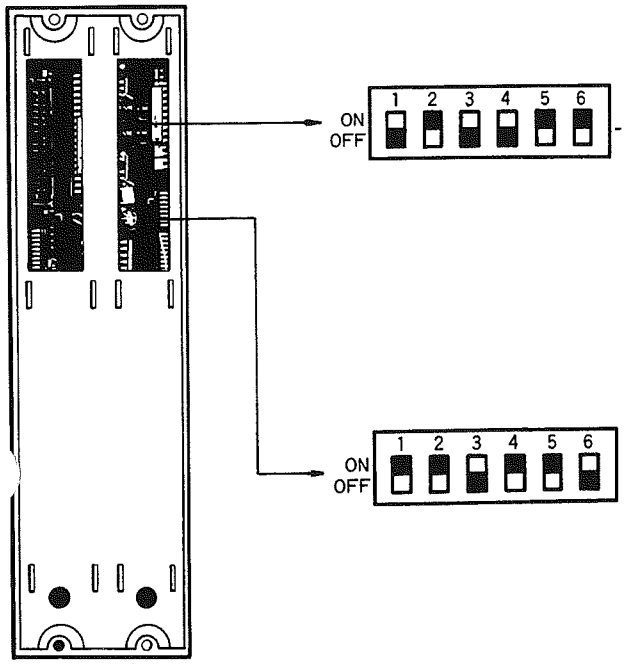
This schematic drawing shows the wiring for this control system.



The following figure shows in detail the wiring of the position control unit's terminals with the resolver pulse converter and the AC servomotor driver.



Because a servomotor is to be controlled in this example, set the DIP switches on the rear of the position control unit as follows:



Rear view of position control unit

Bit No.	ON/OFF	Description
1	OFF	Encoder Z phase
2	OFF	Parameter write enable
3	ON	Servomotor
4	OFF	Z phase active "H"
5	OFF	Multiple (x1)
6	OFF	

Bit No.	ON/OFF	Description
1	ON	12 V driver x1 loop gain
2	ON	
3	OFF	
4	OFF	
5	OFF	
6	ON	

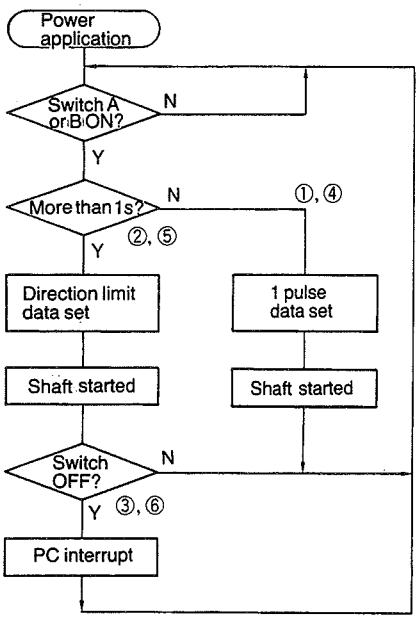
10.3.3 INTERNAL SETTING

Now that the object to be controlled has been outlined, now let's see how the control program should be written. The program in this application example will perform the following operations.

- It performs JOG operation in remote mode without using the teaching box. For this, an inching command is received as an input signal to the PC which directs the position control unit to perform the inching operation.
- It moves the work in the CW direction the distance of one pulse when switch A is ON for 1 second or less.
- If the ON time of switch A is more than 1 second, it continuously moves the work in the CW direction as long as the switch remains ON.
- It moves the work in the CCW direction the distance of one pulse when switch B is ON for 1 second or less.
- If the ON time of switch B is more than 1 second, it continuously moves the work in the CCW direction as long as the switch remains ON.

Note: Switches A and B are not turned ON simultaneously.

The following charts illustrate the operation of the position control unit.

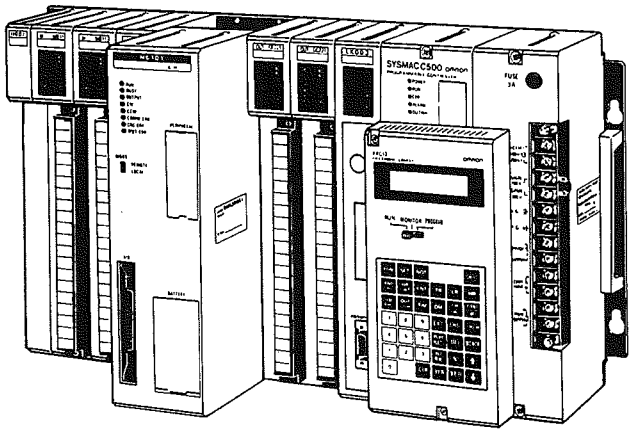


A: Input for JOG operation in CW direction
B: Input for JOG operation in CCW direction

Input for JOG operation in CW direction (SW-A)	①	Moves work by one pulse at rising edge of SW
	②	If SW is ON for more than 1 s, moves work in CW direction, toward limit
	③	If SW turns OFF during movement, generates interrupt at the falling edge to stop movement
Input for JOG operation in CCW direction (SW-B)	④	Moves work by one pulse at rising edge of SW
	⑤	If SW is ON for more than 1 s, moves work in CCW direction, toward limit
	⑥	If SW turns OFF during movement, generates interrupt at the falling edge to stop mevement

Programming

When the required wiring has been done, the program must be written into the PC's memory through the programming console. For this, first mount the position control unit to the CPU rack of the SYSMAC-C500 (the PC used for this example), as shown below. The following figure shows the position control unit mounted to channels 5 to 8 of the CPU rack.



SYSMAC-C500 CPU rack

Then apply power to the C500.

<PROGRAM>
PASSWORD!

<MONITOR>

0000

Upon power application, the POWER LED indicator of the C500 illuminates. At this time, the operating mode of the PC is displayed on the programming console, enclosed by < >.

If the C500 is in program mode at the time of power application, you'll see this displayed on the programming console.

To enable the programming console operations, press CLR, MONTR, and CLR keys.

CLR → MONTR → CLR

```
0000
```

```
0000
FUN(??)
```

```
MEMORY ERR.
```

or "NO END INSTR"

```
I/O VER.ERR.
```

Note that the message MEMORY ERR and I/O VERIFY ERR may be displayed respectively at the first and second depressions of the CLR key. If that happens, you need to identify and correct the error. To read the error, press

CLR → FUN → MONTR → MONTR

```
0000
```

```
0000
```

```
0000
```

```
0000MEMORY CLR ?
   HR CNT DM
```

```
0000MEMORY CLR
END HR CNT DM
```

If the message MEMORY ERR is consequently displayed, press these keys to clear all memory contents.

CLR → PLAY SET → NOT → REC RESET → MONTR

```
0000
```

```
0000
FUN(??)
```

```
0000
FUN(0?)
```

```
0000
END(01)
```

```
0001
NOP(??)
```

If the problem was a NO END INSTR, write the END instruction this way at the end of the program already in the memory.

CLR → FUN → 0 → 1 → WRITE

```
0000
```

```
0000
FUN(??)
```

```
0000I/OTBL?
   ?-?U=
```

```
0000I/OTBL WRITE
          ????
```

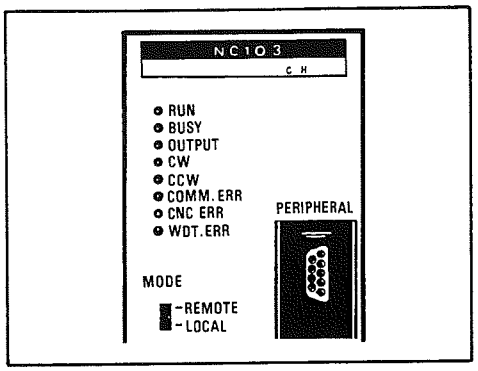
```
0000I/OTBL WRITE
          9713
```

```
0000I/OTBL WRITE
OK
```

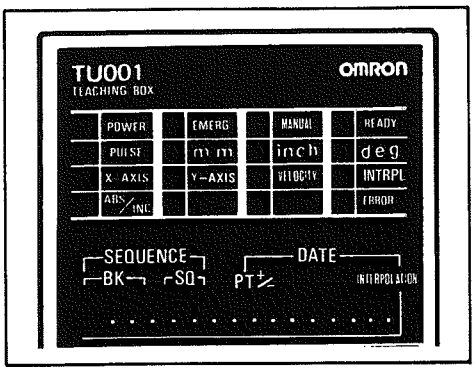
If I/O VERIFY ERR message appears, the I/O numbers must be assigned by generating an I/O table. Do this as follows:

CLR → FUN → SHIFT CH → CHG → 9 7 1 3 → WRITE

In this application example, the position control unit is set in local mode so that parameter data, speed data, and position data are set by the teaching box.



For a detailed description on how the teaching box operates, refer to 7.3, Local mode.
The data set by the teaching box is listed in the following tables.



Parameter data

Address	Set value	Description
2000	1	Dimension
2001	1	Pulse rate
2002	999999	CW limit zone
2003	999999	CCW limit zone
2004	0.0	Backlash correction
2005	1000	Max. speed
2006	0.0	Start speed
2007	0.5	Acceleration/deceleration time
2008	0.0	Near-zero
2009	0.0	Dwell time
2010	01	Origin search direction and current value
2011	0	Origin correction

Speed data

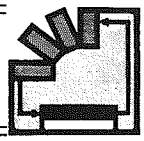
Address	Set value	Description
4000	3000	Origin return speed
4001	5000	Origin search speed
4002	1000	Manual speed

Position data

Address	Set value	Description
1000	1	1-pulse data in CW direction (incremental data)
1001	−1	1-pulse data in CCW direction (incremental data)
1002	999999	CW direction limit data (absolute data)
1003	−999999	CCW direction limit data (absolute data)

These are the relay assignments for the position control unit.

CH / Bit	0	1	2	3
0	PC → position control unit data bus	Address write	Position control unit → PC data bus	ACK (handshake BUSY)
1		Data1 write		Data1 transmit
2		Data2 write		Data2 transmit
3		Program read command		Program data transmit
4		Scan clock		NC RUN
5		Address setting		Handshake error
6		Handshake error clear		Current position data transmit
7		Operation mode		Execution address transmit
8		Start shaft		BUSY (positioning under way)
9		Pause		Sequence end
10		Origin return		Origin
11		Forced origin		Bank end
12		Home shift		CNC error
13		PC interrupt		Interrupt
14		Origin search		Near-zero
15		Stop		Emergency and immediate stop



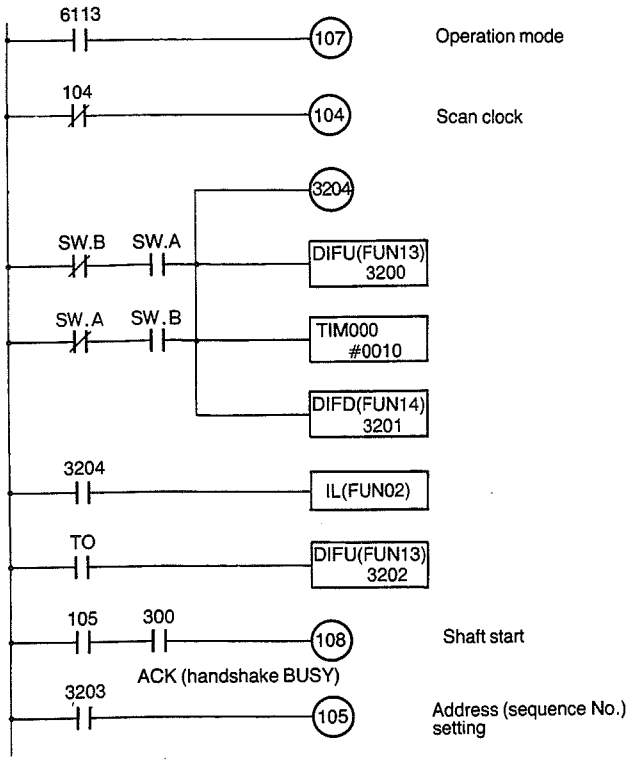
The relay assignment on the PC side is:

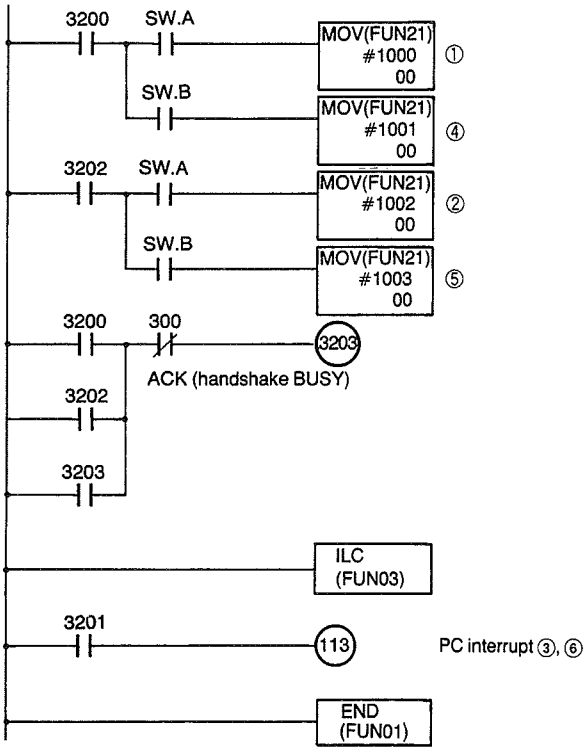
Bit \ CH	32
0	Command input auxiliary relay
1	Interrupt input auxiliary relay
2	Limit data setting auxiliary relay
3	Address setting auxiliary relay
4	IL auxiliary relay
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

A: JOG input in CW direction
B: JOG input in CCW direction

10.3.4 DATA SETTING

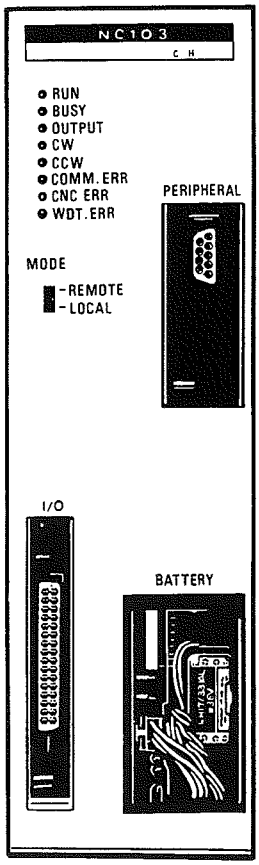
Once you have finished the preparations described in the last several pages, write the following program to the PC's memory via the programming console. Note that the PC must be in program mode to write a program.

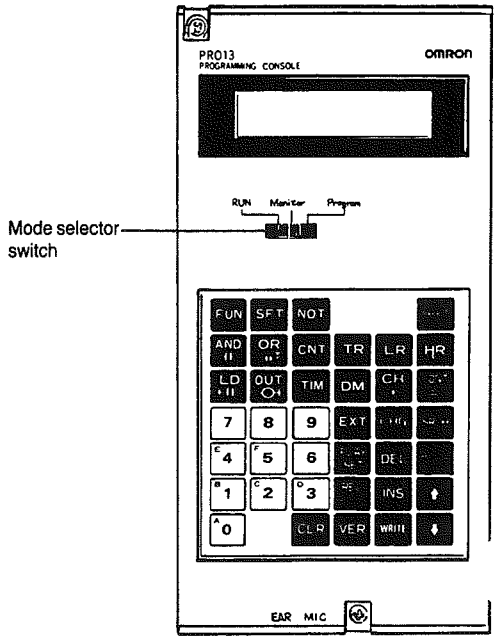




10.3.5 TEST RUN

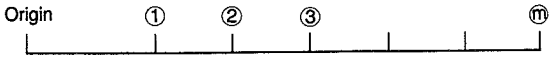
Now set the position control unit in remote mode and the PC in either monitor or run mode using the mode selector switch on the programming console. When the RUN LED indicator on the position control unit illuminates, input commands A and B to check whether the position control unit operates normally.





10.4 Reference PC program

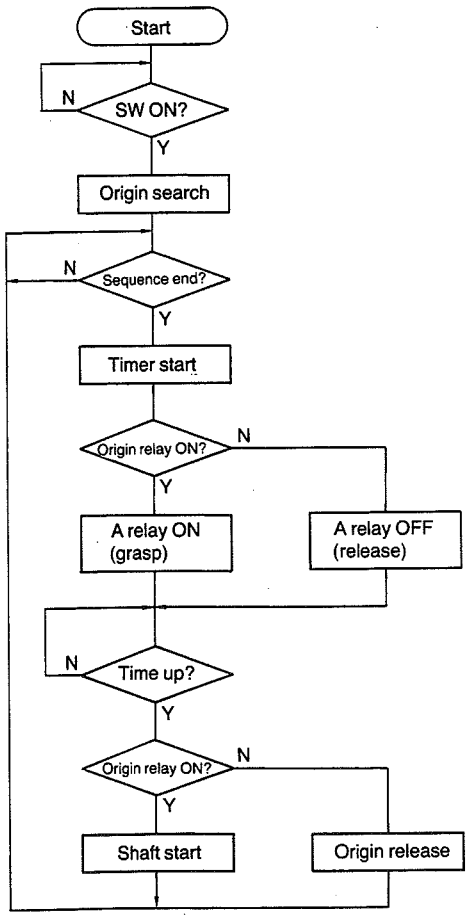
This section introduces another example of a PC program for the position control unit to describe slightly more complicated programming principles. In this case, a program will be written to make the position control unit perform the following operations.



- First a robot hand grasps an object located at the point of origin and carries it to point 1.
- It then releases the object at point 1 and returns to the origin.
- Next, the hand grasps another object at the origin and carries it to point 2.
- The object is released at point 2 and the hand returns to the origin.
- This operation is repeated until objects are carried to points 3, 4, and m.
- After the object for point m has been carried, the cycle begins anew from point 1.

It is assumed that all parameter data, speed data, and position data for points ① to ⓜ are stored in memory.

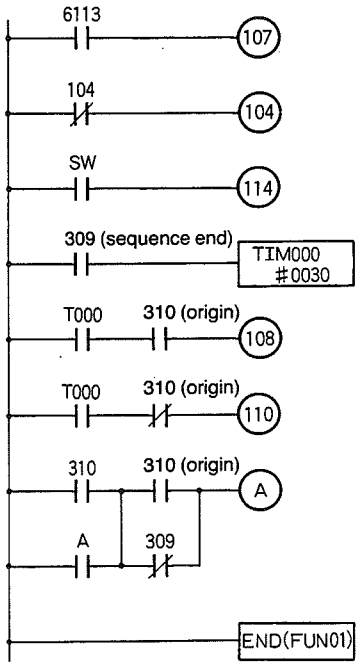
How the program works is illustrated by this flowchart.



This is the relay assignment of the position control unit for this particular program:

CH / Bit	0	1	2	3
0	PC → position control unit data bus	Address write	Position control unit → PC data bus	ACK (handshake BUSY)
1		Data1 write		Data1 transmit
2		Data2 write		Data2 transmit
3		Program read command		Program data transmit
4		Scan clock		NC RUN
5		Address setting		Handshake error
6		Handshake error clear		Current position data transmit
7		Operation mode		Execution address transmit
8		Start shaft		BUSY (positioning under way)
9		Pause		Sequence end
10		Origin return		Origin
11		Forced origin		Bank end
12		Home shift		CNC error
13		PC interrupt		Interrupt
14		Origin search		Near-zero
15		Stop		Emergency and immediate stop

The program for the PC is as follows:



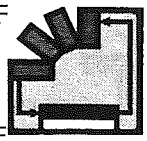
SW: Operation start switch

A: Relay controlling graspping/releasing object
When this is ON, the object is grasped. When it is OFF, the object is released.

POSITION CONTROL UNIT DATA SHEET
Position data

BK	SQ	Pattern	ABS INC	+/–	Position data	Speed
0	00					
0	01					
0	02					
0	03					
0	04					
0	05					
0	06					
0	07					
0	08					
0	09					
0	10					
0	11					
0	12					
0	13					
0	14					
0	15					
0	16					
0	17					
0	18					
0	19					
0	20					
0	21					
0	22					
0	23					
0	24					
0	25					
0	26					
0	27					
0	28					
0	29					
0	30					
0	31					
0	32					
0	33					
0	34					
0	35					
0	36					
0	37					
0	38					
0	39					
0	40					
0	41					
0	42					
0	43					
0	44					
0	45					
0	46					
0	47					
0	48					
0	49					

BK	SQ	Pattern	ABS INC	+/–	Position data	Speed
0	50					
0	51					
0	52					
0	53					
0	54					
0	55					
0	56					
0	57					
0	58					
0	59					
0	60					
0	61					
0	62					
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0	95					
0	96					
0	97					
0	99					
0	99					



POSITION CONTROL UNIT DATA SHEET
Position data

BK	SQ	Pattern	ABS INC	+/–	Position data	Speed
1	00					
1	01					
1	02					
1	03					
1	04					
1	05					
1	06					
1	07					
1	08					
1	09					
1	10					
1	11					
1	12					
1	13					
1	14					
1	15					
1	16					
1	17					
1	18					
1	19					
1	20					
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1	32					
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1	34					
1	35					
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1	37					
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1	41					
1	42					
1	43					
1	44					
1	45					
1	46					
1	47					
1	48					
1	49					

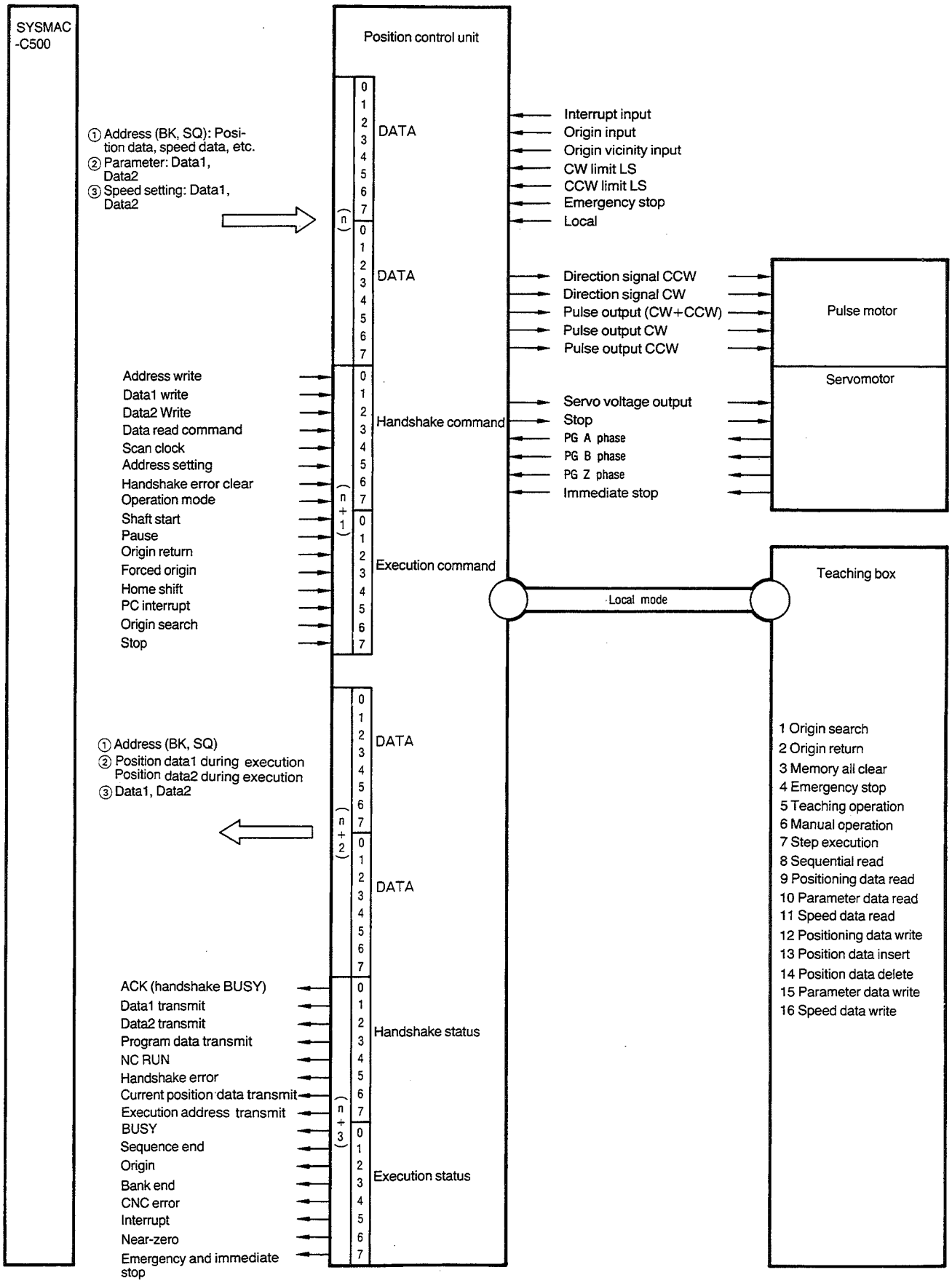
BK	SQ	Pattern	ABS INC	+/–	Position data	Speed
1	50					
1	51					
1	52					
1	53					
1	54					
1	55					
1	56					
1	57					
1	58					
1	59					
1	60					
1	61					
1	62					
1	63					
1	64					
1	65					
1	66					
1	67					
1	68					
1	69					
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1	86					
1	87					
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1	95					
1	96					
1	97					
1	98					
1	99					
2	00					

Parameter

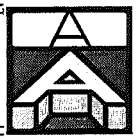
Data No.	Item	Numeric value	Parameter data
0	Dimension	1-mm, 2-inch, 3-deg, 4-NCN	
1	Pulse rate	0.0001 to 1	
2	+limit zone	0 to 999999	
3	−limit zone	0 to 999999	
4	Backlash correction	0 to 9999	
5	Maximum speed	0 to 999999	
6	Start speed	0 to 999999	
7	Acceleration/deceleration time	0 to 99.99	
8	Near-zero	0 to 255	
9	Dwell time	0 to 99.99	
10	Origin search direction	CW=1, CCW=0	
11	Origin correction	±0 to 9999	

Speed data

Data No.	Item	Speed data
	Numeric value	Speed (0 to 999999)
*0	Origin return	
*1	Origin search	
*2	Manual speed	
*3		
*4		
*5		
*6		
*7		
*8		
*9		


SYSMAC
-C500
Position control unit
① Address (BK, SQ): Position data, speed data, etc.
② Parameter: Data1, Data2
③ Speed setting: Data1, Data2
DATA
n
DATA
n+1
Handshake command
Execution command
Interrupt input
Origin input
Origin vicinity input
CW limit LS
CCW limit LS
Emergency stop
Local
Direction signal CCW
Direction signal CW
Pulse output (CW+CCW)
Pulse output CW
Pulse output CCW
Pulse motor
Servomotor
Servo voltage output
Stop
PG A phase
PG B phase
PG Z phase
Immediate stop
Address write
Data1 write
Data2 Write
Data read command
Scan clock
Address setting
Handshake error clear
Operation mode
Shaft start
Pause
Origin return
Forced origin
Home shift
PC interrupt
Origin search
Stop
Local mode
Teaching box
1 Origin search
2 Origin return
3 Memory all clear
4 Emergency stop
5 Teaching operation
6 Manual operation
7 Step execution
8 Sequential read
9 Positioning data read
10 Parameter data read
11 Speed data read
12 Positioning data write
13 Position data insert
14 Position data delete
15 Parameter data write
16 Speed data write
① Address (BK, SQ)
② Position data1 during execution
Position data2 during execution
③ Data1, Data2
DATA
n+2
DATA
ACK (handshake BUSY)
Data1 transmit
Data2 transmit
Program data transmit
NC RUN
Handshake error
Current position data transmit
Execution address transmit
BUSY
Handshake status
n+3
Sequence end
Origin
Bank end
CNC error
Interrupt
Near-zero
Emergency and immediate stop
Execution status

Appendix



AVAILABLE TYPES

Classification	Specifications	Weight	Type name
Position control unit	Single-axis, CNC control unit	950 g max.	3G2A5-NC101-E
Teaching box	For position control unit	800 g max.	3G2A5-TU001-E
Adapter box	Interface box for printer, cassette tape recorder	750 g max.	3G2A5-IF101-E



Appendix

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