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MITSUBISHI

PROGRAMMABLE CONTROLLER

MELSEC-A

User's Manual

Positioning module type AD71

CATALOG # UMPM
$ 15.00

MITSUBISHI ELECTRIC

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REVISIONS

※The manual number is given on the bottom left of the back cover.

Print Date	*Manual Number	Revision
Mar., 1987	IB (NA) 66101-A	First edition
May., 1987	IB (NA) 66101-B	Correction Page 3-5 Deletion Page 6-20, 6-22, 6-38
Dec., 1988	IB (NA) 66101-C	Correction CONTENTS, Page 2-4, 2-5, 2-7, 3-1, 3-2, 3-3, 3-5, 3-8, 3-19, 3-20, 3-21, 3-29, 3-48, 3-50, 3-53, 6-16, 6-17, 6-24, 6-31, 6-35, 6-37, 6-38, 6-42, 7-2, 7-3, 8-1, 8-6, APP-16, INDEX Addition Page 5-5, 7-1 Deletion Section 8.1.4 "Instructions for Strategic Materials" added

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INTRODUCTION

Thank you for choosing the Mitsubishi MELSEC-A Series of General Purpose Programmable Controllers. Please read this manual carefully so that the equipment is used to its optimum. A copy of this manual should be forwarded to the end User.

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1. INTRODUCTION

The AD71 is a position controller module for use with the MELSEC-A series of programmable controllers. The operation of the position controller may be adapted to suit the individual requirements of the system by using the extensive MELSEC-A series software features. This manual covers both hardware and software and contains all the information required to install and operate the unit to its optimum.

The manual is arranged as follows:

Chapter 2 System Configuration

Explains the AD71 operating principles together with a glossary of terms and describes the MELSEC-A series system configurations suitable for use with the AD71.

Chapter 3 Specifications

Gives the AD71 specifications, functions, a description of the data required for operation, I/O specifications with external equipment, etc.

Chapter 4 Handling

AD71 nomenclature, etc.

Chapter 5 Loading and Installation

Gives AD71 installation and wiring instructions, etc.

Chapter 6 Programming

Explains the PC programming required to control the AD71.

Chapter 7 Check Lists

Gives pre-start-up test procedures.

Chapter 8 Troubleshooting

Hardware and software fault finding

Chapter 9 Maintenance

Appendices

Gives AD71 dimensions, connection examples with various servo motors, etc.

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Refer also to the following manuals:

SW0-AD71P Operating Manual
A6GPP User's Manual
A1, A2, A3CPU User's Manual
Relevant drive unit instruction manual

POINT

In this manual, AD71 I/O numbers assigned from the PC CPU assume that the AD71 is loaded in slot 0 of the main base.

Packing list:

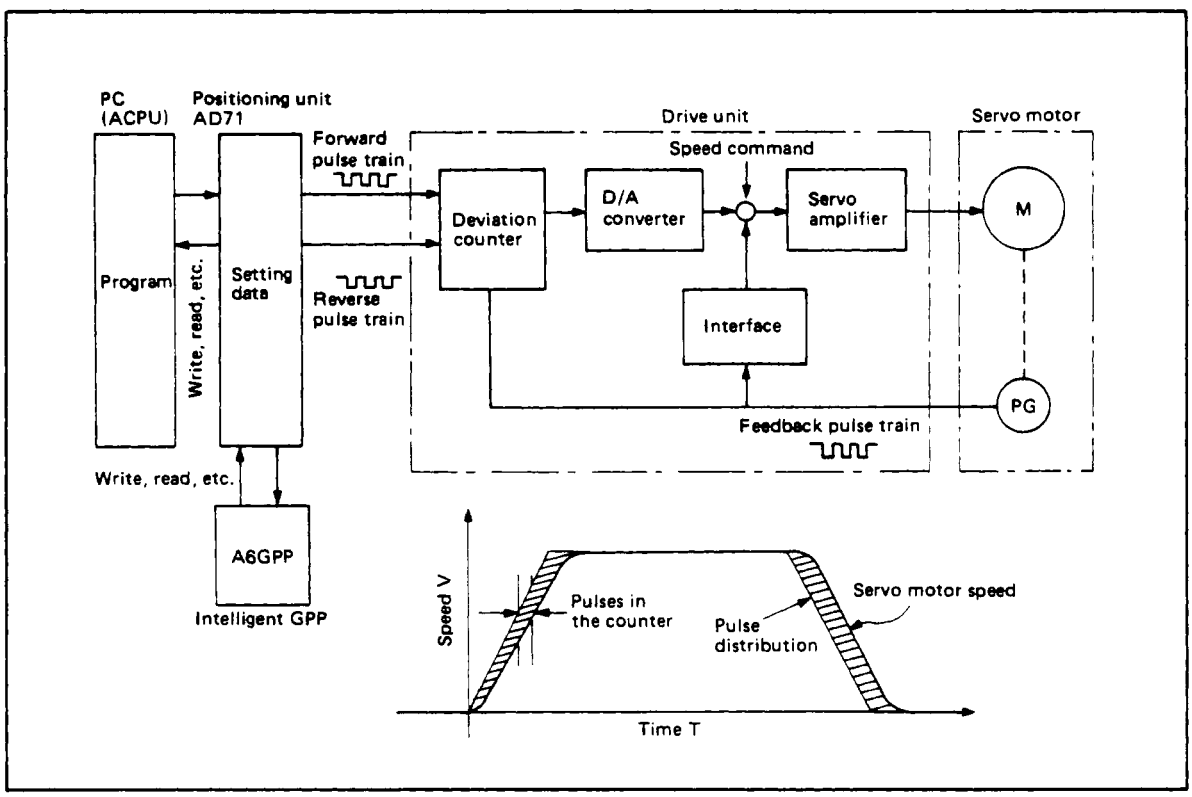
Description	Quantity
AD71 positioning unit	1
40-pin connector for external wiring	1

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2. SYSTEM CONFIGURATION

2.1 Introduction to the AD71

The AD71 gives a pulse chain output. The number of pulses determines the system position and the pulse frequency determines the positioning traverse speed. Positioning can consequently be specified in a number of units (namely mm, inch, degrees or pulses) by specifying a feedrate per pulse where the feedrate is proportional to the pulse frequency. A system schematic is shown below:



The deviation counter in the drive unit integrates the incoming pulse chain from the AD71 and converts the resultant value into an analog voltage for use as a speed signal. This causes the motor to start turning and the pulse generator to generate feedback pulses to the deviation counter. The feedback pulse chain is compared with the input pulse chain from the AD71 and an error value generated until the error value is sufficient to maintain the motor at the desired speed. When the AD71 pulse output is switched off, the deviation counter value decreases and the speed decreases accordingly until finally the deviation counter value is zero and the motor stops.

Before positioning can begin, the system must be zeroed. This involves driving the motor in a known direction to a known point and loading a home position or zero address to the AD71's positioning counter. All subsequent positioning uses memory addresses referred to this zero address, either as an absolute address (i.e. each point specified as an individual address) or as an incremental address (i.e. a given distance from the previous address).

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The system can be zeroed in one of three ways. All use a "zeroing dog." The "zeroing dog" is a switch or actuator which provides one of two conditions which define the home position. The second condition depends on the zeroing method used, this will be one of the following:

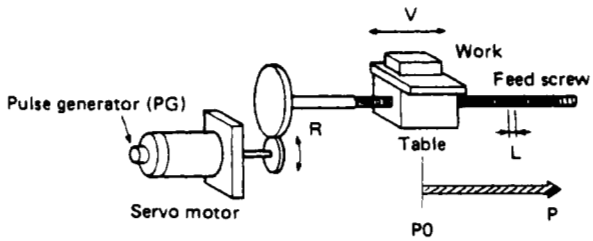
- A zero phase signal from the rotary encoder.
- A mechanical stop followed by a timer timing-out.
- A mechanical stop followed by a torque feedback signal from the drive unit.

The operating data for the AD71 is stored in the buffer memory and consists of parameters (defining system constants such as maximum feedrates, etc.), zeroing data (defining the zeroing process), positioning data (containing the individual addresses, speeds, etc.) and start data (defining which position to start at, etc.).
Positioning data is referred to by a positioning data number, which is defined by its location in the buffer memory.
There are two methods for manual control of the AD71 pulse chain output, these are jog operation and inching. During jog operation, the output pulse chain is maintained for as long as the jog signal from the PC is on however during inching a defined number of pulses is output every time a manual pulse generator input signal is given. (The manual pulse generator is also referred to as "manual pulser"). The inching function therefore requires the provision of an external manual pulse generator hard wired to the AD71 connector in order to operate effectively.

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General design of positioning system



A : Position detection increment (mm/p)
Vs : Command pulse frequency (p/s)
n : Number of pulse generator slits (slits/rev)
L : Feed screw lead (mm/rev)
R : Reduction ratio
V : Moving part speed (mm/s)
N : Motor speed (rpm)
K : Position loop gain (sec^{-1})
ϵ : Deviation counter pulse value
P0 : Zero point (pulse)
P : Address (pulse)

(1) Position detection increment

$$A = \frac{L}{R \times n} \text{ (mm/p)}$$

(2) Command pulse frequency

$$Vs = \frac{V}{A} \text{ (p/s)}$$

(3) Deviation counter pulse value

$$\epsilon = \frac{Vs}{K} \text{ (pulse)}$$

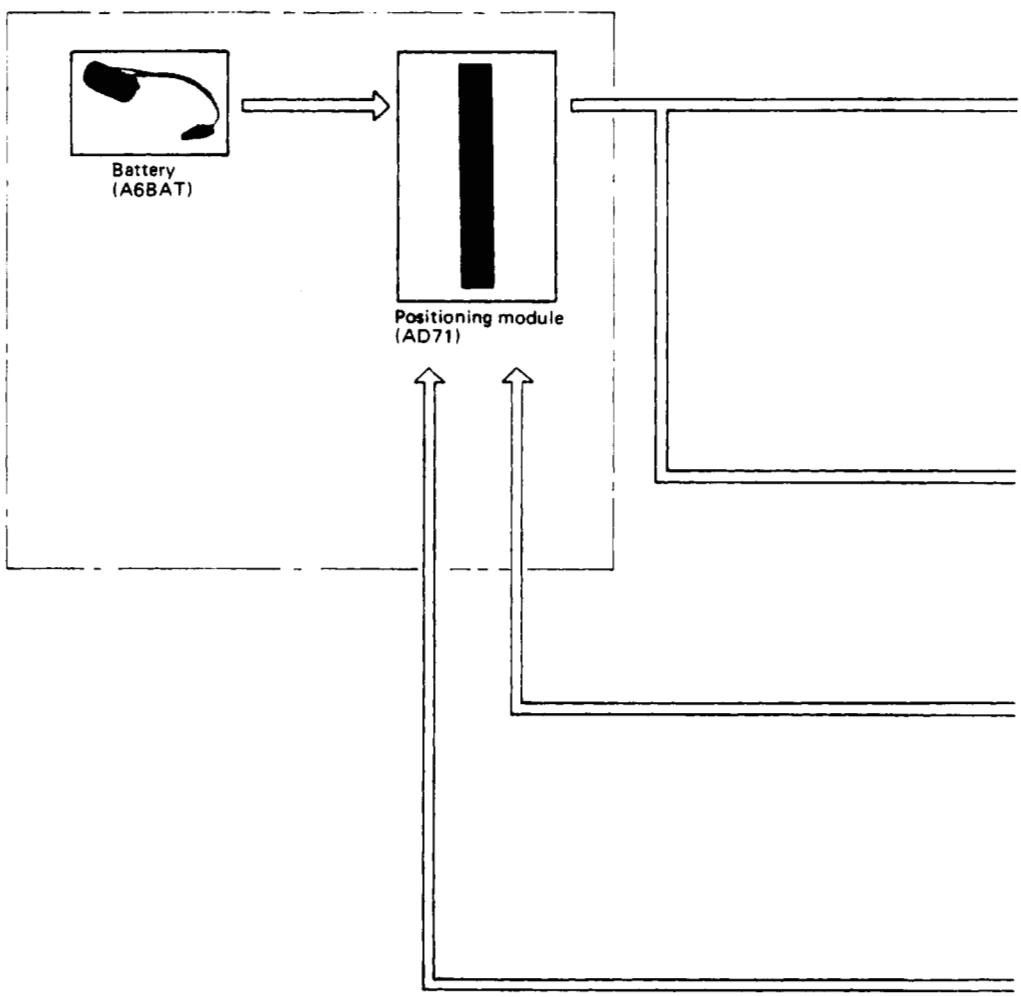
Expression (1) indicates the travel per pulse, i.e. the number of output pulses x A. Using expression (2), calculate the command pulse frequency from the work speed and position detection increment. Expression (3) indicates the relation between the command pulse frequency and deviation counter pulse value.

Any of the four positioning units, (mm), (inch), (degree), and (PULSE), may be selected individually for the X and Y axes.

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2.2 MELSEC-A Series Equipment

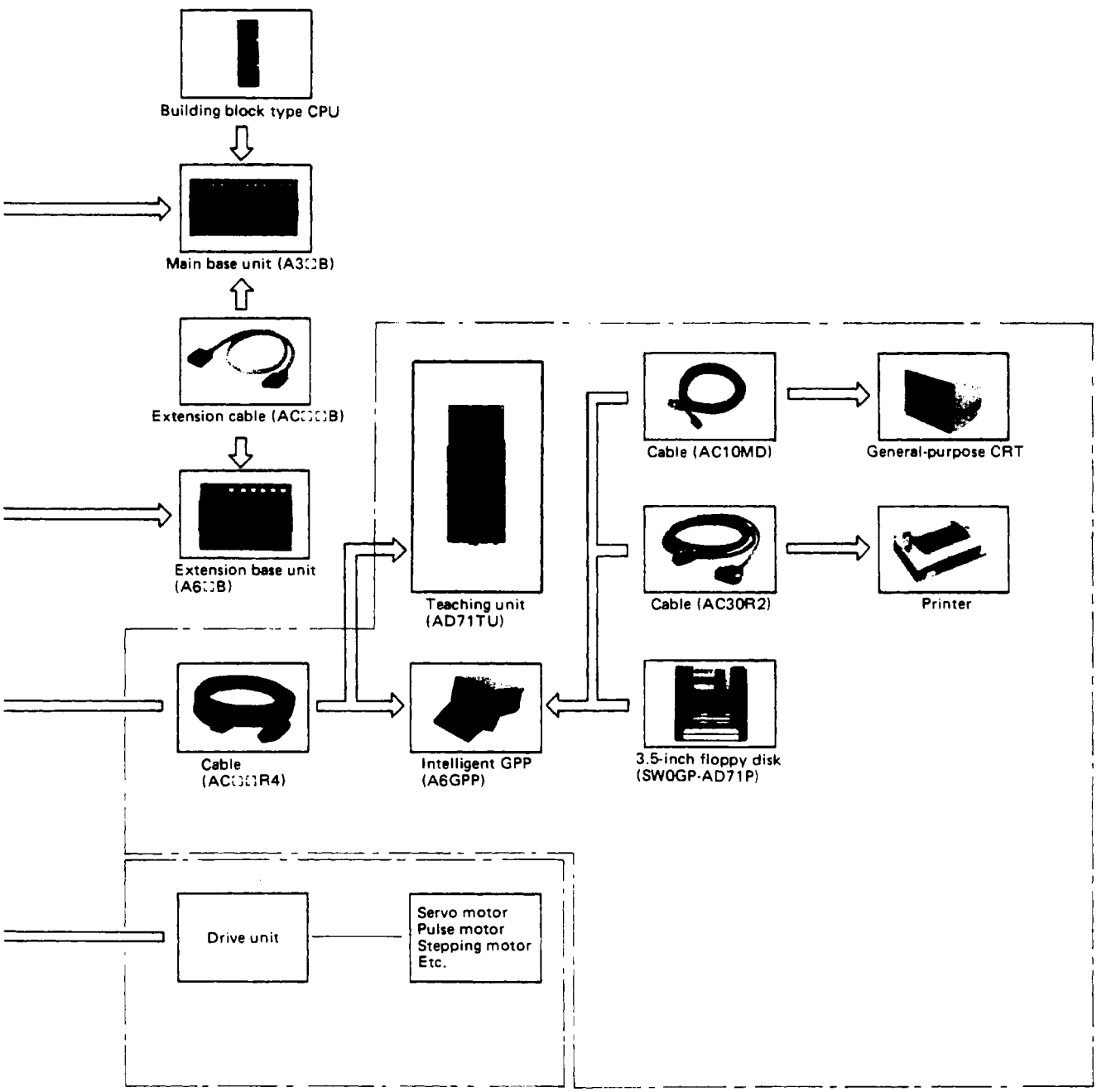
Fig. 2.1 shows a schematic diagram of the MELSEC-A series equipment for use with the AD71.



Note 1: For use of the positioning unit in the data link system, refer to Section 2.2.

Fig. 2.1 Overall Configuration

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The AD71 can be used with the following independent CPUs:

Applicable model	A1(E)CPU A2(E)CPU A3(E)CPU

Do not use the AD71 on any extension base which does not include a power supply (i.e. A5□B).
The following CPU types are required for a data link system.

A1(E)CPU P21/R21
A2(E)CPU P21/R21
A3(E)CPU P21/R21

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2.3 AD71 Programming Equipment

The following table indicates the equipment available for programming the AD71.

<table>
<tr><th>Unit Division</th><th>Description</th><th>Type</th><th>Remarks</th></tr>
<tr><td></td><td>Software package</td><td>SW0GP-AD71P</td><td>AD71/AD72 software package</td></tr>
<tr><td rowspan="8">Programming unit</td><td>Intelligent GPP</td><td>A6GPP-SET</td><td>○ Consists of the following:
<table>
<tr><th>Type</th><th>Remarks</th></tr>
<tr><td>A6GPP</td><td>○Programming unit with CRT
○Equipped with ROM writer, FDD and printer interface functions.</td></tr>
<tr><td>SW□-GPPA</td><td>A series system disk</td></tr>
<tr><td>SW□-GPPK</td><td>K series system disk</td></tr>
<tr><td>SW0-GPPU</td><td>User disk (3.5 inch, formatted)</td></tr>
<tr><td>AC30R4</td><td>Cable for connecting AD71 and A6GPP.</td></tr>
</table></td></tr>
<tr><td>Plasma handy programmer</td><td>A6PHP-SET</td><td>○ Consists of the following:
<table>
<tr><th>Type</th><th>Remarks</th></tr>
<tr><td>A6PHP</td><td>○Programming unit with plasma display
○Equipped with FDD, printer interface and memory cassette functions.</td></tr>
<tr><td>SW□GP-GPPA</td><td>A series system disk</td></tr>
<tr><td>SW□GP-GPPK</td><td>K series system disk</td></tr>
<tr><td>SW0-GPPU</td><td>User disk (3.5 inch, formatted)</td></tr>
<tr><td>AC30R4</td><td>Cable for connecting AD71 and A6PHP.
3m (9.84 ft) length.</td></tr>
</table></td></tr>
<tr><td>User disk</td><td>SW0-GPPU</td><td>Floppy disk for storing user programs (3.5 inch, formatted)</td></tr>
<tr><td>RS-422 cable</td><td>AC30R4</td><td>Cable for connecting CPU and A6GPP. 3m (9.84 ft) length.</td></tr>
<tr><td>Composite video cable</td><td>AC10MD</td><td>Cable for connecting GPP screen monitor display. 1m (3.28 ft) length.</td></tr>
<tr><td>Cleaning disk</td><td>SW0-FDC</td><td>Floppy disk for cleaning floppy disk drive.</td></tr>
<tr><td>Cable</td><td>RS-422 cable</td><td>AC300R4</td><td>Cable for connecting CPU and A6GPP. 30m (98.4 ft) length.</td></tr>
<tr><td rowspan="4">Printer</td><td rowspan="2">Printer</td><td>K6PR</td><td rowspan="2">For print out of program ladder diagrams and lists.</td></tr>
<tr><td>K7PR</td></tr>
<tr><td>RS-232C cable</td><td>AC30R2</td><td>Cable for connecting A6GPP and printer (K6PR, K7PR, general-purpose printer with RS-232C interface). 3m (9.84 ft) length.</td></tr>
<tr><td>Printer paper</td><td>K6PR-Y</td><td>Paper for K6PR printer. 9 inch. Available in units of 2000 pcs.</td></tr>
<tr><td>K6PR ink ribbon</td><td>K6PR-R</td><td>Replacement ink ribbon for K6PR.</td></tr>
<tr><td></td><td>Teaching unit</td><td>AD71TU</td><td>AD71/AD72 teach box.</td></tr>
</table>

Table 2.1 AD71 Programming Equipment

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3. SPECIFICATIONS

3.1 General Specifications

Item	Specifications				
Operating ambient temperature	0 to 55°C				
Storage ambient temperature	−20 to 75°C				
Operating ambient humidity	10 to 90%RH, non-condensing				
Storage ambient humidity	10 to 90%RH, non-condensing				
Vibration resistance	Conforms to JIS C 0911	Frequency	Acceleration	Amplitude	Sweep Count
		10 to 55Hz	−	0.075mm (0.003inch)	10 times *(1 octave/minute)
		55 to 150Hz	1g	−	
Shock resistance	Conforms to JIS C 0912 (10g x 3 times in 3 directions)				
Noise durability	By noise simulator of 1500Vpp noise voltage, 1μs noise width and 25 to 60Hz noise frequency				
Dielectric withstand voltage	500V AC for 1 minute across DC external terminals and ground				
Insulation resistance	5MΩ or larger by 500V DC insulation resistance tester across AC external terminals and ground				
Operating ambience	Free of corrosive gases. Dust should be minimal.				
Cooling method	Self-cooling				

Table 3.1 General Specifications

REMARKS

One octave marked * indicates a change from the initial frequency to double or half frequency. For example, any of the changes from 10Hz to 20Hz, from 20Hz to 40Hz, from 40Hz to 20Hz, and 20Hz to 10Hz are referred to as one octave.

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3.2 Performance Specifications and Functions

3.2.1 AD71 performance specifications

Item		Performances and Specifications
Number of I/O points		32
Number of control axes		2 (simultaneous or independent)
Interpolation		Linear interpolation (for 2 axes)
Positioning data	Capacity	400 points per axis
	Setting method	Input from A6GPP or sequence program
RAM memory backup		15 minutes without battery (25°C) Lithium battery guarantees power failure backup for a total of 300 days. Battery guaranteed for five years.
Positioning	Method	Absolute and/or incremental method.
	Positioning units	1 to 16,252,928 (PULSE) Max. 162 (m) (command unit: 0.1 to 10μm/PLS) Max. 16200 (inch) (command unit: 1 x 10^{-5} to 0.001 inch/PLS) Max. 16200 (degree) (command unit: 1 x 10^{-5} to 0.001 degree/PLS)
	Positioning speed	10 to 200000 (PLS/sec) (command unit: 10 PLS/sec) 10 to 120000 (mm/min) (command unit: 10 mm/min) 1 to 12000 (inch/min) (command unit: 1 inch/min) 1 to 12000 (degree/min) (command unit: 1 degree/min)
	Acceleration and deceleration	Automatic trapezoidal acceleration and deceleration
	Acceleration and deceleration times	64 to 4999 (msec)
	Backlash compensation	0 to 65535 x position command unit (0 to 255 pulses if unit is PULSE)
	Error compensation	The AD71 may be "calibrated" to allow for mechanical errors.
Zeroing		With zero address change function. Zeroing direction and speed depend on setting.
Jog operation function		Jog operation by jog start signal input.
Inching function		Operation using manual pulse generator.
M function		M code output
Internal current consumption		5V DC, 1.5A
External supply voltage, current		4.75 to 26.4V, max. 50mA
Size mm (inch)		250 (9.84) (H) x 37.5 (1.48) (W) x 121 (4.76) (D)
Weight kg (lb)		0.63 (1.93)

Table 3.2 Performance Specifications

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3.2.2 Functions

The AD71 can drive two axes independently or with linear interpolation, either:

(1) Using the A6GPP or teaching unit, or

(2) From the PC sequence program

For use of the A6GPP, refer to the SW0GP-AD71P Operating Manual. For use of the AD71TU, refer to the AD71TU Operating Manual. Positioning control functions are shown below.

Function		Sequence Program or A6GPP	
		Two-axis independent operation	Two-axis interpolation operation
Error detection		An error code is provided by the AD71 if a data setting or positioning control error occurs. (For details of the error codes, refer to Chapter 8.)	
Set data read and write		AD71 set data (parameters, zeroing data, positioning data) can be read and written.	
Present value and speed read		Present value data and speed data can be read from the AD71. (Present value can be read and monitored during positioning.)	
Teaching (positioning data write)		After manual positioning, present value can be written as position data.	
Inching operation		The drive for the given axis is advanced by a predefined number of pulses each time a manual pulse is received. The manual pulse is provided by a manual pulse generator.	Unavailable
Jog operation		The drive for the given axis is operated for as long as the jog input is on.	Unavailable
Zeroing		Returns the drive to a defined start position and refers the zero address to that position.	Unavailable
Positioning	Individual point positioning	Moves from the current position to the set position at set speed.	Moves from the current position to the set position at interpolated speed.
	Continuous positioning	Moves consecutively to a series of positions after receiving a single start signal.	As for two-axis independent operation but with interpolation.
	Continuous positioning with speed change (Pattern change)	Moves consecutively to a series of positions at different speeds after receiving a single start signal.	Unavailable

Table 3.3 Positioning Control Functions

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Note 1: Error compensation and backlash compensation functions are valid for all the functions shown in Table 3.3.

2: An indexed code may be used as a digital signal for the control of associated processes during positioning. This is known as an "M" code.

3: The AD71 present value can be re-written before positioning is started using the sequence program or A6GPP.

4: Positioning may be executed continuously for up to 20 points by writing positioning start data to the buffer memory (X axis: 0 to 39, Y axis: 300 to 339).

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3.3 Positioning System Operation

3.3.1 AD71 interfaces

Fig. 3.2 indicates the signal communications between the AD71 and external devices.

- Communication between PC CPU and AD71

  Control signals and data communications via base unit, they consist of:

  Control signals. . . .I/O signals given in Section 3.6 (page 3-48).
  Data . . . . . .Written to and read from the buffer memory by the PC CPU. Detailed in Section 3.4 (page 3-8).

- Communication between A6GPP (or AD71TU) and AD71

  Data write, AD71 test, AD71 monitor, etc. via the AD71's RS422 connector.

- Communications between drive unit and AD71

  Control signal communication to and from the drive unit and pulse train output from the AD71. (For the I/O interface, refer to Section 3.7 (page 3-54).)

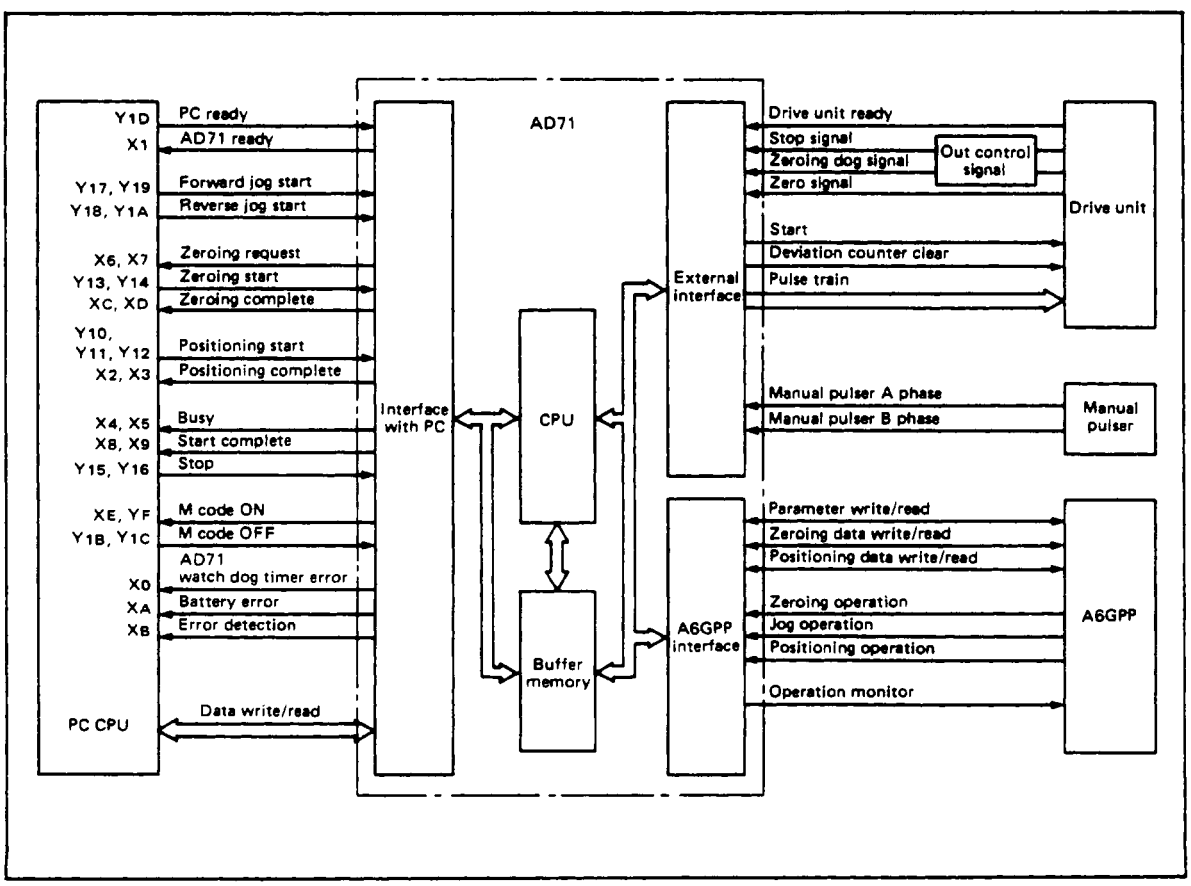


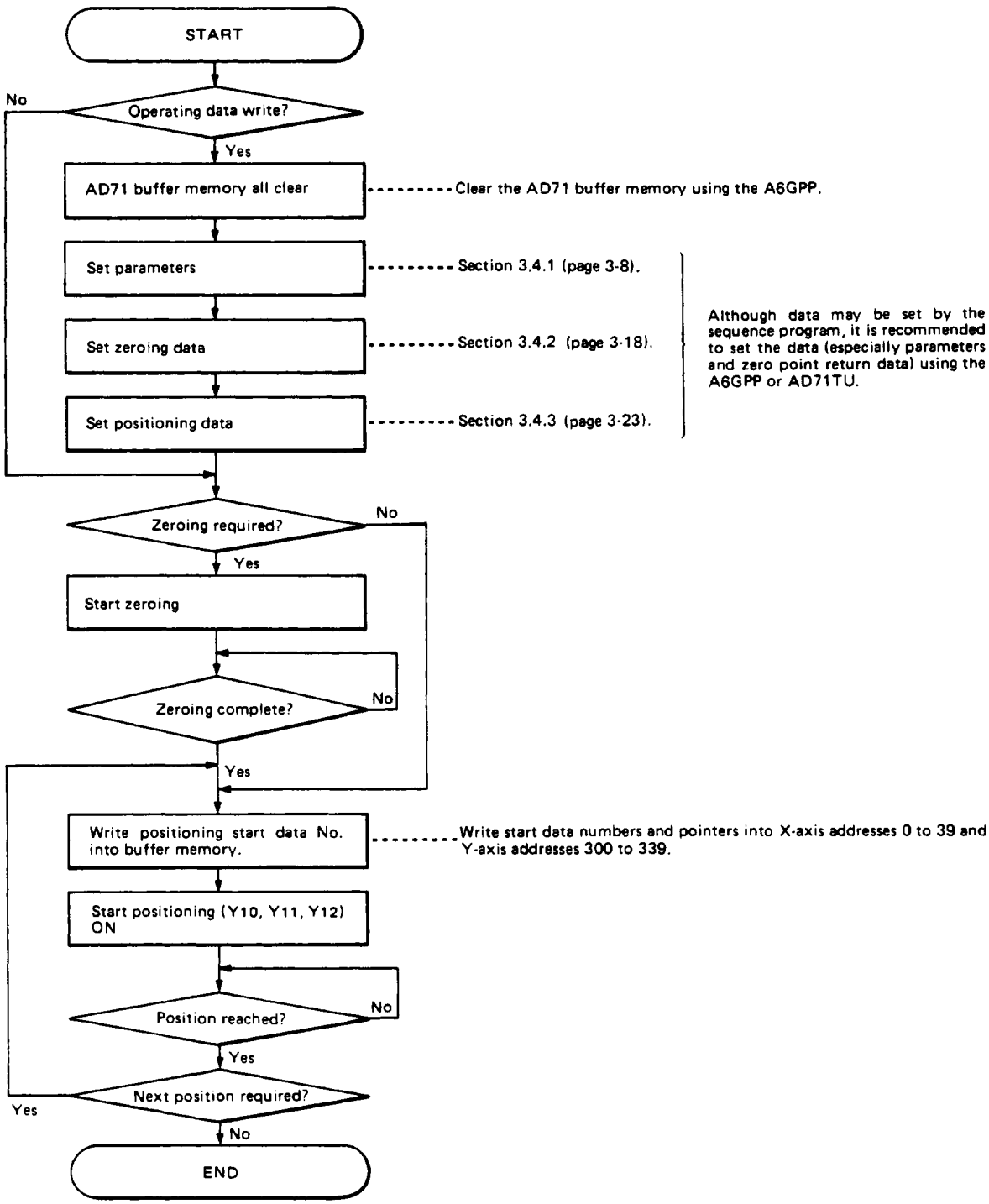
Fig. 3.2 AD71 Function Block Diagram

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3.3.2 AD71 operation

Fig. 3.2 PC initiated positioning procedure



Note 1: For home position and positioning start conditions, refer to Chapter 6.

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Data \ Function		Manual pulser Operation	Jog Operation	Zeroing	Positioning
Parameter	Unit setting	○	○	○	○
	Travel per pulse	○	○	○	○
	Speed limit value		○	○	○
	Jog speed limit value		○		
	Starting bias speed		○	○	○
	Backlash compensation	○	○		○
	Upper stroke limit				○
	Lower stroke limit				○
	Error compensation	○	○		○
	Travel per manual pulse during inching	○			
	Acceleration and deceleration times		○	○	○
	Positioning complete signal output time				○
	Pulse output mode	○	○	○	○
	Rotation direction setting	○	○	○	○
	Positioning method				○
	M code ON/OFF timing				○
Zeroing data	Zeroing direction	○	○	○	○
	Zeroing method			○	
	Zeroing address	○	○	○	○
	Zeroing speed			○	
	Zeroing creep speed			○	
	Zeroing dwell time			○	
	Torque limit			○	
Positioning data	Positioning information				○
	Positioning speed				○
	Positioning address				○
	Dwell time				○
Other	Start data area				○
	Speed change data		○*	○*	○*
	Jog speed		○		
	Inching operation enable	○			

Table 3.4 Relation between Data and Positioning Functions

* Indicates functions used to change the speed when the AD71 is busy.

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3.4 Format and Functions of Operating Data

The following three blocks of data are required for positioning using the AD71. This data is written to the buffer memory which will be explained in Section 3.5 (page 3-30).

- Parameters
- Zeroing data
- Positioning data

Operating data is written using:

1) A6GPP or AD71TU. . . .For details, refer to the SW0GP-AD71P or AD71TU Operating Manual.

2) Sequence program. . . . .For details, refer to Chapter 6.

It is necessary to set data for the two axes (X and Y).

3.4.1 Parameters

This is the general information required for positioning. Table 3.5 gives a list of all the parameters which must be set for the AD71.

Initial parameter values

If parameters are not set or an error is found (for example parameter is outside the allowed setting range), all data defaults to the values shown in Table 3.5 and the faulty set of parameters will remain in the buffer memory.

Parameters are checked when:

1) the power is switched on;
2) parameters are transferred from the A6GPP to the AD71;
3) "PC ready signal" from the PC CPU to the AD71 switches from "off" to "on"; or
4) (1) zeroing, (2) positioning, (3) jog operation, or (4) inching has been selected in A6GPP test mode.

Error code and error detection signal are not given for the "power on" parameter check.

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No.	Item	mm		Inch		degree		PULSE(PLS)		Default Value	
		Setting range	Unit	Setting range	Unit	Setting range	Unit	Setting range	Unit		Unit
1	Units	0	—	1	—	2	—	3	—	3	—
2	Travel per pulse	1 to 100	$\times 10^{-1}$ μm/PLS	1 to 100	$\times 10^{-5}$ inch/PLS	1 to 100	$\times 10^{-5}$ degree/PLS	—	—	—	—
3	Speed limit value	1 to 12000	$\times 10^{1}$ mm/min	1 to 12000	$\times 1$ inch/min	1 to 12000	$\times 1$ degree/min	1 to 20000	$\times 10^{1}$ PLS/sec	20000	$\times 10^{1}$ PLS/sec
4	Jog speed limit value	1 to 12000	$\times 10^{1}$ mm/min	1 to 12000	$\times 1$ inch/min	1 to 12000	$\times 1$ degree/min	1 to 20000	$\times 10^{1}$ PLS/sec	2000	$\times 10^{1}$ PLS/sec
5	Starting bias speed	0 to 12000	$\times 10^{1}$ mm/min	0 to 12000	$\times 1$ inch/min	0 to 12000	$\times 1$ degree/min	0 to 20000	$\times 10^{1}$ PLS/sec	0	$\times 10^{1}$ PLS/sec
6	Backlash compensation	0 to 65535	$\times 10^{-1}$ μm	0 to 65535	$\times 10^{-5}$ inch	0 to 65535	$\times 10^{-5}$ degree	0 to 255	PLS	0	PLS
7	Upper stroke limit	0 to 162000	mm	0 to 16200	inch	0 to 16200	degree	0 to 16252928	PLS	16252928	PLS
8	Lower stroke limit	0 to 162000	mm	0 to 16200	inch	0 to 16200	degree	0 to 16252928	PLS	0	PLS
9	Error compensation	±0 to 100000 (per 1m)	$\times 10^{-1}$ μm	±0 to 100000 (per 100inch)	$\times 10^{-5}$ inch	±0 to 100000 (per 100deg)	$\times 10^{-5}$ degree	—	—	0	—
10	Travel per manual pulse during inching	1 to 100000	$\times 10^{-1}$ μm	1 to 100000	$\times 10^{-5}$ inch	1 to 100000	$\times 10^{-5}$ degree	1 to 100	PLS	1	PLS
11	Acceleration and deceleration times	64 to 4999(msec)								1000	msec
12	Positioning complete signal output time	0 to 20000(msec)								300	msec
13	Pulse output mode	0 : PLS+SIGN(B type) 1 : Forward PLS or reverse PLS(A type)								As previous setting *	—
14	Direction setting	0 : Present value increase when forward pulse is output 1 : Present value increase when reverse pulse is output								As previous setting *	—
15	Positioning method	0 : Absolute 1 : Incremental 2 : Incremental/absolute combined								0= absolute	—
16	M code ON/OFF timing	0 : M code not used 1 : M code used { 0 : WITH mode 1 : AFTER mode								As previous setting *	—

* Unfixed when shipped from factory. All clear sets to 0.

Table 3.5 Parameter List

POINT

(1) No. 2 to No. 12 are set from the sequence program.

(2) When setting No. 1 and No. 13 to No. 16 from the sequence program, refer to Section 3.5.5 (page 3-46).

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IMPORTANT

The AD71 automatically multiplies any numerical data received from the sequence program by the relevant factor. For example, if the AD71 receives the constant K = 200 from the sequence program and the units have been defined as PLS/sec, the speed output to the drive is 2000 PLS/sec (i.e. 200 x 10^1 PLS/sec.)

IMPORTANT

The AD71 controls all speeds to a maximum accuracy of 6.1 pulses per second.
For this reason, if a speed is set to 200 pulses per second, the actual speed will be 195.2 pulses per second. This may be found as follows

$$\frac{200}{6.1} = 32.78688.....$$

The AD71 can only deal with whole number multiples of 6.1, so the actual speed will be 32 x 6.1 = 195.2 pulses per second.

Parameter data is explained as follows.

(1) Unit

Selects the units (mm, inch, degree, or pulse) for positioning control. Can be set independently for X and Y axes (e.g. X axis = mm, Y axis = degree).

(2) Travel per pulse

- Specifies the travel distance per pulse as determined by the mechanics of the system.
- Controls the number of pulses contained in the pulse train from the AD71.

(3) Speed limit value

- Specifies the maximum speed for positioning (or zeroing).
- When the positioning speed called at a given time is greater than the speed limit value, the speed is limited to the value set by the parameter.
- When a new speed is called during positioning by the sequence program and this is greater than the speed limit value, the speed is limited to the value set by the parameter.

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(4) Jog speed limit value

- Specifies the maximum speed for jog operation.
- The jog speed limit value must be within the range shown in Table 3.5 and must not exceed the speed limit value.
- When the jog speed set using the A6GPP or sequence program is greater than the jog speed limit value, the jog speed is kept to the limit value.

*For jog operation, refer to Section 6.3.4 (page 6-23).

(5) Starting bias speed

- A minimum starting speed is required for the smooth operation of some motors (e.g. stepping motors). This may be set as a starting bias speed.
- The starting bias speed is used for positioning, jog operation, and zeroing. See Fig. 3.3.

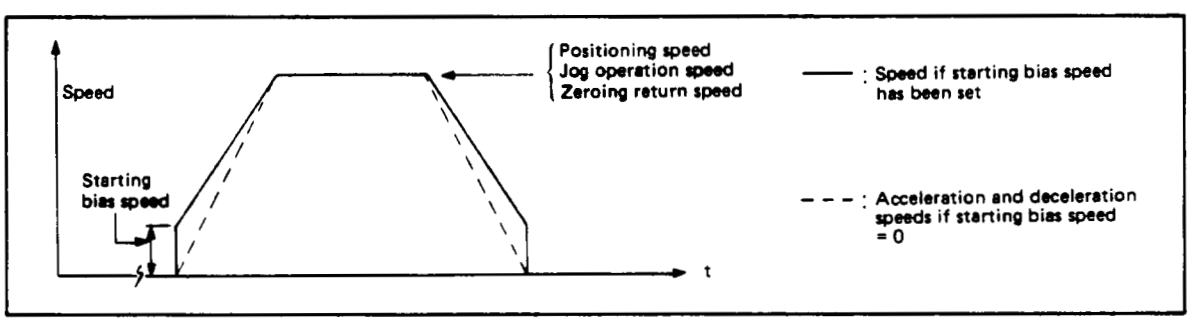


Fig. 3.3 Speed Change When Starting Bias Speed Is Set

For positioning with interpolation between axes, the starting bias speed set for the axis with the shorter distance to travel is ignored.

(6) Backlash compensation

- Allows a backlash compensation (see Fig. 3.4) to be programmed in for accurate positioning.
  Note that there is also an error compensation facility to allow for tolerances within the mechanical drive, see note (9).
- The backlash compensation facility allows extra feed pulses to be generated every time the direction of movement changes during positioning.
  During manual pulser inching, pulse output begins as soon as the number of input pulses exceeds the backlash compensation amount each time the direction of movement changes. (If the inched distance is less than the backlash compensation, feed pulses are not generated but the AD71 calculates subsequent positions according to the updated data.)
  During jog operation, backlash compensation is made for the first movement after a change of direction only.

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- Backlash compensation is valid after zeroing. After redefining the backlash compensation, always zero the system.

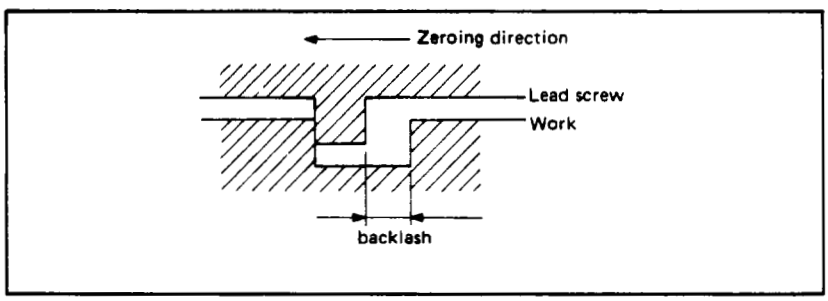


Fig. 3.4 Backlash Compensation

(7) Upper stroke limit

- Defines the upper limit value of machine travel.
- The stroke limit is checked before each positioning operation and if outside the allowed range, positioning is halted. During jog operation and manual pulser inching, the stroke limit is ignored.

(8) Lower stroke limit

- Defines the lower limit value of machine travel.
- The stroke limit is checked before each positioning operation and if outside the allowed range, positioning is halted. During jog operation and manual pulser inching, the stroke limit is ignored.

(9) Error compensation

The AD71 may be calibrated to allow for mechanical errors in the system. This is facilitated by providing an error compensation parameter and is found as follows (example for mm):

1) Set the error compensation to 0.
2) Program the AD71 to provide 1000mm travel.
3) Measure the actual distance travelled.
4) Calculate the error, E, such that
   E = 1m – Measured value. (in mm)
5) Set E as the error compensation parameter (in units of $10^{-1}\,\mu m$).
6) If using inches the calibration distance is 100 inch, and for degrees it is 100 deg.

The AD71 calculates the error compensation value Ec as follows:

$$Ec = \left(\frac{S}{m} \times E \right) \times n$$

Where, S = Travel distance according to AD71
m = Measured distance for S
E = Difference calculated in (4) above.
n = 10^4 when units are mm
= 10^5 when units are inch^{-5} or degree^{-5}

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Error compensation is valid for: manual pulser inching, jogging and positioning applications.
Backlash compensation, Bc, should be set according to the following expression:

$$Bc = B \times E$$

where, B = Actual backlash
E = As above

(10) Manual pulser inching travel increment

- Defines the distance travelled each time a manual pulser inching command is given.
- The AD71 counts the number of manual pulser inching commands input and transmits the appropriate number of output pulses. (The speed is fixed at 20000 PLS/sec.)
- During manual pulser inching there is no automatic acceleration/deceleration.

(11) Acceleration and deceleration times

- Defines the period of time from the start of positioning to when the speed limit value specified in the parameter is reached. (Refer to Fig. 3.5.)

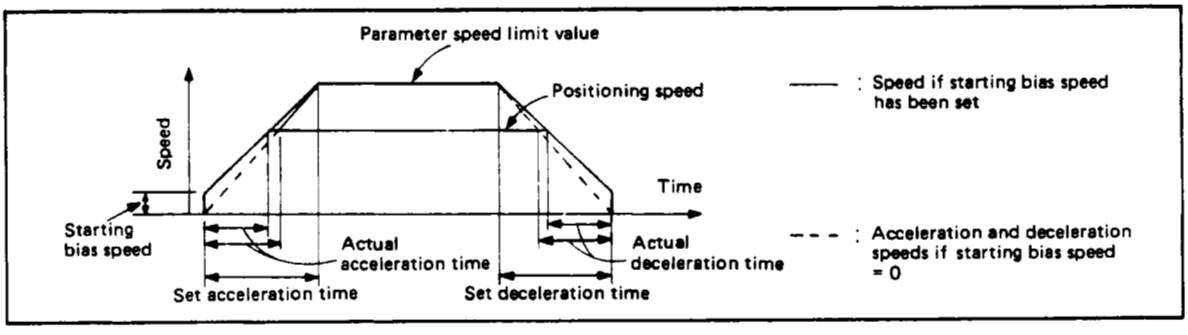


Fig. 3.5 Acceleration and Deceleration Times

- The acceleration and deceleration times cannot be set independently.
- Acceleration and deceleration are controlled at a constant value.
- When the positioning speed is very much lower than the parameter speed limit, the acceleration/deceleration time is comparatively short.
- Acceleration/deceleration time is valid for zeroing, positioning, and jog operations.
- For interpolation positioning, the acceleration/deceleration time for the axis with the longer travel is valid. (The acceleration/deceleration time for the other axis is ignored.)

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(12) Positioning complete signal duration

Sets the duration of the "positioning complete signal" from the AD71.
Positioning is considered to be complete after the AD71 terminates pulse output and the predetermined dwell time has elapsed.

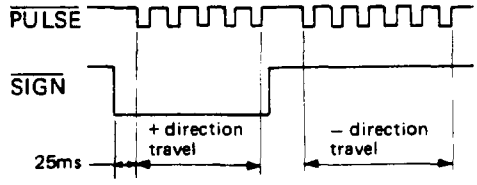
(13) Pulse output mode

Defines the output mode as A type or B type.

- Forward pulse or reverse pulse, two pulse chains.

Forward feed pulse $\overline{\text{PULSE F}}$	$\overline{\text{PULSE F}}$ 	A type
Reverse feed pulse $\overline{\text{PULSE R}}$	$\overline{\text{PULSE R}}$ 	

- PLS + SIGN

Feed pulse $\overline{\text{PULSE}}$	Forward and reverse feed pulses. Travel direction is controlled by direction sign ($\overline{\text{SIGN}}$). 	B type
Direction sign $\overline{\text{SIGN}}$	Low in forward direction. High in reverse direction. (Present value increases in forward direction and decreases in reverse.)	

(14) Direction setting

Selects the direction for which the present value increases. (Set 0 when using forward pulse output. Set 1 when using reverse pulse output.)

(15) Positioning mode

- Specifies incremental, absolute, or incremental/absolute combination modes for positioning.
- In incremental mode positioning, positions are reached with reference to the previous position. (See Fig. 3.6.)

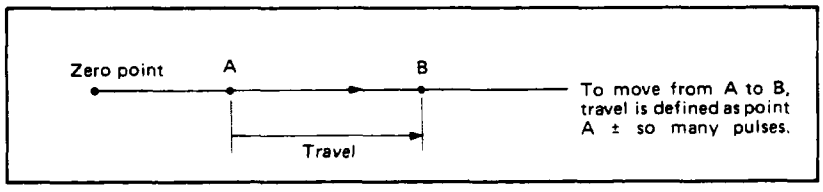


Fig. 3.6 Incremental Method

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- In absolute mode positioning, positions are reached with reference to a zero point address. (See Fig. 3.7.)

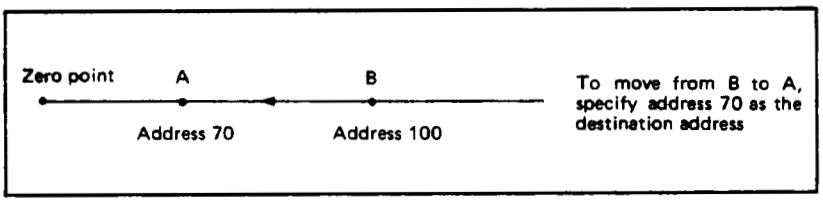


Fig. 3.7 Absolute Method

- To use both incremental and absolute modes in the same axis (e.g. X axis), set 2. In this case, the mode is controlled by the individual piece of positioning data. (Refer to Section 3.4.3 (page 3-23).)

(16) M code ON/OFF timing

M codes are code numbers (1 to 255) assigned by the user to control auxiliary functions at defined points in the positioning cycle. These are used by the PC CPU to co-ordinate the operation of external equipment and processes.

- M code use/non-use must be specified as well as where in the positioning sequence they are to be used.
  When M code non-use is specified or A6GPP test mode is in operation, M code data in the buffer memory is cleared and the "M code ON" signal is not output.
- "M code ON" signal output is available in two timing modes, WITH and AFTER.
- WITH mode
  The "M code ON" signal is given at approximately the same time as the positioning operation starts.

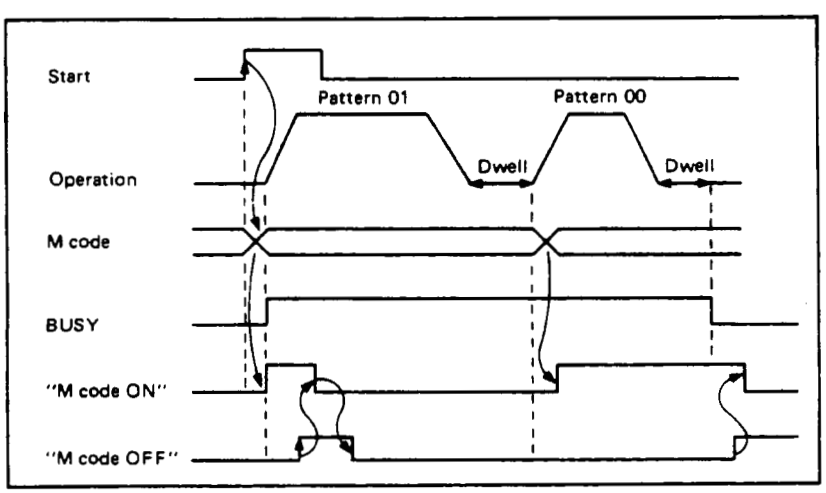


Fig. 3.8 WITH Mode Timing

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- AFTER mode

The "M code ON" signal is given after the positioning operation has finished. In this mode, if the operation is stopped before it is complete the "M code ON" signal is not given.

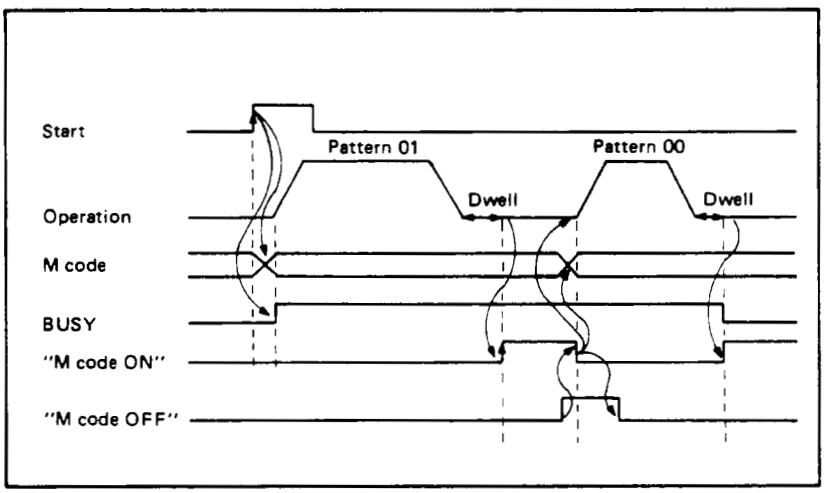


Fig. 3.9 AFTER Mode Timing

POINT

- The "M code ON" signal is not given if the M code data in the positioning data is set at 0.

- The M code is ignored if the positioning pattern is "11" and the "M code ON" signal is not given. (For details of the positioning pattern, refer to Section 3.4.3 (page 3-23).)
  The next positioning operation is not started until the "M code ON" signal is switched off.
  An error condition arises if the "M code ON" signal is on at the rise of the start signal and positioning is not started. The "M code ON" signal is turned off when:

  1. "M code OFF" signal changes from OFF to ON;
  2. PC ready signal (Y1D) is off; or
  3. Zeroing, positioning, jog operation, or inching mode is selected in the A6GPP test mode.

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For a sequence of positions, the first of which are defined as pattern "11", the "M code ON" signal is not given until the first "00" or "01" pattern data is reached. In this case the M code itself is given at the first position. This is illustrated below.

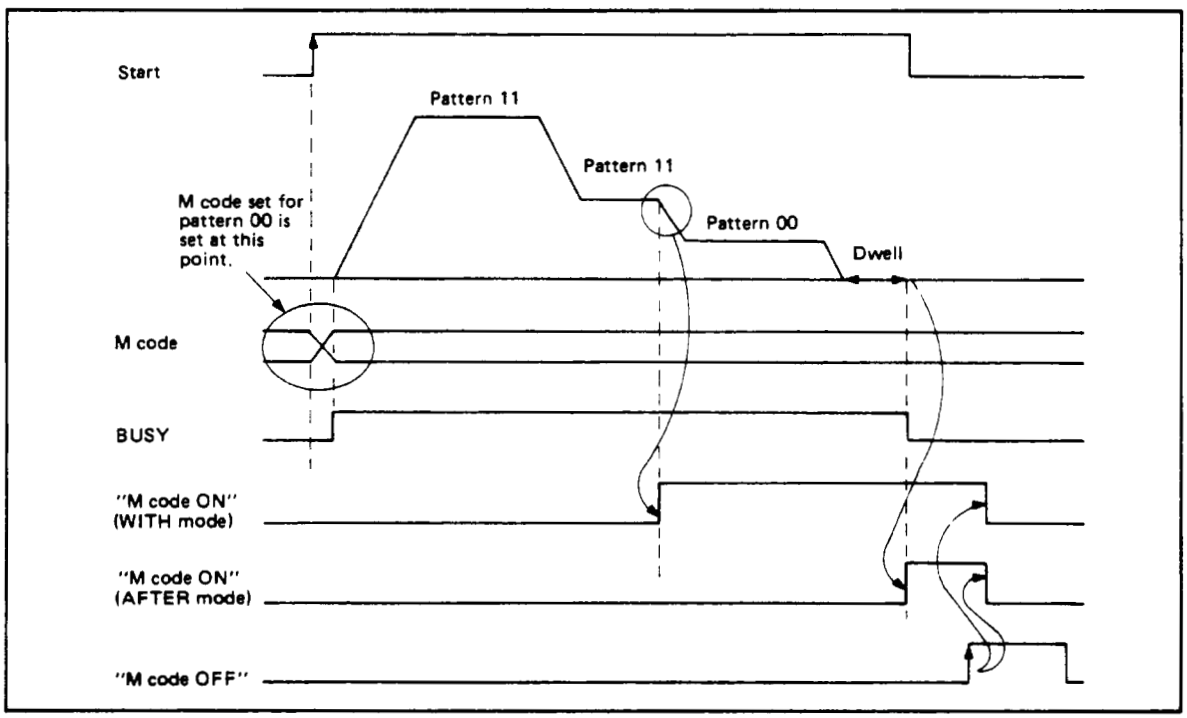


Fig. 3.10 "M Code ON" Signal Timing for Positioning Pattern "11"

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3.4.2 Zeroing data

This defines a home position or zero point for the AD71. Refer to Table 3.6.
Zeroing data is checked when:

1) parameters or zeroing data is transferred from the A6GPP to the AD71;
2) "PC ready signal" output from the PC CPU to the AD71 changes from OFF to ON; or
3) zeroing, positioning, jog operation, or manual pulser inching is selected in A6GPP test mode.

No.	Item	mm		inch		degree		PULSE	
		Setting range	Unit	Setting range	Unit	Setting range	Unit	Setting range	Unit
1	Zeroing direction	0 : Forward direction(address increases) 1 : Reverse direction(address decreases)							
2	Zeroing method	0 : Pulse generator(PG)zero-point signal 1 : Stop and dwell timer time-out 2 : Stop and signal from drive unit							
3	Zeroing address	0 to 162×10^7	$\times10^{-1}\mu$m	0 to 162×10^7	$\times10^{-5}$inch	0 to 162×10^7	$\times10^{-5}$deg	0 to 16252928	PLS
4	Zeroing speed	1 to 12000	$\times10^1$ mm/min	1 to 12000	$\times1$ inch/min	1 to 12000	$\times1$ deg/min	1 to 20000	$\times10^1$ PLS/sec
5	Creep speed	1 to 12000	$\times10^1$ mm/min	1 to 12000	$\times1$ inch/min	1 to 12000	$\times1$ deg/min	1 to 20000	$\times10^1$ PLS/sec
6	Zeroing dwell time	0 to 499($\times10^1$msec)							
7	Torque limit	10 to 250(%)							

Table 3.6 Zeroing Data

POINT

(1) No. 3 to No. 7 can be set by the sequence program.

(2) When setting No. 1 and No. 2 from the sequence program, refer to Section 3.5.6 (page 3-47).

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Zeroing data is explained below:

(1) Zeroing direction

- Specifies the direction for zeroing.

IMPORTANT

Zeroing is controlled according to the zeroing direction and speed. Deceleration is started when an actuator is operated. Always ensure that the zeroing direction is correct for the drive system used.

(2) Zeroing methods

Zero the system using one of the following methods, all methods require a "zeroing dog" or actuator to reduce the speed to the creep speed.

a) Zero-phase signal from pulse generator (PG)
b) Stop and dwell timer time-out
c) Stop and signal from drive unit

(a) Zero-phase signal from PG

The sequence of events is as follows (See Fig. 3.11):

- Zeroing signal received – move in appropriate direction.
- "Zeroing dog" on – start decceleration to creep speed.
- "Zeroing dog" off – continue at creep speed.
- Zero phase signal – stop drive, zeroing complete.

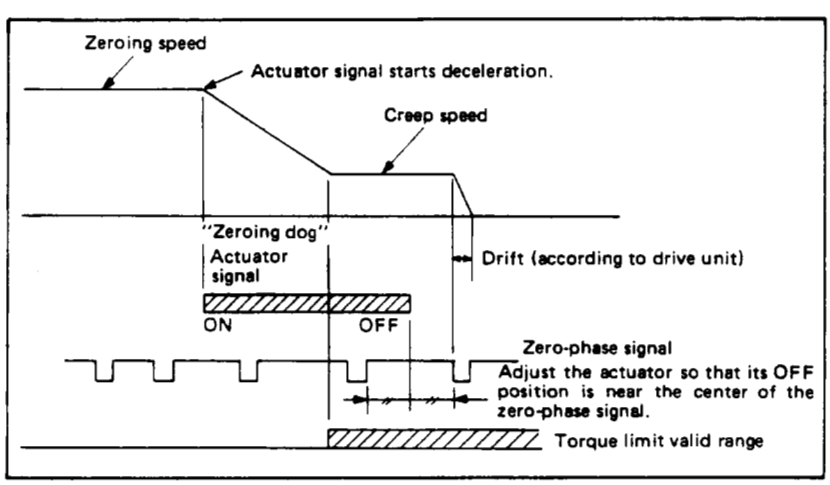


Fig. 3.11 Zeroing Using a Zero-Phase Encoder and an Actuator (method a)

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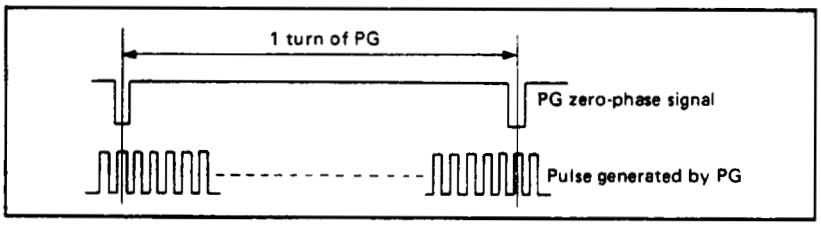


Fig. 3.12 Pulse Generator (PG) Output

(b) Stop and dwell timer time-out

The sequence of events is as follows (See Fig. 3.13-1):

- Zeroing signal received – move in appropriate direction.
- "Zeroing dog" on – start decceleration to creep speed and start dwell timer.
- Work is stopped by mechanical stopper.
- Dwell timer times out – zeroing complete.

(c) Stop and signal from drive unit

The sequence of events is as follows (See Fig. 3.13-2):

- Zeroing signal received– move in appropriate direction.
- "Zeroing dog" on – start decceleration to creep speed.
- Work is stopped by mechanical stopper.
- Feedback signal from drive unit (e.g. torque limit exceeded), zeroing complete. (The feedback signal is fed into the zero-phase signal input).

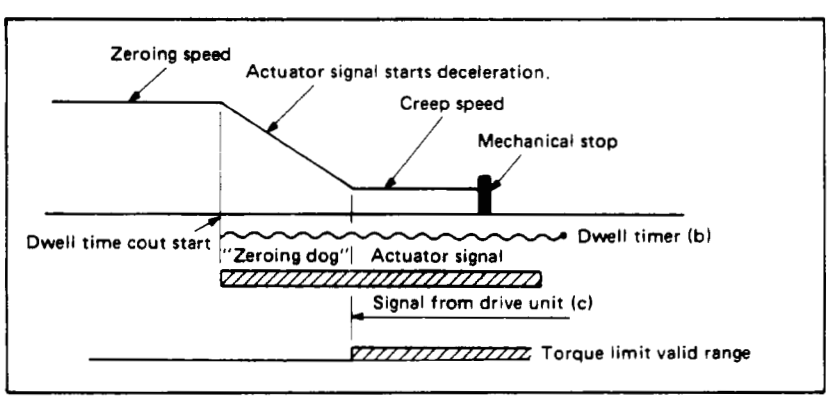


Fig. 3.13 Home Positioning Using Stop Signal

(3) Zeroing address

- This address is set as the present value of the home position upon completion of zeroing.
- Set the zeroing address to either the upper or lower stroke limit set in the parameters.

(4) Zeroing speed

- Sets the zeroing speed. (Refer to Fig. 3.14.)

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(5) Creep speed

- This is the low speed used to approach the home position. (See Fig. 3.14.)
- This speed should be set with consideration for errors in zeroing as well as the impact with the end stop.

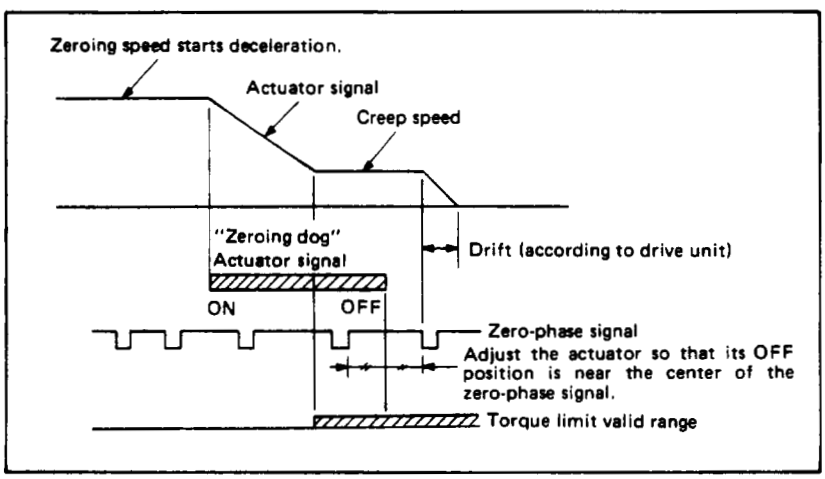


Fig. 3.14 Zeroing and Creep Speeds

(6) Zeroing dwell time

- This is the period of time starting from when the actuator is turned on to when home positioning is complete.
- Set the time interval to allow the creep speed to stabilize and the drive to hit the mechanical stopper.
- When the dwell timer home positioning method is not being used, this may be set to any value within the setting range.

(7) Torque limit

- Sets a limit for the servo motor torque after the creep speed is reached.

POINT

- **A D/A converter module is necessary for torque limiting.**
- **Any value within the setting range may be specified if the torque limit zeroing method is not being used.**

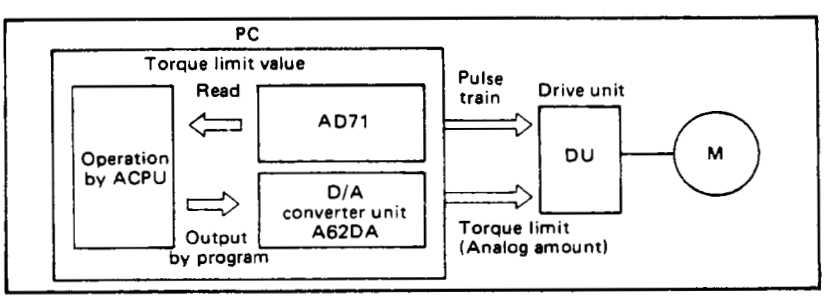


Fig. 3.15 Torque Limit Block Diagram

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3.4.3 Positioning data

Positioning data is used in the AD71 to execute positioning control (i.e. control other than home positioning, inching and jog operation). Refer to Table 3.7.
Table 3.7 shows one block of positioning data. 400 blocks can be set for the X and Y axes, respectively.
The block of data used for positioning is dictated by the number set in the positioning start area of the buffer memory.
Positioning data is checked when positioning is started.

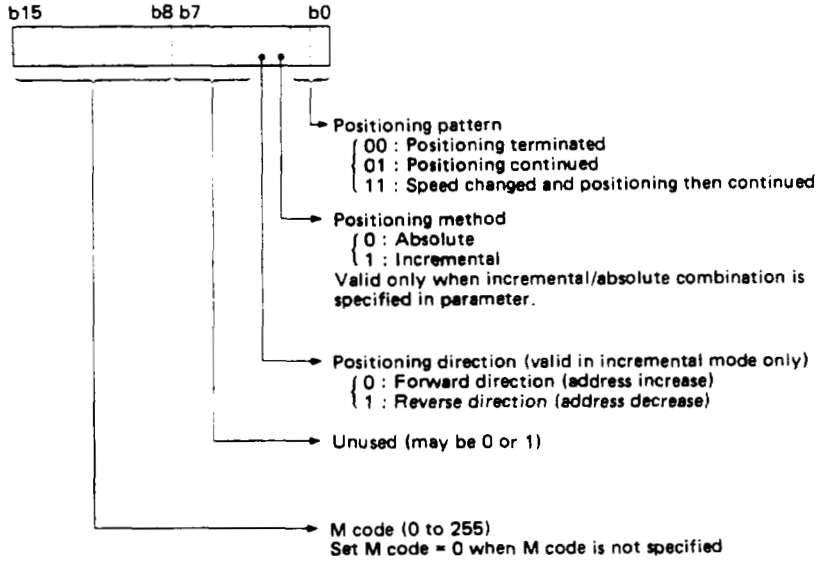
<table>
<tr><th colspan="2">No. \ Item</th><th colspan="8">Setting Data</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Positioning information</td><td colspan="8">
</td></tr>
<tr><td colspan="2">mm</td><td colspan="2">inch</td><td colspan="2">degree</td><td colspan="2">PULS</td></tr>
<tr><td></td><td>Setting range</td><td>Unit</td><td>Setting range</td><td>Unit</td><td>Setting range</td><td>Unit</td><td>Setting range</td><td>Unit</td></tr>
<tr><td>2</td><td>Positioning speed</td><td>1 to 12000</td><td>$\times 10^1$ mm/min</td><td>1 to 12000</td><td>$\times 1$ inch/min</td><td>1 to 12000</td><td>$\times 1$ deg/min</td><td>1 to 20000</td><td>$\times 10^1$ PLS/sec</td></tr>
<tr><td>3</td><td>Positioning address</td><td>0 to 162×10^7</td><td>$\times 10^{-1}\mu$m</td><td>0 to 162×10^7</td><td>$\times 10^{-5}$inch</td><td>0 to 162×10^7</td><td>$\times 10^{-5}$deg</td><td>0 to 16252928</td><td>PLS</td></tr>
<tr><td>4</td><td>Dwell time</td><td colspan="8">0 to 499 ($\times 10^1$ msec)</td></tr>
</table>

Table 3.7 Positioning Data List

POINT

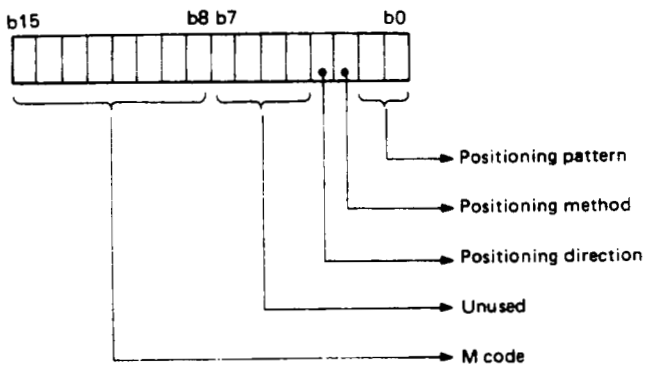
No. 2 to No. 4 can be set from the sequence program.

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Positioning data is explained below.

(1) Positioning information

- Separate the information for the X and Y axes.
- Positioning information consists of 16 bits and includes the following.



(a) Positioning pattern

This specifies whether the operation is to be continued to the next position, or if operation is to be halted after the current position has been reached.
Continued operation is further divided as follows:

1) Consecutive positions are reached using the same speed.

2) The speed is changed at the specified address and positioning then proceeds in the same direction.

This pattern data is specified by the first two bits of the positioning information.

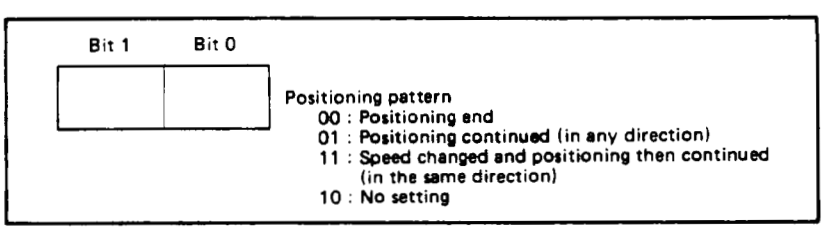


Fig. 3.16 Positioning Pattern

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- Positioning end

  Drives to the specified address, positioning is complete after the dwell time has elapsed.

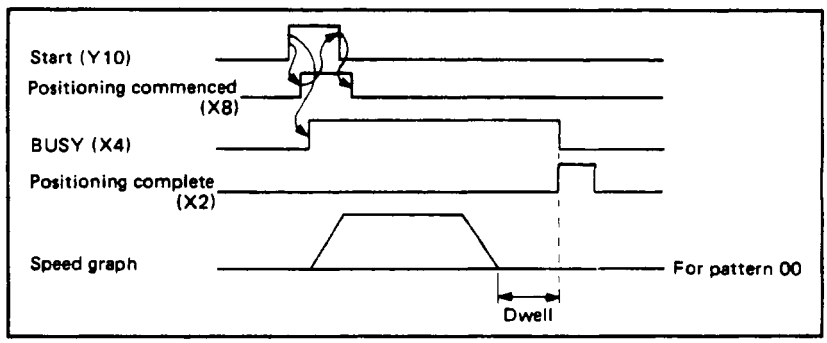


Fig. 3.17 Pattern 00

- Positioning continued

  The positions are reached consecutively in the order specified by their data numbers by a single start signal. (The BUSY signal remains on during positioning.)

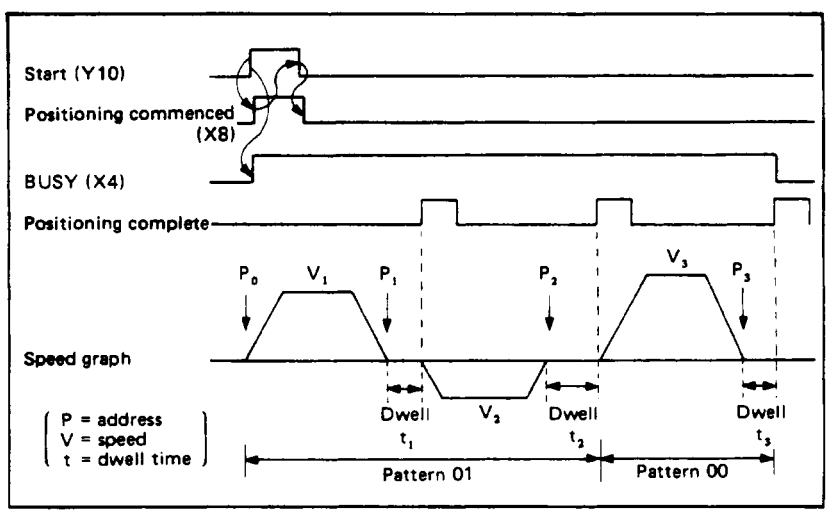


Fig. 3.18 Pattern 01

POINT

Pattern 00 should be set for the last position in a series of continuous operations.
Pattern 01 may be set for interpolation positioning. In this case, the patterns for the X and Y axes should be the same. The X and Y axis patterns are checked before operation and any error will stop positioning.

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- Positioning continues with speed change

The positions are reached consecutively in the order specified by their data numbers by a single start signal. During positioning, the speed may be changed but the direction remains the same. (Refer to Fig. 3.19.)

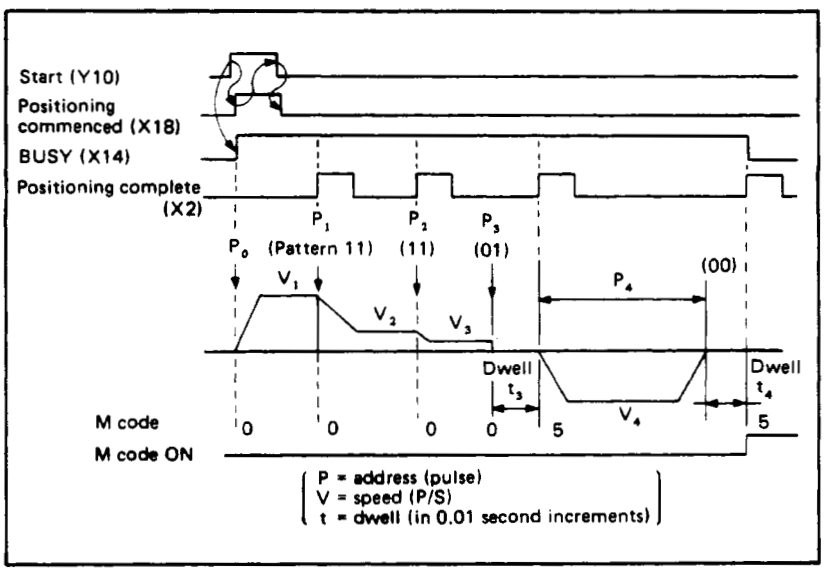


Fig. 3.19 Pattern 11

Table 3.8 shows the positioning data for Fig. 3.19. The following conditions apply:

M code ON/OFF timing : AFTER mode
Incremental/absolute method: Incremental and absolute combined

	Data No.	Pattern	Speed	Address	Dwell	Method	M Code
X axis	100	11	V_1	P_1	—	Abs.	0
	101	11	V_2	P_2	—	Abs.	0
	102	01	V_3	P_3	t_3	Abs.	0
	103	00	V_4	P_4	t_4	Inc.	5
	104						
	105						
	106						
	107						
	108						

In the method column, Abs. indicates absolute method and Inc. incremental method.

Table 3.8 Positioning Data

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POINT

For continuous positioning, pattern 11 should not be used more than nine times consecutively. Where a large number of consecutive 11 patterns are being used, they must be broken down by placing 01 pattern data every nine 11 patterns. (e.g. pattern 11 = 9 times, pattern 01 = 1 time, pattern 11 = 9 times, pattern 00 = 1 time).

Always set pattern 00 in the final data block.

While pattern 11 is continuing, the direction of movement and the positioning method should remain unchanged, only after pattern 01 or 00 may these be changed. If the speed is changed after deceleration has started, the new speed is ignored and, if the M code has been set in WITH mode, the "M code ON" signal is not given.

During positioning using pattern 11, dwell time data and M code will be ignored.

Interpolation positioning cannot be specified when pattern 11 is being used.

(b) Positioning method

Incremental or absolute positioning must be specified assuming that it has not been set in the parameters (item 15, page 3-9). Parameter data takes precedence over this data.

POINT

The positioning method cannot be changed if pattern 11 has been specified.
The positioning method can be changed after patterns 00 or 01 have been executed.

(c) Positioning direction

For incremental mode positioning, the direction of travel relative to the previous address must be specified. (0 specifies forward, increasing address numbers and 1 specifies reverse, decreasing address numbers.)
In absolute mode, the positioning direction is ignored.

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(d) M code

Specifies an "M" code relevant to that position address. (range: 0 to 255)
The code should be set to 0 if it is not required.
During interpolation positioning, M codes are given individually for the X and Y axes. (X-axis M code, buffer address = 46. Y-axis M code, buffer address = 346.)

(2) Positioning speed

Specifies the speed at which the next position is to be approached.

POINT

Before operation, the parameter speed limit is checked and if the positioning speed exceeds the speed limit value, the parameter speed limit value is used.

Positioning speed for linear interpolation

During linear interpolation positioning, the speed set for the axis with the furthest to travel takes precedence and the speed of the other axis is derived as follows.

(Short travel axis speed)

$$= (\text{long travel axis speed}) \times \frac{(\text{short travel distance})}{(\text{long travel distance})}$$

An example of this is given in Fig. 3.20 which uses the following data:

	X Axis	Y Axis
Parameter set value : speed limit value	20KPLS/sec	50KPLS/sec
Positioning data set value : positioning speed	20KPLS/sec	50KPLS/sec

To move from point A (address 0, 0) to point B (100kp, 200kp), X-axis travel is less than Y-axis travel so Vy = 50kp/s has precedence.

$$\text{X-axis positioning speed} = 50 \times \frac{100}{200} = 25\text{KPLS/sec}$$

(This speed exceeds the speed limit value which is ignored in this case.)

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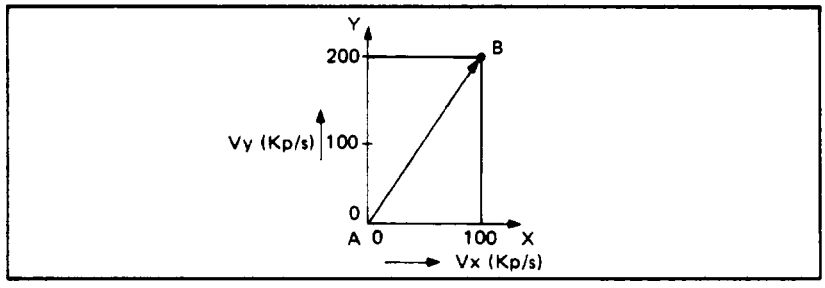


Fig. 3.20 Linear Interpolation

Note: For interpolation positioning, the actual positioning speed is approximately 5% lower than the set speed. (If the set speed is extremely low, the error will be larger, e.g. about 10% at 100P/S.)

POINT

During linear interpolation positioning it is possible for the speed of a given axis to exceed the set speed and the speed limit value if the travel distance for the two axes varies greatly.
For linear interpolation, it is suggested that the positioning speeds and speed limits for the X and Y axes are set to the same value.

(3) Positioning address

The positioning address is set either as an absolute value or an incremental value.

(4) Dwell time

The dwell time is the period of time indicated in Fig. 3.21 below.

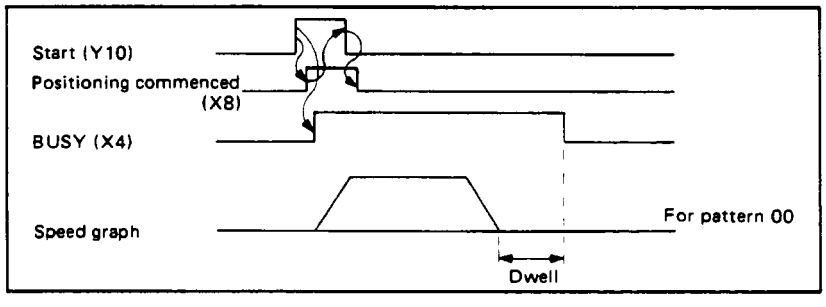


Fig. 3.21 Pattern 00

During interpolation positioning, the longer dwell time value is valid irrespective of the distance travelled (e.g. if X axis = 1 sec and Y axis = 1.5 sec, 1.5 sec is valid.)

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3.5 Buffer Memory

The AD71 has a battery backed buffer memory for communication of data with the PC CPU. The memory map is shown in Fig. 3.22.

Data can be read from the buffer memory as follows:

- Reading data using the sequence program

  One word (16 bit) or two word data can be read by using the buffer read application instructions.

- Reading data using the A6GPP

  For details, refer to the SW0GP-AD71P Operating Manual.

Data can be written to the buffer memory as follows:

(The writing of data may be restricted depending on the status of the AD71. General write conditions are shown in Fig. 3.22. For further details, refer to Section 3.5.1 to 3.5.6.)

- Writing data from the sequence program

  One word (16 bit) or two word data can be written by using the buffer write application instructions.

- Writing data from the A6GPP

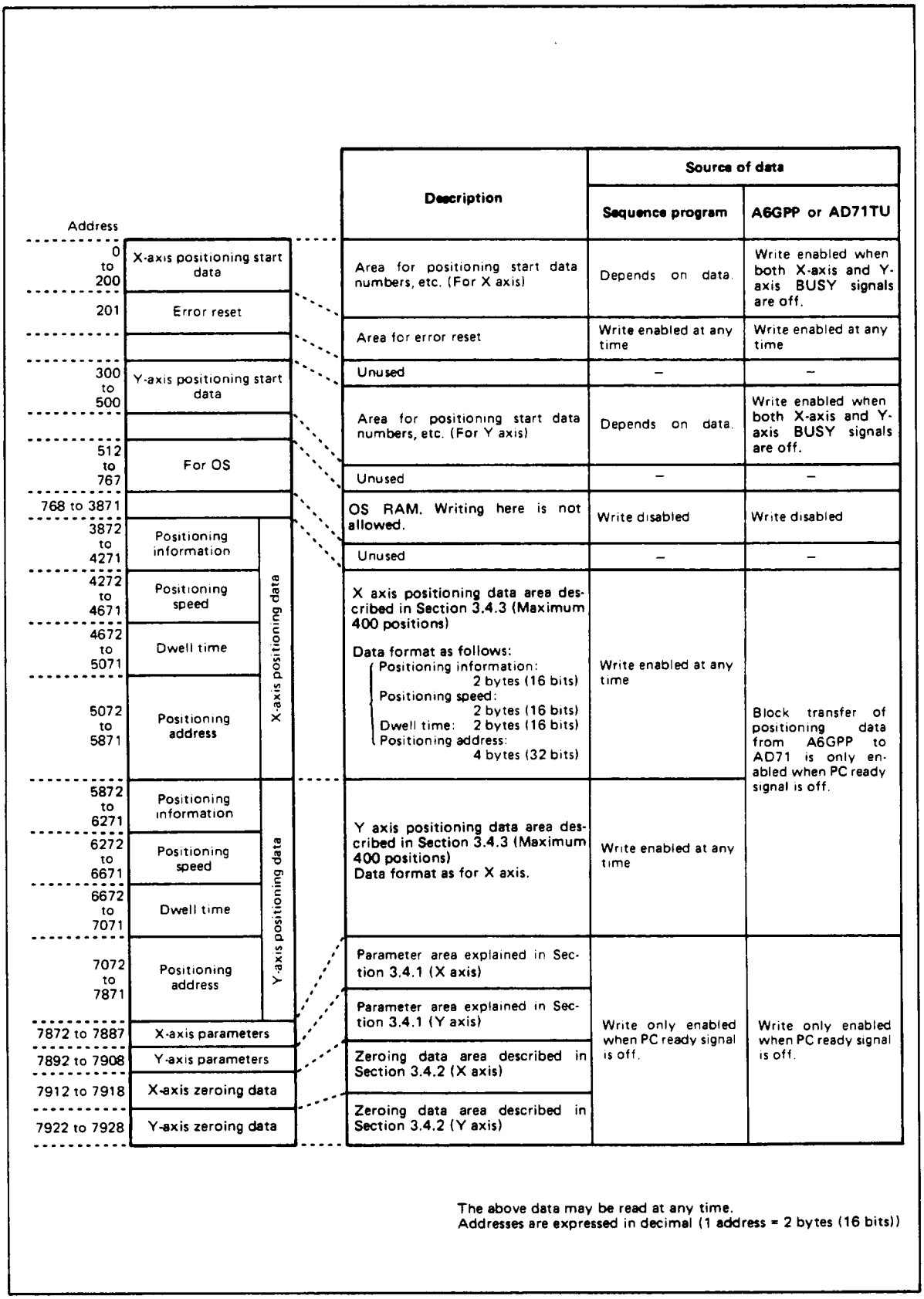
  Transfers data in blocks from the A6GPP memory to the buffer memory.

An additional function allows individual pieces of positioning data to be written to the buffer memory if the AD71 is busy. For details, refer to the SW0GP-AD71P Operating Manual.

REMARKS

For buffer memory access instructions, refer to Chapter 6 "Programming."

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Address			Description	Source of data: Sequence program	Source of data: A6GPP or AD71TU
0 to 200	X-axis positioning start data		Area for positioning start data numbers, etc. (For X axis)	Depends on data.	Write enabled when both X-axis and Y-axis BUSY signals are off.
201	Error reset		Area for error reset	Write enabled at any time	Write enabled at any time
			Unused	–	–
300 to 500	Y-axis positioning start data		Area for positioning start data numbers, etc. (For Y axis)	Depends on data.	Write enabled when both X-axis and Y-axis BUSY signals are off.
512 to 767	For OS		Unused	–	–
768 to 3871			OS RAM. Writing here is not allowed.	Write disabled	Write disabled
3872 to 4271	Positioning information	X-axis positioning data	Unused	–	–
4272 to 4671	Positioning speed	X-axis positioning data	X axis positioning data area described in Section 3.4.3 (Maximum 400 positions) Data format as follows: Positioning information: 2 bytes (16 bits) Positioning speed: 2 bytes (16 bits) Dwell time: 2 bytes (16 bits) Positioning address: 4 bytes (32 bits)	Write enabled at any time	Block transfer of positioning data from A6GPP to AD71 is only enabled when PC ready signal is off.
4672 to 5071	Dwell time	X-axis positioning data			
5072 to 5871	Positioning address	X-axis positioning data			
5872 to 6271	Positioning information	Y-axis positioning data	Y axis positioning data area described in Section 3.4.3 (Maximum 400 positions) Data format as for X axis.	Write enabled at any time	
6272 to 6671	Positioning speed	Y-axis positioning data			
6672 to 7071	Dwell time	Y-axis positioning data			
7072 to 7871	Positioning address	Y-axis positioning data			
7872 to 7887	X-axis parameters		Parameter area explained in Section 3.4.1 (X axis)	Write only enabled when PC ready signal is off.	Write only enabled when PC ready signal is off.
7892 to 7908	Y-axis parameters		Parameter area explained in Section 3.4.1 (Y axis)		
7912 to 7918	X-axis zeroing data		Zeroing data area described in Section 3.4.2 (X axis)		
7922 to 7928	Y-axis zeroing data		Zeroing data area described in Section 3.4.2 (Y axis)		

The above data may be read at any time.
Addresses are expressed in decimal (1 address = 2 bytes (16 bits))

Fig. 3.22 Buffer Memory Map

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3.5.1 Positioning start data

The positioning start data area is shown in Fig. 3.23. The arrangement of the data is the same for both X and Y axes, only addresses are different.

POINT

Both the X-axis and Y-axis BUSY signals must be off to write this data into the AD71 from the A6GPP.

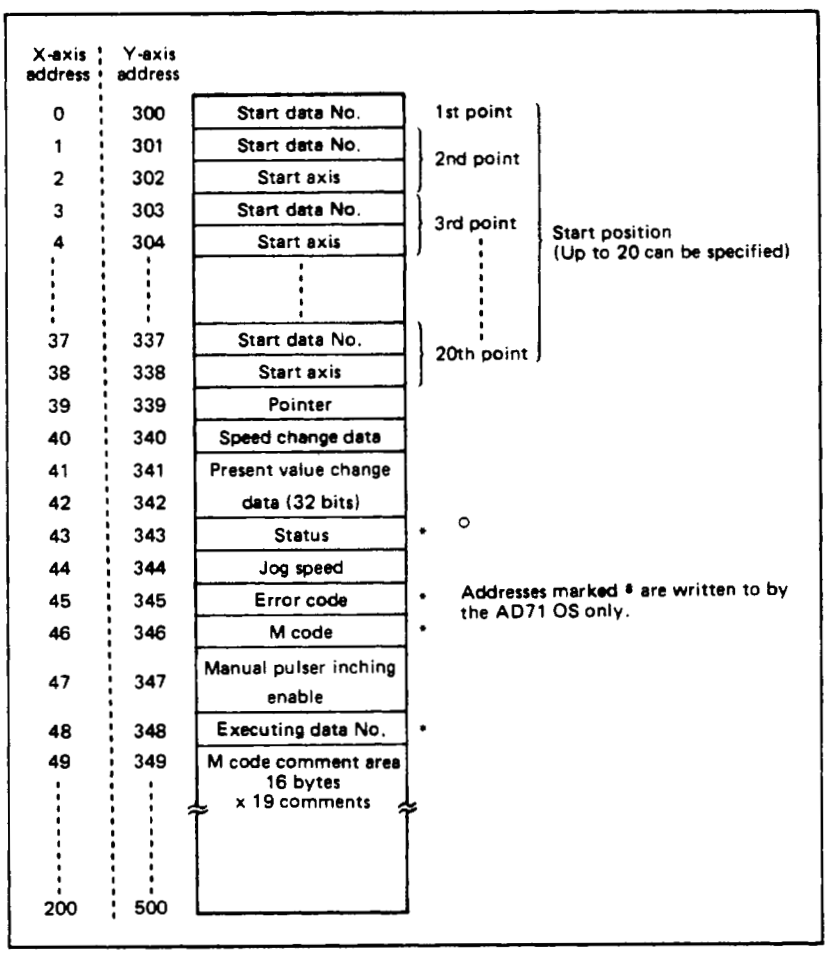


Fig. 3.23 Positioning Start Data

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(1) Speed change area (X axis: address 40, Y axis: address 340)

To change the speed of traverse during positioning, jog operation or home positioning, write the new speeds to these addresses. (To be within the range shown in Table 3.7 page 3-23) This data overrides the speed set in the positioning data. Speed change is illustrated in Fig. 3.24 below.

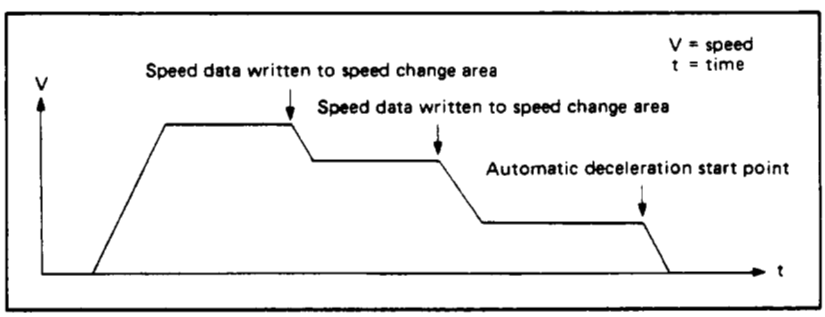


Fig. 3.24 Speed Change Example

POINT

Acceleration and deceleration cycles use the positioning data speed regardless of any forced speed change.
The speed cannot be force changed under the following circumstances:

- **after a deceleration start point;**
- **in inching mode;**
- **after a stop command or after the jog signal is turned off; or**
- **during interpolation positioning.**

(2) Present value change area (X axis: address 41, 42, Y axis: address 341, 342)

To change the present value data in the AD71, write the new value to these addresses.

POINT

The present value cannot be changed while the AD71 is BUSY.
Present value data is two words long, one word data cannot be written.

(3) Jog speed area (X axis: address 44, Y axis: address 344)

Specify the jog speed by writing speed data to these addresses. This data may be written at any time.

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(4) Inching enable area (X axis: address 47, Y axis: address 347)

Enable the manual pulser inching function by writing a 1 to the least significant bit in this address. This data may be written at any time.

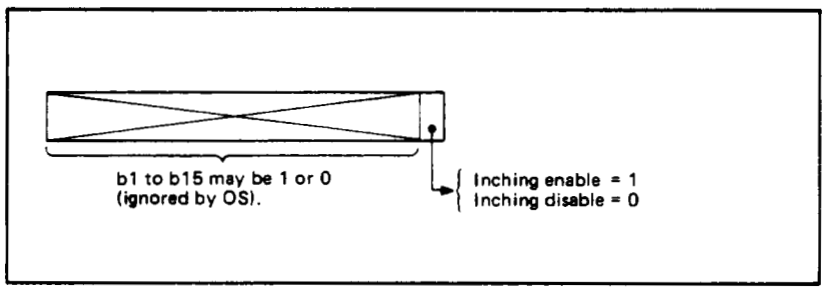


Fig. 3.25 Inching Enable

(5) M code comment area (X axis: address 49 to 200, Y axis: 349 to 500)

Up to 16 ASCII characters may be entered as M code comment data (using the A6GPP or sequence program).
Comments may be written to M code numbers 1 to 19 for both X and Y axes.

(6) Status area (X axis: address 43, Y axis: address 343)

Is reserved for the information shown in Fig. 3.26 and is set by the AD71 OS.

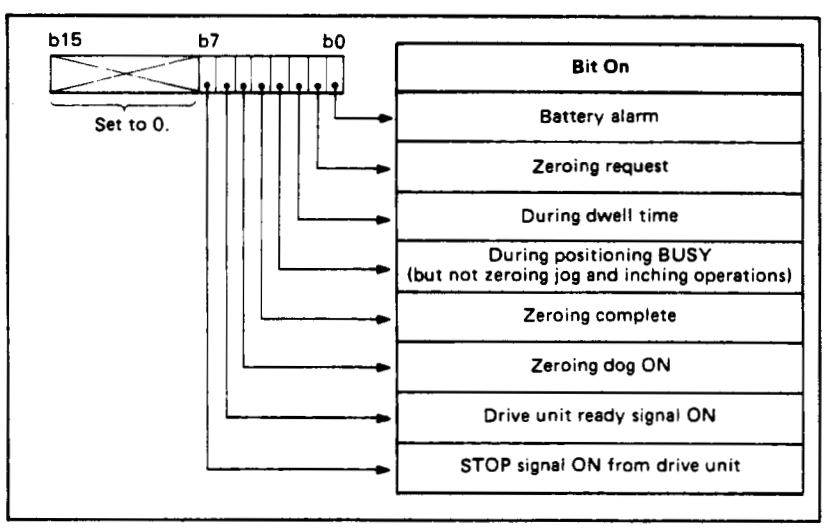


Fig. 3.26 Status Area

POINT

Do not write data to this area.

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(7) Error code area (X axis: address 45, Y axis: address 345)

The code number of any error detected by the AD71 is written to these addresses by the OS. Use in conjunction with the error detection signal (XB).

POINT

- **The error code area is used by the AD71 OS and data must not be written here.**
- **The most recent error code is written to this area. The absence of any error is indicated by a "0" in this address.**
- **For error codes, refer to Chapter 8.**

(8) M code area (X axis: address 46, Y axis: address 346)

The "M code" specified in the positioning data for the current positioning operation is written to these addresses. The M code number can be used to co-ordinate external equipment and processes.

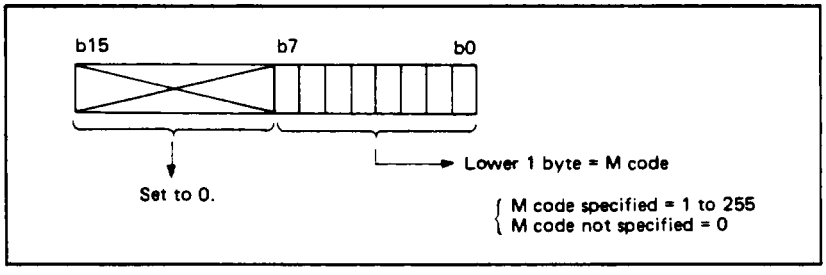


Fig. 3.27 M Code Area

POINT

- **Do not write data to these addresses.**
- **For M code data timing details, refer to Section 3.4.1 (16) (page 3-15).**

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(9) Current data number (X axis: address 48, Y axis: address 348)

The number of the positioning data block currently being processed is written to these addresses by the OS. This number is retained until the next positioning operation begins. (Refer to Fig. 3.28.)

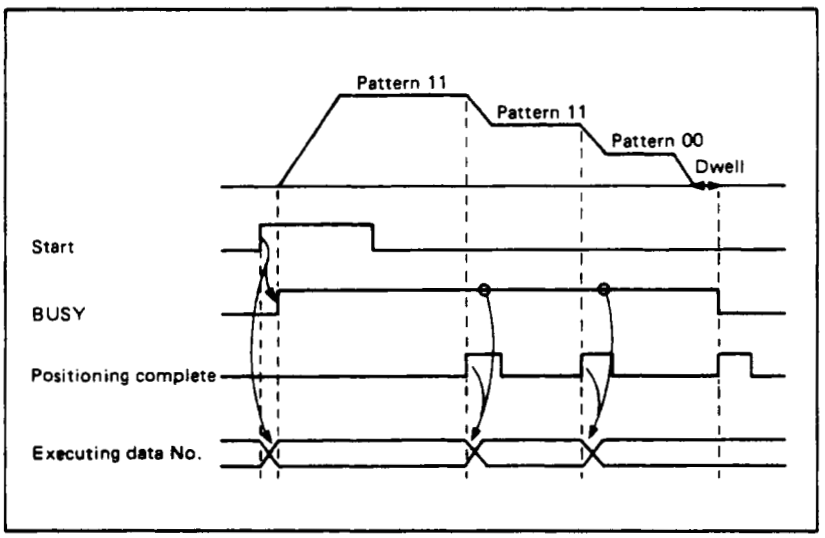


Fig. 3.28 Current Data No. Update Timing

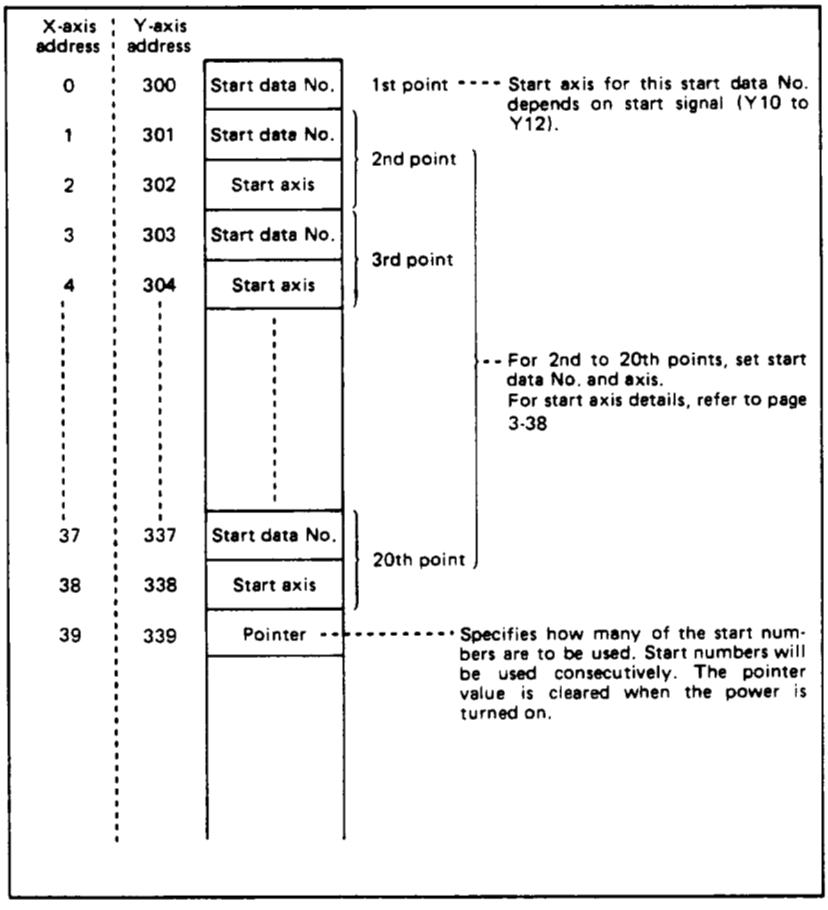
POINT

Do not write data to these addresses.

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(10) Start data number area

For continuous positioning, the AD71 uses consecutive position data numbers starting at the data number indicated in these addresses. A maximum of 20 start numbers can be specified for each axis, providing a maximum of 20 positioning sequences from the total of 400 positions. These sequences can be called in turn by using the pointer to specify how many start numbers (and hence, how many sequences) are to be processed.



POINT

- **The BUSY signal remains on between consecutive positions.**

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(a) Start axis area details

Use the two least significant bits of these addresses to define the start axis. (See Fig. 3.30.)

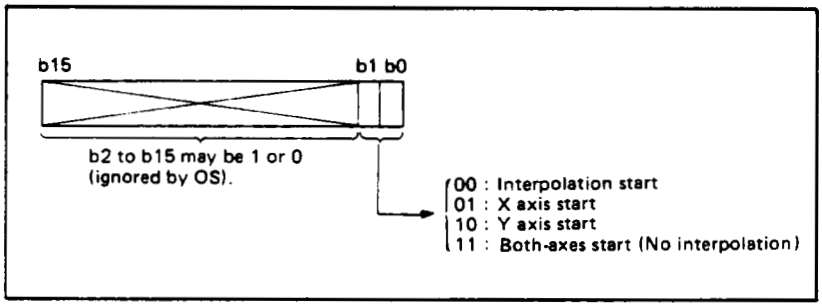


Fig. 3.30 Start Axis Area

The following occurs if both axes are started and an error is found in one:

1) both axes stop if the error has occurred between consecutive positions.
2) only the axis with the error stops if the error occurred after both axes have started.

(b) Data setting precautions

1) When both axes are to be started together (i.e. interpolation setting 00 or independent setting 11) ensure that the start axis data matches for both X and Y axes at that point. Processing will stop if the data does not match. Refer to Fig. 3.31.

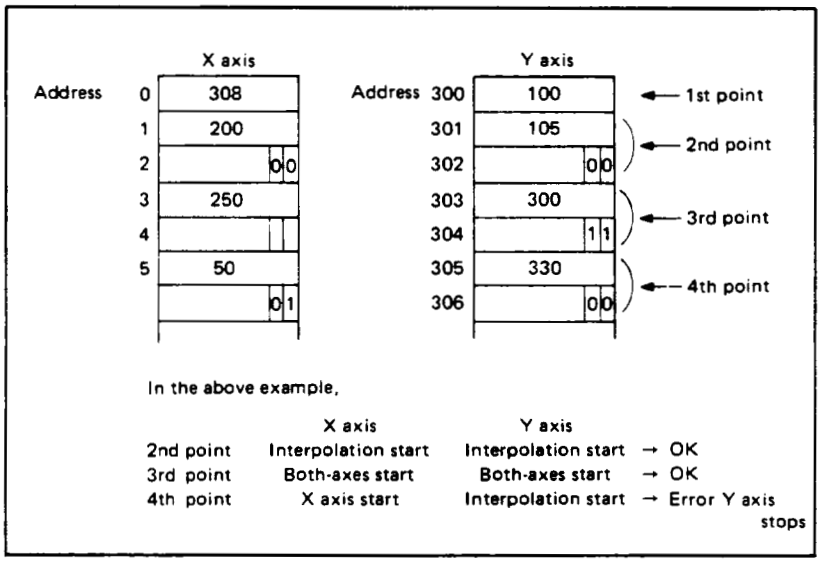


Fig. 3.31 Start Data Example 1

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2) A start point is ignored if its start axis is wrongly defined. In Fig. 3.32 X axis points 2 and 3 have been defined as Y axis starts and Y axis point 3 has been defines as an X axis start. These points are therefore ignored and processing proceeds to the next valid start point.

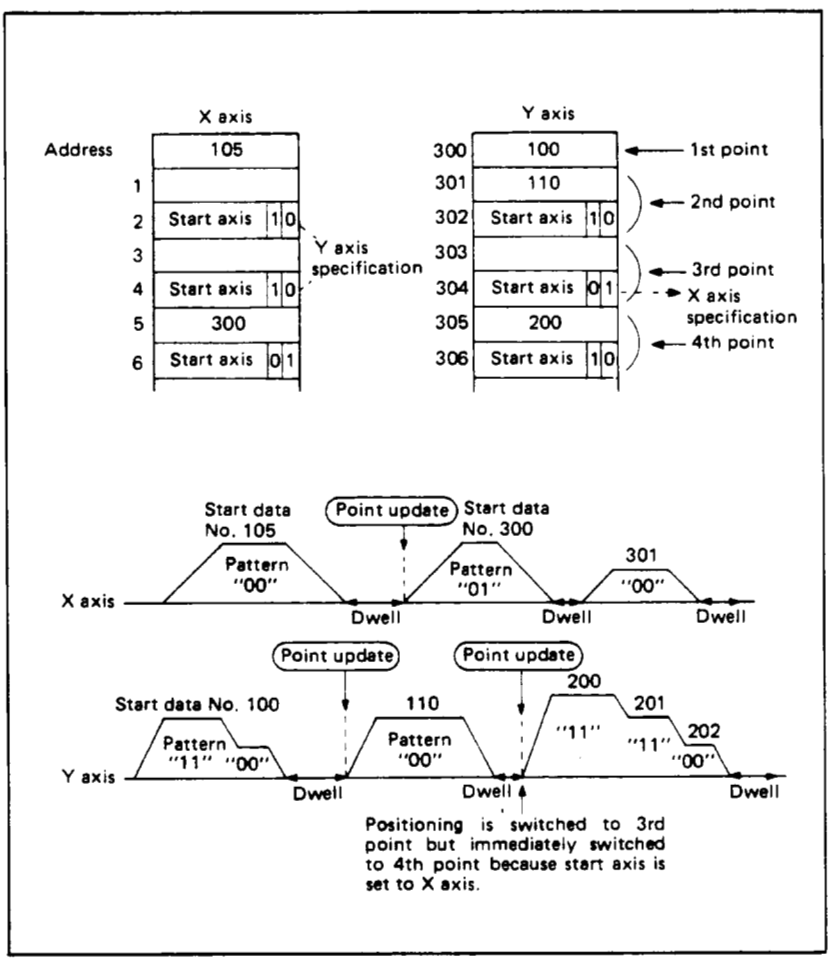


Fig. 3.32 Start Data Example 2

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3) In a situation where single axis operation is changed to two axes operation, the new axis begins operation from the data number corresponding to the pointer value for the original axis. This is illustrated in Fig. 3.33. Axis Y is working independently until point 3 when interpolation starts. Axis X then starts operation from point 3.

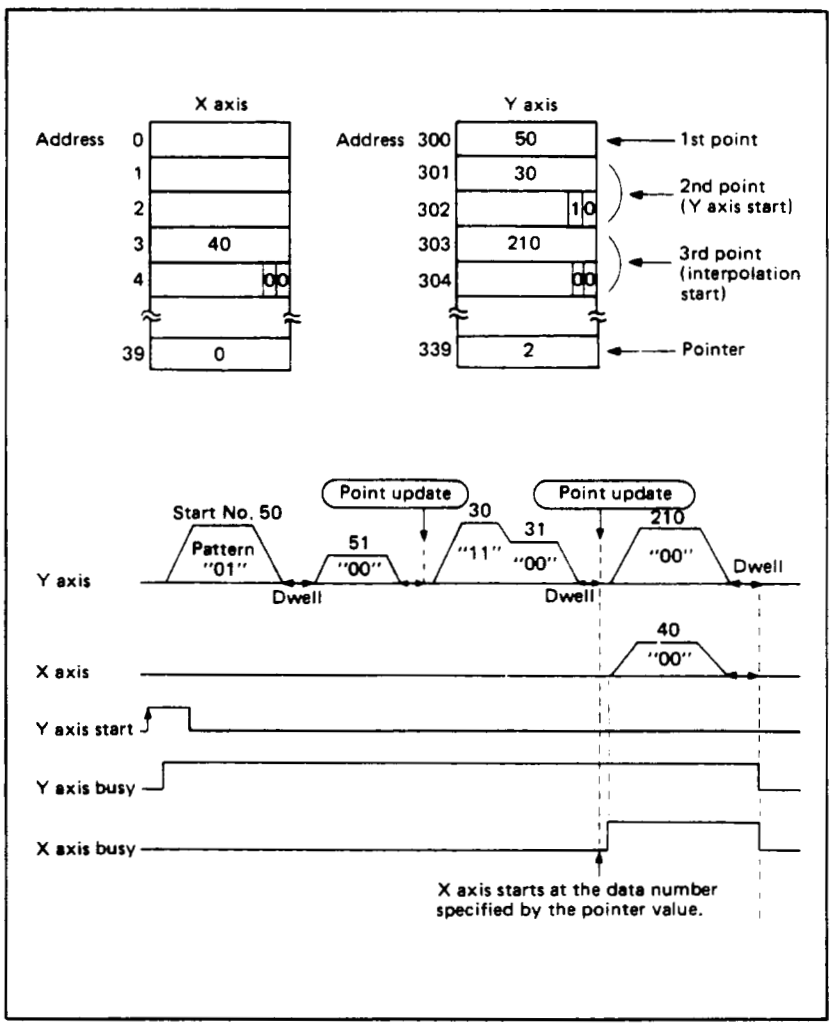


Fig. 3.33 Start Data Example 3

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4) Processing will stop if interpolation (00) or independent (11) operations have been called and the other axis is under different control (e.g. zeroing jog operation or inching).

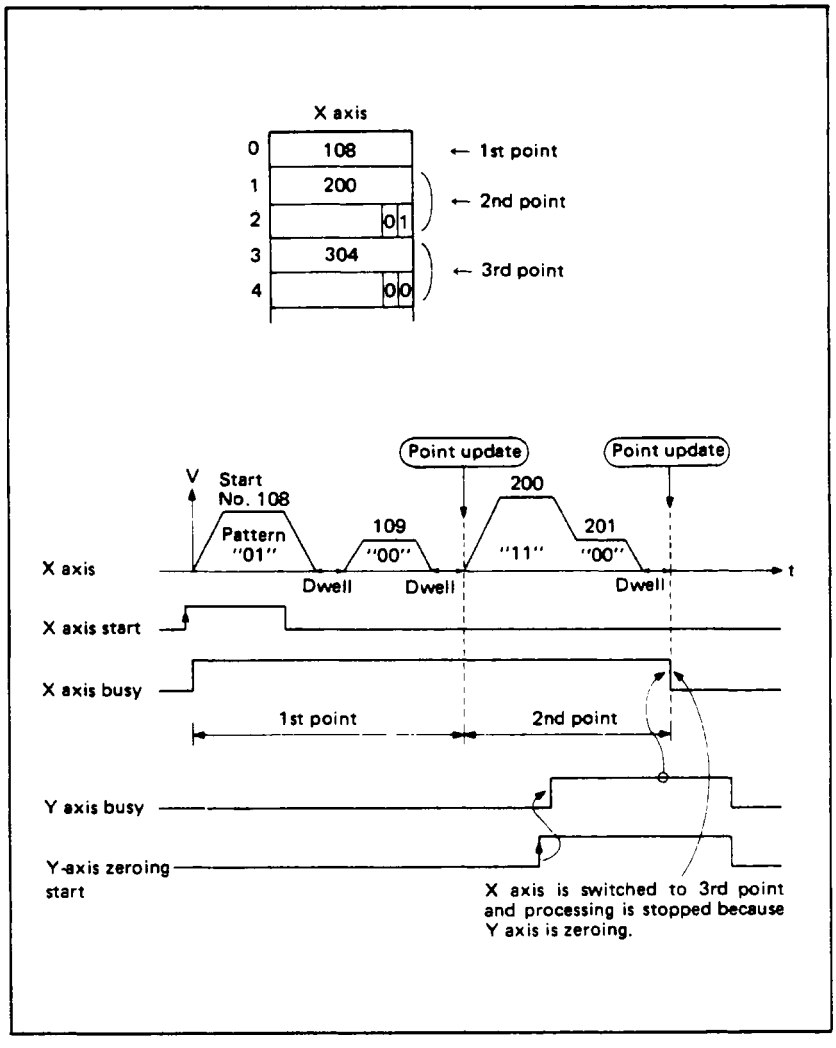
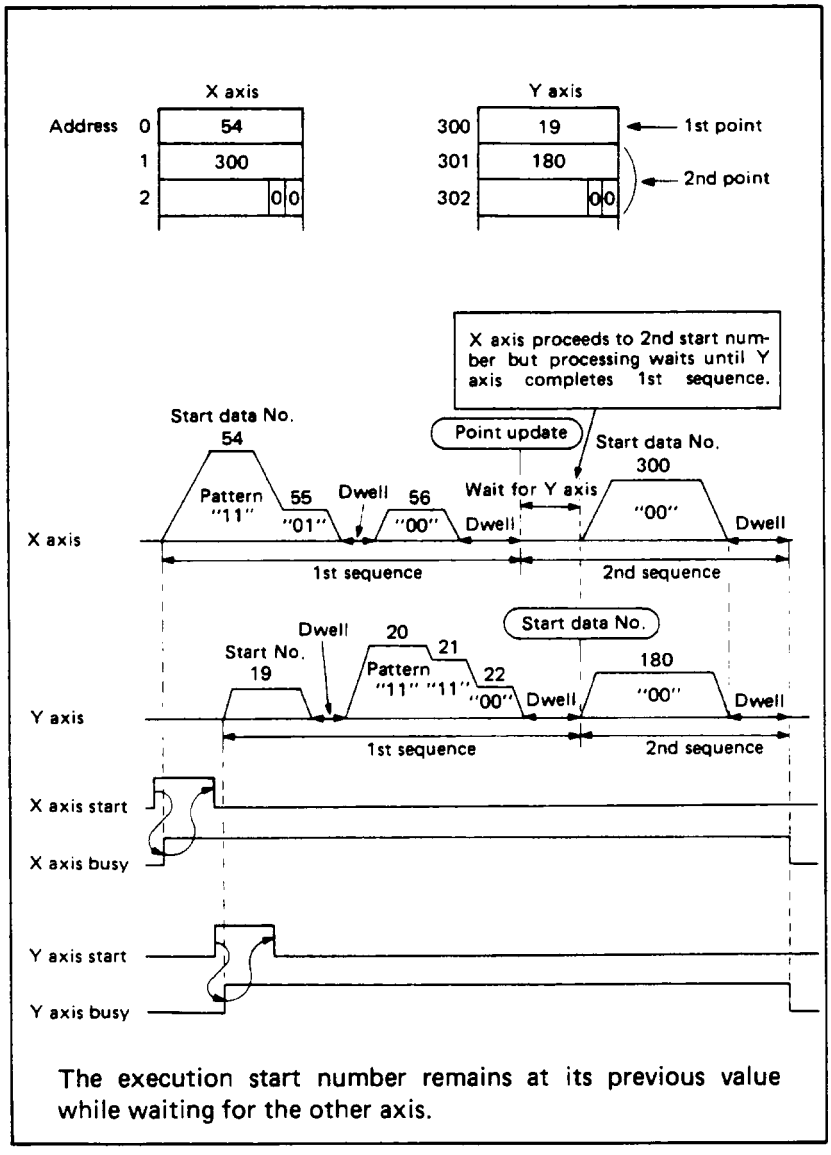


Fig. 3.34 Start Data Example 4

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5) In a situation where interpolation (00) or independent (11) start has been defined at one axis and the other axis is still positioning, processing will vary as described below.

- An axis will wait for the other to finish its current process or for its busy signal to turn off. This is illustrated in Fig. 3.35 below.

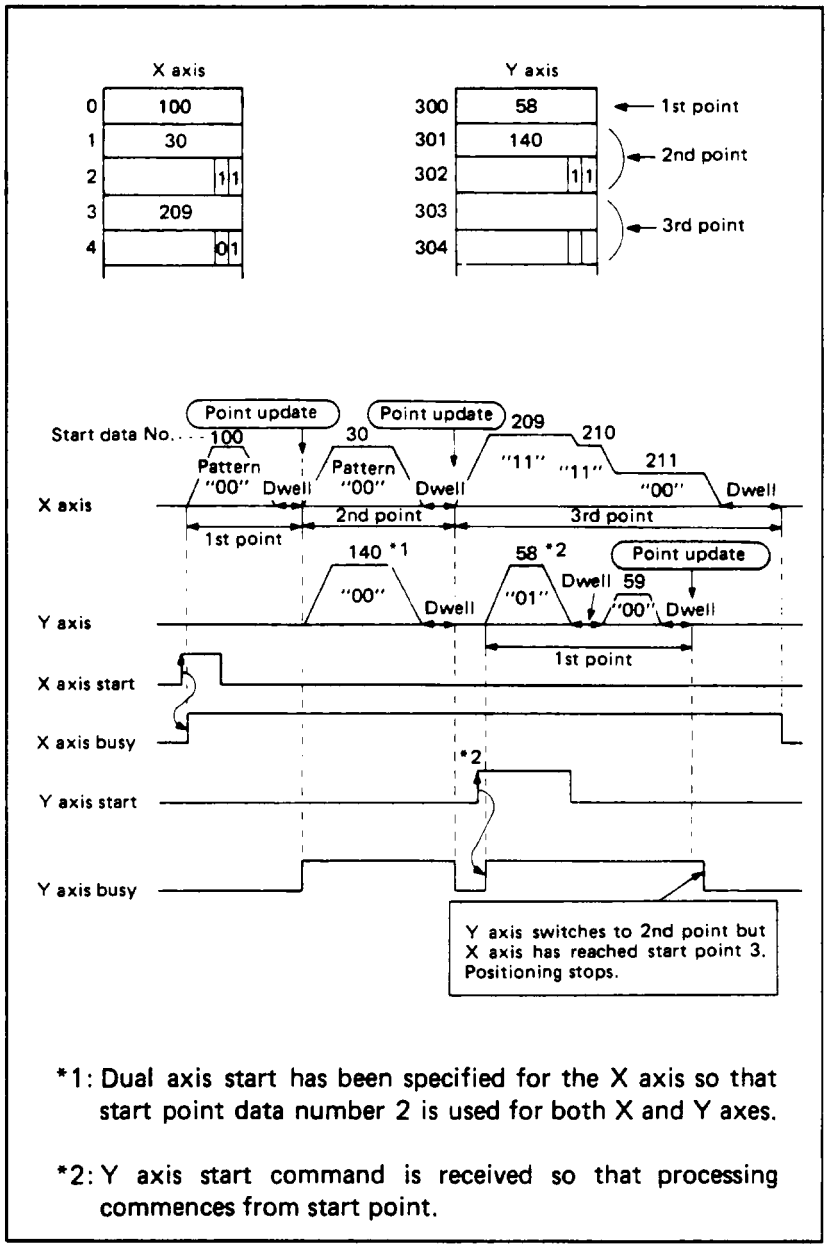


The execution start number remains at its previous value while waiting for the other axis.

Fig. 3.35 Start Data Example 5

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- Processing will stop if one axis proceeds ahead of the other and dual axis processing is called. See Fig. 3.36.



*1: Dual axis start has been specified for the X axis so that start point data number 2 is used for both X and Y axes.

*2: Y axis start command is received so that processing commences from start point.

Fig. 3.36 Start Data Example 6

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3.5.2 Error reset (Address 201)

The error codes for both axes can be reset by writing a 1 to the least significant bit of this address. This also resets the error detection signal XB.
The OS then acknowledges that error signals have been reset by writing a 0 to this bit.

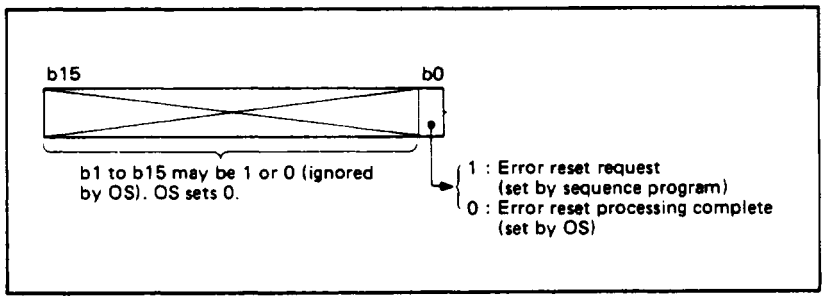


Fig. 3.37 Error Reset Area Details

3.5.3 OS data (Address 512 to 767)

Addresses 512 to 767 are used by the OS.
The data stored in this area is indicated below. It can only be read.

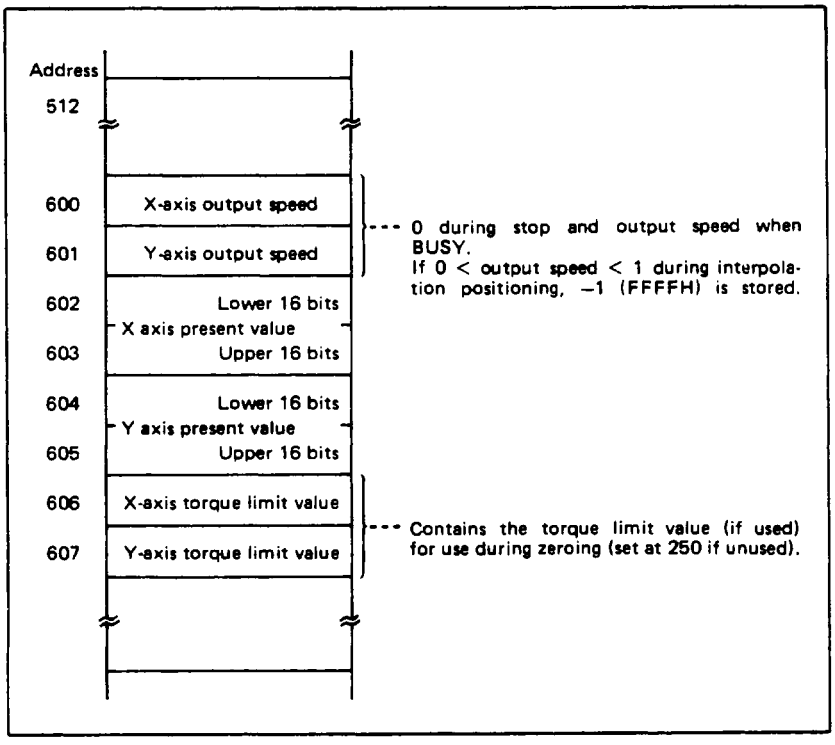


Fig. 3.38 OS Data Area

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3.5.4 Positioning data area (X axis: address 3872 to 5871, Y axis: address 5872 to 7871)

This area stores the positioning data explained in Section 3.4.3. The positioning data consists of positioning information, positioning speed, dwell time, and positioning address as shown in Fig. 3.39. For the conversion of expressions from a data number to a buffer memory address, refer to the next page.
As an example, for X axis data number = 2, data is stored in the following areas:

Positioning information : Address = 3873
Positioning speed : Address = 4273
Dwell time : Address = 4673
Positioning address : Address = 5074 (lower 16 bits),
5075 (upper 16 bits)

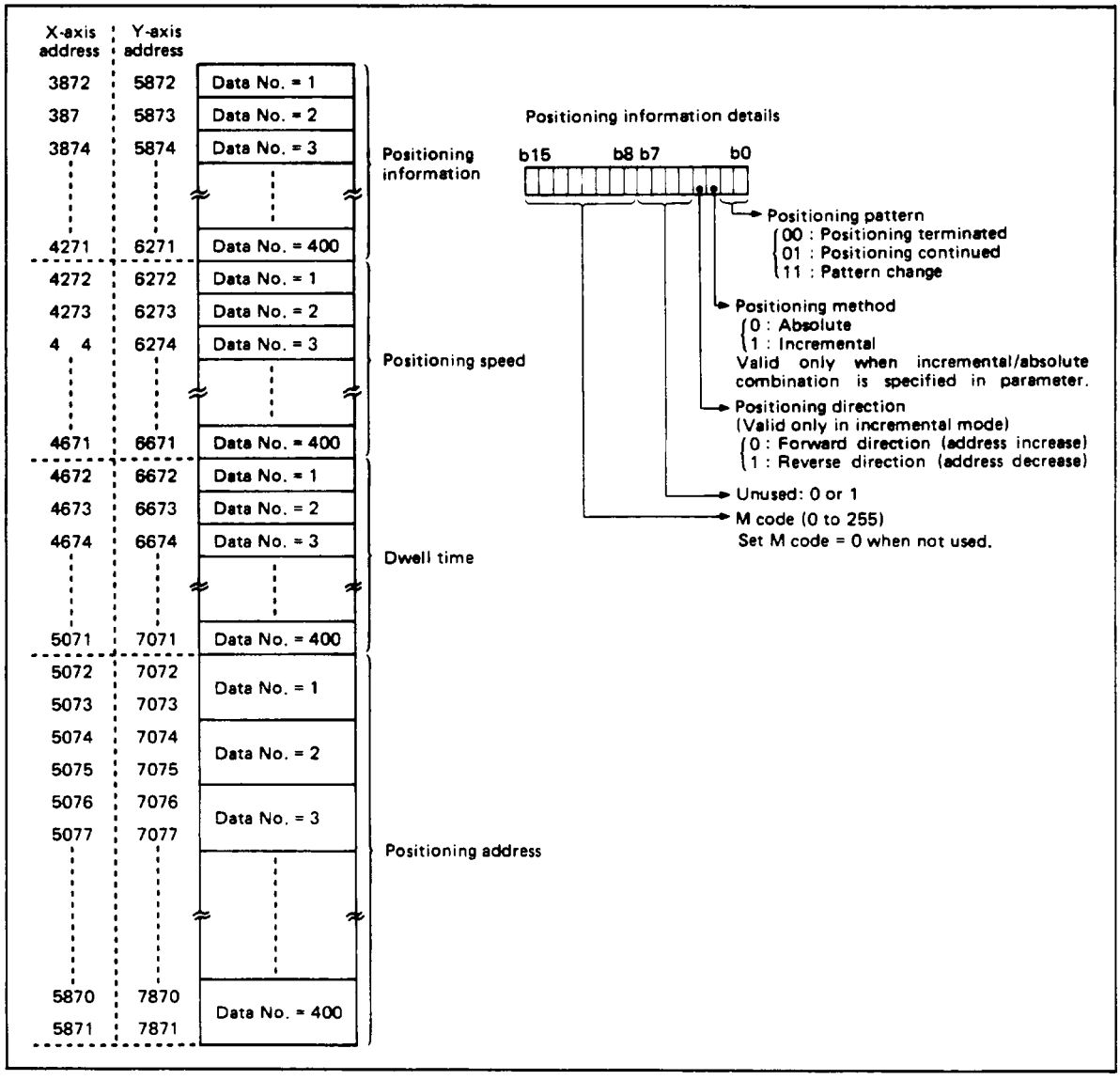


Fig. 3.39 Positioning Data Area

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Conversion from data number to buffer memory address

	X Axis	Y Axis
Positioning information	A=3872+(data No.−1) or A=3871+(data No.	A= 872+(data No.−1) or A=5871+(data No.)
Positioning speed	A=4272+(data No.−1) or A=4271+(data No.	A=6272+(data No.−1) or A=6271+(data No.)
Dwell time	A=4672+(data No.−1) or A=4671+(data No.	A=6672+(data No.−1) or A=6671+(data No.)
Positioning address	Lower 16 bits A_2=5072+(data No.−1)x2 or A_2=5070+(data No.)x2	Lower 16 bits A_2=7072+(data No.−1)x2 or A_2=7070+(data No.)x2
	Upper 16 bits $A_1=A_2+1$	Upper 16 bits $A_1=A_2+1$

REMARKS

A conversion table is given in Appendix 5.

3.5.5 Parameter area (X axis: address 7872 to 7887, Y axis: address 7892 to 7907)

Stores the parameters described in Section 3.4.1.

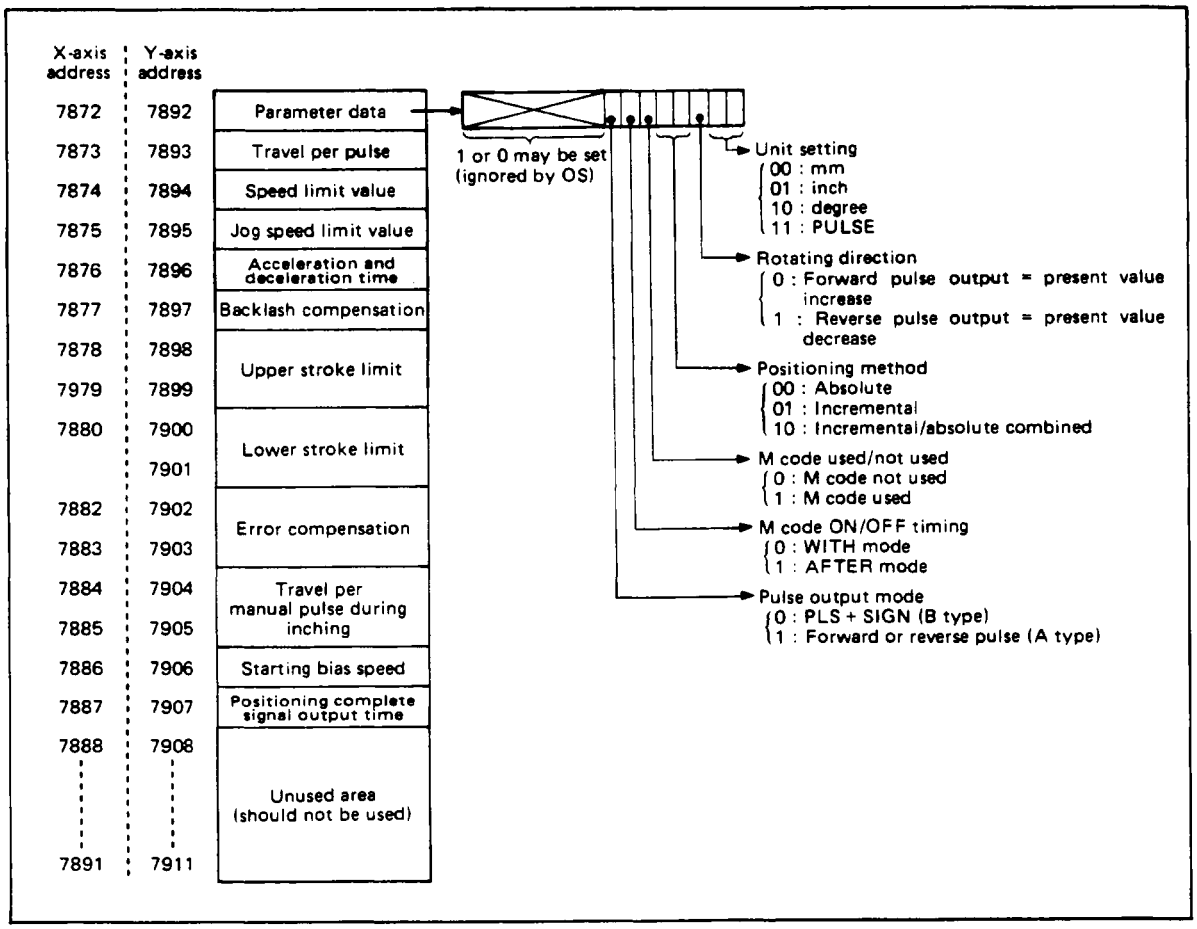


Fig. 3.40 Parameter Area

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3.5.6 Zeroing data area (X axis: address 7912 to 7918, Y axis: address 7922 to 7928)

Stores zeroing data described in Section 3.4.2.

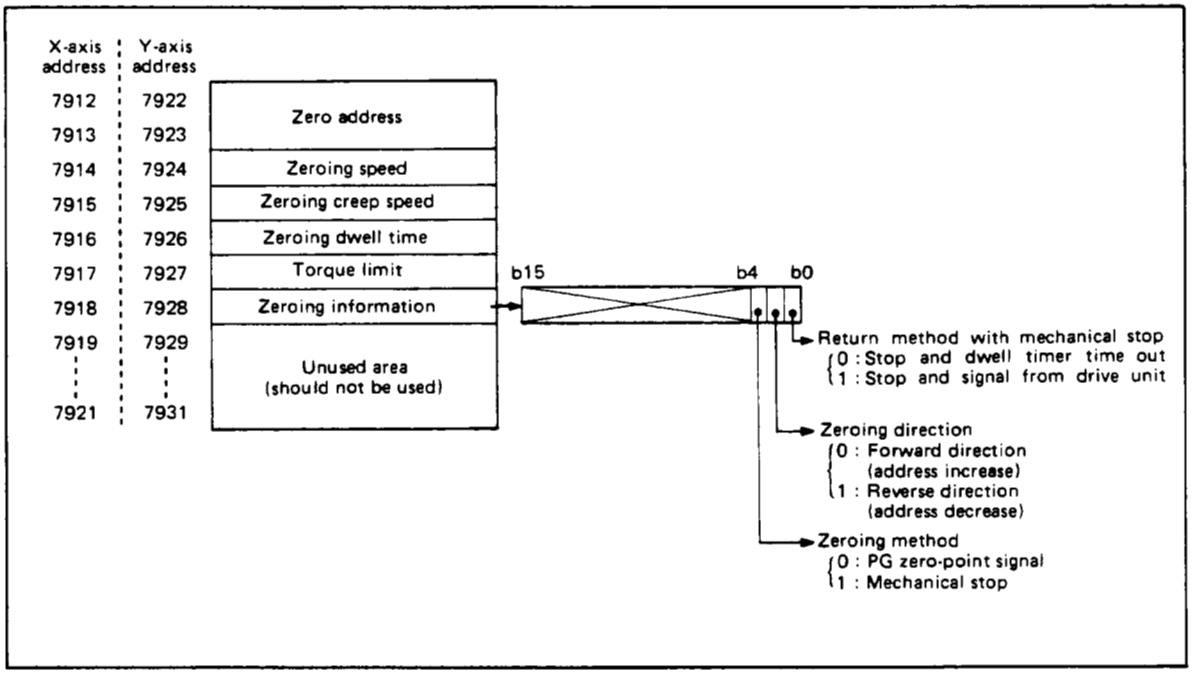


Fig. 3.41 Zeroing Data Area

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3.6 I/O Signals To and From PC CPU

The AD71 uses 16 inputs and 16 outputs for non-numerical communications with the PC CPU. I/O signal assignment and functions are given below.
Table 3.9 shows I/O signals with the AD71 in slot No. 0 of the main base unit.
Device X indicates an input signal from the AD71 to the PC CPU.
Device Y indicates an output signal from the PC CPU to the AD71.

Signal Direction: AD71 to PC CPU			Signal Direction: PC CPU to AD71		
Device No.	Signal		Device No.	Signal	
X0	Watch dog timer error (detected by AD71)		Y10	X axis	Positioning start
X1	AD71 ready		Y11	Y axis	
X2	X axis	Positioning complete	Y12	Inter-polation	
X3	Y axis		Y13	X axis	Zeroing start
X4	X axis	BUSY	Y14	Y axis	
X5	Y axis		Y15	X axis	Stop
X6	X axis	Zeroing request	Y16	Y axis	
X7	Y axis		Y17	X axis	Forward jog start
X8	X axis	Positioning commenced	Y18	X axis	Reverse jog start
X9	Y axis		Y19	Y axis	Forward jog start
XA	Battery error		Y1A	Y axis	Reverse jog start
XB	Error detection		Y1B	X axis	M code OFF
XC	X axis	Zeroing return complete	Y1C	Y axis	
XD	Y axis		Y1D	PC ready	
XE	X axis	M code ON	Y1E	} Reserved.	
XF	Y axis		Y1F		

Table 3.9 I/O Signal List

IMPORTANT

Y1E, Y1F, and Y0 to YF are reserved for use by the OS or for special applications which are detailed later.

I/O signal details (See Fig. 3.42.)

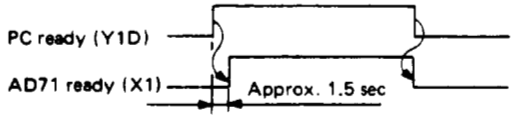
(1) Watch dog timer error (X0)

Switches on when the AD71 self-diagnostics detect a watch dog timer error.

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(2) AD71 ready (X1)

Changes state according to the PC ready signal (Y1D). Used for interlocking, etc. in the sequence program.



(3) Positioning complete (X2, X3)

Switches on for a period set in the parameters (Table 3.5, page 3-9, item 12) after each position is reached. (Ignored if the positioning complete signal output time = 0.)
Switched off at positioning start, zeroing start, inching start, jog start, and power on.
If positioning is stopped midway, the positioning complete signal does not switch on.

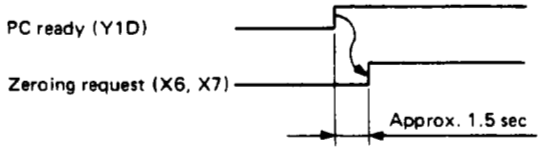
(4) BUSY (X4, X5)

Switches on at positioning start, zeroing start, inching start, and jog start. Switches off after pulse output and dwell time have elapsed. (Refer to Fig. 3.42.) (Remains on during positioning.)
Switches on while the test function is being used on the A6GPP.

(5) Zeroing request (X6, X7)

Switches on under the following conditions. Switches off upon completion of zeroing.

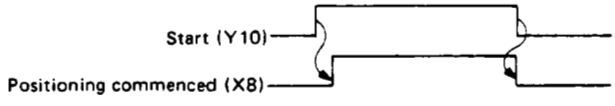
AD71 power is switched on;
Drive unit ready signal (READY) has turned off in BUSY state;
PC ready signal (Y1D) has turned on;



Parameters and/or zeroing data has been written from the A6GPP;
Zeroing is started; or
1) zeroing, 2) positioning, 3) jog operation, or 4) inching has been selected in A6GPP test mode.

(6) Positioning commenced (X8, X9)

Switches on to confirm that the AD71 has started the specified operation. Switches off when the start signal turns off.



Does not switch on in A6GPP test mode.

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(7) Battery error (XA)

Switches on when battery voltage drops.

(8) Error detection (XB)

Switched on by any of the errors in Chapter 8. Switched off when the error is reset. For resetting, refer to Section 3.5.2 (page 3-44).

(9) Zeroing complete (XC, XD)

Switches on to indicate the completion of zeroing. Switched off at the start of the next process.

(10) M code ON (XE, XF)

The ON timing for this signal depends on the parameter setting (see Table 3.5, page 3-9, item 16). If set in WITH mode, the "M code ON" signal is given at the start of positioning, if set in AFTER mode it is given after positioning is complete. Switched off by the "M code OFF" signal. Remains off when the M code is not used (M code = 0) or in test mode using the A6GPP.

(11) Positioning start (Y10, Y11, Y12)

The leading edges of the pulses cause the operations to start as shown in Table 3.9.

(12) Zeroing start (Y13, Y14)

The leading edges of the pulses cause the operations to start as shown in Table 3.9.

(13) Stop (Y15, Y16)

Terminates the current operation. (If the BUSY signal is on, the "M code ON" signal turns off.)
For restarting the operation see Section 6.3.9.

(14) Jog start (Y17 to Y1A)

The motor is driven for as long as the jog start signal is on. When it is switched off the motor is ramped down to a halt.

(15) M code OFF (Y1B, Y1C)

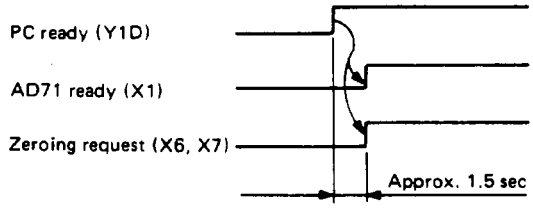
The leading edge of this signal switches the "M code ON" signal off.

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(16) PC ready (Y1D)

Indicates correct PC CPU operation. At the start of all operations (other than those carried out in A6GPP test mode) this signal must be on.
The following control actions occur when the PC ready signal switches from off to on. (Also applies for A6GPP test mode when neither axis is BUSY.)

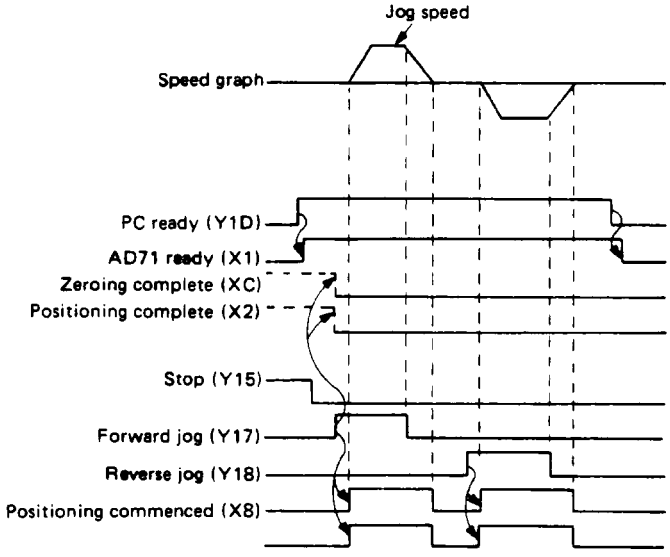
1) Parameter check and initialization;
2) Zeroing data check; and
3) Zeroing request ON, AD71 ready signal ON



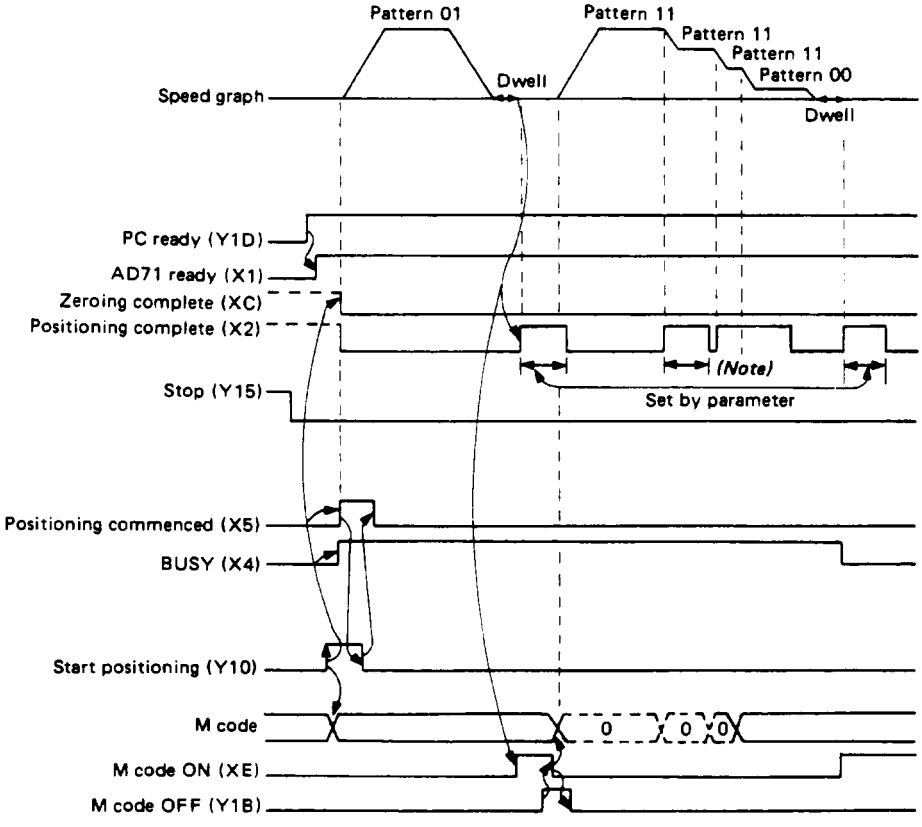
Switching the PC ready signal off while the AD71 is BUSY causes positioning to stop, and the "M code ON" signal to be disabled as well as the M code to be cleared. (Not for A6GPP test mode)

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Jog operation



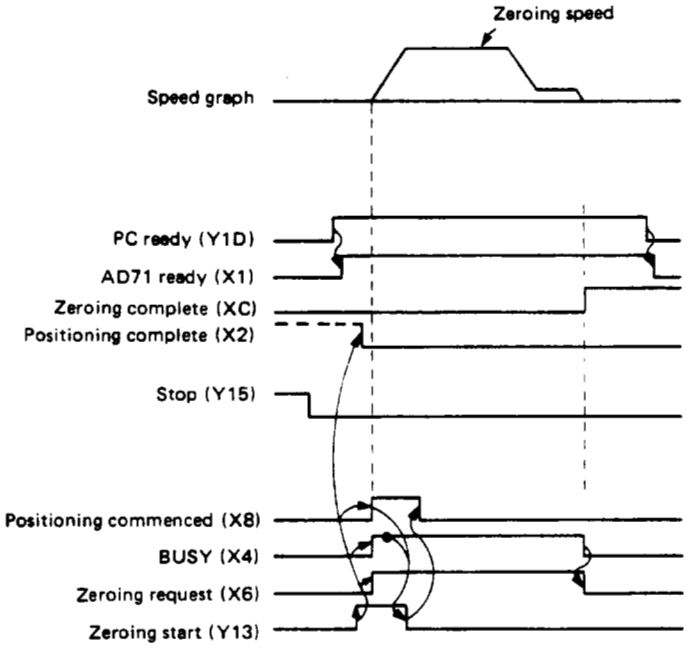
Positioning operation



Note: If positioning operation is shorter than the positioning complete signal output time in the parameter, the positioning complete signal may be output continuously.

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Zeroing



Inching

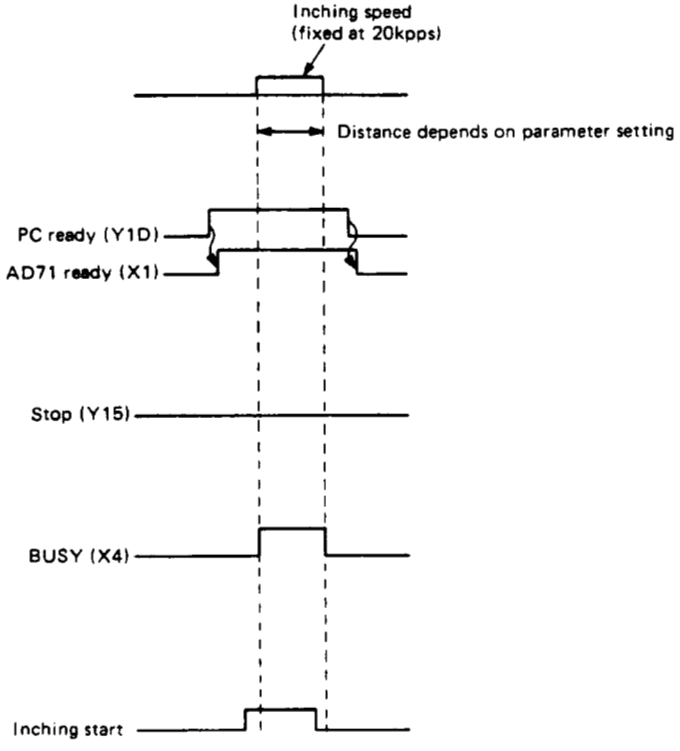


Fig. 3.42 I/O Signal ON/OFF Timing

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3.7 I/O Interface with External Equipment

3.7.1 AD71 electrical specifications

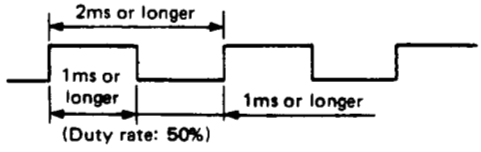
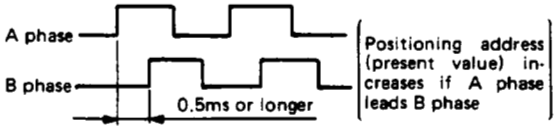
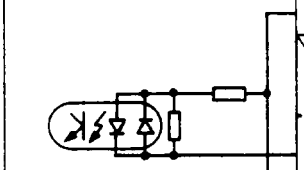
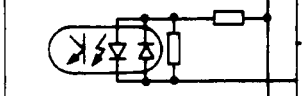
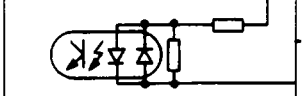
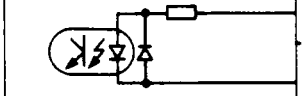
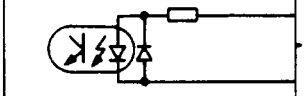
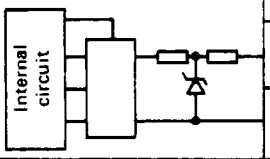
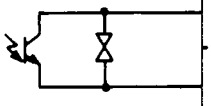
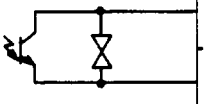
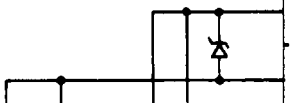
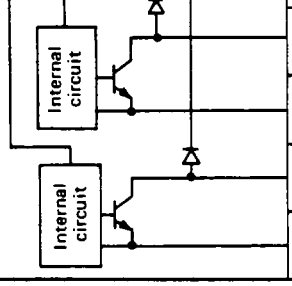
I/O	Signal	Description
Input	Supply power	5 to 24V DC (Prepare a 4.75 to 26.4V stabilized power supply.) 150mA (maximum)
	Drive unit ready (READY) Stop signal (STOP) Zeroing dog (DOG)	Input voltage : 4.75 to 26.4V DC High : (Supply power voltage – 1V) or more (Input current: 0.3mA or less) Low : (Supply power voltage – 3V) or less (Input current: 2.5mA or more)
	Inching A phase (PULSER A) Inching B phase (PULSER B)	Input voltage : 5V DC $^{+20\%}_{-10\%}$ High : 4.5V or more, 3mA or more Low : 1.0V or less, 0mA Pulse width :  Phase difference:  Inuput pulse rise, fall time : 500μs max.
	Zero phase signal (PGO)	Input voltage : 4.75 to 26.4V DC High : (Supply power voltage – 1V) or more (Input current: 0.3mA or less) Low : (Supply power voltage – 3V) or less (Input current: 2.5mA or more) Pulse width : 50μs or more Pulse rise time : 3μs or less Pulse fall time : 3μs or less
Output	Start signal (START) Error detector clear (CLEAR)	Output form : Open collector Load voltage : 4.75 to 26.4V DC Load current : 10mA (maximum) Output voltage when ON : 0.6V or less Lead current when OFF : 0.1mA or less
	Forward feed pulse (PULSE F) Reverse feed pulse (PULSE R)	Output form : Open collector, output duty ratio 50% ± 10% Load voltage : 4.75 to 26.4V DC Load current : 20mA (maximum) Use within the range 2 to 15mA. If load current is less than 2mA, add a load resistor.

Table 3.10 AD71 Electrical Specifications

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3.7.2 I/O interface electrical details

I/O	Circuit	Pin Number X axis	Pin Number Y axis	Signal	Description
Input		5A	7A	Power supply (+)	5 to 24V DC (external supply)
		5B	7B	Drive unit ready $\overline{\text{READY}}$	(1) Low indicates servo drive unit is serviceable. (2) AD71 checks the drive unit ready signal prior to start. If not ready, the AD71 outputs a zeroing request. (3) Arrange for drive unit errors, e.g. control power error to set this signal high. (4) Switching this signal to high during positioning stops the operation. Resetting the signal will not restart operation.
		6A	8A	Stop signal $\overline{\text{STOP}}$	(1) Low to stop positioning. Signal duration 20ms or more. (2) Input switches start signal ($\overline{\text{START}}$) off (high). Start signal will not then restart.
		6B	8B	Zero-point signal $\overline{\text{DOG}}$	(1) Switched to low by zero point actuator. (2) For zeroing information, see Section 3.4.2, page 3-18.
		1A	3A	Inching A phase $\overline{\text{PULSER A}}$	Refer to Table 3.10.
		1B	3B		
		2A	4A	Inching B phase $\overline{\text{PULSER B}}$	Refer to Table 3.10.
		2B	4B		
		9A	10A	Zero-phase signal $\overline{\text{PGO}}$	(1) Switched to low by encoders with zero-phase channel. (2) For zeroing information, see Section 3.4.2, page 3-18.
		9B	10B		
Output		11A	13A	Start $\overline{\text{START}}$	(1) Low while positioning. (2) On (low) during feed pulse output and dwell. Used as a brake release signal for servos with mechanical brakes. Feed pulse output after this signal turns on.
		11B	13B		
		12A	14A	Error detector clear $\overline{\text{CLEAR}}$	Given before and after zeroing. Resets the deviation in the servo unit error detector. 20ms (1st time) 20ms (2nd time) Before feed pulse output After feed pulse output
		12B	14B		
		17A	20A	(+) 24V power (+) 5 to 12V power	5 to 24V DC (external supply) 17B and 20B for 5 to 12V DC. 17A and 20A for 24V DC.
		17B	20B		
		15A	18A	A type: Forward feed pulse $\overline{\text{PULSE F}}$ / B type: Feed pulse $\overline{\text{PULSE}}$	B type: Forward and reverse feed pulses $\overline{\text{PULSE}}$ $\overline{\text{SIGN}}$ 25ms + direction travel − direction travel
		15B	18B		
		16A	19A	Reverse feed pulse $\overline{\text{PULSE R}}$ / Direction sign $\overline{\text{SIGN}}$	A type: $\overline{\text{PULSE F}}$ $\overline{\text{PULSE R}}$
		16B	19B		

Select A or B type by parameter setting. (For details, refer to Section 3.4.1.)

Table 3.11 AD71 I/O Interface

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3.8 Battery Specifications

Item \ Type	A6BAT
Nominal voltage	3.6V DC
Guarantee period	5 years
Total power failure time	300 days (7200 hours)
Application	Power failure back-up for buffer memory
Size (mm)	16 diameter x 30 length

Table 3.12 Battery Specifications

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4. HANDLING

4.1 Handling Instructions

(1) Protect the AD71 from mechanical shock and vibration.

(2) Keep conductive debris out of the unit.

(3) Switch off the PC power supply before loading or unloading the unit to or from the base.

(4) Turn off the PC and drive unit powers before connecting or disconnecting the drive unit.

(5) Do not connect the A6GPP or AD71TU when the AD71 is busy.

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4.2 Nomenclature

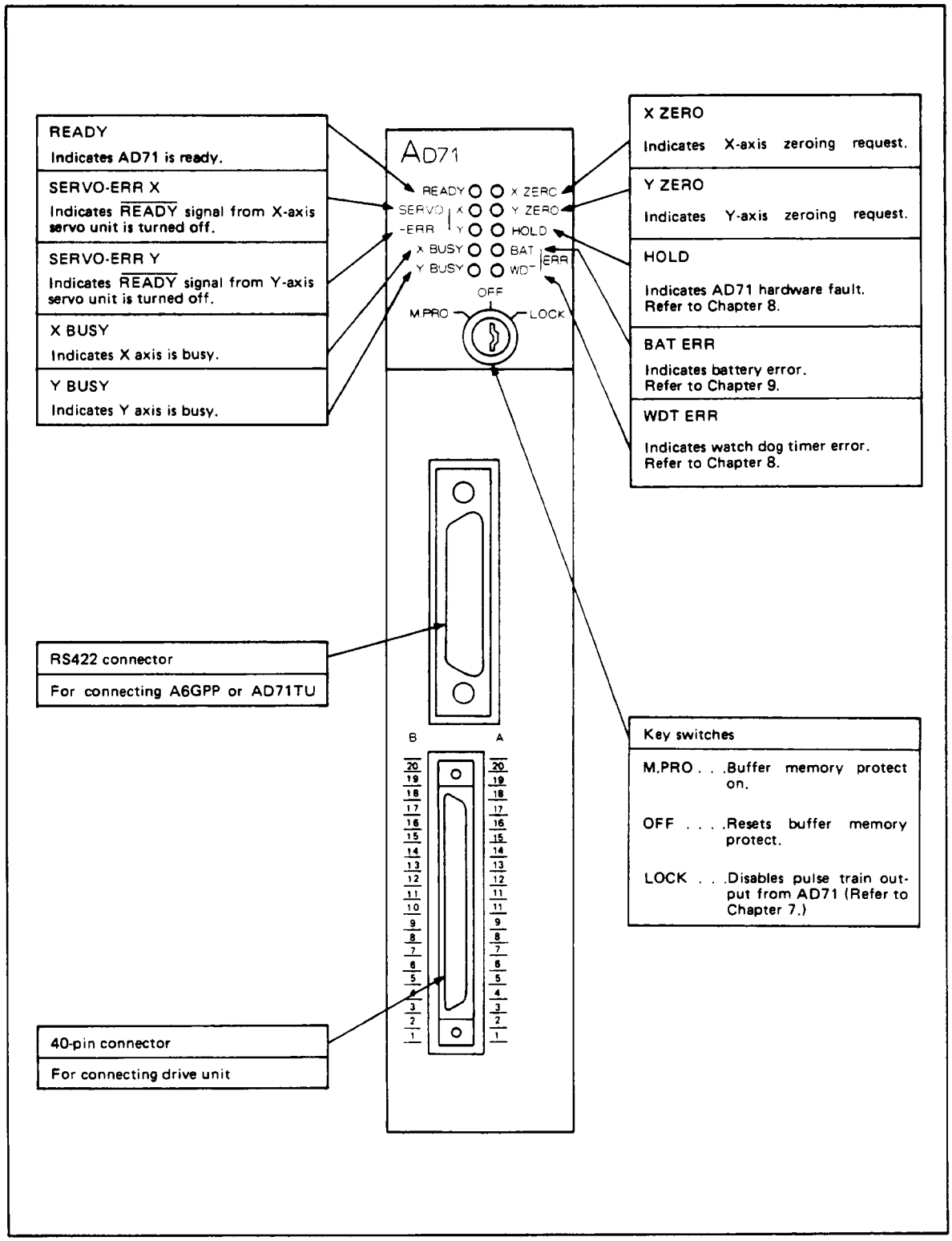


Fig. 4.1 AD71 Nomenclature

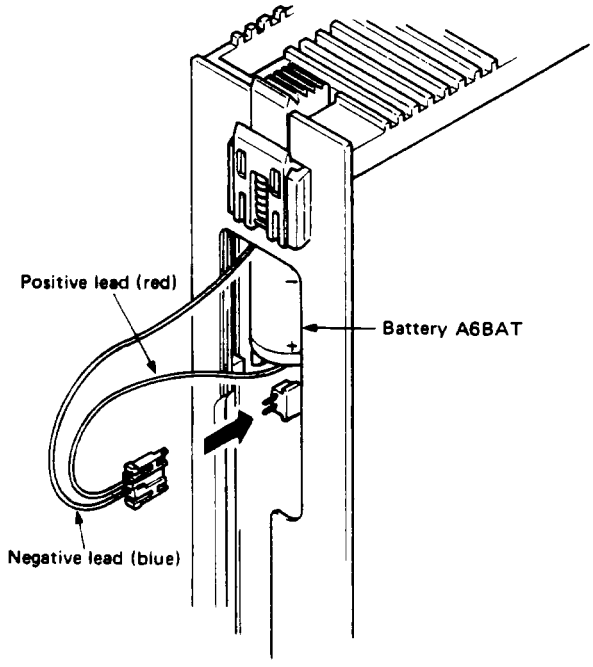
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4.3 Preparation

4.3.1 Battery connection

The battery backs up the IC-RAM during power failure. The leads are disconnected before shipment to prevent battery consumption. Always connect the leads before using the AD71. (For battery life, etc., refer to Chapter 9.)



IMPORTANT

The components on the printed circuit board may be damaged by static electricity. When handling the printed circuit board:

1) ground all tools, work bench, etc.
2) do not touch conductive areas or electrical components.

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5. LOADING AND INSTALLATION

5.1 Installation Environment

The following installation environments are unsuitable for this equipment.

(1) Ambient temperature outside the range 0 to 55°C.

(2) Ambient humidity outside the range 10 to 90%RH.

(3) Excessive condensation (e.g. due to sudden temperature changes)

(4) Corrosive and/or combustible gasses.

(5) Excessive amounts of conductive powder such as dust, iron filings, oil mist, salt, or organic solvent.

(6) Direct exposure to sunlight

(7) In the vicinity of strong power and magnetic fields.

(8) Excessive vibration and shock transmitted directly to the main unit.

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5.2 System Design Precautions

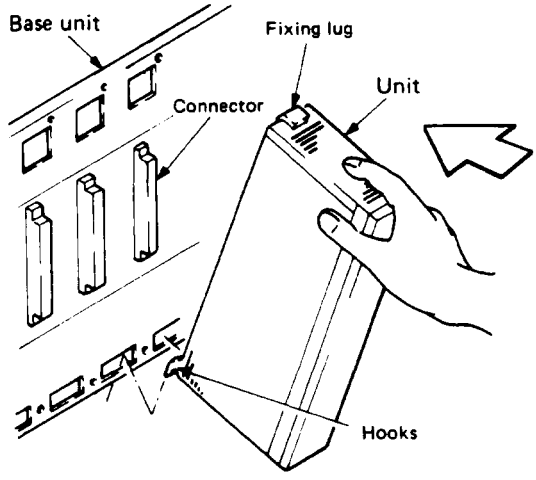
(1) Do not use the AD71 on any extension base which does not include a power supply (i.e. A5□B).

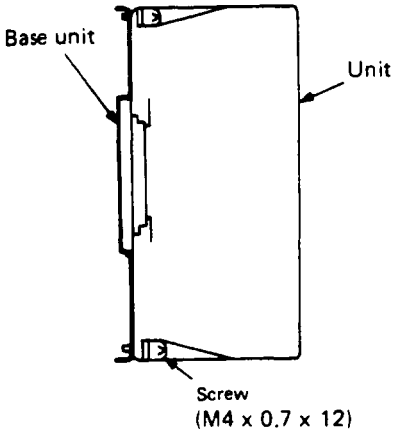
(2) Where the temperature inside a panel is likely to exceed 55°C, forced ventilation or cooling must be provided.

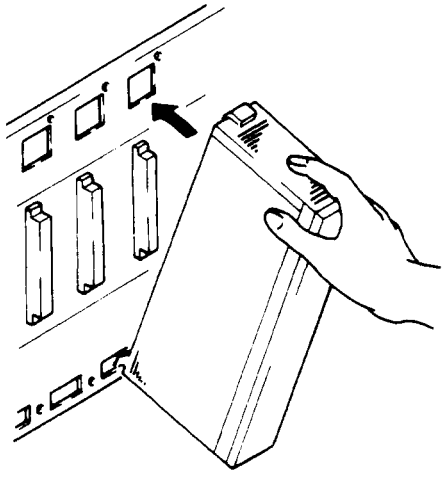
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5.3 Installation and Removal

(1) Installation





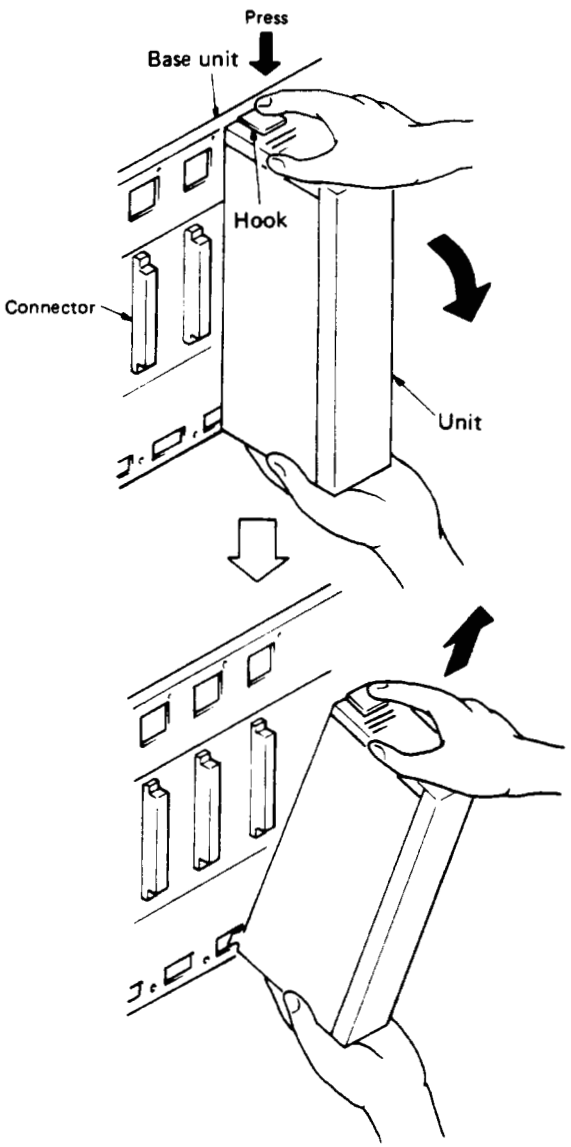


POINT

1. **Take care not to damage the connector pins by forcing the unit wrongly into place.**
2. **M4 x 0.7 x 12 screws may be used to secure the unit against vibration, etc.**

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(2) Removal



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5.4 Wiring

5.4.1 Wiring precautions

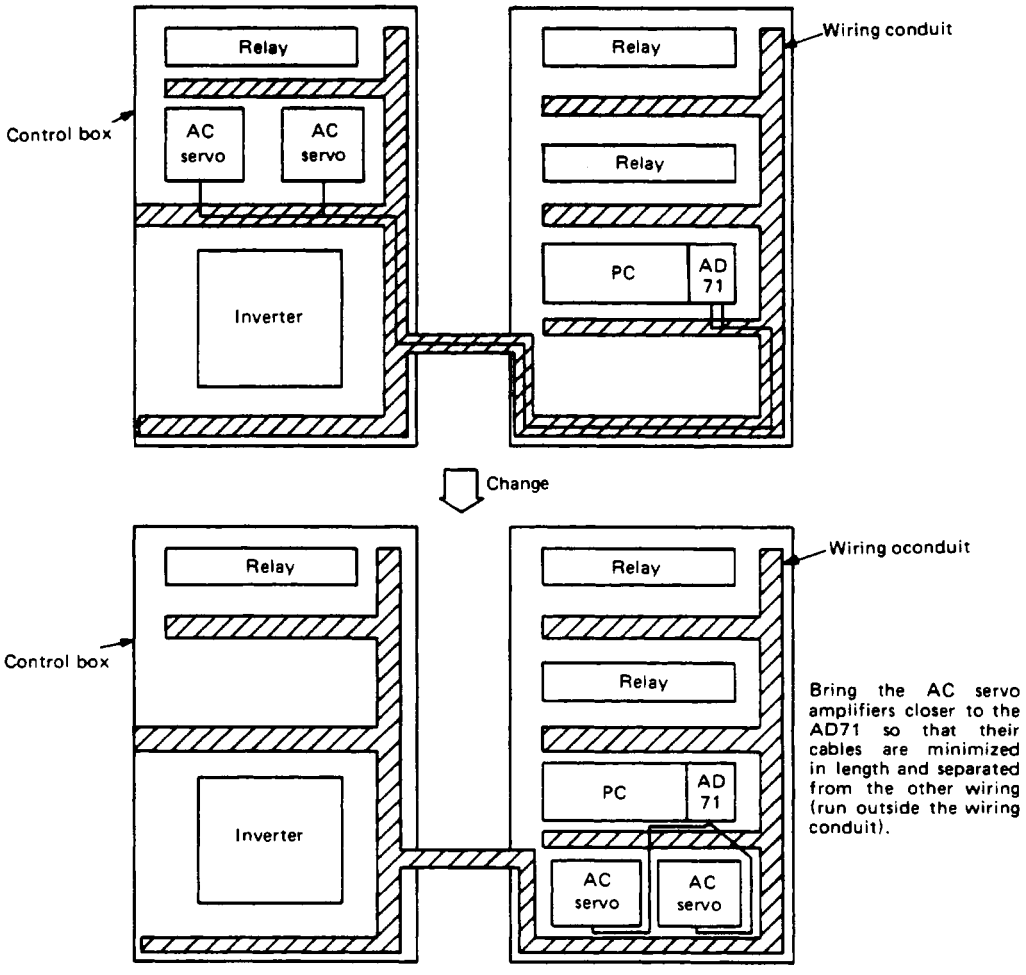
(1) Connection cable length

Generally the cable length should be less than 3m.

(2) I/O signal wiring

- Separate I/O signal wires from other cables and use separate conduit where applicable.
- In excessively noisy environments I/O signal wires should be screened and the PC grounded.
- When running I/O signal wires in metal piping, this should be grounded.

Examples (bad example at top, good example at bottom)



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5.4.2 Drive unit connector

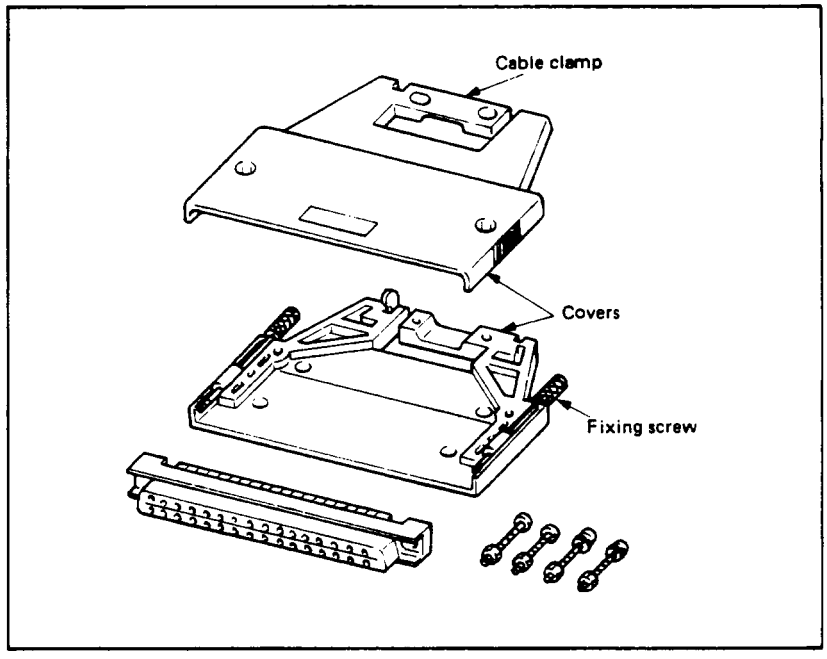


Fig. 5.1 Connector

See Section 3.7, page 3-54 for pin details.

(1) Use 0.3mm^2 wire.

(2) Solder the wires to the pins and finish with insulating tubing.

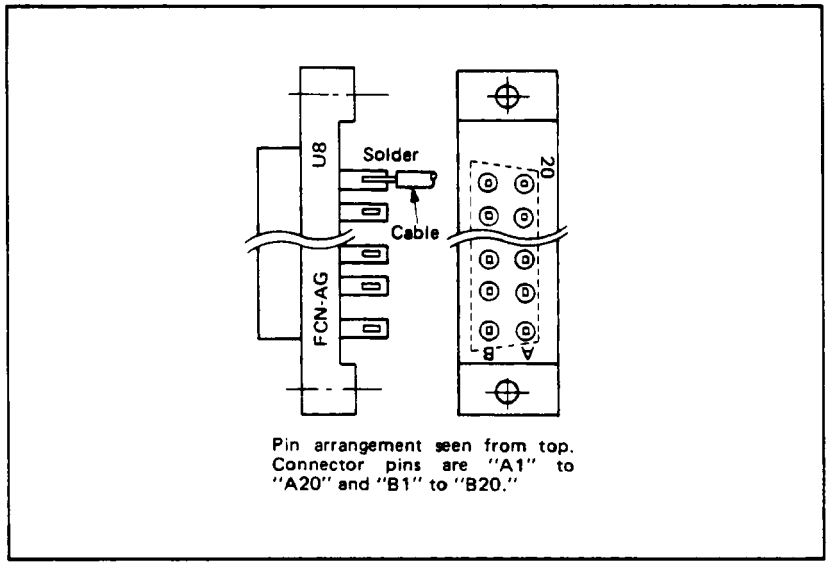


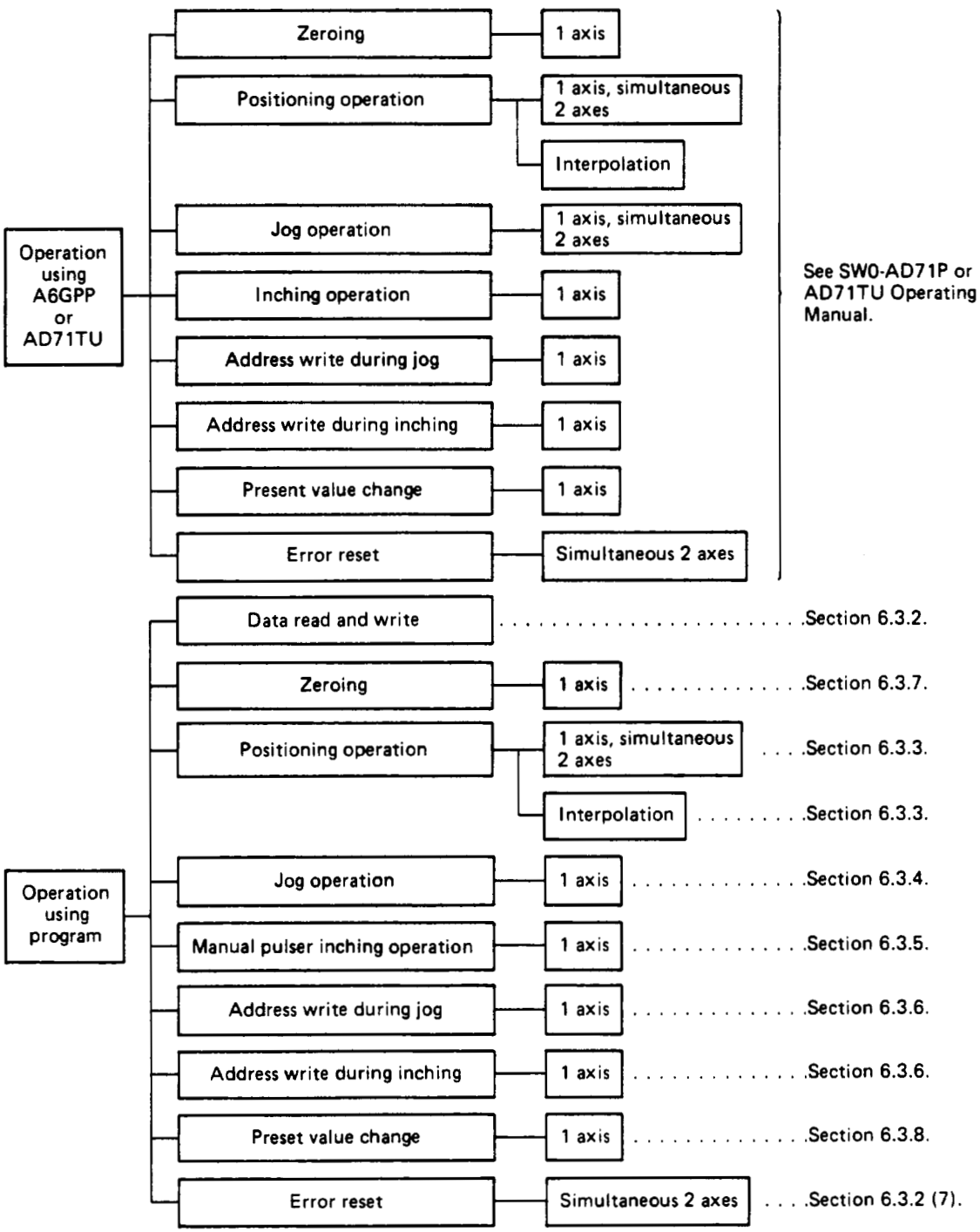
Fig. 5.2 Connector

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6. PROGRAMMING

6.1 Writing Programs

6.1.1 Program structure



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REMARKS

Unless otherwise specified, I/O numbers used in this manual assume that the AD71 is located at slot 0 of the main base.

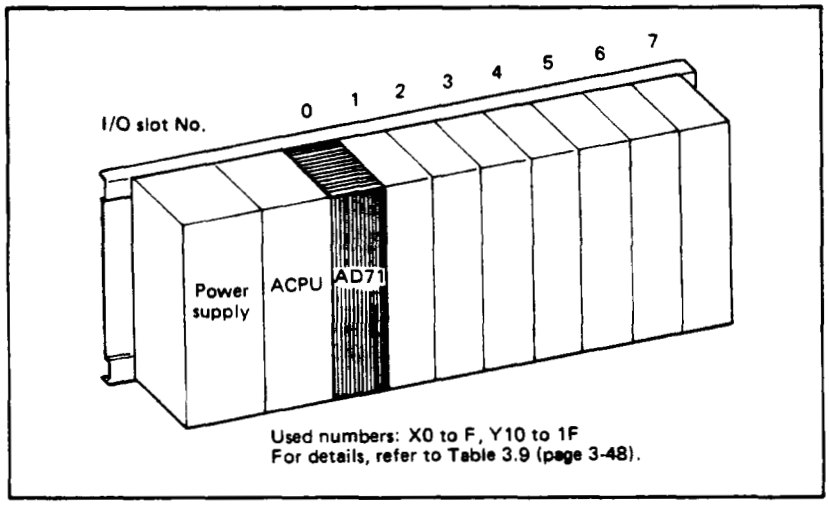


Fig. 6.1 AD71 Location for the Following Examples

The A1, A2, and A3CPUs are referred to as "ACPU."

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6.1.2 Notes on programming

(1) Initial program

The following program steps should be used with the AD71.

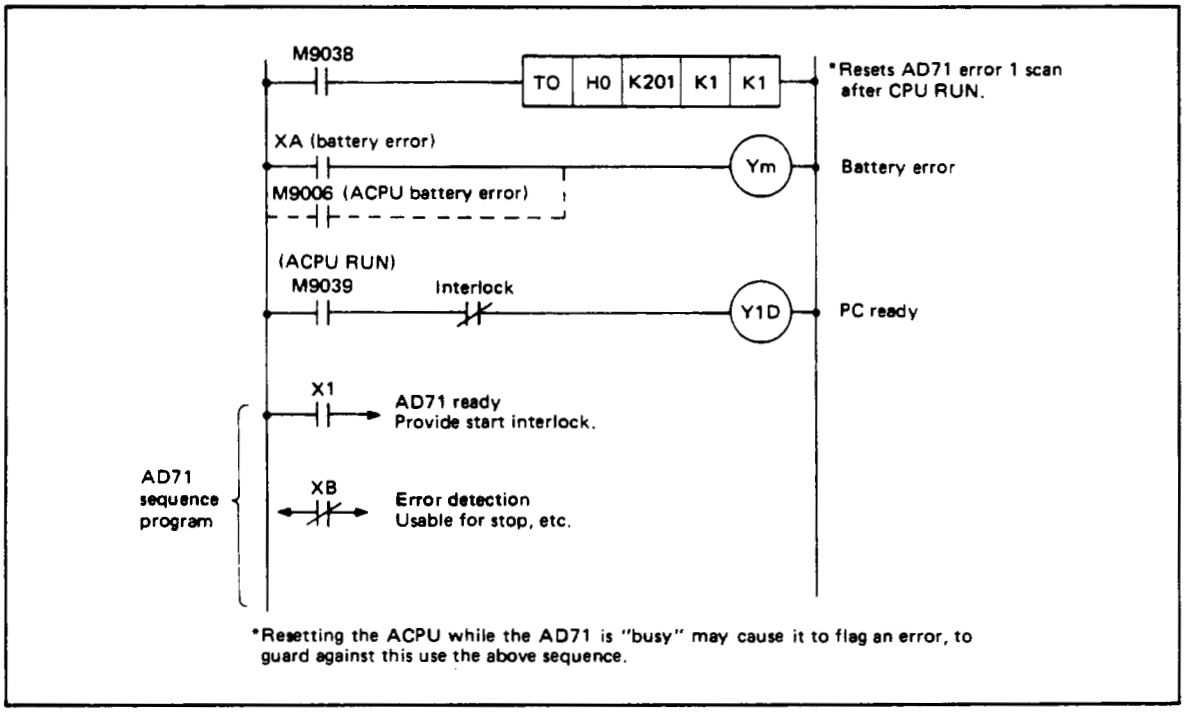


Fig. 6.2 Initial Program

(2) PC ready reset

Where necessary, the PC ready signal should be disabled when an error is detected.

(3) Zeroing

The system should be zeroed before positioning is started and when a zeroing request is received from the AD71.

(4) Zeroing actuator

Ensure that the zeroing actuator is serviceable and reliable. Failure to receive an input from this switch will allow the zeroing routine to maintain the drive signal.

(5) Overrun precautions

The upper and lower stroke limits will only be operable if the AD71 is functioning normally. Upper and lower limit switches should be hard wired into the system.

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(6) Emergency stop signal

Emergency stop signals must be hard wired into the system.

(7) Upper and lower stroke limit values should be checked before operation.

(8) The speed limit parameter should be checked before operation.

(9) Set the jog speed low when initially setting up the system.

(10) For interpolation positioning, set the X and Y axis speeds to the same value. This will represent the maximum speed that either axis can travel at.

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6.2 Notes on Use of the A6GPP and AD71TU

1) Operation can be performed with the PC ready signal (Y1D) or AD71 ready signal (X1) on or off.

2) Data cannot be transferred from or to the GPP when the AD71 is "busy" and the GPP (or AD71TU) is in test mode.

3) The M code is ignored. (Data in the M code area of the buffer memory (X axis: 46, Y axis: 346) is cleared.)

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6.3 ACPU Programming

6.3.1 Data read and write precautions

(1) Data read from and written to the sequence program should be kept to a minimum for optimum program scan time. The majority of the AD71 data must therefore be written to the buffer memory by the GPP.

(2) The parameters and zeroing data is checked at power on and when the PC ready signal (Y1D) changes from OFF to ON.

(3) Positioning data is checked immediately before it is processed. Any error will cause the error signal (XB) to switch on and, in most cases, positioning to stop.

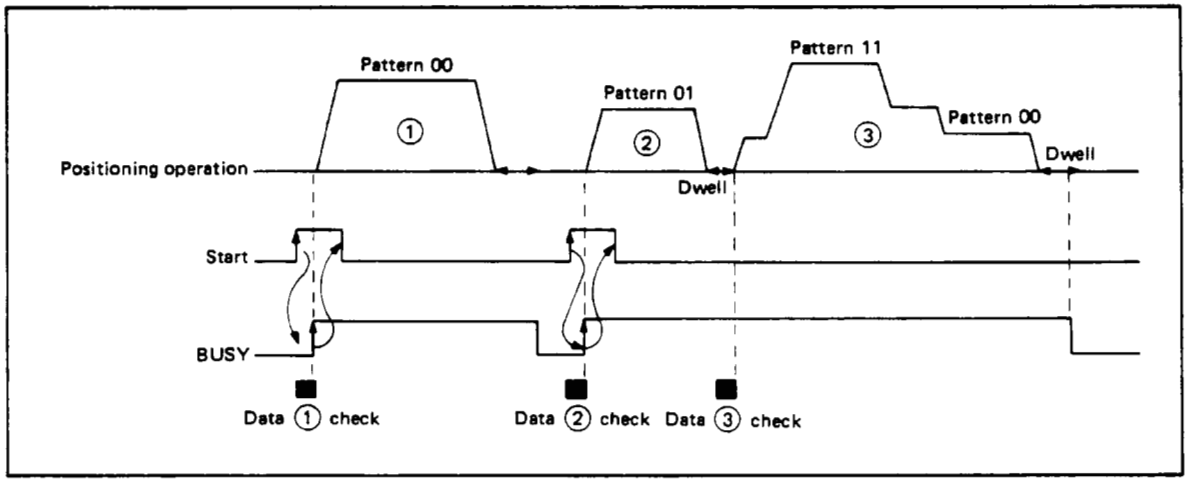


Fig. 6.3 Positioning Data Check

An error is flagged if the total distance requested exceeds the upper (or lower) stroke limit when incremental position addressing is used.

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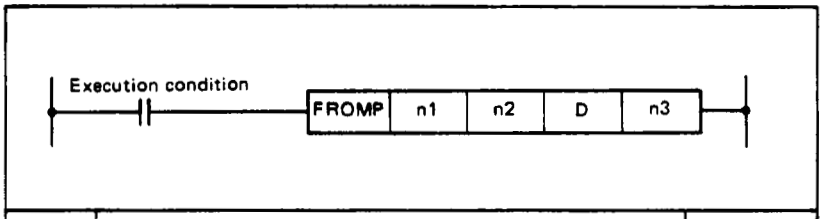
6.3.2 Data communication with PC program

(1) Read and write instructions

(a) Read from AD71

FROM instruction: Also FROMP, DFRO, and DFROP.

[Format]



Symbol	Description	Device
n1	Upper 2 digits of the 3-digit head I/O number to which the AD71 has been assigned (e.g. 4 when the head I/O number is X, Y040)	K, H
n2	Buffer head address of stored data	K, H
D	Head number of devices to which data will be written	T, C, D, W, R
n3	Number of words to be read	K, H

Fig. 6.4 Read Instruction FROM

Example: To read one word from buffer memory address 600 (X axis output speed) to D2 with the AD71 assigned to X130 to X13F and Y140 to Y14F.

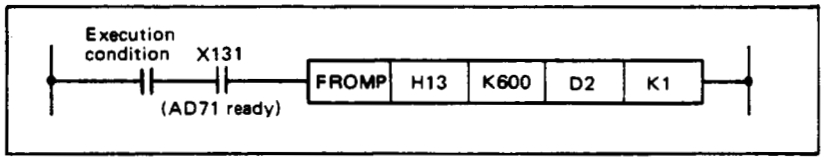


Fig. 6.5 Read Example

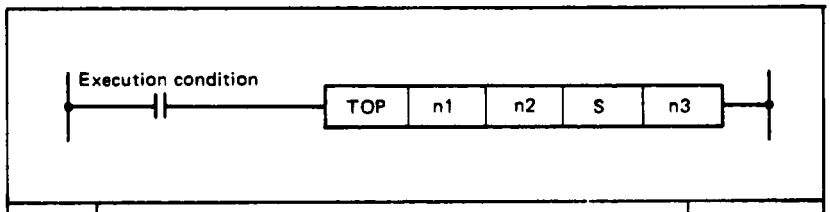
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(b) Write to AD71

TO instruction: Also TOP, DTO, and DTOP.

[Format]



Symbol	Description	Available Device
n1	Upper 2 digits of the 3-digit head I/O number to which the AD71 has been assigned (e.g. 4 when the head I/O number is X, Y040)	K, H
n2	Buffer head address for written data	K, H
S	Head number of devices from which data will be written (may also be a constant)	T, C, D, W, R, K, H
n3	Number of words to be written	K, H

Fig. 6.6 Write Instruction TO

Example: To write positioning information to buffer memory address 3872, with the AD71 assigned to X20 to X2F and Y30 to 3F.

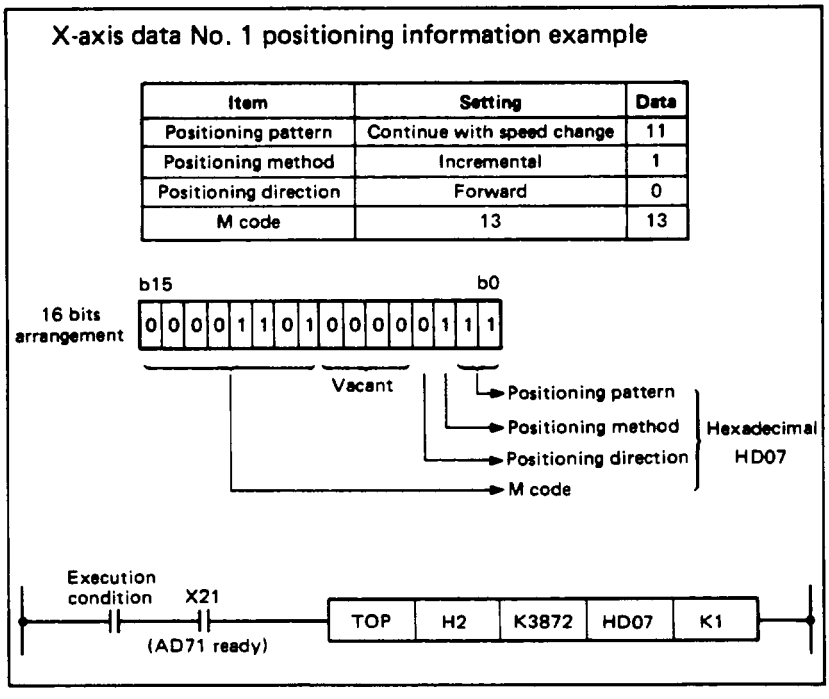


Fig. 6.7 Write Example

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POINT

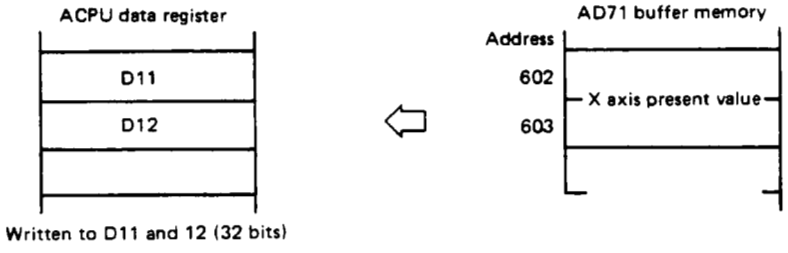
A maximum of 2,000 words may be read or written using one instruction.
Note however that in this case the watch dog timer (WDT) may need to be reset.

(2) Present value read program

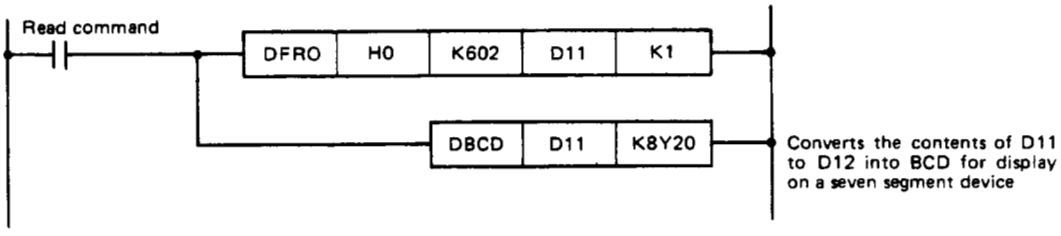
[Example] Indication of X axis present value

[Notes] (1) During positioning, the present value as stored in the AD71 buffer memory lags behind the actual value by about 0.1 seconds.
(2) The present value is two words long.

[Data transfer]



[Program]



Note: The "D" in the two instructions DFRO and DBCD specifies 32 bit processing.

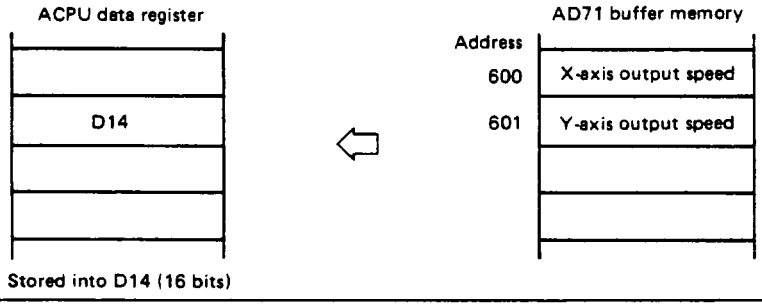
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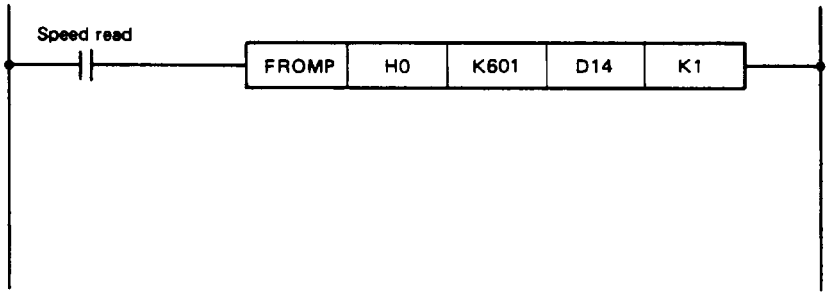
(3) Speed read while BUSY

[Example] Y axis speed read

[Data transfer]



[Program]



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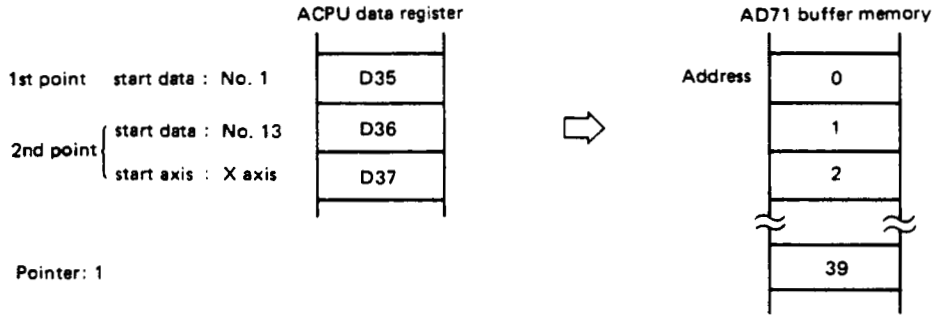
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(4) Data number and pointer write

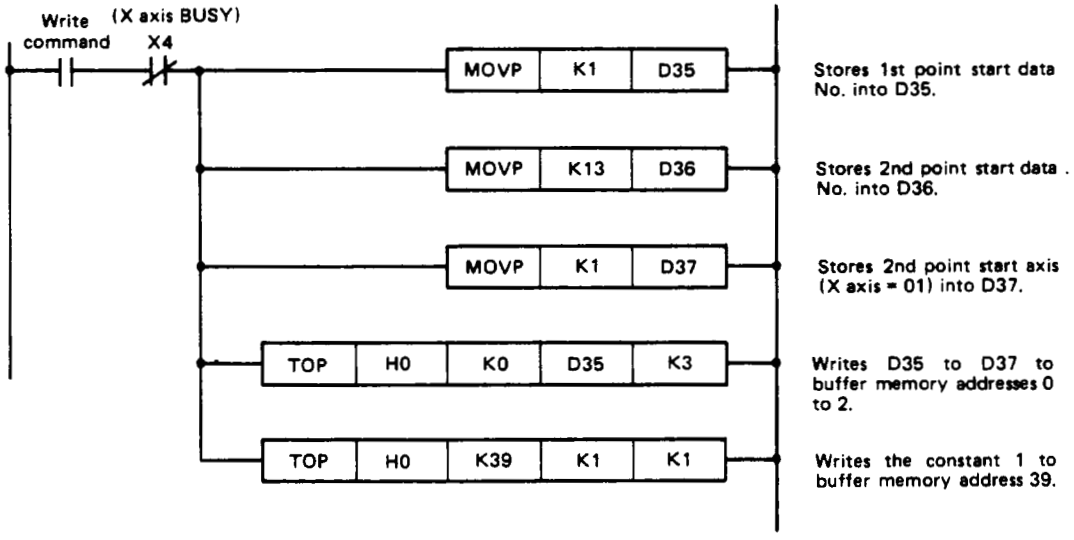
[Exmaple] X axis data number and pointer write

[Note] The relevant axis must not be busy.

[Data transfer]



[Program]



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(5) Parameter and zeroing data write

[Example] X axis parameter write – Assume that the parameters are already in D16 to 31

[Note] When writing parameters and zeroing data, the PC ready signal (Y1D) should be off.

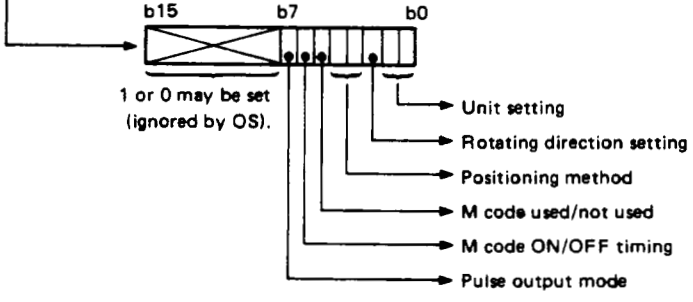
[Data transfer]

ACPU data register
(Data already written)

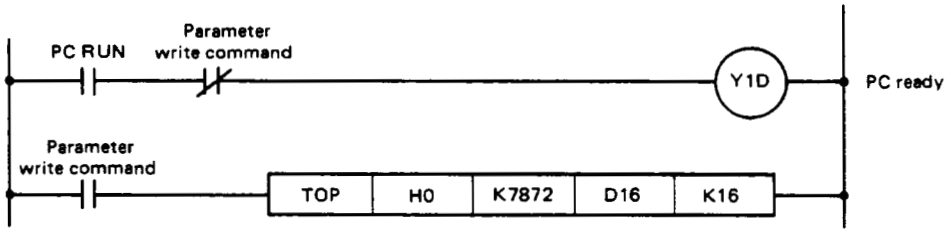
Parameter information	D16
Travel per pulse	D17
Speed limit value	D18
Jog speed limit value	D19
Acceleration and deceleration times	D20
Backlash compensation	D21
Upper stroke limit	D22
	D23
Lower stroke limit	D24
	D25
Error compensation	D26
	D27
Travel per inching input	D28
	D29
Starting bias speed	D30
Positioning complete signal output duration	D31

AD71 buffer memory

Address	7872
	7873
	7874
	7875
	7876
	7877
	7878
	7879
	7880
	7881
	7882
	7883
	7884
	7885
	7886
	7887



[Program]



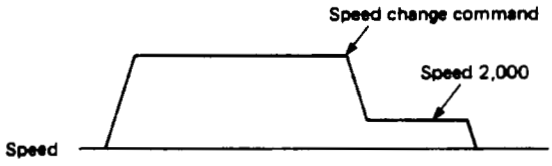
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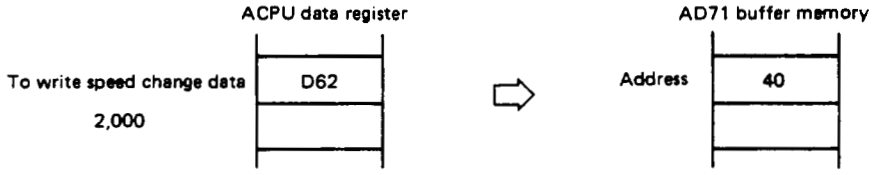
(6) Speed change when BUSY

[Example] To change X axis positioning speed to 2,000

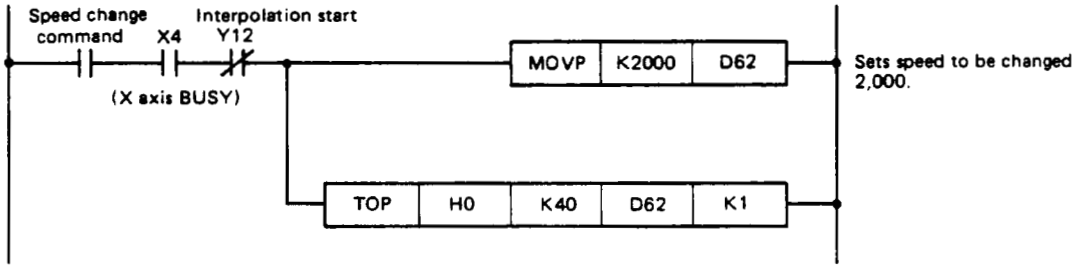
[Note] Speed cannot be changed during interpolation.

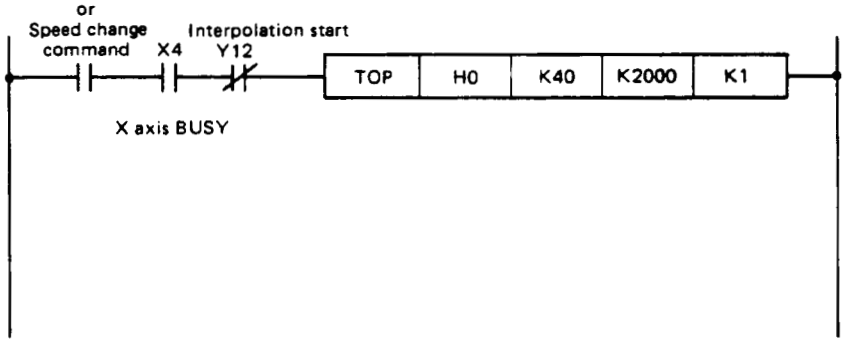


[Data transfer]



[Program]





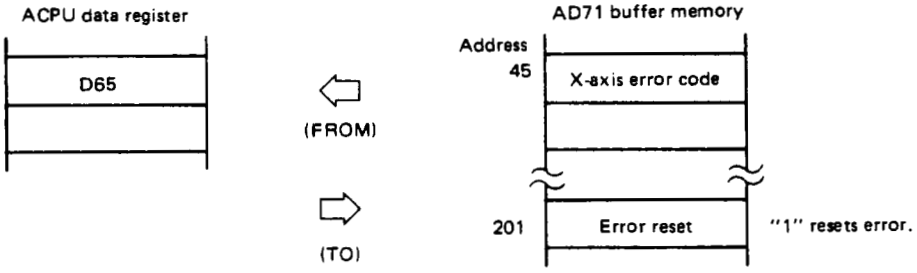
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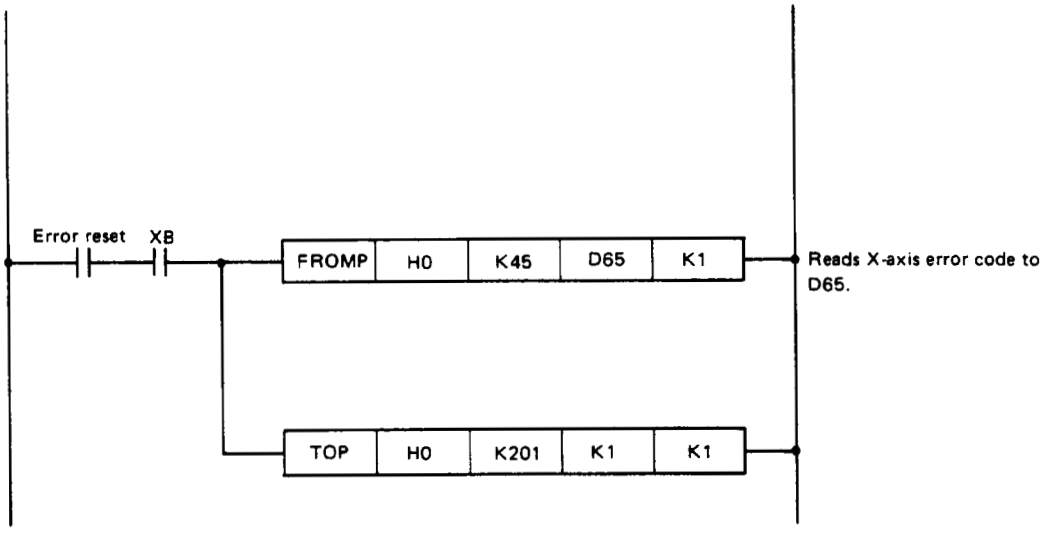
(7) Error reset

[Example]	To read an error code and then reset it.
[Notes]	(1) The error detection (XB) signal should be used. (2) The buffer memory error reset (address 201) is used for both the X and Y axes. Writing a 1 to this address clears the error.

[Data transfer]



[Program]



REMARKS

Writing "1" to the buffer memory error reset address resets the error code and XB. The error reset address is then automatically changed to "0".

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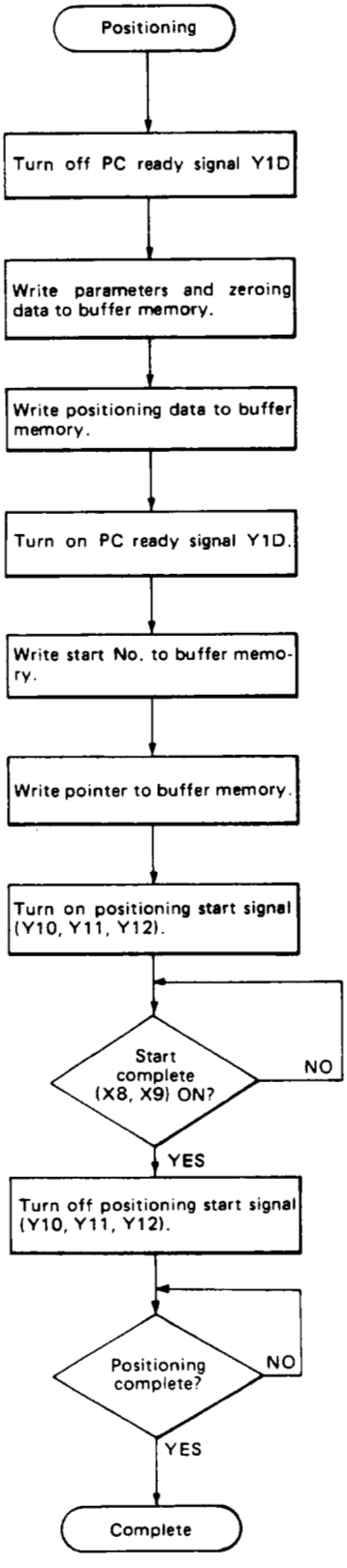
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6.3.3 Start positioning

The start of a positioning operation will be greatly simplified if all the relevant data has already been written to the buffer memory. (e.g. from the A6GPP)
Complex programs with long scan times are required if all the operating data must be written from the sequence program.

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(1) Flow chart



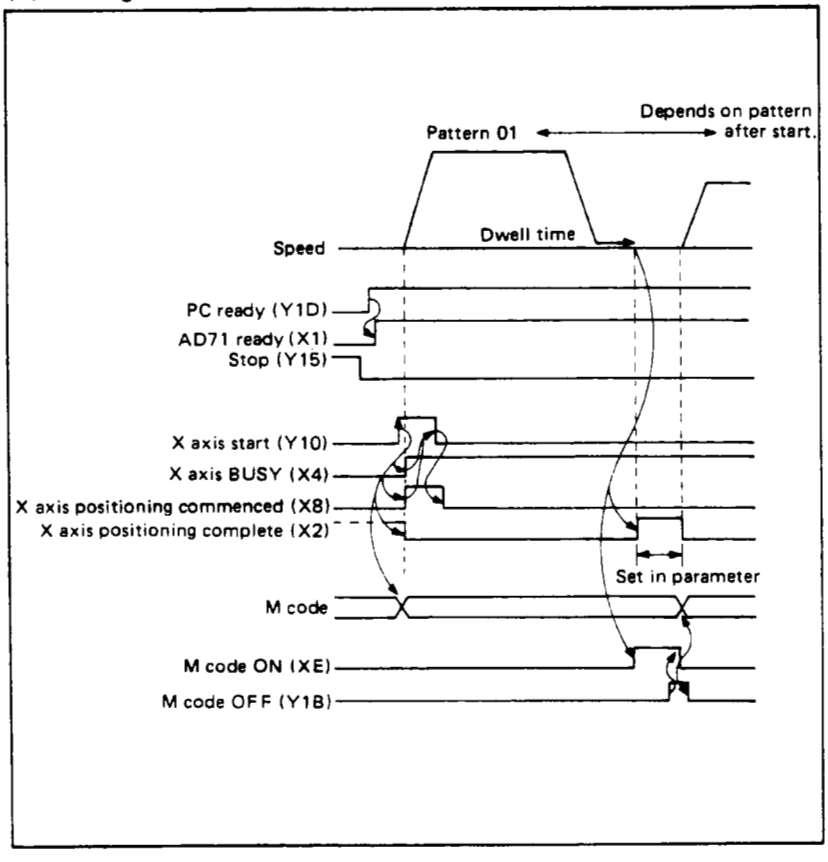
(2) Conditions

	Signal	State	Remarks
External signal	Drive unit READY	ON	
	STOP	OFF	
Interface signal	AD71 ready (X1)	ON	*
	Relevant axis busy (X4, X5)	OFF	
	Relevant axis positioning commenced (X8, X9)	OFF	
	Relevant axis M code ON (XE, XF)	OFF	
	Relevant axis stop (Y15, Y16)	OFF	
	PC ready (Y1D)	ON	*
Other	Positioning data	Within setting range	If positioning speed is higher than the speed limit value, positioning is executed at the speed limit value.
	Start data number		
	Start axis		
	Pointer		
	Zero address		
	Monitor present value	0 ≦ present value ≦ 16,252,928	
	After BREAK signal from the GPP or STOP signal from the AD71TU, neither axis should be busy.		

*In GPP or AD71TU test mode, X1 and Y1D may be off.

Table 6.1 Start Conditions

(3) Timing



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(4) Program

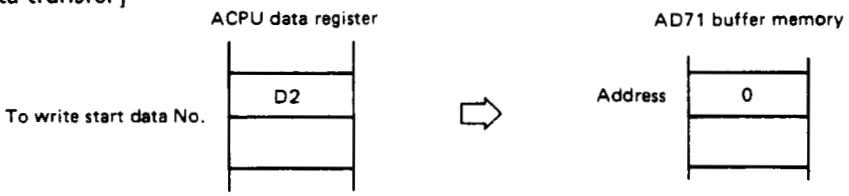
(a) Operating data already written from GPP

The following program assumes that parameters, zeroing data, and positioning data have already been written to the AD71 buffer memory using the GPP or AD71TU.

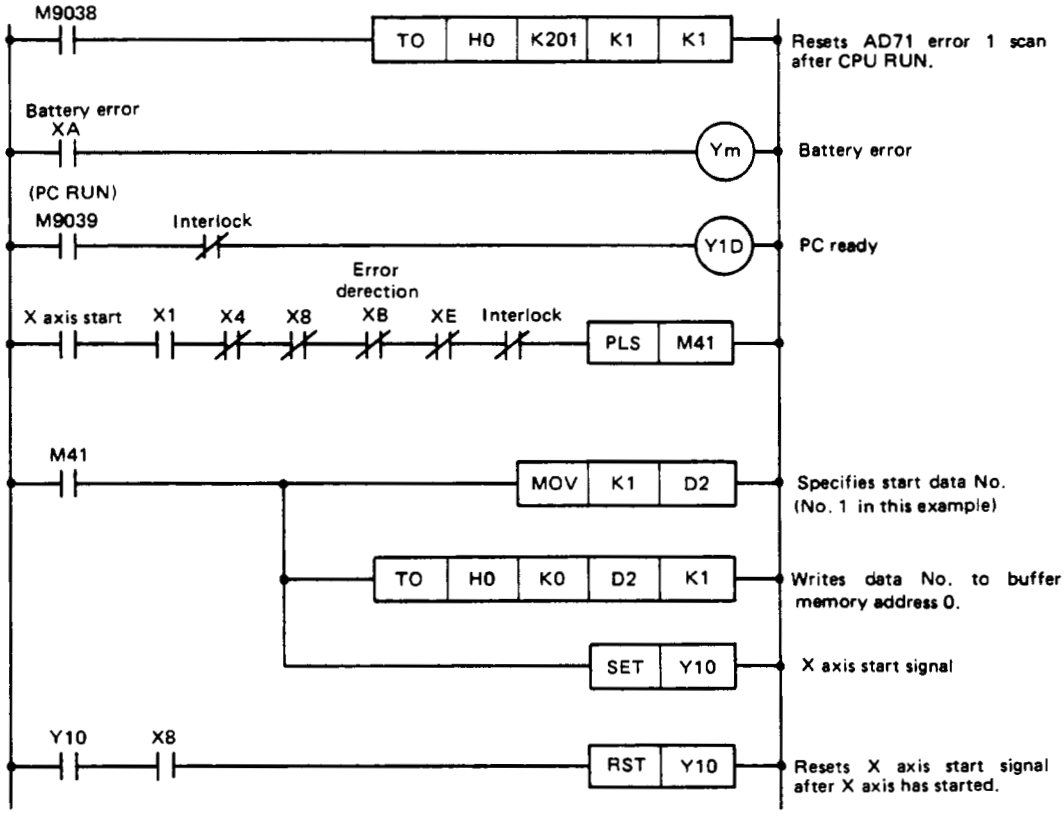
[Example] To start at X axis data number 1.

[Notes] (1) For start conditions, see Table 6.1.
(2) Actual positioning operation depends on data No. 1 pattern setting.
(3) For stop during positioning, refer to Section 6.3.9 (page 6-41).

[Data transfer]



[Program]



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(b) Setting data specified using sequence program

Assumes data is stored in registers as shown in Table 6.2, page 6-19.

[Notes] (1) For start conditions, see Table 6.1.
(2) For stop during positioning, refer to Section 6.3.9 (page 6-41).
(3) To write parameters and zeroing data, turn off PC ready signal (Y1D).

[Data transfer]

		ACPU data register	AD71 buffer memory
(X axis)			
1st point	start data No.	D0	0
2nd point	start data No.	D1	1
	start axis	D2	2
3rd point	start data No.	D3	3
	start axis	D4	4
X axis pointer		D5	39
(Y axis)			
1st point	start data No.	D10	300
2nd point	start data No.	D11	301
	start axis	D12	302
3rd point	start data No.	D13	303
	start axis	D14	304
Y axis pointer		D15	339
(X axis)			
Positioning information data	No. 1	D20	3872
	No. 2	D21	3873
	No. 3	D22	3874
	No. 4	D23	3875
	No. 5	D24	3876
	No. 6	D25	3877
	No. 7	D26	3878
	No. 8	D27	3879
	No. 9	D28	3880
	No. 10	D29	3881
(X axis)			
Positioning speed data	No. 1	D30	4272
	No. 2	D31	4273
	No. 3	D32	4274
	No. 4	D33	4275
	No. 5	D34	4276
	No. 6	D35	4277
	No. 7	D36	4278
	No. 8	D37	4279
	No. 9	D38	4280
	No. 10	D39	4281

(X axis)			
Dwell time data	No. 1	D40	4672
	No. 2	D41	4673
	No. 3	D42	4674
	No. 4	D43	4675
	No. 5	D44	4676
	No. 6	D45	4677
	No. 7	D46	4678
	No. 8	D47	4679
	No. 9	D48	4680
	No. 10	D49	4681
(X axis)			
Positioning address data	No. 1	D50	5072
		D51	5073
	No. 2	D52	5074
		D53	5075
	No. 3	D54	5076
		D55	5077
	No. 4	D56	5078
		D57	5079
	No. 5	D58	5080
		D59	5081
	No. 6	D60	5082
		D61	5083
	No. 7	D62	5084
		D63	5085
	No. 8	D64	5086
		D65	5087
	No. 9	D66	5088
		D67	5089
	No. 10	D68	5090
		D69	5091

(Y axis positioning data omitted)

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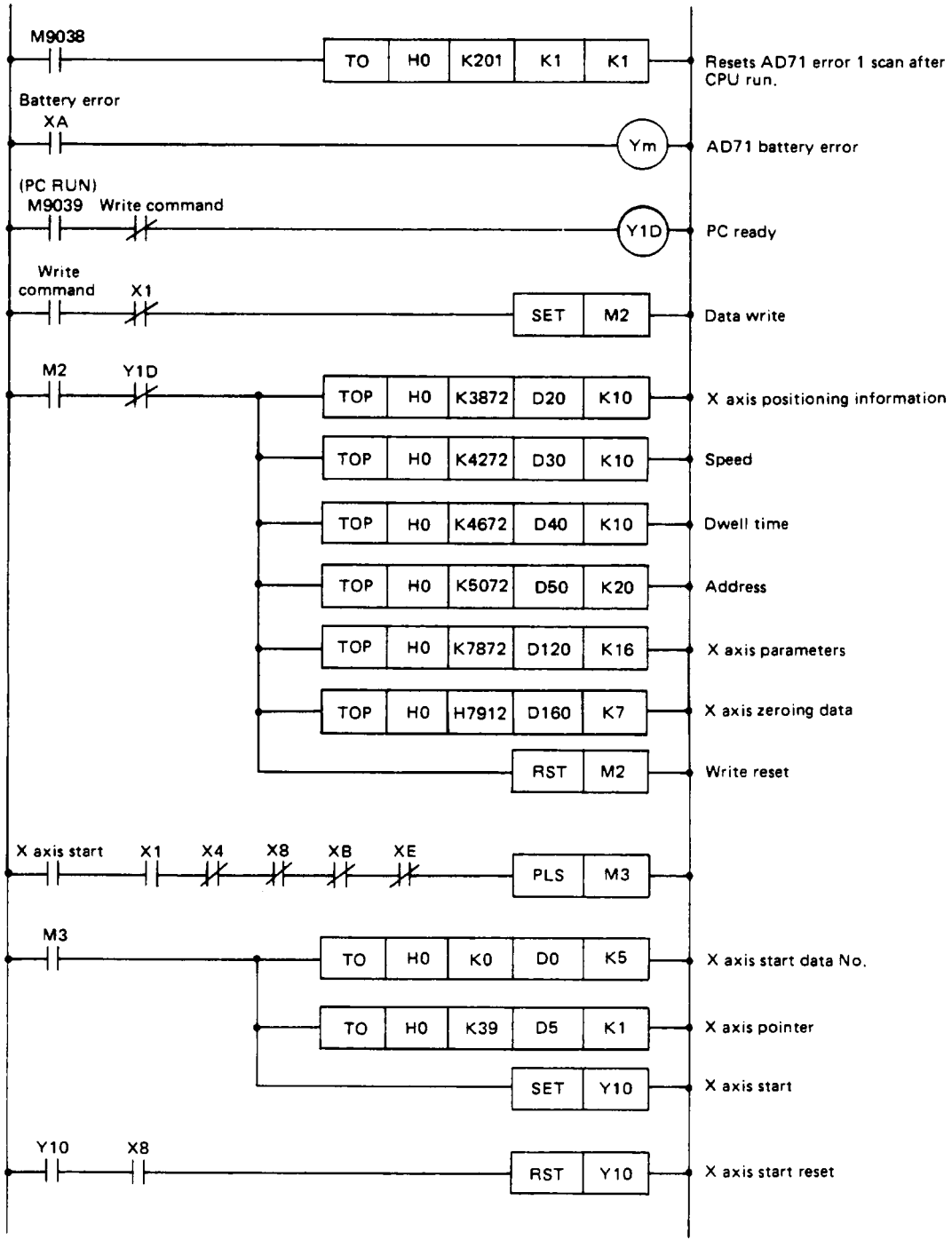
(X axis parameters)		
Parameter information	D120	7872
Travel per pulse	D121	7873
Speed limit value	D122	7874
Jog speed limit value	D123	7875
Acceleration and deceleration times	D124	7876
Backlash compensation	D125	7877
Upper stroke limit	D126	7878
	D127	7879
Lower stroke limit	D128	7880
	D129	7881
Error compensation	D130	7882
	D131	7883
Travel per inching input	D132	7884
	D133	7885
Starting bias speed	D134	7886
Positioning complete signal output duration	D135	7887
(Y axis parameters)		
Parameter information	D140	7892
Travel per pulse	D141	7893
Speed limit value	D142	7894
Jog speed limit value	D143	7895
Acceleration and deceleration times	D144	7896
Backlash compensation	D145	7897
Upper stroke limit	D146	7898
	D147	7899
Lower stroke limit	D148	7900
	D149	7901
Error compensation	D150	7902
	D151	7903
Travel per inching input	D152	7904
	D153	7905
Starting bias speed	D154	7906
Positioning complete signal output duration	D155	7907
(X axis zeroing data)		
Zero address	D160	7912
	D161	7913
Zeroing speed	D162	7914
Zeroing creep speed	D163	7915
Zeroing dwell time	D164	7916
Torque limit	D165	7917
Zeroing information	D166	7918
(Y axis zeroing data)		
Zero address	D170	7922
	D171	7923
Zeroing speed	D172	7924
Zeroing creep speed	D173	7925
Zeroing dwell time	D174	7926
Torque limit	D175	7927
Zeroing information	D176	7928

Item			Data Register
X axis start data number (3 points)			D0 to 4
X axis pointer (2)			D5
Y axis start data number (3 points)			D10 to 14
Y axis pointer (2)			D15
Positioning data	X axis	Positioning information (No. 1 to 10)	D20 to 29
		Positioning speed (No. 1 to 10)	D30 to 39
		Dwell time (No. 1 to 10)	D40 to 49
		Positioning address (No. 1 to 10)	D50 to 69
	Y axis	Positioning information (No. 1 to 10)	D70 to 79
		Positioning speed (No. 1 to 10)	D80 to 89
		Dwell time (No. 1 to 10)	D90 to 99
		Positioning address (No. 1 to 10)	D100 to 119
X axis parameters			D120 to 135
Y axis parameters			D140 to 155
X axis zeroing data			D160 to 166
Y axis zeroing data			D170 to 176

Table 6.2 Data Register Contents

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[Example 1] X axis start

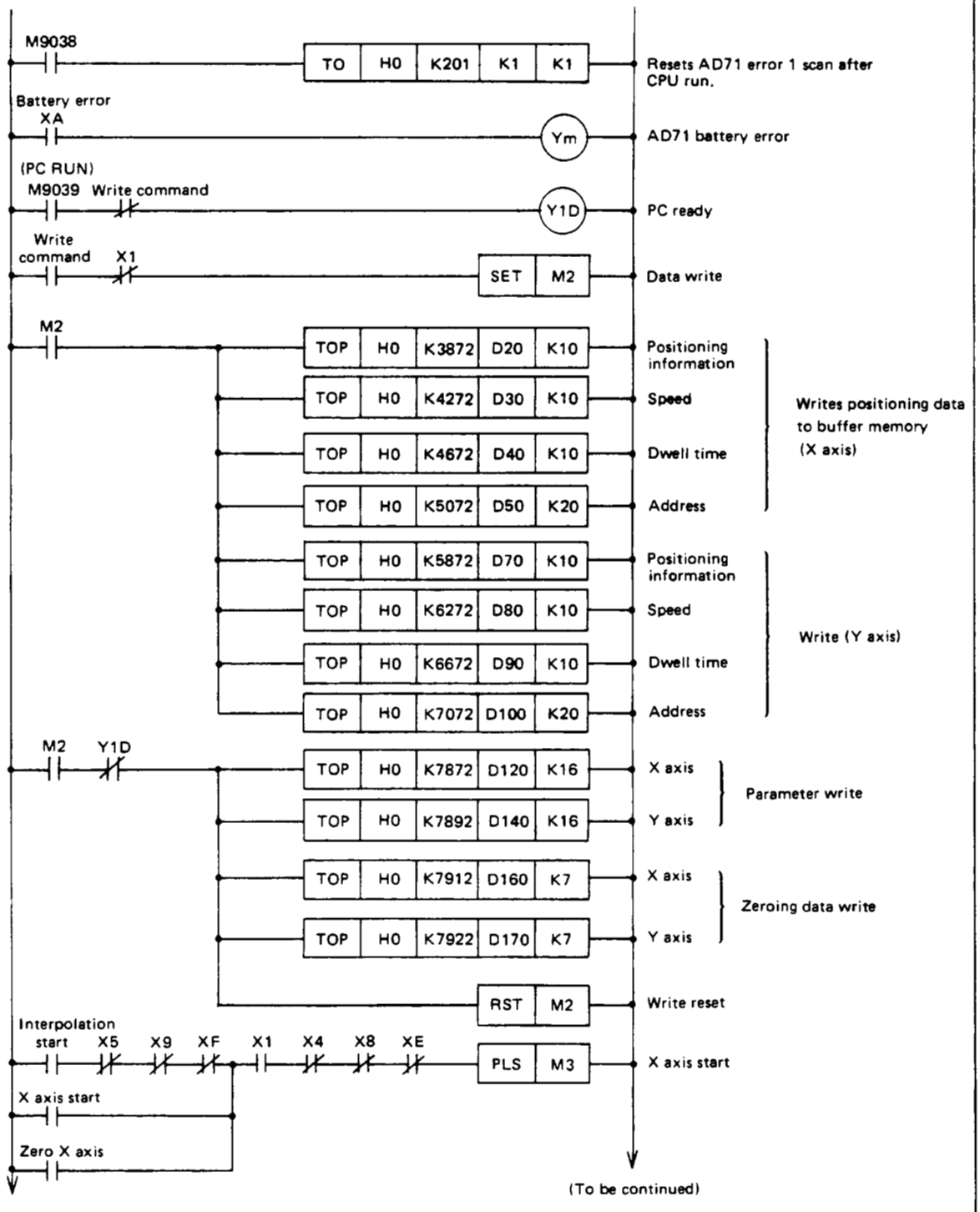


Timing is same as on page 6-16.

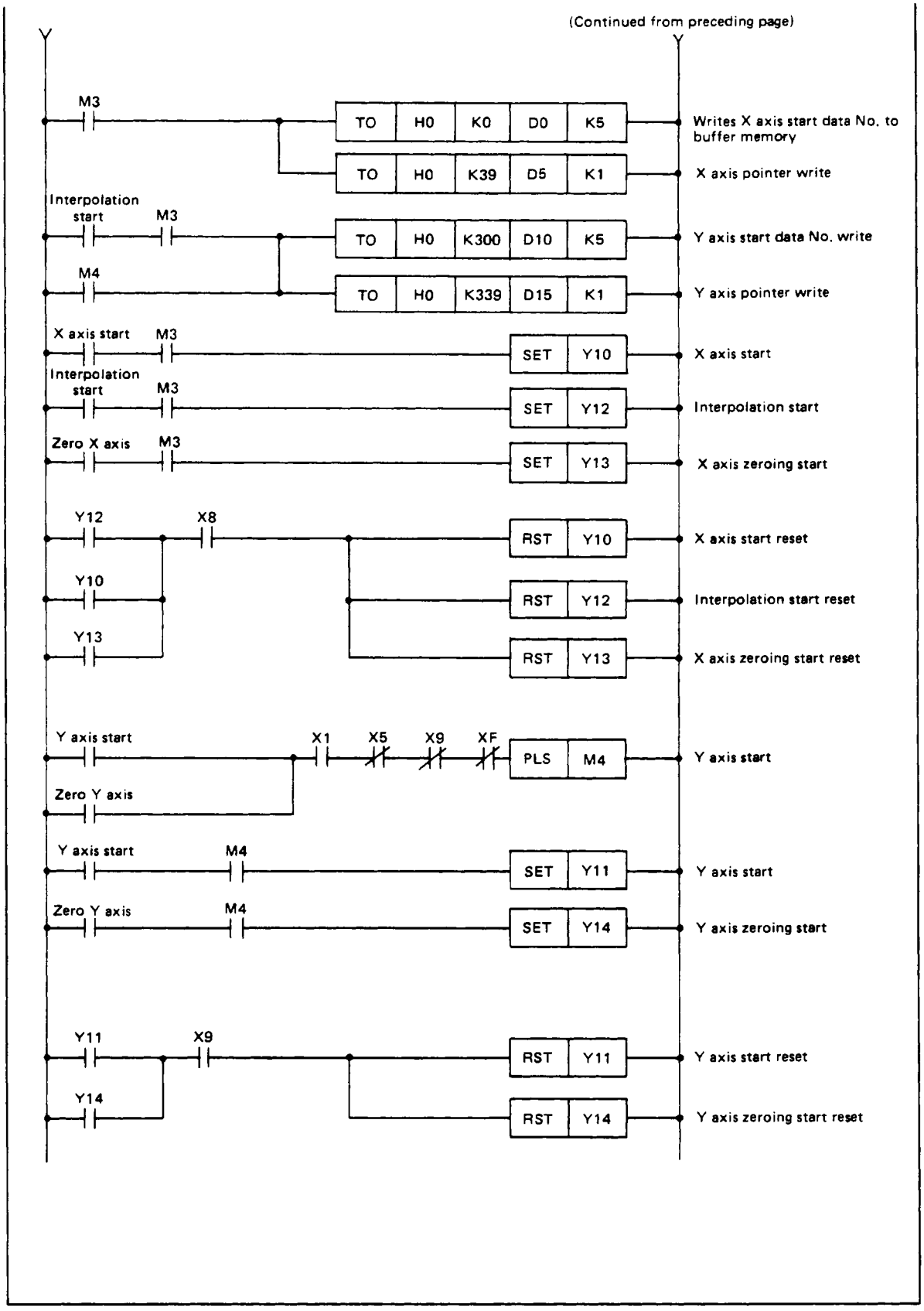
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[Example 2] XY interpolation start



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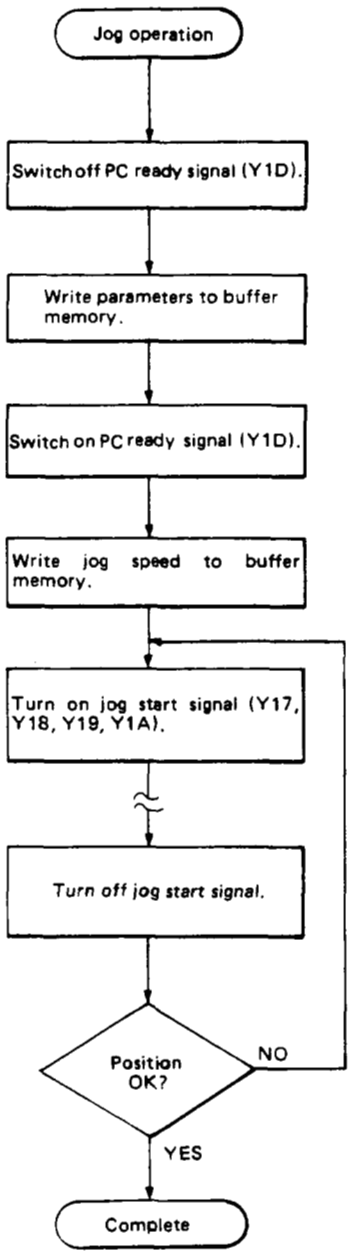


Note: For time schedule, refer to Fig. 3.42 (page 3-56).

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6.3.4 Jog operation program

(1) Flow chart



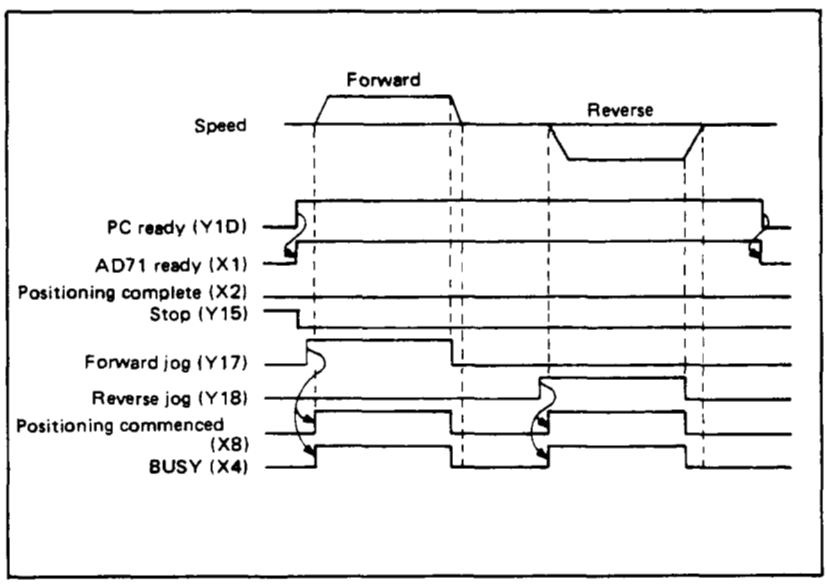
(2) Conditions

	Signal	State	Remarks
External signal	Drive unit READY	ON	
	STOP	OFF	
Interface signal	AD71 ready (X1)	ON	*
	Relevant axis busy (X4, X5)	OFF	
	Relevant axis positioning commenced (X8, X9)	OFF	
	Relevant axis M code ON (XE, XF)	OFF	
	Relevant axis stop (Y15, Y16)	OFF	
	PC ready (Y1D)	ON	*
Others	Jog speed	Starting bias speed or higher	If jog speed specified is higher than the jog speed limit value, operation is performed at the jog speed limit value.
	Parameters	Within setting range.	
	Neither axis should be busy after a BREAK signal has been received from the GPP and both axes have stopped.		
	Neither axis should be busy after a STOP signal has been received from the AD71TU and both axes have stopped.		

*In GPP or AD71TU test mode, X1 and Y1D may be off.

Table 6.3 Jog Operation Start Conditions

(3) Timing



POINT

(1) During jog operation the upper and lower stroke limits are ignored.
(2) When backlash compensation has been specified, the minimum movement allowed will be the backlash specified.

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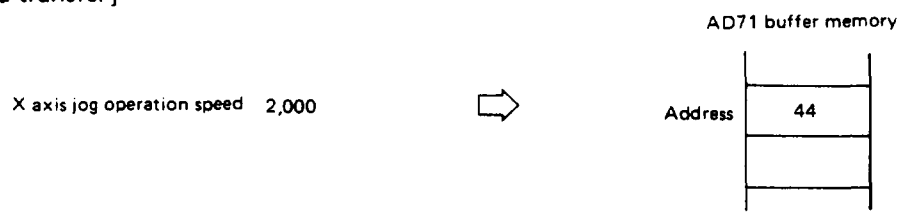
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(4) Program

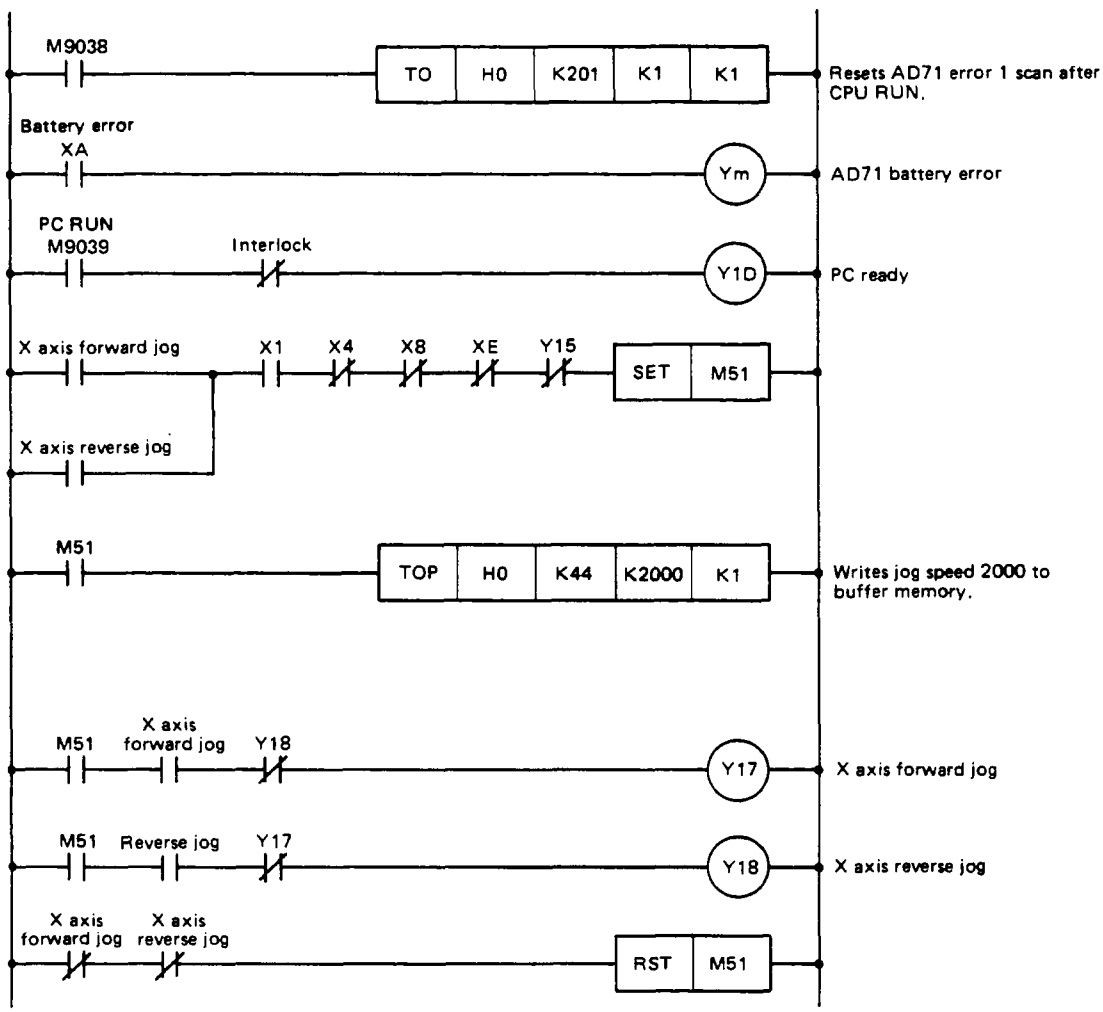
The drive is enabled for as long as the jog switch is pressed.

[Example]	X axis jog at speed 2,000 (20,000 mm/min)
[Note]	Start conditions are shown in Table 6.3. The jog speed must be written to the buffer memory.

[Data transfer]



[Program]



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REMARKS

1. The AD71 will wait until the output speed is zero before giving a second jog output.

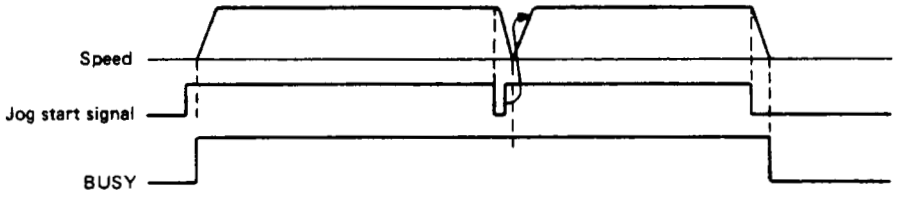


Fig. 6.8 Jog Repetition

2. Interpolation is not enabled during jog operation.

3. The AD71 defaults to forward jog if both forward and reverse jog commands are given simultaneously.

6.3.5 Inching

The operating principle for the manual pulser inching function is described below:

1) When the manual pulser instruction is given the inching signal is transmitted to the AD71.

2) The number of manual pulses is converted into output pulses according to the following expression:

$$\text{Number of output pulses to drive} = \frac{R \times Q}{P}$$

where P = "travel per pulse" in the parameters
Q = "travel per inching input" in the parameters
R = number of manual pulses

3) The output pulses are fed to the motor drive unit.
   - Pulse output speed is fixed at 20KPLS/sec and is not under acceleration/deceleration control. Hence, if the inching speed is too high, the drive unit cannot keep up. In this case, set the travel per pulse to a smaller value.

4) The BUSY signal for the relevant axis is on during inching.

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POINT

(1) Always disable manual pulser inching when not in use (i.e. write "0" to buffer memory address 47 (X axis) or 347 (Y axis). See page 3-34.

(2) Manual pulser inching is allowed if:

- Inching is enabled in the buffer memory.
- The relevant axis is not busy, or is busy in inching mode.

(3) The input and output counters which count the number of manual pulses given, are cleared approx. 0.2 seconds after disabling the function or switching off the PC ready signal (Y1D).
When the stop signals (Y15, Y16) are switched on, the pulse input and output counters are cleared to 0.

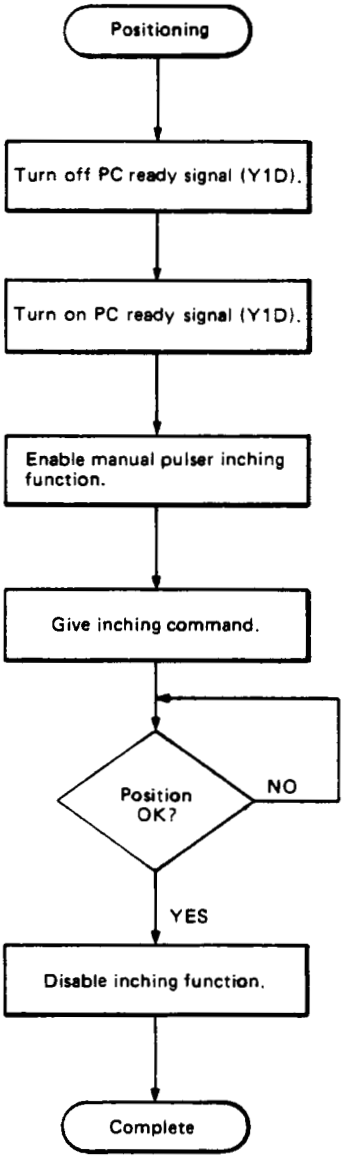
(4) Travel requiring backlash compensation is not started if the number of output pulses is less than the backlash setting value.

(5) The manual pulse input counter is not cleared if there is an error preventing operation. In this case disable the function (which clears the counter), clear the error, and then re-enable the function.

(6) The input buffer for the manual pulser pulse chain will hold 16777215 pulses.

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(1) Flow chart



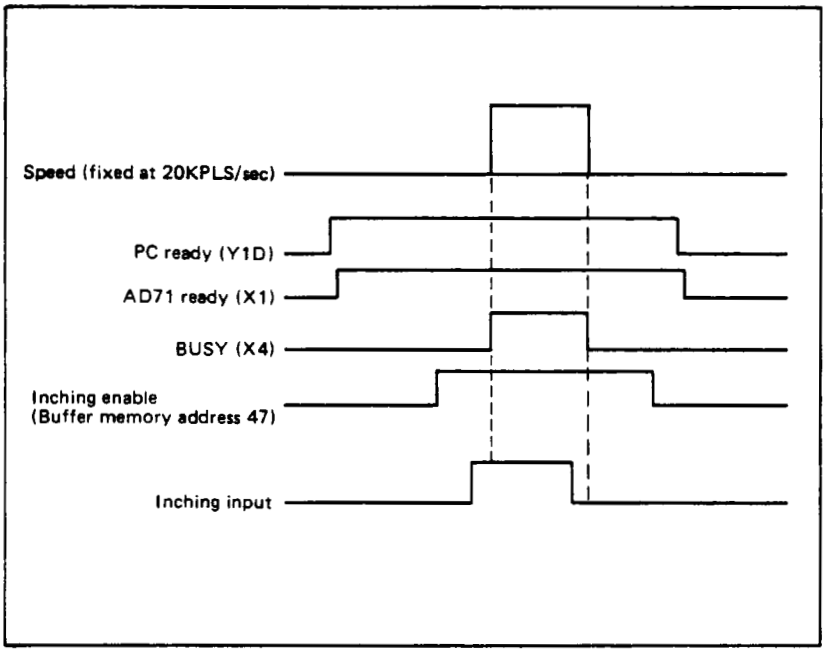
(2) Conditions

	Signal	State	Remarks
External signal	Drive unit READY	ON	
	STOP	OFF	
Interface signal	AD71 ready (X1)	ON	*
	Relevant axis busy (X4, X5)	OFF	On during manual pulser pulse generation
	Relevant axis positioning commenced (X8, X9)	OFF	
	Relevant axis M code ON (XE, XF)	OFF	
	Relevant axis stop (Y15, Y16)	OFF	
	PC ready (Y1D)	ON	*
Others	"Inching enable" in buffer memory [X axis 47 / Y axis 347]	Bit = 1	
	Parameters	Within setting range.	
	Neither axis should be busy if a [BREAK] (A6GPP) or [STOP] (AD71TU) signal has been received and positioning has stopped.		

*In GPP or AD71TU test mode, X1 and Y1D may be off.

Table 6.4 Start Conditions

(3) Timing



IMPORTANT

Error code 72 is given if the inching command is given while the AD71 is "BUSY" during positioning, zeroing or jog operation. For this reason, it is recommended that inching is disabled while not in use.

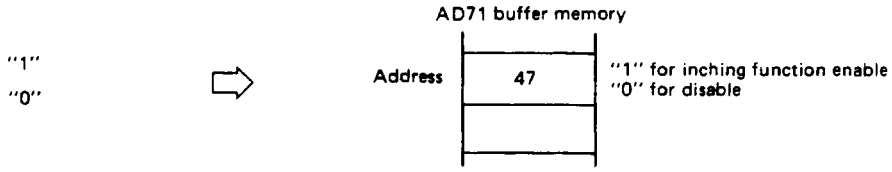
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(4) Program

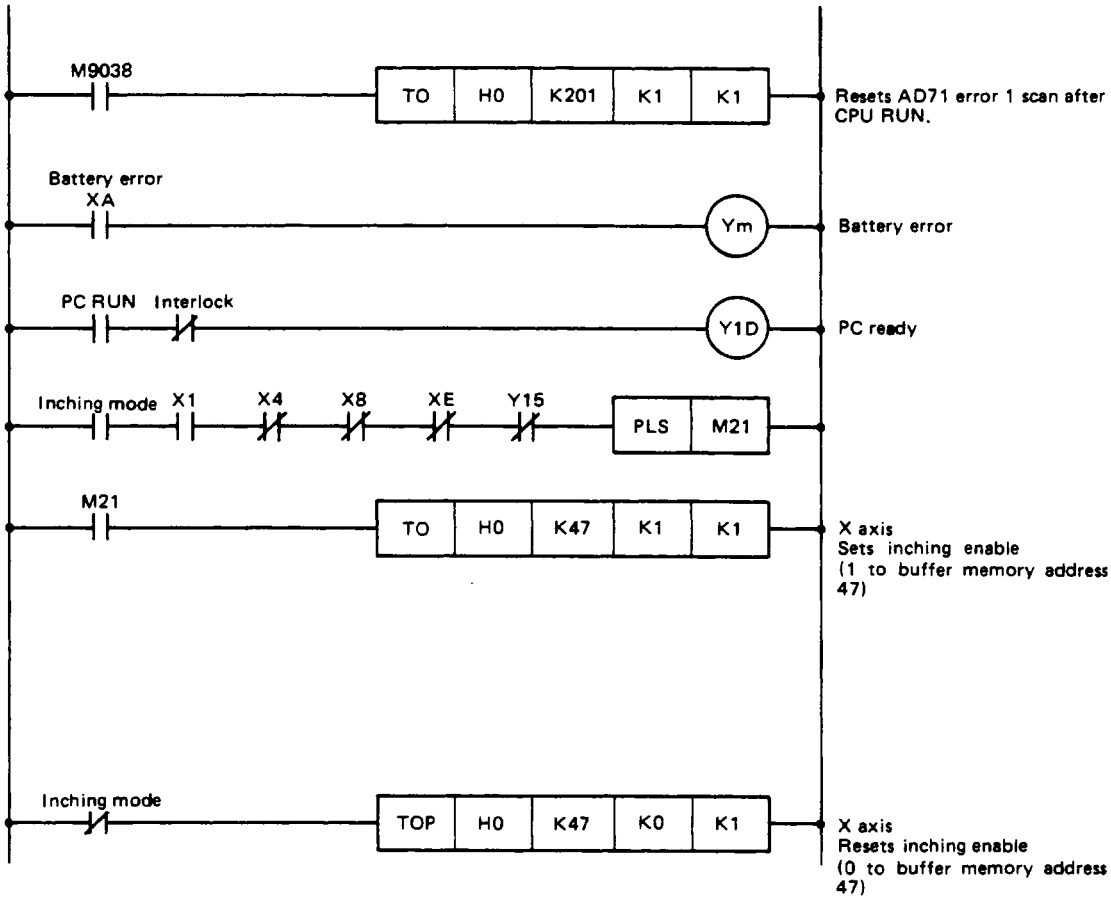
[Example] X axis inching

[Note] Start conditions are shown in Table 6.4.

[Data transfer]



[Program]



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6.3.6 Position address teaching

May be achieved as follows:

(1) Jog operation

Move the system to the required position using the jog operation and write that address into the buffer memory.

(2) Inching operation

Move the system to the required position using the manual pulser and write that address into the buffer memory.

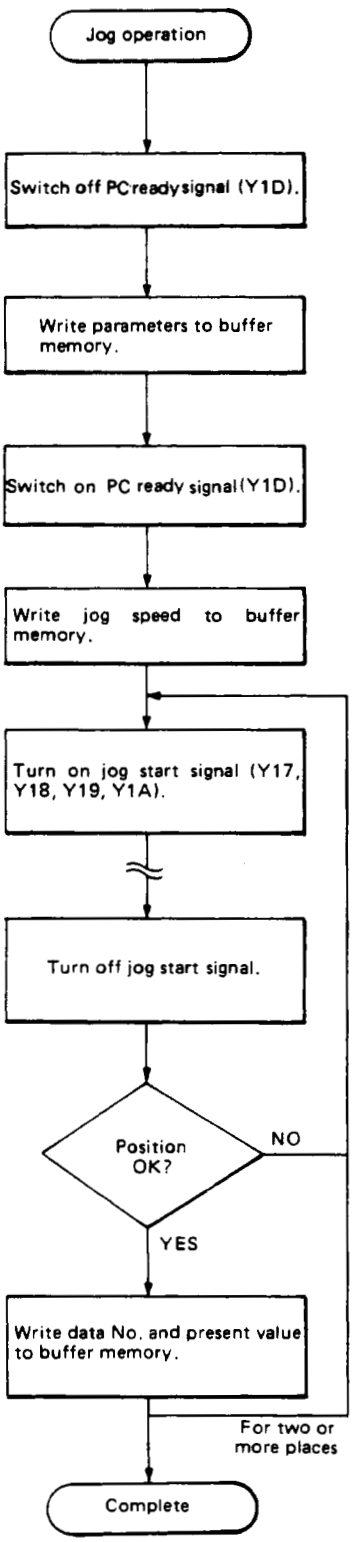
(3) Jog then inching combined

Coarse position using the jog operation then fine position with the manual pulser. Write the address to the buffer memory.

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[1] Jog to position and teach

(1) Flow chart



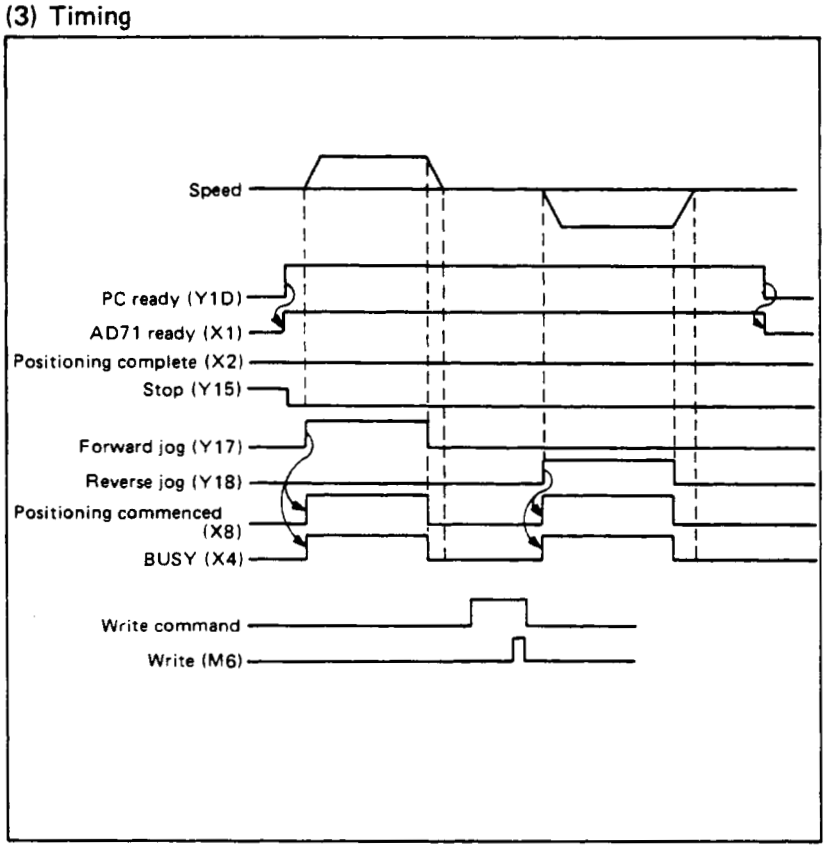
(2) Conditions

	Signal	State	Remarks
External signal	Drive unit READY	ON	
	STOP	OFF	
Interface signal	AD71 ready (X1)	ON	*
	Relevant axis busy (X4, X5)	OFF	
	Relevant axis positioning commenced (X8, X9)	OFF	
	Relevant axis M code ON (XE, XF)	OFF	
	Relevant axis stop (Y15, Y16)	OFF	
	PC ready (Y1D)	ON	*
Others	Jog speed	Starting bias speed or higher	If jog speed specified is higher than the jog speed limit value, operation is performed at the jog speed limit value.
	Parameters	Within setting range.	
	Neither axis should be busy after a BREAK signal has been received from the A6GPP and both axes have stopped.		
	Neither axis should be busy after a STOP signal has been received from the AD71TU and both axes have stopped.		

*In GPP or AD71TU test mode, X1 and Y1D may be off.

Table 6.5 Address Write Conditions Using Jog Operation

(3) Timing



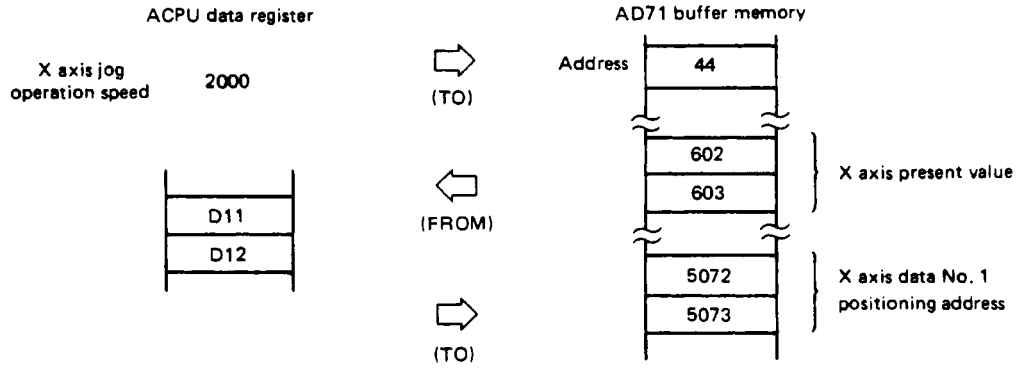
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(4) Program

System is positioned in jog mode and resulting address written to buffer memory.

[Example]	X axis jog and address written as data No. 1 (jog speed = 2,000 (20,000 mm/min))
[Notes]	(1) Start conditions are shown in Table 6.5. (2) A delay of approx. 0.5 seconds occurs after positioning stops to allow the current value of the buffer memory to be updated.

[Data transfer]

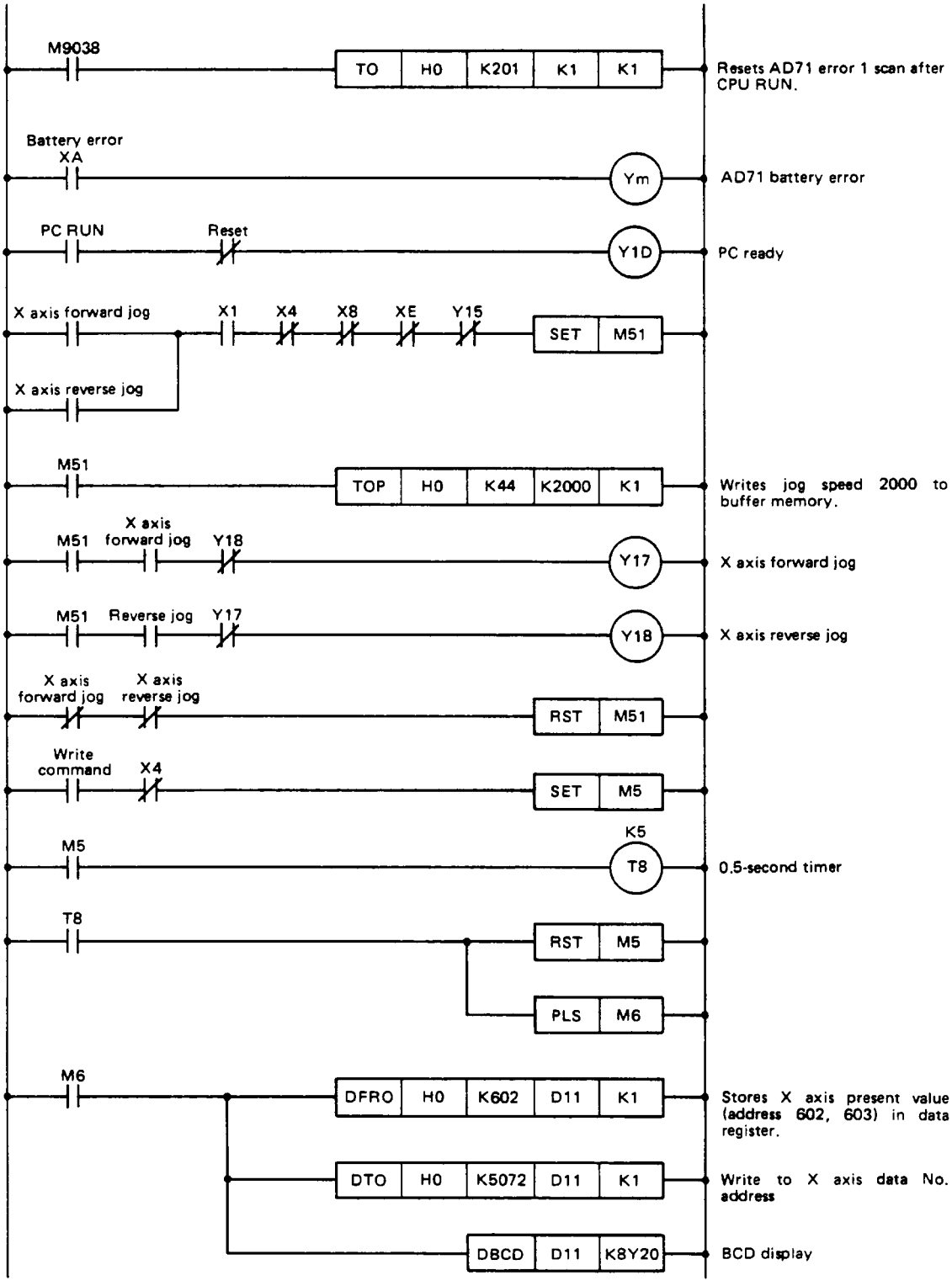


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[Program]

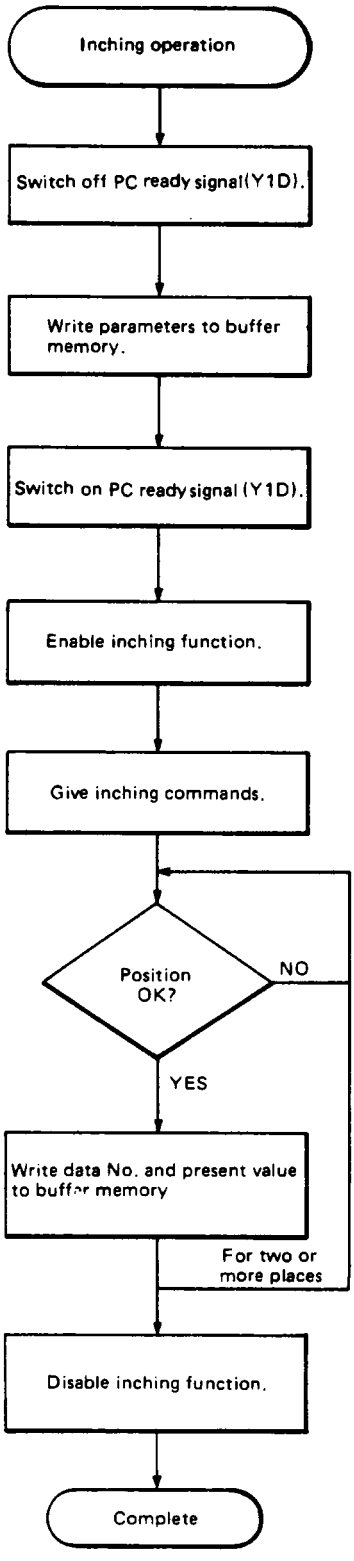
To write address to data No. 1



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[2] Inch to position and teach

(1) Flow chart



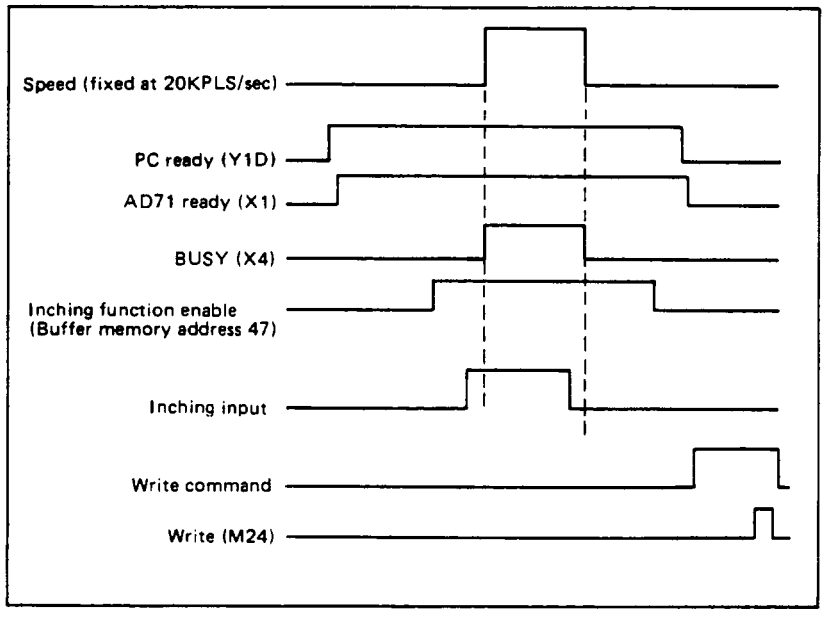
(2) Conditions

	Signal	State	Remarks
External signal	Drive unit READY	ON	
	STOP	OFF	
Interface signal	AD71 ready (X1)	ON	*
	Relevant axis busy (X4, X5)	OFF	
	Relevant axis positioning commenced (X8, X9)	OFF	
	Relevant axis M code ON (XE, XF)	OFF	
	Relevant axis stop (Y15, Y16)	OFF	
	PC ready (Y1D)	ON	*
Others	Inching function enable in buffer memory [X axis 47 / Y axis 347]	Bit 0 = 1	
	Parameters	Within setting range.	
	Neither axis should be busy if a BREAK (A6GPP) or STOP (AD71TU) signal has been received and positioning has stopped.		

*In GPP or AD71TU test mode, X1 and Y1D may be off.

Table 6.6 Address Write Conditions

(3) Timing



IMPORTANT

Error code 73 is given if the inching command is given while the AD71 is "BUSY" during positioning, zeroing or jog operations. For this reason it is recommended that inching is disabled when not in use.

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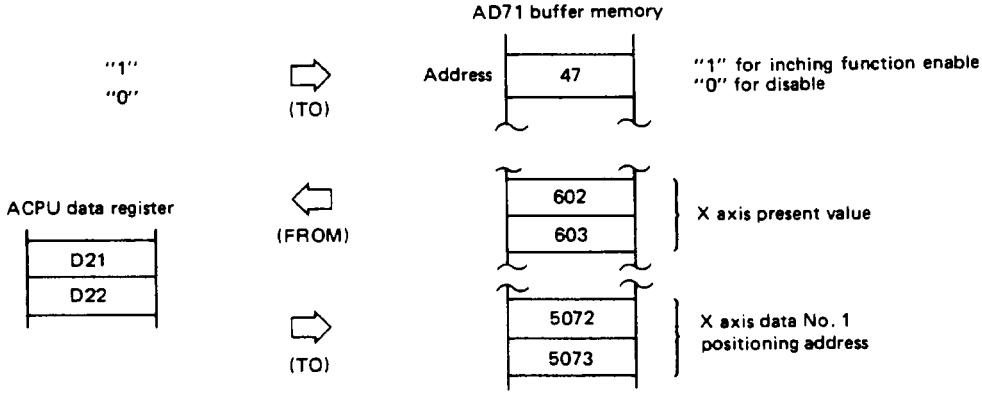
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(4) Program

System is inched to the required position and the resulting address written to the buffer memory.

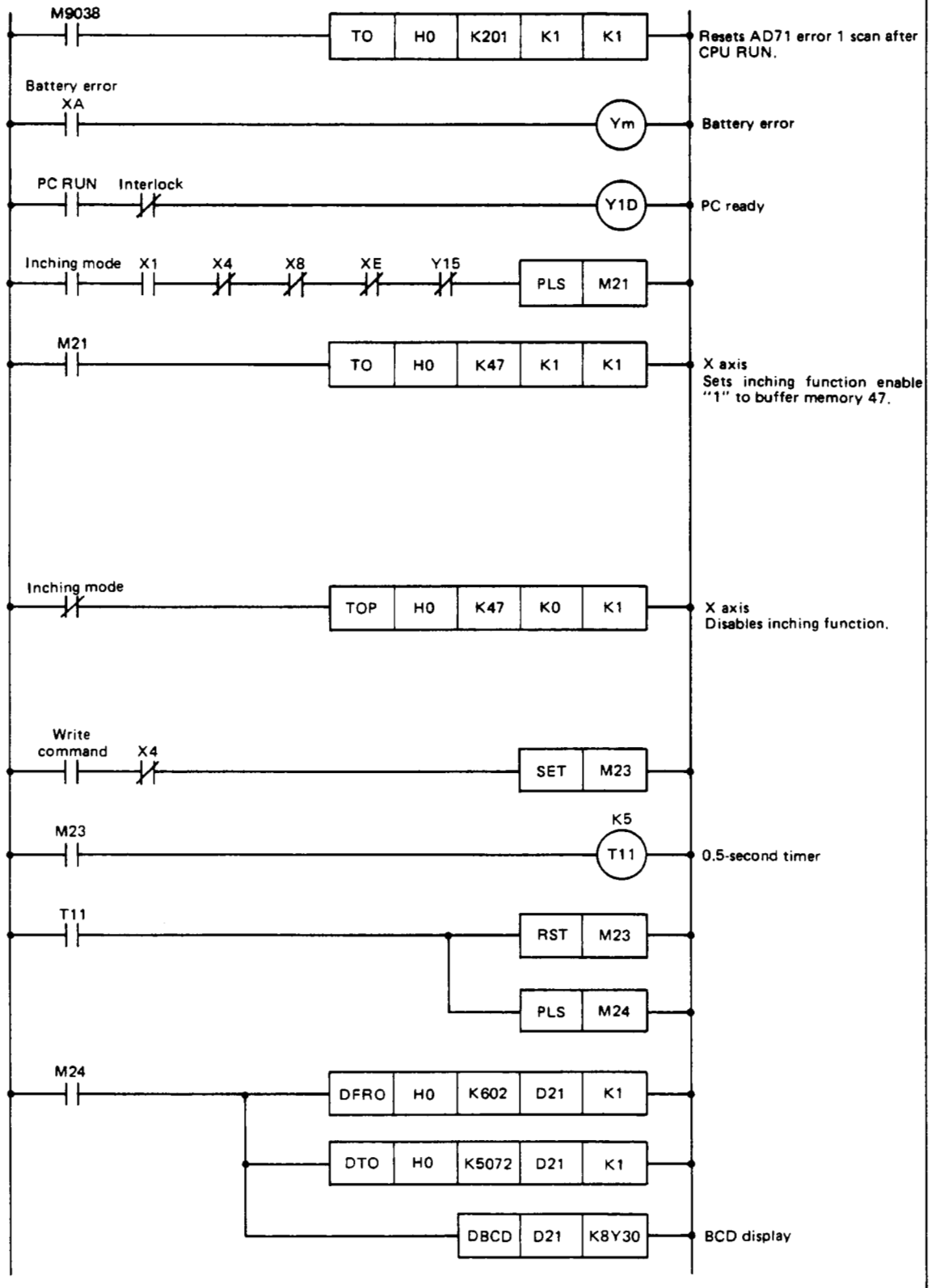
[Example]	Move X axis and address written as data No. 1.
[Notes]	(1) Start conditions are shown in Table 6.6. (2) A delay of approx. 0.5 seconds occurs after positioning stops to allow the current value of the buffer memory to be updated.

[Data transfer]



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[Program]

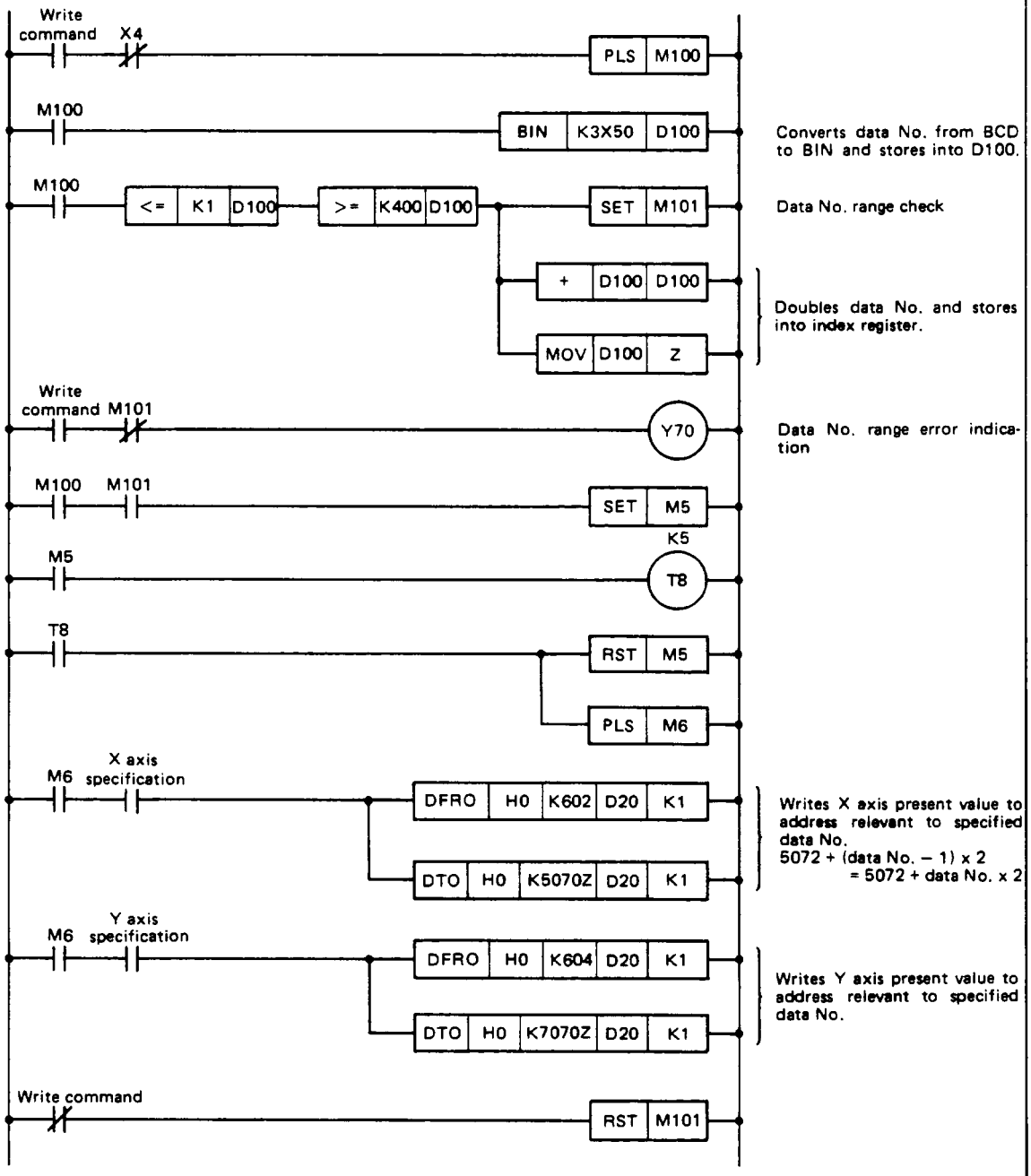


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[3] Teaching the position address and defining the data number using a thumbwheel switch

[Example] The data number for the address reached is input from a 3 digit BCD switch wired to inputs X50 to X5B.

[Program]

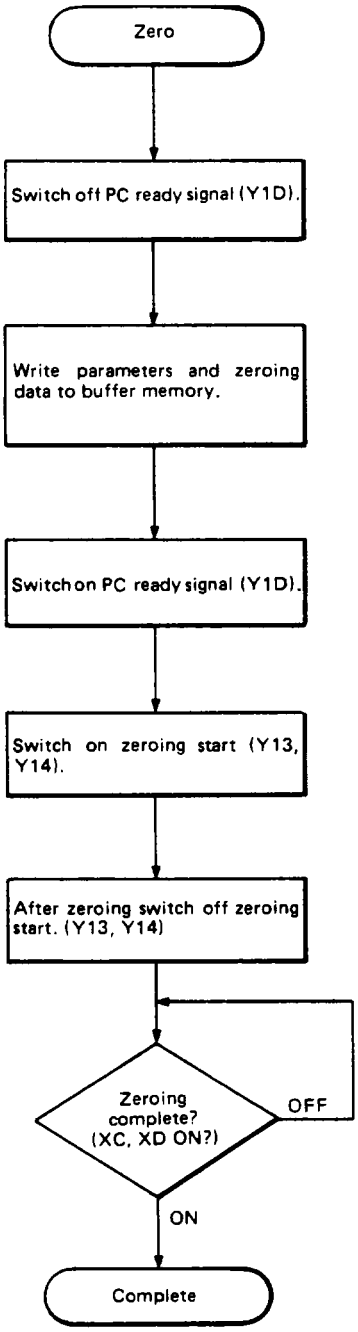


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6.3.7 Zeroing

(1) Flow chart



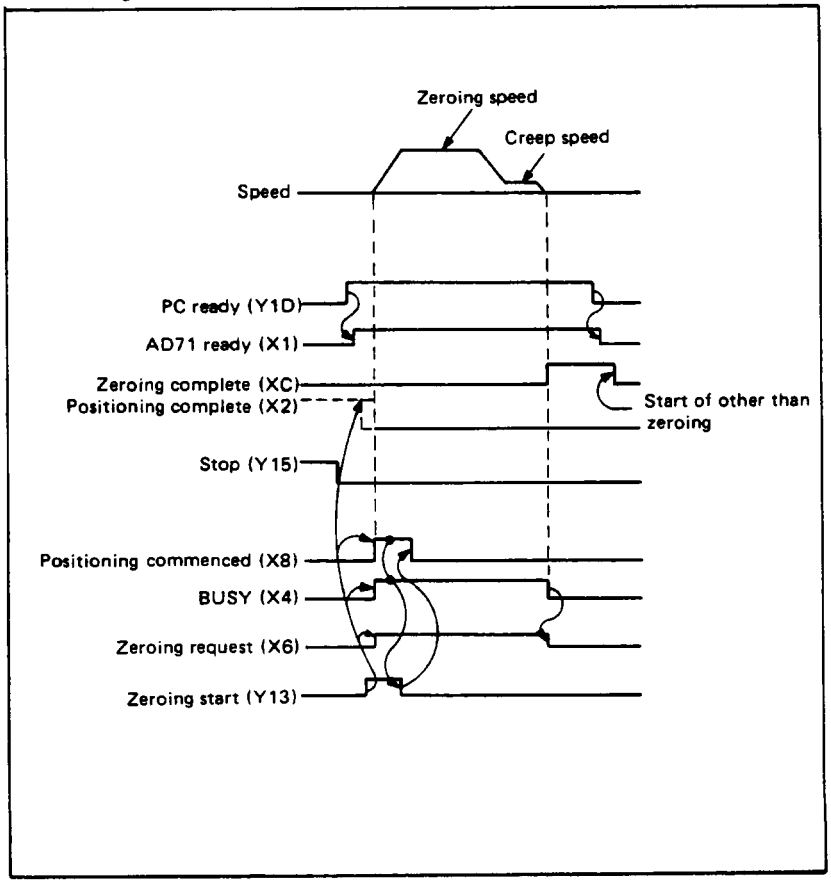
(2) Conditions

	Signal	State	Remarks
External signal	Drive unit READY	ON	
	STOP	OFF	
Interface signal	AD71 ready (X1)	ON	*
	Relevant axis busy (X4, X5)	OFF	
	Relevant axis positioning commenced (X8, X9)	OFF	
	Relevant axis zeroing complete (XC, XD)	OFF	
	Relevant axis M code ON (XE, XF)	OFF	
	Relevant axis stop (Y15, Y16)	OFF	
	PC ready (Y1D)	ON	*
Others	Zeroing data	No error	
	Repetition of zeroing start	Max. twice consecutively.	
	Neither axis should be busy after BREAK (A6GPP) or STOP (AD71TU) has been received and positioning has stopped.		

*In GPP or AD71TU test mode, X1 and Y1D may be off.

Table 6.7 Zeroing Conditions

(3) Timing



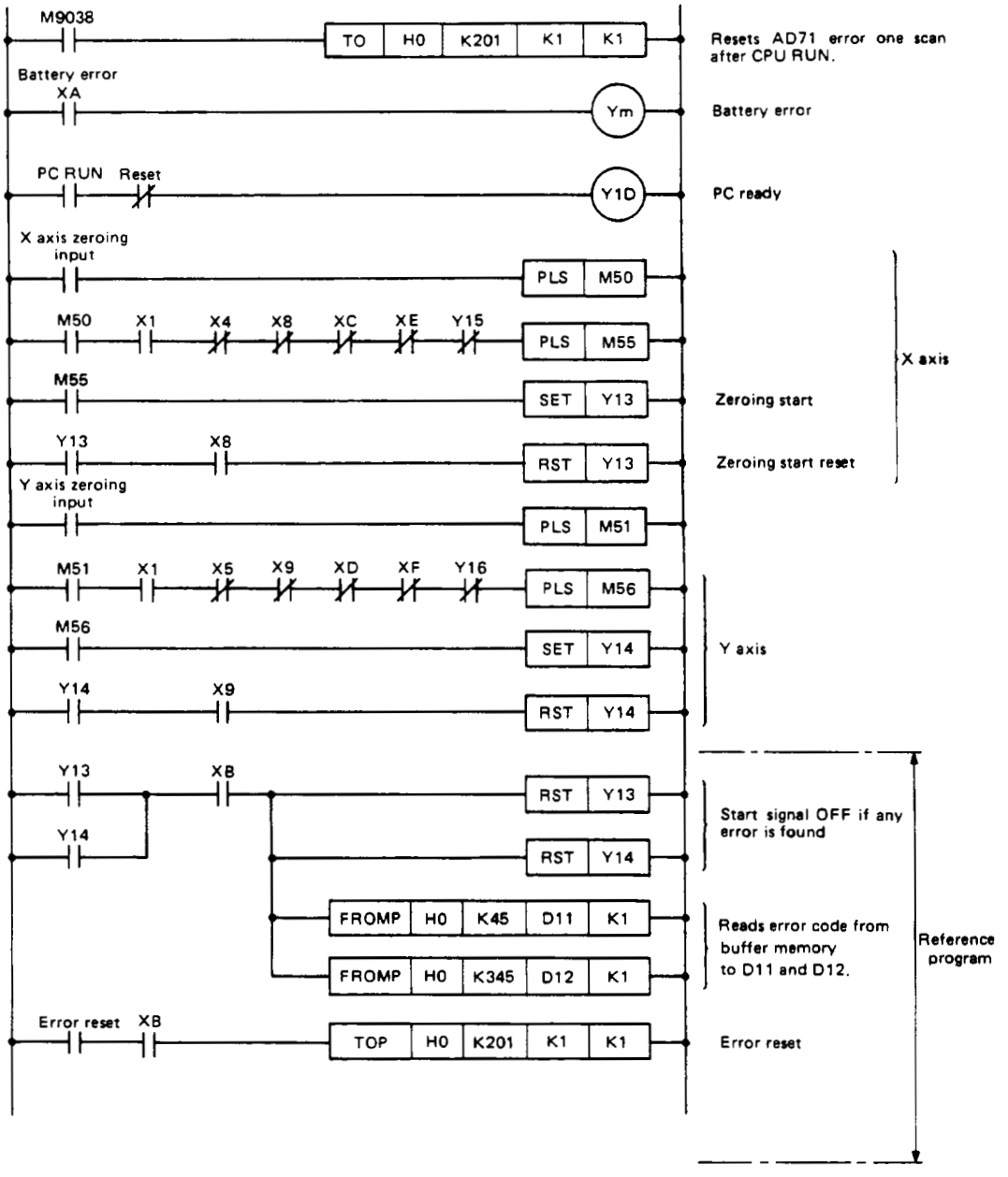
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(4) Program

[Example] To zero the system, the X and Y axis zeroing inputs are pulsed. In the event of an error occurring during zeroing, the error number is read to data registers D11 and D12.

[Notes]
(1) Start conditions are shown in Table 6.7.
(2) Interpolation is not enabled during zeroing.
Giving a simultaneous zeroing command to both axes causes one axis to delay about 50ms before starting.
(3) The system may only be zeroed once. Repeating the zeroing command with no intermediate operation will give an error.

[Program]

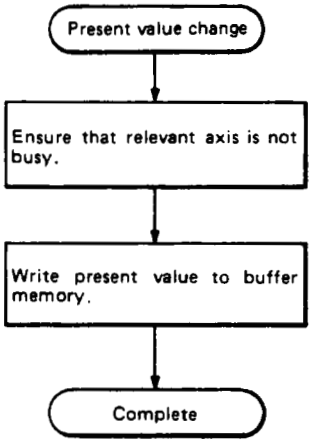


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6.3.8 Present value change

(1) Flow chart



(2) Conditions

Signal	State	Remarks
Relevant axis BUSY	OFF	

Table 6.8 Present Value Change Condition

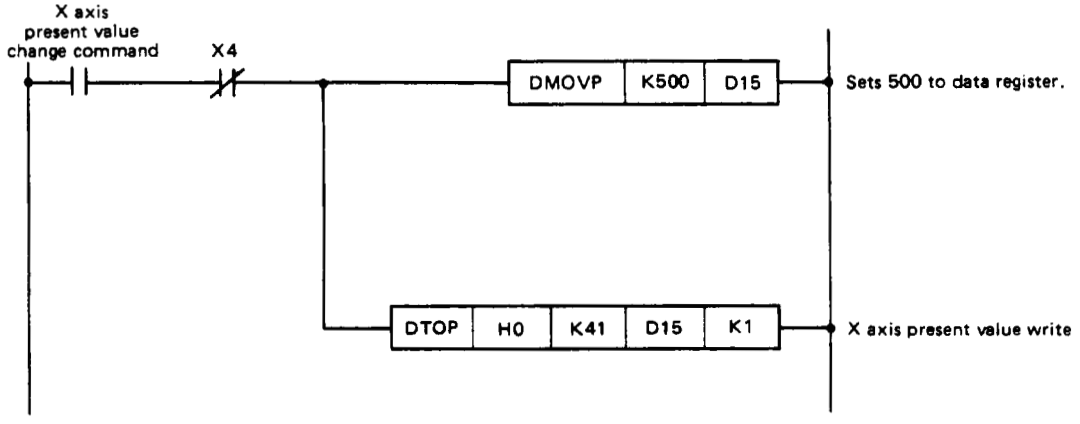
(3) Program

[Example] To set the X axis present value to 500

[Data transfer]



[Program]



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REMARKS

1. Always write the two (upper and lower) words to the present value change addresses simultaneously. Writing one word only will not change the present value and will cause an error to be flagged.

2. Zeroing will always set the present value back to the zero address, however the zeroing data and the parameters should be written to the buffer memory before zeroing.

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6.3.9 Positioning stop

The positioning process may be stopped while the AD71 is busy as follows:

Item	Valid Signal	Independent Operation		Interpolation Operation
		Relevant axis	Other axis	
STOP signal from drive unit ON	↑	○		○
PC ready signal (Y1D) OFF*	↓	○	○	○
Stop signal from PC (Y15, Y16) ON	↑	○		○
BREAK key input from GPP or STOP key input from AD71TU	↑	○	○	○

○ indicates that the signal is valid.
*In GPP or AD71TU test mode, positioning is not stopped if Y1D is on or off.

Table 6.9 Stop Signals

(1) Note on use of stop signal

(a) Deceleration is valid after stop signal is received

On receiving any of the stop commands given in Table 6.9, the system is decelerated to a stop.
All emergency stops and limits must be hard-wired.

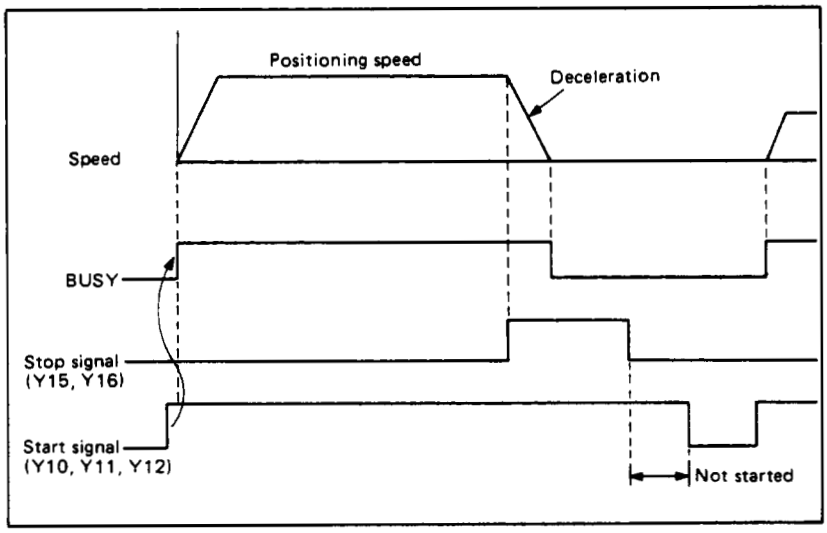


Fig. 6.9 Stop Signal

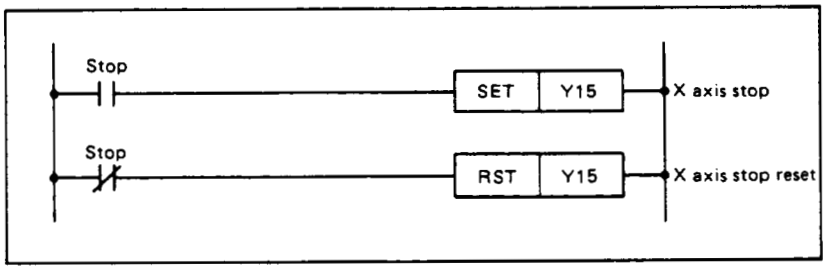


Fig. 6.10 Stop Program Example

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(b) Stop signal during deceleration

When a stop signal is received during normal deceleration, this has no effect on the rate etc. However if the signal is received during zeroing, positioning stops immediately.

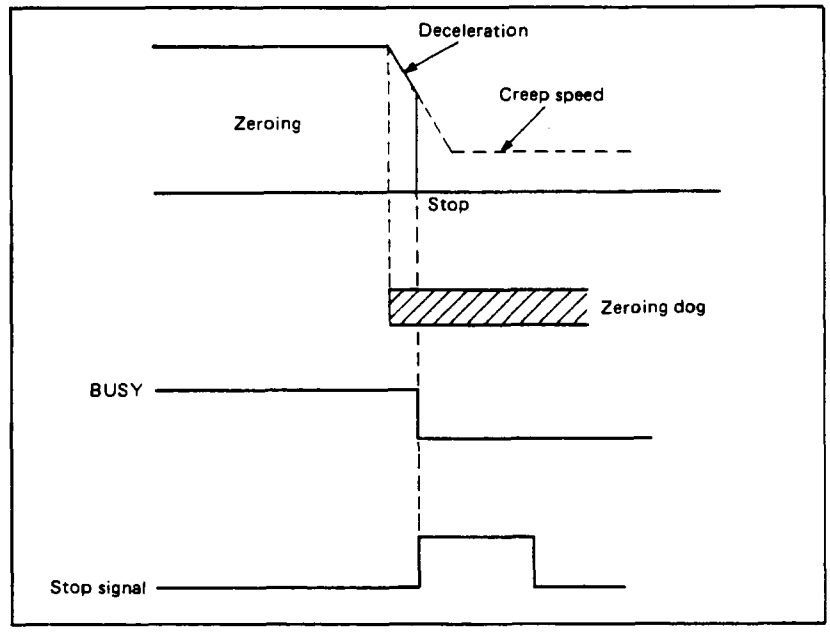


Fig. 6.11 Stop Command Received during Zeroing Deceleration

REMARKS

Giving the stop command at any point after the zeroing dog has been actuated will invalidate the zeroing process. In this case the system must be manually driven (jog or inch) to a point before the zeroing dog and the process repeated.

(c) Stop signal reset

A start signal (Y10, Y11, Y12) is only valid at its leading edge, therefore if it is already on when the stop signal is reset the process will not restart.

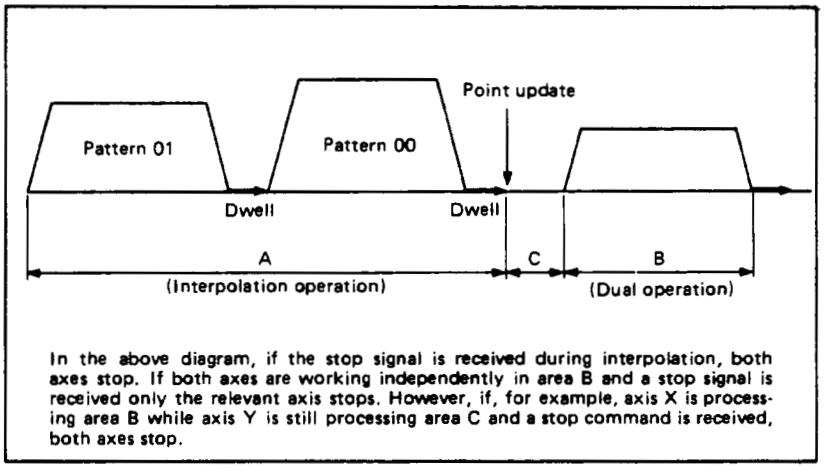
(d) M code

The conditions shown in Table 6.10 turn off the M code ON signal at the relevant axis. When the PC ready signal is turned off, the M code is set to "0".

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(e) Stop during interpolation operation

During interpolation, both axes are stopped by either the X- or the Y-axis stop signal. Where interpolation and dual operation are combined the effect of the stop command will depend on where in the cycle the AD71 has reached (see below).



In the above diagram, if the stop signal is received during interpolation, both axes stop. If both axes are working independently in area B and a stop signal is received only the relevant axis stops. However, if, for example, axis X is processing area B while axis Y is still processing area C and a stop command is received, both axes stop.

Fig. 6.12 Stop during Interpolation

(2) Other stop signals

In addition to the four stop signals in Table 6.9, the following also stop processing while the AD71 is BUSY. For all the following, positioning is decelerated to a stop and the GPP displays an error message.

Item	Valid Signal	Independent Operation		Interpolation Operation
		Relevant axis	Other axis	
Ready signal from drive unit OFF	↓	○		○
Operation error (8231 error)		○	○	○
AD71 bus error		○	○	○

Table 6.10 Stop Signals (Hardware)

(3) Restart after stop

(a) Proceed to next address

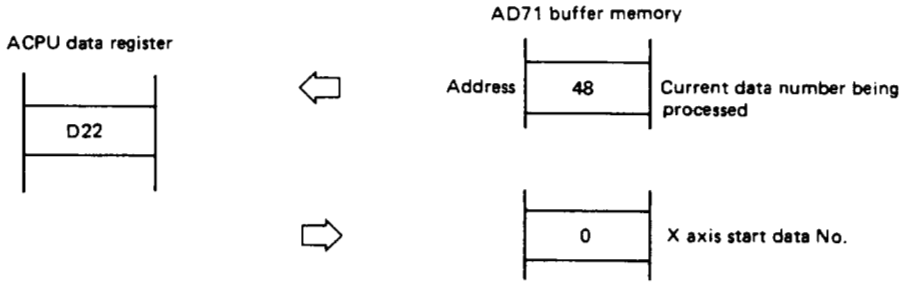
When a sequence of start data numbers have been specified with a pointer, it will be necessary to zero the system or to reset the positioning data after a stop signal is received. The above also applies to incremental processing when only one start number is specified.
Only in absolute address processing can the system proceed to the next address after a restart.

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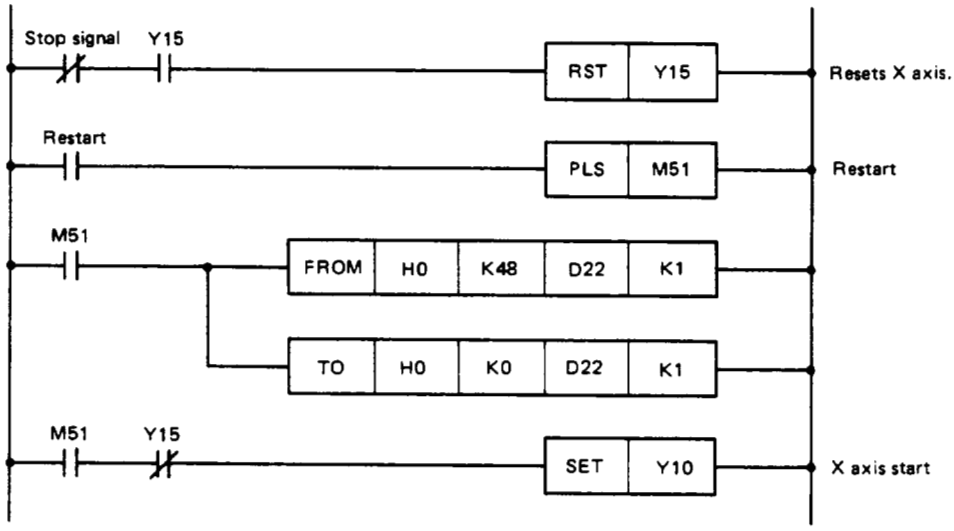
1) Absolute processing with one start data number

During positioning, the current data number is stored in buffer memory address 48 (X axis) and 348 (Y axis) and retained until the next positioning process is started. This data can be used to restart the process.

[Data transfer]



[Program]



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(b) Positioning has been stopped using the "BREAK" key on the GPP

The "BREAK" key stops both the X and Y axes. Positioning can be restarted when both axes are not busy.

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6.4 ACPU Remote I/O Station Programming

6.4.1 Notes on programming

Data communication with a remote I/O station is on a batch refresh basis after the END (or FEND) instruction is executed in the master station program.
For detailed data link specifications, refer to the Data Link Unit User's Manual.

(1) There is a short time delay in the communication of control data between master and remote I/O stations which must be allowed for when specifying the system.

(2) The following data communication instructions are used between master and remote stations:

Data write from master to AD71	: RTOP instruction
Data read from AD71 to master	: RFRP instruction

Note that link registers W, are used for data communication between master and remote stations.

(3) The RTOP and RFRP instructions cannot be executed in the same scan for one AD71 in a remote I/O station. (These may be used in the same scan if addressed to separate AD71 units.) All data communication must therefore be interlocked as shown in the examples that follow.
I/O numbers have been assigned as X0 to 1F and Y0 to 1F.

(4) Control signals between master and remote stations

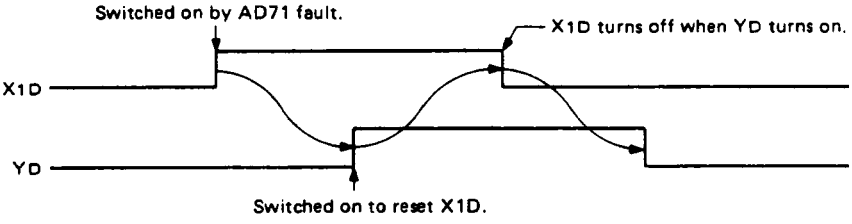
The PLS instruction must not be used for control I/O communication.

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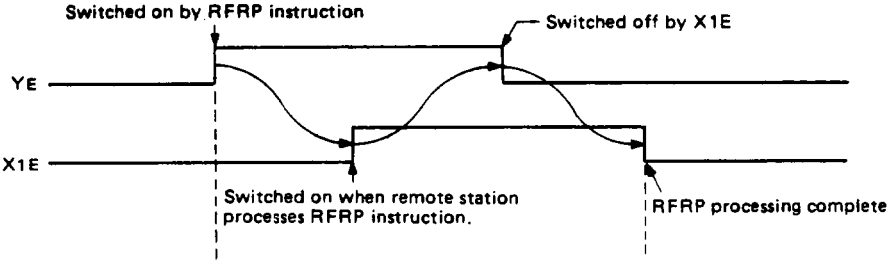
Signal Direction: PC CPU to AD71		Signal Direction: AD71 to PC CPU	
Device No.	Signal	Device No.	Signal
Y0 to YC	Reserved	X1D to X1C	Reserved
YD	Switches X1D off.	X1D	On indicates AD71 fault. RFRP and RTOP instructions cannot be used.
YE	Switched on by master station CPU when RFRP instruction is executed (data transferred from link unit to master station CPU). To be reset in user program after ensuring that X1E is on.	X1E	On while AD71 in remote station is processing RFRP instruction.
YF	Switched on by master station CPU when RTOP instruction is executed (data transferred from master station CPU to link unit). To be reset in user program after ensuring that X1F is on.	X1F	On while AD71 in remote station is processing RTOP instruction.

Timing

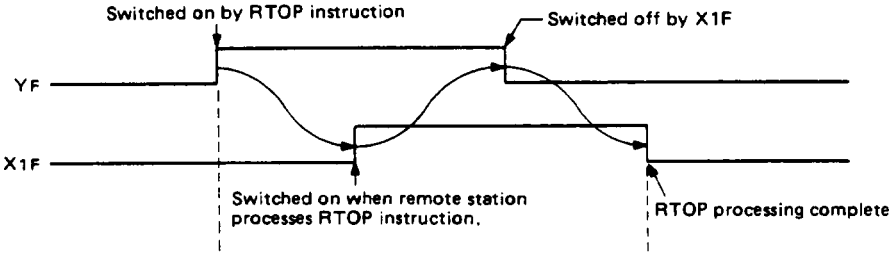
AD71 fault. RTOP and RFRP instructions cannot be used.



Execution of RFRP instruction



Execution of RTOP instruction

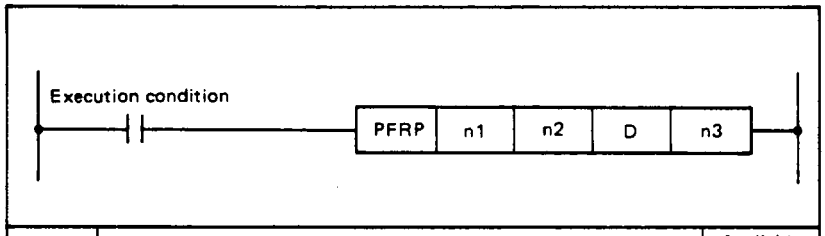


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6.4.2 Reading and writing data

(1) Read from remote I/O station

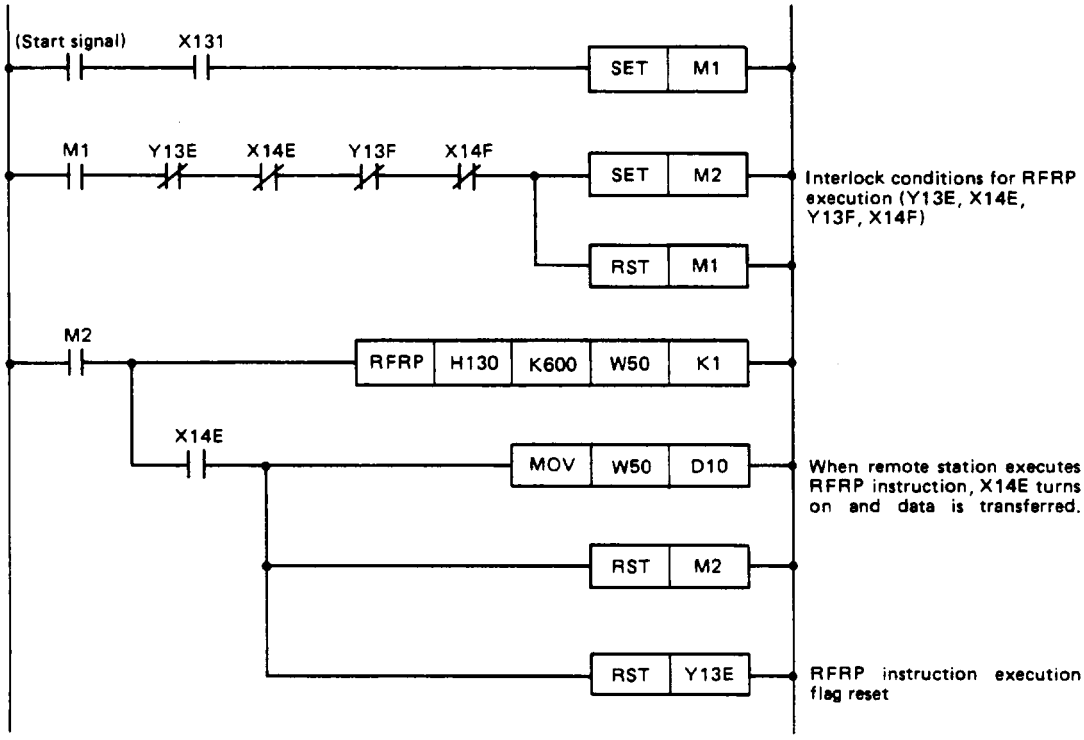
[Format]



Symbol	Description	Available Device
n1	AD71 I/O number assignment from master station	K, H
n2	Head buffer address to be read	K, H
D	Head link register to which data will be written	W
n3	Number of data words to be read (1 to 16)	K, H

Example: Reading one word from buffer address 600 of the AD71 located at I/O address X, Y130 to 14F in a remote I/O station.

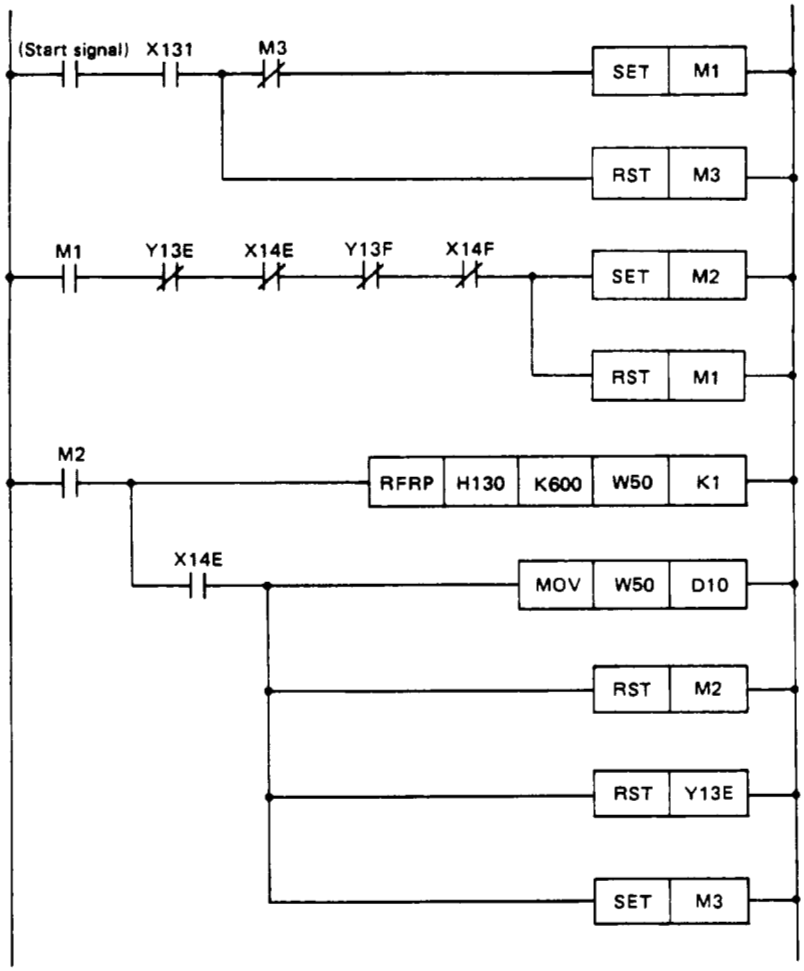
To read once on receiving the start signal



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To continually read while start signal is on.



POINT

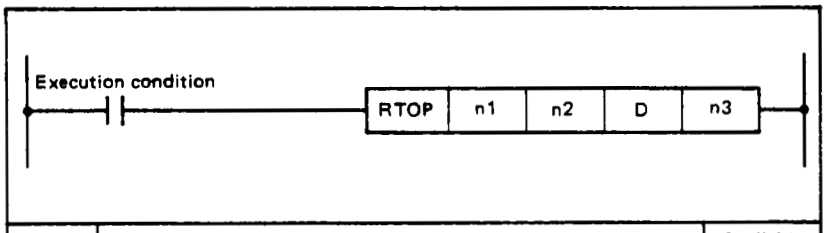
The head I/O number specified in the RFRP and RTOP instructions is the complete number.

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(2) Write to remote I/O station AD71

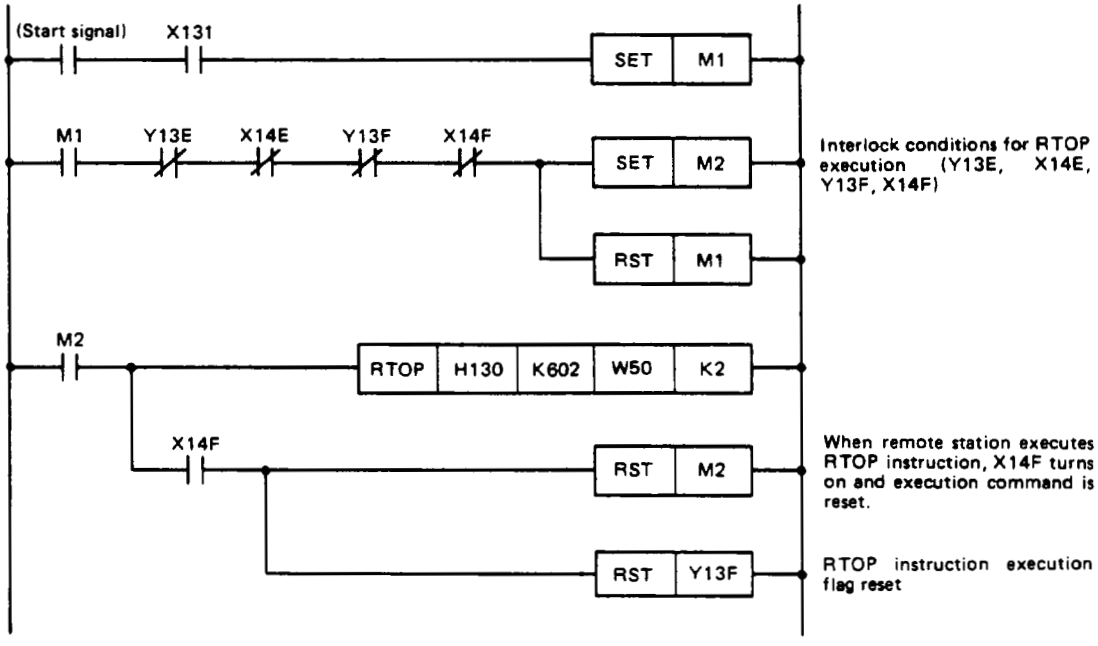
[Format]



Symbol	Description	Available Device
n1	AD71 I/O number assignment from master station	K, H
n2	Head buffer address to which data will be written	K, H
D	Head link register from which data will be read	W
n3	Number of data words to be written (1 to 16)	K, H

Example: Writing two words to buffer address 602 and 603 of the AD71 located at I/O address X, Y130 to 14F in a remote I/O station.

To write once on receiving the start signal



POINT

The head I/O number specified in the RFRP and RTOP instructions is the complete number.

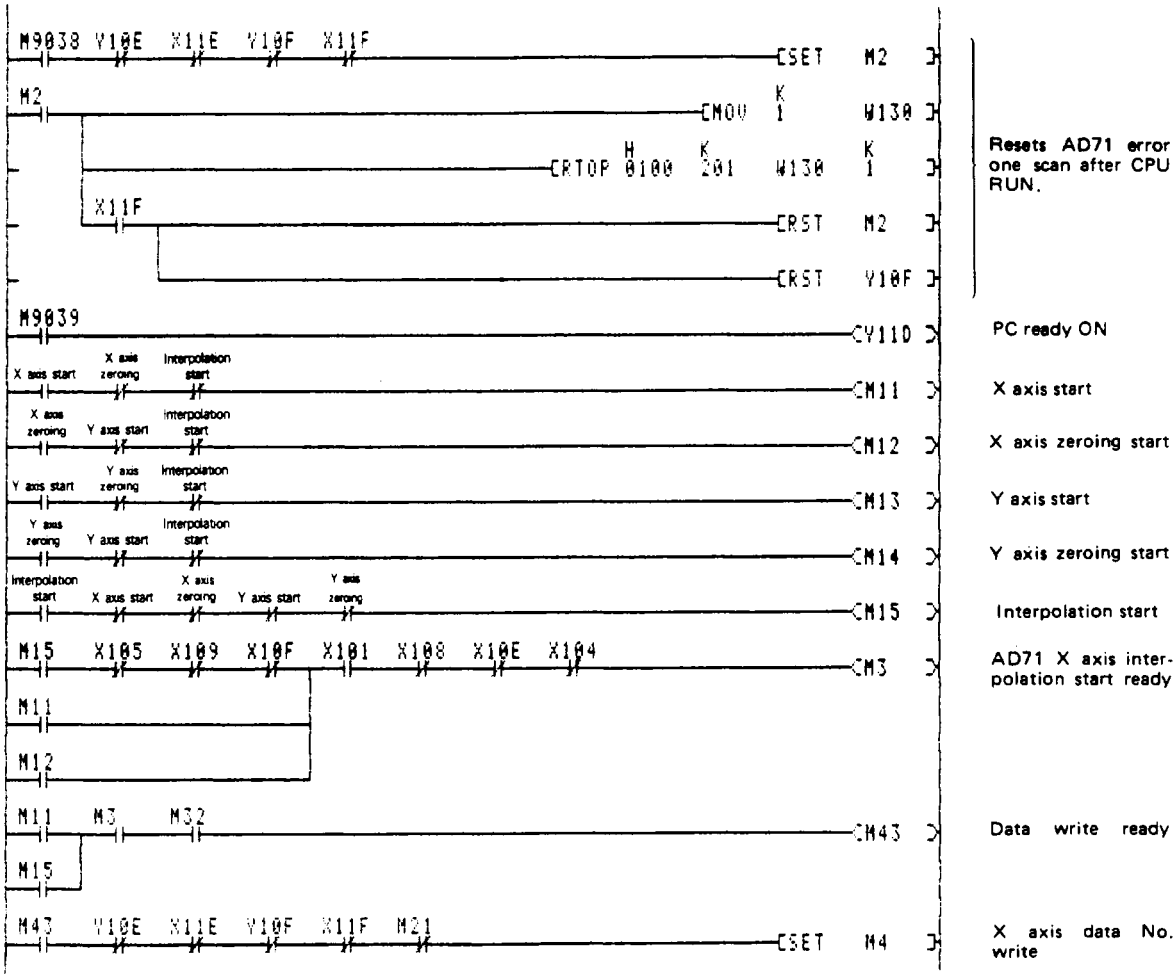
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6.4.3 Program example

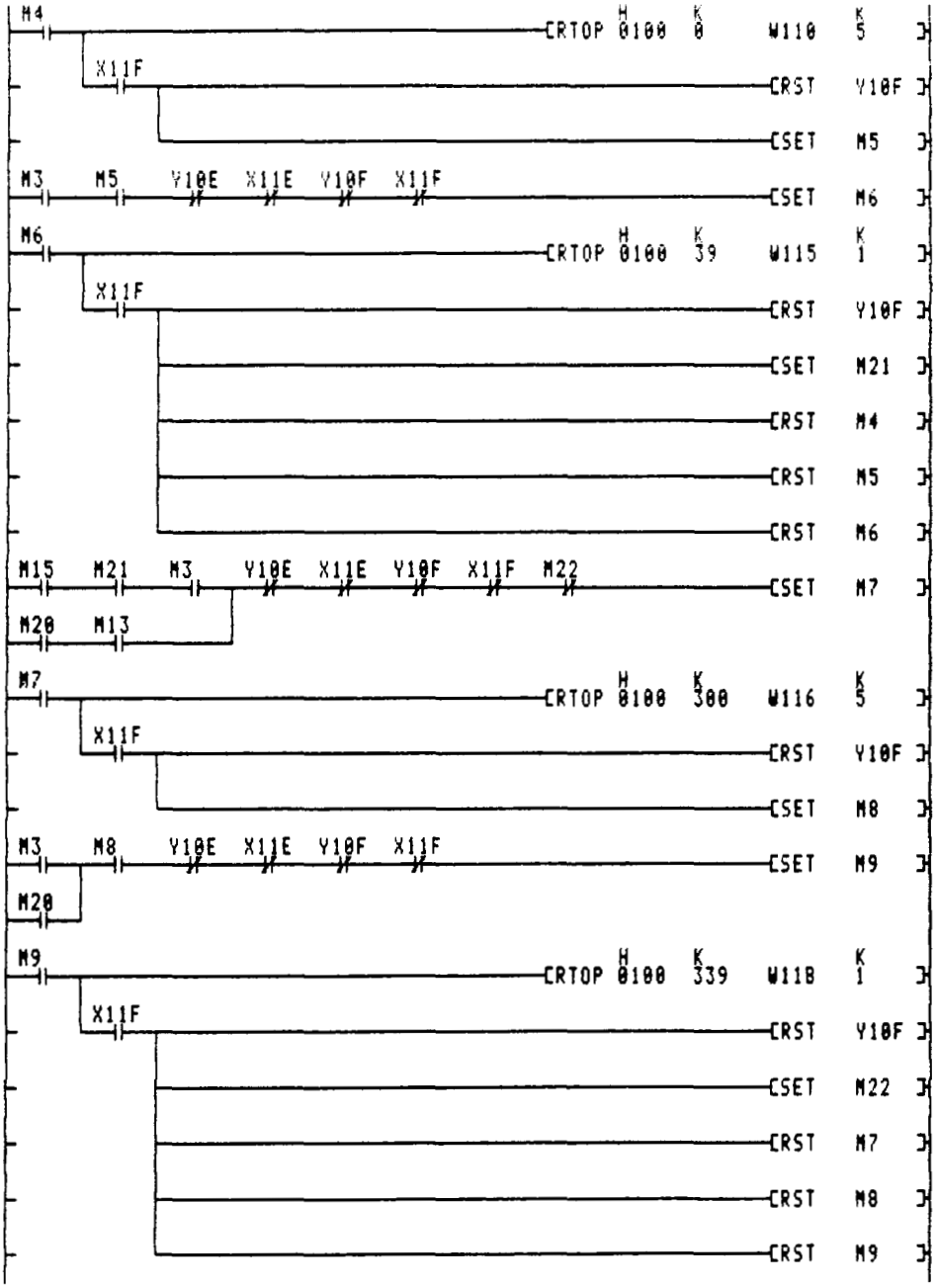
The following program enables X and Y axis starts, interpolation start, and zeroing. Preconditions are as follows:

1. Parameters, zeroing data, and positioning data should all have been written to the AD71 in the remote I/O station using the A6GPP (SW0-AD71P).
2. The AD71 should have been assigned from the master station to X, Y100 to 11F.
3. 64 link registers are used (W100 to 13F) for RTOP instruction and 64 (W200 to 23F) for RFRP.
4. Data numbers, pointers, etc. should have been written to the link registers.

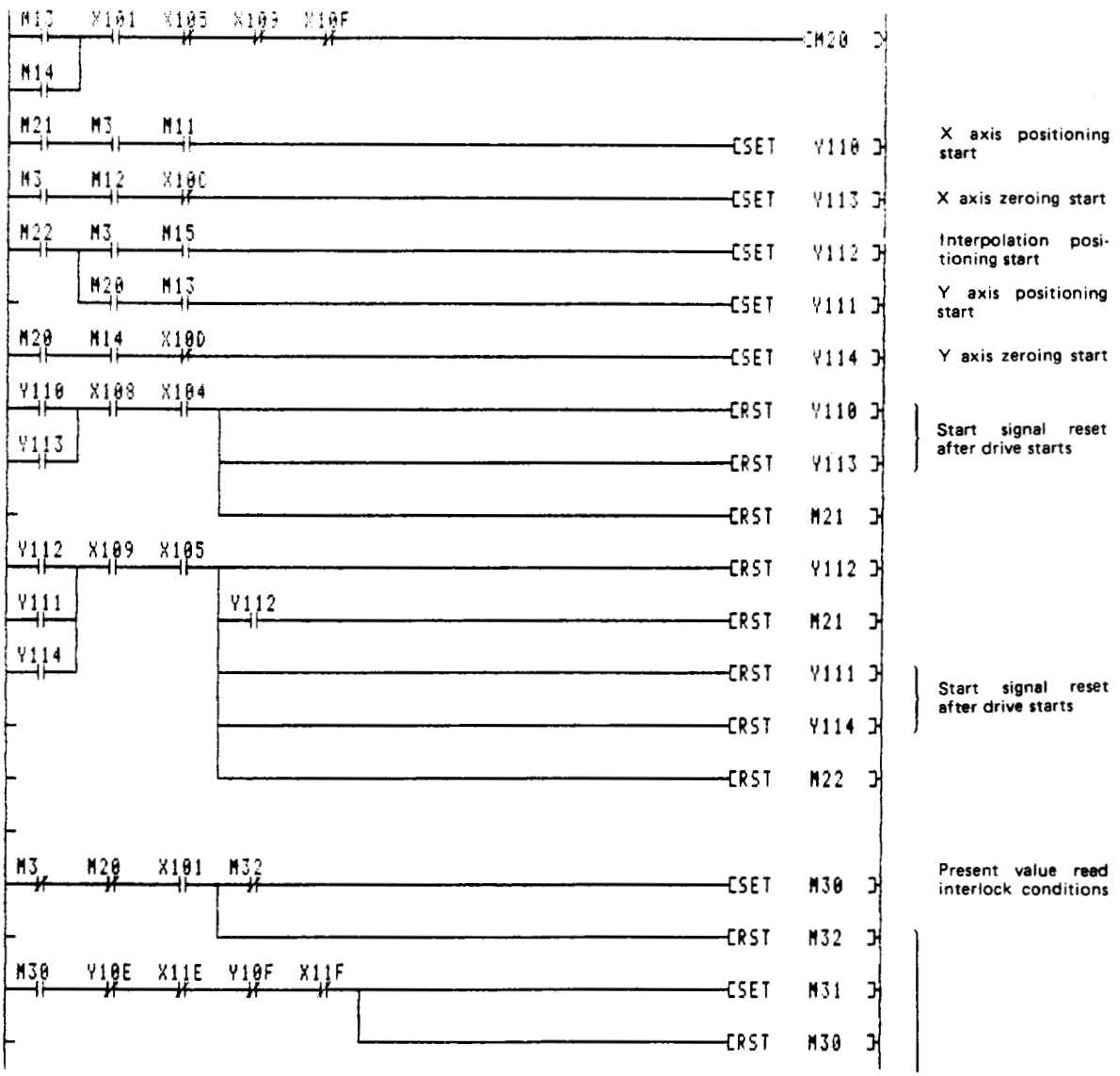


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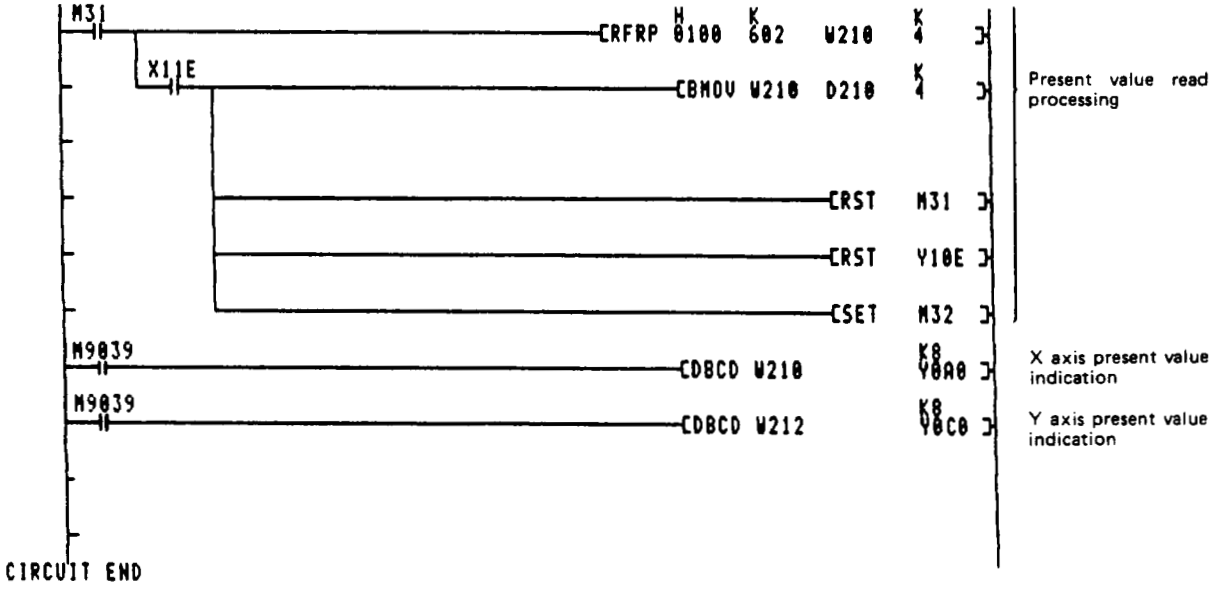
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7. CHECK LISTS

The checklists given in associated equipment manuals should also be referred to.

7.1 General Check List

Before testing the AD71, check the following:

	Check Point	Description	Check
1	Battery	• Check that battery leads are connected to the printed circuit board.	
2	Parameter setting	• Check that parameters have been set. • Check that values are correct.	
3	Zeroing data setting	• Check that zeroing data has been set. • Check that values are correct.	
4	Positioning data	• Check that positioning data has been set. • Check that values are correct.	

Table 7.1 General Check List

POINT

If only one axis (X or Y axis) is used, parameters and zeroing data must be written to the unused axis. Otherwise zeroing will result in error and switch on the X0B (error detection) signal.
(Data written must be within the range given in the User's Manual. Parameters may be default values.)

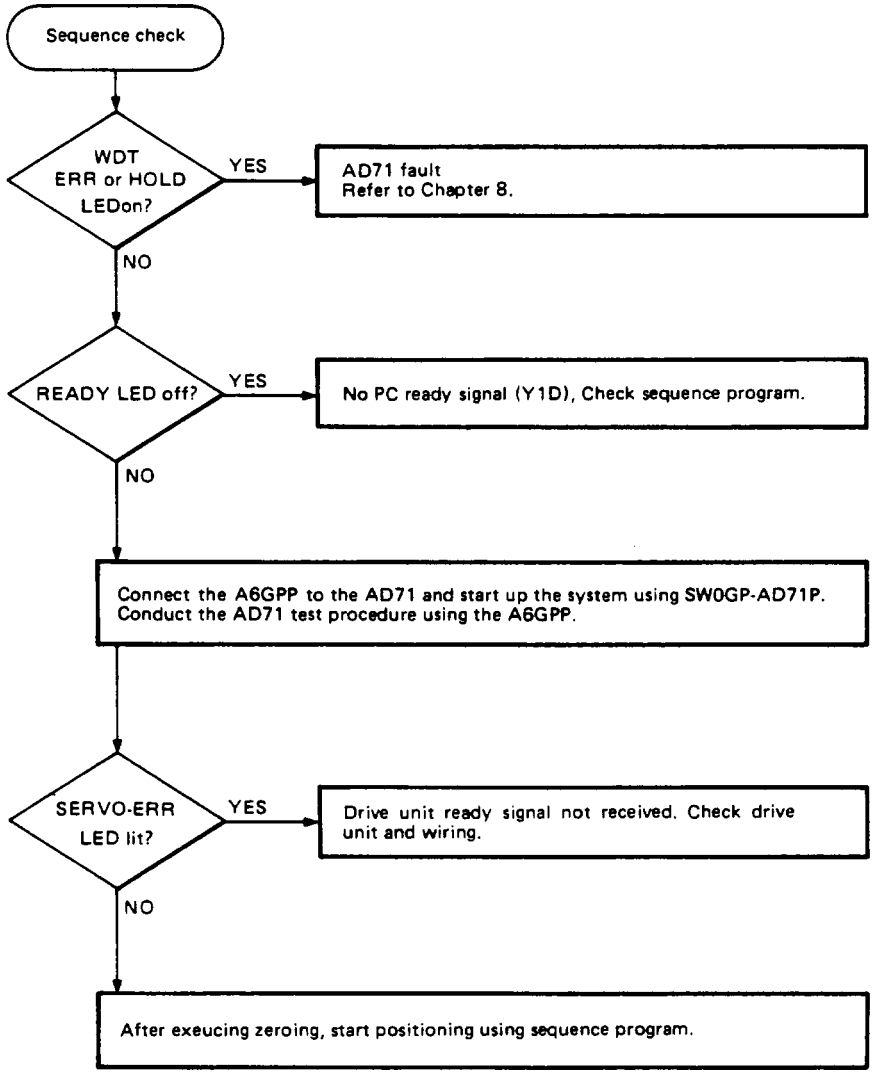
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7.2 Tests and Adjustments

Refer also to the A series CPU User's Manual.

7.2.1 Sequence check

Use the following procedure to check the system.
Set the key switch on the AD71 front panel to "LOCK." This only changes the present value and allows checking of the positioning functions with the feed pulse output stopped.



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7.2.2 Checking positioning operation

After completing the checks given in Section 7.2.1, move the key switch on the AD71 front panel to "OFF" or "M.PRO."
Set the speed limit parameter to a low value.
Zero the system and check positioning operation. Use the SW0GP-AD71P monitoring function to check for error codes etc.

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8. TROUBLESHOOTING

Errors may be detected by:

1) the AD71 CPU; or
2) the A6GPP during program development and debugging.

This section describes errors detected by the AD71 CPU, for other errors see the SW0GP-AD71P Operating Manual.

8.1 Errors Detected by AD71

The AD71 has various error check functions. When an error occurs, an error code is written to address 45 (X axis) and 345 (Y axis) in the buffer memory.

(1) A new error will overwrite the previous one in the buffer memory.

(2) Error code "0" indicates no error.

(3) Error reset

Errors are reset by writing a "1" to buffer address 201. (See Section 6.3.2 (7), page 6-14.)
For resetting of errors using the A6GPP, refer to the SW0GP-AD71P Operating Manual.

(4) Error detection

XB is the error detection flag. Resetting the error also resets XB.

Error codes are classified as shown in Table 8.1.

Error Code	Error Classification	Remarks
1 to 49	Data range error	Refer to Section 8.1.1.
50 to 59	AD71 HOLD error	Refer to Section 8.1.2.
60 to 69	Buffer memory write disable error	Refer to Section 8.1.3.
70 to 79	AD71 start and operation error	Refer to Section 8.1.4.
80 to 89	AD71 BUSY stop error	Refer to Section 8.1.5.

Table 8.1 Error Code Classification

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8.1.1 Data range errors

Any of the operations shown in Table 8.2 will prompt a data range check by the AD71 as shown below.

Data	Operation
Parameters	• At power on* • When parameters have been transferred from the A6GPP to the AD71. • When PC ready signal (Y1D) changes from OFF to ON. • When positioning, zeroing, jog, or inching has been selected in A6GPP test mode.
Zeroing data	• When parameters or zeroing data has been transferred from the A6GPP to the AD71. • When PC ready signal (Y1D) changes from OFF to ON. • When positioning, zeroing, jog, or inching has been selected in A6GPP test mode.
Positioning data	• At the start of positioning (Refer to the figure in Section 6.3.)

*: The power on check will not give an error code or an error detection signal (XB).

Table 8.2 Data Range Check

A list of error codes is shown in Table 8.3.

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Error Code	Data Type	Check Point	Check Range	Re-marks
0			Normal	
1	Parameter	Travel per pulse	1 to 100	
2		Speed limit value	1 to 12,000 in mm, inch, or degree { If travel per pulse is "a" (unit/PLS), speed V range is restricted as given below: $\frac{V\ (unit/PLS)}{a\ (unit/PLS)} \leqq 200{,}000$ PLS/sec } 1 to 20,000 in PLS	
3		Jog speed limit value	1 to parameter speed limit value	
4		Starting bias speed	0 to parameter speed limit value	
5		Acceleration and deceleration times	64 to 4,999	
6		Backlash	0 to 255 in PLS	
7		Upper stroke limit	0 to 162,000 in mm 0 to 16,200 in inch or degree 0 to 16,252,928 in PLS	*2
8		Lower stroke limit	0 to upper stroke limit	
9		Error compensation	0 to 100,000 in mm, inch, or degree	
10		Travel per manual pulse during inching	1 to 100,000 in mm, inch, or degree 1 to 100 in PLS	
11		Positioning method	00, 01, or 10 in bits b4 and b3	
12		Positioning complete signal duration	0 to 20,000	
20	Zeroing data	Zero address	0 to 1,620,000,000 in mm, inch, or degree 0 to 16,252,928 in PLS	*2
21		Zeroing speed	Starting bias speed to parameter speed limit. (Not 0)	*1
22		Creep speed	Starting bias speed to parameter zero point return. (Not 0)	
23		Dwell time	0 to 499	
24		Torque limit	10 to 250	
30	Positioning data	Positioning speed	Starting bias speed to parameter speed limit. (Not 0)	*1
31		Positioning address	Within stroke limits	
32		Dwell time	0 to 499	
33		Positioning pattern	00, 01, or 11 in bits 0 and 1 (00 only if start data No. is 400)	
34			Pattern 11 may be used a max. of 9 times consecutively.	
35			Travel for consecutive 11 patterns must be in the same direction.	
36			The addressing method must be the same for consecutive 11 patterns.	
37			Interpolation start setting for both axes must be the same (00 or 01).	

Table 8.3 Data Range Error Codes (Continue)

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Error Code	Data Type	Check Point	Check Range	Remarks
40	Positioning start data	Start number	1 to 400	
41		Pointer	0 to 19	
42		Speed change	Starting bias speed to parameter speed limit (Not 0)	*1
43		Present value change	0 to 1,620,000,000 in mm, inch, or degree 0 to 16,252,928 in PLS	*2
44		Jog speed	Starting bias speed to parameter jog speed limit (Not 0)	*1
45		Start axis	When two axes are to be started at the same time, both must be set for interpolation start or for dual axis start.	
46		Start axis	The second axis must not be busy or must be behind the start point when an interpolation start or a dual axis start is called.	

*1: If the set speed exceeds the parameter speed limit value, positioning is controlled at the parameter speed limit value.

*2: If the units are mm, inch, or degree and travel per pulse is "a" (unit/PLS), the address S range is restricted as given below:

$$\frac{S\ (\text{unit})}{a\ (\text{unit/PLS})} \leqq 16{,}252{,}928\ (\text{PLS})$$

Table 8.3 Data Range Error Codes

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8.1.2 "HOLD" LED

The errors shown in Table 8.4 are indicated by the AD71 "HOLD" LED. Errors 50 or 51 indicate a hardware failure.
A bus error may be due to a hardware failure or to the sequence program accessing too much of the buffer memory too frequently. In the case of the latter, the sequence program must be changed in order to allow sufficient time for the AD71 to access the buffer memory between buffer → PC transactions.

Error Code	Check Point	Error Definition
50	Operation element (8231)	Operation time-out error (hardware fault)
51		Operation error (overflow, underflow, etc.)
	AD71 bus error	The PC has priority for accessing the buffer memory. If accessing is too frequent the AD71 may not be able to access the data.

Table 8.4 AD71 Hold Error Codes

In the event of any of the above errors occurring 1) turn off the AD71 ready (X1) and 2) force BUSY processing to stop. The start signal is then not accepted.

8.1.3 Buffer memory write errors

Writing data from the sequence program to prohibited buffer addresses or writing when the buffer cannot accept the data prompts the error codes shown in Table 8.5.

Error Code	Shared Memory Address	Error Definition
60	39,339	Pointer value is not 0 though 20th point has been reached. Data has been written to pointer address while BUSY.
61	40,340	"Speed change" during interpolation.
62	41, 42, 341, 342	"Present value change" while BUSY.
63	7872 to 7928	Data written from PC while Y1D is on.
64	Monitoring present value area Speed area	Data written from PC to a write prohibit address.

Table 8.5 Buffer Memory Write Error Codes

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8.1.4 AD71 BUSY (positioning) stop errors

The following error codes result from the AD71 losing the READY signal while it is BUSY or zeroing is stopped.

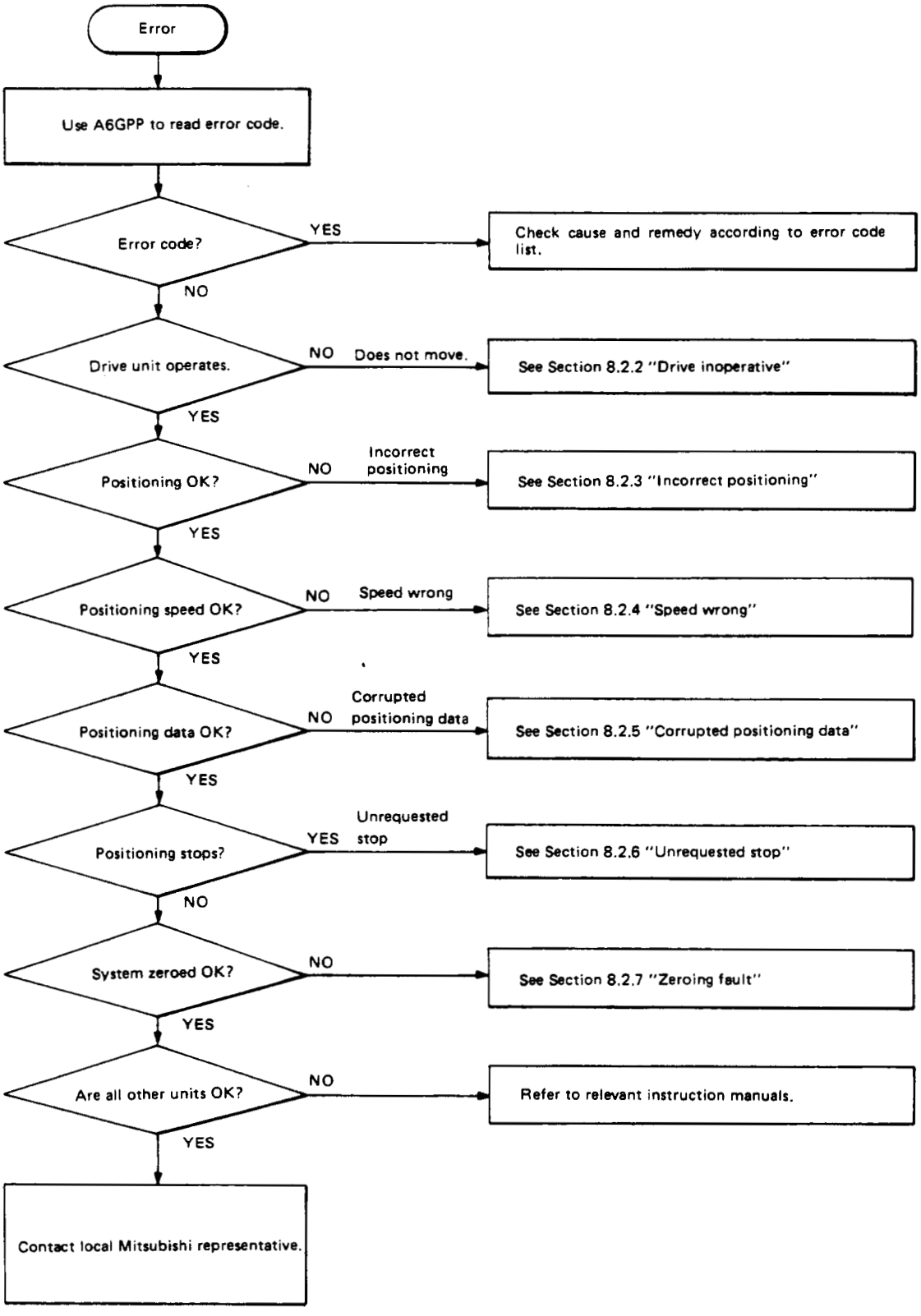
Error Code	Factor	Corrective Action
80	READY lost while AD71 is BUSY.	Check drive unit and READY signal.
81	Zeroing stopped.	Zeroing is not allowed more than twice consecutively. If necessary jog to a safe position in front of zeroing dog and restart zeroing.

Table 8.7 BUSY Error Codes

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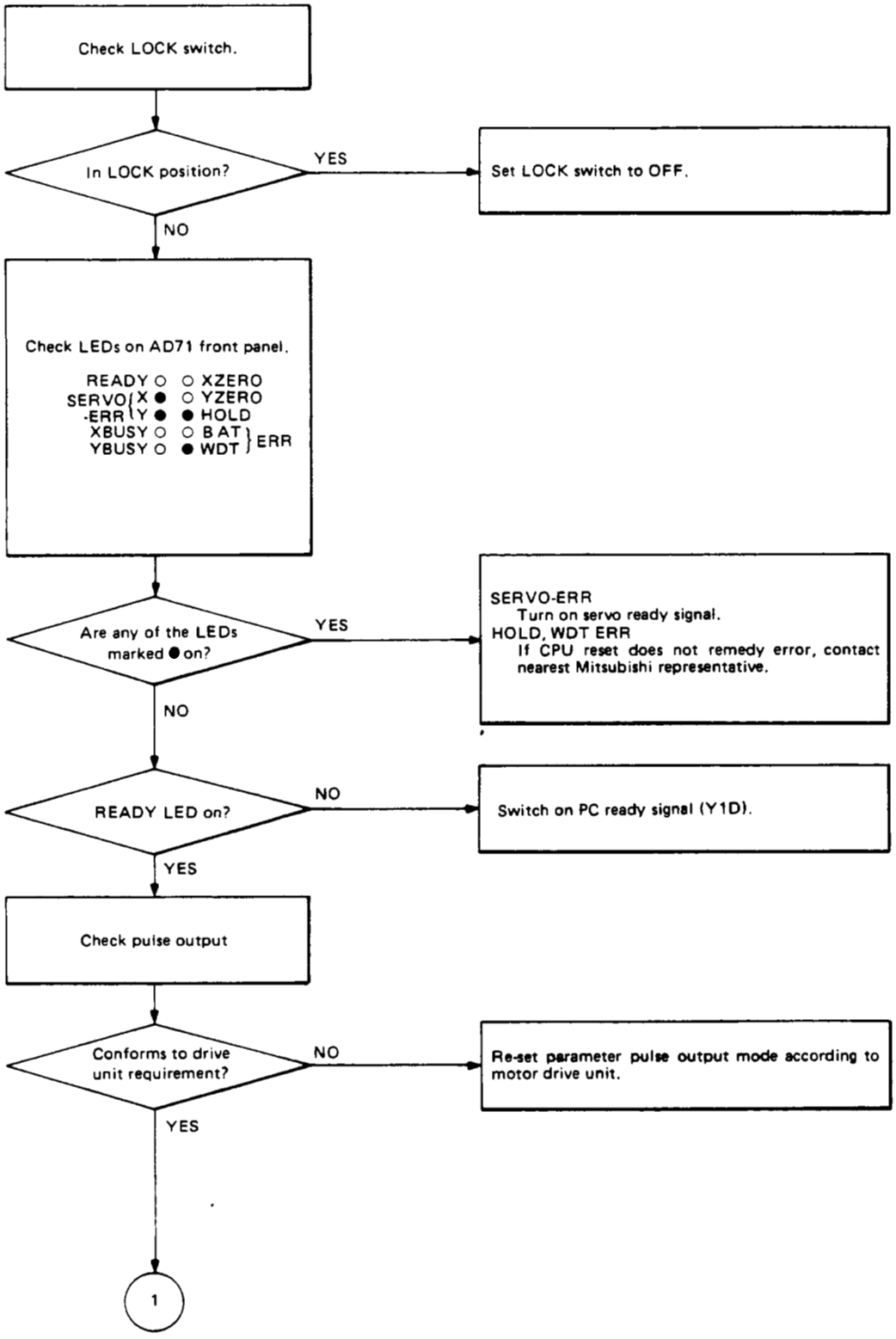
8.2 Troubleshooting

8.2.1 General troubleshooting

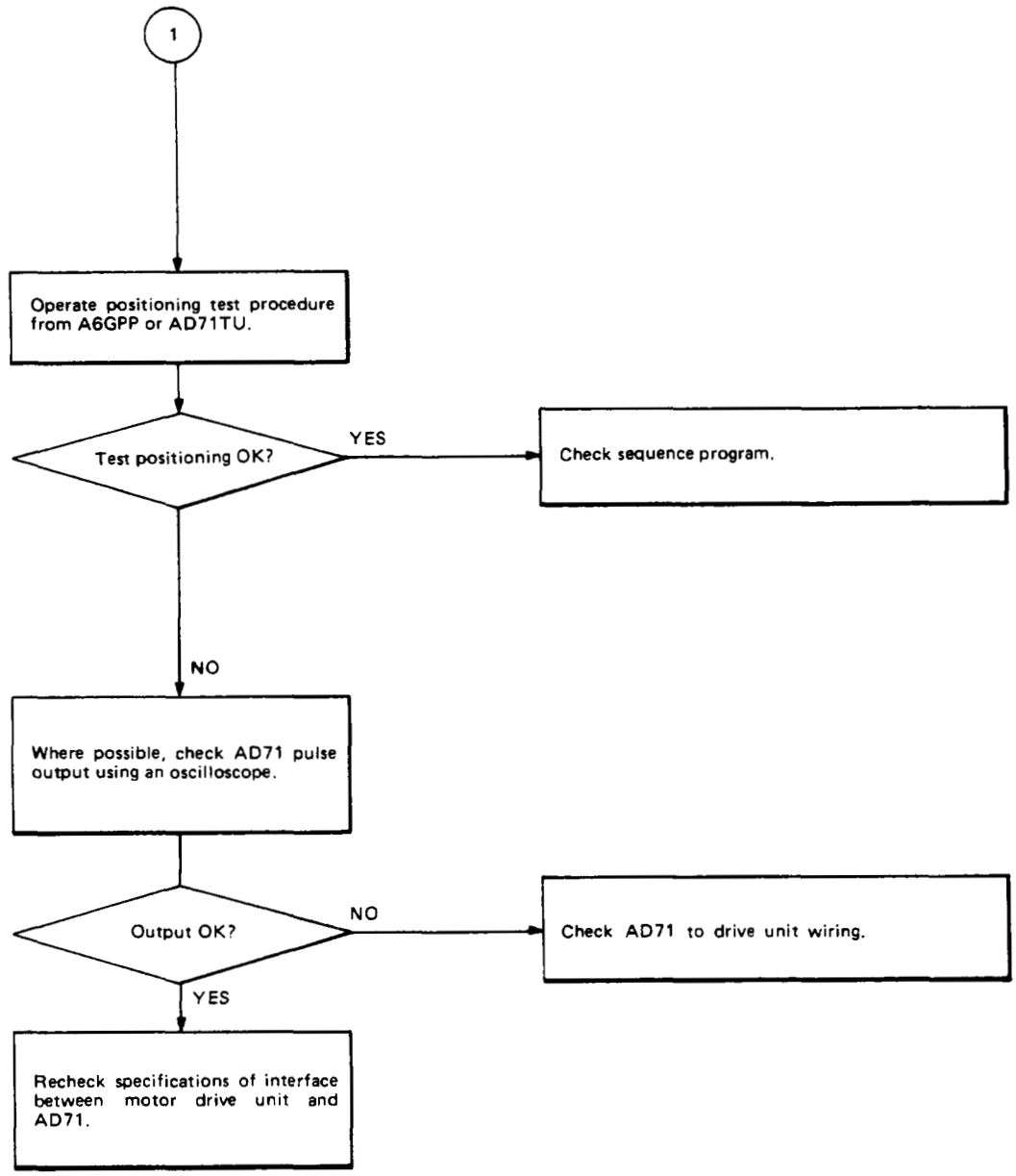


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8.2.2 Drive inoperative

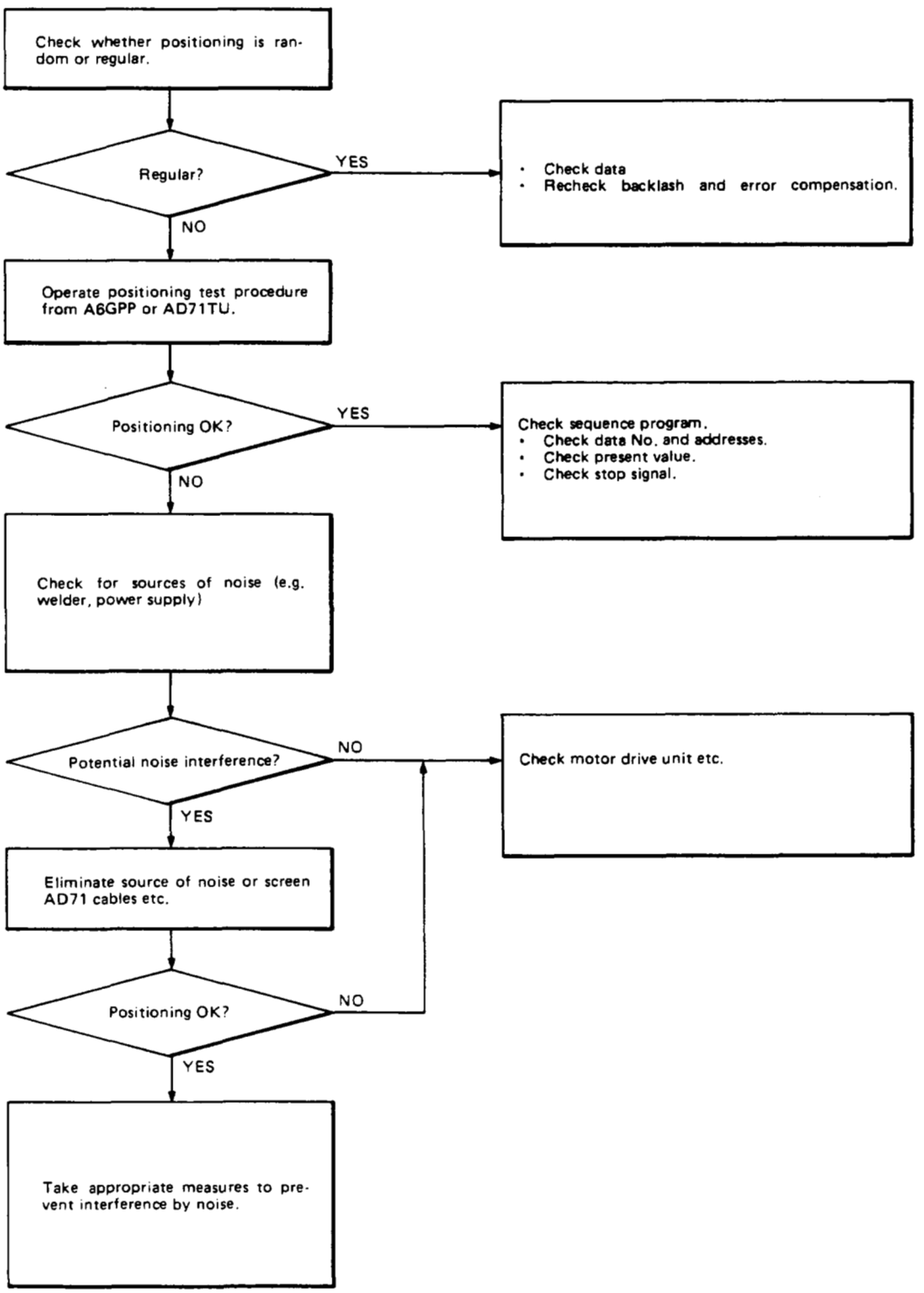


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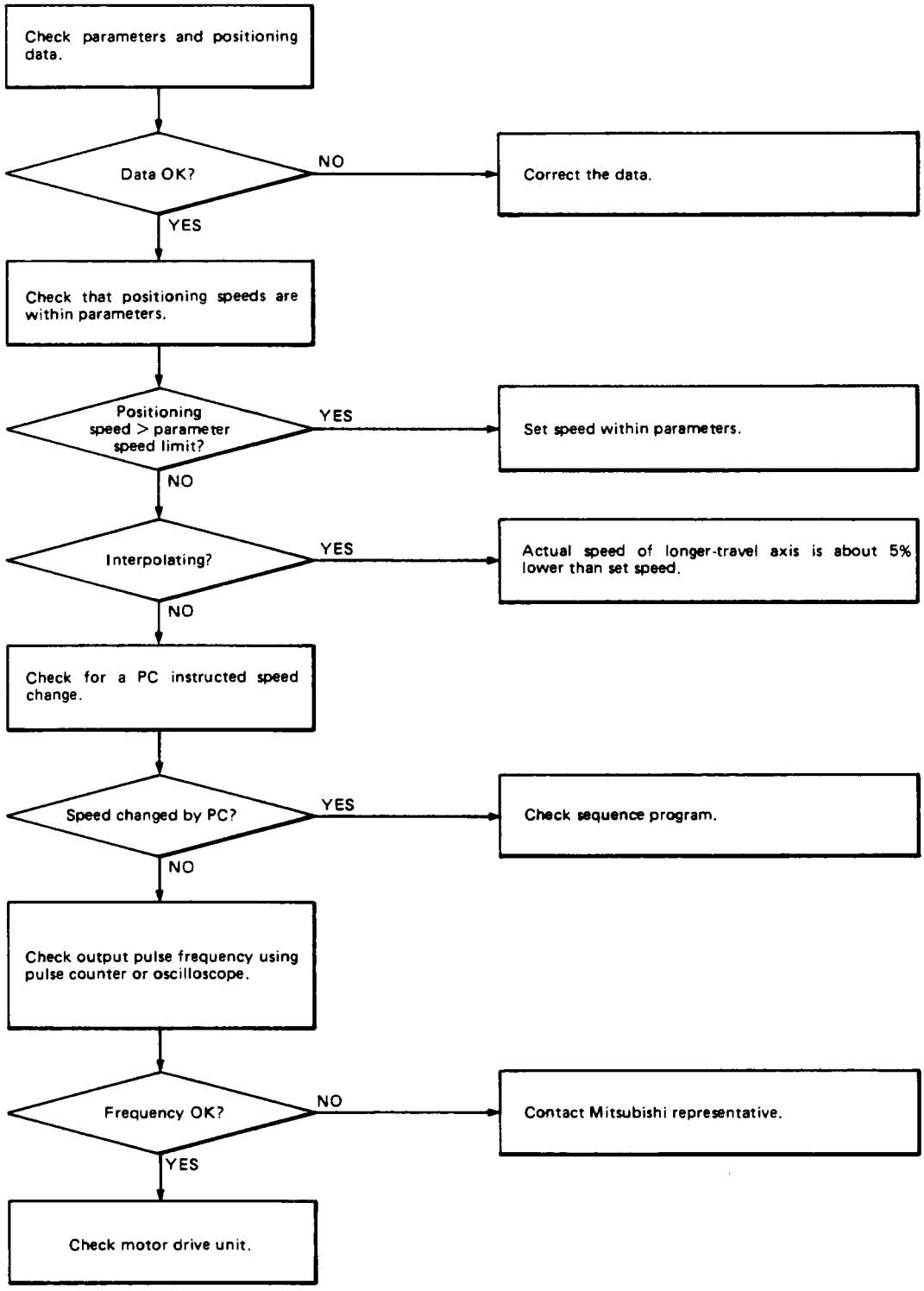
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8.2.3 Incorrect positioning



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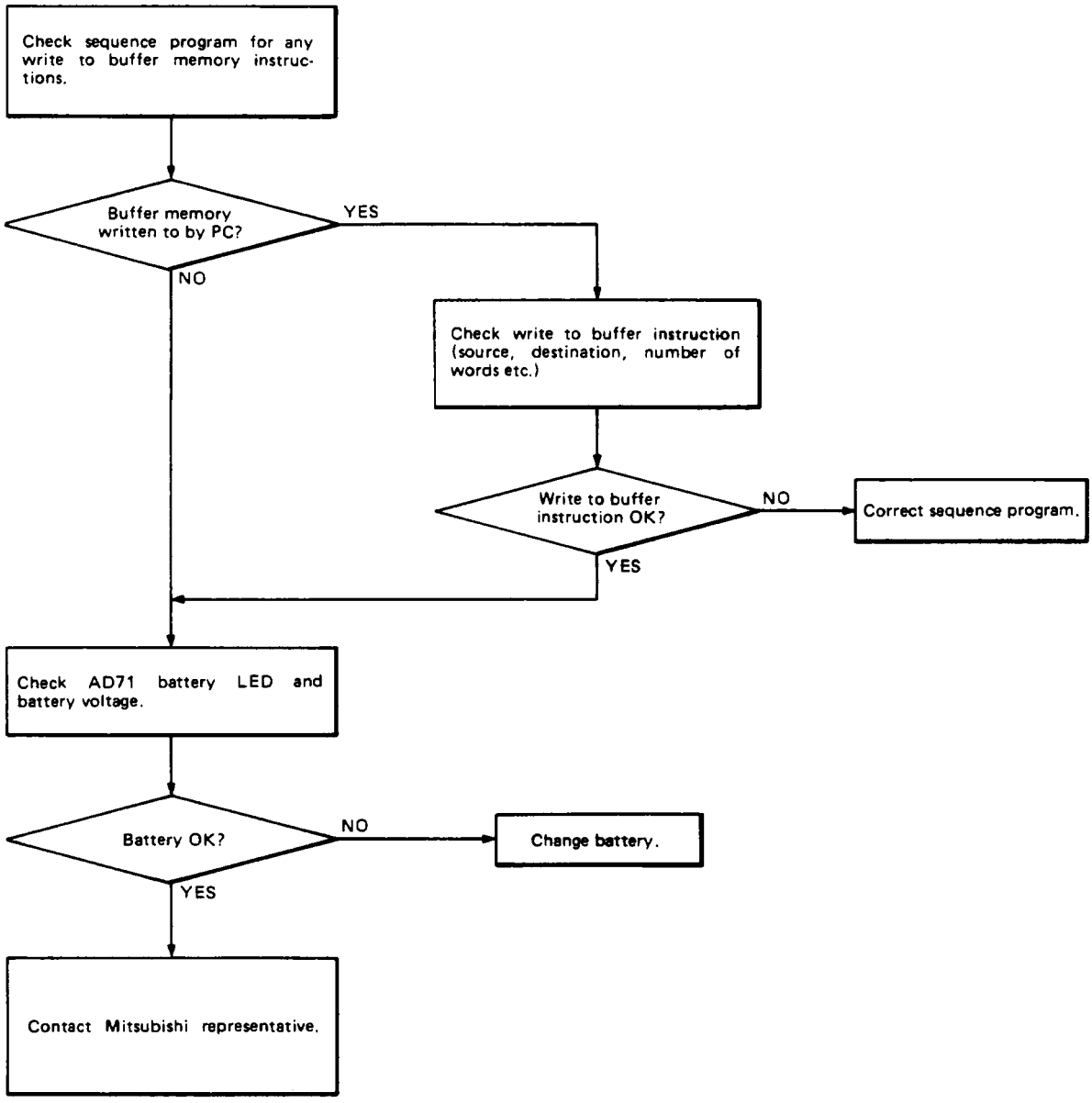
8.2.4 Speed wrong



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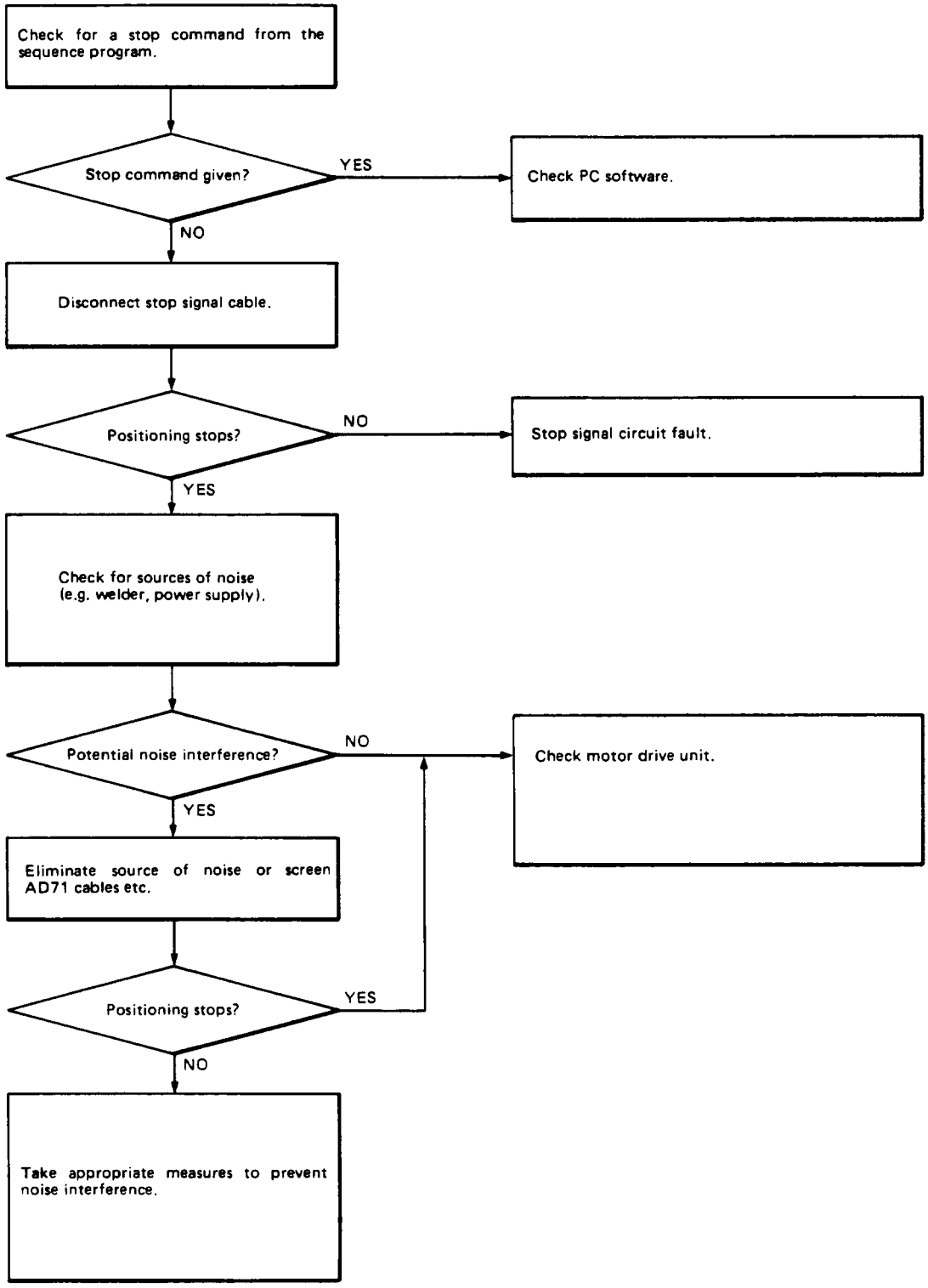
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8.2.5 Corrupted positioning data



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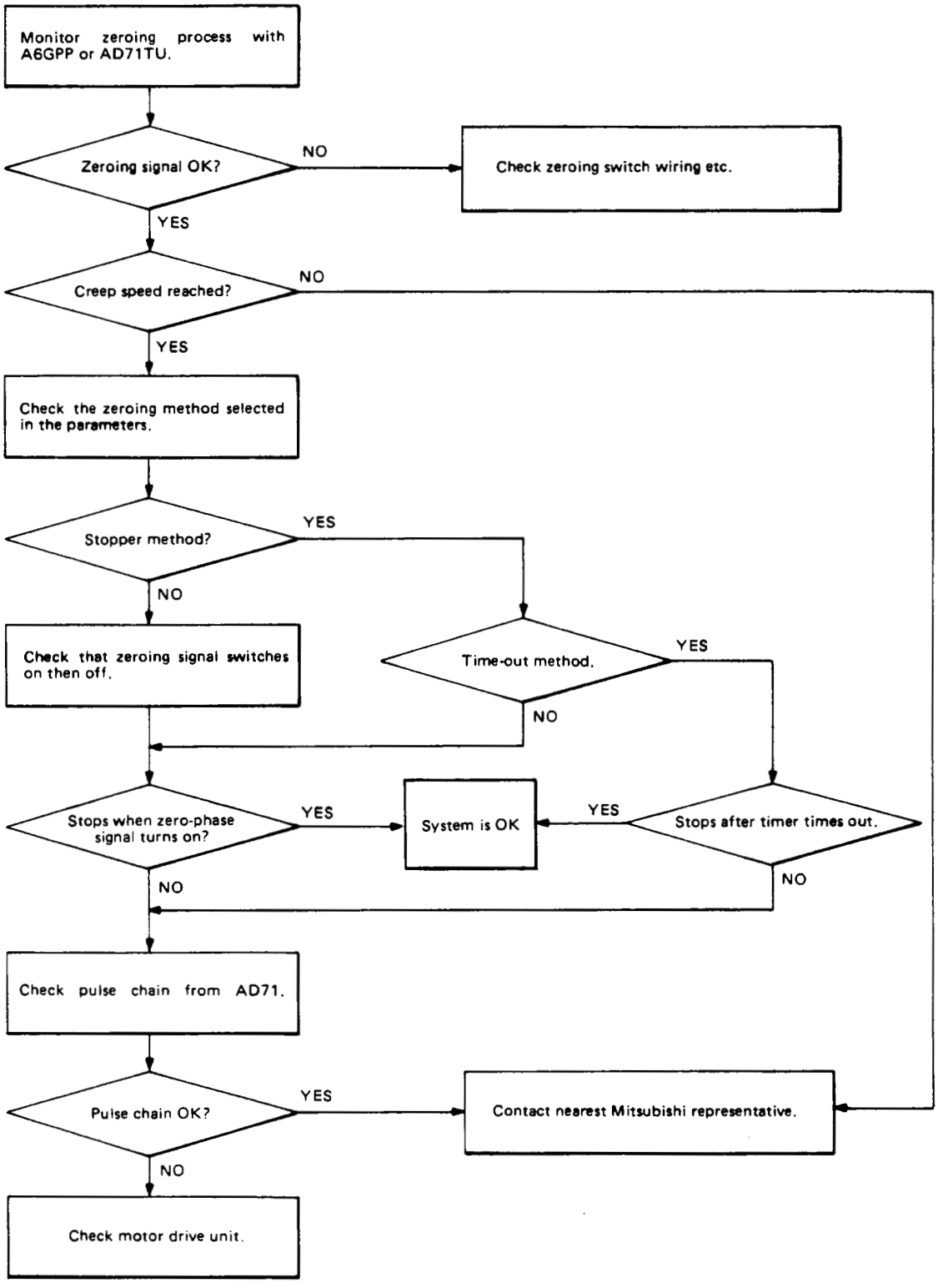
8.2.6 Unrequested stop



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8.2.7 Zeroing fault

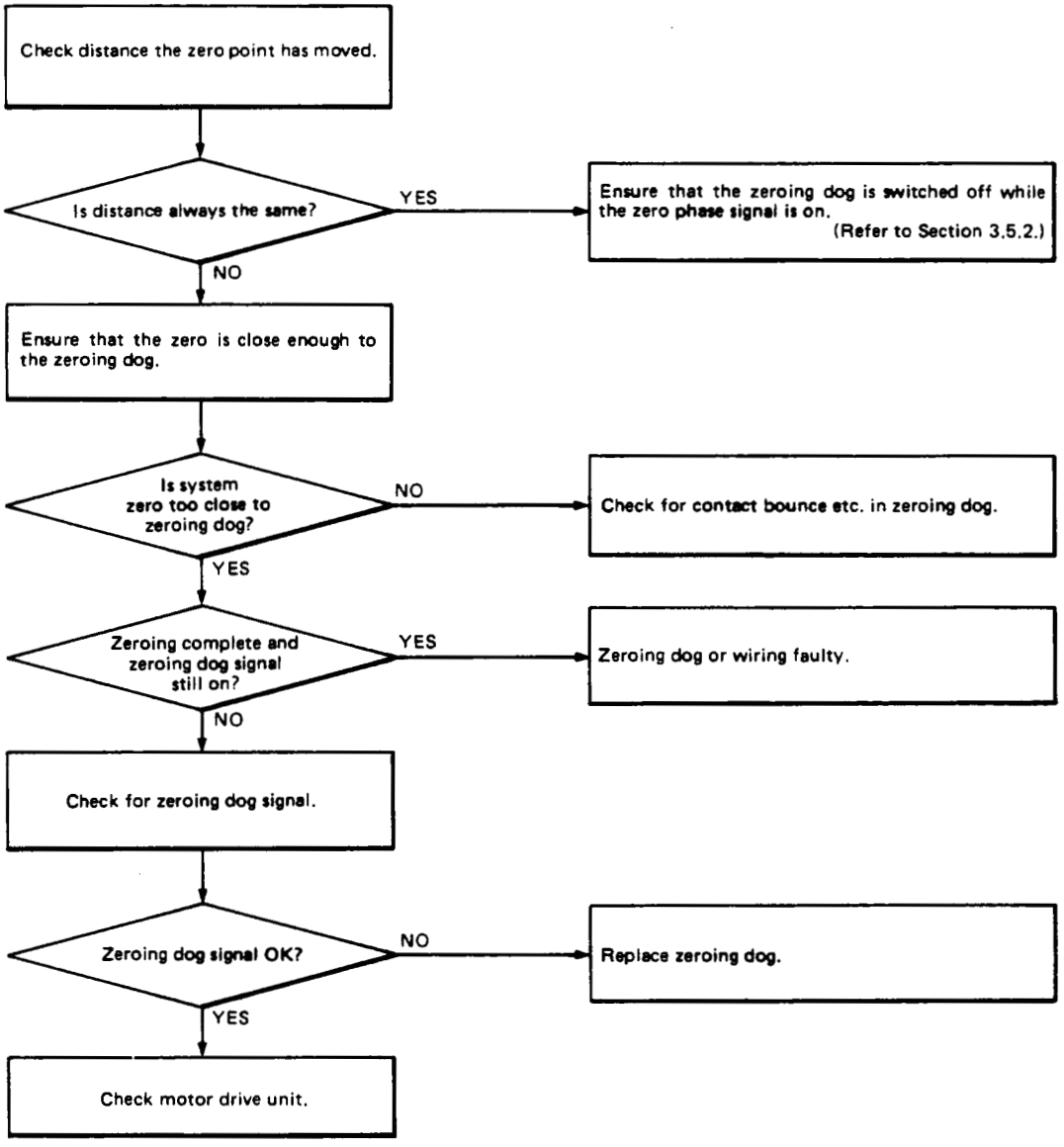
(1) Partial zeroing



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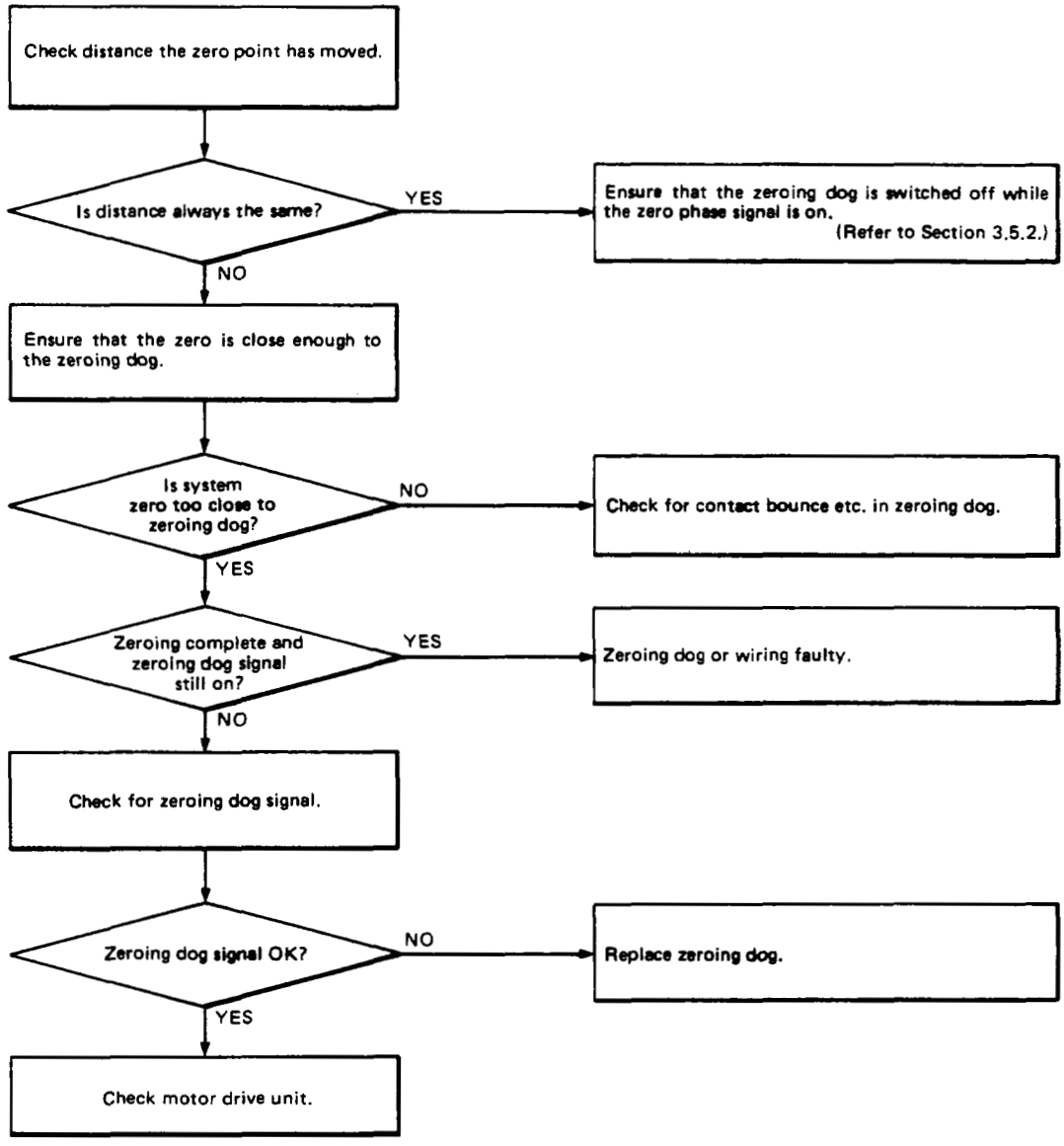
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(2) System zero has moved



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(2) System zero has moved



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9. MAINTENANCE

9.1 Unit Storage

The AD71 should be stored in the following environments:

(1) Ambient temperature 0 to 75°C.

(2) Ambient humidity 10 to 90%RH.

(3) No condensation (e.g. due to sudden temperature changes).

(4) No direct exposure to sunlight.

(5) Free from excessive amounts of conductive powder such as dust, iron filings, oil mist, salt, or organic solvent.

A two hour "warming up" period should be allowed if the AD71 has not been powered up for over 12 months. (This is to allow the electrolyte in electrolytic capacitor to stabilize.) The battery should be replaced every 10 months if the unit is not powered up to maintain buffer memory data.

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9.2 Battery Change

9.2.1 Battery change frequency

When the data backup battery voltage drops, the LED on the AD71 front panel is lit and an input signal (battery error) to the PC CPU is enabled. The battery is live for about one month more and, if it is not replaced, data will then be lost or corrupted.

Guide for preventive maintenance

1) The battery should be replaced every 4 to 5 years if it is only used for memory back up for a maximum of 300 days in that period.

2) Battery changing frequency for memory backup duty exceeding 300 days can be calculated as follows.

Example

Assume that there are five operation days (10-hour operation and 14-hour power-off during a day) and two power-off days in a week. Under these conditions, power-off period during one week is:

14 (hours) x 5 (days) = 70 hours
24 (hours) x 2 (days) = 48 hours

7200 (hours) / (70+48) (hours) = 61 (weeks)

61 (weeks) x 7 (days) = 427 (days)

Regarding one month as 30 days,

427 (days) / 30 (days) = 14.2 months

Hence,

it is necessary to change the battery every 14 months.

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REMARKS

The battery is the same as that for the MELSEC-A series.
The battery may be stored for five years. The total power failure guarantee period is 300 days.
The following battery is used:

Description : Lithium battery
Type and rating : Type A6BAT (3.6V with leads and socket)

Handling:

(1) Do not short.
(2) Do not disassemble.
(3) Do not burn.
(4) Do not heat.
(5) Do not solder electrodes.
(6) Do not measure voltage with an analog voltmeter.

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9.2.2 Changing the battery

Fig. 9.1 shows battery changing procedure.

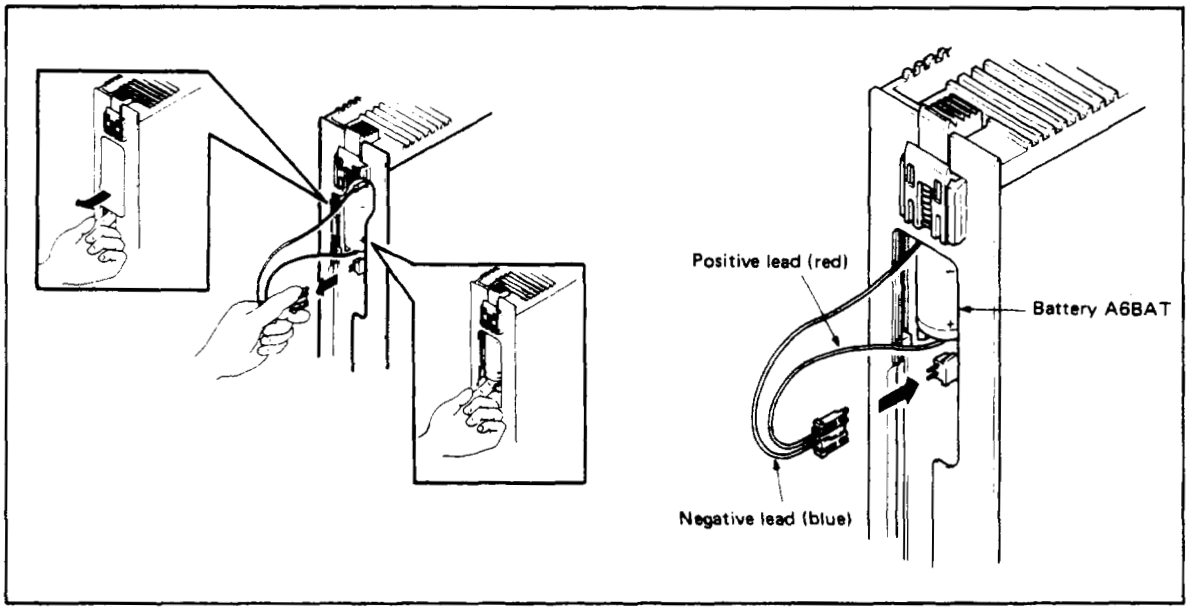


Fig. 9.1 Battery Changing

Buffer memory data is maintained for approx. 15 minutes by a capacitor without the battery.

IMPORTANT

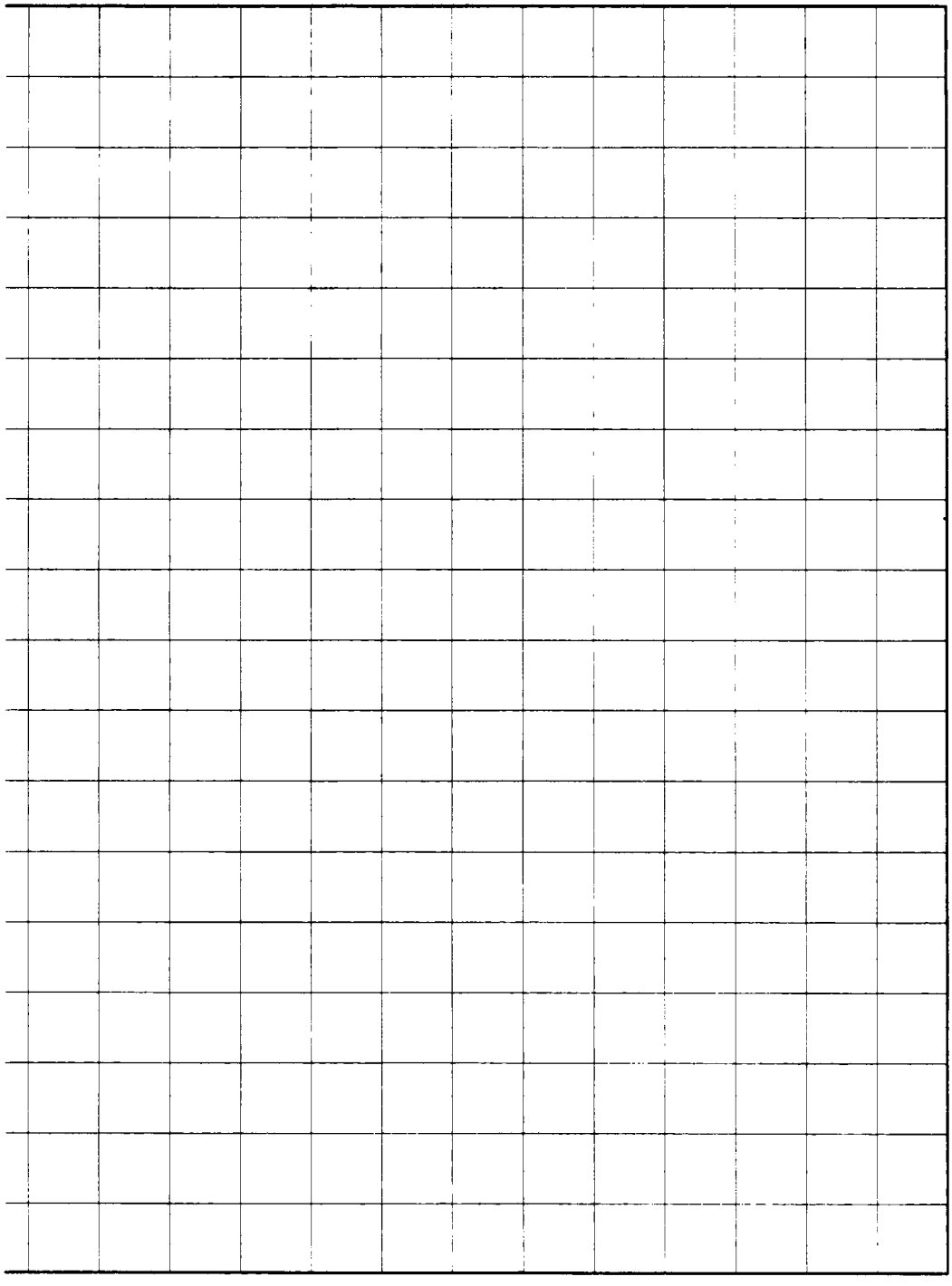
The components on the printed circuit board may be damaged by static electricity. When handling the printed circuit board:

1) **Ground all tools, work bench, etc.**
2) **Do not touch the conductive areas or electrical components.**

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APPENDICES

APPENDIX 1 Format Sheets

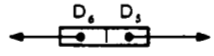


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1.2 Format sheets

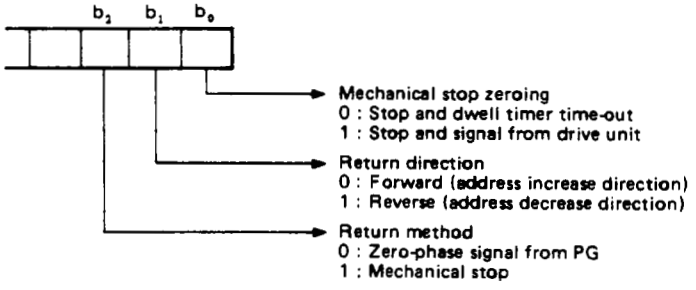
(1) Parameters

	Item	Initial Value	X Axis	Y Axis	mm		inch		degree		PULSE (PLS)	
					Setting range	Unit	Setting range	Unit	Setting range	Unit	Setting range	Unit
1	Unit setting	3			0	–	1	–	2	–	3	–
2	Travel per pulse	Set value			1 to 100	$X10^{-1}$ μm/ PLS	1 to 100	$X10^{-5}$ inch/ PLS	1 to 100	$X10^{-5}$ deg/ PLS	–	
3	Speed limit value	20,000			1 to 12,000	X10 mm/ min	1 to 12,000	X1 inch/ min	1 to 12,000	X1 deg/ min	1 to 20,000	X10 PLS/ sec
4	Jog speed limit value	2,000			1 to 12,000	X10 mm/ min	1 to 12,000	X1 inch/ min	1 to 12,000	X1 deg/ min	1 to 20,000	X10 PLS/ sec
5	Starting bias speed	0			1 to 12,000	X10 mm/ min	1 to 12,000	X1 inch/ min	1 to 12,000	X1 deg/ min	1 to 20,000	X10 PLS/ sec
6	Backlash	0			0 to 65, 35	$X10^{-1}$ μm	0 to 65,535	$X10^{-5}$ inch	0 to 65,535	$X10^{-5}$ deg	0 to 255	PLS
7	Upper stroke limit	16,252,928			0 to 162,000	mm	0 to 16,200	inch	0 to 16,200	deg	0 to 16,252,928	PLS
8	Lower stroke limit	0			0 to 162,000	mm	0 to 16,200	inch	0 to 16,200	deg	0 to 16,252,928	PLS
9	Error compensation	0			±0 to 100,000 (per 1m)	$X10^{-1}$ μm	±0 to 100,000 (per 100 inch)	$X10^{-5}$ inch	±0 to 100,000 (per 100 deg)	$X10^{-5}$ deg	–	
10	Travel per manual pulse during inching	1			0 to 100,000	$X10^{-1}$ μm	0 to 100,000	$X10^{-5}$ inch	0 to 100,000	$X10^{-5}$ deg	0 to 100	PLS
11	Acceleration and deceleration times	1,000			64 to 4,999 msec							
12	Positioning complete signal output time	300			0 to 20,000 msec							
13	Pulse output mode	Set value			0 : PLS + SIGN 1 : forward pulse, reverse pulse							
14	Rotating direction setting	Set value			0 : present value increase with forward pulse output 1 : present value increase with reverse pulse output							
15	Absolute/ incremental setting	0			0 : absolute 1 : incremental 2 : absolute/incremental combined							
16	M code ON/OFF timing	Set value			0 : WITH mode 1 : AFTER mode  0 : not used 1 : used							

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(2) Zeroing data

	Item	X Axis	Y Axis	mm		inch		degree		PULSE (PLS)	
				Setting range	Unit	Setting range	Unit	Setting range	Unit	Setting range	Unit
1	Zeroing direction			0 : forward direction (address increase) 1 : reverse direction (address decrease)							
2	Zeroing method			See below.							
3	Zeroing address			0to 1,620,000,000	$X10^{-1}$ μm	0to 1,620,000,000	$X10^{-5}$ inch	0to 1,620,000,000	$X10^{-5}$ deg	0to 16,252,928	PLS
4	Zeroing speed			1 to 12,000	X10 mm/ min	1 to 12,000	X1 inch/ min	1 to 12,000	X1 deg/ min	1 to 20,000	X10 PLS/ sec
5	Creep speed			1 to 12,000	X10 mm/ min	1 to 12,000	X1 inch/ min	1 to 12,000	X1 deg/ min	1 to 20,000	X10 PLS/ sec
6	Dwell			0 to 499 x 10 msec							
7	Torque limit			1 to 25 x 10%							



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1.3 Positioning data (Data No. to)

X AXIS							
Data No.	Pattern	Abs./ Inc.	Direc- tion	Speed	Address	Dwell	M Code
1							
2							
3							
4							
5							
6							
7							
8							
9							
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
0							

00 : END
01 : Continue
11 : Change

0 : Abs.
1 : Inc.

For Inc.
0 : Address increase direction
1 : Address decrease direction

0 to 255
0 : Without M code
1 to 19 : With comment

Y AXIS							
Data No.	Pattern	Abs./ Inc.	Direc- tion	Speed	Address	Dwell	M Code
1							
2							
3							
4							
5							
6							
7							
8							
9							
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
0							

00 : END
01 : Continue
11 : Change

0 : Abs.
1 : Inc.

For Inc.
0 : Address increase direction
1 : Address decrease direction

0 to 255
0 : Without M code
1 to 19 : With comment

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1.4 M code comments

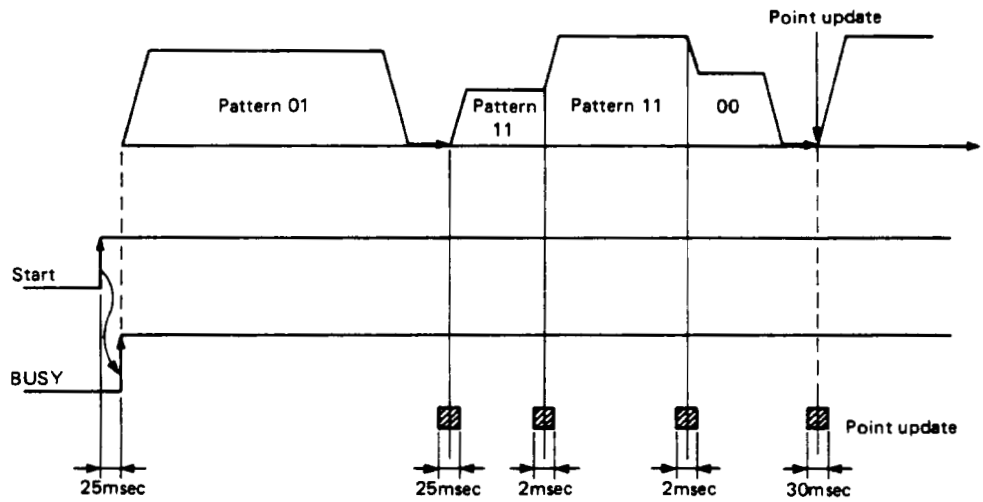
M CODE	X AXIS	M CODE	Y AXIS
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
18		18	
19		19	

Maximum 16 characters per comment

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APPENDIX 2 AD71 Processing Times

(1) Pattern operation



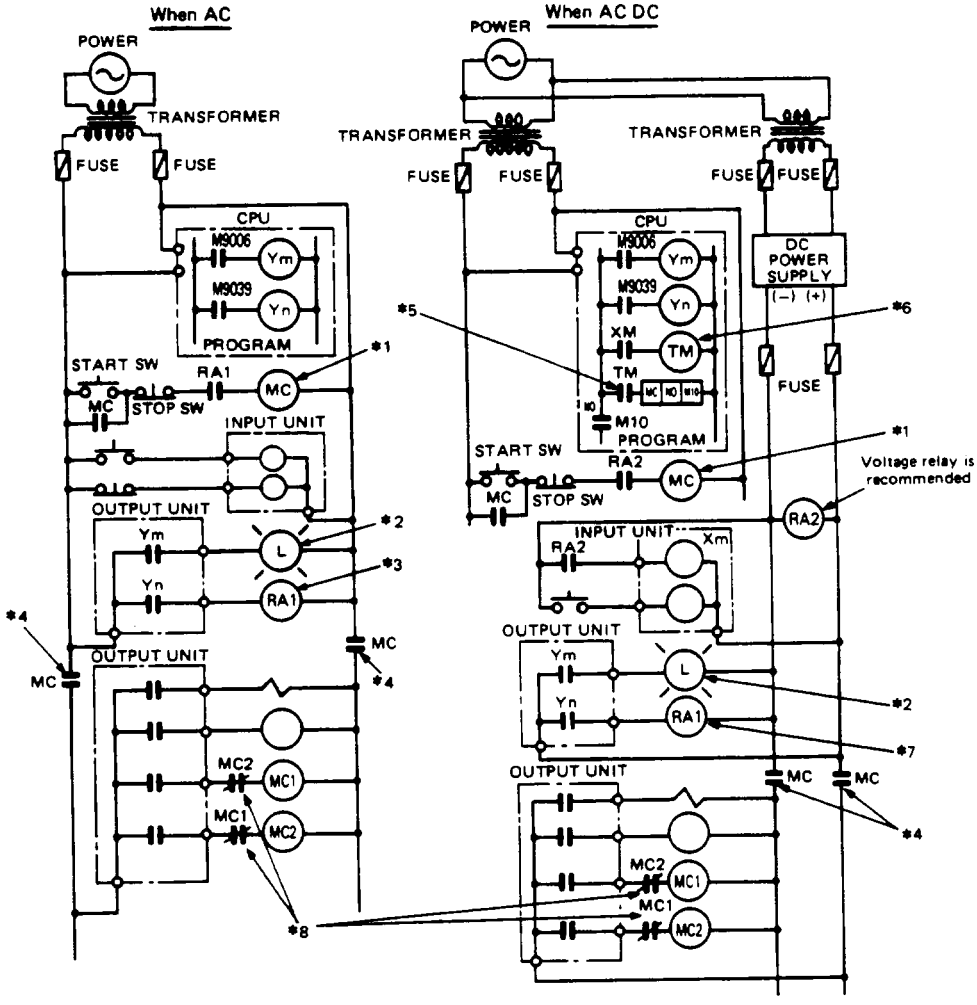
The above time indicates AD71 processing times and does not include PC operating time.

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APPENDIX 3 System Design Considerations

On switching on the PC power supply there is a short but finite time before the DC levels reach their operating values. During this period the unit will not operate normally. The same applies when the power is cut as the DC levels drop below their operating values.
The following circuit will overcome any problems which may arise in extreme circumstances due to this phenomenon.

System design circuit example



*1: Run/stop circuit interlocked with RA1 (run monitor relay)
*2: Battery low alarm
*3: RA1 turned on by M9039 (run monitor relay)
*4: Power to output equipment turned off when STOP signal given.
*5: Input switched when power supply established.
*6: Set time for DC power supply to be established (approx. 0.5 secs)
*7: On when run by M9039
*8: Interlock circuit as necessary.

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Power on procedure:

(a) AC

1) Switch power on.

2) Set CPU to RUN.

3) Switch on the START switch.

4) When magnetic contactor (MC) comes in, output equipment is powered and may be driven by the program.

(b) AC·DC

1) Switch power on.

2) Set CPU to RUN.

3) When DC power is established, RA2 turns on.

4) When DC power reaches 100%, timer TM starts.
(Timer (TIM) should be set to the time required for the DC voltage to reach 100% of its value after RA2 turns on.)

5) Switch on the START switch.

6) When the magnetic contactor (MC) comes in, the output equipment is powered and may be driven by the program.

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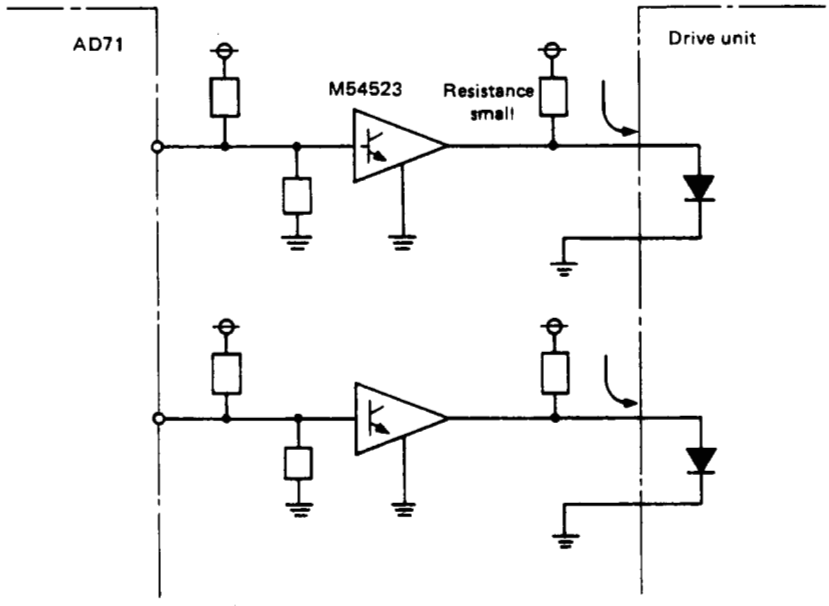
APPENDIX 4 Connection with Servo Motors

The following connection diagrams are provided as examples only and do not indicate the availability or otherwise of the drives shown.

[CAUTION]

(1) The AD71 output is a sink output pulse chain.
The drive unit should be sink input.

(2) For use with source input drive units, use the interface shown below.

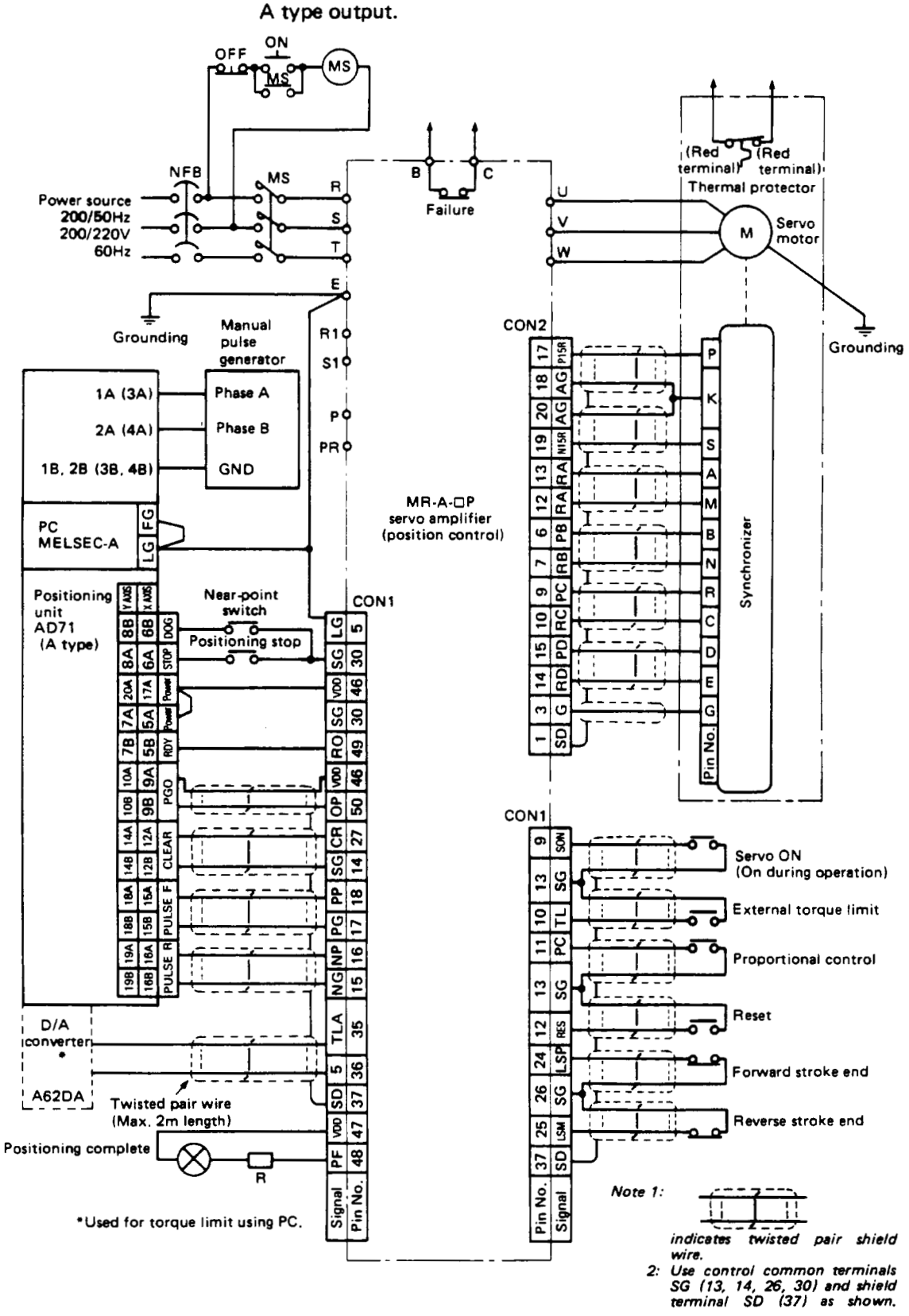


Signal Reversing Example

(3) The AD71 pin numbers in parentheses are for the Y axis.

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4.1 Connection with Mitsubishi MELSERVO-A

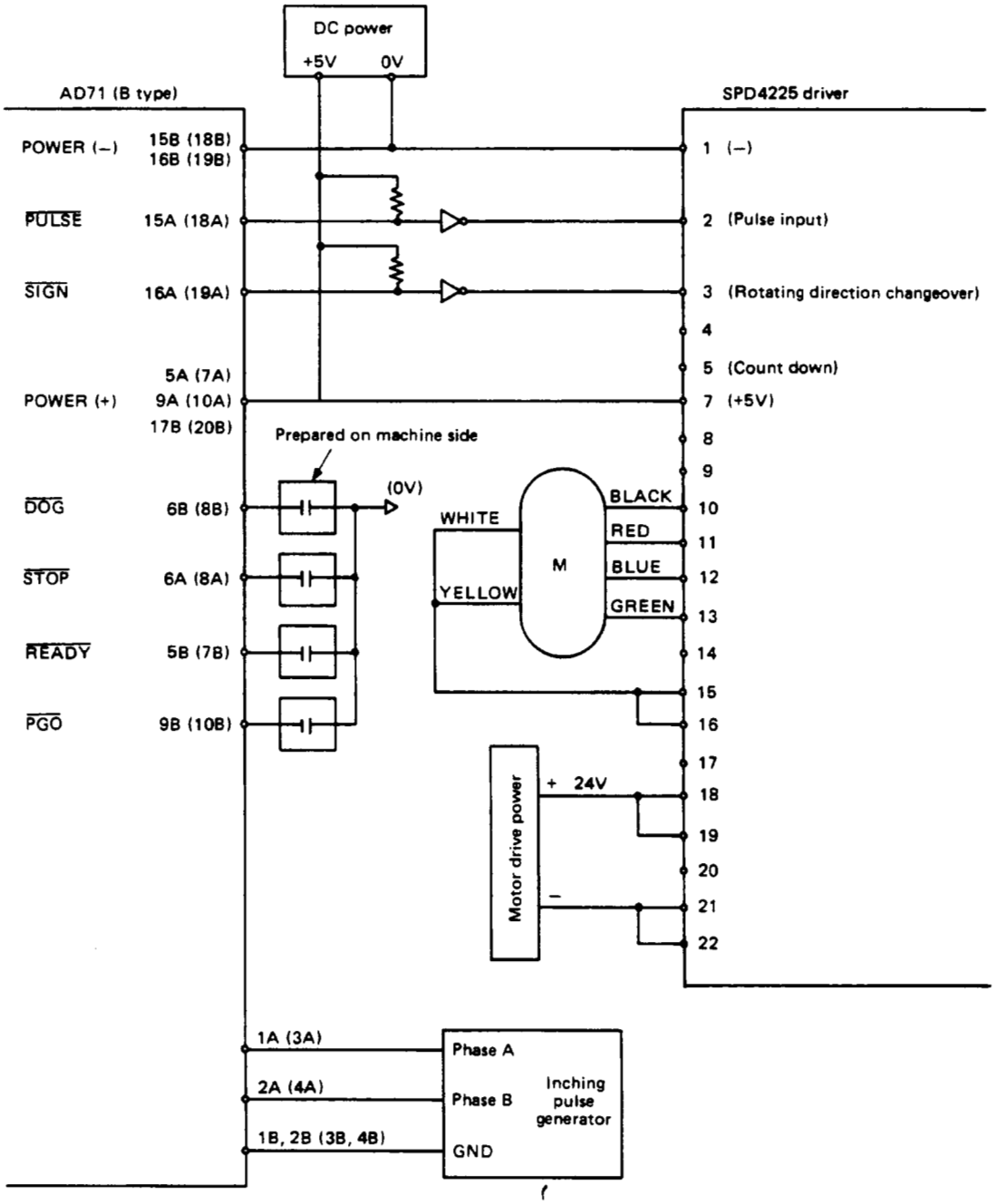


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4.2 Connection with Oriental's pulse motor

[Example 1]

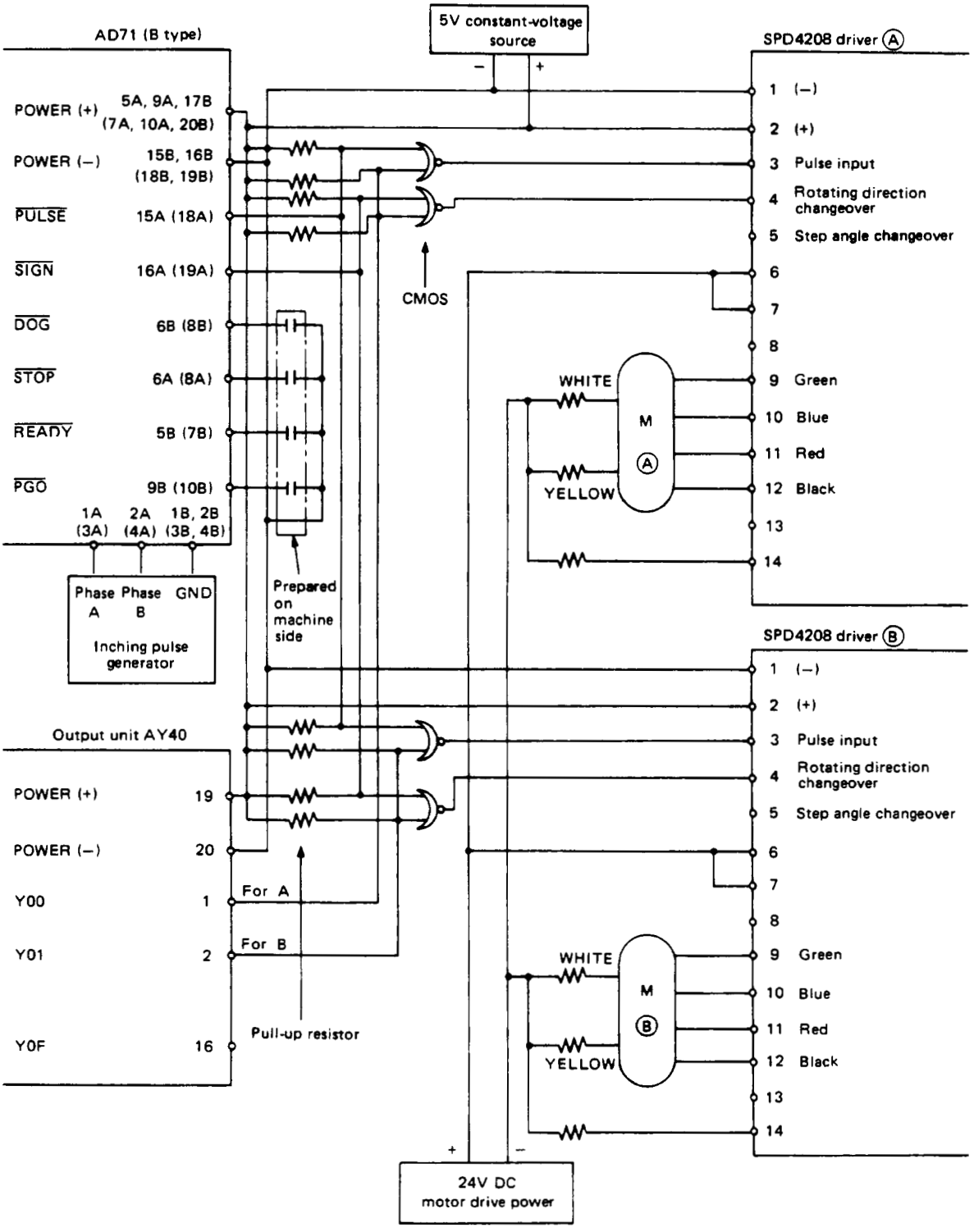
One motor. B type output.



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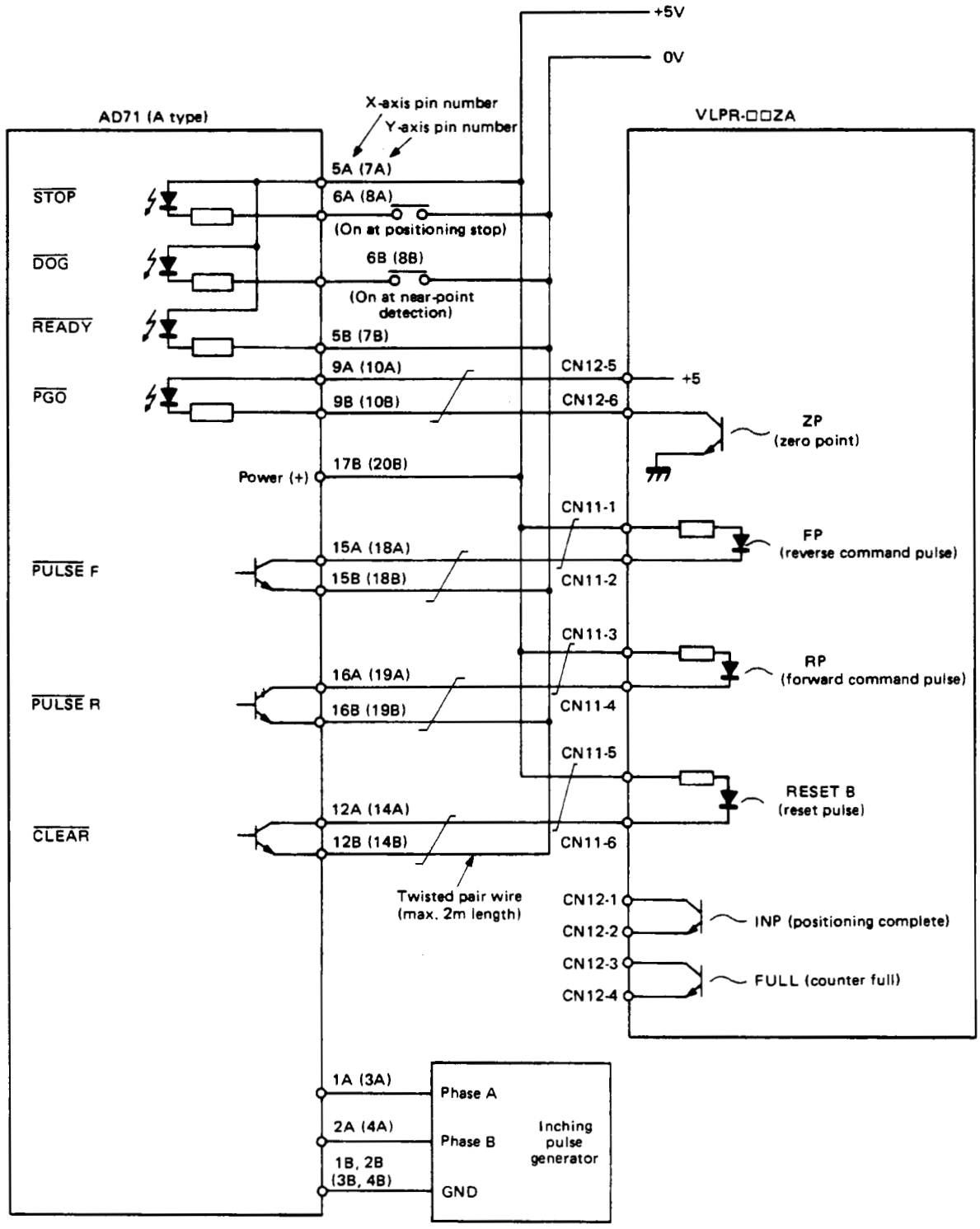
[Example 2]



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4.3 Connection with Toei Electric's VELCONIC (resolver type position unit VLPR-ZA)

A type AD71 output.

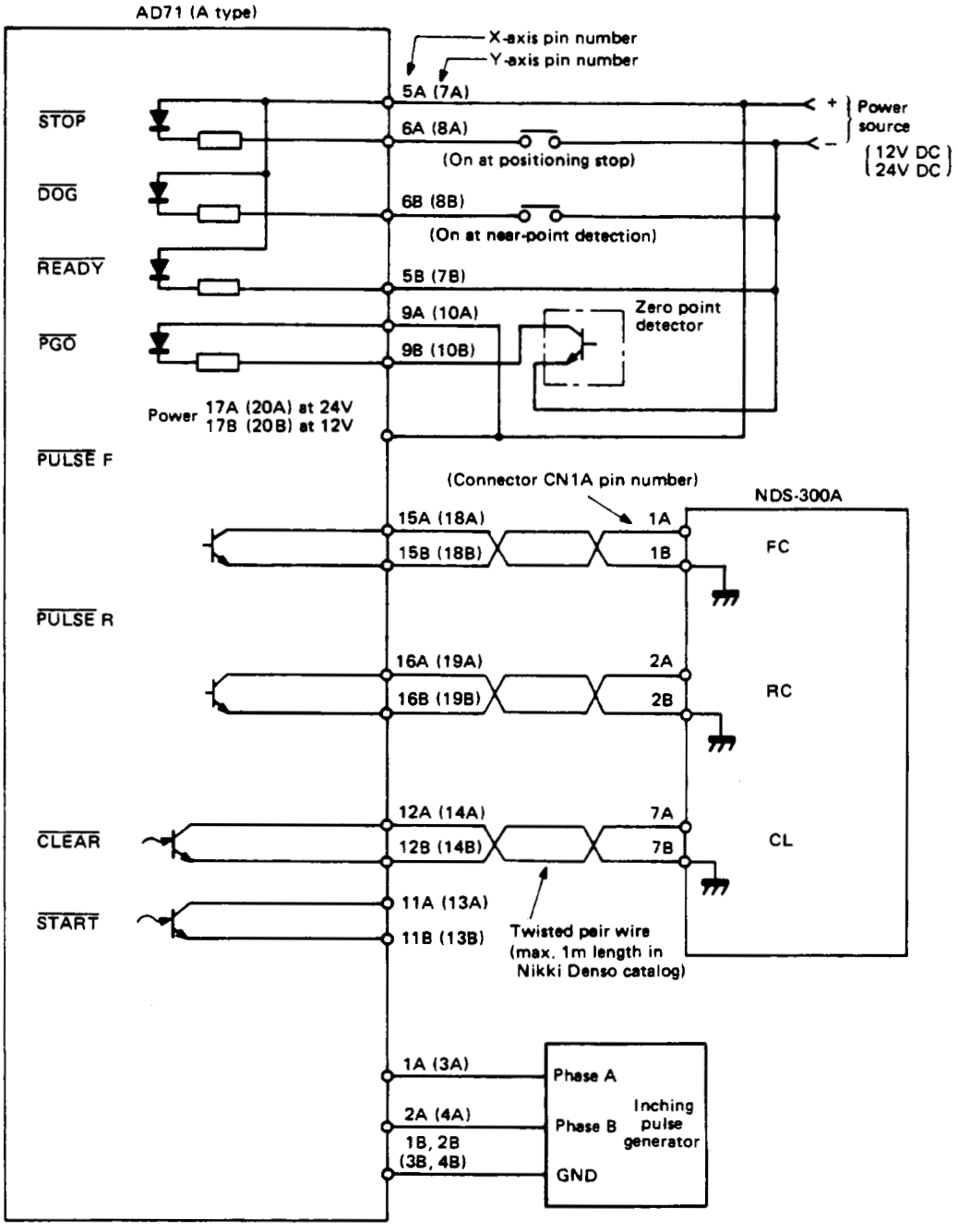


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4.4 Connection with Nikki Denso's DIGITAL S-PACK NDS-300

A type AD71 output.

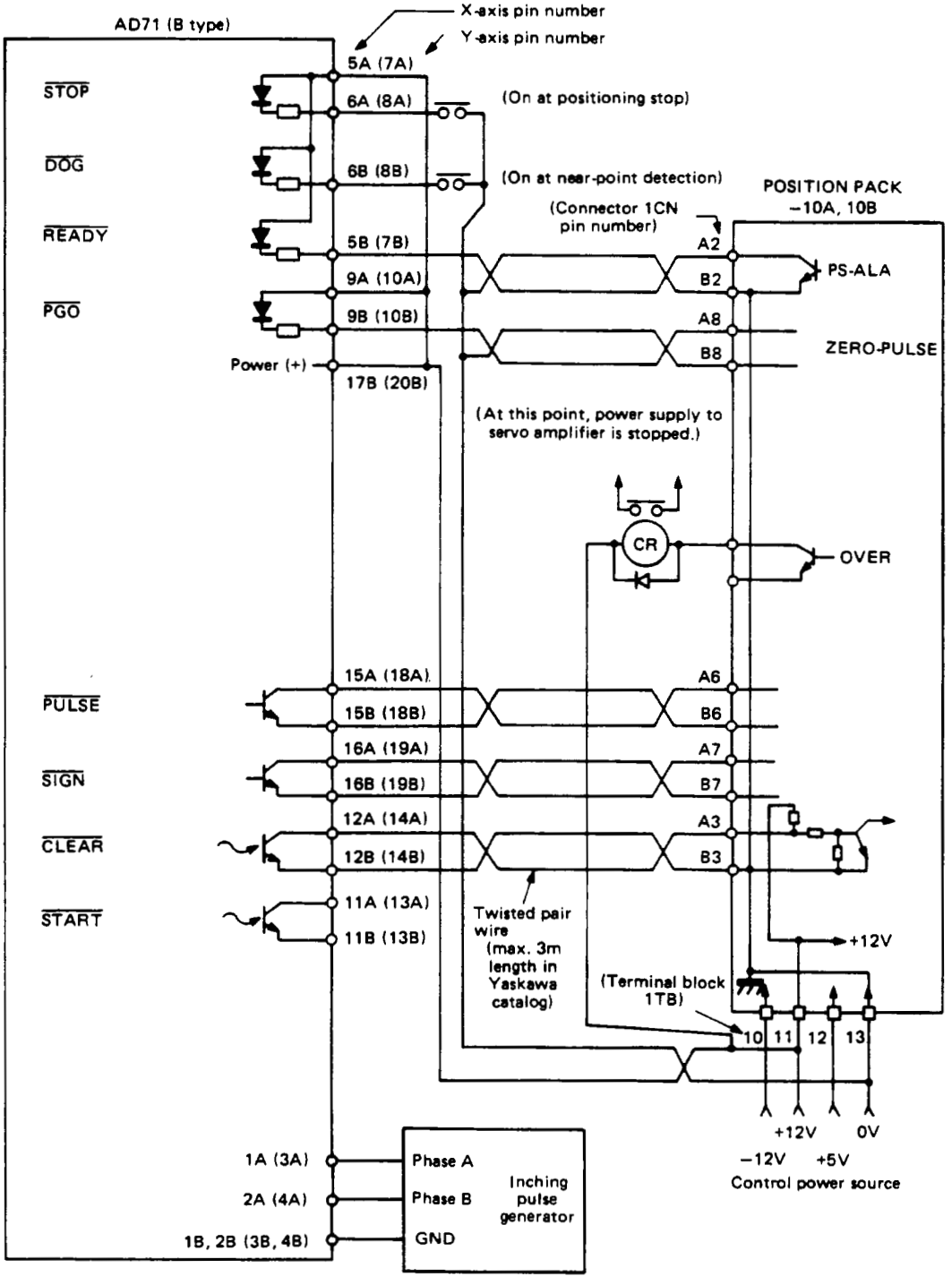


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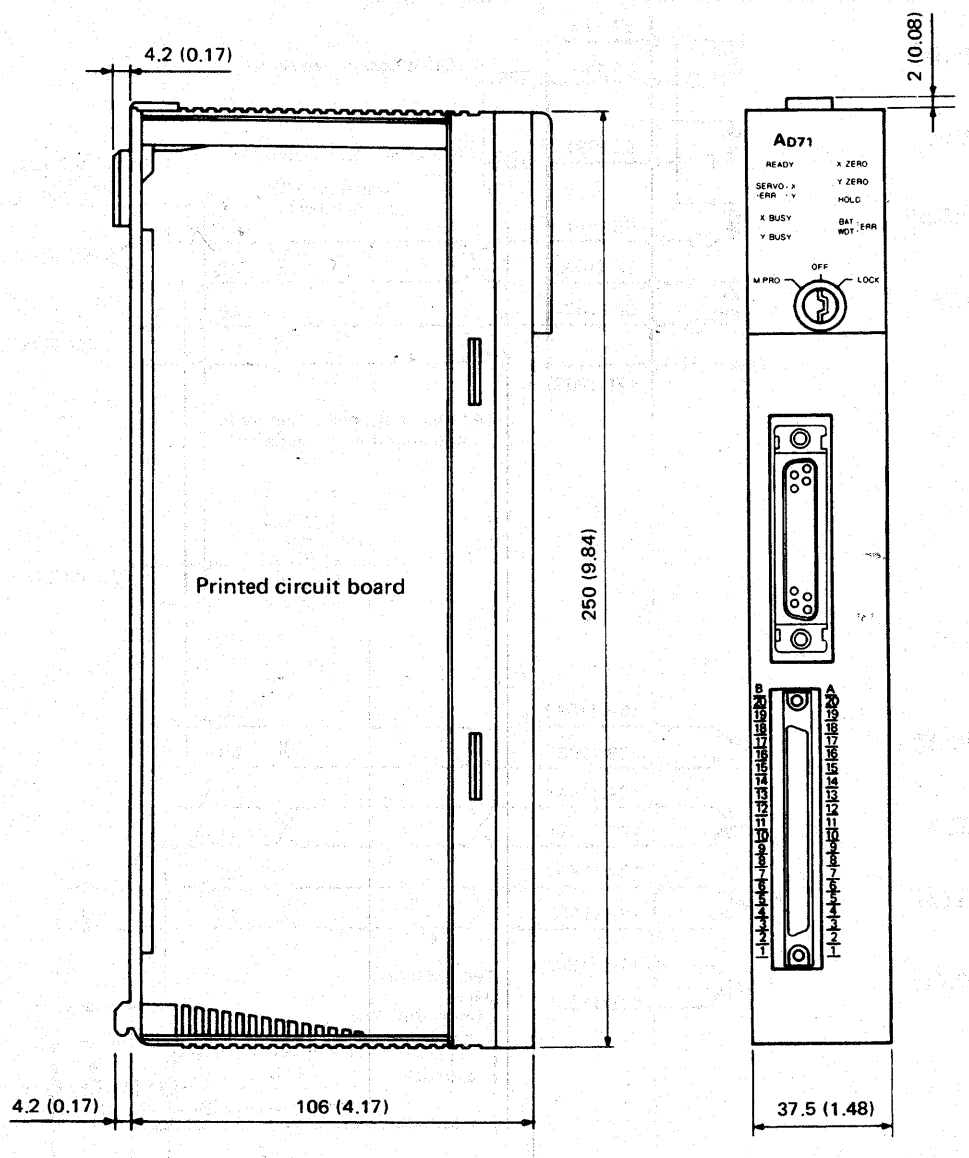
4.5 Connection with Yaskawa Electric's POSITION PACK-10A and 10B

B type AD71 output. Set $\overline{\text{PULSE}}$ and $\overline{\text{SIGN}}$ to 5V in the POSITION PACK.



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APPENDIX 5 Dimensions



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APPENDIX 6 Positioning Data Number and Buffer Memory Address Conversion Table

Positioning Data No. and Buffer Memory Address Conversion Table

Data No.	(X Axis)					(Y Axis)				
	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper
1	3872	4272	4672	5072	5073	5872	6272	6672	7072	7073
2	3873	4273	4673	5074	5075	5873	6273	6673	7074	7075
3	3874	4274	4674	5076	5077	5874	6274	6674	7076	7077
4	3875	4275	4675	5078	5079	5875	6275	6675	7078	7079
5	3876	4276	4676	5080	5081	5876	6276	6676	7080	7081
6	3877	4277	4677	5082	5083	5877	6277	6677	7082	7083
7	3878	4278	4678	5084	5085	5878	6278	6678	7084	7085
8	3879	4279	4679	5086	5087	5879	6279	6679	7086	7087
9	3880	4280	4680	5088	5089	5880	6280	6680	7088	7089
10	3881	4281	4681	5090	5091	5881	6281	6681	7090	7091
11	3882	4282	4682	5092	5093	5882	6282	6682	7092	7093
12	3883	4283	4683	5094	5095	5883	6283	6683	7094	7095
13	3884	4284	4684	5096	5097	5884	6284	6684	7096	7097
14	3885	4285	4685	5098	5099	5885	6285	6685	7098	7099
15	3886	4286	4686	5100	5101	5886	6286	6686	7100	7101
16	3887	4287	4687	5102	5103	5887	6287	6687	7102	7103
17	3888	4288	4688	5104	5105	5888	6288	6688	7104	7105
18	3889	4289	4689	5106	5107	5889	6289	6689	7106	7107
19	3890	4290	4690	5108	5109	5890	6290	6690	7108	7109
20	3891	4291	4691	5110	5111	5891	6291	6691	7110	7111
21	3892	4292	4692	5112	5113	5892	6292	6692	7112	7113
22	3893	4293	4693	5114	5115	5893	6293	6693	7114	7115
23	3894	4294	4694	5116	5117	5894	6294	6694	7116	7117
24	3895	4295	4695	5118	5119	5895	6295	6695	7118	7119
25	3896	4296	4696	5120	5121	5896	6296	6696	7120	7121
26	3897	4297	4697	5122	5123	5897	6297	6697	7122	7123
27	3898	4298	4698	5124	5125	5898	6298	6698	7124	7125
28	3899	4299	4699	5126	5127	5899	6299	6699	7126	7127
29	3900	4300	4700	5128	5129	5900	6300	6700	7128	7129
30	3901	4301	4701	5130	5131	5901	6301	6701	7130	7131
31	3902	4302	4702	5132	5133	5902	6302	6702	7132	7133
32	3903	4303	4703	5134	5135	5903	6303	6703	7134	7135
33	3904	4304	4704	5136	5137	5904	6304	6704	7136	7137
34	3905	4305	4705	5138	5139	5905	6305	6705	7138	7139
35	3906	4306	4706	5140	5141	5906	6306	6706	7140	7141
36	3907	4307	4707	5142	5143	5907	6307	6707	7142	7143
37	3908	4308	4708	5144	5145	5908	6308	6708	7144	7145
38	3909	4309	4709	5146	5147	5909	6309	6709	7146	7147
39	3910	4310	4710	5148	5149	5910	6310	6710	7148	7149
40	3911	4311	4711	5150	5151	5911	6311	6711	7150	7151
41	3912	4312	4712	5152	5153	5912	6312	6712	7152	7153
42	3913	4313	4713	5154	5155	5913	6313	6713	7154	7155
43	3914	4314	4714	5156	5157	5914	6314	6714	7156	7157
44	3915	4315	4715	5158	5159	5915	6315	6715	7158	7159
45	3916	4316	4716	5160	5161	5916	6316	6716	7160	7161
46	3917	4317	4717	5162	5163	5917	6317	6717	7162	7163
47	3918	4318	4718	5164	5165	5918	6318	6718	7164	7165
48	3919	4319	4719	5166	5167	5919	6319	6719	7166	7167
49	3920	4320	4720	5168	5169	5920	6320	6720	7168	7169
50	3921	4321	4721	5170	5171	5921	6321	6721	7170	7171

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Positioning Data No.and Buffer Memory Address Conversion Table

Data No.	(X Axis)					(Y Axis)				
	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper
51	3922	4322	4722	5172	5173	5922	6322	6722	7172	7173
52	3923	4323	4723	5174	5175	5923	6323	6723	7174	7175
53	3924	4324	4724	5176	5177	5924	6324	6724	7176	7177
54	3925	4325	4725	5178	5179	5925	6325	6725	7178	7179
55	3926	4326	4726	5180	5181	5926	6326	6726	7180	7181
56	3927	4327	4727	5182	5183	5927	6327	6727	7182	7183
57	3928	4328	4728	5184	5185	5928	6328	6728	7184	7185
58	3929	4329	4729	5186	5187	5929	6329	6729	7186	7187
59	3930	4330	4730	5188	5189	5930	6330	6730	7188	7189
60	3931	4331	4731	5190	5191	5931	6331	6731	7190	7191
61	3932	4332	4732	5192	5193	5932	6332	6732	7192	7193
62	3933	4333	4733	5194	5195	5933	6333	6733	7194	7195
63	3934	4334	4734	5196	5197	5934	6334	6734	7196	7197
64	3935	4335	4735	5198	5199	5935	6335	6735	7198	7199
65	3936	4336	4736	5200	5201	5936	6336	6736	7200	7201
66	3937	4337	4737	5202	5203	5937	6337	6737	7202	7203
67	3938	4338	4738	5204	5205	5938	6338	6738	7204	7205
68	3939	4339	4739	5206	5207	5939	6339	6739	7206	7207
69	3940	4340	4740	5208	5209	5940	6340	6740	7208	7209
70	3941	4341	4741	5210	5211	5941	6341	6741	7210	7211
71	3942	4342	4742	5212	5213	5942	6342	6742	7212	7213
72	3943	4343	4743	5214	5215	5943	6343	6743	7214	7215
73	3944	4344	4744	5216	5217	5944	6344	6744	7216	7217
74	3945	4345	4745	5218	5219	5945	6345	6745	7218	7219
75	3946	4346	4746	5220	5221	5946	6346	6746	7220	7221
76	3947	4347	4747	5222	5223	5947	6347	6747	7222	7223
77	3948	4348	4748	5224	5225	5948	6348	6748	7224	7225
78	3949	4349	4749	5226	5227	5949	6349	6749	7226	7227
79	3950	4350	4750	5228	5229	5950	6350	6750	7228	7229
80	3951	4351	4751	5230	5231	5951	6351	6751	7230	7231
81	3952	4352	4752	5232	5233	5952	6352	6752	7232	7233
82	3953	4353	4753	5234	5235	5953	6353	6753	7234	7235
83	3954	4354	4754	5236	5237	5954	6354	6754	7236	7237
84	3955	4355	4755	5238	5239	5955	6355	6755	7238	7239
85	3956	4356	4756	5240	5241	5956	6356	6756	7240	7241
86	3957	4357	4757	5242	5243	5957	6357	6757	7242	7243
87	3958	4358	4758	5244	5245	5958	6358	6758	7244	7245
88	3959	4359	4759	5246	5247	5959	6359	6759	7246	7247
89	3960	4360	4760	5248	5249	5960	6360	6760	7248	7249
90	3961	4361	4761	5250	5251	5961	6361	6761	7250	7251
91	3962	4362	4762	5252	5253	5962	6362	6762	7252	7253
92	3963	4363	4763	5254	5255	5963	6363	6763	7254	7255
93	3964	4364	4764	5256	5257	5964	6364	6764	7256	7257
94	3965	4365	4765	5258	5259	5965	6365	6765	7258	7259
95	3966	4366	4766	5260	5261	5966	6366	6766	7260	7261
96	3967	4367	4767	5262	5263	5967	6367	6767	7262	7263
97	3968	4368	4768	5264	5265	5968	6368	6768	7264	7265
98	3969	4369	4769	5266	5267	5969	6369	6769	7266	7267
99	3970	4370	4770	5268	5269	5970	6370	6770	7268	7269
100	3971	4371	4771	5270	5271	5971	6371	6771	7270	7271

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Positioning Data No. and Buffer Memory Address Conversion Table

Data No.	(X Axis)					(Y Axis)				
	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper
101	3972	4372	4772	5272	5273	5972	6372	6772	7272	7273
102	3973	4373	4773	5274	5275	5973	6373	6773	7274	7275
103	3974	4374	4774	5276	5277	5974	6374	6774	7276	7277
104	3975	4375	4775	5278	5279	5975	6375	6775	7278	7279
105	3976	4376	4776	5280	5281	5976	6376	6776	7280	7281
106	3977	4377	4777	5282	5283	5977	6377	6777	7282	7283
107	3978	4378	4778	5284	5285	5978	6378	6778	7284	7285
108	3979	4379	4779	5286	5287	5979	6379	6779	7286	7287
109	3980	4380	4780	5288	5289	5980	6380	6780	7288	7289
110	3981	4381	4781	5290	5291	5981	6381	6781	7290	7291
111	3982	4382	4782	5292	5293	5982	6382	6782	7292	7293
112	3983	4383	4783	5294	5295	5983	6383	6783	7294	7295
113	3984	4384	4784	5296	5297	5984	6384	6784	7296	7297
114	3985	4385	4785	5298	5299	5985	6385	6785	7298	7299
115	3986	4386	4786	5300	5301	5986	6386	6786	7300	7301
116	3987	4387	4787	5302	5303	5987	6387	6787	7302	7303
117	3988	4388	4788	5304	5305	5988	6388	6788	7304	7305
118	3989	4389	4789	5306	5307	5989	6389	6789	7306	7307
119	3990	4390	4790	5308	5309	5990	6390	6790	7308	7309
120	3991	4391	4791	5310	5311	5991	6391	6791	7310	7311
121	3992	4392	4792	5312	5313	5992	6392	6792	7312	7313
122	3993	4393	4793	5314	5315	5993	6393	6793	7314	7315
123	3994	4394	4794	5316	5317	5994	6394	6794	7316	7317
124	3995	4395	4795	5318	5319	5995	6395	6795	7318	7319
125	3996	4396	4796	5320	5321	5996	6396	6796	7320	7321
126	3997	4397	4797	5322	5323	5997	6397	6797	7322	7323
127	3998	4398	4798	5324	5325	5998	6398	6798	7324	7325
128	3999	4399	4799	5326	5327	5999	6399	6799	7326	7327
129	4000	4400	4800	5328	5329	6000	6400	6800	7328	7329
130	4001	4401	4801	5330	5331	6001	6401	6801	7330	7331
131	4002	4402	4802	5332	5333	6002	6402	6802	7332	7333
132	4003	4403	4803	5334	5335	6003	6403	6803	7334	7335
133	4004	4404	4804	5336	5337	6004	6404	6804	7336	7337
134	4005	4405	4805	5338	5339	6005	6405	6805	7338	7339
135	4006	4406	4806	5340	5341	6006	6406	6806	7340	7341
136	4007	4407	4807	5342	5343	6007	6407	6807	7342	7343
137	4008	4408	4808	5344	5345	6008	6408	6808	7344	7345
138	4009	4409	4809	5346	5347	6009	6409	6809	7346	7347
139	4010	4410	4810	5348	5349	6010	6410	6810	7348	7349
140	4011	4411	4811	5350	5351	6011	6411	6811	7350	7351
141	4012	4412	4812	5352	5353	6012	6412	6812	7352	7353
142	4013	4413	4813	5354	5355	6013	6413	6813	7354	7355
143	4014	4414	4814	5356	5357	6014	6414	6814	7356	7357
144	4015	4415	4815	5358	5359	6015	6415	6815	7358	7359
145	4016	4416	4816	5360	5361	6016	6416	6816	7360	7361
146	4017	4417	4817	5362	5363	6017	6417	6817	7362	7363
147	4018	4418	4818	5364	5365	6018	6418	6818	7364	7365
148	4019	4419	4819	5366	5367	6019	6419	6819	7366	7367
149	4020	4420	4820	5368	5369	6020	6420	6820	7368	7369
150	4021	4421	4821	5370	5371	6021	6421	6821	7370	7371

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Positioning Data No. and Buffer Memory Address Conversion Table

Data No.	(X Axis)					(Y Axis)				
	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper
151	4022	4422	4822	5372	5373	6022	6422	6822	7372	7373
152	4023	4423	4823	5374	5375	6023	6423	6823	7374	7375
153	4024	4424	4824	5376	5377	6024	6424	6824	7376	7377
154	4025	4425	4825	5378	5379	6025	6425	6825	7378	7379
155	4026	4426	4826	5380	5381	6026	6426	6826	7380	7381
156	4027	4427	4827	5382	5383	6027	6427	6827	7382	7383
157	4028	4428	4828	5384	5385	6028	6428	6828	7384	7385
158	4029	4429	4829	5386	5387	6029	6429	6829	7386	7387
159	4030	4430	4830	5388	5389	6030	6430	6830	7388	7389
160	4031	4431	4831	5390	5391	6031	6431	6831	7390	7391
161	4032	4432	4832	5392	5393	6032	6432	6832	7392	7393
162	4033	4433	4833	5394	5395	6033	6433	6833	7394	7395
163	4034	4434	4834	5396	5397	6034	6434	6834	7396	7397
164	4035	4435	4835	5398	5399	6035	6435	6835	7398	7399
165	4036	4436	4836	5400	5401	6036	6436	6836	7400	7401
166	4037	4437	4837	5402	5403	6037	6437	6837	7402	7403
167	4038	4438	4838	5404	5405	6038	6438	6838	7404	7405
168	4039	4439	4839	5406	5407	6039	6439	6839	7406	7407
169	4040	4440	4840	5408	5409	6040	6440	6840	7408	7409
170	4041	4441	4841	5410	5411	6041	6441	6841	7410	7411
171	4042	4442	4842	5412	5413	6042	6442	6842	7412	7413
172	4043	4443	4843	5414	5415	6043	6443	6843	7414	7415
173	4044	4444	4844	5416	5417	6044	6444	6844	7416	7417
174	4045	4445	4845	5418	5419	6045	6445	6845	7418	7419
175	4046	4446	4846	5420	5421	6046	6446	6846	7420	7421
176	4047	4447	4847	5422	5423	6047	6447	6847	7422	7423
177	4048	4448	4848	5424	5425	6048	6448	6848	7424	7425
178	4049	4449	4849	5426	5427	6049	6449	6849	7426	7427
179	4050	4450	4850	5428	5429	6050	6450	6850	7428	7429
180	4051	4451	4851	5430	5431	6051	6451	6851	7430	7431
181	4052	4452	4852	5432	5433	6052	6452	6852	7432	7433
182	4053	4453	4853	5434	5435	6053	6453	6853	7434	7435
183	4054	4454	4854	5436	5437	6054	6454	6854	7436	7437
184	4055	4455	4855	5438	5439	6055	6455	6855	7438	7439
185	4056	4456	4856	5440	5441	6056	6456	6856	7440	7441
186	4057	4457	4857	5442	5443	6057	6457	6857	7442	7443
187	4058	4458	4858	5444	5445	6058	6458	6858	7444	7445
188	4059	4459	4859	5446	5447	6059	6459	6859	7446	7447
189	4060	4460	4860	5448	5449	6060	6460	6860	7448	7449
190	4061	4461	4861	5450	5451	6061	6461	6861	7450	7451
191	4062	4462	4862	5452	5453	6062	6462	6862	7452	7453
192	4063	4463	4863	5454	5455	6063	6463	6863	7454	7455
193	4064	4464	4864	5456	5457	6064	6464	6864	7456	7457
194	4065	4465	4865	5458	5459	6065	6465	6865	7458	7459
195	4066	4466	4866	5460	5461	6066	6466	6866	7460	7461
196	4067	4467	4867	5462	5463	6067	6467	6867	7462	7463
197	4068	4468	4868	5464	5465	6068	6468	6868	7464	7465
198	4069	4469	4869	5466	5467	6069	6469	6869	7466	7467
199	4070	4470	4870	5468	5469	6070	6470	6870	7468	7469
200	4071	4471	4871	5470	5471	6071	6471	6871	7470	7471

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Positioning Data No.and Buffer Memory Address Conversion Table

Data No.	(X Axis)					(Y Axis)				
	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper
201	4072	4472	4872	5472	5473	6072	6472	6872	7472	7473
202	4073	4473	4873	5474	5475	6073	6473	6873	7474	7475
203	4074	4474	4874	5476	5477	6074	6474	6874	7476	7477
204	4075	4475	4875	5478	5479	6075	6475	6875	7478	7479
205	4076	4476	4876	5480	5481	6076	6476	6876	7480	7481
206	4077	4477	4877	5482	5483	6077	6477	6877	7482	7483
207	4078	4478	4878	5484	5485	6078	6478	6878	7484	7485
208	4079	4479	4879	5486	5487	6079	6479	6879	7486	7487
209	4080	4480	4880	5488	5489	6080	6480	6880	7488	7489
210	4081	4481	4881	5490	5491	6081	6481	6881	7490	7491
211	4082	4482	4882	5492	5493	6082	6482	6882	7492	7493
212	4083	4483	4883	5494	5495	6083	6483	6883	7494	7495
213	4084	4484	4884	5496	5497	6084	6484	6884	7496	7497
214	4085	4485	4885	5498	5499	6085	6485	6885	7498	7499
215	4086	4486	4886	5500	5501	6086	6486	6886	7500	7501
216	4087	4487	4887	5502	5503	6087	6487	6887	7502	7503
217	4088	4488	4888	5504	5505	6088	6488	6888	7504	7505
218	4089	4489	4889	5506	5507	6089	6489	6889	7506	7507
219	4090	4490	4890	5508	5509	6090	6490	6890	7508	7509
220	4091	4491	4891	5510	5511	6091	6491	6891	7510	7511
221	4092	4492	4892	5512	5513	6092	6492	6892	7512	7513
222	4093	4493	4893	5514	5515	6093	6493	6893	7514	7515
223	4094	4494	4894	5516	5517	6094	6494	6894	7516	7517
224	4095	4495	4895	5518	5519	6095	6495	6895	7518	7519
225	4096	4496	4896	5520	5521	6096	6496	6896	7520	7521
226	4097	4497	4897	5522	5523	6097	6497	6897	7522	7523
227	4098	4498	4898	5524	5525	6098	6498	6898	7524	7525
228	4099	4499	4899	5526	5527	6099	6499	6899	7526	7527
229	4100	4500	4900	5528	5529	6100	6500	6900	7528	7529
230	4101	4501	4901	5530	5531	6101	6501	6901	7530	7531
231	4102	4502	4902	5532	5533	6102	6502	6902	7532	7533
232	4103	4503	4903	5534	5535	6103	6503	6903	7534	7535
233	4104	4504	4904	5536	5537	6104	6504	6904	7536	7537
234	4105	4505	4905	5538	5539	6105	6505	6905	7538	7539
235	4106	4506	4906	5540	5541	6106	6506	6906	7540	7541
236	4107	4507	4907	5542	5543	6107	6507	6907	7542	7543
237	4108	4508	4908	5544	5545	6108	6508	6908	7544	7545
238	4109	4509	4909	5546	5547	6109	6509	6909	7546	7547
239	4110	4510	4910	5548	5549	6110	6510	6910	7548	7549
240	4111	4511	4911	5550	5551	6111	6511	6911	7550	7551
241	4112	4512	4912	5552	5553	6112	6512	6912	7552	7553
242	4113	4513	4913	5554	5555	6113	6513	6913	7554	7555
243	4114	4514	4914	5556	5557	6114	6514	6914	7556	7557
244	4115	4515	4915	5558	5559	6115	6515	6915	7558	7559
245	4116	4516	4916	5560	5561	6116	6516	6916	7560	7561
246	4117	4517	4917	5562	5563	6117	6517	6917	7562	7563
247	4118	4518	4918	5564	5565	6118	6518	6918	7564	7565
248	4119	4519	4919	5566	5567	6119	6519	6919	7566	7567
249	4120	4520	4920	5568	5569	6120	6520	6920	7568	7569
250	4121	4521	4921	5570	5571	6121	6521	6921	7570	7571

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Positioning Data No.and Buffer Memory Address Conversion Table

Data No.	(X Axis)					(Y Axis)				
	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper
251	4122	4522	4922	5572	5573	6122	6522	6922	7572	7573
252	4123	4523	4923	5574	5575	6123	6523	6923	7574	7575
253	4124	4524	4924	5576	5577	6124	6524	6924	7576	7577
254	4125	4525	4925	5578	5579	6125	6525	6925	7578	7579
255	4126	4526	4926	5580	5581	6126	6526	6926	7580	7581
256	4127	4527	4927	5582	5583	6127	6527	6927	7582	7583
257	4128	4528	4928	5584	5585	6128	6528	6928	7584	7585
258	4129	4529	4929	5586	5587	6129	6529	6929	7586	7587
259	4130	4530	4930	5588	5589	6130	6530	6930	7588	7589
260	4131	4531	4931	5590	5591	6131	6531	6931	7590	7591
261	4132	4532	4932	5592	5593	6132	6532	6932	7592	7593
262	4133	4533	4933	5594	5595	6133	6533	6933	7594	7595
263	4134	4534	4934	5596	5597	6134	6534	6934	7596	7597
264	4135	4535	4935	5598	5599	6135	6535	6935	7598	7599
265	4136	4536	4936	5600	5601	6136	6536	6936	7600	7601
266	4137	4537	4937	5602	5603	6137	6537	6937	7602	7603
267	4138	4538	4938	5604	5605	6138	6538	6938	7604	7605
268	4139	4539	4939	5606	5607	6139	6539	6939	7606	7607
269	4140	4540	4940	5608	5609	6140	6540	6940	7608	7609
270	4141	4541	4941	5610	5611	6141	6541	6941	7610	7611
271	4142	4542	4942	5612	5613	6142	6542	6942	7612	7613
272	4143	4543	4943	5614	5615	6143	6543	6943	7614	7615
273	4144	4544	4944	5616	5617	6144	6544	6944	7616	7617
274	4145	4545	4945	5618	5619	6145	6545	6945	7618	7619
275	4146	4546	4946	5620	5621	6146	6546	6946	7620	7621
276	4147	4547	4947	5622	5623	6147	6547	6947	7622	7623
277	4148	4548	4948	5624	5625	6148	6548	6948	7624	7625
278	4149	4549	4949	5626	5627	6149	6549	6949	7626	7627
279	4150	4550	4950	5628	5629	6150	6550	6950	7628	7629
280	4151	4551	4951	5630	5631	6151	6551	6951	7630	7631
281	4152	4552	4952	5632	5633	6152	6552	6952	7632	7633
282	4153	4553	4953	5634	5635	6153	6553	6953	7634	7635
283	4154	4554	4954	5636	5637	6154	6554	6954	7636	7637
284	4155	4555	4955	5638	5639	6155	6555	6955	7638	7639
285	4156	4556	4956	5640	5641	6156	6556	6956	7640	7641
286	4157	4557	4957	5642	5643	6157	6557	6957	7642	7643
287	4158	4558	4958	5644	5645	6158	6558	6958	7644	7645
288	4159	4559	4959	5646	5647	6159	6559	6959	7646	7647
289	4160	4560	4960	5648	5649	6160	6560	6960	7648	7649
290	4161	4561	4961	5650	5651	6161	6561	6961	7650	7651
291	4162	4562	4962	5652	5653	6162	6562	6962	7652	7653
292	4163	4563	4963	5654	5655	6163	6563	6963	7654	7655
293	4164	4564	4964	5656	5657	6164	6564	6964	7656	7657
294	4165	4565	4965	5658	5659	6165	6565	6965	7658	7659
295	4166	4566	4966	5660	5661	6166	6566	6966	7660	7661
296	4167	4567	4967	5662	5663	6167	6567	6967	7662	7663
297	4168	4568	4968	5664	5665	6168	6568	6968	7664	7665
298	4169	4569	4969	5666	5667	6169	6569	6969	7666	7667
299	4170	4570	4970	5668	5669	6170	6570	6970	7668	7669
300	4171	4571	4971	5670	5671	6171	6571	6971	7670	7671

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Positioning Data No. and Buffer Memory Address Conversion Table

Data No.	(X Axis)					(Y Axis)				
	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper
301	4172	4572	4972	5672	5673	6172	6572	6972	7672	7673
302	4173	4573	4973	5674	5675	6173	6573	6973	7674	7675
303	4174	4574	4974	5676	5677	6174	6574	6974	7676	7677
304	4175	4575	4975	5678	5679	6175	6575	6975	7678	7679
305	4176	4576	4976	5680	5681	6176	6576	6976	7680	7681
306	4177	4577	4977	5682	5683	6177	6577	6977	7682	7683
307	4178	4578	4978	5684	5685	6178	6578	6978	7684	7685
308	4179	4579	4979	5686	5687	6179	6579	6979	7686	7687
309	4180	4580	4980	5688	5689	6180	6580	6980	7688	7689
310	4181	4581	4981	5690	5691	6181	6581	6981	7690	7691
311	4182	4582	4982	5692	5693	6182	6582	6982	7692	7693
312	4183	4583	4983	5694	5695	6183	6583	6983	7694	7695
313	4184	4584	4984	5696	5697	6184	6584	6984	7696	7697
314	4185	4585	4985	5698	5699	6185	6585	6985	7698	7699
315	4186	4586	4986	5700	5701	6186	6586	6986	7700	7701
316	4187	4587	4987	5702	5703	6187	6587	6987	7702	7703
317	4188	4588	4988	5704	5705	6188	6588	6988	7704	7705
318	4189	4589	4989	5706	5707	6189	6589	6989	7706	7707
319	4190	4590	4990	5708	5709	6190	6590	6990	7708	7709
320	4191	4591	4991	5710	5711	6191	6591	6991	7710	7711
321	4192	4592	4992	5712	5713	6192	6592	6992	7712	7713
322	4193	4593	4993	5714	5715	6193	6593	6993	7714	7715
323	4194	4594	4994	5716	5717	6194	6594	6994	7716	7717
324	4195	4595	4995	5718	5719	6195	6595	6995	7718	7719
325	4196	4596	4996	5720	5721	6196	6596	6996	7720	7721
326	4197	4597	4997	5722	5723	6197	6597	6997	7722	7723
327	4198	4598	4998	5724	5725	6198	6598	6998	7724	7725
328	4199	4599	4999	5726	5727	6199	6599	6999	7726	7727
329	4200	4600	5000	5728	5729	6200	6600	7000	7728	7729
330	4201	4601	5001	5730	5731	6201	6601	7001	7730	7731
331	4202	4602	5002	5732	5733	6202	6602	7002	7732	7733
332	4203	4603	5003	5734	5735	6203	6603	7003	7734	7735
333	4204	4604	5004	5736	5737	6204	6604	7004	7736	7737
334	4205	4605	5005	5738	5739	6205	6605	7005	7738	7739
335	4206	4606	5006	5740	5741	6206	6606	7006	7740	7741
336	4207	4607	5007	5742	5743	6207	6607	7007	7742	7743
337	4208	4608	5008	5744	5745	6208	6608	7008	7744	7745
338	4209	4609	5009	5746	5747	6209	6609	7009	7746	7747
339	4210	4610	5010	5748	5749	6210	6610	7010	7748	7749
340	4211	4611	5011	5750	5751	6211	6611	7011	7750	7751
341	4212	4612	5012	5752	5753	6212	6612	7012	7752	7753
342	4213	4613	5013	5754	5755	6213	6613	7013	7754	7755
343	4214	4614	5014	5756	5757	6214	6614	7014	7756	7757
344	4215	4615	5015	5758	5759	6215	6615	7015	7758	7759
345	4216	4616	5016	5760	5761	6216	6616	7016	7760	7761
346	4217	4617	5017	5762	5763	6217	6617	7017	7762	7763
347	4218	4618	5018	5764	5765	6218	6618	7018	7764	7765
348	4219	4619	5019	5766	5767	6219	6619	7019	7766	7767
349	4220	4620	5020	5768	5769	6220	6620	7020	7768	7769
350	4221	4621	5021	5770	5771	6221	6621	7021	7770	7771

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Positioning Data No.and Buffer Memory Address Conversion Table

Data No.	(X Axis)					(Y Axis)				
	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper	Positioning Information	Positioning Speed	Dwell Time	Positioning Lower	Address Upper
351	4222	4622	5022	5772	5773	6222	6622	7022	7772	7773
352	4223	4623	5023	5774	5775	6223	6623	7023	7774	7775
353	4224	4624	5024	5776	5777	6224	6624	7024	7776	7777
354	4225	4625	5025	5778	5779	6225	6625	7025	7778	7779
355	4226	4626	5026	5780	5781	6226	6626	7026	7780	7781
356	4227	4627	5027	5782	5783	6227	6627	7027	7782	7783
357	4228	4628	5028	5784	5785	6228	6628	7028	7784	7785
358	4229	4629	5029	5786	5787	6229	6629	7029	7786	7787
359	4230	4630	5030	5788	5789	6230	6630	7030	7788	7789
360	4231	4631	5031	5790	5791	6231	6631	7031	7790	7791
361	4232	4632	5032	5792	5793	6232	6632	7032	7792	7793
362	4233	4633	5033	5794	5795	6233	6633	7033	7794	7795
363	4234	4634	5034	5796	5797	6234	6634	7034	7796	7797
364	4235	4635	5035	5798	5799	6235	6635	7035	7798	7799
365	4236	4636	5036	5800	5801	6236	6636	7036	7800	7801
366	4237	4637	5037	5802	5803	6237	6637	7037	7802	7803
367	4238	4638	5038	5804	5805	6238	6638	7038	7804	7805
368	4239	4639	5039	5806	5807	6239	6639	7039	7806	7807
369	4240	4640	5040	5808	5809	6240	6640	7040	7808	7809
370	4241	4641	5041	5810	5811	6241	6641	7041	7810	7811
371	4242	4642	5042	5812	5813	6242	6642	7042	7812	7813
372	4243	4643	5043	5814	5815	6243	6643	7043	7814	7815
373	4244	4644	5044	5816	5817	6244	6644	7044	7816	7817
374	4245	4645	5045	5818	5819	6245	6645	7045	7818	7819
375	4246	4646	5046	5820	5821	6246	6646	7046	7820	7821
376	4247	4647	5047	5822	5823	6247	6647	7047	7822	7823
377	4248	4648	5048	5824	5825	6248	6648	7048	7824	7825
378	4249	4649	5049	5826	5827	6249	6649	7049	7826	7827
379	4250	4650	5050	5828	5829	6250	6650	7050	7828	7829
380	4251	4651	5051	5830	5831	6251	6651	7051	7830	7831
381	4252	4652	5052	5832	5833	6252	6652	7052	7832	7833
382	4253	4653	5053	5834	5835	6253	6653	7053	7834	7835
383	4254	4654	5054	5836	5837	6254	6654	7054	7836	7837
384	4255	4655	5055	5838	5839	6255	6655	7055	7838	7839
385	4256	4656	5056	5840	5841	6256	6656	7056	7840	7841
386	4257	4657	5057	5842	5843	6257	6657	7057	7842	7843
387	4258	4658	5058	5844	5845	6258	6658	7058	7844	7845
388	4259	4659	5059	5846	5847	6259	6659	7059	7846	7847
389	4260	4660	5060	5848	5849	6260	6660	7060	7848	7849
390	4261	4661	5061	5850	5851	6261	6661	7061	7850	7851
391	4262	4662	5062	5852	5853	6262	6662	7062	7852	7853
392	4263	4663	5063	5854	5855	6263	6663	7063	7854	7855
393	4264	4664	5064	5856	5857	6264	6664	7064	7856	7857
394	4265	4665	5065	5858	5859	6265	6665	7065	7858	7859
395	4266	4666	5066	5860	5861	6266	6666	7066	7860	7861
396	4267	4667	5067	5862	5863	6267	6667	7067	7862	7863
397	4268	4668	5068	5864	5865	6268	6668	7068	7864	7865
398	4269	4669	5069	5866	5867	6269	6669	7069	7866	7867
399	4270	4670	5070	5868	5869	6270	6670	7070	7868	7869
400	4271	4671	5071	5870	5871	6271	6671	7071	7870	7871

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IMPORTANT

The components on the printed circuit boards will be damaged by static electricity, so avoid handling them directly. If it is necessary to handle them take the following precautions.

(1) Ground human body and work bench.

(2) Do not touch the conductive areas of the printed circuit board and its electrical parts with any non-grounded tools etc.

Under no circumstances will Mitsubishi Electric be liable or responsible for any consequential damage that may arise as a result of the installation or use of this equipment.

All examples and diagrams shown in this manual are intended only as an aid to understanding the text, not to guarantee operation. Mitsubishi Electric will accept no responsibility for actual use of the product based on these illustrative examples.

Owing to the very great variety in possible applications of this equipment, you must satisfy yourself as to its suitability for your specific application.

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