NSK

Robot Module System

- P Series Module Main Unit
- R Series Module Main Unit
- EXEA Controller

User's Manual 1

= Installation and Maintenance of EXEA Controller =

1 Installation and Maintenance of EXEA Controller

1. Introduction
2. Safety Precautions
3. System Configuration
4. Glossary
5. Reference Number • Specifications
6. Unpacking and Installation
7. Wiring
8. Startup
9. Initial Setting
10. Trial Running
11. Protection and Safety
12. Maintenance • Checking
13. Alarms
14. Troubleshooting

Appendix

2 Programming and Operation of EXEA Controller

15. Programming
16. Description of Function
17. Operation of Robot Module
18. Remote Control Operation

3 Installation and Maintenance of Module Main Unit

19. Reference Number • Specifications
20. Unpacking
21. Installation
22. Maintenance • Checking

M–E099XE0K2–022

NSK Ltd.

Document Number: K20078-01

EC-T

Limited Warranty

NSK Ltd. warrants its products to be free from defects in material and/or workmanship which NSK Ltd. is notified of in writing within, which comes first, one (1) year of shipment or 2400 total operation hours. NSK Ltd., at its option, and with transportation charges prepaid by the claimant, will repair or replace any product which has been proved to the satisfaction of NSK Ltd. to have a defect in material and/or workmanship.

This warranty is the sole and exclusive remedy available, and under no circumstances shall NSK Ltd. be liable for any consequential damages, loss of profits and/or personal injury as a result of claim arising under this limited warranty. NSK Ltd. makes no other warranty express or implied, and disclaims any warranties for fitness for a particular purpose or merchantability.

Robot Module System
EC Directives Conformity

NSK Ltd. declares that "Robot Module System" conforms to EC Directive (CE Marking).

However, please note that the following conditions are added for conformity to the EC directive.

⊙ EC Declaration of Incorporation

- NSK Ltd. declares that the Robot Module System is a machine component which is to be incorporated into the machine. (EC Declaration of Incorporation)
- The Robot Module System must not be operated until it is incorporated to the machine.
- The Robot Module System, as the machine component, conforms with following EC Directives.
  - ◊ EC Machinery Directive 89/392 as amended 94/368 and 93/44.
  - ◊ EC Low Voltage Directive 73/23 as amended 93/68.
- The customer has to take appropriate measures to its machine to conform to Electromagnetic Compatibility Directive. The Robot Module must not put into service until the machinery into which it to be incorporated has been declared in conformity with the provisions of EC Directives.
- Our declaration becomes invalid if technical or operational modifications are introduced without the consent of Mechatronics Technology Department of NSK Ltd.

⊙ Remaining Hazards (Following notes should be observed for your safety.)

- EXEA controller shall be put into the enclosure conforming to relevant European standard in terms of fire protection and electrical shock protection. The protection grade of the enclosure must be IP 54 or better. EXEA controller shall not be exposed to water or oil.
- Just after the power is turned on and off, there will be the hazardous voltage on the parts of EXEA controller, such as the power input terminal, motor connector and connector for an external regenerative dump resistor. Put covers on those parts to protect from touching when operating the machine or doing maintenance work.
  Furthermore, provide appropriate protection from disconnecting the motor connector accidentally.
- An isolation transformer must be used to prevent electrical shock. The isolation transformer must have enough capacity for the Robot Module System power consumption.
- Install noise filter in the primary AC power line as a measure for Electromagnetic Compatibility Directive.
- A circuit breaker must be installed to the primary AC power line of Robot Module System.
- Ground earthing must be provided to EXEA controller.
- Wiring inside of EXEA controller is simply internal wirings and the grounding wire is not distinguished by color as the protective grounding conductive.
- Secure the controller cables and motor cables firmly so that those cables do not break or have loose contact.
- Surround the machine, to which the Robot Module System is incorporated, with safety fence to prevent any personnel from entering its moving range.

⊙ Unit Limitation

- Units of Robot Module System which conform to EC Directives are limited to the following reference number only.

  1. EXEA controller

     Reference No. : M-EXEA □ – □ □ □ □ T □ □

                                                  ↑

                                  T : Indicates conformity with the Directive

  2. Teaching Box

     Reference No. : M-EXTB 04

- However, all robot module main units are compatible with the EC Directives. If you require to build the Robot Module System that complies to the EC Directives, the EXEA controller and the Teaching Box must be compatible with the EC Directives.

Contents

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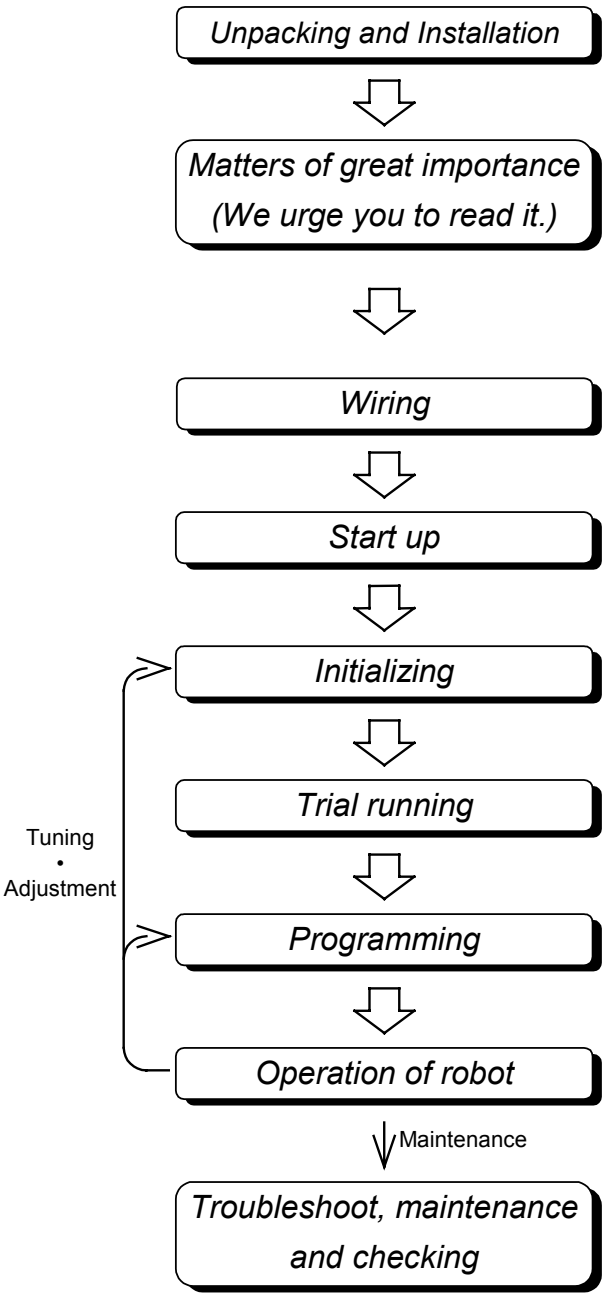
1. Introduction

- This manual describes how to build and operate a Cartesian type robot system configured with the P series and the R series module main units and the EXEA controller.
- This manual covers the EXEA controller, of which version number is 03 or later, for single axis (one axis) system or multi-axis (2 ~ 4 axes) combination main unit.

Example of Reference number: M–EXEA3–0210C00–03
Version number

- This manual consists of three volumes. The contents of each volume are listed on the front cover. Follow the basic procedure as shown below and read the chapters.



User's Manual 1 : "6. Unpacking and Installation."
User's Manual 3 : "20. Transportation, Storage and Unpacking."
User's Manual 3 : "21. Installation."

User's Manual 1 : "1. Introduction"
User's Manual 1 : "2. Safety Precautions"
User's Manual 1 : "3. System Configuration"
User's Manual 1 : "4. Glossary"
User's Manual 1 : "5. Reference Number • Specifications"
User's Manual 3 : "19. Reference Number • Specifications"

User's Manual 1 : "7. Wiring."
*User's Manual 2 : "18. Remote Control Operation"

User's Manual 1 : "8. Start up"

User's Manual 1 : "9. Initial Setting"
*User's Manual 2 : "18. Remote Control Operation"

User's Manual 1 : "10. Trial Running"
User's Manual 1 : "11. Protection and Safety"

User's Manual 2 : "15. Programming"
User's Manual 2 : "16. Description of Function"
*User's Manual 2 : "18. Remote Control Operation"

User's Manual 2 : "17. Operation"
*User's Manual 2 : "18. Remote Control Operation"

User's Manual 1 : "12. Maintenance • Checking"
User's Manual 1 : "13. Alarm"
User's Manual 1 : "14. Troubleshooting"
User's Manual 3 : "22. Maintenance • Checking"

* Only when using the personal computer through remote commbzbunication.

Note: If the reference number of your modules are different from the information in this manual, some part of explanation may not be applied to your model. In such a case, ask your local NSK representative for the information.

1.1. Notes for Safety

- Before operating the robot module system, you should first thoroughly read this manual.
- Following notice are added to the clause of safety precautions to get your attention.

  Danger : *Might cause serious injury.*

  Warning : *Might cause injury.*

  Caution : *Might damage ancillary equipment and/or the end effector.*

- Observe the applicable safety regulations for industrial-use robot. Pay great attention for safety when building and operating the robot system.
- Do not use the robot module system in any manner not shown in this manual.

1.2. General Description

- The robot module main unit and the EXEA controller can configure a Cartesian type robot.
- The EXEA controller is capable of positioning control or external signal control, and is suitable for pick and place, palletizing, adhesive dispensing, machining and inspecting operations. It may be used as a component of industrial robot.

1.3. Notes to Users

1.3.1. Axis Indication

- When the matters related to the teaching box are described, the indication of the axes in the display of the teaching box is basically for two axes combination. For three axes, Z axis will be added on the display as the third axis and for four axis combination, R axis will be added on the display as the fourth axis as well. All axes X, Y, Z and R are displayed in teaching process.
  For a single axis system, there is the description that is different from the indication of display of the teaching box. In such a case, refer to the added notes on the description.
  When it dose not necessary to indicate number of axis, one axis system is referred to as "single axis" system and the 2 ~ 4 axes combination is referred to as "multi-axis" combination,

- Relations in initial state between axis indication of program, Jog keys on the teaching box and an axis number indicated on the controller are shown in Table 1-1 below.

U1: Unit 1
U2: Unit 2

Table 1-1

Axis number on controller	Jog keys on the teaching box and indication in a program			
	Single axis	Two axes	Three axes	Four axes
1st. *	X *	U1-X	U1-X	U1-X
2nd.	–	U1-Y	U1-Y	U1-Y
3rd.	–	–	U1-Z	U2-X
4th.	–	–	–	U2-Y

* On the panel of the EXEA controller for single axis, there is no indication of axis number. Indication of single axis is only "X."

- You may change the indication of a vertical axis to Z axis in the multi-axis controller. (Refer to "9.5. Parameter for Unit Setting.")

1.3.2. Regeneration

- When decelerating or descending a heavy load, a servo motor of the main unit generates the regenerative current.

- Regenerative current is dissipated by a regenerative dump resistor in the internal circuit of the controller. However, if the large regeneration of servo motor continues, the regenerative dump resistor will be overheated and an overheat alarm will arise.

- In such a case, it is necessary to ease up the operational condition. Lower velocity, decrease acceleration/deceleration and reduce duty cycle.

1.3.3. Dynamic Brake

- When a module main unit is connected to an EXEA controller, the dynamic brake functions under servo-off or power off condition.

- When moving the slider manually, you feel some resistance. However, this is not an abnormal phenomenon.

- Dynamic brake does not function if the controller cable is disconnected.

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2. Safety Precautions

2.1. Robot Module System

Danger : *Any person in the operating area of robot module may be hit by or caught in the robot module when a module main unit or the EXEA controller fails or functions improperly. Such a hazard exists though the system is running normally at a high speed.*

1) For safety in daily operation, provide guard fences and take the measures to prevent persons from entry into the robot operating area.

2) When you must enter the area bound by the guard fences for adjusting or tuning of the system, keep off the robot operating area and stand in a place where you can see the motion of the robot module clearly. The traveling speed of module main unit at this time should be set lower than the safety speed (250 mm/s).
*Jogging and teaching speed are set to 50 mm/second initially.

3) Before starting maintenance or other work which requires to get in the operating area of the robot module, be sure to turn off the power of the system.

4) If it is necessary to go beyond the fence for troubleshooting without turning off the power, follow the instructions shown in "14. Troubleshooting." In any other cases, do not enter in the guard fence without turning off power.

Danger : *If a back drive force is always applied to the ball screw when the power is turned off (e.g. a vertical axis), use a robot module main unit with motor brake.*
If a module main unit without a brake is used for a vertical axis, the slider (or the main unit if it is a moving axis type combination) drops or moves when the power is turned off.

Warning : *All models of module main unit employ the same type of connectors regardless the size and motor rated power.*

◊ *Before turning on the power, check if the robot module is connected with the controller properly.*

◊ *If the robot module is operated with improper connection to the controller, the module may move unexpectedly or the motor may be broken. See "8.1.1. Preparation before Turning on Power."*

Warning : *Any special measures against EMC (Electromagnetic compatibility of CE Marking) are not taken for the robot module system. Do not use the robot module in an environment subject to much external noises. In an environment where noises produced by the robot module system give influences on your equipment, shield the EXEA controller, use a noise filter or take other measures.*

- The following shows the noise resistance of the EXEA controller itself.

Table 2-1

Specification	Noise resistance	Remarks
Line noise resistance	1000V 1μs	Checked by a noise simulator
Static noise resistance	3 kV	

Warning : The robot module main unit does not have over-travel sensor. Be sure to set the software over-travel limit switch as soon as Home return operation is completed after the power is turned on for the first time. (Refer to "9.3.4. Parameters for Position and Coordinates.")

Caution : Before turning off the controller power, be sure to deactivate the servo system. Otherwise the slider (or the module main unit when the moving axis combination) of a vertical axis may drop by 5 to 10 mm approximately.

* If a critical failure occurs or the robot module system is stopped in an emergency, the hardware deactivates immediately and automatically the servo system. The slider (or the module main unit when the moving axis combination) of a vertical axis may drop due to the time lag between deactivating servo system and engaging motor brake. This does not imply any error of the system.

Caution : Set the system parameter in accordance with the type of module main unit. Especially improper parameter settings to a module main unit in the encoder resolution, the ball screw lead, way of motor mounting or the unit with motor brake will result in malfunction of the system. (Refer to "9.5. Parameters for Unit Setting.")

* When a memory error occurs, you must initialize (reset) the system parameters. In such a case, set the system parameters in accordance with the robot module main unit.

Caution : The robot module is a precision machinery component. Handle it with great care not to give any shock to it.

Caution : An excessive moment load will result in premature failure. Check for an excessive moment load referring to "19.1.3. Precautions against Use of Module Main Unit."

2.2. EXEA Controller

Danger : *Observe the following environmental conditions when installing and/or operating the EXEA controller.*

Table 2-2

Condition		Environmental condition
Temperature	Operating	0°C ~ 50°C
	Storing	-10°C ~ 70°C
Humidity	Operating	20% ~ 85% (non-condensation)
	Storing	
Ambient condition		Free from dust, corrosive gas and inflammable/explosive gas. Protected from cutting oil and cooling water.

- If these conditions are not met, it may shorten the life of the EXEA controller, and may induce malfunction. Also, it may cause serious accident such as electrical shock or fire.

Danger : *The controller has a very high capacity electrolytic condenser in the circuit. There remains residual voltage for few minutes after the power is turned off. Do not remove the case or cover unless it is necessary. Please refer to "12.2.2. Replacement" when removing the case.*

Danger : *Be sure to ground the FGND terminal of the EXEA controller to prevent electric shock. Refer to "7.2.4. Grounding."*

Caution : *Do not conduct an insulation resistance test or a megger test on the EXEA controller. It may damage the internal circuits.*

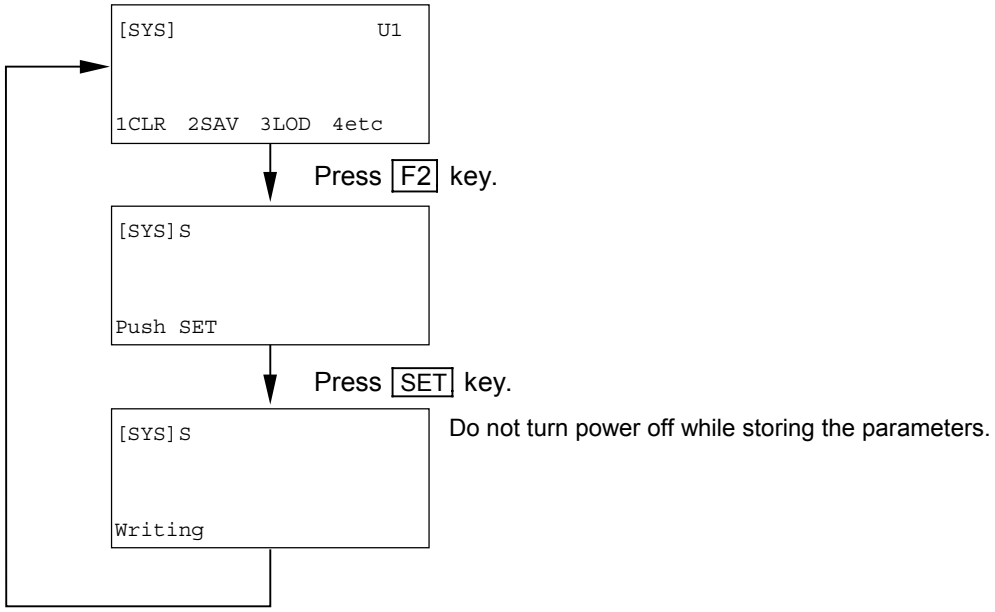
2.2.1. Cautions for Storing Data to Memory

- The EXEA controller has two kinds of memory internally. One is a RAM that stores the data temporarily when the power is on, and loses data as the power is turned off. The data must be stored to the other memory (flash memory which does not need a back-up battery) that does not lose data when the power is turned off.

- When you need to store the data such as rewritten programs, teaching data and initial parameter setting, follow the relevant instructions in this manual.

  Caution : When saving the data to the memory, the display of teaching box reports "Writing." Never turn off the power when this "Writing" is displayed. Otherwise the memory error arises.
  (The system does not recover unless the all data, including programs, are cleared when this alarm arises.)

  Example: Procedure to store system parameter



- The information or the record of parameters which are stored in the EXEA controller may be lost or changed due to mishandling of the system, external noise, failure of the controller or an accidental termination of the power in the middle of loading data.

- Keep the record of necessary data or parameters in handwritten notes or in the back-up function of optional application software beforehand.

- Even initializing the controller for some reason, back up all data and parameters beforehand. The initialization changes all data and parameters to the shipping set.

3. System Configuration

- You can build a robot module system that consists of the module main units and EXEA controller.

3.1. System Setup

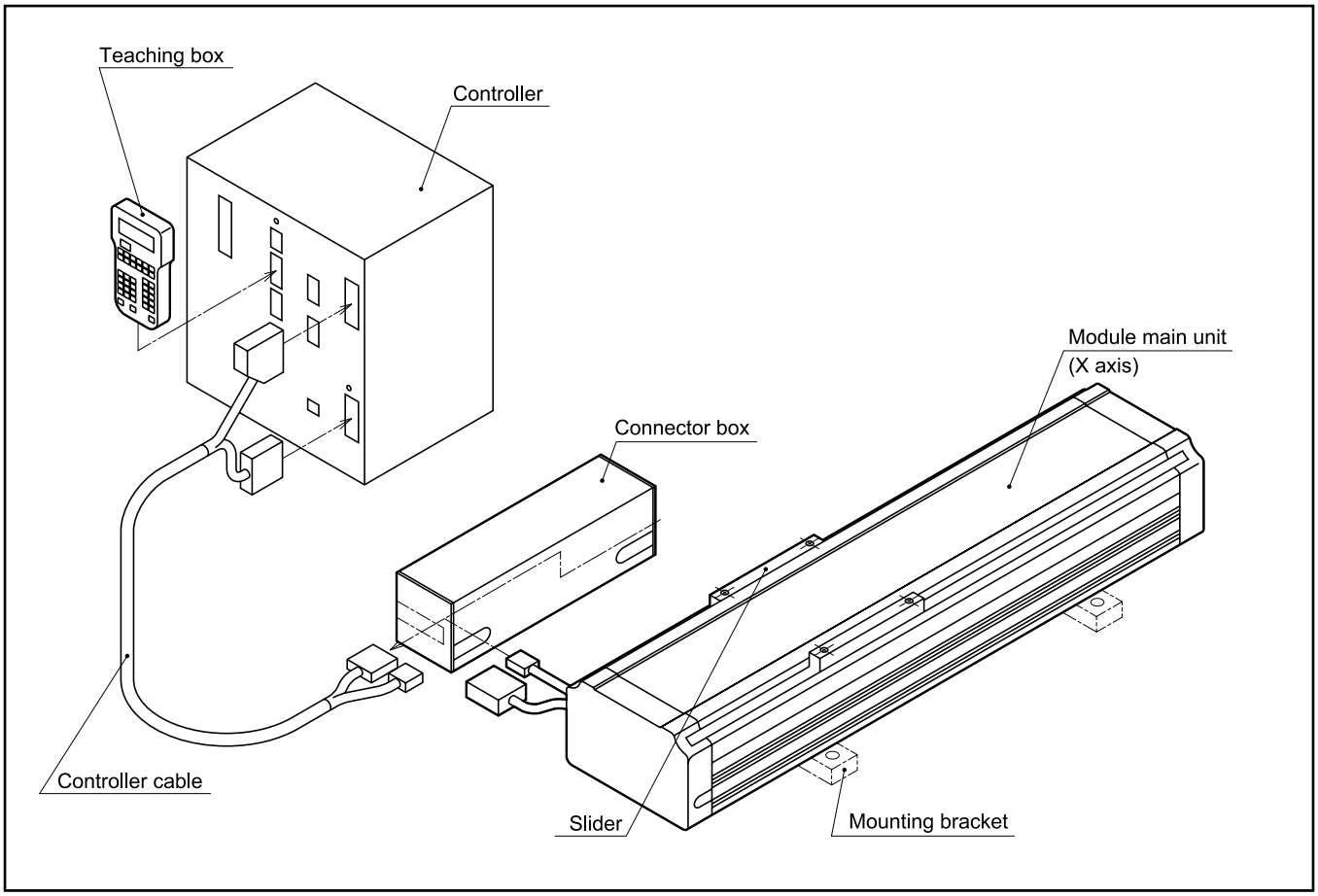
3.1.1. Connection of Module Main Unit and Controller

3.1.1.1. Single Axis Configuration

- A module main unit may be fixed to a mounting base from its bottom using bolts. Optional mounting bracket is available to fix module main unit from top side. (Two mounting brackets are required for a main unit.)
- Use the controller cable and the cable support to connect a main unit and an EXEA controller.
- The controller cable consists of wiring of motor power, encoder signal and protective ground.
- Fix the end effector to bolt holes on the top of a slider of main unit.

Note: Refer to "21. Installation" for assembly procedure.

Figure 3-1

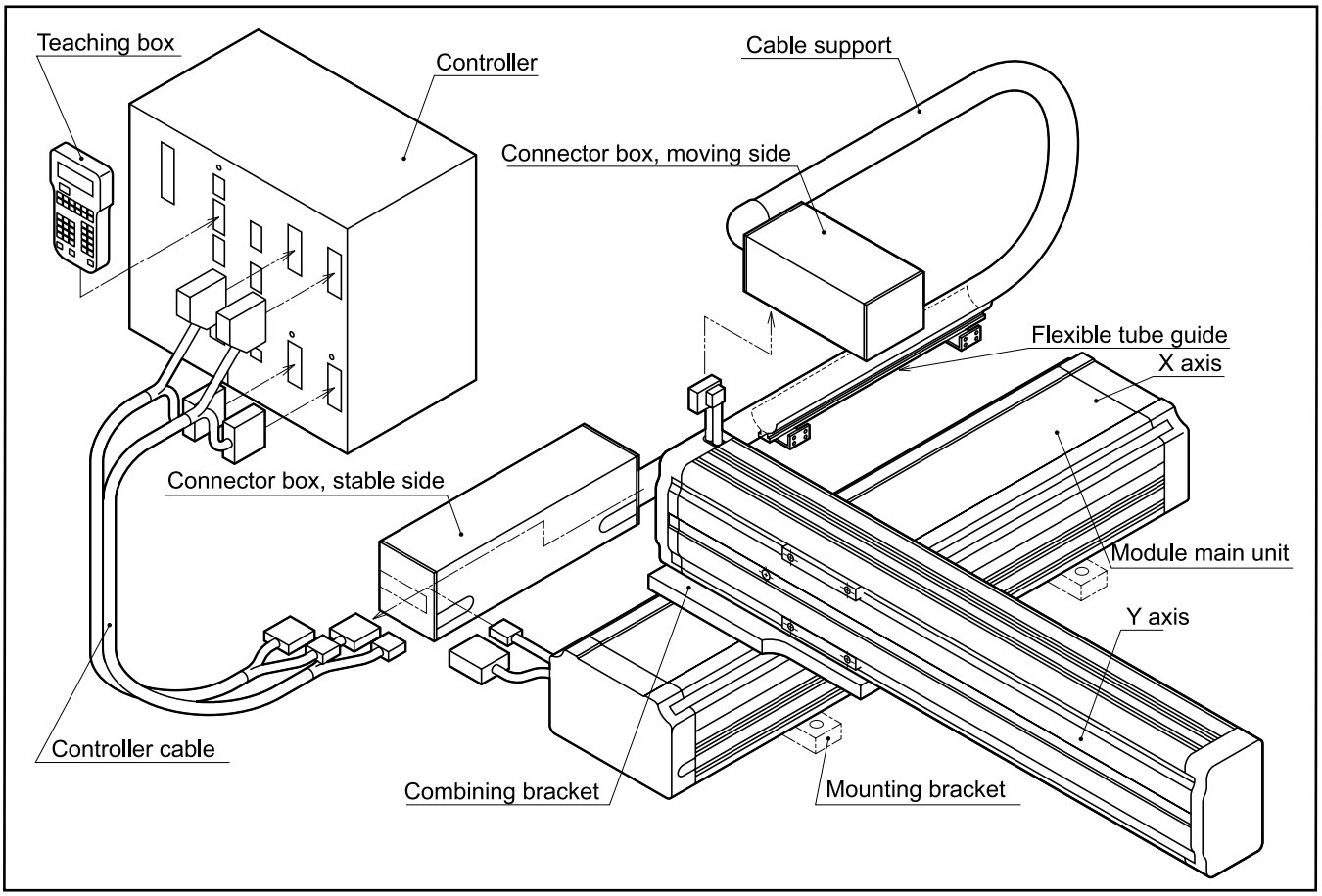


3.1.1.2. Multi-axis Configuration (Example of 2 axes controller)

- A module main unit may be fixed from its bottom surface using the bolts. Optional mounting bracket is available to fix the main unit from its top side.
  (Two mounting brackets are required for a main unit.)
- Use the combining brackets to combine two or more main units.
- Use a controller cable and cable support to connect the controller and the main units.
- The wiring of motor power, encoder signal and protective ground are connected to the controller from the main unit by the controller cable.
- The user does not need to prepare the connector box as it is provided with a cable support.
- User's signal cable and air tube may be added to the cable support. Refer to "19.3. Cable Support."
- Fix an end effector to the bolt holes on the top of the slider of main unit.

Note: Refer to "21. Installation" for assembly procedure.

Figure 3-2

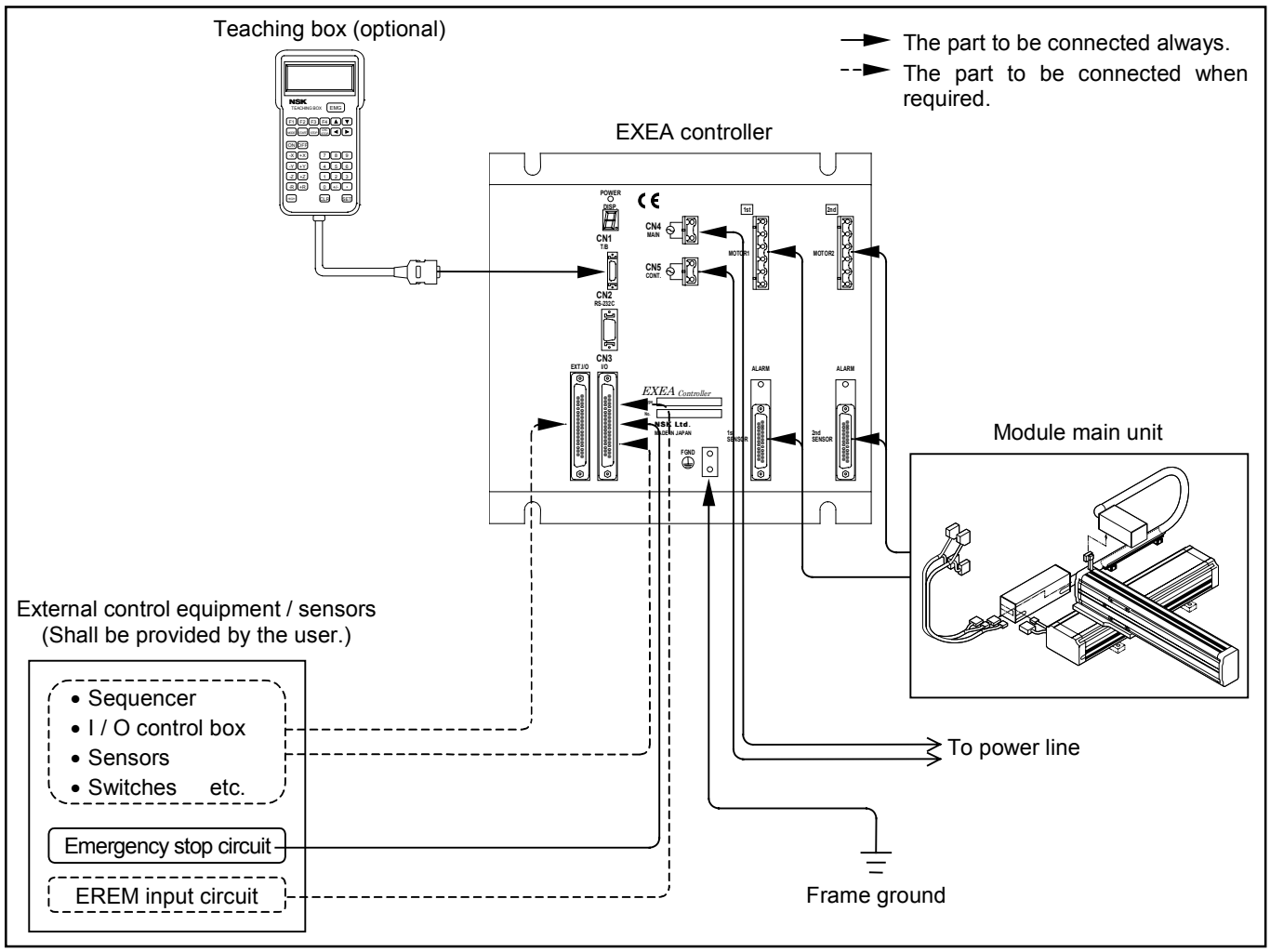


3.1.2. Connecting Peripherals

- There are three ways to operate the EXEA controller. This section describes the fundamental ways of connection in case of two axes EXEA controller. For 1, 3 and 4 axes controller, the connection is basically the same, though the numbers of connecting points of the main power source and the controller cables are different.

1 Using the teaching box
(Refer to "17.3. Operation by Teaching Box.")

Figure 3-3



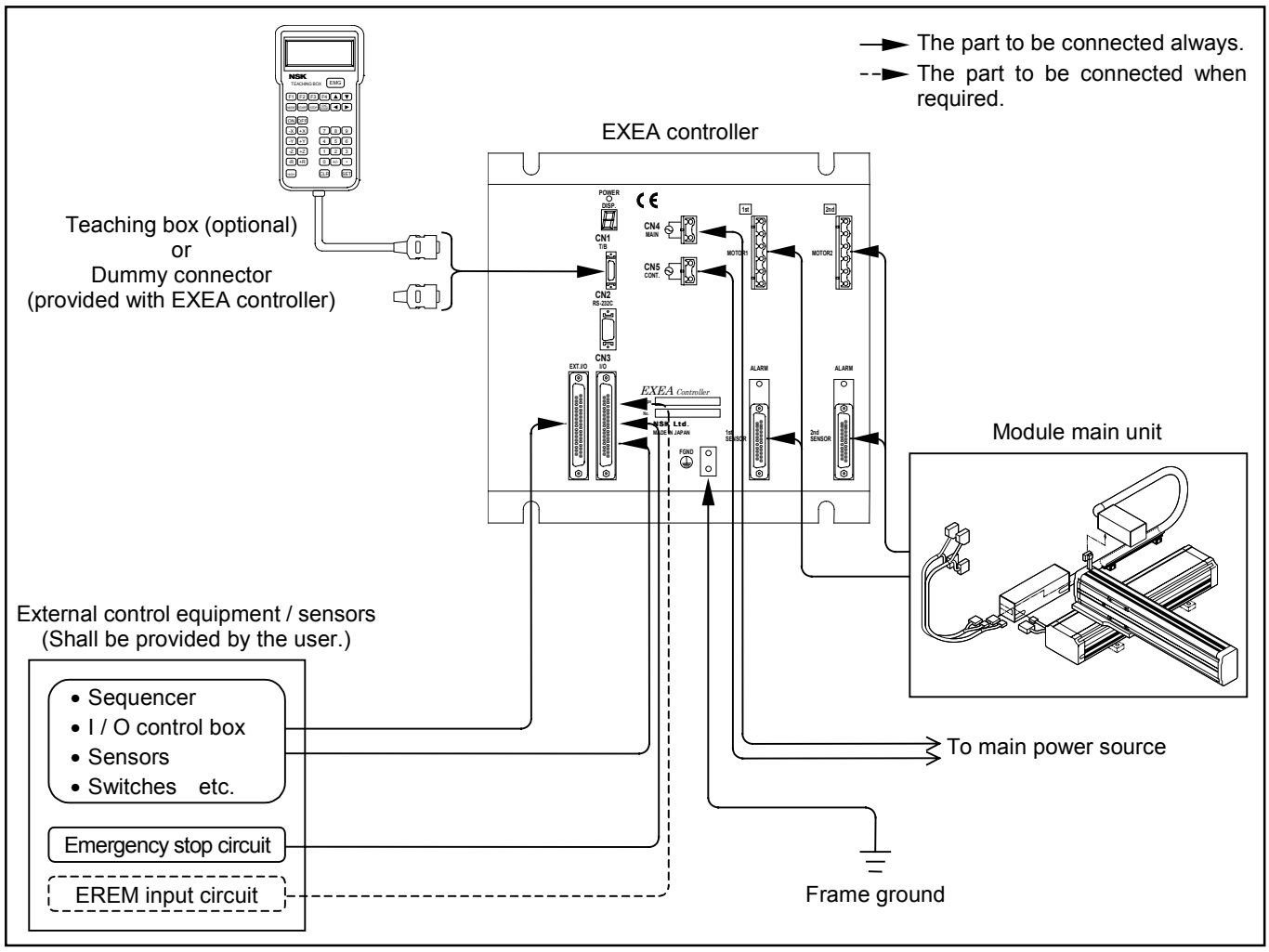
- All operations (initial setting, programming and operation) can be done through the Teaching box.

- The emergency stop circuit of CN3 connector must be connected, otherwise you cannot move the robot module.
(Refer to "11.3. Protection and Function for Safety.")

2 Operation by remote control mode

(Refer to "17.4. Operation in External Control Mode" for more details.)

Figure 3-4



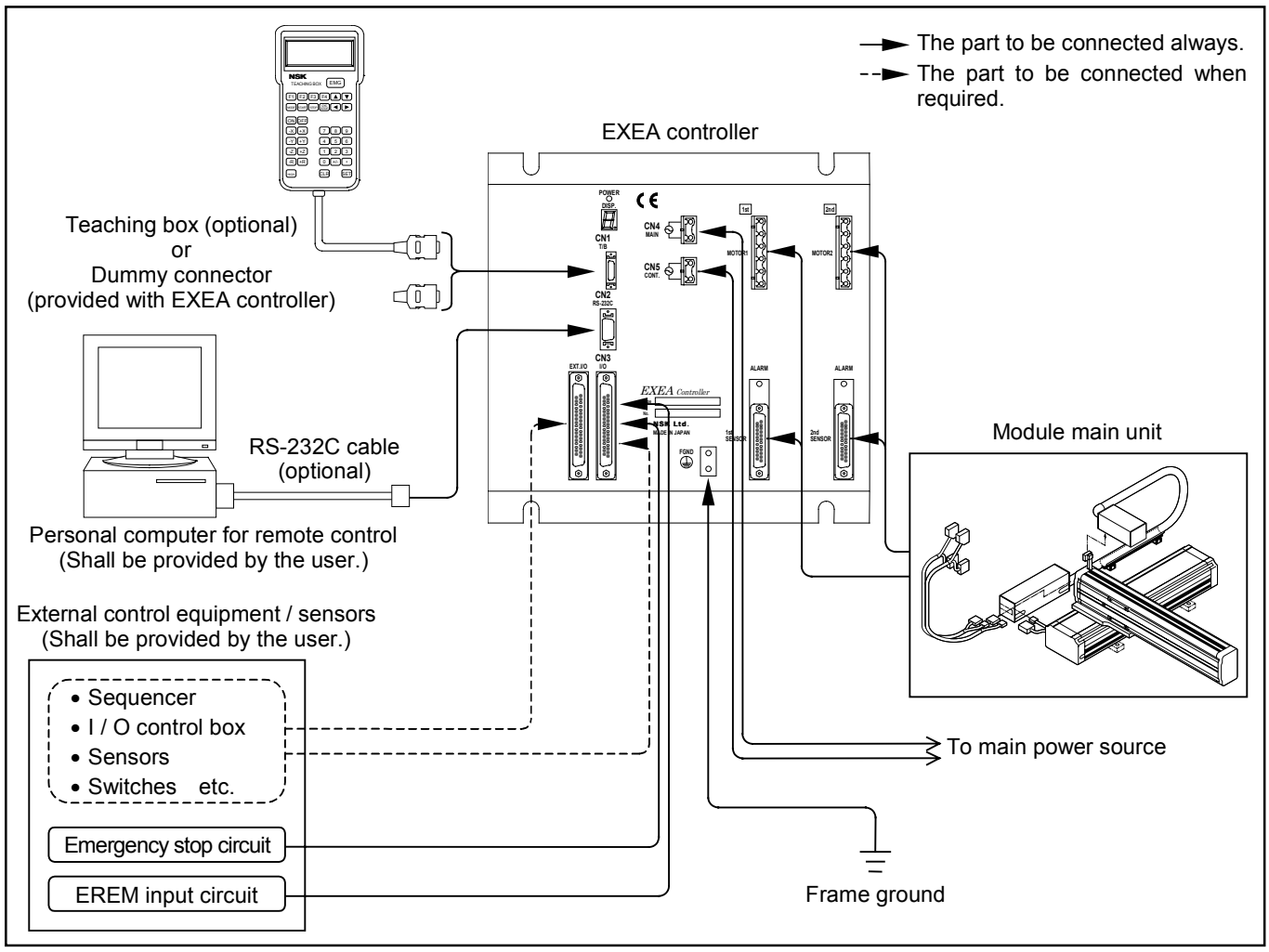
- You can operate the robot system through the external equipment.
- You need the teaching box for initial setting, programming and tuning.
- The emergency stop circuit of CN3 connector shall be connected, otherwise you cannot operate the robot module system.
  (Refer to "11.3. Protection and Function for Safety.")
- For normal operations after setup of the system, you may use the dummy connector instead of the teaching box.

Danger : Be sure to turn off the power when connecting or disconnecting the connectors.

3 Remote control operation

(Refer to "18. Remote Control Operation" for more details.)

Figure 3-5



- All operations such as Initial setting, programming and operation, excluding Jog operation, can be done through the personal computer.
- Purchase the optional application software and RS-232C cable for the external control using a personal computer.
  (Refer to "5.3.3. Application Software for Personal Computer" and "5.3.4. RS-232C Cable.")
- Wiring of the emergency stop circuit of CN3 and EREM input circuit are required for the remote control.

  Note: Switch the control mode to the remote control mode or the external control mode through the EREM input circuit. When the EXEA controller is in the external control mode, turning EREM input on makes to get in the remote control mode. When the EREM circuit is not wired, you cannot select the remote control mode.

- You may use the dummy connector instead of the teaching box when you do not require the operations such as Jog or tuning servo..

  Danger *: Be sure to turn off the power when connecting or disconnecting the connectors.*

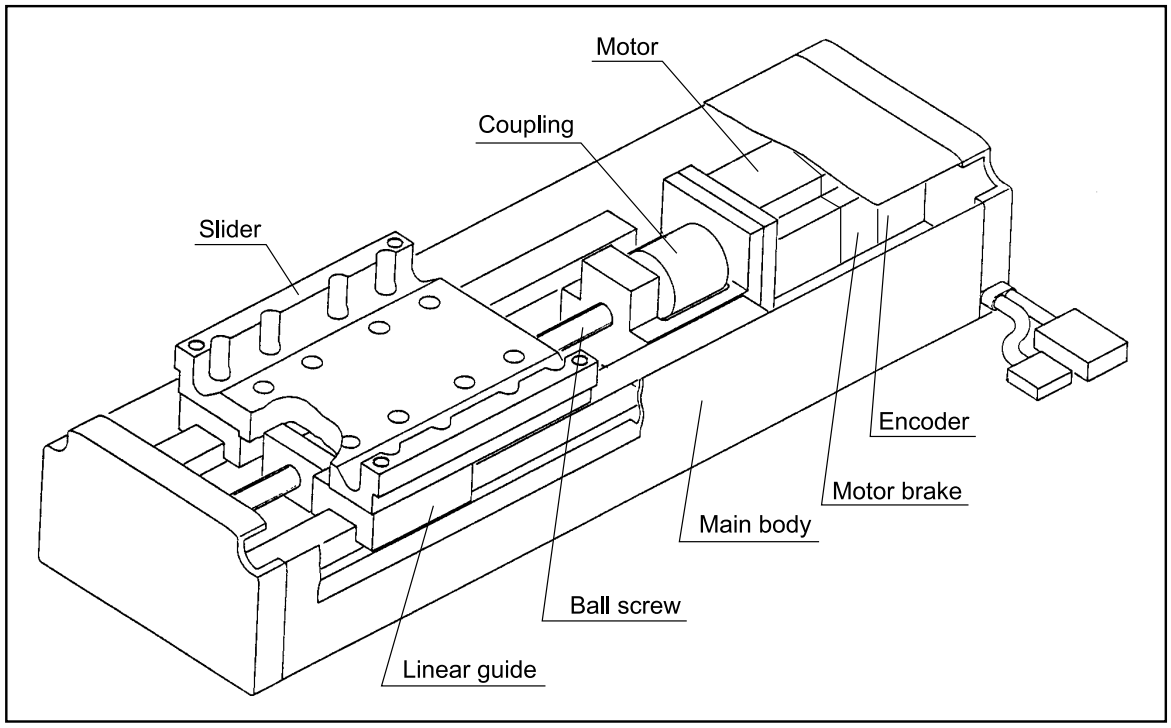
3.2. Structure of Module Main Unit

● Table below shows components of a module main unit and their functions.

Table 3-1

Component	Function
Motor	• Generates driving force (rotational torque) produced by electric current supplied from the EXEA controller.
Encoder	• Outputs electrical signals in accordance with rotation angles of motor and transmit the signals to the EXEA controller.
Coupling	• Couples the motor shaft with the ball screw shaft and transmits motor torque to the ball screw.
Ball screw	• Converts rotational torque (rotational motion) of the screw shaft into thrust force (linear motion) of the ball nut.
NSK linear guide	• Functions as a linear guide way. Supports vertical, lateral and moment loads and achieves precise linear motion of slider.
Slider	• Combines the ball screw nut and the ball slides of linear guide for highly precise linear motion. • An end effector or a combining bracket may be mounted to the slider.
Motor brake	• Prevent the slider from dropping when the power of a vertical main unit is turned off. • The brake is released when the current is given from the EXEA controller. It engages when the power is off. • Module main unit with motor brake is optional.

Figure 3-6 : Components of module main unit



3.3. Structure of EXEA Controller

● Table 3-2 shows components of controller and their functions.

Table 3-2

Component	Function	Remarks
EXEA controller	• Controls the entire robot module system. • When the start command is activated, it supplies electric current to motor(s) to execute the operations in accordance with programs and system parameters set in the controller. • Realizes highly precise positioning utilizing the encoder signals as feed back signals of the motion.	
Teaching box	• Use it to edit programs and set parameters. Can be used to execute manual operations such as Jog, Home return and inputting Run command to start a programmed operation.	Sold separately from the EXEA controller.
Main console, sequencer and DC 24V power supply	• The unit to input control signal externally when an EXEA controller is in the external control mode. • Can be used with incorporated DC 24V power supply. Refer to "5.1.1.1. Internal DC 24V Power Supply" for its specifications.	Should be provided by the user.
CN3: Controller I / O cable*	• Connect the EXEA controller and the external control units (e. g. main console and sequencer).	Should be provided by user.
EXT: General I / O cable*	• Transmit general I / O to control the end effector or other units.	Should be provided by user.
Application software	• The software is compatible to Windows98 and Windows NT4.0 Workstation. • You can edit the programs, set and save the parameters of the EXEA controller.	It is provided in the CD-ROM. This is separately sold from the EXEA controller.
Personal computer	• Necessary to control an EXEA controller through remote control mode (personal computer communication control), or through use of application software.	Should be provided by user.
RS-232C cable*	• Connect an EXEA controller and personal computer for communication control and for use of the application software.	Should be provided by user.
Power supply cable	• Connect main power line to the EXEA controller.	Should be provided by user.

* Use the shielded cable for "CN3: Control I/O cable", "EXT: general I/O cable" and RS-232C cable.

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4. Glossary

◆ Safeguard

- A fence or cover installed around the robot in order to prevent the operator from entering the moving range of robot while it is running.

◆ Safety speed

- A reduced velocity selected by the user which automatically restricts the robot velocity to allow sufficient time for persons either to withdraw from hazardous motions or to stop the robot. Recommended safety speed is 250 mm/second or under.

◆ Moving speed

- The maximum speed of the moving member of the robot (i.e. the slider or the main unit of a moving axis type robot), which is achieved after completion of accelerating.

◆ Motion acceleration / deceleration

- Acceleration and deceleration of moving member of the robot (i.e. the slider or main unit of a moving axis type) when it is starting or stopping. Acceleration and deceleration in an EXEA controller are set to the same value.

◆ Operation duty

- The frequency of operation. The ratio of stopping and operating time. Or, in some cases, the frequency of accelerating and decelerating in the unit time. If accelerating and decelerating are repeated at all times or frequently, the operation duty is great.

◆ Moving range

- The largest area occupied by the robot when the robot is combined with all axes, end effectors are installed, the work piece is set, and the slider or each axis (or a main unit of a moving axis type robot) moves to the stroke end. If a person exists in this area, he may possibly be hit, caught or drawn in.

◆ Servo ON condition

- The condition when the servo is active and the motor can accept an operation command. If no motion command is input in the servo ON condition, the servo driver keeps current position. Such a condition is called "servo lock."

◆ Servo OFF condition

- In this condition no current flows through the motor, and the motor does not accept an operation command. Unless a brake is incorporated, movable part can be moved by external force.

◆ CPU

- Central Processing Unit. In the EXEA controller, CPU performs all processing including motor control and executing programs.

◆ Slider movement / moving axis

- The slider moves linearly as the motor rotates. This is referred to as "slider movement" in this manual. If the slider is stable and main unit moves, the main unit is referred to as "moving axis."

◆ Coasting

- Motion of moving member due to its inertia. Although the power is turned off to the motor, the motor keeps rotating due to kinetic energy acquired up to that point.

◆ Interpolation

- In a multi-axis combination, a resultant induced by simultaneous operation of multiple axes is called "interpolation." It is referred to as linear interpolation for a linear resultant, and as circular interpolation for a circular resultant.

◆ Work piece

- An object of robot operation such as machining, assembly, pick and place, packing sealing and transporting.

◆ End effector

- A tool which manipulates work pieces. Hand or another additional devices attached to the robot module to perform its tasks.

◆ EMC

- Electromagnetic compatibility of noises. To comply to EMC, measures against EMI (electromagnetic interference: Emission) and EMS (electromagnetic sensitivity: Immunity) must be taken.

◆ Flash memory

- Non volatile memory which stores all memories without any back up of electric power.

5. Reference Number • Specifications

5.1. Specifications of EXEA Controller

5.1.1. Specifications

Table 5-1: Power capacity and environmental condition

Item		Specification
Power voltage		Single phase AC200/240V
Maximum power capacity *	M-EXEA1-1000□□□	0.5kVA
	M-EXEA1-0100□□□	0.9kVA
	M-EXEA1-0010□□□	1.6kVA
	M-EXEA2-2000□□□	0.9kVA
	M-EXEA2-1100□□□	1.2kVA
	M-EXEA2-1010□□□	2.0kVA
	M-EXEA2-0200□□□	1.5kVA
	M-EXEA2-0110□□□	2.4kVA
	M-EXEA2-0020□□□	3.1kVA
	M-EXEA3-3000□□□	1.3kVA
	M-EXEA3-2100□□□	1.6kVA
	M-EXEA3-2010□□□	2.5kVA
	M-EXEA3-1200□□□	2.0kVA
	M-EXEA3-1020□□□	3.6kVA
	M-EXEA3-0300□□□	2.4kVA
	M-EXEA3-0210□□□	3.1kVA
	M-EXEA3-0120□□□	4.0kVA
	M-EXEA3-0030□□□	4.7kVA
	M-EXEA4-4000□□□	1.6kVA
	M-EXEA4-3100□□□	2.0kVA
	M-EXEA4-3010□□□	2.9kVA
	M-EXEA4-2200□□□	2.4kVA
	M-EXEA4-2110□□□	3.3kVA
	M-EXEA4-2020□□□	4.0kVA
	M-EXEA4-1300□□□	2.7kVA
	M-EXEA4-1210□□□	3.6kVA
	M-EXEA4-1120□□□	4.3kVA
	M-EXEA4-1030□□□	5.1kVA
	M-EXEA4-0400□□□	3.0kVA
	M-EXEA4-0310□□□	3.9kVA
	M-EXEA4-0220□□□	4.6kVA
	M-EXEA4-0130□□□	5.5kVA
	M-EXEA4-0040□□□	6.2kVA
Built-in driver unit capacity		100W, 200W, 400W
Noise resistance	Line noise	1000V 1μS (by noise simulator)
	Static noise	3kV (by noise simulator)
Ambient temperature		0 ~ 50℃
Operation / storage humidity		20 ~ 85% (No condensation)
Environment		Free from dust, corrosive gas, inflammable and/or explosive gas. Do not expose to cutting oil and lubrication oil.
Storage temperature		-10 ~ 70℃

* Exclude inrush current.

Table 5-2 : Inrush current and leakage current

Item		EXEA 1 (Single axis)	EXEA 2 (Two axes)	EXEA 3 (Tree axes)	EXEA 4 (Four axes)
Inrush current	Main power	210A approx.	210A approx.	420A approx.	420A approx.
	Control power	30A approx.	30A approx.	60A approx.	60A approx.
Leak current		10mA approx.	25mA approx.	40mA approx.	50mA approx.

Table 5-3: Functional specifications

Item			EXEA
Number of control axes			1 ~ 4 axes
Teaching			Numerical data input or teaching
Position data capacity			4000 points
Program capacity			Approximately 5000 steps in normal use. (Maximum 45000* steps approximately) /128 Programs. * When it consists of simple commands. (Command of which bit length is one such as RET and END) Refer to "15.2.1. Programming Area" for more details.
Backup			Flash memory
Speed setting range	Maximum speed		0.1 ~ 1200 mm/s * Actual maximum speed depends on the type of module main unit. Refer to "19.1.2. Specifications" for more details.
Acceleration / Deceleration setting range	Maximum acceleration / deceleration		0.1 ~ 35m/s^2
Acceleration / deceleration pattern			Modified sine profile
Program command	Motion	1 ~ 4 axes	Home return, PTP
		2 ~ 4 axes	Maximum 3 axes for linear interpolation, maximum 3 axes circular interpolation, Maximum 3 axes continue pass, arch motion and 2 axes palletizing
	Sequence		General Input / Output, timer, Jump, Conditional Jump
	Others		Repeating, subroutine call and interruption (reserved)
Program editing			Insert step, delete and copy steps
Control function			Feed forward, digital filter
Coordinates setting			Over travel, Home position off-set, reverse the sign of direction (plus/minus)
Alarm • Protection			Over travel, CPU error, Memory error, Encoder disconnection, Excessive position error, Power voltage abnormal, Over current, Overheat, Overload
Input / Output	Exclusive input		Servo ON, Emergency stop, Cycle stop, Hold, Home return start, Programmed operation start, Resume programmed operation, Alarm clear, Pulse train (single axis only)
	Exclusive output		Driver ready, Alarm, Home return complete, Cycle stop, Hold, Program operation ready Mode status
	General Input / Output		16 points each. [Can be extended to 64 points. (32 points for single axis system)] However several inputs and outputs are shared with program selection, position data selection and FIN signal output.

5.1.1.1. Internal DC 24V Power Supply

Table 5-4: Specifications of Internal DC 24V power supply

Item	Specification
Voltage	DC24V ±10%
Maximum output current	2A*

* This may be used as a power for brake. When using a main unit with brake, take into the account of current for a brake. A brake requires 250mA.

Caution : *Maximum current should be 2A or less when outputs and inputs, including motor brake, are simultaneously on. If more current over 2A is required, provide an extra DC24V power supply. Maximum available current 2A remains same although the external I/O are added.*

5.1.2. Appearance and Dimensions

Figure 5-1 : EXEA controller (Single axis)

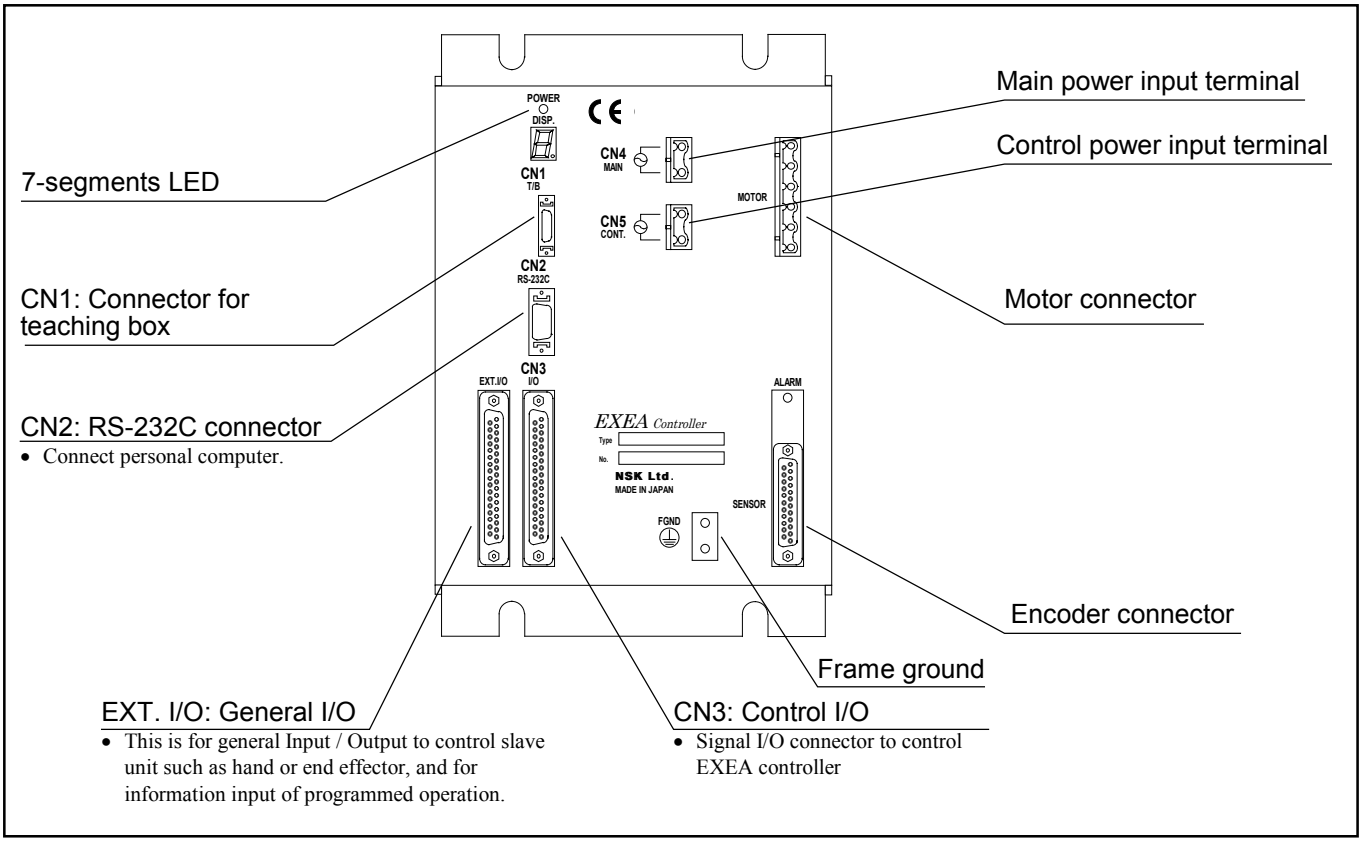


Figure 5-2 : EXEA controller (2 axes)

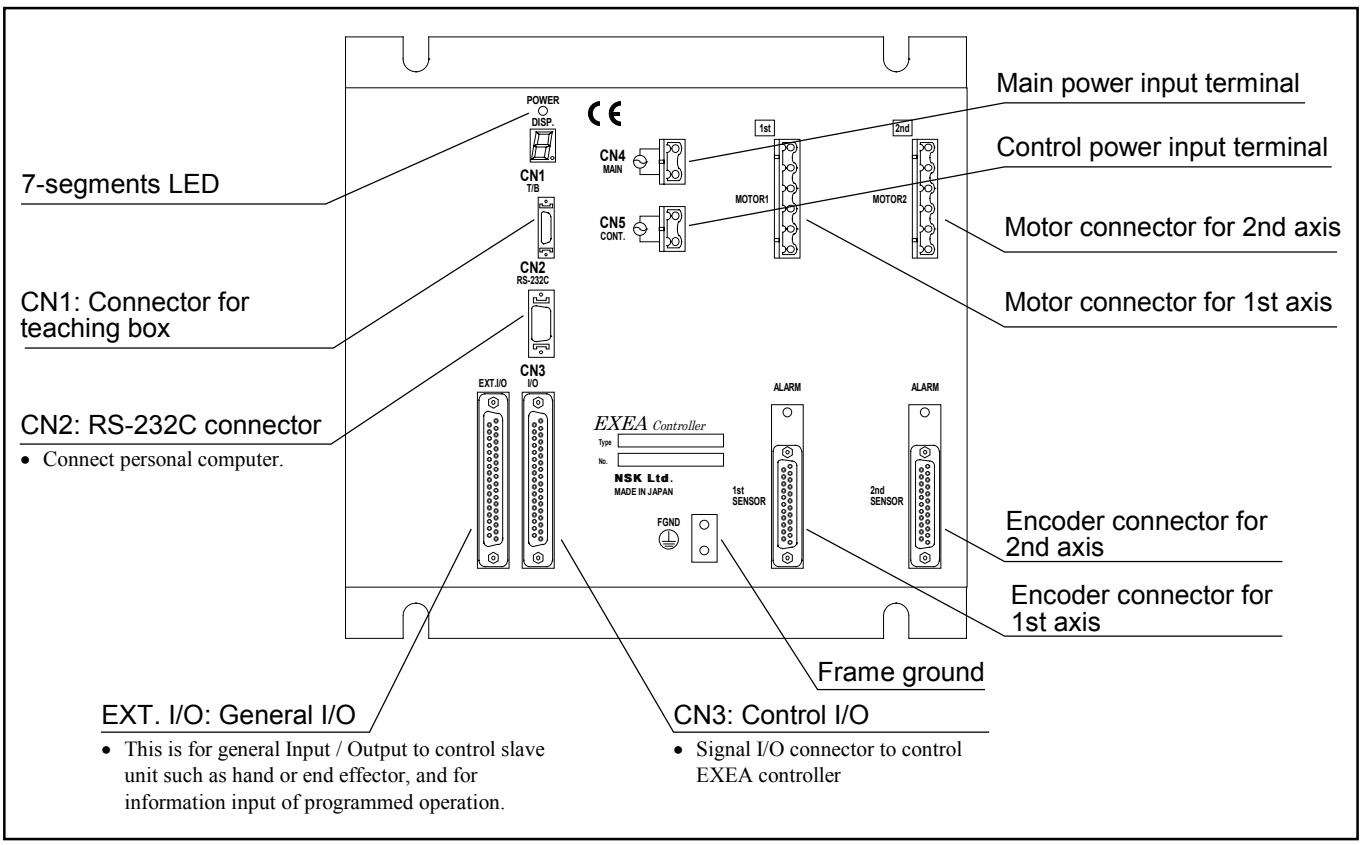
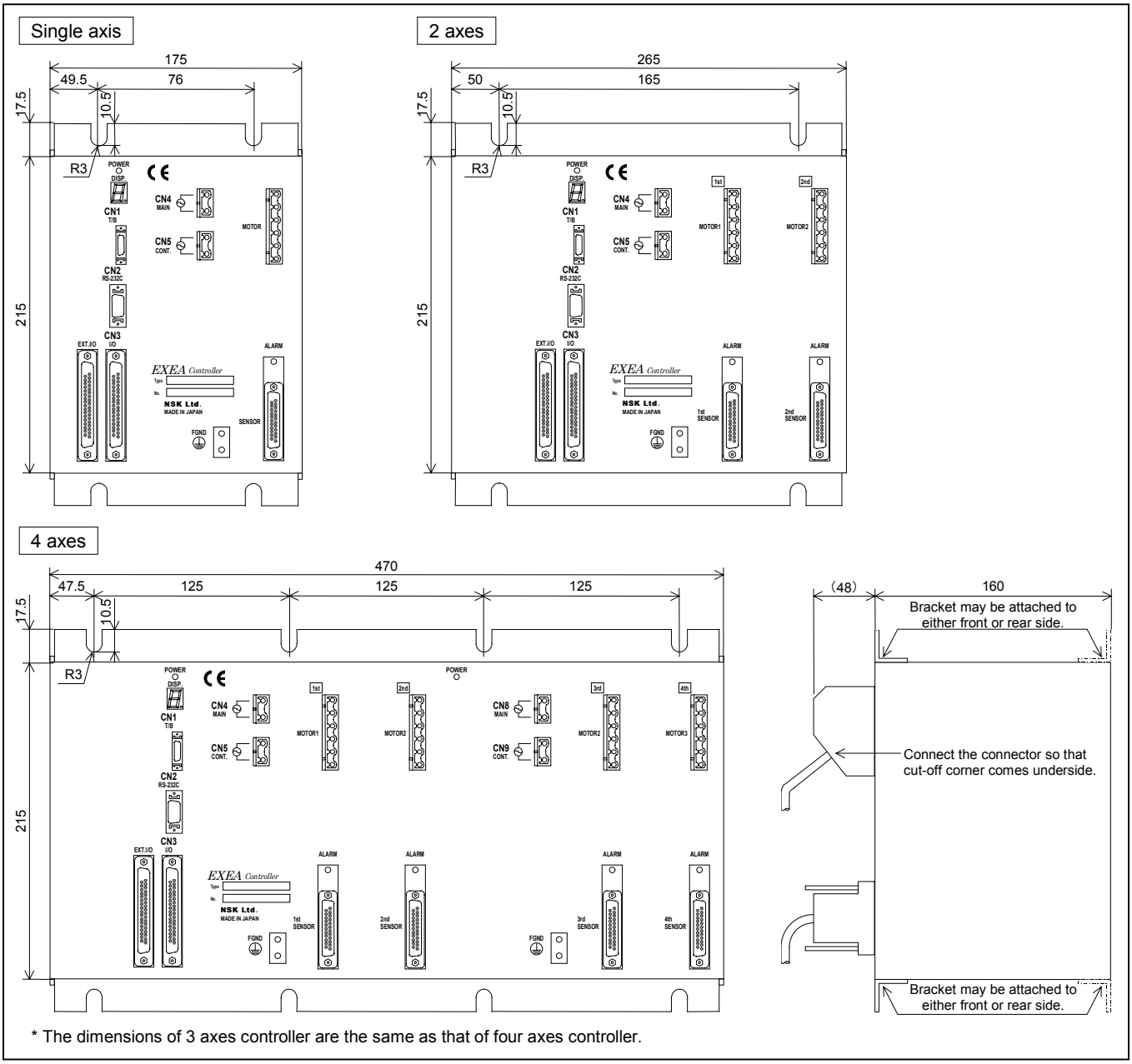


Figure 5-2



* The dimensions of 3 axes controller are the same as that of four axes controller.

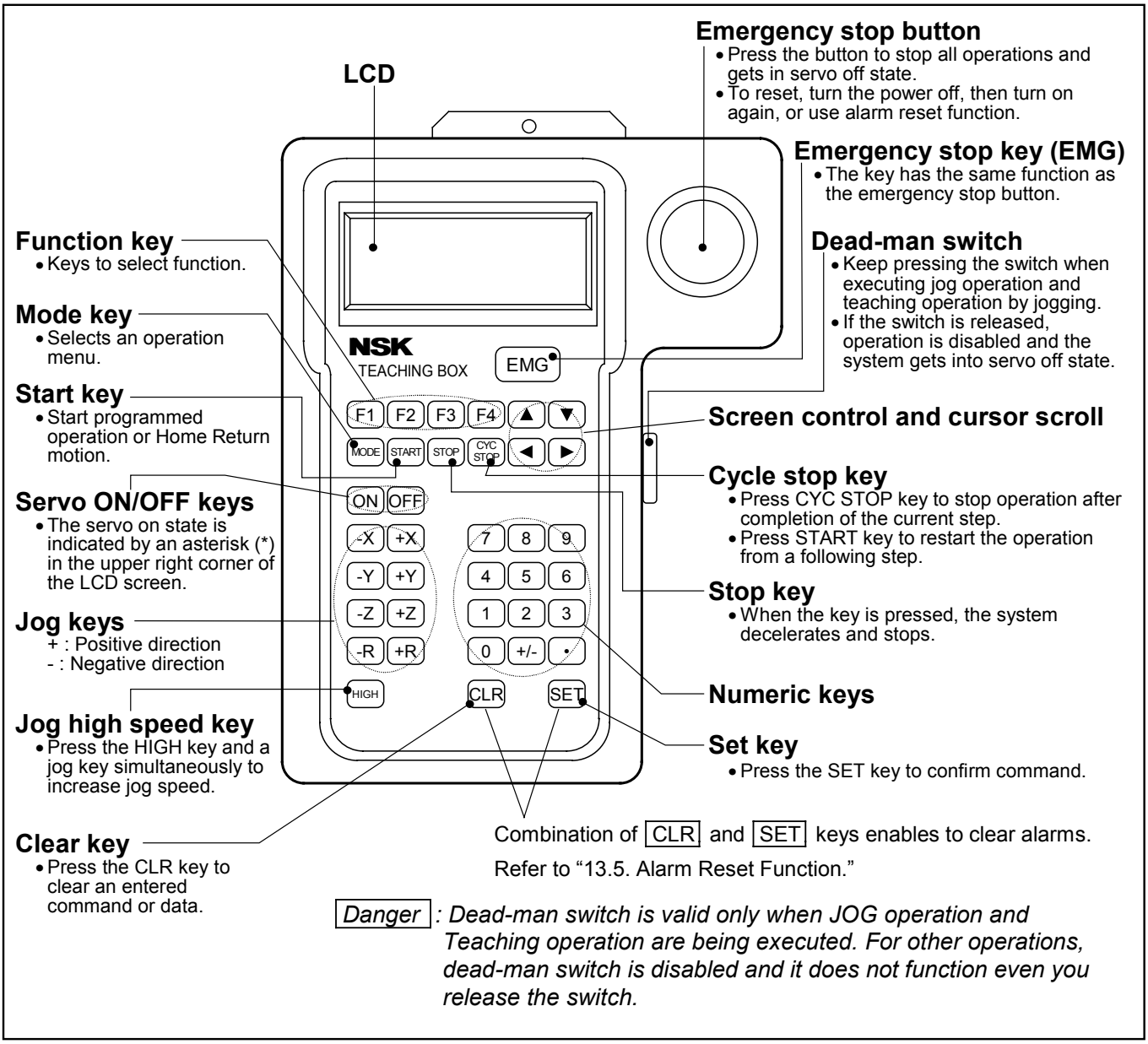
5.2. Teaching Box

5.2.1. Operational Function

Table 5-5

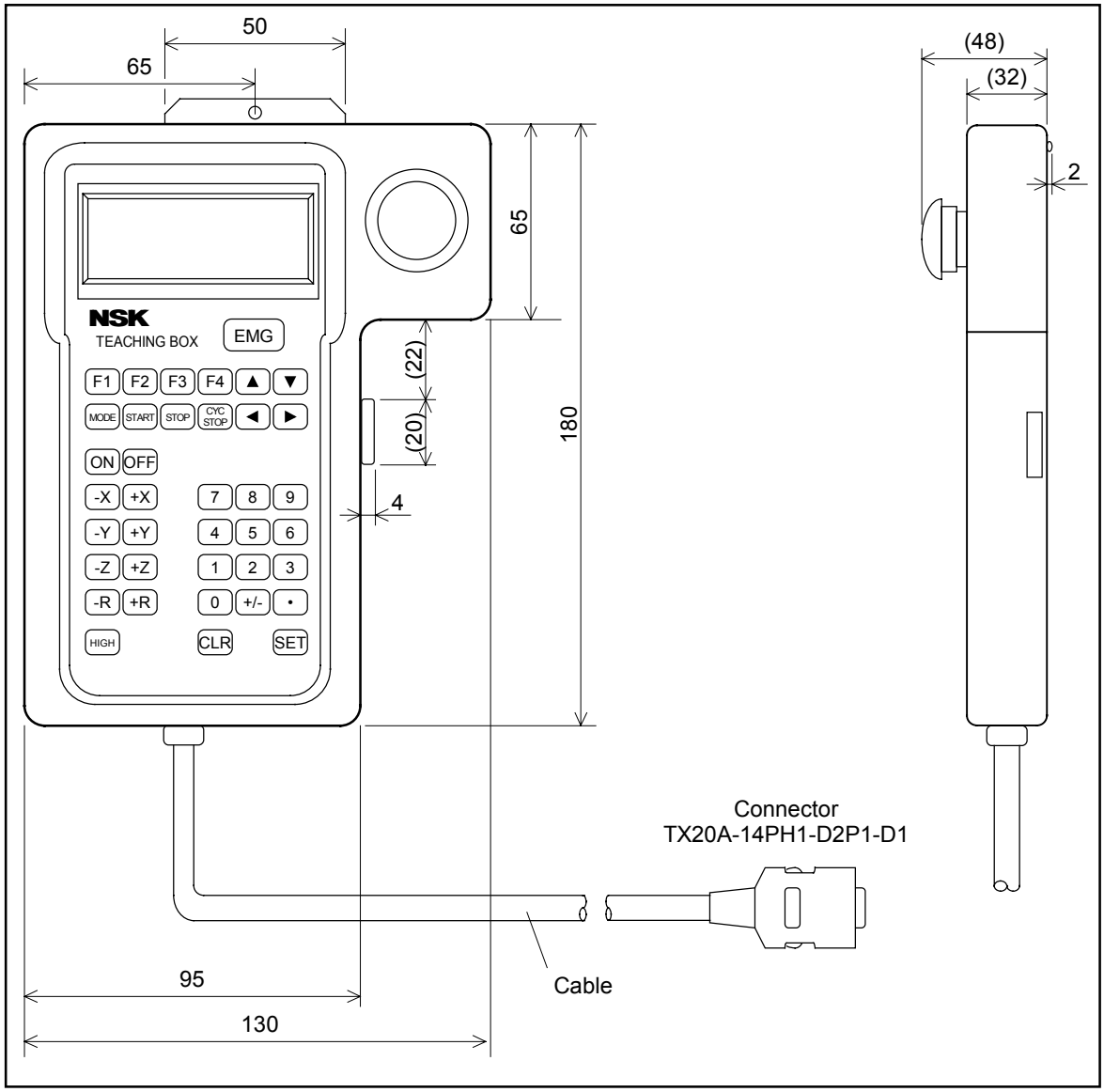
Setting / programming	• Internal parameters, servo gain • Programming, teaching
Operation start / stop	• Jog, Home return , Start / stop of programmed operation, emergency stop
Outputs	• Exclusive output, general output and on / off of motor brake
Monitoring	• Alarm indication • Monitor control signal and general output • Programmed operation monitor: current position of each axis
Other	• Alarm reset

Figure 5-4: Keys on teaching box and their function



5.2.2. Teaching Box Dimensions

Figure 5-5 *[Unit: mm]*

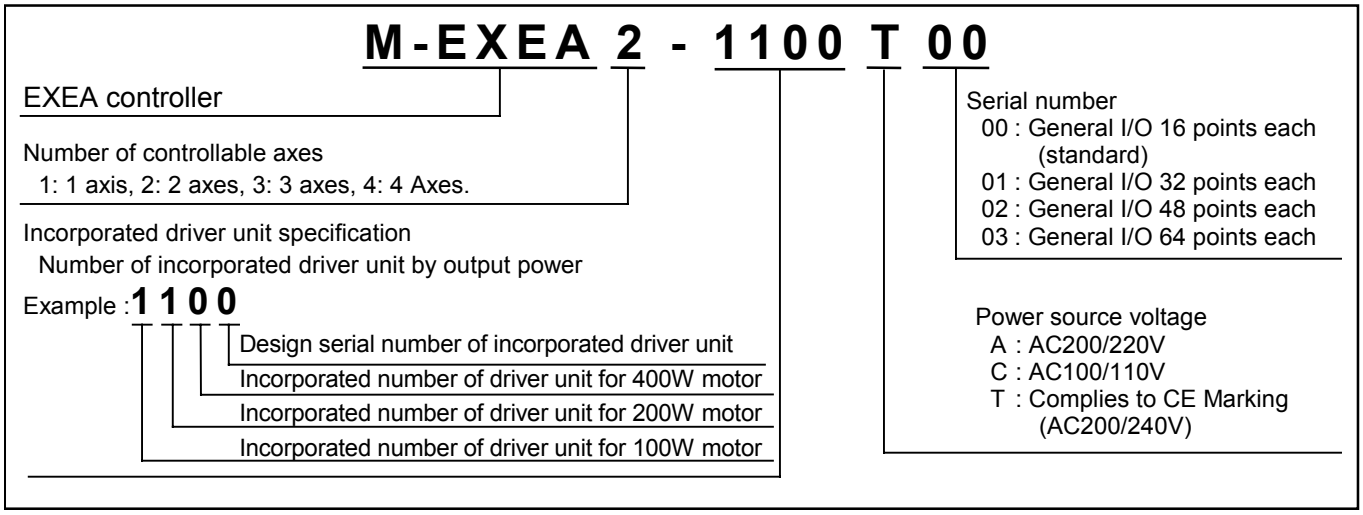


5.3. Reference Nember

5.3.1. EXEA Controller

- EXEA controller is a versatile controller incorporated with a servo motor driver unit.
  - ◊ Sequence command --- Timer, conditional jump, repeat
  - ◊ Motion command ------ Linear interpolation, circular interpolation, continuos path, etc.
  - ◊ Multi-task operation (parallel operation possible)
  - ◊ Control slave unit (e. g. hand or end effector), through general input/output
  - ◊ Program capacity ------ 128 programs, approximately 5000 steps (45000 maximum) in normal use.
- In addition to the above functions, the higher level of motion control can be achieved utilizing other functions such as modified sine acceleration / deceleration, feed forward compensation and digital noise filters.

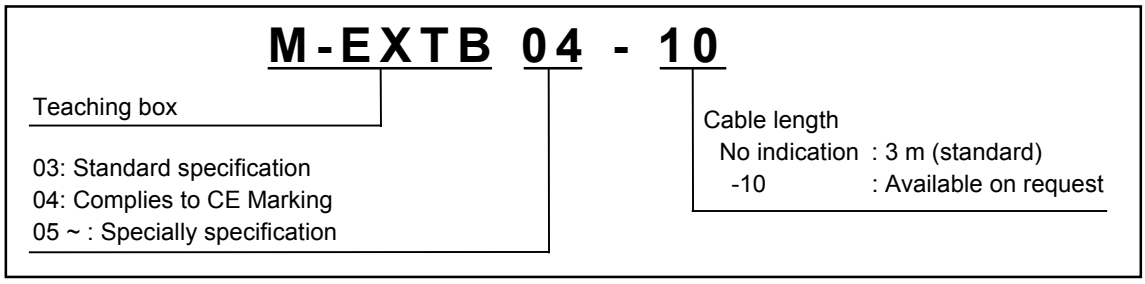
Figure 5-6: Reference number configuration of EXEA controller



5.3.2. Teaching Box

- Teaching box is to be connected to EXEA controller and is used for initializing parameters, logging in programs and conducting trial operation.

Figure 5-7: Reference number configuration of teaching box



5.3.3. Application Software for Personal Computer

- This is an application software for a personal computer which is compatible to Windows 98 or NT 4.0 Workstation to edit programs and set the parameters.

  * Windows 98 and NT 4.0 Workstation are registered trademark of Microsoft Corporation in the United States.

- The application software is for programming, setting parameters and data backup.

Figure 5-8: Reference number

M-EXTA02

5.3.4. RS-232C Cable

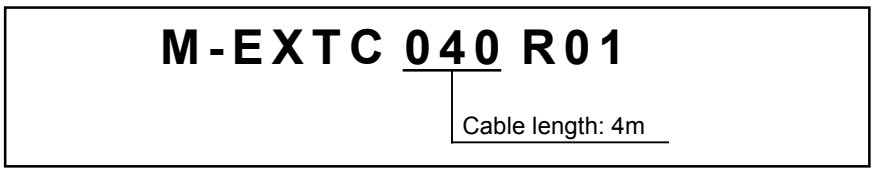
- This is the cable to connect the EXEA controller and user's personal computer to control the EXEA controller in remote control mode, or to use the application software for personal computer.

- The connector of the personal computer side must be a D-sub25 pin standard connector (male), but not for half pitch.

- The user shall provide a cable matcher in accordance with your perusal computer specification beyond D-sub25 pin.

- Refer to "7.4. CN2: RS-232C Connector" for the connectors.

Figure 5-9: Reference number of RS-232C cable



6. Unpacking and Installation

6.1. Cautions for Transporting and Storage

- Do not apply shocks to the module components during transportation.
- Store products indoors in a clean environment, and not to expose to wind, rain or direct sunlight. For storage temperature and humidity, refer to "5.1.1. Controller Specifications."

Caution : *The robot module is not provided any special measures against environmental problems in transportation or storage. Trouble may take place or the service life may be reduced unless it is handled with great care as a precision instrument.*

6.2. Unpacking

6.2.1. Checking Product

1 Damages to products and missing parts

- Unpack all containers and check for damages on products and missing parts.

2 Check with ordered reference number

- See "Figure 5-6: Reference number configuration of EXEA controller" and check that the affixed seal on the controller corresponds to your order.
- Data indicated on seal
  - ◊ Type : Reference number without "M- " is indicated on the seal.
    Last numbers "-01" indicate its version. The numbers will be changed following its upgrading.
  - ◊ No. : Serial number

3 Check accessory

- Table 6-1 is the list of the accessories which are provided with the controller.

Table 6-1

Name of part	Description	Quantity	Remarks
Dummy connector for teaching box	• This connector is used as a dummy connector when operating EXEA controller without the teaching box.	1	
Control I / O Connector and connector shell	• Cable connector and connector shell for CN3 connector of EXEA controller	1 set	
General I / O connector and connector shell	• Cable connector and connector shell for EXT. I / O connector of EXEA controller	1 set	Maximum 4 sets for option (2 sets maximum for the single axis controller)
Control power connector and connector shell	• Cable connector and connector cover for control power connector of EXEA controller	1 set	2 sets for 3 and 4 axes controller.
Main power connector and connector shell	• User side connector and its cover to wire main power connector of EXEA controller	1 set	2 sets for 3 and 4 axes controller.
Fuse	• Protection fuse for main power input	1	
Instruction manual	• This manual	1 set	3 volumes

6.2.2. Combination Check

- Please check that the combination of module main units and an EXEA controller matches with the catalog or your requirement.

  Caution : Improper combination may result in burning of motor and / or driver unit.

1 Is the power voltage to the controller correct?

- Check the indication on power terminal block of controller.
- Do not supply 200 V power to a module main unit of which power specification is 100 V.

2 Are there any discrepancy between motor output of main unit and controller and connecting axes?

- Make sure that the motor output corresponds to controller reference number. (See "Figure 5-6: Reference number configuration of EXEA controller.")
- Rated motor output of main unit
  PH module : 200W
  PM module : 100W
  RH module : 400W
  RM module : 400W or 200W
  RS module : 200W or 100W

6.3. Installation of EXEA Controller

- Prepare a base strong enough to support the weight of the controller. Fix the controller firmly to the base using U slots for panel mounting.

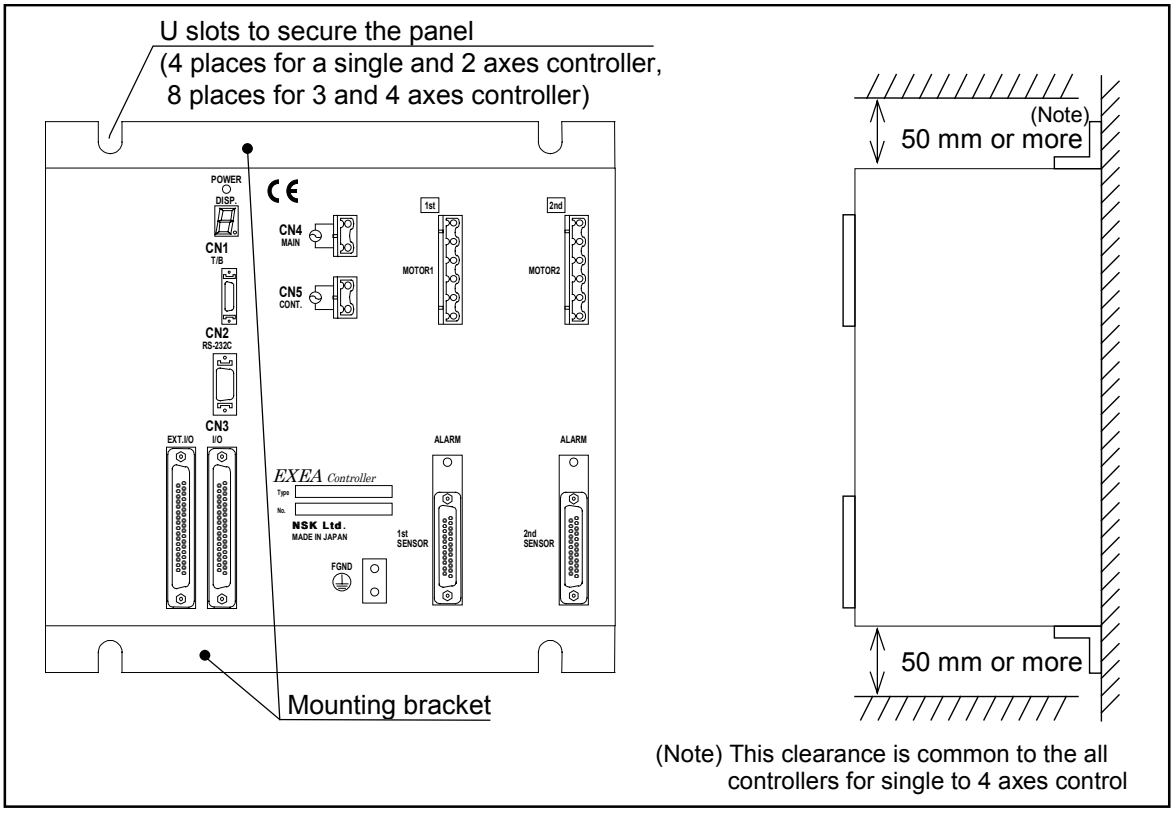
Danger : *Use the controller at ambient humidity between 20 to 85 % with no dew condensation.*
Protect the controller from splashing water or oil. Also protect it from conductive fine particles, corrosive gas, inflammable gas and explosive gas. Insufficient protection may result in a fire, malfunctioning or break down.

1) After installing the EXEA controller, make sure that it is secured to the base and there is no possibility of danger.

2) EXEA controller adopts natural convection air cooling. Leave a 50 mm or more spaces above and below of it. Insufficient natural convection may cause an overheat alarm or excessive temperature rise inside the controller, resulting in malfunction or reduced service life.

◊ *Maintain the temperature around the controller between 0 to 50°C. In the temperature over or below of this range, the controller may not operate normally. When the temperature is close to 50°C, it is recommended to use a forced cooling system.*

Figure 6-1



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7. Wiring

7.1. Connector List

- The connectors for external connection of the EXEA controller are shown in Table 7-1.
- For positions of the connectors, see "5.1.2. Appearance and Dimensions" of the EXEA controller.

Table 7-1

Name of connector	Function	Cables / wiring
CN1	• Connector for the teaching box	• Connect the cable supplied with the teaching box.
CN2	• Connector for RS-232C communication	• Wiring of this connector is not required when the remote control through RS-232C communication is not used. • Please refer to "7.4. CN2: RS-232C Connector" and provide them. • RS-232C cable set for the personal computer is available from NSK Ltd. (optional)
CN3	• A control Input / Output connector to control EXEA controller externally	• Wiring should be provided by user. See "7.5. CN3: Control Input / Output Signal Connector." • Connectors and connector shells are provided as accessories.
CN4, CN5	• Main power (CN4) and control power (CN5) connectors	• Wiring should be provided by customer. See "7.6. CN4, CN5: Main Power and Control Power Connector." • Connectors and connector shells are provided with the controller as accessories.
EXT.I/O	• General Input / Output connector	• Wiring should be provide by user. See "7.7. EXT IO: General Input / Output Signal Connector" • Connectors and connector shells are supplied with the controller as accessories.
MOTOR	• Motor connector	• Exclusive controller cable for the robot module system is available. • Refer to "19.2. Controller Cable (common to P and R series module main unit)" for its reference number. • See "Appendix 1: Motor Connector" and "Appendix 2: Encoder Sensor Connector" for connector specification.
SENSOR	• Encoder connector	
FGND	• Frame ground terminal	• Be sure to ground the EXEA controller. • Refer to "7.2.4. Grounding."

7.2. Precautions for Wiring

7.2.1. Making Cables

- When making cables and selecting parts for the cables, follow the instructions described in the chapter for each connector.

  Warning : *Use the optional controller cable and cable support for motor and encoder cables.*
  We do not recommend to provide the cables by yourself or modify (i.e. extend, shorten and/or cut) our optional controller cable to avoid miss-wiring. If you need to modify the controller cable or the cable support, be sure not to miss-wire it. Miss-wiring may lead to breakage of the equipment or malfunction of robot module system.

  ◊ We do not compensate for damages or accident induced by miss-wiring by user.

7.2.2. Connection of Cable

Danger : *Do not disconnect cables while power of EXEA controller is turned on. Such an action may cause short circuit and / or malfunction of the controller.*

Warning : *When connecting motor and encoder connectors to the controller, pay great attention not to connect to a wrong axis connector. When the power is turned on and operation command is input under improper connection, it may result in burnt motor or controller malfunction.*

PH module : 200W
PM module : 100W
RH module : 400W
RM module : 400W or 200W
RS module : 200W or 100W

Warning : *Insert connectors in proper manner as the connectors have orientation for insertion. Plug in connectors smoothly keeping their orientations. Wrong connections result in motor breakage or malfunction of the system. (Refer to Figure 7-17.)*

7.2.3. Securing Connectors

- Push connectors to the very end firmly and secure it.
- If a connector is provided with screws, use them to secure connector. If connector does not have screws, make sure it is locked.
- Take measures not to apply external force to connectors. Fix connector firmly to prevent from unplugging and losing contact.

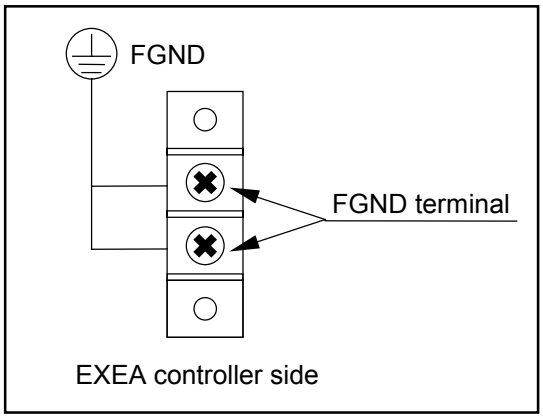
  Caution : *If a connector is not secured sufficiently, it may be unplugged or loosened, and may result in malfunctions*

7.2.4. Grounding

Danger : *The system must be grounded properly to avoid electric shock or malfunctions due to noises. Be sure to ground FGND terminal of EXEA controller.*

- Refer to Figure 7-1 for FGND terminal. Though there are two FGND terminals, they are connected inside of the controller. Connect to either one of them.
- There are two RGND terminals for 3 ~ 4 axes EXEA controllers. Ground them respectively at a one-point.

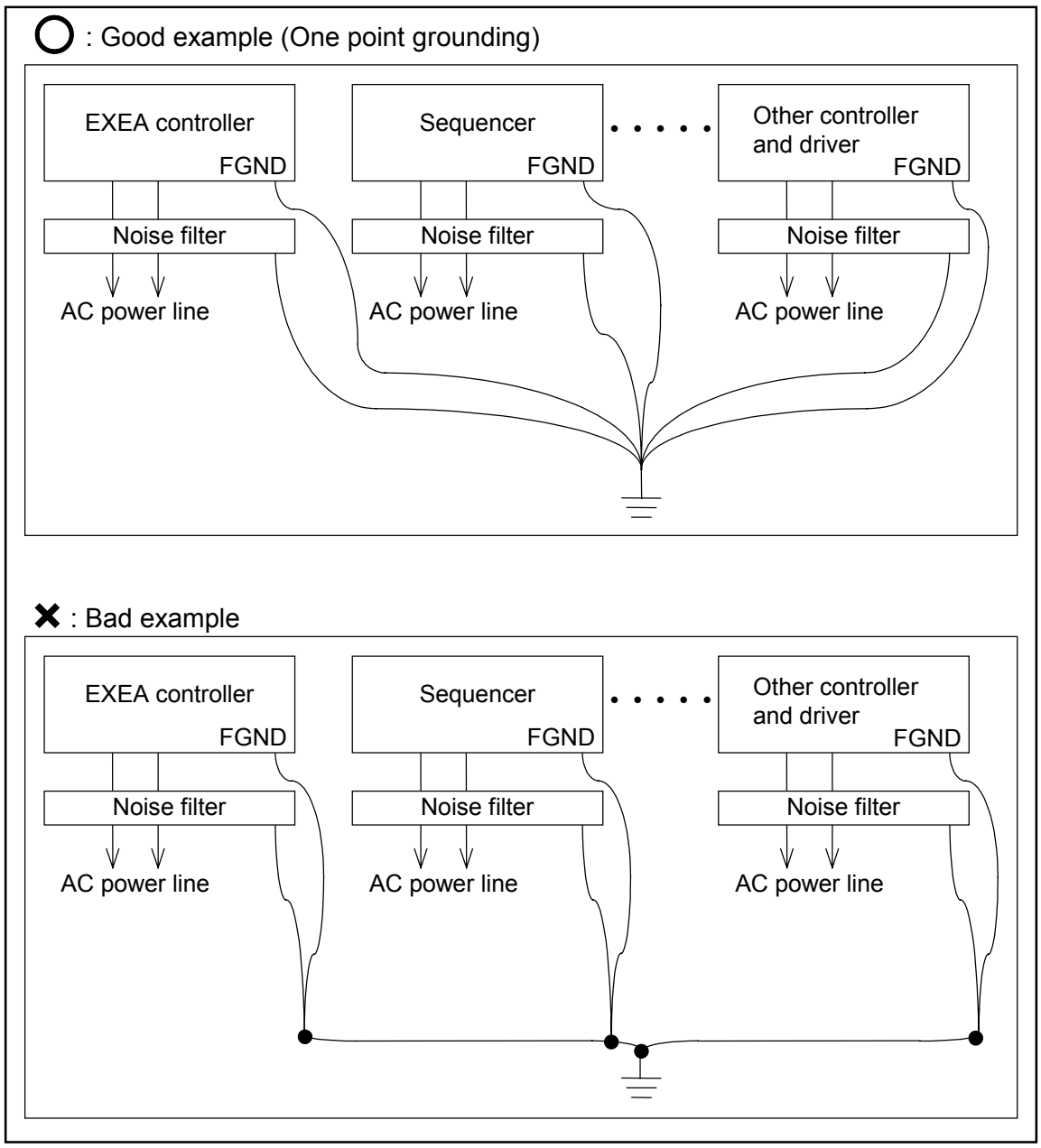
Figure 7-1



- The grounding shall be a one-point and class 3. (Ground resistance: 100 Ω or less.)
- If another equipment is mounted in the same enclosure, ground the equipment and devices at one point. (Refer to Figure 7-2.)
- The grounding cable of the controller must be a thick cable as possible, such as a flat braided copper wire or 3.5 square mm.

Note: The FG pins of each connector of EXEA controller are connected to the FGND in the controller.

Figure 7-2


○ : Good example (One point grounding)
EXEA controller
FGND
Sequencer
FGND
Other controller and driver
FGND
Noise filter
Noise filter
Noise filter
AC power line
AC power line
AC power line
✖ : Bad example
EXEA controller
FGND
Sequencer
FGND
Other controller and driver
FGND
Noise filter
Noise filter
Noise filter
AC power line
AC power line
AC power line

7.2.5. Measures against Noises

Warning : *Any special measures against EMC (Electromagnetic compatibility of CE Marking) are not taken for the robot module system. Do not use the robot module in an environment subject to much external noises. In an environment where noises produced by the robot module system give influences on your equipment, shield the EXEA controller, use a noise filter or take another measures.*

- The following shows the noise resistance of the EXEA controller itself.

Table 7-2

Item	Noise resistance	Remarks
Line noise resistance	1000V 1μs	Checked by a noise simulator
Static noise resistance	3 kV	

Caution : *In order to eliminate influences of excessive noises, follow instructions hereunder.*

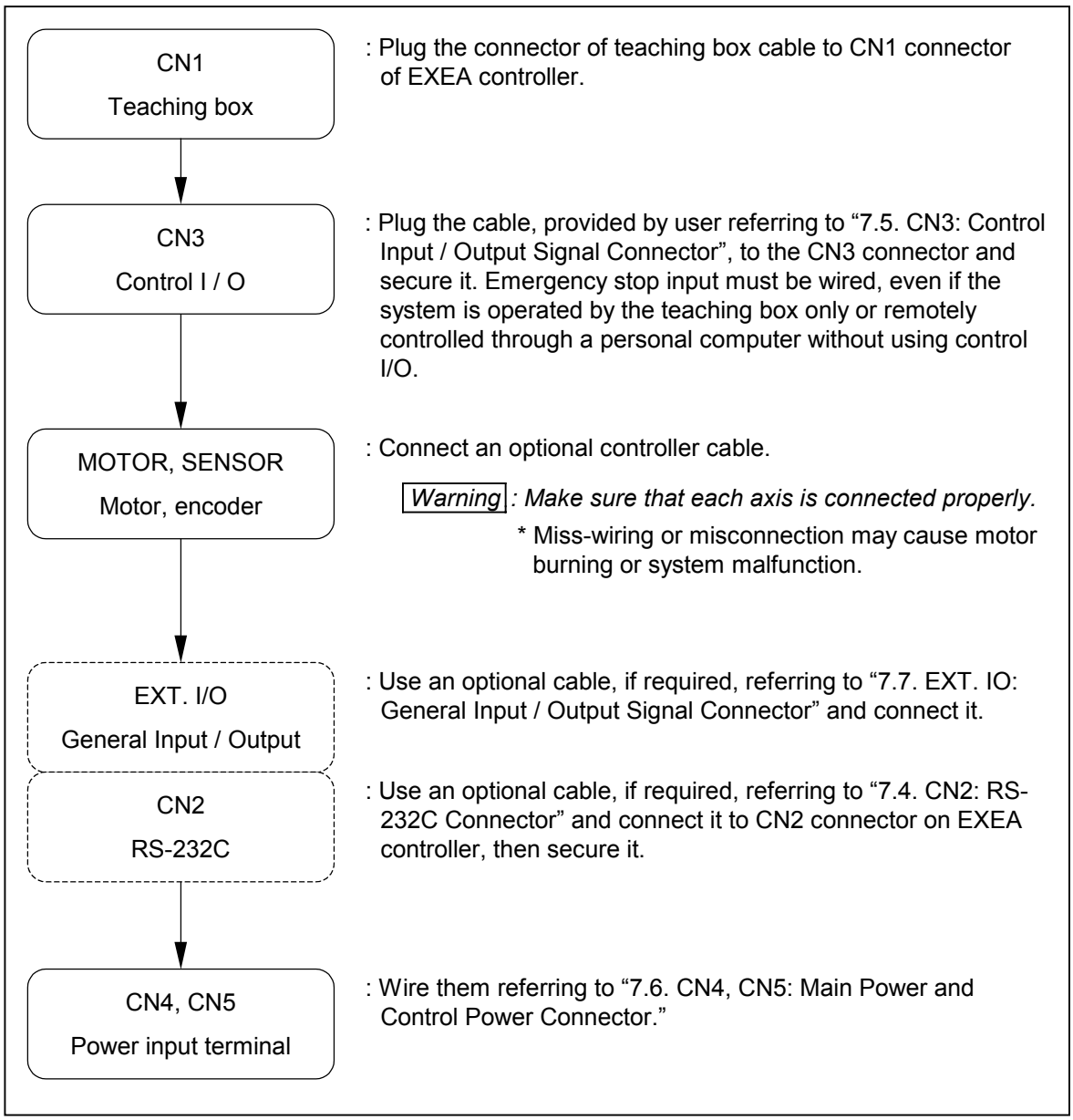
1) *Make sure to connect FGND terminal of the controller to the ground.*
2) *Separate cable routings of the primary power line (AC line), motor power line and operation signal (DC line). Never lay these lines in the same conduit.*
3) *Use a shielded cable for signal cables. Connect the end of shield to the ground.*
4) *Always supply sufficient AC power to the controller. Connect a controller to the power line with less power variation. Do not connect to the same power line to which noise emitting machines (e.g. welding machines, compressors or ultrasonic washing machines) are connected.*
5) *Do not use a thin and long cable for the AC main power. Use thicker and shorter cable as possible.*

Caution : *In case of the application that emits electrostatic noises, ground the part of module system where electrostatic noises pass through (e.g. the slider of main unit) in order to prevent electrostatic noise from being applied to the EXEA controller.*

7.3. Wiring

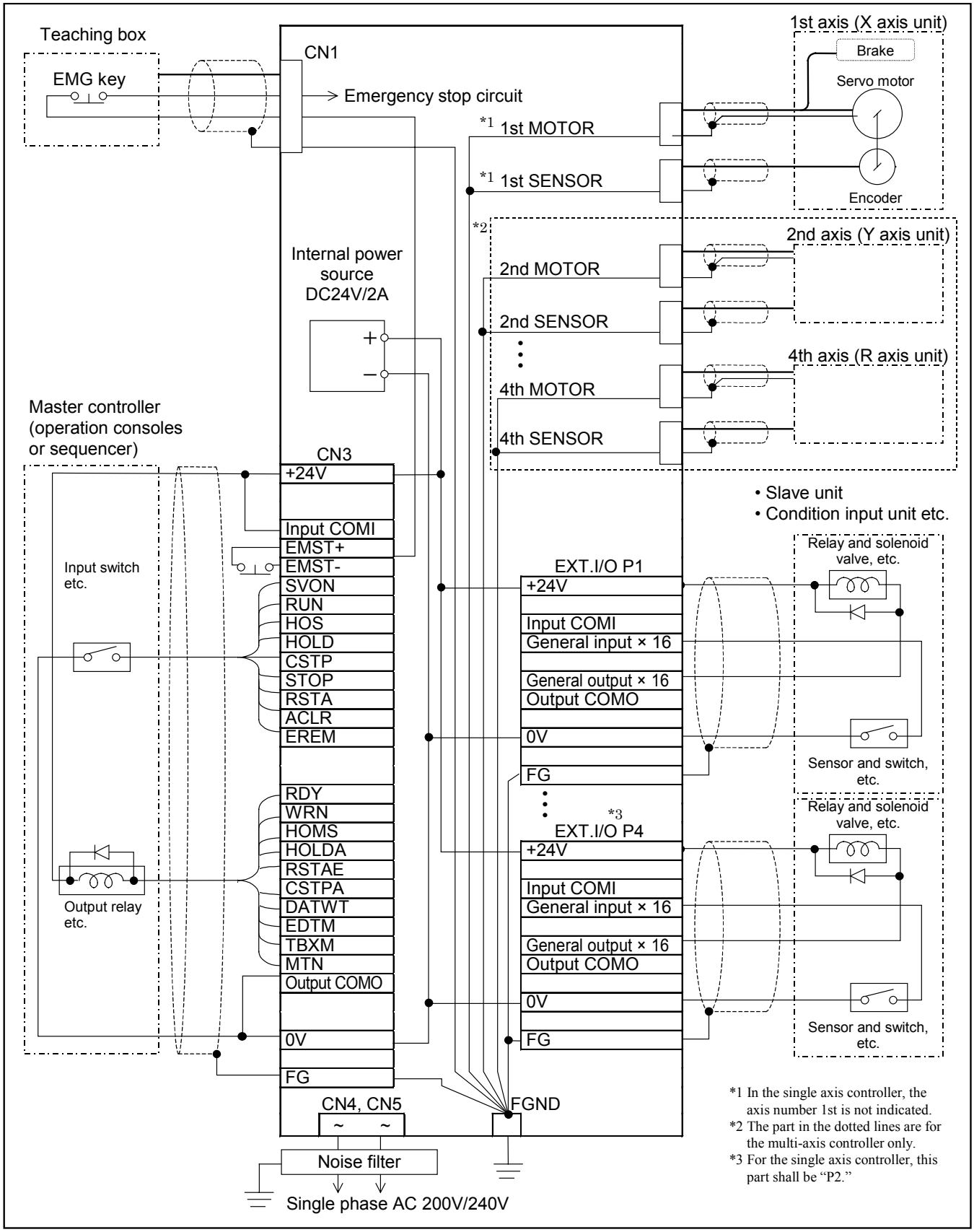
7.3.1. Wiring Procedures

Figure 7-3



7.3.2. Wiring Example

Figure 7-4 Wiring example



Note: Wiring of CN3 and EXT.I/O in the figure is the example when the internal power source (+24V, 0V) is used. Do not wire the internal power source when the external power source is used.

7.4. CN2: RS-232C Connector

- This connector is used to set EXEA controller to RS-232C control (remote control) mode.
- Refer to "18. Remote Control Operation" for the remote control.

7.4.1. Cable on the Market (Standard Cable)

- Refer to Figure 7-5 when using an RS-232C standard cable on the market.
- NSK carries an optional cable for RS-232C. Refer to "RS-232C Cable."

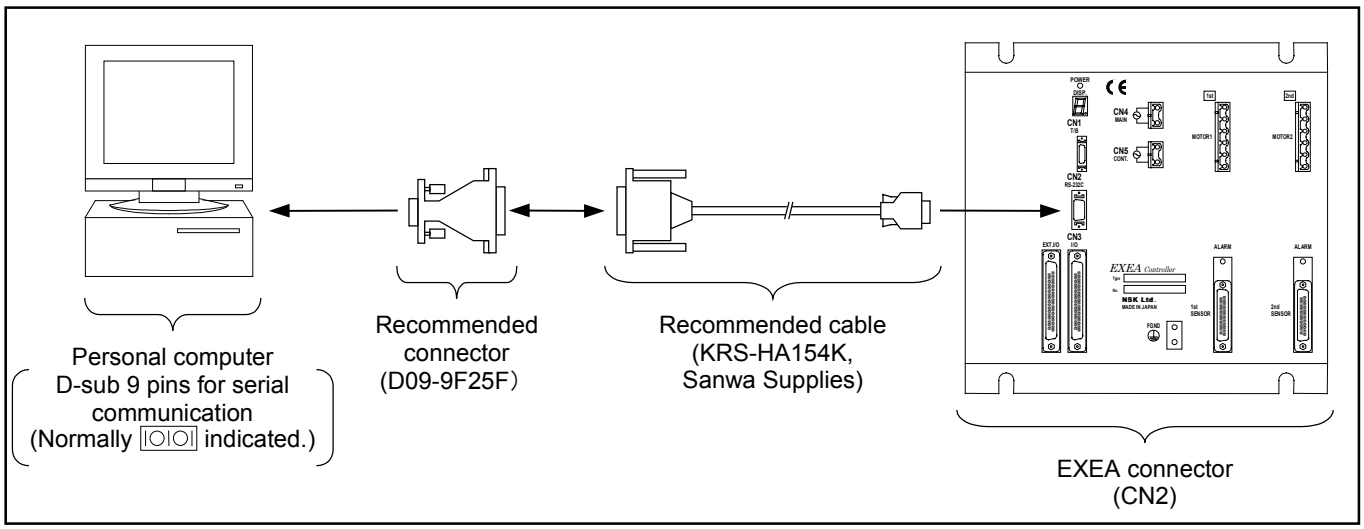
  Note: You must provide a cable matcher in accordance with your personal computer specification.

- Refer to Table 7-3 for information on the connectors and cables.

Table 7-3: Specifications of connectors and cables

Personal computer	Connector on personal computer	Recommended connectors	Recommended cable	Connector on EXEA controller
PC9821(NEC) or equivalent	D-sub 25 pins (female)	Not required	M-EXTC040R01 (Optional cable from NSK) or KRS-HA154K (Sanwa Supplies) [D-sub 25 ins (male)/ Half pitch 14 pins (Centronics) (male)]	Half pitch 14 pins (Centronics) (female)
PC9821 note (NEC) or equivalent	Half pitch 14 pins (Centronics) (female)	KRS-HA1520fK (Sanwa Supplies) or equivalent [Half pitch 14 pins (Centronics) (male) / D-sub 25 pins (female)]		
PC98NX or DOS/V equivalent	D-sub 9 pins (male)	D09-9F25F (Sanwa Supplies) [D-sub 9 pins (male) / 25 pins (female)]		

Figure 7-5: Example of cable /connector combination



7.4.2. Making RS-232C Cable

- Refer to Table 7-4, Table 7-5 and Figure 7-6 if you make the RS-232C cable for CN2 connector.

Table 7-4: CN2 connector parts

Connector, EXEA controller side	Sumitomo-3M 10214-52A2JL
Mating connector (cable side)*	Sumitomo-3M 10114-3000VE
Applicable connector shell*	Sumitomo-3M 10314-52A0-008

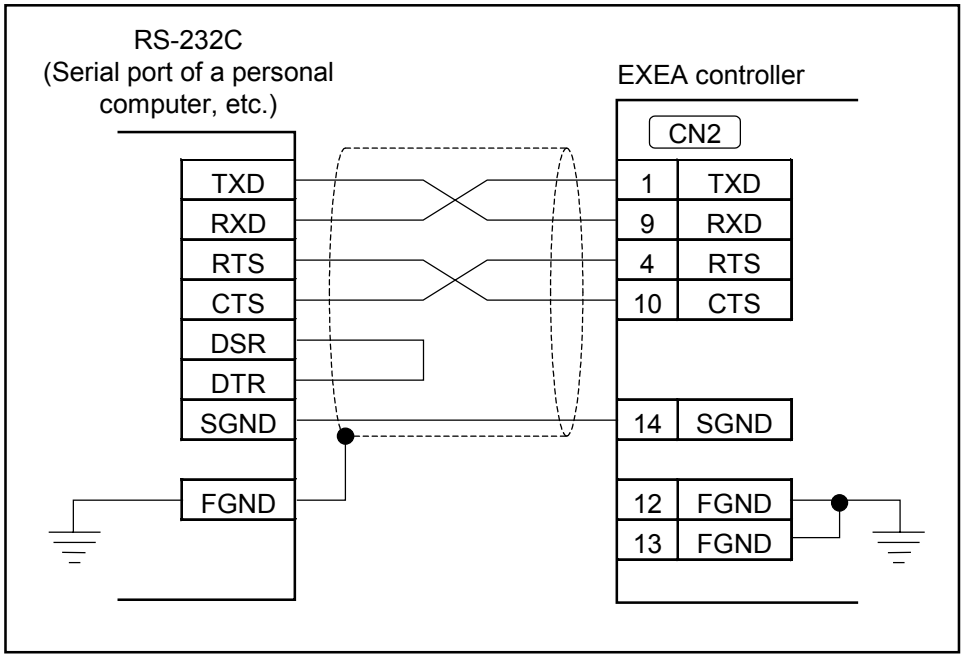
* Shall be prepared by user.

Table 7-5: CN2 signal name and function

Pin No.	Signal	I / O	Function
1	TXD	output	Transmit data
2	–		
3	–		
4	RTS	output	Ready to send
5	–		
6	–		
7	–		

Pin No.	Signal	I / O	Function
8	–		
9	RXD	input	Receive data
10	CTS	input	Clear to send
11	–		
12	FGND		Frame ground
13	FGND		Frame ground
14	SC		Signal ground

Figure 7-6



7.5. CN3: Control Input / Output Signal Connector

- Wire Input / Output signal to control the EXEA controller in the external operation mode.
- EMST (emergency stop) input must be wired, even if the system is operated by the teaching box in a trial operation without using control I/O or, the system is remotely controlled by a personal computer.

EMST input is a B contact. (normally close)

Note: When using the external DC 24V power supply, it must be turned on simultaneously with the main power supply of EXEA controller. If not, EMST input is detected as OFF and the system goes into EMST(emergency stop) state.

Table 7-6: CN3 connector parts

Connector, EXEA controller side	Japan Aviation Electronics Industries Ltd. DCLC-J37SAF-13L9
Mating connector (cable side) *	Japan Aviation Electronics Industries Ltd. DC-37PF-N
Mating connector shell type (cable side) *	Japan Aviation Electronics Industries Ltd. DC-C8-J13-F1-1

* Provided with EXEA controller as an accessory.

7.5.1. Precautions for Wiring CN3

- Be sure to use shielded cable and ground the shield.
- When connect a relay to an output signal, install a surge killer to the relay.
- Lay the CN3 signal wiring apart from the power lines (main power line cable, motor cable). Do not put them in the same conduit.
- Make CN3 cable short as possible. (3 meters or less) If a longer cable is required, take proper measures against external noises.

Caution : Disobedience to the instructions above may result in malfunction or memory data corruption due to noises.

Caution : Follow the electric specification shown in Table 7-7 below. In particular, any of the following three issues may lead to breakage of electrical elements of the input and output signal.

1) Out of allowable range of power supply voltage (24 VDC ± 10%)
2) Reversed phase connection of the power supply (24 VDC)
3) Output signal exceeds maximum switching ability.

Table 7-7: CN3 signal specification

Classification	Item	Specification
Input signal	Input voltage	DC24V ± 10%
	Input impedance	3.3kΩ
	Max. input current	10mA (per one point)
Input signal * (Pulse train input)	Input voltage	DC5V ±10%
	Input impedance	240Ω
	Input current	25mA or less
Output signal	Maximum switching ability	DC24V / 100mA
	Saturation voltage	2V or less

* This is for a single axis controller only.

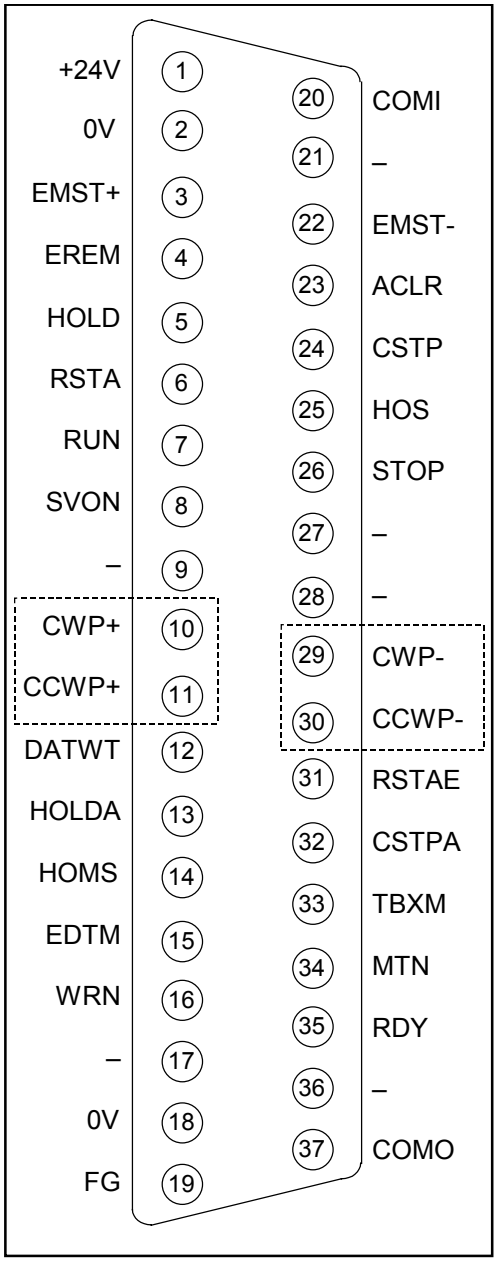
7.5.2. CN3 Signal Function

Table 7-8: CN3

Classification	Signal name	I/O	Function
State control	SVON	Input	Select the motor servo state. In some abnormal situation, such as in alarms, inputting SVON signal does not activate the servo. • SVON input = ON: Motor is in servo on state. • SVON input = OFF: Motor is in servo off state.
	ACLR	Input	Clears an alarm. Rising edge detection signal.
	EREM	Input	When EREM signal is activated, the external control mode is changed to the remote communication mode and the control and operation through remote command is enabled. When EREM is off, only monitoring data is possible on remote communication.
Start	HOS	Input	Starts Home return operation. Rising edge detection signal.
	RUN	Input	Starts programmed operation selected by PROG 0 to 6 ports of EXT. IO. Rising edge detection signal.
Programmed operation control	RSTA	Input	Resumes a halted programmed operation when RUN input is turned on while RSTA is on. However, this command is only effective when RSTAE input is closed. When it is opened, inputting this command activates "error" message. Refer to "17.5.2. Resume Programmed Operation" for restart of operation.
Stop	EMST+	Input	Activates emergency stop when + and - of EMST is cut off and motor gets in servo off state. Once the emergency stop condition is established, operation cannot be started unless the emergency stop condition is canceled. For canceling emergency stop, refer to "11.3.1.3. Recovery from Emergency Stop."
	EMST-		
	STOP	Input	Stops the operation when this input is on. (Motor decelerates and stops.) The program that has been executed is forced to cancel and the motor goes in servo-lock state. You cannot resume the operation automatically keeping the signal ON, as the signal is a state signal (signal level detection). Even the STOP signal is off, the operation won't start automatically. It requires to make RUN command ON again. The programmed operation will start from the beginning.
	CSTP	Input	Stops after execution of a program step when CSTP is on during programmed operation. Motor goes in servo-lock state. (cycle stop) RUN input resumes the programmed operation from the next step when CSTP input is off. When it is on, a RUN input executes a programmed step operation. (Each RUN command executes a program in a program step one by one.)
	HOLD	Input	HOLD input holds a programmed operation being executed. (Makes the motor to decelerate and stop.) The motor goes in servo-lock state. RUN command after HOLD input is off will resume the programmed operation from the position at where it stopped.
Error status indication	RDY	Output	Normally close. Opens in case of a serious error.
	WRN	Output	Normally open. Closes in case of a minor error.
Status indication	MTN	Output	Closes during execution of operation such as Home return and programmed operation. It keeps closing during "cycle stop" or "operation hold."
	EDTM	Output	Closes while editing the memories through teaching box or remote command, indicating that the starting operation command is disabled.
	TBXM	Output	Closes to indicate that the external operation and the remote control modes are disabled when the controller is under teaching box operation mode.
	HOMS	Output	Closes after completion of Home return. It opens to indicate the necessity of Home return when the encoder is in abnormal condition, or the parameters related to Home return operation are changed.
	CSTPA	Output	Closes during cycle stop.
	HOLDA	Output	Closes during HOLD input is on.
	RSTAE	Output	Closes when a resuming operation is enabled under temporary discontinuation of programmed operation.
	DATWT	Output	Closes when writing programs and parameters to the internal flash memory. All data must be lost if power is turned off at this moment, and may lead to "memory error." Operations, such as programmed operation or Home return, are disabled when this output is closed.

7.4.3. CN3: Signal Specification

Figure 7-7: CN3 pin-out



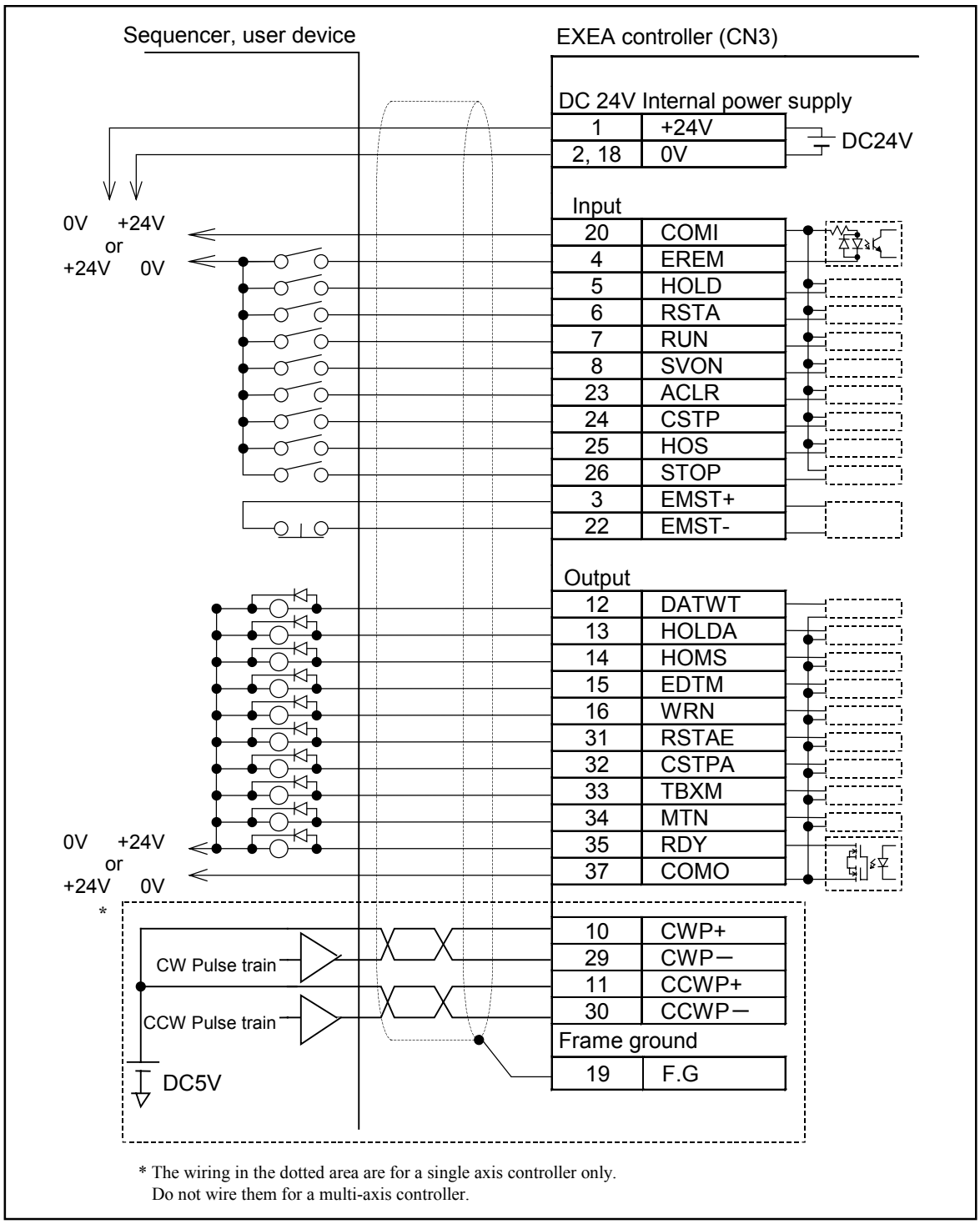
* The pins in the dotted area are for single axis controller only. Do not connect them for a multi-axis controller.

Pin	Signal name	Input / Output	Description
1	+24V	output	+ side output, DC24V internal power supply
2	0V	output	- side output, DC24V internal power supply
3	EMST+	input	Emergency stop (+)
4	EREM	input	Remote control enables
5	HOLD	input	Hold
6	RSTA	input	Restart
7	RUN	input	Start
8	SVON	input	Servo on
9	-	-	Do not connect.
10	CWP+	input	CW pulse train (+) *
11	CCWP+	input	CCW pulse train (+) *
12	DATWT	output	Writing data
13	HOLDA	output	Hold
14	HOMS	output	Home return complete
15	EDTM	output	Remote editing
16	WRN	output	Warning
17	-	-	Do not connect.
18	0V	output	- side output, 24V internal power supply
19	FG	-	Frame ground
20	COMI	input	Common, input
21	-	-	Do not connect.
22	EMST-	input	Emergency stop (-)
23	ACLR	input	Alarm clear
24	CSTP	input	Cycle stop
25	HOS	input	Home return start
26	STOP	input	Operation stop
27	-	-	Do not connect.
28	-	-	Do not connect.
29	CWP-	input	CW pulse train (-) *
30	CCWP-	input	CCW pulse train (-) *
31	RSTAE	output	Resume operation enabled
32	CSTPA	output	Stopping (cycle stop)
33	TBXM	output	Teaching box operation
34	MTN	output	Operating status
35	RDY	output	Controller ready
36	-	-	Do not connect.
37	COMO	output	Common, output signal

* These pins are for a single axis controller only. Do not connect them for a multi-axis controller.

Note: In an operation through the teaching box or a programmed operation, all input signals other than EMST is not accepted.

Figure 7-8: Sample wiring diagram



Caution : *Do not connect the internal DC 24V power supply if the external DC 24V power supply is used. It may lead to breakage of the internal power supply.*

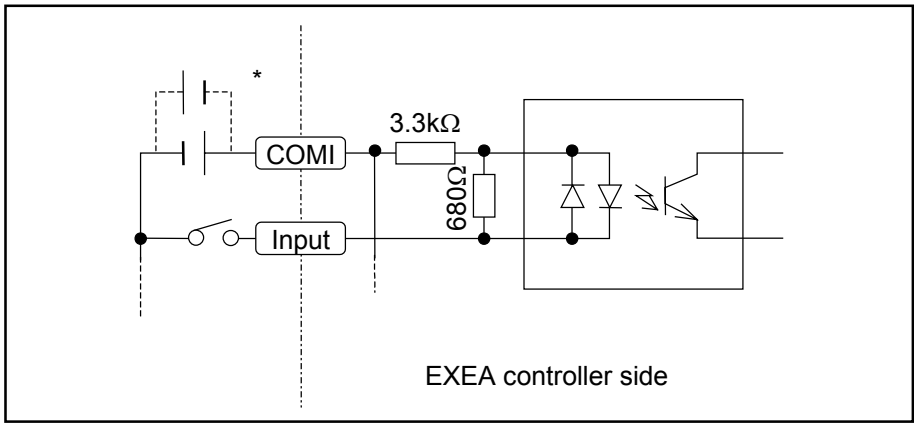
7.5.3.1. Specification of Control Signal

General input: EREM, HOLD, RSTA, RUN, SVON, ACLR, CSTP, HOS, STOP

Table 7-9

Item	Specification
Input voltage	DC24V±10%
Input impedance	3.3kΩ
Input current	10mA or less (per port)

Figure 7-9



* You may connect here as "Minus common" when the polarity of the external power supply is reversed.

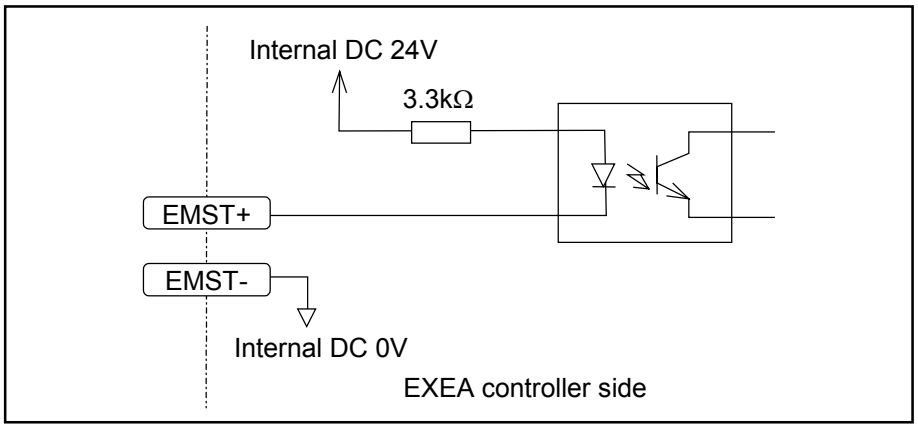
7.5.3.2. EMST Input Signal Specification

General input: EMST+, EMST-

Table 7-10

Item	Specification
Required switching ability	DC24V, 10mA or over

Figure 7-10



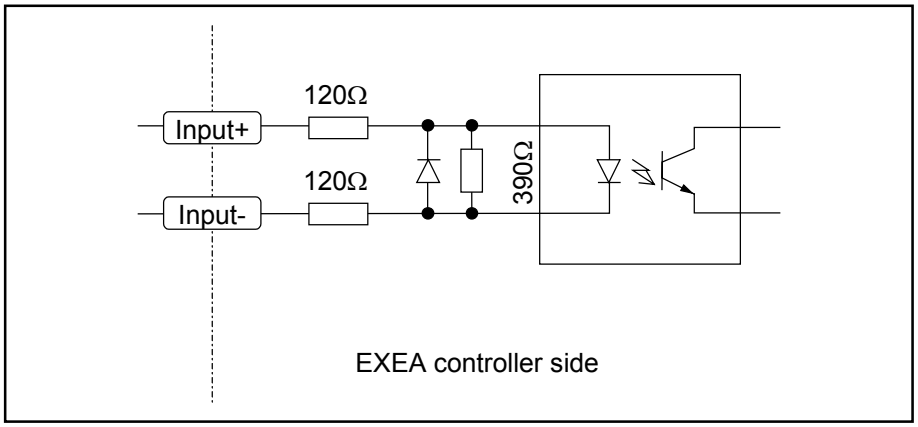
7.5.3.3. Pulse Train Input (Single axis controller only)

Applicable input: CCWP+, CCWP-, CWP+, CWP-

Table 7-11

Item	Specification
Input voltage	DC5V±10%
Input impedance	240Ω
Input current	25mA or less

Figure 7-11



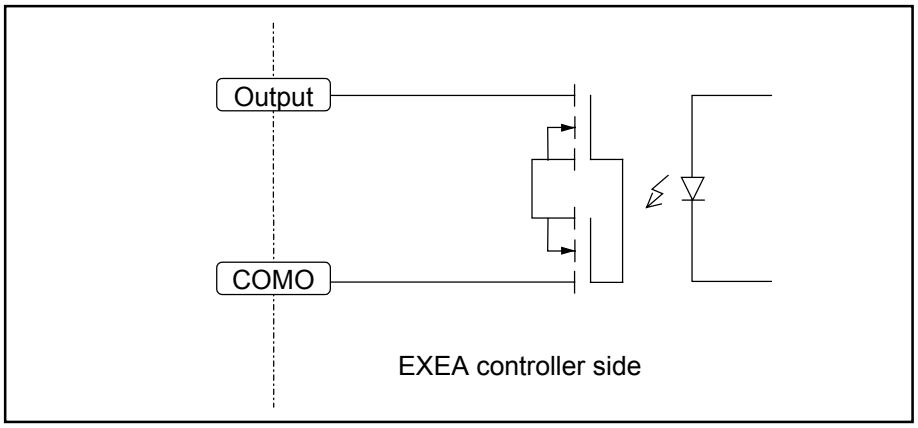
7.5.3.4. Specification of Control Output Signal

Applicable output : DATWT, HOLDA, HOMES, EDTN, WRN, RSTAE, CSTPA, TBXM, MTN, RDY

Table 7-12

Item	Specification
Maximum switching ability	DC24V/100mA
Saturation voltage	2V or less

Figure 7-12



* COMO may be either "plus common" or "minus common."

7.6. CN4, CN5: Main Power and Control Power Connector

7.6.1. Precautions for Wiring of Power Input Connector

- The connector of main power supply must have sufficient capacity for required power consumption of the EXEA controller.

Table 7-13

Motor power	100W	200W	400W
Required power capacity (per axis)	0.33kVA	0.66kVA	1.5kVA

- Use a 1.25 mm^2 power cable for 1.5 kVA or less capacity. Use a 2 mm^2 or larger power cable for 1.5 to 3.0 kVA capacity.

Danger *: An isolation transformer* must be used to avoid electric shock. It must have enough capacity for the power consumption of EXEA controller. The isolation transformer should have protection against overheat for both in normal and abnormal conditions.*

Danger *: A circuit breaker* which has enough capacity of EXEA controller power capacity must be provided to the main power supply line to avoid large incoming current due to the system failure.*

Note*: An isolation transformer and a circuit breaker have to conform to the requirements of relevant European standard. Refer to "5.1.1. Specifications" for specifications of power capacity and inrush current.

Danger *: Install noise filter as one of the measures to Electromagnetic compatibility (EMC). Select the noise filter so that your machine will clear the requirements of EMC Directive after its installation.*

Danger *: Connect the FGND terminal securely to the ground. Improper grounding may cause electric shock, damages to the equipment or malfunction due to noises. Refer to "7.2.4. Grounding."*

Danger *: Secure the main power input connector firmly.*

Danger *: Connection to a different specification voltage line may cause damages to controller and / or motor. Refer to Figure 5-6 for reference number of the EXEA controller and confirm voltage specification of your controller.*

Table 7-14

Code on reference number	Power source voltage spec.	Main power voltage range	Control power voltage range
T	AC200V / 240V	Single phase AC180V ~ AC264V	Single phase AC180V ~ AC264V

Caution *: If it is necessary to provide power line with a magnet switch or earth leakage breaker, add inrush current at the moment of turning on power and leakage current* to the power capacity shown above. If the capacity is insufficient, the contacts may fuse.*

* For inrush current and leakage current, refer to "5.1.1. Specifications."

- Use a magnet switch with rated current of 30A or over. Separately install the power supply line of 3 ~ 4 axes controller and 1 ~ 2 axes controller.
- Be sure to provide a surge killer to coils of magnetic switches, relays and solenoids.
- Install a noise filter between main power supply and controller in order to avoid external noises.

Table 7-15: Recommended noise filter (reference use only)

Shaffner EMC Ltd.	FN2070-10

- Separate the primary wiring from the secondary wiring of noise filter and lay them in different routs.
- Install the noise filter close to the controller as much as possible and do not install any magnetic switch or relay between them.

7.6.2. Power Line Wiring

Table 7-16: Terminal and function

Connector	Terminal code	Function
CN4 MAIN	L	Single phase AC 200 / 240 V main power supply
	N	
CN5 CONT	L	Single phase AC 200 / 240 V control power supply
	N	
FGND		Frame ground

Caution : Connection to an improper power voltage may lead to breakdown of the controller and/or the motor.

7.7. EXT. IO: General Input / Output Signal Connector

- Wire general Input / Output signals for the external control mode to control slave units, or to input a conditional jump command of EXEA controller.

Table 7-17: EXT. I / O connector parts

Connector, EXEA controller side	Japan Aviation Electronics Industries Ltd DCLC–J37SAF–13L9
Mating connector, cable side *	Japan Aviation Electronics Industries Ltd DC–37PF–N
Mating connector shell type, cable side *	Japan Aviation Electronics Industries Ltd. DC–C8–J13–F1–1

◊ * These are provided as the accessories.

7.7.1. Precautions for Wiring

- Be sure to use shielded cables and ground the shield securely.
- If it is necessary to install a relay to the output port, a surge killer must be installed to a relay.
- EXT. I / O signal cable must be separated from the power line (main power supply or motor cable) and do not put then in the same conduit or duct.
- Make EXT. I / O cables short as possible. (3 meters or less) If the cables is longer than this criterion, take measures against external noise.

Caution : Failure to observe above notices may lead to malfunction and memory loss due to the noises.

Caution : Be sure to meet the electrical specifications in Table 7-18. Especially following three issues are critical for breakage of electrical element of input and output circuit.

1) Power supply range (DC24V ±10 %)

2) Reversed connection of power supply polarity (DC24V)

3) Over output switching ability

Table 7-18: EXT. I / O signal electrical specification

Signal	Item	specification
Input signal	Input voltage	DC24V ±10%
	Input impedance	3.3kΩ
	Maximum current	10mA (per port)
Output signal	Maximum switching ability	DC24V / 100mA
	Maximum saturated voltage	2V or less

7.7.2. EXT.IO Signal Function

Table 7-19: EXT: Input / Output

Signal name	Signal function name	Input / Output	Function
IN1 ~ IN16 (Programmed operation control (Set to either one of PROGn/UNTNn Note 3) or POSNn/USER) Note 1)	PROG0 ~ PROG6	Input	Select the program number (0 to 127) to be executed. The input is referred when RUN input is on. After RUN is on it may be used as a general input (USER).
	UNTN0 ~ UNTN2 Note 3)	Input	Select number of units in the direct operation. This input is referred when RUN input is on.
	POSN0 ~ POSN11	Input	This is to select point number (0 to 3999) in the direct operation. This input is referred when RUN input is on.
	USER	Input	This is for general input. It can be applied to a command using the input signal.
	RSRV	Input	Reserved
OUT1 ~ OUT16 (Indication of state (Set either FINn or USER) Note 2)	FIN1 ~ FIN8 Note 4)	Output	It is closed when a designated unit by its number completes a motion. (Only Unit 1 is set for a single axis controller) The time for this state is set at the initialization. When the time expires, this port will open.
	USER	Output	This is the general output. This is the port that can be outputted during a programmed operation.
	RSRV	Output	Reserved

Note: 1) The shipping set are PROG0 ~ PROG6 (IN1 to IN7), RSVR (IN8) and USER (IN9 to IN16).

2) The shipping set is USER (OUT 1 to OUT16).

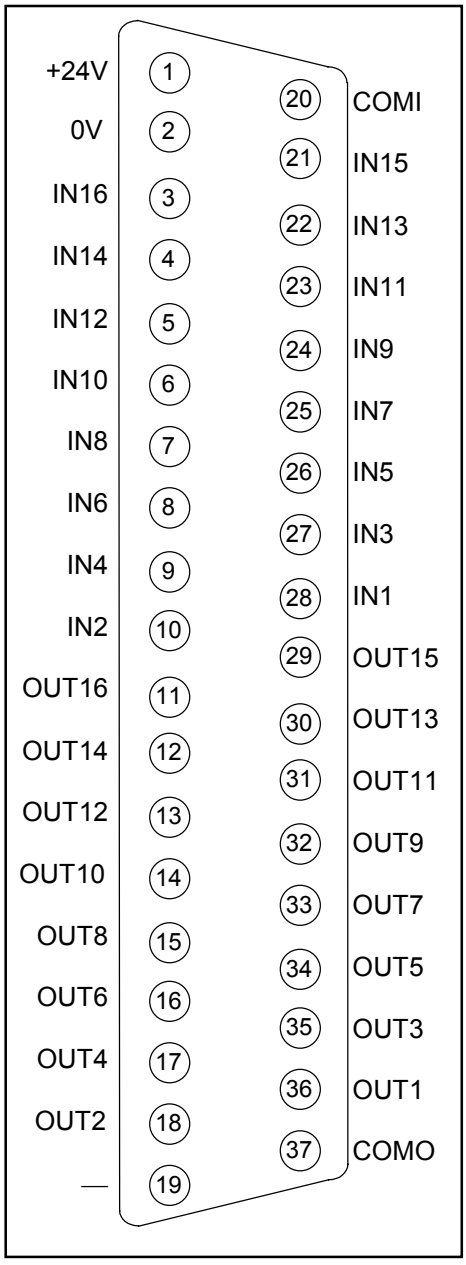
3) These are not used for the single axis controller.

4) Only FIN1 is available in the single axis controller.

- Select EXT.IO function at initial setting. Refer to "9.8. Parametes for Input Signal Format" and "9.9. Parameters for Output Signal Format."

7.7.3. CN3 Signal Specification

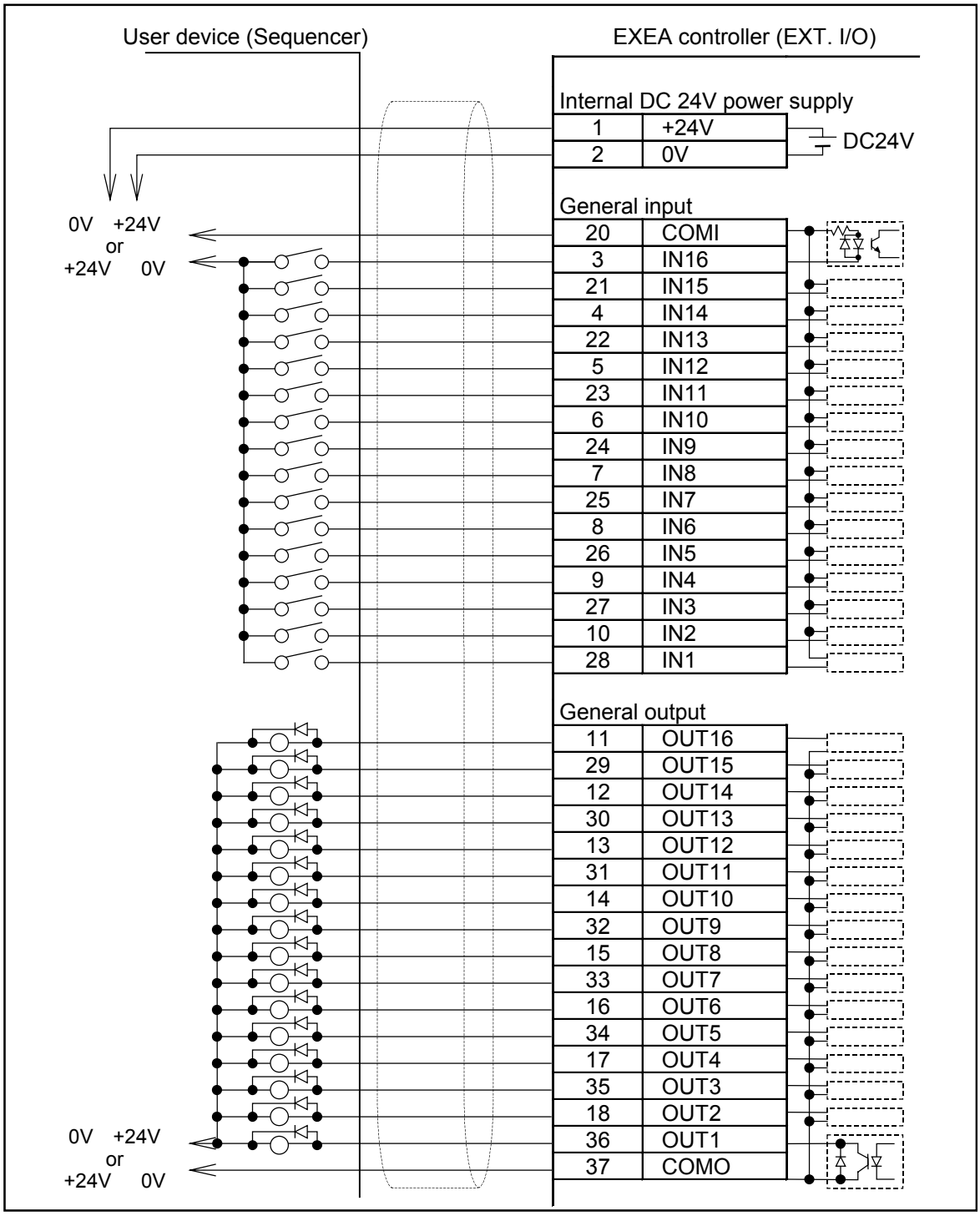
Figure 7-13: EXT. I / O connector pin-out



Pin No.	Signal name	I / O	Description
1	+24V	output	Internal DC 24V power supply, + side output
2	0V	output	Internal DC 24V power supply, - side output
3	IN16	input	Reserve / POSN11 / USER
4	IN14	input	Reserve / POSN 9 / USER
5	IN12	input	Reserve / POSN 7 / USER
6	IN10	input	Reserve / POSN 5 / USER
7	IN8	input	Reserve / POSN 3 / USER
8	IN6	input	PROG5 / POSN1 / USER
9	IN4	input	PROG3 / Reserve / USER
10	IN2	input	PROG1 / UNTN1* / USER
11	OUT16	output	Reserve / USER
12	OUT14	output	Reserve / USER
13	OUT12	output	Reserve / USER
14	OUT10	output	Reserve / USER
15	OUT8	output	FIN8* / USER
16	OUT6	output	FIN6* / USER
17	OUT4	output	FIN4* / USER
18	OUT2	output	FIN2* / USER
19	—	–	Do not connect
20	COMI	input	Input common
21	IN15	input	Reserve / POSN10 / USER
22	IN13	input	Reserve / POSN8 / USER
23	IN11	input	Reserve / POSN6 / USER
24	IN9	input	Reserve / POSN4 / USER
25	IN7	input	PROG6 / POSN2 / USER
26	IN5	input	PROG4 / POSN0 / USER
27	IN3	input	PROG2 / UNTN2* / USER
28	IN1	input	PROG0 / UNTN0* / USER
29	OUT15	output	Reserve / USER
30	OUT13	output	Reserve / USER
31	OUT11	output	Reserve / USER
32	OUT9	output	Reserve / USER
33	OUT7	output	FIN7* / USER
34	OUT5	output	FIN5* / USER
35	OUT3	output	FIN3* / USER
36	OUT1	output	FIN1 / USER
37	COMO	output	Output signal common

* For the singla axis controller these parts are indicated as "Reserved."

Figure 7-14: Sample wiring diagram



Caution : *If the external DC24V power supply is used, do not connect the internal DC24V power supply. It leads to breakage of the power supply if the connection is made.*

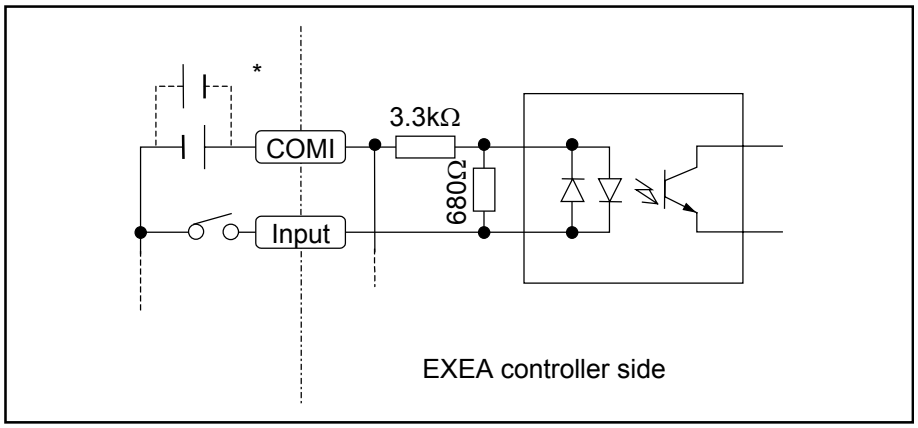
7.7.3.1. Input Signal Specifications

General input : IN1 ~ IN16

Table 7-20

Item	Specification
Input voltage	DC24V±10%
Input impedance	3.3kΩ
Input current	10 ma or less (per port)

Figure 7-15



* You may connect here as "Minus common" when the polarity of the external power supply is reversed.

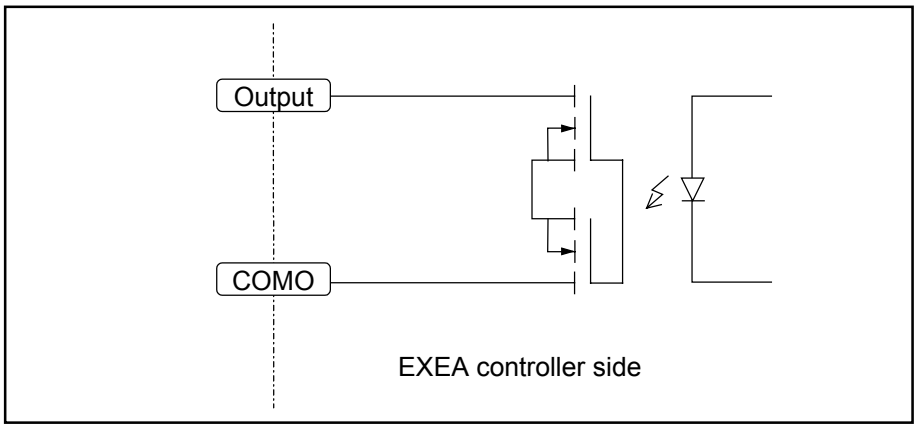
7.7.3.2. Output Signal Specifications

Applicable output: OUT1 ~ OUT16

Table 7-21

Item	Specification
Maximum switching ability	DC24V/100mA
Saturation voltage	2V or less

Figure 7-16



* COMO can be either "plus" or "minus" common.

7.8. Motor and Encoder Connectors

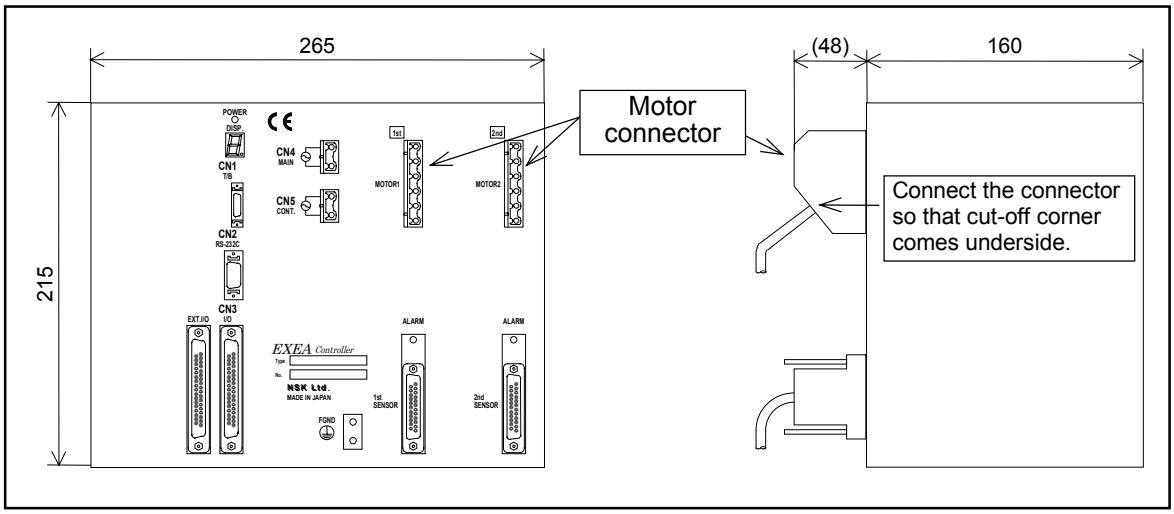
- Connect the controller cable.

  Warning : Be sure not to connect to a wrong axis. Wrong connection and improper wiring may lead to motor breakage or malfunction of EXEA controller.

  Warning : Prevent improper insertion of connectors

  ◊ Insert connectors in proper manner as the connectors have orientation for insertion. Forcing to plug in them may result in breakage of the connectors, or malfunction of the system if the connectors are left in insufficient connection. Confirm their orientations, insert them smoothly and make a correct connection.

Figure 7-17



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8. Startup

8.1. Turn on Power

8.1.1. Preparation before Turning on Power

1 Check the wiring of controller and robot module cables.

- Make a proper connection of cables referring to the seals affixed to the connectors.

2 Clear emergency stop state.

- Clear EMST input of CN3 connector. (Turn EMST input on.)

3 Connect the teaching box.

- If the teaching box is not used, connect a provided dummy connector, otherwise the system gets into emergency stop state.

4 Check for the safety.

Danger *: Check if the fixing bolts of module main unit are securely fastened.*

◊ If the bolts are not secured properly, it may cause a serious injuries when robot starts to move.

Danger *: Check if a vertical axis are securely hold by motor brake.*

◊ If it is not hold, it back-drives and may cause injuries or the damage to the robot and ancillaries.

Danger *: Do not enter motion range of robot modules when doing start-up, adjusting and test running.*

◊ Never enter motion range of robot module system, otherwise it may cause serious accident.

◊ For maintenance work, observe the notes and safety precautions in "14. Troubleshooting."

Warning *: Is there any disconnection, defective connection and / or connection to wrong axis ?*

◊ Normal operation cannot be expected. Make sure for connections because a wrong connection may cause a defective controller and module main unit.

Caution *: Assure that there is no mechanical interference when all module main units make their full stroke.*

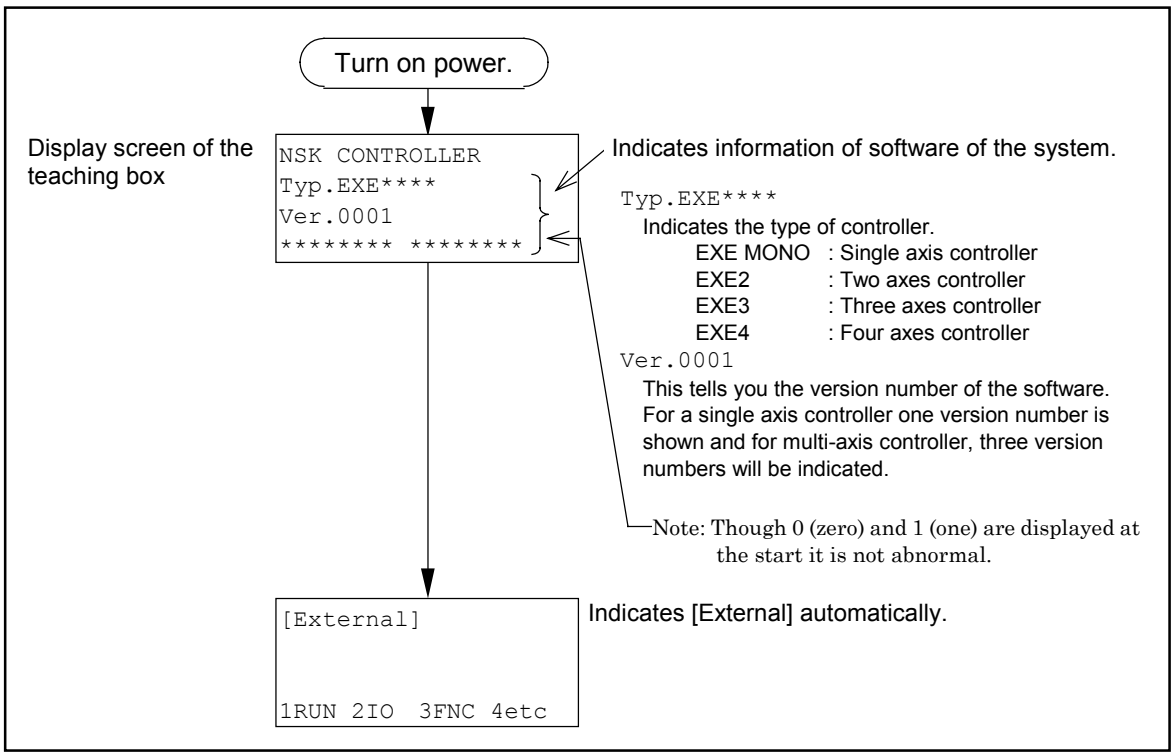
◊ Mechanical interference may damage the module main unit and other ancillaries.

Note: When turning off the power or servo, the dynamic brake functions. Existence of some resistance when moving the slider manually is not abnormal. The dynamic brake does not work when the controller cable is disconnected.

8.1.2. Checks When Turning on Power

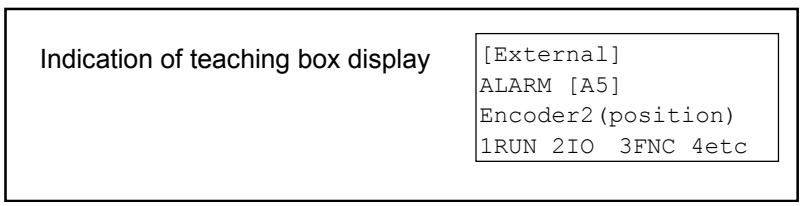
- Turn on power.
- After turning on the power, confirm that 7 segment LED on the front panel of EXEA controller is indicating no abnormality, a round green LED over the 7 segment LED is on, and the display of the teaching box (Figure 8-1) is normal.

Figure 8-1



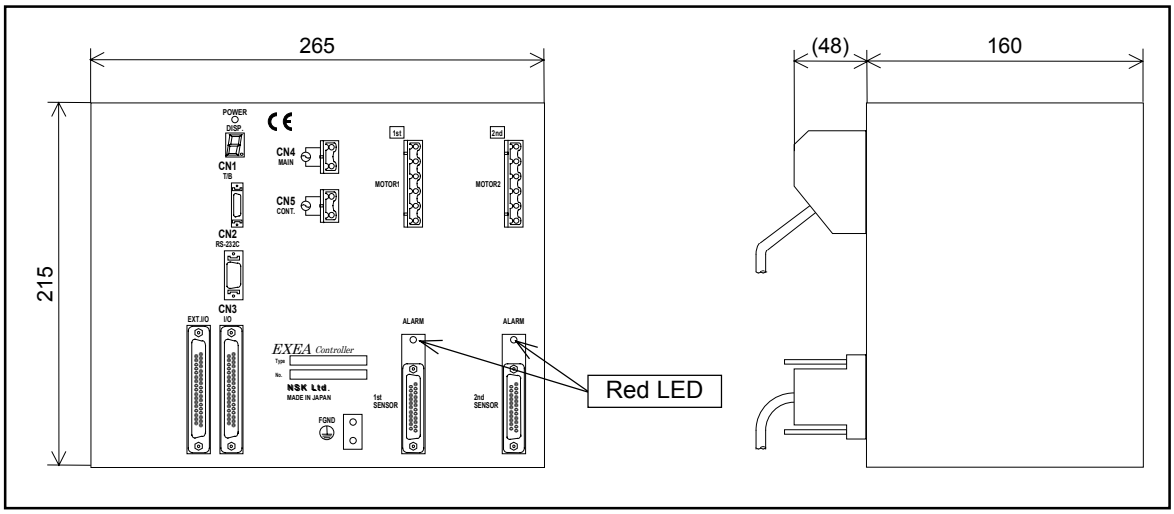
- Press MODE key to get in [External] immediately.
- Eliminate cause of an alarm referring to "13. Alarms" and "14. Troubleshooting" when an alarm is detected.
- At the startup in the first time, or after 20 minutes of controller cable disconnection, the alarm of encoder will be on. However, this is not abnormal. Execution of Home return after initial setting will terminate the alarm.

Figure 8-2



- After the power is turned on, red ALARM LED over SENSOR connector is on sometimes. (See Figure 8-3.) This is not abnormal. It will be automatically off when a capacitor of smoothing circuit is charged after SERVO is on.

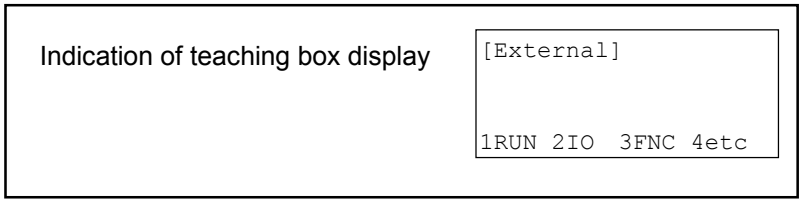
Figure 8-3



8.2. Selection of Control Mode

- The system gets into External control mode automatically after turning on power. At this time, RDY output (CN3) is closed when it is normal.
- All operations, such as start and stop, are controlled through the control Input / Output signal (CN3) of EXEA controller.
- The system gets in the external control mode every time the power is turned on.
- In this control mode, the function keys of the teaching box, along with EMG key, are effective. (Refer to "17.4.6. Teaching Box Operation in External Control Mode.")

Figure 8-4



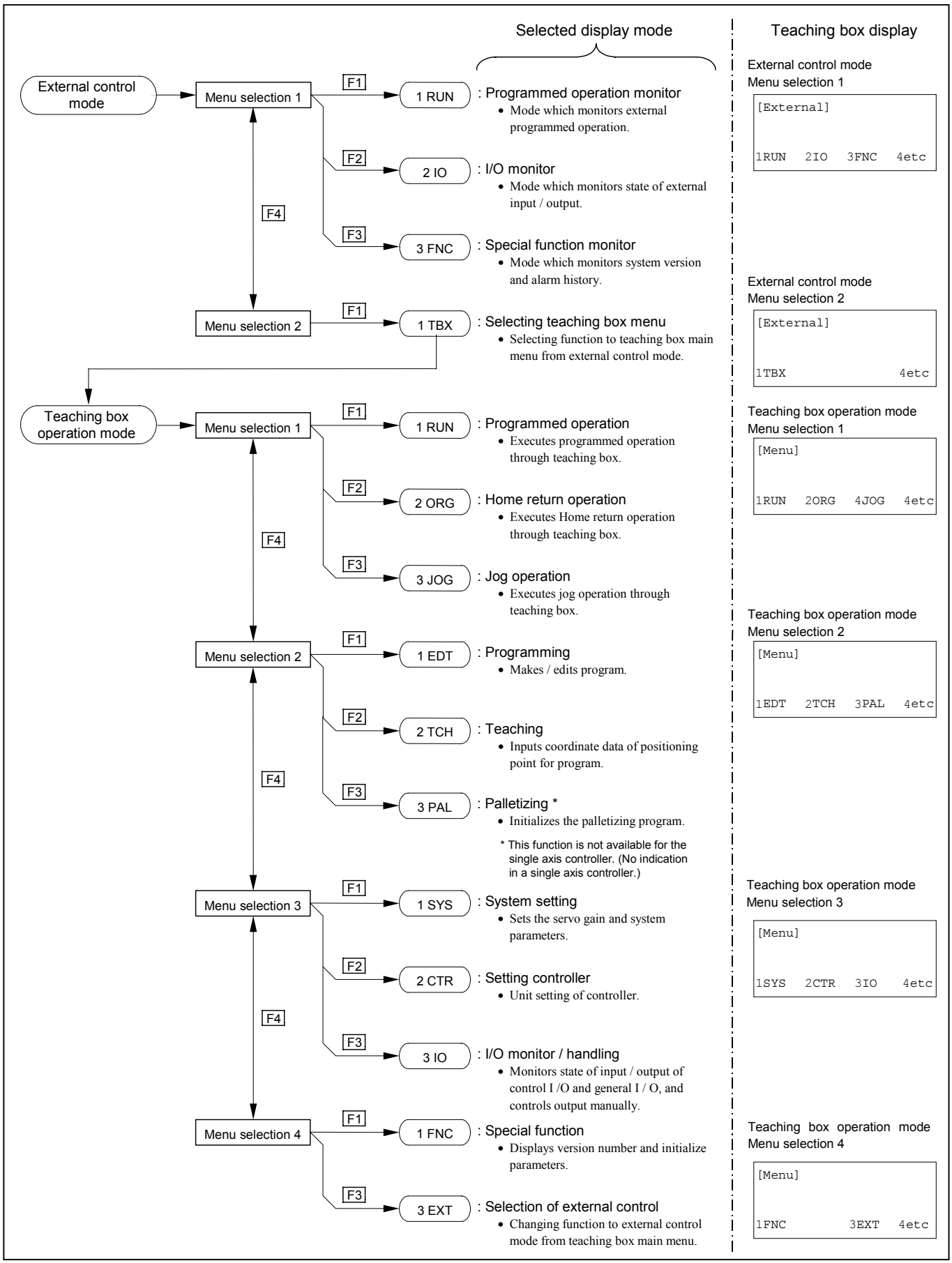
8.2.1. Teaching Box Operation Mode

- For execution of initial setting, programming and operation through the teaching box, put the system in the teaching box operation mode pressing F1 TBX after F4 etc. (See Figure 8-5.)

> Use Teaching Box for selection of operation mode.
> → Refer to "5.2.1. Operational Function" for function of the keys.)

- Use F1, F2 and F3 keys for the selection of operation in the display and use F4 key for selecting the display.

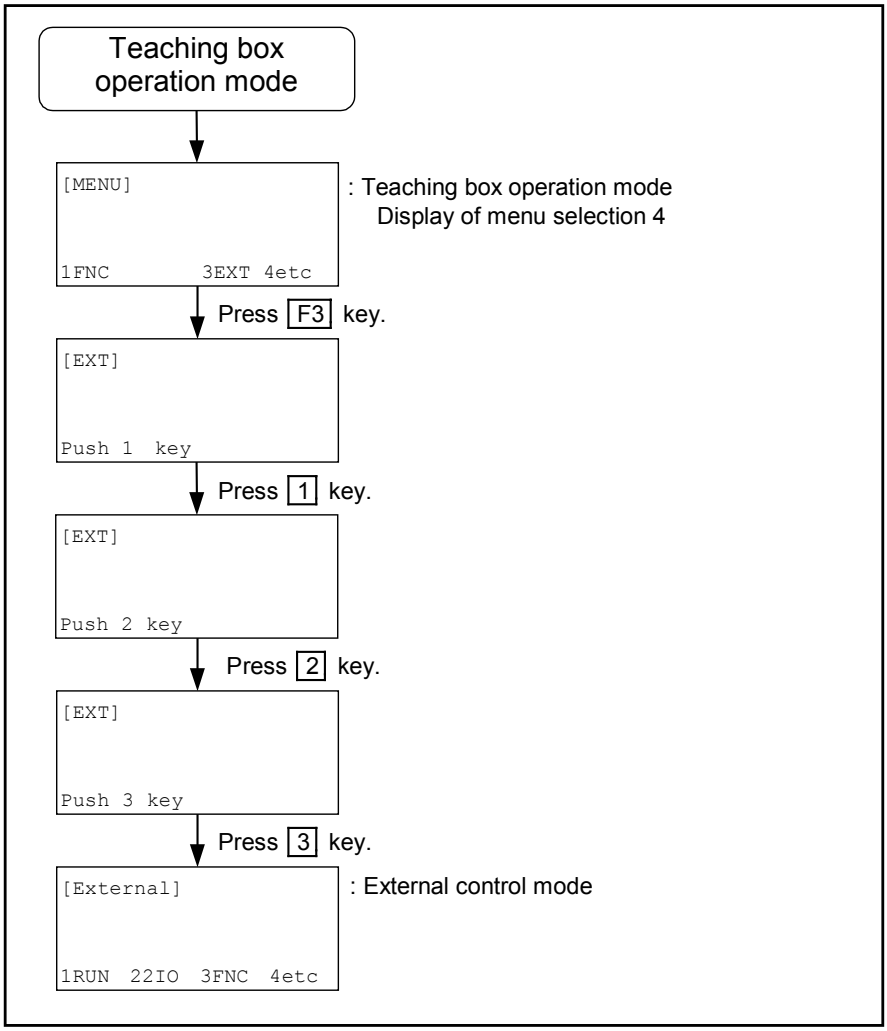
Figure 8-5: Changing operation mode



8.2.2. Changing to External Control Mode from Teaching Box Operation Mode

- To return to the external control mode, press 1, 2, 3 keys after F3 key on the display of menu selection 4 in teaching box operation.

Figure 8-6



* When this procedure is executed while the system is operating, the controller terminates the programmed operation and gets in [Eternal] control mode.

9. Initial Setting

- This chapter describes how to set the EXEA controller according to the combination of the module main units and the purpose of its use.
- Please refer to this chapter for initializing, adjusting or correcting the setting in the middle of operation after the startup or initialization of the EXEA controller.

9.1. Initial Setting Procedure

- Use the teaching box or the optional application software for initial setting.
- Refer to "8.2. Selection of Control Mode" and set the objective parameters selected from "9.2. Initial Setting List."
- Take the same procedure for the application software. Refer to the instruction manual for the setting in the personal computer.
- Following initial setting procedures are required after "8. Startup" has competed to operate the EXEA controller. Observe to set as described hereunder before test running.

Procedure1: Setting type of module main unit.

- Set the type of main units (X-module Name) which are to be connected to the EXEA controller.
- Set X axis only for the single axis controller while all axes must be set for multi-axis combination.
- Refer to "9.5. Parameters for Unit Setting" for setting and saving the parameters.

⇩

Procedure 2: Setting total load mass

- Set the total load mass to the module main units (Payload).
- For the multi-axis combination, add all payload including the combining bracket to respective module main units, other than a module main unit to which the effector is directly attached.
- Refer to "9.4.1. Parameters for Servo" for contents of setting and saving the parameters.
- Optimum servo parameter shall be set through the payload setting. However, when the system tends to vibrates set rather lower payload than the actual value.

Caution *: 1) The robot may make unexpected motion or the main unit may break if the robot system keeps running under wrong setting of the type of module main unit.*

2) Initialize the system parameters when the memory error arises. In such a case set parameters according to the module main unit again.

9.2. Initial Setting List

- As shown in Figure 9-1(Single axis controller), Figure 9-2 (Multi-axis controller) and Figure 9-3 (Common), the system setting mode and the controller setting mode are drawn like a tree diagram. Select each parameter setting mode with the function keys of the teaching box.

Figure 9-1: System setting mode list (Single axis controller)

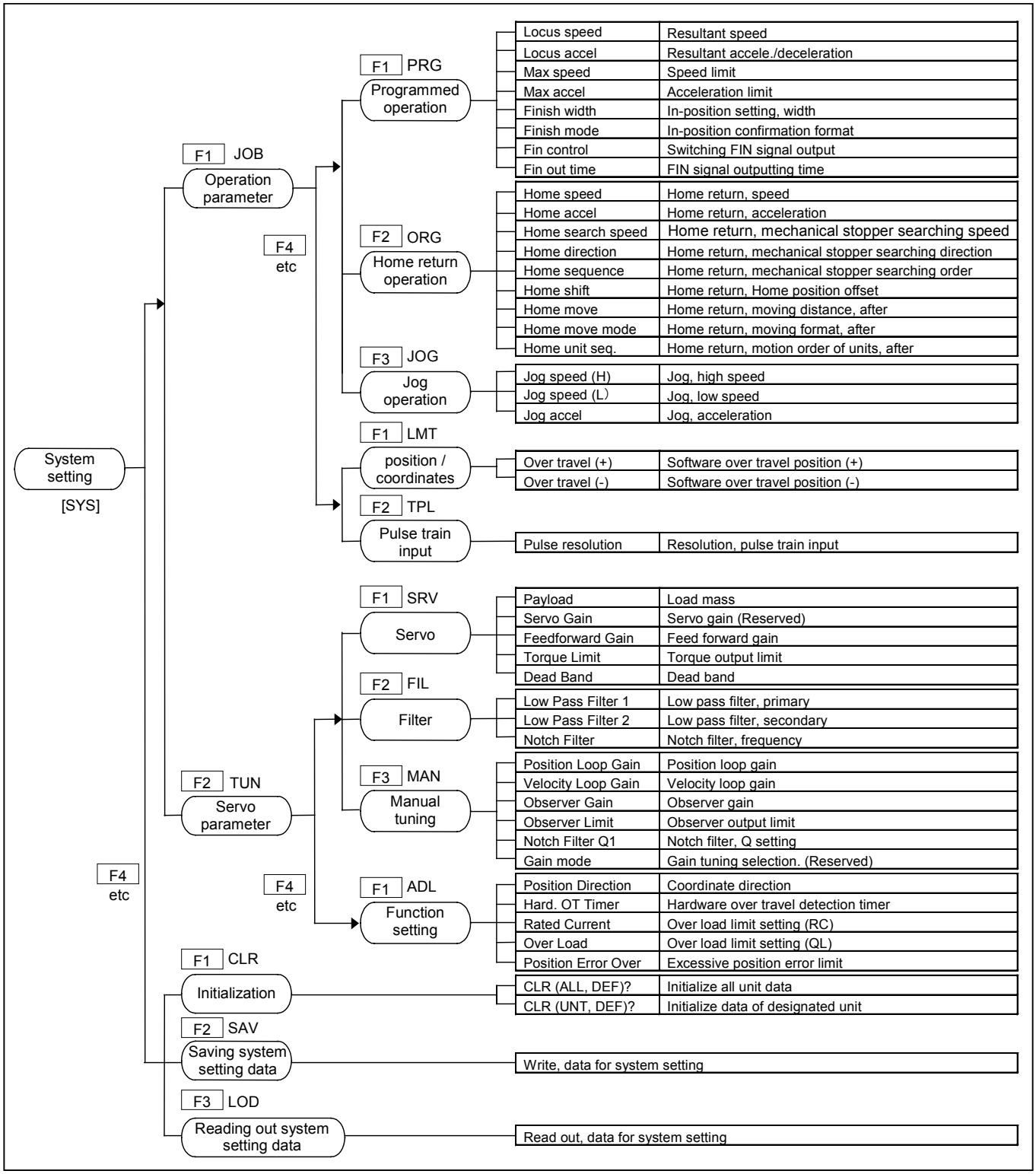


Figure 9-2: System setting mode (Multi-axis controller)

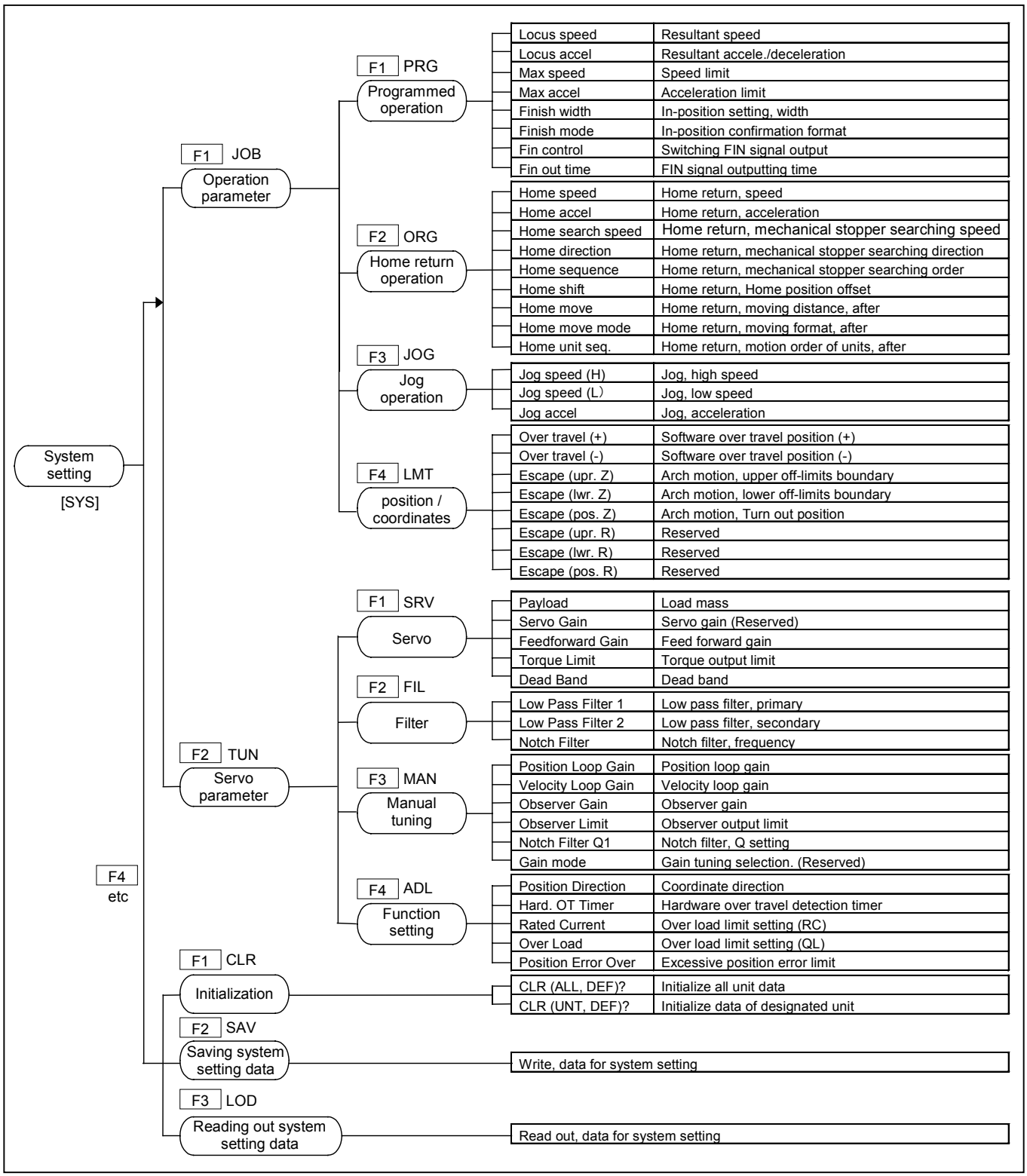
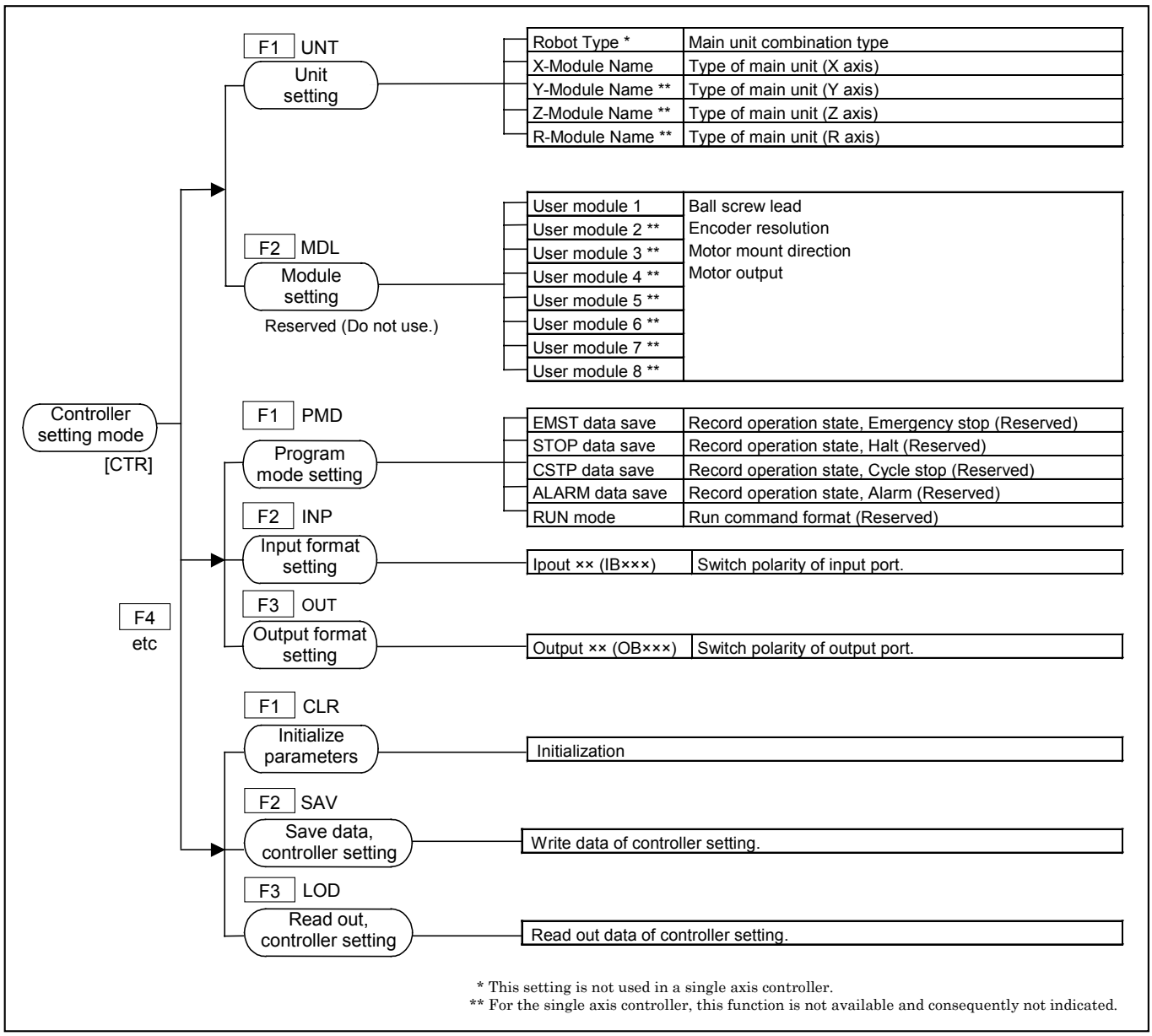


Figure 9-3: Controller setting mode



* This setting is not used in a single axis controller.
** For the single axis controller, this function is not available and consequently not indicated.

- Table 9-1 and Table 9-2 show the parameters of system setting and the controller setting respectively.

- We recommend to keep the notes on the right side column of the tables when the user changes a parameter from the shipping set. When plural units in a multi-axis combination other than U1 are set, make a list for each unit and record the respective settings.

- The parameters once saved to the memory will be backed up after the power is turned off and they won't change until the parameters are changed to new setting or are initialized.

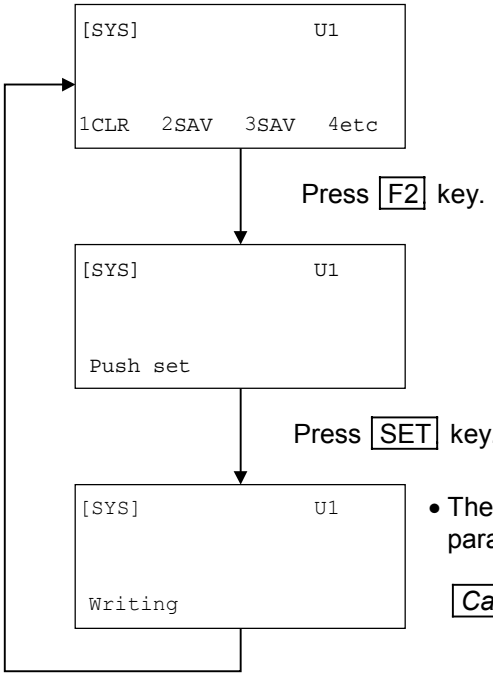
Caution *: Save the data before turn off the power. Otherwise initialized data will be back to original setting (setting before initialization) after the power is turned off. Refer to the following for saving the settings.*

1) System setting mode: "9.10.1.1. Procedure to Save Parameters of System Setting."

2) Controller setting mode: "9.10.2.1. Procedure to Save Parameters of Controller Setting."

Caution *: When saving the data, the display of teaching box indicates "Writing." While it is indicated, do not turn off the power. Otherwise "memory error" alarm will be given. (All data, including program, must be deleted to recover the system.)*

[Example]: Saving the system parameter



- The display indicates "Writing" while the parameters are being saved.

Caution *: Do not turn the power off while saving data.*

Caution *: Make sure that the servo is inactive while the system parameters are being set. Do not press the ON key of the teaching box.*

Caution *: The system parameters include ones that change settings of coordinates system. On completion of initial setting, be sure to execute the home return once. Completion of the home return makes the initial settings of coordinates system effective.*

Caution *: If the memory is initialized, the parameters are reset to the factory settings.*

Table 9-1: Initial setting (System setting mode)

Classification			Unit	Setting range	Shipping set	User setting
1	2	3				
Operation parameter (JOB)	Programmed operation (PRG)	Locus speed	mm/s	0.1 ~ 1200.0	600.0	
		Locus accel	m/s^2	0.1 ~ 35.0	0.5	
		Max speed	mm/s	0.1 ~ 1200.0	1200.0	
		Max accel	m/s^2	0.1 ~ 35.0	35.0	
		Finish width	mm	0 ~ 99.99, OFF	OFF	
		Finish mode	–	ONE, ALL	ALL	
		Fin control	–	OFF, ON	OFF	
		Fin out time	sec	0 ~ 99.99, OFF	0.1	
	Home return operation (ORG)	Home speed	mm/s	0.1 ~ 50.0	20.0	
		Home accel	m/s^2	0.1 ~ 35.0	0.5	
		Home search speed	mm/s	0.1 ~ 10.0	1.0	
		Home direction	–	NRM, REV	NRM	
		Home sequence *	–	0 ~ 7	0	
		Home shift	mm	0 ~ ±9999.99	0	
		Home move	mm	0 ~ ±9999.99	0	
		Home move mode	–	NOP, ABS, INC	NOP	
		Home unit seq. *	–	0 ~ 7	0	
	Jog operation (JOG)	Jog speed (H)	mm/s	0.1 ~ 250.0	100.0	
		Jog speed (L)	mm/s	0.1 ~ 250.0	50.0	
		Jog accel	m/s^2	0.1 ~ 35.0	0.5	
	Coordinate setting (LMT)	Overtravel (+)	mm	0 ~ ±9999.99, OFF	OFF	
		Overtravel (-)	mm	0 ~ ±9999.99, OFF	OFF	
	Pulse train input (TPL)	Pulse resolution **	–	-1 ~ 10	1	
Servo parameter (TUN)	Servo (SRV)	Payload	kg	0.0 ~ 200.0	5.0	
		Servo Gain	Hz	(Reserved), OFF	OFF	
		Feed forward Gain	%	0 ~ 100, OFF	OFF	
		Torque Limit	%	1 ~ 100, OFF	OFF	
		Dead Band	pulse	1 ~ 100, OFF	OFF	
	Filter (FIL)	Low Pass Filter 1	Hz	10 ~ 500, OFF	OFF	
		Low Pass Filter 2	Hz	10 ~ 500, OFF	30	
		Notch Filter	Hz	10 ~ 500, OFF	OFF	
	Manual tuning (MAN)	Gain Mode	–	(Reserved), MANU	MANU	
		Position Loop Gain	Hz	1.0 ~ 100.0	5.0	
		Velocity Loop Gain	Hz	1.0 ~ 500.0	20.0	
		Observer Gain	Hz	1.0 ~ 150.0	10.0	
		Observer Limit	%	0.1 ~ 100.0, OFF	OFF	
		Notch Filter Q1	–	0.10 ~ 5.00	1.00	
	Function setting (ADL)	Position Direction	–	NRM/REV	NRM	
		Hard. OT Timer	–	200 ~ 30000, AUTO	AUTO	
		Rated Current	%	0 ~ 100	43	
		Over Load	–	1 ~ 1000, OFF	20	
		Position Error Over	pulse	0 ~ 30000	30000	

* This part is not used in the single axis controller.

** This function / indication does not exist in the single axis controller.

Table 9-2: Initial setting: (Controller setting mode)

Classification		Shipping set	User setting
1	2		
Unit setting (UNT)	Robot Type *	OFF	
	X-Module Name	OFF 1 X	
	Y-Module Name **	OFF 2 Y	
	Z-Module Name **	OFF 3 Z	
	R-Module Name **	OFF 4 R	
Module setting (MDL)	User module 1	L20 R4096 NRM W100 (Do not use.)	
	User module 2 **	L20 R4096 NRM W100 (Do not use.)	
	User module 3 **	L20 R4096 NRM W100 (Do not use.)	
	User module 4 **	L20 R4096 NRM W100 (Do not use.)	
	User module 5 **	L20 R4096 NRM W100 (Do not use.)	
	User module 6 **	L20 R4096 NRM W100 (Do not use.)	
	User module 7 **	L20 R4096 NRM W100 (Do not use.)	
	User module 8 **	L20 R4096 NRM W100 (Do not use.)	
PMD setting (PMD)	EMST data save	NOP	
	STOP data save	NOP	
	CSTP data save	NOP	
	ALRM data save	NOP	
	RUN mode	PRG	

* This part is not used in the single axis controller.

** This function / indication does not exist in the single axis controller.

Table 9-2: Initial setting list (controller setting mode) continued

Classification		Signal name	Shipping set		Function can be changed		User setting	
1	2		Function	Contact polarity	Changeable signal name	Polarity change	Signal name	Polarity
Input format setting (INP)	Input IP00(IB000)	EMST	EMST	B	Cannot change.	No		
	Input IP00(IB001)	SVON	SVON	A	Cannot change.	No		
	Input IP00(IB002)	STOP	STOP	A	Cannot change.	Yes		
	Input IP00(IB003)	RUN	RUN	A	Cannot change.	Yes		
	Input IP00(IB004)	HOS	HOS	A	Cannot change.	Yes		
	Input IP00(IB005)	RSTA	RSTA	A	Cannot change.	Yes		
	Input IP00(IB006)	CSTP	CSTP	A	Cannot change.	Yes		
	Input IP00(IB007)	HOLD	HOLD	A	Cannot change.	Yes		
	Input IP01(IB010)	ACLR	ACLR	A	Cannot change.	Yes		
	Input IP01(IB011)	EREM	EREM	A	Cannot change.	Yes		
	Input IP10(IB100)	IN1	PROG0	A	UNTN0*/USER/RSRV	Yes		
	Input IP10(IB101)	IN2	PROG1	A	UNTN1*/USER/RSRV	Yes		
	Input IP10(IB102)	IN3	PROG2	A	UNTN2*/USER/RSRV	Yes		
	Input IP10(IB103)	IN4	PROG3	A	USER/RSRV	Yes		
	Input IP10(IB104)	IN5	PROG4	A	POSN0/USER/RSRV	Yes		
	Input IP10(IB105)	IN6	PROG5	A	POSN1/USER/RSRV	Yes		
	Input IP10(IB106)	IN7	PROG6	A	POSN2/USER/RSRV	Yes		
	Input IP10(IB107)	IN8	RSRV	A	POSN3/USER	Yes		
	Input IP11(IB110)	IN9	USER	A	POSN4/RSRV	Yes		
	Input IP11(IB111)	IN10	USER	A	POSN5/RSRV	Yes		
	Input IP11(IB112)	IN11	USER	A	POSN6/RSRV	Yes		
	Input IP11(IB113)	IN12	USER	A	POSN7/RSRV	Yes		
	Input IP11(IB114)	IN13	USER	A	POSN8/RSRV	Yes		
	Input IP11(IB115)	IN14	USER	A	POSN9/RSRV	Yes		
	Input IP11(IB116)	IN15	USER	A	POSN10/RSRV	Yes		
	Input IP11(IB117)	IN16	USER	A	POSN11/RSRV	Yes		
Output format setting (OUT)	Output OP00(OB000)	RDY	RDY	B	Cannot change.	No		
	Output OP00(OB001)	WRN	WRN	A	Cannot change.	Yes		
	Output OP00(OB002)	MTN	MTN	A	Cannot change.	Yes		
	Output OP00(OB003)	EDTM	EDTM	A	Cannot change.	Yes		
	Output OP00(OB004)	TBXM	TBXM	A	Cannot change.	Yes		
	Output OP00(OB005)	HOMS	HOMS	A	Cannot change.	Yes		
	Output OP00(OB006)	CSTPA	CSTPA	A	Cannot change.	Yes		
	Output OP00(OB007)	HOLDA	HOLDA	A	Cannot change.	Yes		
	Output OP01(OB010)	RSTAE	RSTAE	A	Cannot change.	Yes		
	Output OP01(OB011)	DATWT	DATWT	A	Cannot change.	Yes		
	Output OP10(OB100)	OUT1	USER	A	FIN1/RSRV	Yes		
	Output OP10(OB101)	OUT2	USER	A	FIN2*/RSRV	Yes		
	Output OP10(OB102)	OUT3	USER	A	FIN3*/RSRV	Yes		
	Output OP10(OB103)	OUT4	USER	A	FIN4*/RSRV	Yes		
	Output OP10(OB104)	OUT5	USER	A	FIN5*/RSRV	Yes		
	Output OP10(OB105)	OUT6	USER	A	FIN6*/RSRV	Yes		
	Output OP10(OB106)	OUT7	USER	A	FIN7*/RSRV	Yes		
	Output OP10(OB107)	OUT8	USER	A	FIN8*/RSRV	Yes		
	Output OP11(OB110)	OUT9	USER	A	RSRV	Yes		
	Output OP11(OB111)	OUT10	USER	A	RSRV	Yes		
	Output OP11(OB112)	OUT11	USER	A	RSRV	Yes		
	Output OP11(OB113)	OUT12	USER	A	RSRV	Yes		
	Output OP11(OB114)	OUT13	USER	A	RSRV	Yes		
	Output OP11(OB115)	OUT14	USER	A	RSRV	Yes		
	Output OP11(OB116)	OUT15	USER	A	RSRV	Yes		
	Output OP11(OB117)	OUT16	USER	A	RSRV	Yes		

* This function or indication does not exist in the single axis controller.

9.3. Operation Parameter

- There are three types of operation parameter settings.
  1) Programmed operation
  2) Home return operation
  3) Jog operation

9.3.1. Parameters for Programmed Operation

9.3.1.1. Parameter List

Table 9-3: Parameter list of programmed operation

Parameter	Description	Unit	Setting range	Factory set
Locus speed	• Specifies a speed in the programmed operation. *1	mm/s	0.1 ~ 1200.0	600.0
Locus accel	• Specifies an acceleration / deceleration in the programmed operation. *1	m/s^2	0.1 ~ 35.0	0.5
Max speed *2	• Specifies the speed limit. • Set to 1 200 mm / s for normal operation. • Lower speed of either "Locus speed" or "Max speed" is valid. • The maximum speed varies according to a main unit. Refer to "19.1.2. Specifications."	mm/s	0.1 ~ 1200.0	1200.0
Max accel *2	• Sets the limit of acceleration and deceleration. • Set to 35 m / s^2 for a normal operation. • Lower setting of either "Locus accel" or "Max accel" is valid.	m/s^2	0.1 ~ 35.0	35.0
Finish width *2	• Sets the detecting criteria of position error width for completion of positioning. *3 • When the deviation of error counter falls in the set range, [FIN] output is closed. • [FIN] signal closes when the pulse generation (motion command) is completed, if this parameter set to OFF.	mm	0.0 ~ 99.99, OFF	OFF
Finish mode	• Defines the detecting format of completion of positioning. *3 One: Outputs FIN signal when either one of the operating axes completes positioning, not waiting for completion of other axis. All : Outputs FIN signal when all axes complete positioning.	—	ONE, ALL	ALL
Fin control	• Setting of [FIN] output. ON : Outputs [FIN] signal. OFF: Does not output [FIN] signal.	—	OFF, ON	OFF
Fin out time	• Sets time length for [FIN] output is being on. (FIN spec.) OFF : Hold [FIN] outputs till next motion.	s	0.0 ~ 99.99, OFF	0.1

Note: Detecting sequence is the same in ONE or All format setting in the single axis system.

*1. The speed denotes the speed of the slider for the single axis system and the resultant speed for the multi-axis combination.

*2. For a multi-axis combination, set these parameters to all axes to which the type of module main unit is set including an axis in another unit number. The parameters won't be indicated for an axis to which the type of module main unit is not set.

*3. Refer to "17.5.3. Output of In-position" for completion of positioning.

9.3.1.2. Travel Speed in Programmed Operation

- The travel speed in the programmed operation follows the setting of "Locus speed" parameter unless it is not stated specially in a program.
- Use SPD command to specify travel speed in a program. Setting travel speed in the motion command is possible. SPD command is effective until other SPD command in the same program is input latter. The speed set in the motion command is only effective for execution of the motion.
- When the MOV command without a linear interpolation is set to the multi-axis combination, each axis travels in the speed set in "Locus speed"

  Note: Refer to "15.2.7.3. Program Command" for SPD and MOV commands.
- The maximum speed varies according to the module main unit.
  Refer to "19.1.2. Specifications."
- The "Max speed" may be set to 0.1 mm/s. However, it will be impossible to have smooth operation due to excessive velocity ripple caused by friction, etc.

Table 9-4: Velocity ripple (Reference only.)

Motor rotational speed	Velocity ripple (reference only)
Maximum speed*	1 %
Maximum speed* × 0.10	5 %
Maximum speed* × 0.01	30 %

* 1200 mm/s when ball screw lead is 20 mm.

9.3.1.3. Acceleration / Deceleration in Programmed Operation

- The Acceleration and the deceleration in the programmed operation follow the setting of "Locus accel" parameter unless it is not stated specially in a program.
- Use SPD command to specify acceleration/deceleration in a program.
  Setting acceleration/deceleration in the motion command is possible. SPD command is effective until other SPD command in the same program is input latter. Acceleration/deceleration set in the motion command is only effective for execution of its motion.
- When the MOV command without a linear interpolation is set to the multi-axis combination, each axis accelerates or decelerates in the acceleration / deceleration set in "Locus accel."

  Note: Refer to "15.2.7.3. Program Command" for SPD and MOV commands.
- Excessive acceleration and deceleration may cause overshoot or vibration, if the load mass is too large or a combination type of the main units is not sufficiently rigid for an application. Do not set excessive acceleration and deceleration. For rigidity of the main unit, refer to "9.1.3. Precautions against Using Module Main Unit."

  Caution : If excessive acceleration/deceleration is specified to some combination of main units, it induces excessive moment load to the main units which is more than their moment strength limit and consequently, it may damage the main units. Refer to "19.1.3. Precautions against Using Module Main Unit."

9.3.1.4. Parameter Setting Procedure: Programmed Operation

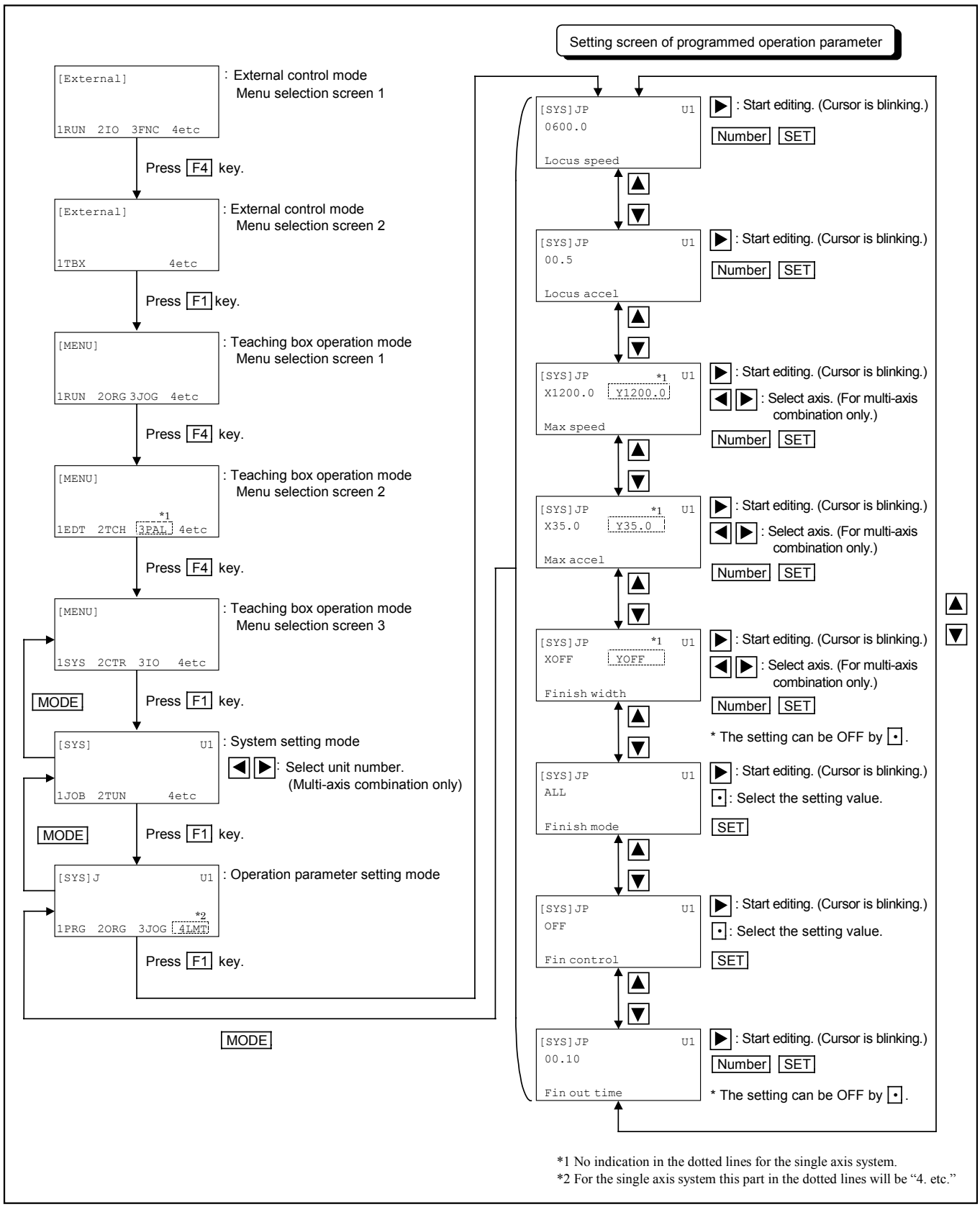
- Set the mode to the system setting mode referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to the programmed operation parameter setting screen as described hereinafter.

  System setting mode [SYS] → Operation parameter [JOB] → Programmed operation [PRG]

  The parameter setting may start from "Locus speed," then follow one after another/
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start editing.
- Use ◀, ▶, ▲ and ▼ keys to move the cursor when editing the program and selecting an axis in multi-axis combination.
- Use ◀ and ▶ keys to scroll the cursor for editing.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key word. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- For a multi-axis combination, you may select a unit number using ◀ and ▶ keys in the screen of system setting mode. It requires to set the unit number besides U1 to set the parameters for the unit other than U1. Refer to "9.5. Parameters for Unit Setting" to set the unit number.

  Caution : After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."

Figure 9-4: Parameter Setting Procedure: Programmed Operation



*1 No indication in the dotted lines for the single axis system.
*2 For the single axis system this part in the dotted lines will be "4. etc."

9.3.2. Parameters for Home Return Operation

9.3.2.1. Parameter List

Table 9-5: List of parameter for home return operation

Parameter	Description	Unit	Setting range	Factory set
Home speed	• Specifies the speed of main unit in the home return operation. ◊ To Home position of absolute encoder. ◊ To offset point by "Home shift." ◊ To set position by "Home move."	mm/s	0.1 ~ 50.0	20.0
Home accel	• Specifies the maximum acceleration / deceleration of a main unit in the home return operation.	m/s^2	0.1 ~ 35.0	0.5
Home search speed	• Specifies searching speed of position of mechanical stopper in the home return operation.	mm/s	0.1 ~ 10.0	1.0
Home direction *1	• Specifies direction of the home return NRM : Motor side REV : Opposite to the motor	–	NRM, REV	NRM
Home sequence *1 *2	• Specifies a sequential order for home return of each axis unit. An axis unit with lower number has the priority. Home return starts simultaneously when the axis number is the same.	–	0 (fixed)	0
Home shift	• Specifies offset distance of Home position. • After moving the offset distance from the Zero point, it completes the home return.	mm	0 ~ ±9999.99	0
Home move *1	• Specifies the stand-by position after completion of the home return. • When the parameter is set to on, a slider moves to the stand-by position after completion of the home return.	mm	0 ~ ±9999.99	0
Home move mode	• Specifies the moving mode described above after the home return is completed. NOP : Do not move to the stand-by position ABS : Move to the stand-by position, of which coordinates are recognized as absolute position. INC : (Reserved) When INC is set, it functions same as ABS.	–	NOP, ABS, INC	NOP
Home unit seq. *2	• Specifies the home return sequential order of the units. A smaller number unit has the priority If the units have the same number, they start simultaneously.	–	0 (fixed)	0

*1. For a multi-axis combination, set these parameters to all axis units to which the type of module main unit is specified including an axis of another unit number. The parameters won't be indicated for an axis unit to which the type of module main unit is not specified.

*2. This parameter is not necessary for the single axis system.

Caution : *Over-travel limit sensors are not provided to the robot module. Therefore, the slider reaches to a mechanical stopper position when executing Home return.*

9.3.2.2. Setting Procedure of Parameter: Home Return

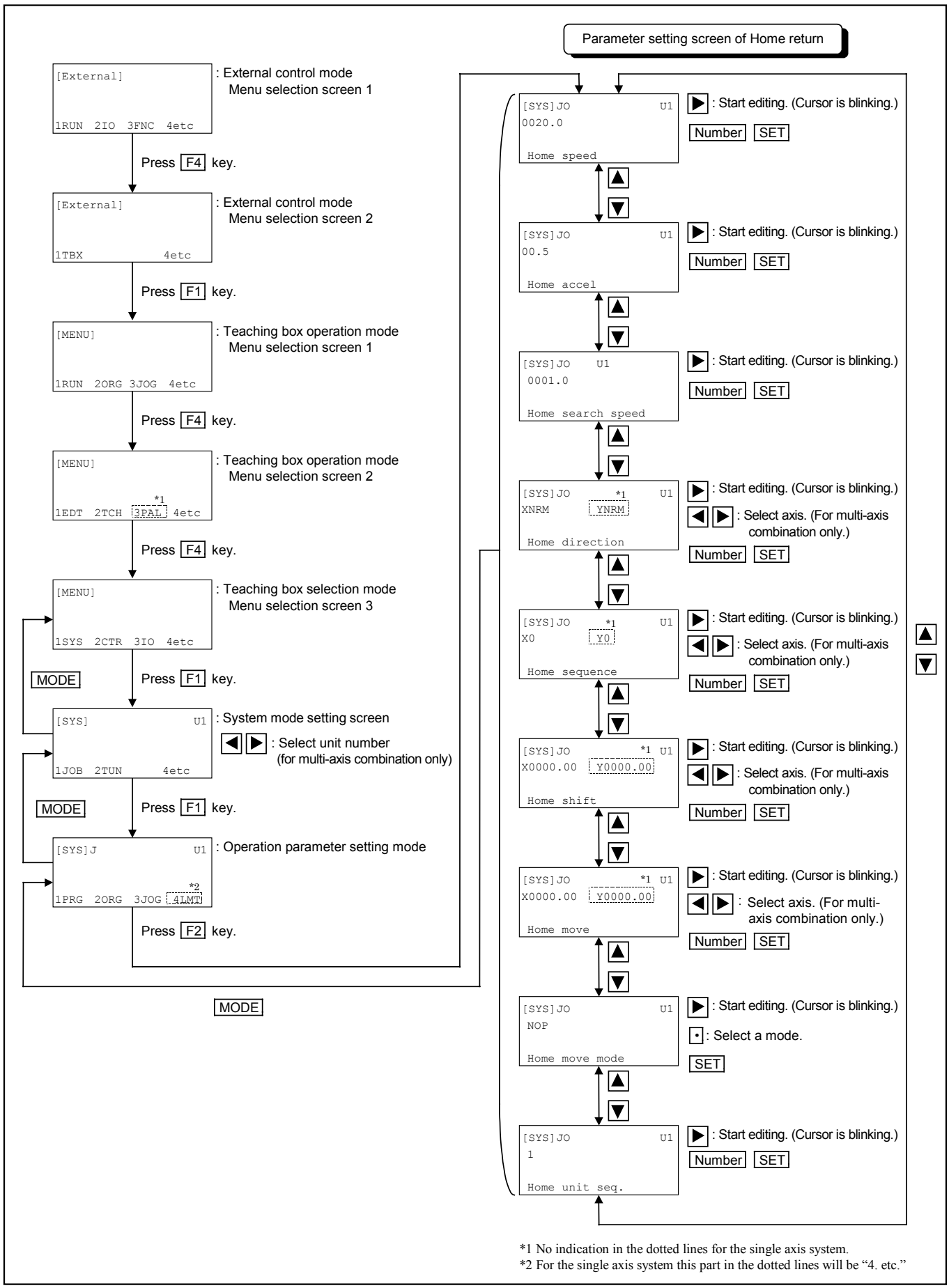
- Set the mode to the system setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to the home return operation parameter setting screen as shown below.

  System setting mode [SYS] → Operation parameter [JOB] → Home return operation [ORG]

  The parameter setting may start from "Home speed," then foolow one after another.
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use ◀, ▶, ▲ and ▼ keys to move the cursor when editing the program and selecting an axis in multi-axis combination.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key word. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- For a multi-axis combination, you may select a unit number using ◀ and ▶ keys in the screen of system setting mode. It requires to set the unit number besides U1 to set the parameters for the unit. Refer to "9.5. Parameters for Unit Setting" to set the unit number.

  Caution *: After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."*

Figure 9-5: Parameter Setting Procedure: Home Return



*1 No indication in the dotted lines for the single axis system.
*2 For the single axis system this part in the dotted lines will be "4. etc."

9.3.3. Parameters for Jog Operation

9.3.3.1. Parameter List

Table 9-6: Parameter list of jog operation

Parameter	Description	Unit	Setting range	Factory set
Jog speed (H)	• The speed of an axis is set when HIGH key and Jog key are pressed simultaneously under the jog operation.	mm/s	0.1 ~ 250.0	100.0
Jog speed (L)	• Specifies speed of each main unit in Jog operation.	mm/s	0.1 ~ 250.0	50.0
Jog accel	• Specifies acceleration / deceleration of each main unit in the jog operation.	m/s^2	0.1 ~ 35.0	0.5

9.3.3.2. Parameter Setting Procedure: Jog Operation

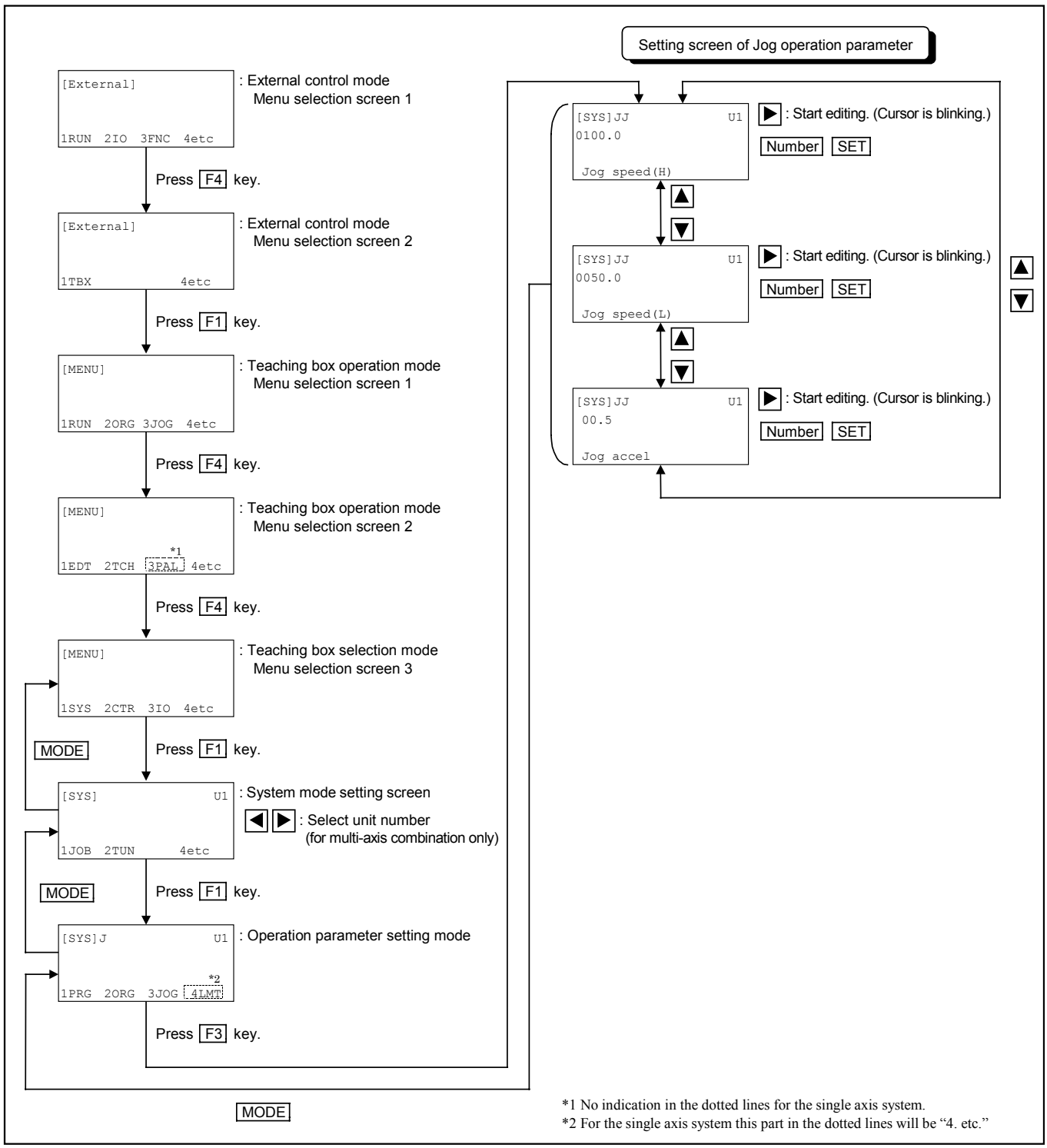
- Set the mode to the system setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to Jog operation parameter setting screen as shown below.

  System setting mode [SYS] → Operation parameter [JOB] → Jog operation [JOG]

  The parameter setting may start from "Jog speed (H)," then follow one after another.
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use ◀, ▶, ▲ and ▼ keys to move the cursor when editing the program and selecting an axis in multi-axis combination.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key word. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- For a multi-axis combination, you may select a unit number using ◀ and ▶ keys in the screen of system setting mode. It requires to set the unit number besides U1 to set the parameters for the unit. Refer to "9.5. Parameters for Unit Setting" to set the unit number.

  Caution : *After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."*

Figure 9-6: Parameter setting procedure: Jog operation



*1 No indication in the dotted lines for the single axis system.
*2 For the single axis system this part in the dotted lines will be "4. etc."

9.3.4. Parameters for Position and Coordinates

9.3.4.1. Parameter List

Table 9-7: Parameter List of position and coordinates

Parameter	Description	Unit	Setting range	Shipping set
Over travel (+) *1	• This is to set the detecting position of software over travel limit in positive (+) direction.	mm	-9999.99 ~ 9999.99, OFF	OFF
Over travel (-) *1	• This is to set the detecting position of software over travel limit in negative (-) direction.	mm	-9999.99 ~ 9999.99, OFF	OFF
Escape (upr.Z) *2	• This is to set the upper limit of off-limits area for the Z axis. • This is to specify the operating area of the Arch-motion using a Z axis unit.	mm	-9999.99 ~ 9999.99	0
Escape (lwr.Z) *2	• This is to set the lower limit of off-limits area for the Z axis. • This is to specify the operating area of the Arch-motion using a Z axis unit.	mm	-9999.99 ~ 9999.99	0
Escape (pos.Z) *2	• Specifies the turnout position of the Z axis. • This is to specify the operating area of the Arch-motion using a Z axis unit.	mm	-9999.99 ~ 9999.99, OFF	OFF
Escape (upr.R) *2	• Reserved	–	–	–
Escape (lwr.R) *2	• Reserved	–	–	–
Escape (pos.R) *2	• Reserved	–	–	–

*1 Set to all axes to which the module type are specified in a multi-axis combination (including axes in different unit numbers.) The parameters for an axis unit of which module type is not set won't be indicated.

*2 These parameters do not function and are not indicated for a single axis system.

Caution : *Software over-travel limit is valid after completion of the home return. Be sure to execute the home return when the software over-travel limit is newly set, or changed.*

9.3.4.2. Parameter Setting Procedure: Position and Coordinates

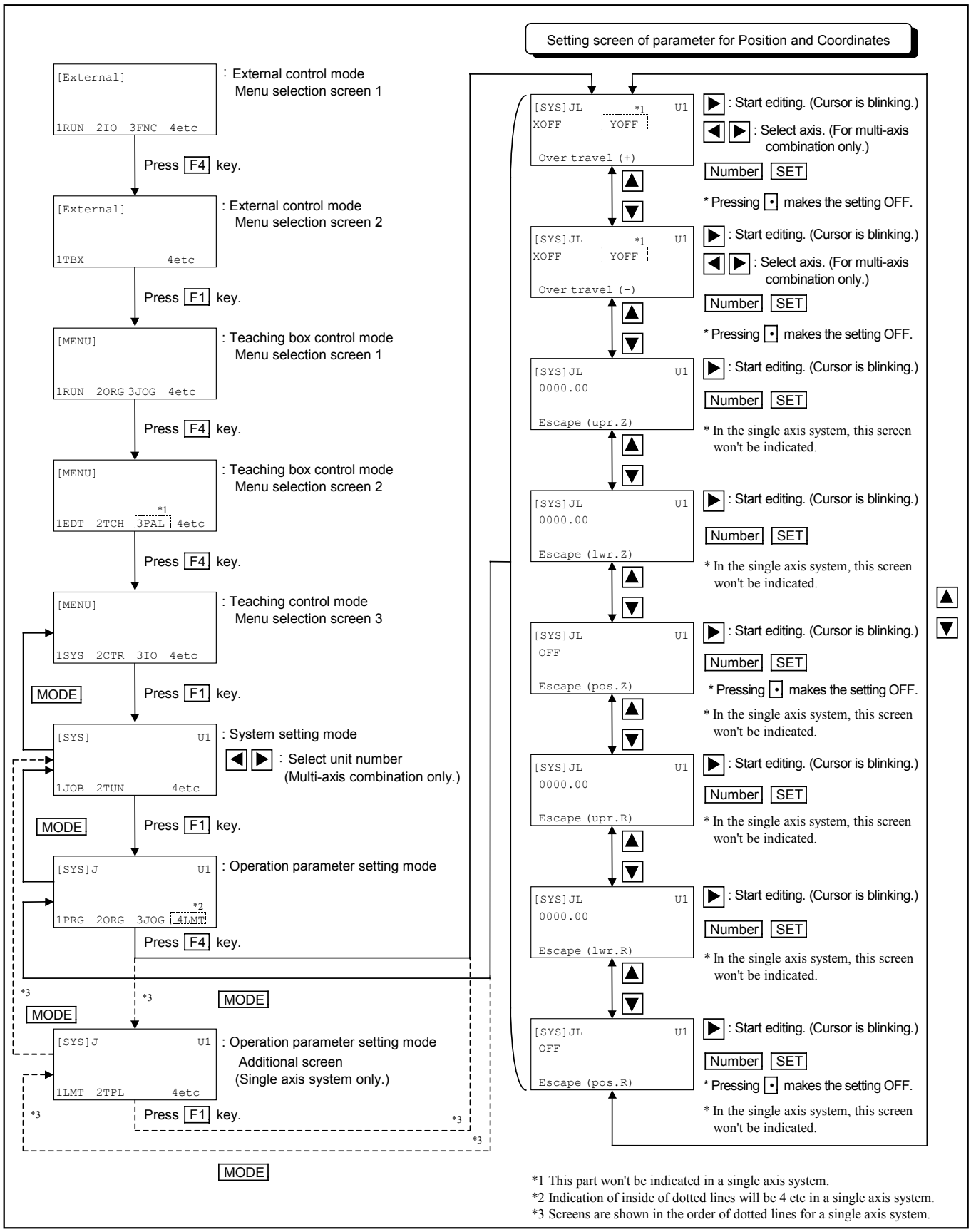
- Set the mode to the system setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to the position and coordinates parameter setting screen as shown below.

  System setting mode [SYS] → Operation parameter [JOB] → Position and coordinates [LMT]

  The parameter setting may start from "Over travel (+)," then follow one after another.
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use ◀, ▶, ▲ and ▼ keys to move the cursor when editing the program and selecting an axis in multi-axis combination.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key word. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- For a multi-axis combination, you may select a unit number using ◀ and ▶ keys in the screen of system setting mode. It requires to set the unit number besides U1 to set the parameters for the unit. Refer to "9.5. Parameters for Unit Setting" to set the unit number.

  Caution : After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."

Figure 9-7: Parameter setting procedure: Position and coordinates



9.3.5. Parameters for Pulse Train Input (Single Axis System Only)

9.3.5.1. Parameter List

Table 9-8: Parameter list of pulse train input

Parameter	Description	Unit	Setting range	Shipping set
Pulse resolution	Sets resolution of pulse train input. • 1 ~ 10 Parameter sets a multiplying factor to pulse train input. The resolution will be 0.01 mm × data. • 0 The pulse train input is invalid. • -1 The resolution is obtained by a formula below. $\frac{\text{Ball screw lead}}{\text{Encoder resolution}} \times$ speed reduction ratio [mm] * Refer to " Table 19-1. Description code" for an adoption of speed reduction.	–	-1～10	1

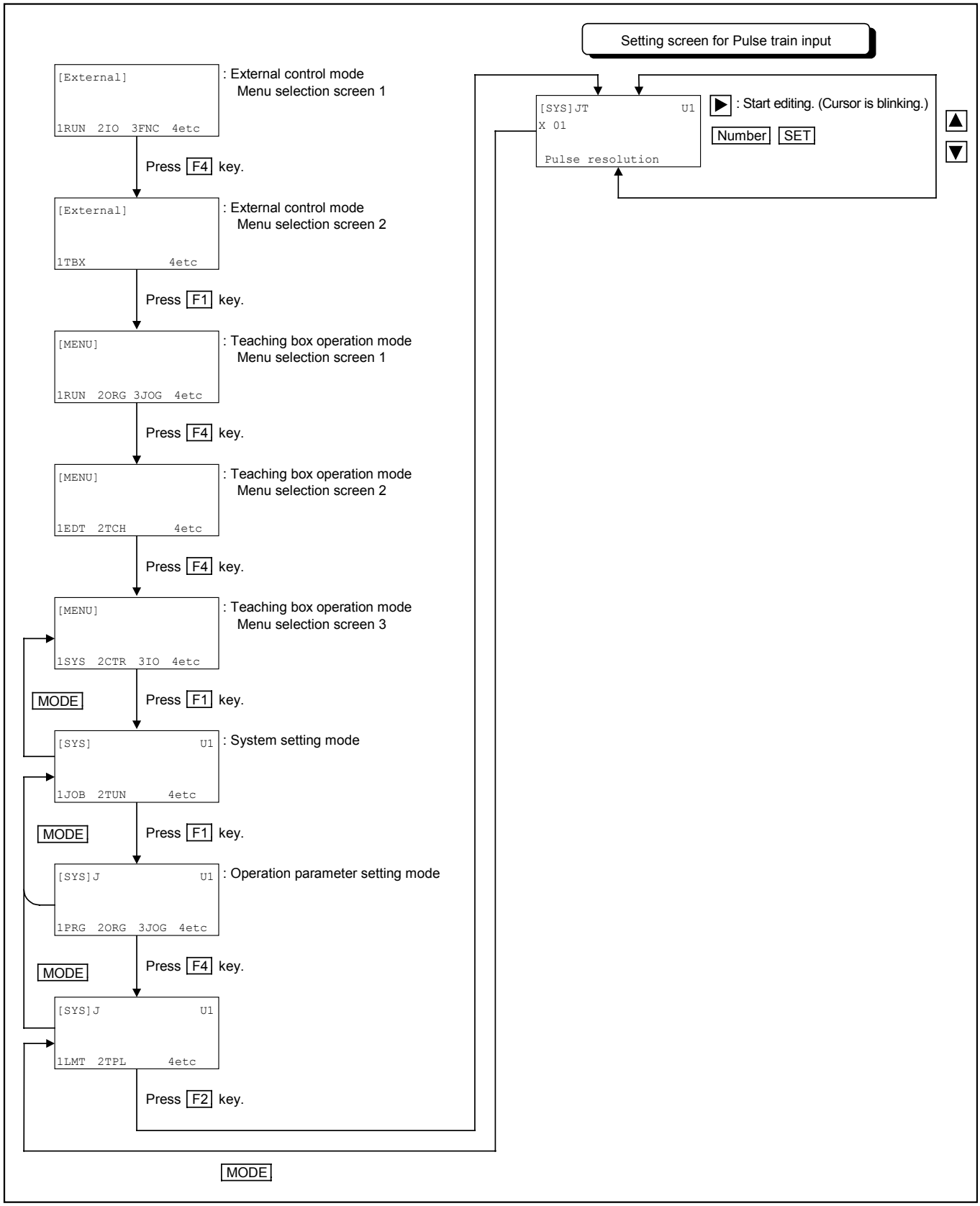
9.3.5.2. Setting Procedure for Pulse Train Input

- Set the mode to the system setting mode referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to Pulse train input screen [TPL].

  System setting [SYS] → Operation parameter [JOB] → Pulse train input [TPL]
- Use ▶ key to start the editing.
- Use ◀ and ▶ keys to move the cursor.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- In each display screen, pressing MODE key makes the screen to go one step back.

Caution : *After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."*

Figure 9-8: Parameter setting procedure : Pulse train input



9.4. Servo Parameters

- These are tuning parameters of EXEA controller such as "servo gain" and "filters."
- Be sure to check around the robot system for safety, then perform tuning or adjusting work of the system. Setting improper gain to the system may result in hunting (large vibration). Thus, take a great care for tuning the robot module system.
- There are four kinds of servo parameters
  - ◊ Motor control
  - ◊ Filter
  - ◊ Manual tuning
  - ◊ Function setting
- Tuning is greatly affected by setting of acceleration and deceleration as well as the servo parameters. Do not set excessive acceleration and deceleration.

Danger *: Tighten the fixing bolts of module main units.*

◊ Loose bolts may cause a serious accident.

Danger *: Do not allow any personnel in the robot operation area while tuning the system.*

◊ Never enter the robot operation area. Put the guard fence to prevent from the entry when the robot is operating.

Warning *: Confirm that there is no disconnected cables, insufficient connection of connectors and miss-connection of cables to wrong axis.*

◊ If the cables are connected improperly, the system fails to demonstrate its full performance. The controller or motors may become defective.

Caution *: Check for interference of each axis when the axis makes its full stroke.*

◊ Mechanical interference may damage the robot, end effector and the ancillaries.

9.4.1. Parameters for Servo

9.4.1.1. Parameter List

- The servo parameters have been set to the values for the normal use before shipment. However, be sure to set the actual load mass (Payload) of each module main unit.
- For a multi-axis combination set the servo parameters to respective axes of all units to which the module type is assigned. Parameters won't be indicated for axis units to which the module type is not set.

Table 9-9: Parameter list of servo

Classification	Parameter	Description	Unit	Setting range	Shipping set
SRV	Payload	• Specifies load mass to be applied to an axis unit. • For multi-axis combination add all mass of main units and combining brackets to be applied to a slider of all units other than the one to which the work or end effector is attached.	kg	0 ~ 200.0	5.0
	Servo Gain	• Reserved. (Do not use.) • Do not set any value other than OFF.	Hz	OFF	OFF
	Feedforward Gain	• Specifies feed forward gain. • This is to improve the system ability of command tracking. However, setting excessive gain likely causes overshoot or vibration. • In normal operation, it shall be set to OFF.	%	0 ~ 100, OFF	OFF
	Torque Limit	• Stets the limit of output torque.	%	1 ~ 100, OFF	OFF
	Dead Band	• Specifies dead band.	pulse	1 ~ 100, OFF	OFF

9.4.1.2. Parameter Setting Procedure: Servo Parameters

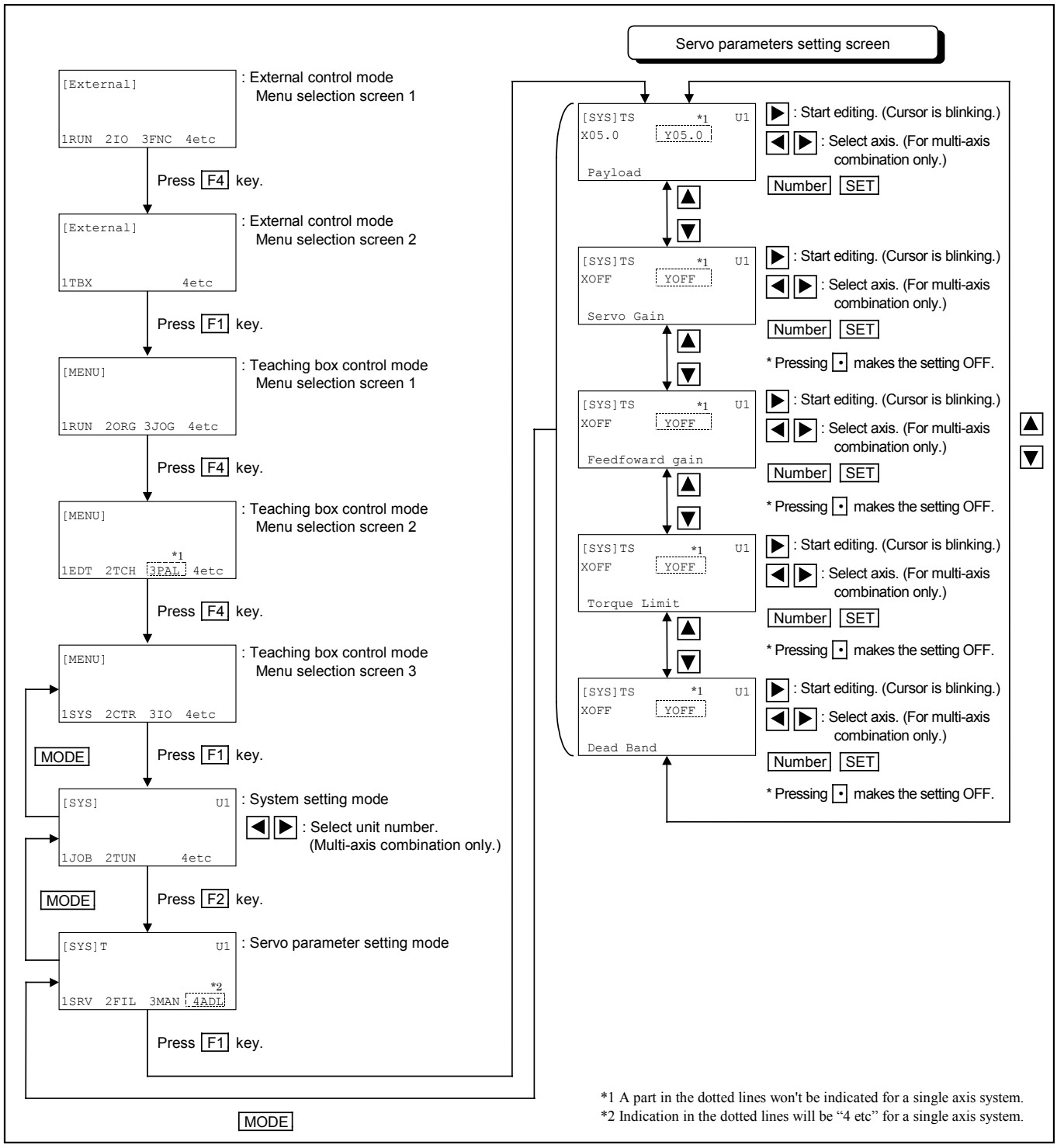
- Set the mode to the system setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to Servo [SRV] setting screen as shown below.

  System setting mode [SYS] → Servo parameter [TUN] → Servo [SRV]

- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use ◀ and ▶ keys to scroll the cursor for editing.
- Use ◀, ▶, ▲ and ▼ keys to move the cursor to edit or select an axis of multi-axis combination.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key words. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- In the system setting screen use ◀ and ▶ keys to select a unit number. Prior to set the parameters of each unit other than U1, it is necessary to specify unit number using "parameters related to unit." Refer to "9.5. Parameters for Unit Setting."

Caution : *After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."*

Figure 9-9: Parameter setting procedure: Servo



9.4.2. Parameters for Filter

- When the noise and vibration are large, yet the system is operating smoothly, setting adequate filter (FIL) may improve noise and vibration without affecting other Servo parameters (without worsening positioning performance).

  1) Low pass filter (Low pass filter 1, 2)

     Controls the frequency band over the set value. It has primary low pass characteristics.

  2) Notch filter

     Controls the frequency band in the proximity of set value. Range of frequency band can be varied by changing Q of notch filter (Notch Filter Q1).

Caution : *Vibration is likely to occur when filters are set in multi-steps. As the secondary low pass filter is set as shipping set, user shall set either one of primary low pass filter or notch filter. Do not set excessively low frequency because it may lead to hunching.*

9.4.2.1. Parameter List

Table 9-10: Parameter list : Filter

Abbreviation	Parameter	Description	Unit	Setting range	Shipping set
FIL	Low Pass Filter 1	• Sets the primary low pass filter frequency.	Hz	10 ~ 500, OFF	OFF
	Low Pass Filter 2	• Sets the secondary low pass filter frequency.	Hz	10 ~ 500, OFF	30
	Notch Filter	• Sets Notch filter cut-off frequency.	Hz	10 ~ 500, OFF	OFF

* For a multi-axis combination set the servo parameters to respective axes of all units to which the module type is assigned. Parameters won't be indicated for axis units to which the module type is not set.

9.4.2.2. Parameter Setting Procedure: Filter

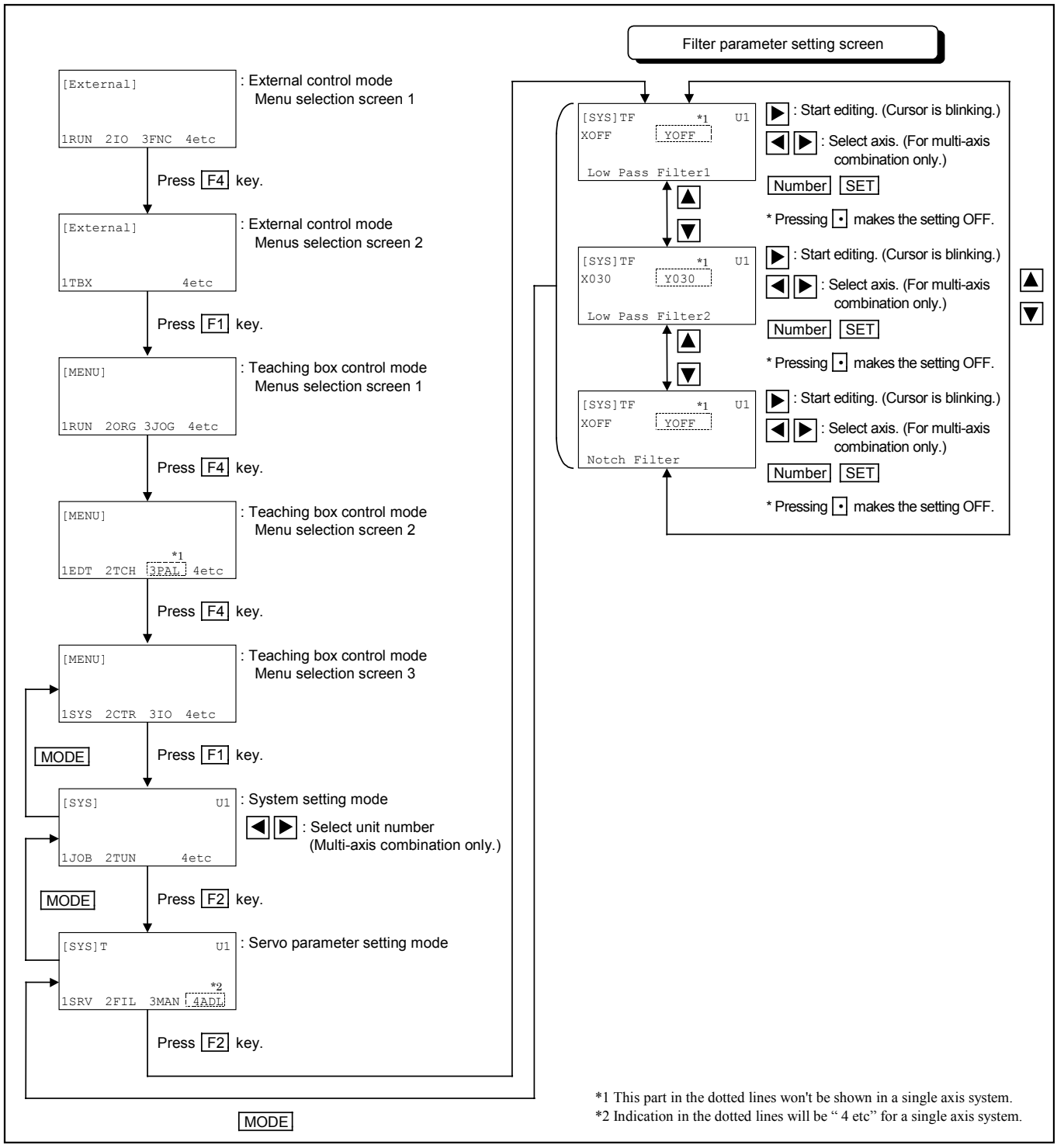
- Set the mode to the system setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to Filter [FIL] setting screen as shown below.

  System setting mode [SYS] → Servo parameter [TUN] → Filter [FIL]

- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use ◀, ▶, ▲ and ▼ keys to move the cursor to edit or select an axis of multi-axis combination.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key words. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- In the system setting screen use ◀ and ▶ keys to select a unit number. Prior to set the parameters of each unit other than U1, it is necessary to specify unit number using "parameters related to unit." Refer to "9.5. Parameters for Unit Setting."

Caution : *After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."*

Figure 9-10: Parameter setting procedure: Filter



9.4.3. Parameters for Manual Tuning

- When motion of the robot is not smooth due to unmatched factory setting of the servo parameters other than an applied load mass (Payload), the manual tuning parameter (MAN) may be adjusted as described hereunder.
  As it is dangerous to perform the tuning under high speed or acceleration, set them to low value to begin with.

  1) Adjusting Velocity Loop Gain

     Set it higher as possible until the robot starts vibration and/or overshooting. It improves rigidity of Servo and command tracking ability as well as overshooting.

  2) Adjusting Observer Gain

     Set it higher as possible just before vibration or overshooting is observed. It improves overshooting and settling, and consequently, shorten the time for positioning. It is effective to improve convergence against external disturbance.

  3) Adjusting Position Loop Gain

     Set it higher as possible until the robot starts vibration and/or overshooting. Criterion is a quarter of Velocity Loop Gain. This is to shorten the positioning time.

9.4.3.1. Parameter List

Table 9-11: Parameter List: Manual tuning

Classification	Parameter	Description	Unit	Setting range	Shipping set
MAN	Gain mode	• Sets the mode to adjust Servo gain. • Setting to MANU makes the following parameters effective. Do not set other than MANU.	–	AUTO, MANU	MANU
	Position Loop Gain	• Sets Position Loop Gain. • Shorten the positioning time. However vibration and overshooting are likely observed if it is set too high. • Set it approximately a quarter of Velocity Loop Gain.	Hz	1.0 ~ 100.0	5.0
	Velocity Loop Gain	• Sets Velocity Loop Gain. • It improves Servo stiffness and command tracking as well as overshooting. • When heavy work or low stiffness work is attached to the slider, resonance is likely observed. Do not set too much gain.	Hz	1.0 ~ 500.0	20.0
	Observer Gain	• Sets Observer Gain. • It improves overshooting and settling as well as convergence against external disturbance. • When the gain is set too high, high overshooting and vibration will be induced.	Hz	1.0 ~ 150.0	10.0
	Observer Limit	• Sets Observer Gain output limit. • This might be an effective way to improve overshooting without lowering Observer Gain. However, set it OFF normally.	%	0.1 ~ 100.0, OFF	OFF
	Notch Filter Q1	• Sets shape of notch filter. • When it is set too high, frequency range which are cut by notch filter gets steeper. Set to 1.00 normally.	–	0.10 ~ 5.00	1.00

* For a multi-axis combination, set the servo parameters to respective axes of all units to which the module type is assigned. Parameters won't be indicated for axis units to which the module type is not set.

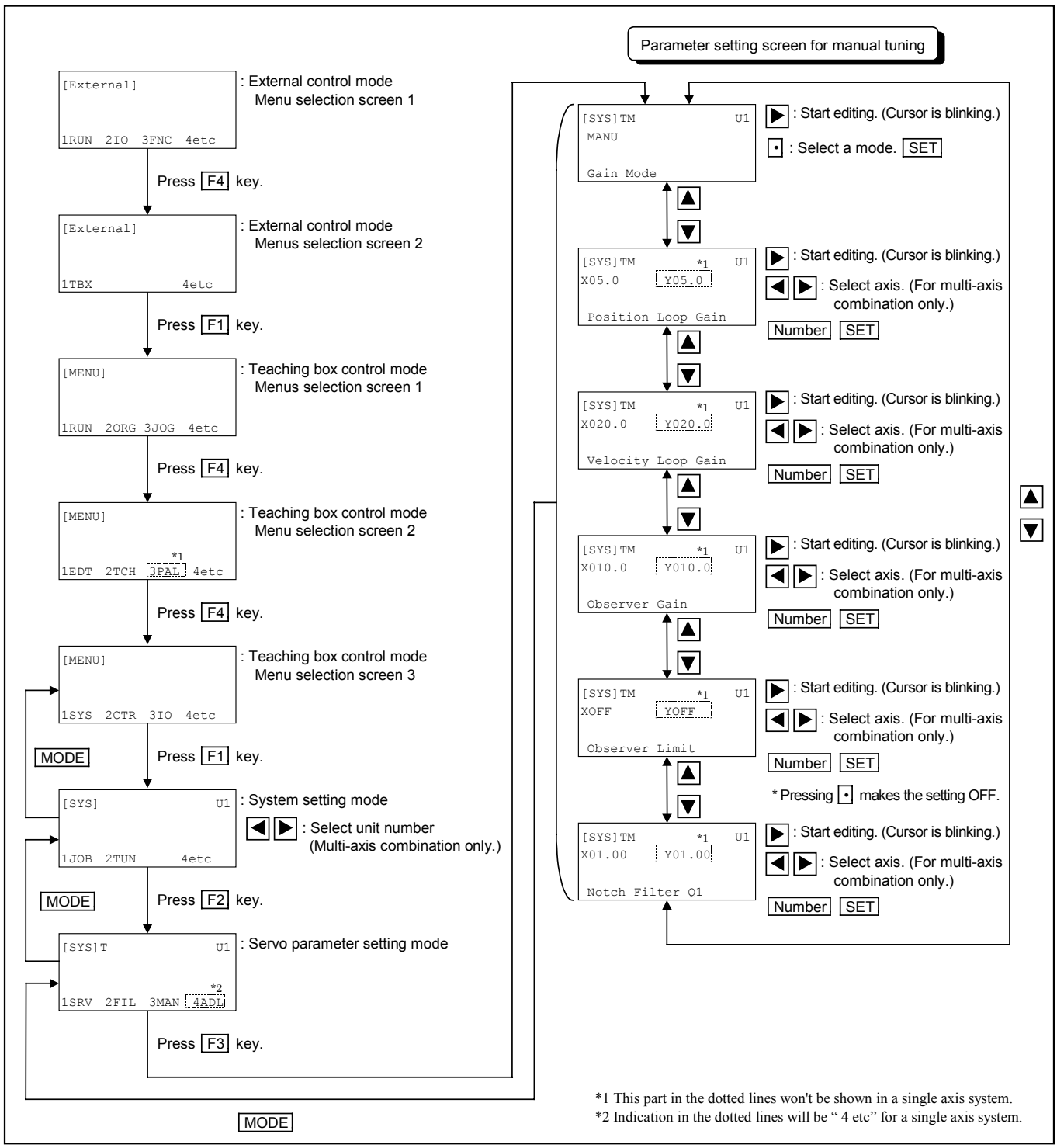
9.4.3.2. Parameter Setting Procedure: Manual Tuning

- Set the mode to the system setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to Manual tuning [MAN] setting screen as shown below.

  System setting mode [SYS] → Servo parameter [TUN] → Manual tuning [MAN]
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use ◀, ▶, ▲ and ▼ keys to move the cursor to edit or select an axis of multi-axis combination.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key words. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- In the system setting screen use ◀ and ▶ keys to select a unit number. Prior to set the parameters of each unit other than U1, it is necessary to specify unit number using "parameters related to unit." Refer to "9.5. Parameters for Unit Setting."

  Caution : After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."

Figure 9-11: Parameter setting procedure: Manual tuning



9.4.4. Parameters for Function Setting

9.4.4.1. Parameter List

Table 9-12: Parameter List: Function Setting

Classification	Parameter	Description	Unit	Setting range	Shipping set
ADL	Position direction	• This is to set direction of the coordinate. • Positive side (+) of the coordinate is opposing to the motor when NRM is set, while it is negative side (-) when REV is set.	–	NRM, REV	NRM
	Hard. OT Timer	• This sets the time to arise over travel alarm after the limit is activated in normal operation. This parameter shall be set when the over travel alarm (F3: mechanical lock) arises frequently because of load condition in which the motor duty exceeds its rated power, or because of external load being applied to the slider. • Criterion of the time may be 50% of the setting in millisecond. • Set to AUTO normally as the motor may overheat under these condition.	–	200 ~ 30000, AUTO	AUTO
	Rated current	• This is to set converting rate of the motor rated current. (Do not change.)	%	0 ~ 100	43
	Over Load	• This parameter sets the criterion of electrical power for detecting level of overloaded motor alarm. (Do not change.)	–	1 ~ 1000, OFF	20
	Position error over	• Sets number of pulses for the criterion of excessive position error alarm. • Refer to "11.3.5. Detection of Excessive Position Error" for the excessive position error.	pulse	0 ~ 30000	30000

* For multi-axis combination, set to all axes of all units to which the type of module main unit is set respectively. These parameters won't be indicated for an axis to which the type of module main unit is not set.

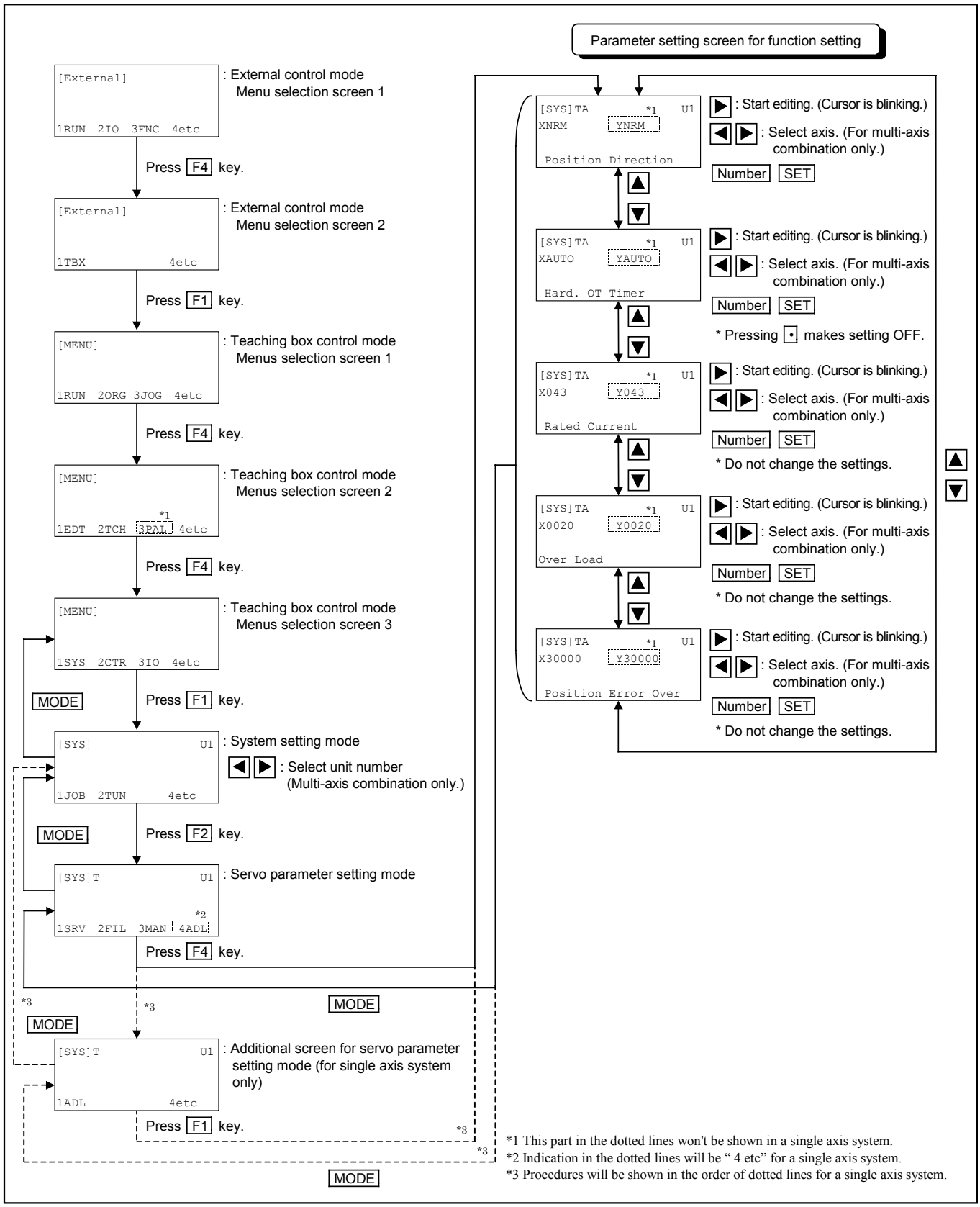
9.4.4.2. Parameter Setting Procedure: Function Setting

- Set the mode to the system setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to Function setting [ADL] screen as shown below.

  System setting mode [SYS] → Servo parameter [TUN] → Function setting [ADL]
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use ◀, ▶, ▲ and ▼ keys to move the cursor to edit or select an axis of multi-axis combination.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key words. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- In the system setting screen use ◀ and ▶ keys to select a unit number. Prior to set the parameters of each unit other than U1, it is necessary to specify unit number using "parameters related to unit." Refer to "9.5. Parameters for Unit Setting."

Caution : *After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."*

Figure 9-12: Parameter setting procedure: Function Setting



*1 This part in the dotted lines won't be shown in a single axis system.
*2 Indication in the dotted lines will be " 4 etc" for a single axis system.
*3 Procedures will be shown in the order of dotted lines for a single axis system.

9.5. Parameters for Unit Setting

- This parameter sets the type of module main unit and axis name to respective main units which are to be connected to EXEA controller.

- An operating axis unit will be assigned by the axis name set by the parameter in EXEA controller.

  [Example]

  The example in Figure 9-13 shows a typical setting in which an X axis module main unit (X-Module) is named "X axis."
  The setting indicates that:

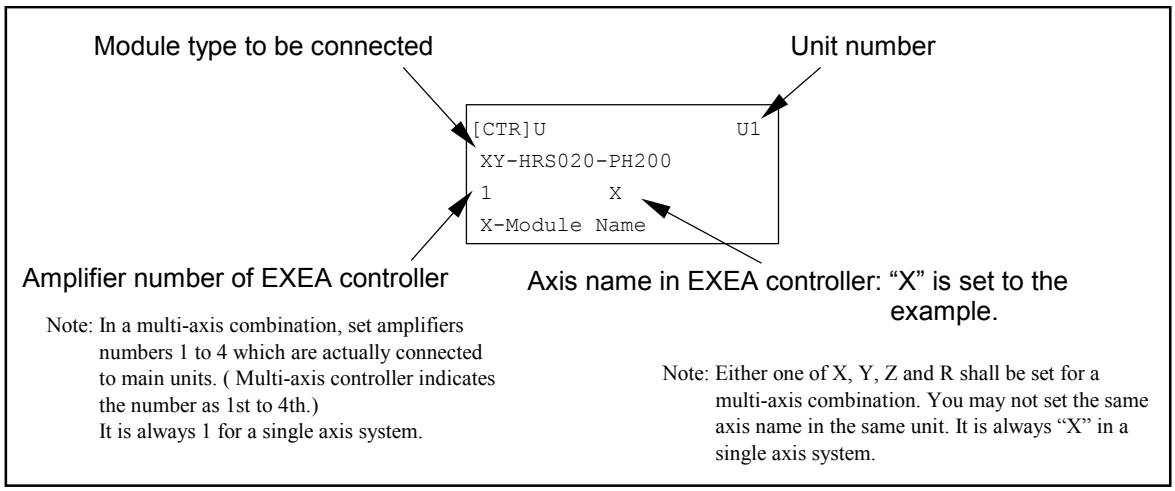
  ◊ Set U1 as a unit number.

  ◊ Axis name is X axis in EXEA controller.
  (EXEA controller indicates and operates the main unit as X axis of Unit 1.
  Initialization and teaching will be done as X axis of Unit 1 as well.)

  ◊ An amplifier to be connected is "1st."

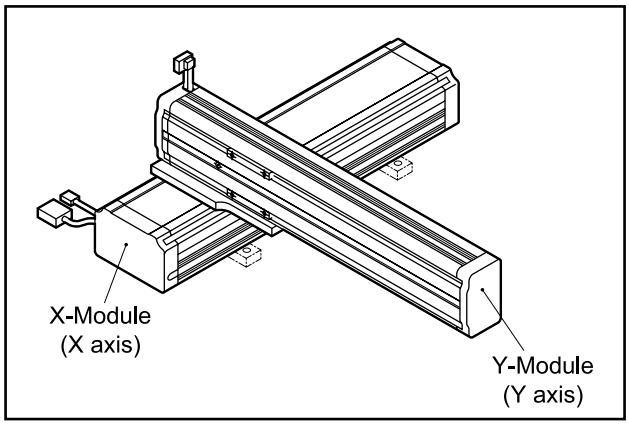
  ◊ Module type is XY-HRS020-PH200.

Figure 9-13



- It shall be basically treated in the order of X (X-Module) to Y (Y-Module) from a base axis main unit to upper one.

  [Example] G-HM combination

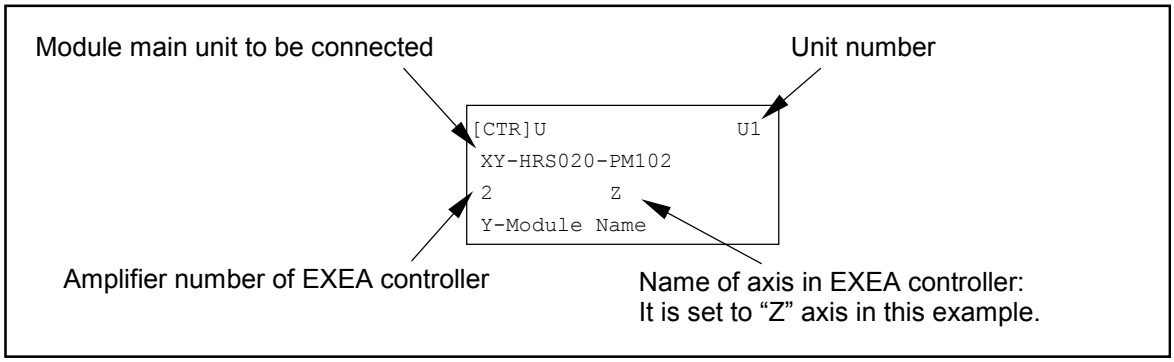


- Unit is a group to be assigned to respective main units.
  Grouping is meaningless for a normal two axes EXEA controller. The grouping to a Unit is useful to operate two of two axes combination systems simultaneously (parallel processing) by a two axes controller in multitask operation. You may program the same operation for both X axes and execute it to X axis of Unit1 and X axis of Unit2.

- You can name the second axis "Z" in two axes combination. (When first axis is named "X" it will be indicated as X-Z combination and initializing or teaching may be performed under this name.)

  Caution : *Arch motion cannot be performed if an axis name of "Z" is not set. Be sure to set Z axis to the one which moves to turnout position in arch motion operation.*

Figure 9-14: Example when second axis is set to Z



9.5.1. Parameter List

- Be sure to set Module Name always according to a module main unit to be used.
- Module Name USR1 to USR 8: These types shall be set for a specific module main unit. (Reserved.) Refer to "9.6. Parameters for Setting Module Type."
- Refer to Tables 9-14 and 9-15 for specifications of a module main unit.

Table 9-13: Parameter list: Unit setting

Parameter	Description	Module type	Factory set
Type	• Reserved. • Set to OFF normally.	OFF Do not set other than OFF even other setting is indicated.	OFF
X-Module Name	• Input a type of module main unit for X axis. *1	USR1～USR8, *2 XY-HRS□□□-PH200, XY-HRS□□□-PM200, XY-HRS□□□-PH102, XY-HRS□□□-PM102, XY-HRS□□□-PH100, XY-HRS□□□-PM100, XY-HRS□□□-PH212, XY-HRS□□□-PM212, XY-HRS□□□-RH200, XY-HRS□□□-RH102, XY-HRS□□□-RH202, XY-HRS□□□-RH204, XY-HRS□□□-RH208, XY-HRS□□□-RH405, XY-HRS□□□-RH409, XY-HRS□□□-RH207, XY-HRS□□□-RH211, XY-HRS□□□-RH206, XY-HRS□□□-RH210, XY-HRS□□□-RH407, XY-HRS□□□-RH411, XY-HRS□□□-RM200, XY-HRS□□□-RM204, XY-HRS□□□-RM208, XY-HRS□□□-RM405, XY-HRS□□□-RM409, XY-HRS□□□-RM134, XY-HRS□□□-RM234, XY-HRS□□□-RM238, XY-HRS□□□-RM238, XY-HRS□□□-RM242, XY-HRS□□□-RM239, XY-HRS□□□-RM243, XY-HRS□□□-RM439, XY-HRS□□□-RM443, XY-HRS□□□-RS104, XY-HRS□□□-RS108, XY-HRS□□□-RS204, XY-HRS□□□-RS208, XY-HRS□□□-RS106, XY-HRS□□□-RS110, XY-HRS□□□-RS138, XY-HRS□□□-RS142, OFF	OFF
Y-Module Name *3	• Input a type of module main unit for Y axis. *1	Ditto	OFF
Z-Module Name *3	• Input a type of module main unit for Z axis. *1 (It is not necessary to set for a two axes controller.)	Ditto	–
R-Module Name *3	• Input a type of module main unit for R axis. *1 (It is not necessary to set for a two and three axes controller.)	Ditto	–

*1. 10th digit of indicated module main unit type is always "–." For a clean room specification main unit, whose 10th digit is "C," select the one after "–" is identical.
*2. Only USR1 will be indicated for a two axes controller.
*3. It won't be indicated for a single axis system.

Table 9-14: Specifications for P type module main unit

Reference number		Motor power [W]	Ball screw lead [mm]	Motor mounting direction	Negative actuation motor brake
XY-HRS□□□*-PH	200	200	20	Direct	–
	212		20	Indirect, back mount	–
	100		10	Direct	–
	102		10	Direct	✓
XY-HRS□□□*-PM	200	100	20	Direct	–
	212		20	Indirect, back mount	–
	100		10	Direct	–
	102		10	Direct	✓

Table 9-15: Specifications of R type module main unit

Reference number		Motor power [W]	Ball screw lead [mm]	Motor mounting direction	Negative actuation motor brake
XY-HRS□□□*-RS or XY-HRS□□□*CRS	104	100	10	Indirect, right	–
	108		10	Indirect, left	–
	106		10	Indirect, right	✓
	110		10	Indirect, left	✓
	204		20	Indirect, right	–
	208		20	Indirect, left	–
	138	200	10	Indirect, right	✓
	142		10	Indirect, left	✓
XY-HRS□□□*-RM or XY-HRS□□□*CRM	200	200	20	Direct	–
	204		20	Indirect, right	–
	208		20	Indirect, left	–
	134	400	10	Direct	✓
	234		20	Direct	✓
	238		20	Indirect, right	✓
	242		20	Indirect, left	✓
	239		20 (10) **	Indirect, right	✓
	243		20 (10) **	Indirect, left	✓
	405	200	40 (20)	Indirect, right	–
	409		40 (20)	Indirect, left	–
	439	400	40 (20)	Indirect, right	✓
	443		40 (20)	Indirect, left	✓
XY-HRS□□□*-RH or XY-HRS□□□*CRH	102	400	10	Direct	✓
	200		20	Direct	–
	204		20	Indirect, right	–
	208		20	Indirect, left	–
	207		20 (10) **	Indirect, right	✓
	211		20 (10) **	Indirect, left	✓
	202		20	Direct	✓
	206		20	Indirect, right	✓
	210		20	Indirect, left	✓
	405		40 (20)	Indirect, right	–
	409		40 (20)	Indirect, left	–
	407		40 (20)	Indirect, right	✓
	411		40 (20)	Indirect, left	✓

* □□□ indicate stroke of a main unit.
Example 040: 400 mm

** The ball screw lead in the parentheses is an actual setting as a timing belt is used to reduce the ball screw rotational speed to 1/2.

9.5.2. Parameter Setting Procedure: Unit Setting

- Set the mode to controller setting referring to " 8.2. Selection of Control Mode."
- Refer to " 9.1. Initial Setting Procedure" and scroll the display to Unit setting [UNT] screen as shown below.

  Controller setting mode [CTR] → Unit setting [UNT] → Each parameter setting screen
- Scroll the screen using ▲ and ▼ keys.
- Use ▶ key to start the editing.
- Use ◀, ▶, ▲ and ▼ keys to move the cursor when editing and selecting an axis in multi-axis combination.
- Use 0 ~ 9, CLR and ± keys to set numbers.
- • key is to be used to set or select keywords (OFF etc,).
- Pressing MODE key switches to the screen backward in each display screen.
- The first letter on third line in the unit parameter setting screen in Figure 9-15 indicates number of amplifier to be connected to a main unit. Numbers 1, 2 ---- correspond to respective indications of 1st, 2nd --- on the front panel of EXEA controller. It is set to 1 for a single axis system.

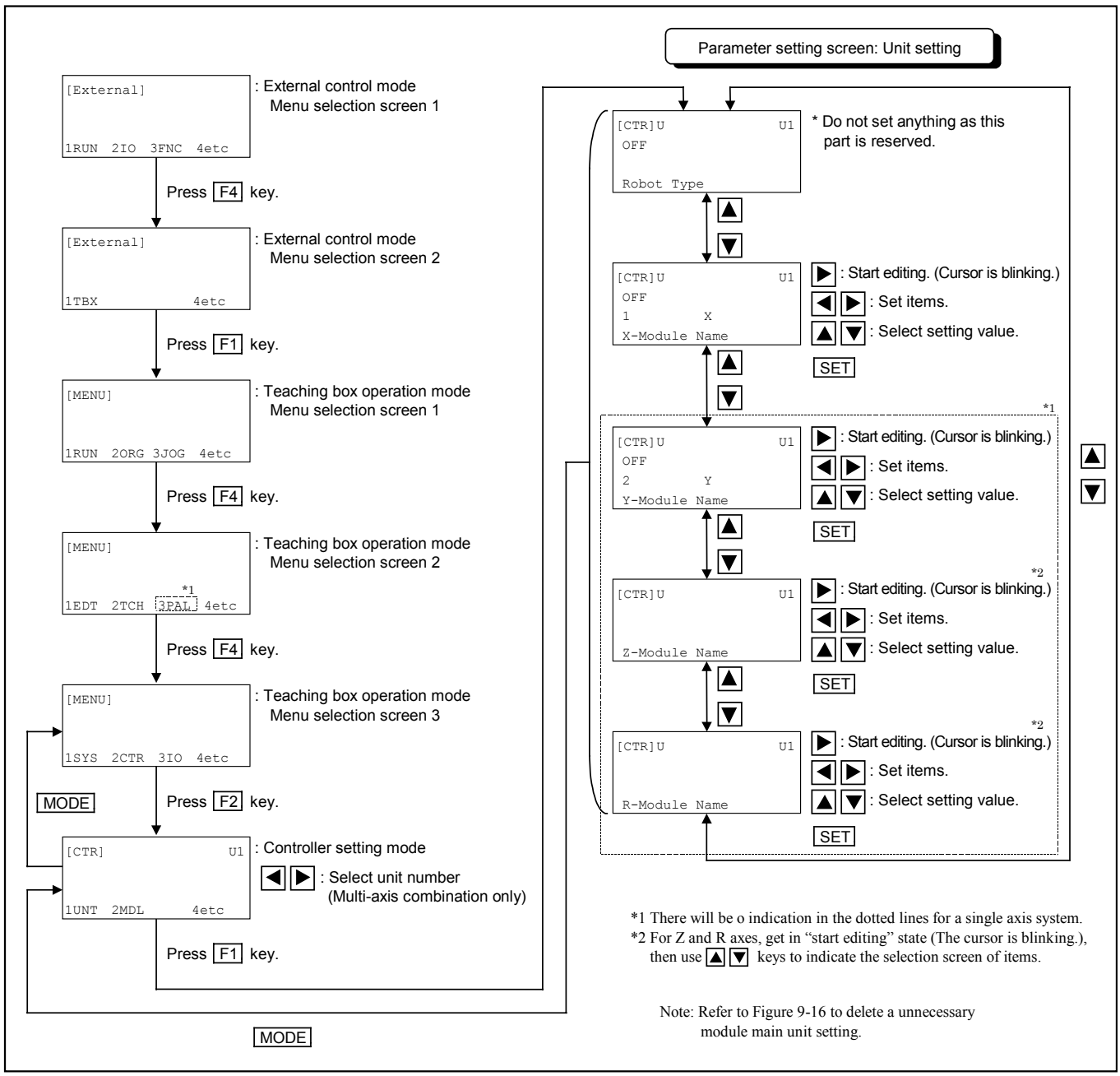
  Caution : Amplifier number 1 and 2 for a 2 axes controller and 1 to 4 for a four axes controller are valid. Amplifier numbers 5 to 8 are not valid. (Reserved)
- Number of amplifier shall be treated as an independent number regardless the unit number U1 to U8. When the same amplifier number is assigned to different unit, the unit of which number is the smallest has precedence, and then the setting to other unit becomes invalid.
  When the same amplifier number is set to different main units in the same unit, the precedence shall be given in the order as shown below.

  X-Module Name → Y-Module Name → Z-Module Name → R-Module Name
- 2nd letters in the 3rd line of parameter setting screen indicates an axis number of each unit. (Refer to Figure 9-15.) Be careful not to duplicate the axis number in the same unit in multi-axis combination. If it is duplicated, the precedence is given in the order shown below.

  X-Module Name → Y-Module Name → Z-Module Name → R-Module Name

  Caution : After inputting parameters, be sure to save them. Otherwise they will be lost when the power is turned off. Refer to "9.10.2.1. Procedure to Save parameters of Controller Setting."

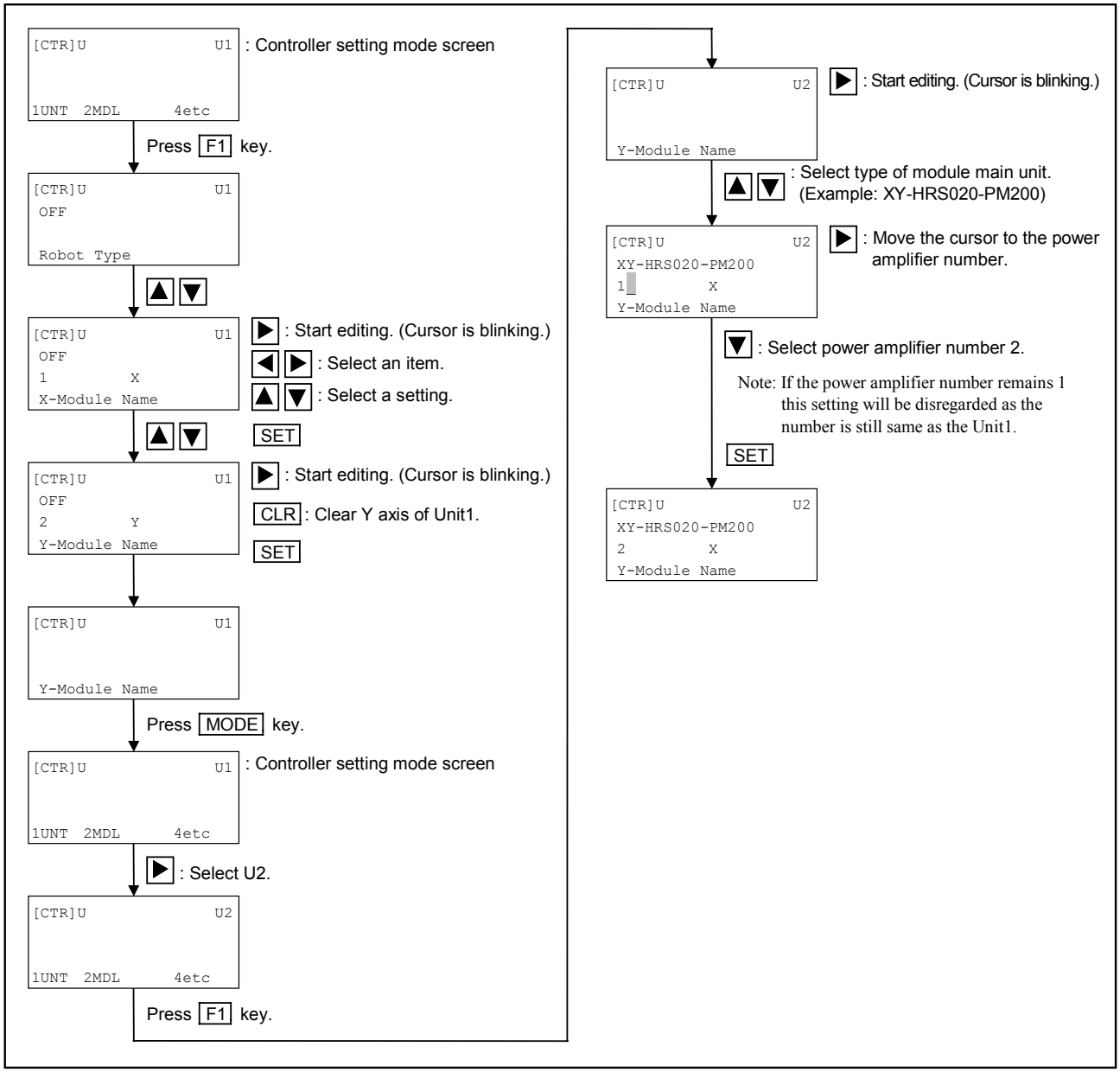
Figure 9-15: Parameter setting procedure: Unit setting



9.5.3. Separating Units for Use

- This chapter is for a Multi-axis combination only.
- All main units are set to Unit 1 when the controller is shipped. (However, two X-Y axis combinations are set to Unit 1 and Unit 2 for a 4 axes controller.) If Unit1 shall be split into some units for use, it requires to set other unit number accordingly.
- Following is a way to split Unit1 into some units.
  1) Clear axes not required for Unit1.
  2) Set the cleared axes to other unit.
- An example in Figure 9-16 shows a way to split a two axes controller to X axis of Unit 1 and X axis of Unit 2.

Figure 9-16



Note: Number of power amplifiers to be connected to module main unit shall be different between respective units. If the same amplifier number is set to two different units, a unit with smaller number takes precedence and the setting for the other unit is ignored. When the number of power amplifier of Y-module of Unit2 is still set to 1 (one) in an example above, Unit 2 is ignored and consequently, only X axis of Unit1 is considered to be exist.

9.6. Parameters for Setting Module Type

- Reserved. (Do not use.)
- This parameter is to register a module type specific to a user. Setting a specific module type is not necessary if it is combined with a standard robot module.
- Module type shall be set to the user module type (USR1 to USR8) in Chapter 9.5 when using a module main unit set by these parameters. The parameters are not valid unless the user module type is not set.
- Following parameters shall be tuned to respective module main units other than a standard module main unit. Refer to relevant chapters in this user's manual as shown below.
  Parameters for servo ---------- Chapter 9.4.1.
  Parameters for filter ---------- Chapter 9.4.2.
  Parameters for manual tuning --- Chapter 9.4.3.

9.6.1. Parameter List

Table 9-16: Parameter list: Module type setting

Parameter	Description	Setting range	Shipping set
User module 1	• A specific module type shall be set by four parameters below. 1. Ball screw lead (L) [mm] 2. Encoder resolution (R) [pulse/rev.] 3. Motor mount direction 4. Motor power (W) [W]	L: 05 ~ 40 R: 1000 ~ 8192 NRM: (Motor direct mound) REV: (motor indirect mount) W: 100, 200, 400, 800	L: 20 R: 4096 NRM W: 100
User module 2 *	Ditto	Ditto	Ditto
User module 3 *	Ditto	Ditto	Ditto
User module 4 *	Ditto	Ditto	Ditto
User module 5 *	Ditto	Ditto	Ditto
User module 6 *	Ditto	Ditto	Ditto
User module 7 *	Ditto	Ditto	Ditto
User module 8 *	Ditto	Ditto	Ditto

* This is not indicated for a single axis system.

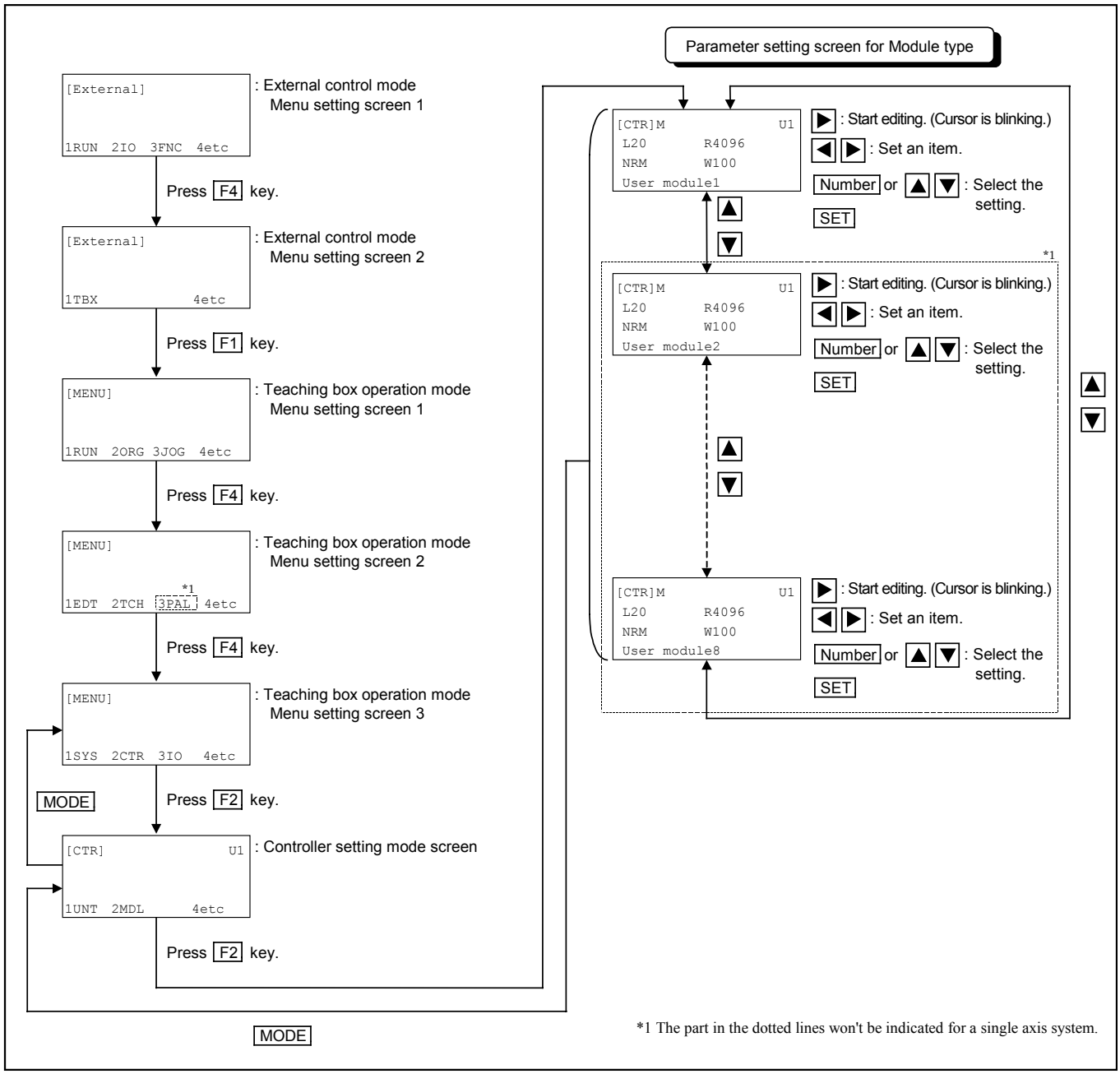
9.6.2. Parameter Setting Procedure: Module Type

- Set the mode to "Controller setting" referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the screen as shown below.
  Controller setting mode [CTR] → Module setting mode [MDL] → Each parameter setting
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start editing.
- Use ◀, ▶, ▲ and ▼ to move the cursor when editing and selecting an axis in multi-axis combination.
- Use 0 ~ 9, CLR and ± keys to set numbers.
- • is to be used to set or select keywords (OFF etc,).

- Pressing MODE key switches to the screen backward in each display screen.
- These parameters do not have any relations with the unit number. Ignore the unit number on the parameter setting screens.

Caution : *After inputting parameters, be sure to save them. Otherwise they will be lost when the power is turned off. Refer to "9.10.2.1. Procedure to Save parameters of Controller Setting."*

Figure 9-17: Parameter setting procedure: Module type



9.7. Parameters for PMD Setting

9.7.1. Parameter List

Table 9-17: Parameter list of PMD setting

Parameter	Description	Setting range	Shipping set
EMST data save	No function. Do not set other than NOP.	NOP, SAVE	NOP
STOP data save	No function. Do not set other than NOP.	NOP, SAVE	NOP
CSTP data save	Saves the data to resume programmed operation* after disturbed by power shut down.	NOP, SAVE	NOP
ALRM data save	No function. Do not set other than NOP.	NOP, SAVE	NOP
RUN mode	Selects operation start format. PRG: Selects programmed operation. POS: Selects direct operation.	PRG, POS	PRG

◊ * Refer to "17.5.2. Resume Programmed Operation" to resume operation.

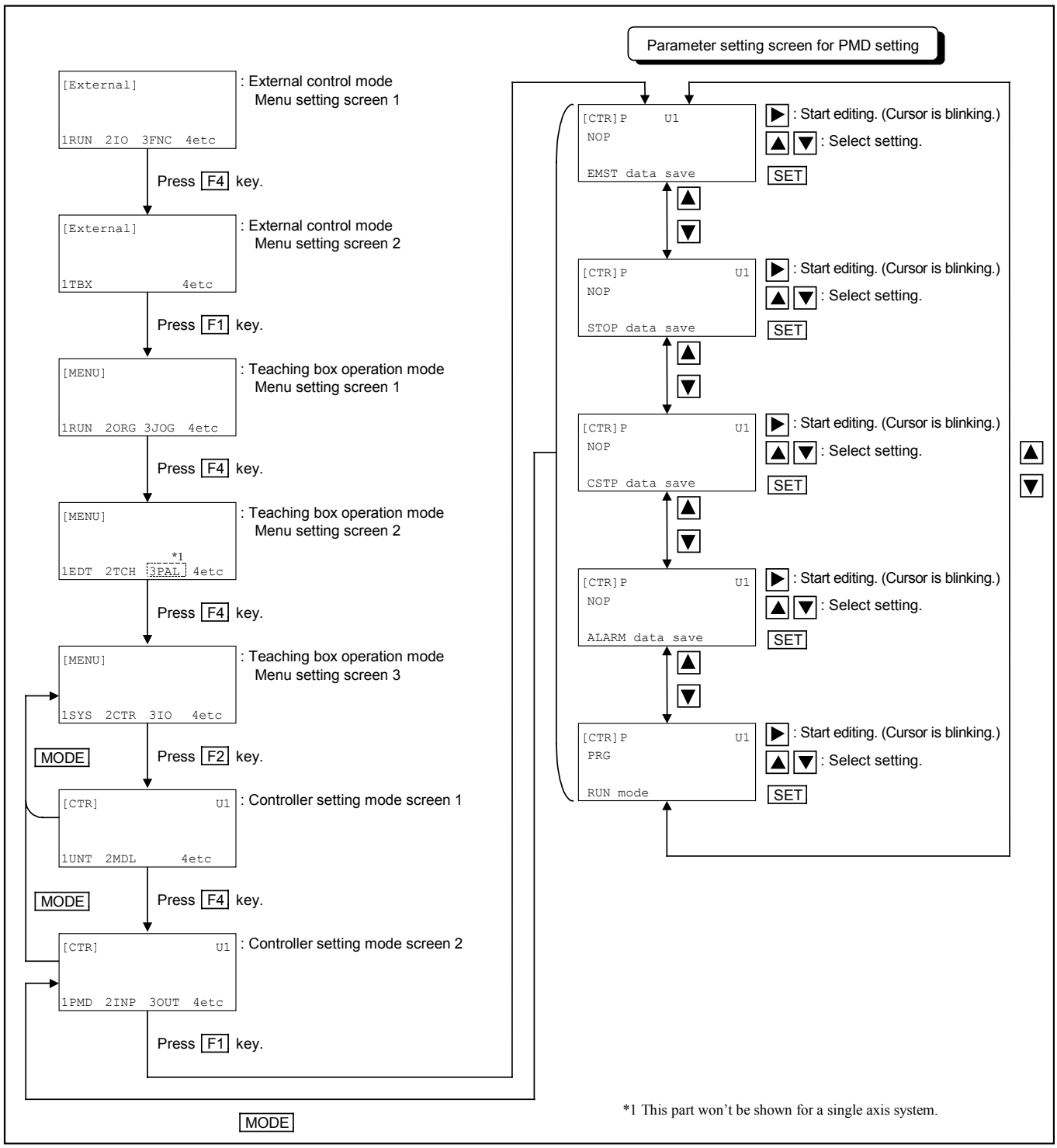
9.7.2. Parameter Setting Procedure: PMD Setting

- Set the mode to the controller setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to PMD [PMD] setting screen as shown below.

  Controller setting mode [CTR] → PMD setting [PMD] → Each parameter setting
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key words. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- The parameters in this section have no relations with the Unit number. Disregard the unit numbers which appears in the parameter screens.

Caution *: After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.2.1. Procedure to Save Parameters of Controller Setting."*

Figure 9-18: Parameter setting procedure: PMD setting



9.8. Parameters for Input Signal Format

9.8.1. Parameter List

- Switches function and polarity of input port.
  Polarity A: Normally open
  Polarity B: Normally close

- Indication of input port

[Example]

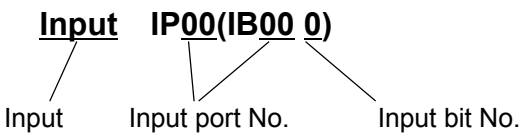


Table 9-18: Parameter list: Input signal function

Connector	Input port	Signal name	Setting range		Shipping set	
			May be changed to:	Switching polarity	Signal function	Contact polarity
CN3	Input IP00(IB000)	EMST±	Cannot change	No	EMST	B
	Input IP00(IB001)	SVON	Cannot change	No	SVON	A
	Input IP00(IB002)	STOP	Cannot change	Yes	STOP	A
	Input IP00(IB003)	RUN	Cannot change	Yes	RUN	A
	Input IP00(IB004)	HOS	Cannot change	Yes	HOS	A
	Input IP00(IB005)	RSTA	Cannot change	Yes	RSTA	A
	Input IP00(IB006)	CSTP	Cannot change	Yes	CSTP	A
	Input IP00(IB007)	HOLD	Cannot change	Yes	HOLD	A
	Input IP01(IB010)	ACLR	Cannot change	Yes	ACLR	A
	Input IP01(IB011)	EREM	Cannot change	Yes	EREM	A
P1-EXT-I/O	Input IP10(IB100)	IN1	PROG0/UNTN0*/USER/RSRV	Yes	PROG0	A
	Input IP10(IB101)	IN2	PROG1/UNTN1*/USER/RSRV	Yes	PROG1	A
	Input IP10(IB102)	IN3	PROG2/UNTN2*/USER/RSRV	Yes	PROG2	A
	Input IP10(IB103)	IN4	PROG3/USER/RSRV	Yes	PROG3	A
	Input IP10(IB104)	IN5	PROG4/POSN0/USER/RSRV	Yes	PROG4	A
	Input IP10(IB105)	IN6	PROG5/POSN1/USER/RSRV	Yes	PROG5	A
	Input IP10(IB106)	IN7	PROG6/POSN2/USER/RSRV	Yes	PROG6	A
	Input IP10(IB107)	IN8	RSRV/POSN3/USER	Yes	RSRV	A
	Input IP11(IB110)	IN9	USER/POSN4/RSRV	Yes	USER	A
	Input IP11(IB111)	IN10	USER/POSN5/RSRV	Yes	USER	A
	Input IP11(IB112)	IN11	USER/POSN6/RSRV	Yes	USER	A
	Input IP11(IB113)	IN12	USER/POSN7/RSRV	Yes	USER	A
	Input IP11(IB114)	IN13	USER/POSN8/RSRV	Yes	USER	A
	Input IP11(IB115)	IN14	USER/POSN9/RSRV	Yes	USER	A
	Input IP11(IB116)	IN15	USER/POSN10/RSRV	Yes	USER	A
	Input IP11(IB117)	IN16	USER/POSN11/RSRV	Yes	USER	A

* This part won't be indicated for a single axis system.

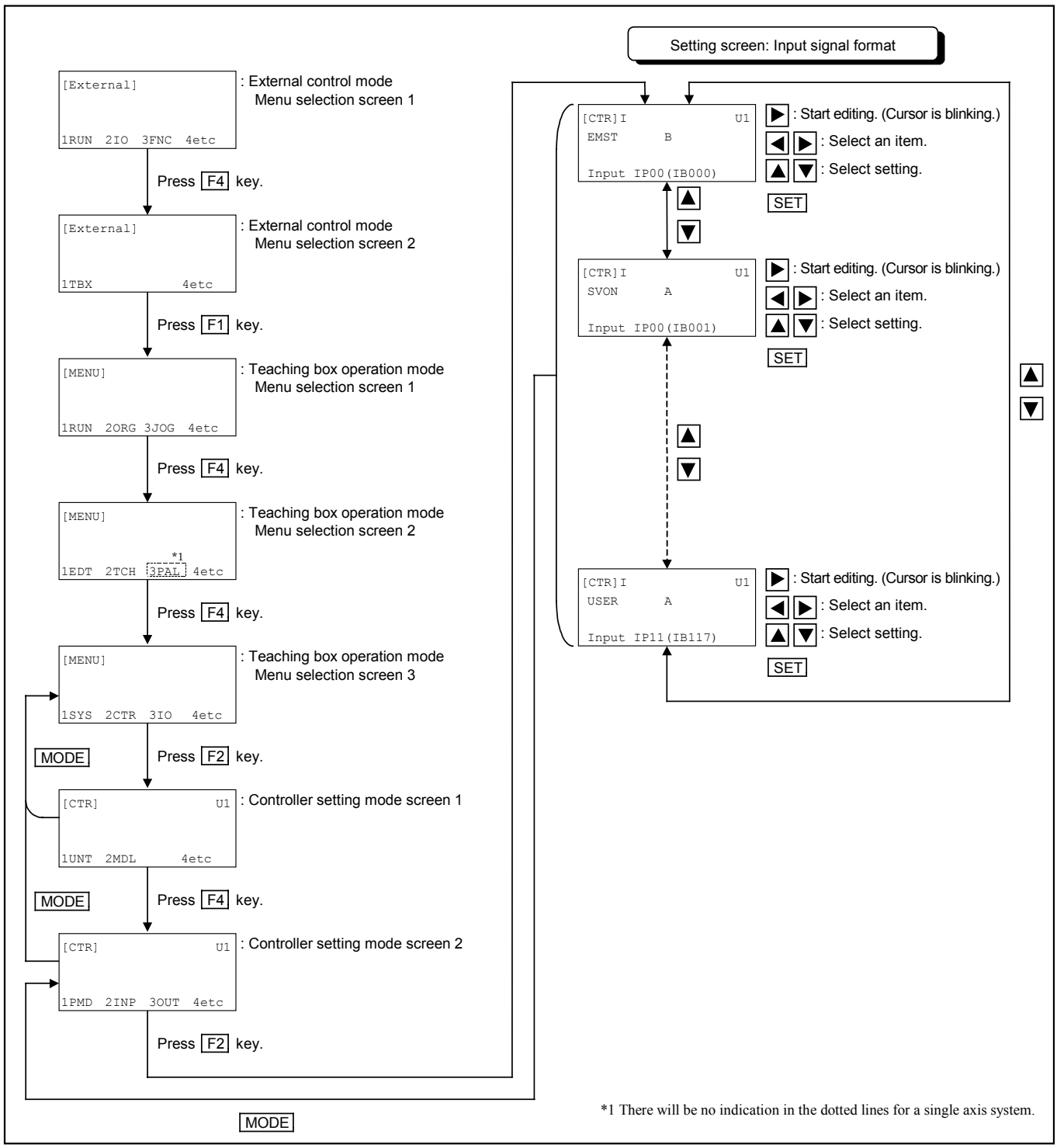
9.8.2. Parameter Setting Procedure: Input Signal Format

- Set the mode to the controller setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to Input Signal Format [INP] setting screen as shown below.

  Controller setting mode [CTN] → INP setting [INP] → Each parameter setting
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use ◀ and ▶ keys to scroll the cursor for editing.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key words. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- The parameters in this section have no relations with the Unit number. Disregard the Unit numbers which appears in the parameter screens.

  Caution : After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.1.1. Procedure to Save Parameters of System Setting."

Figure 9-19: Parameter setting procedure: Input signal format



9.9. Parameters for Output Signal Format

9.9.1. Parameter List

- Switches function and polarity of input port.
  Polarity A: Normally open
  Polarity B: Normally close

- Indication of input port

[Example] **Output OP00(OB00 0)**

Output — Output port No. — Output bit No.

Table 9-19: Parameter list: Output signal format

Connector	Output port	Signal name	Setting range		Shipping set	
			May be changed to:	Switching polarity	Signal function	Contact polarity
CN3	Output OP00(OB000)	RDY	Cannot change.	No	RDY	B
	Output OP00(OB001)	WRN	Cannot change.	Yes	WRN	A
	Output OP00(OB002)	MTN	Cannot change.	Yes	MTN	A
	Output OP00(OB003)	EDTM	Cannot change.	Yes	EDTM	A
	Output OP00(OB004)	TBXM	Cannot change.	Yes	TBXM	A
	Output OP00(OB005)	HOMS	Cannot change.	Yes	HOMS	A
	Output OP00(OB006)	CSTPA	Cannot change.	Yes	CSTPA	A
	Output OP00(OB007)	HOLDA	Cannot change.	Yes	HOLDA	A
	Output OP01(OB010)	RSTAE	Cannot change.	Yes	RSTAE	A
	Output OP01(OB011)	DATWT	Cannot change.	Yes	DATWT	A
P1-EXT-I/O.	Output OP10(OB100)	OUT1	USER/FIN1/RSRV	Yes	USER	A
	Output OP10(OB101)	OUT2	USER/FIN2*/RSRV	Yes	USER	A
	Output OP10(OB102)	OUT3	USER/FIN3*/RSRV	Yes	USER	A
	Output OP10(OB103)	OUT4	USER/FIN4*/RSRV	Yes	USER	A
	Output OP10(OB104)	OUT5	USER/FIN5*/RSRV	Yes	USER	A
	Output OP10(OB105)	OUT6	USER/FIN6*/RSRV	Yes	USER	A
	Output OP10(OB106)	OUT7	USER/FIN7*/RSRV	Yes	USER	A
	Output OP10(OB107)	OUT8	USER/FIN8*/RSRV	Yes	USER	A
	Output OP11(OB110)	OUT9	USER/RSRV	Yes	USER	A
	Output OP11(OB111)	OUT10	USER/RSRV	Yes	USER	A
	Output OP11(OB112)	OUT11	USER/RSRV	Yes	USER	A
	Output OP11(OB113)	OUT12	USER/RSRV	Yes	USER	A
	Output OP11(OB114)	OUT13	USER/RSRV	Yes	USER	A
	Output OP11(OB115)	OUT14	USER/RSRV	Yes	USER	A
	Output OP11(OB116)	OUT15	USER/RSRV	Yes	USER	A
	Output OP11(OB117)	OUT16	USER/RSRV	Yes	USER	A

* This part won't be indicated for a single axis system.

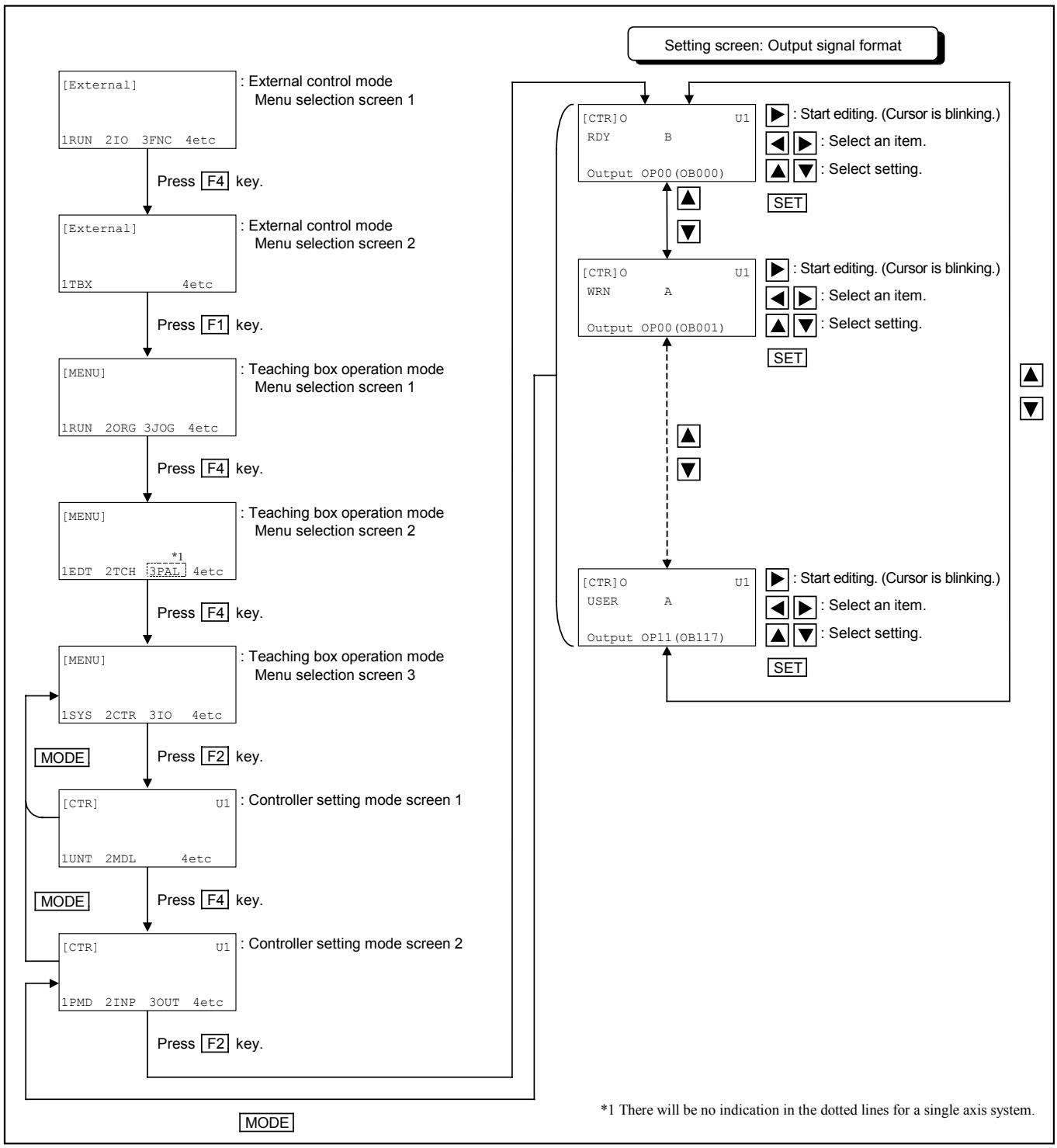
9.9.2. Parameter Setting Procedure: Output Signal Format

- Set the mode to the controller setting referring to "8.2. Selection of Control Mode."
- Refer to "9.1. Initial Setting Procedure" and scroll the display screen to Output signal format [OUT] setting screen as shown below.

  Controller setting mode [CTN] → OUT setting [OUT] → Each parameter setting
- Use ▲ and ▼ keys to scroll the screen.
- Use ▶ key to start the editing.
- Use ◀ and ▶ keys to scroll the cursor for editing.
- Use 0 ~ 9 numeric keys, CLR key and ± key to input numbers.
- • key is used to set or select key words. (OFF etc.)
- In each display screen, pressing MODE key makes the screen to go one step back.
- The parameters in this section have no relations with the Unit number. Disregard the Unit numbers which appears in the parameter screens.

  Caution : After inputting the parameters, be sure to save them. Otherwise, they will be lost when the power is turned off. Refer to "9.10.2.1. Procedure to Save Parameter of Controller Setting."

Figure 9-20: Parameter setting procedure: Output signal format



9.10. Saving Parameter Setting

9.10.1. Saving Parameters of System Setting

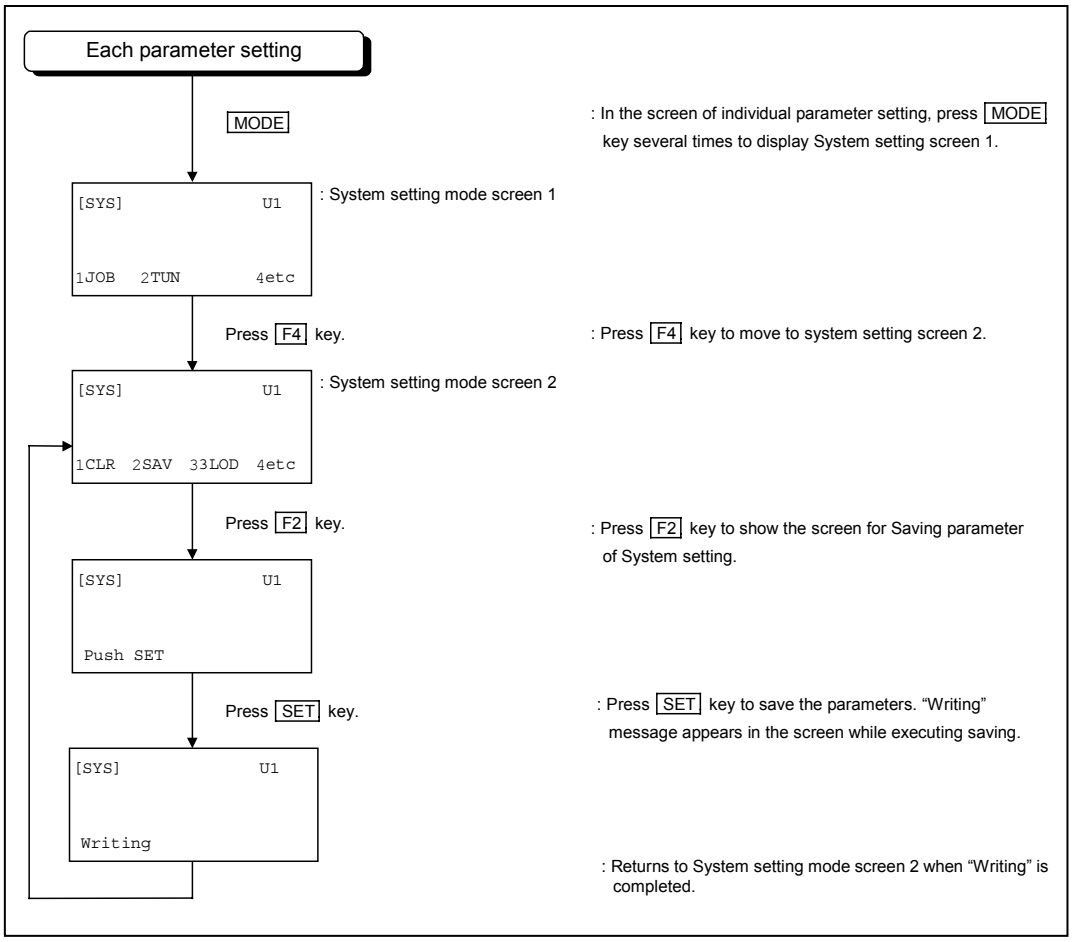
- This section describes how to save parameters of the System settings listed below to the flash memory.

1) Programmed operation
2) Home return
3) Jog
4) Position • Coordinates
5) Pulse train input (Single axis system only.)
6) Servo
7) Filter
8) Manual tuning
9) Function setting

9.10.1.1. Procedure to Save Parameters of System Setting

Caution *: When saving parameters, "Writing" message appears in the screen. Do not disconnect the power while this message is on the screen. Otherwise "memory error" alarm is on and all settings will be lost. (Initialization including programming is necessary to recovery.)*

Figure 9-21: Saving procedure: System setting parameters



9.10.2. Saving Parameters of Controller Setting

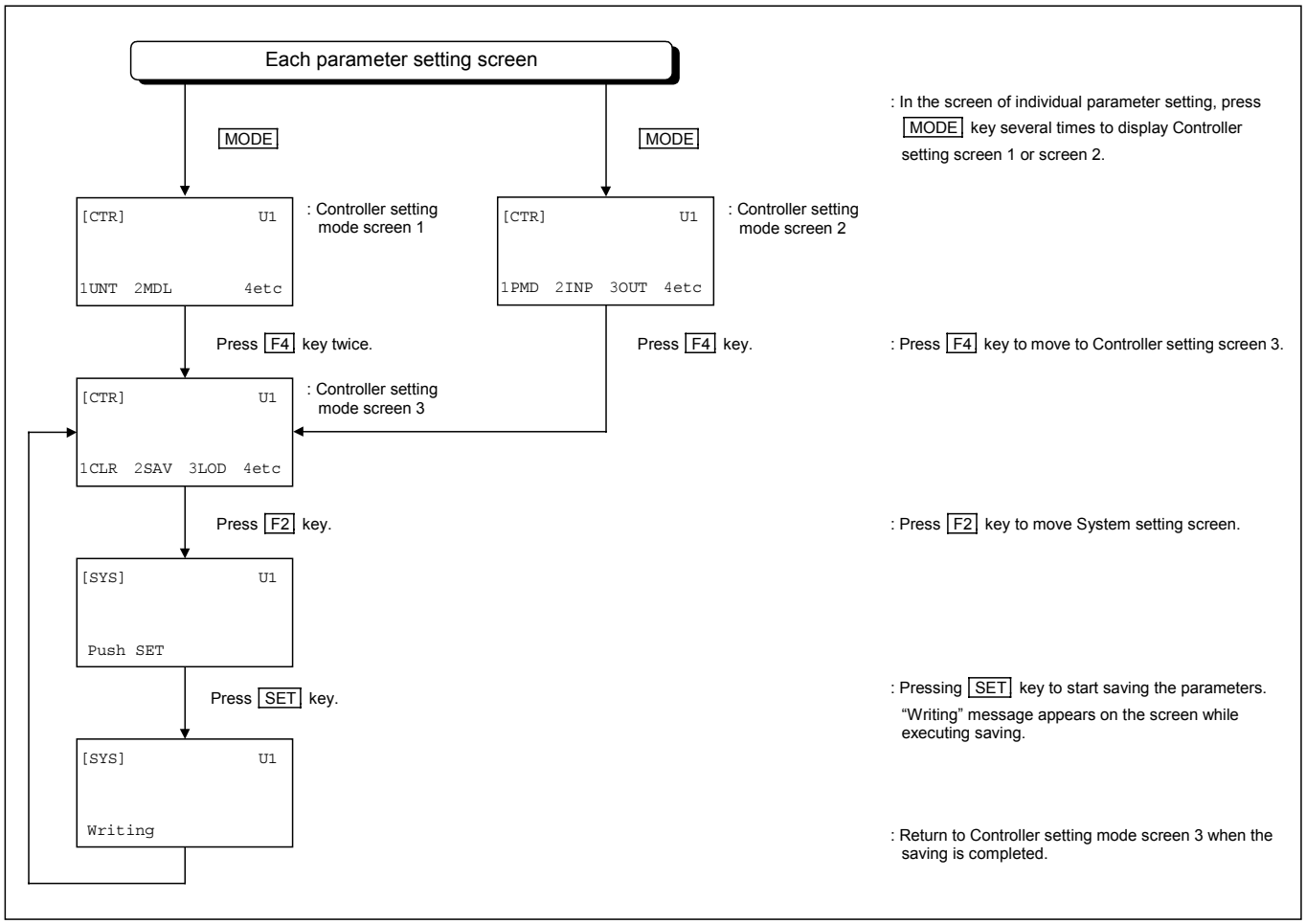
- This section describes how to save parameters of Controller settings listed below to the flash memory.

  1) Unit number
  2) Module setting
  3) PMD setting (Program mode)
  4) Input signal format
  5) Output signal format

9.10.2.1. Procedure to Save Parameters of Controller Setting

Caution : When saving parameters, "Writing" message appears in the screen. Do not disconnect the power while this message is on the screen. Otherwise "memory error" alarm is on and all settings will be lost. (Initialization including programming is necessary for recovery.)

Figure 9-22: Saving parameter: Controller setting parameter



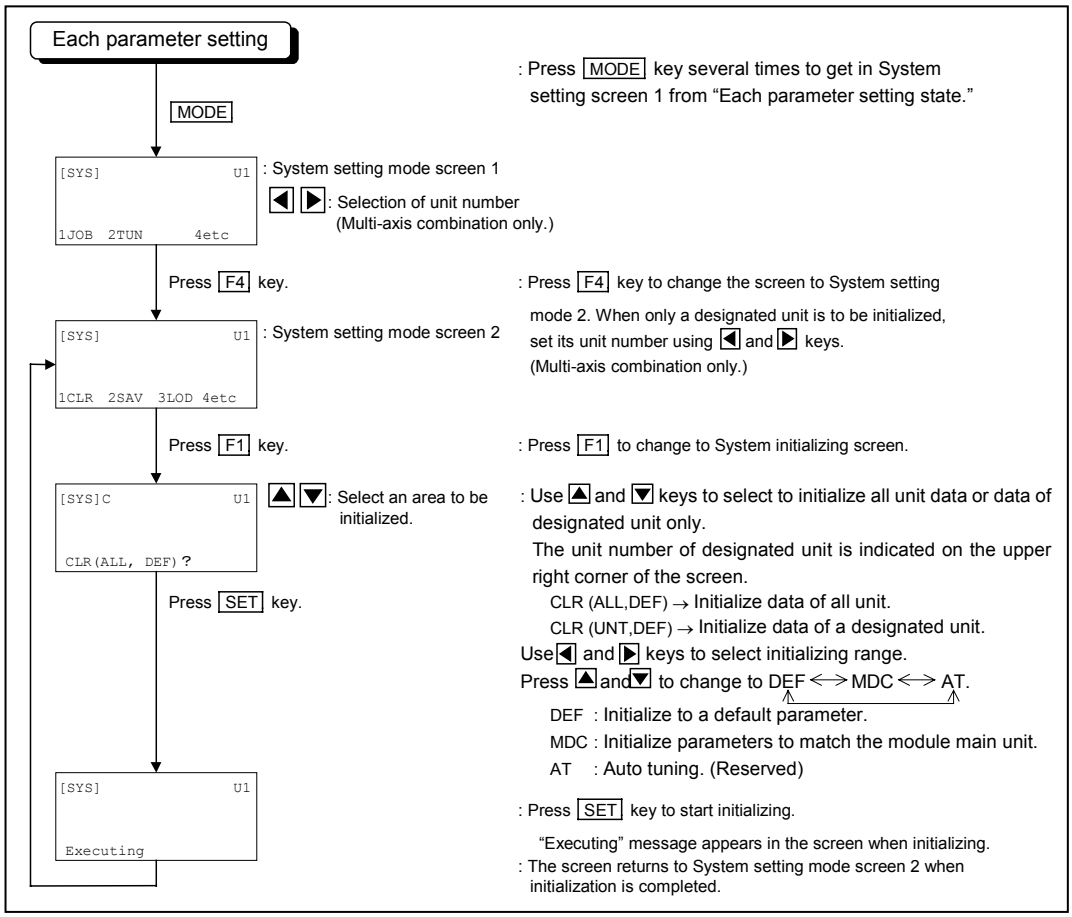
9.11. Initialization of Parameters

9.11.1. Initialization of Parameters for System Setting

- This section describes how to initialize parameters of system setting listed below to the flash memory.
  1) Programmed operation
  2) Home return
  3) Jog
  4) Position • Coordinates
  5) Pulse train input (Single axis system only.)
  6) Servo
  7) Filter
  8) Manual tuning
  9) Function setting

9.11.1.1. Procedure to Initialize System Setting Parameters

Figure 9-23: Procedure to initialize system setting parameters



Note: Refer to "9.10. Saving Parameter Setting" to save the initialized parameters. All parameter returns to the state before initialization if the power is turned off before saving the initialized data.

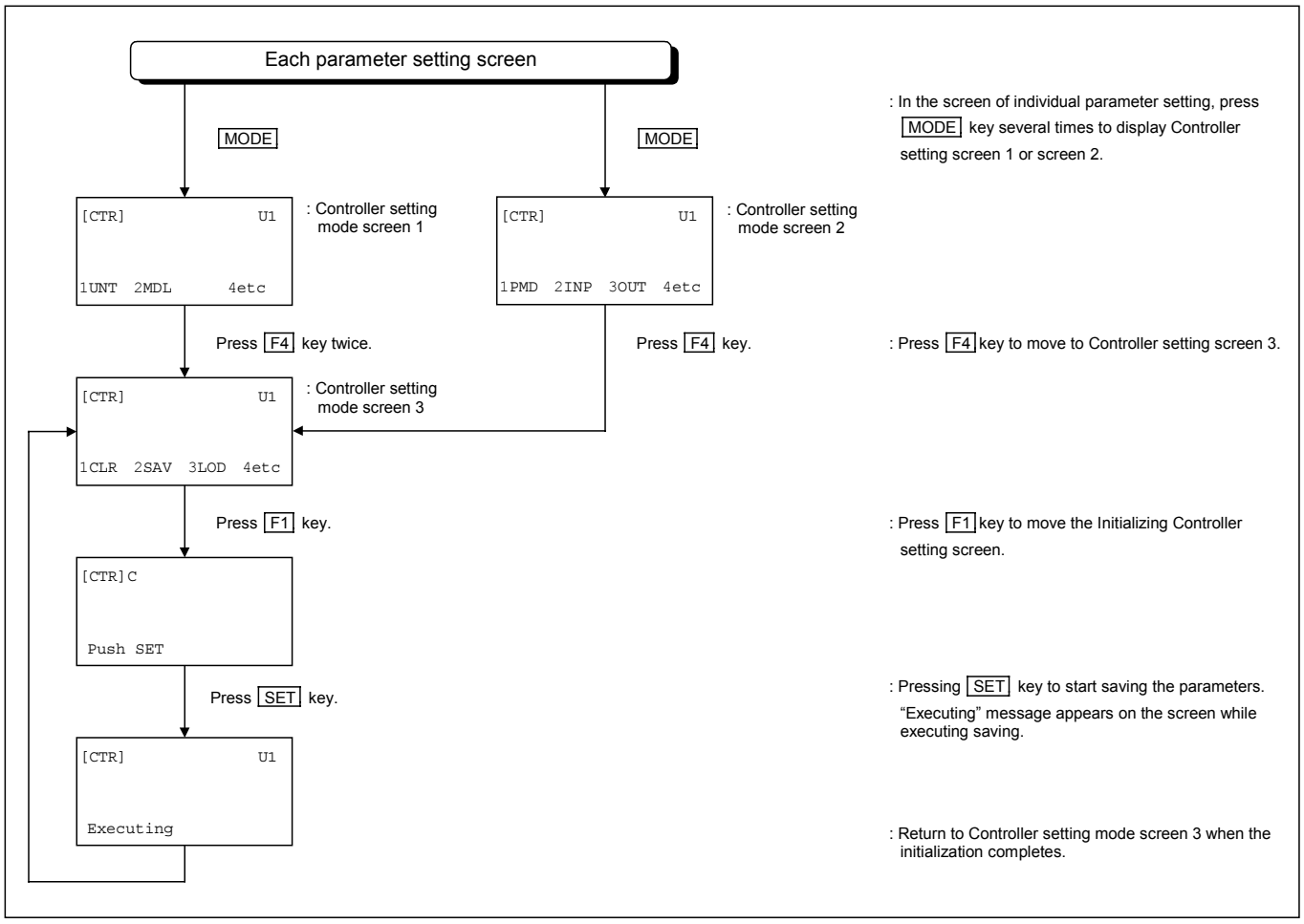
9.11.2. Initialization of Controller Setting Parameters

- This section describes how to initialize Controller setting parameters listed below.

1) Unit number
2) Module setting
3) PMD setting (Program mode)
4) Input signal format
5) Output signal format

9.11.2.1. Procedure to Initialize Controller Setting Parameters

Figure 9-24: Procedure to initialize controller setting parameters



Note: Refer to "9.10. Saving Parameter Setting" to save the initialized parameters. All parameter returns to the state before initialization if the power is turned off before saving the initialized data.

9.12. Readout of Parameters

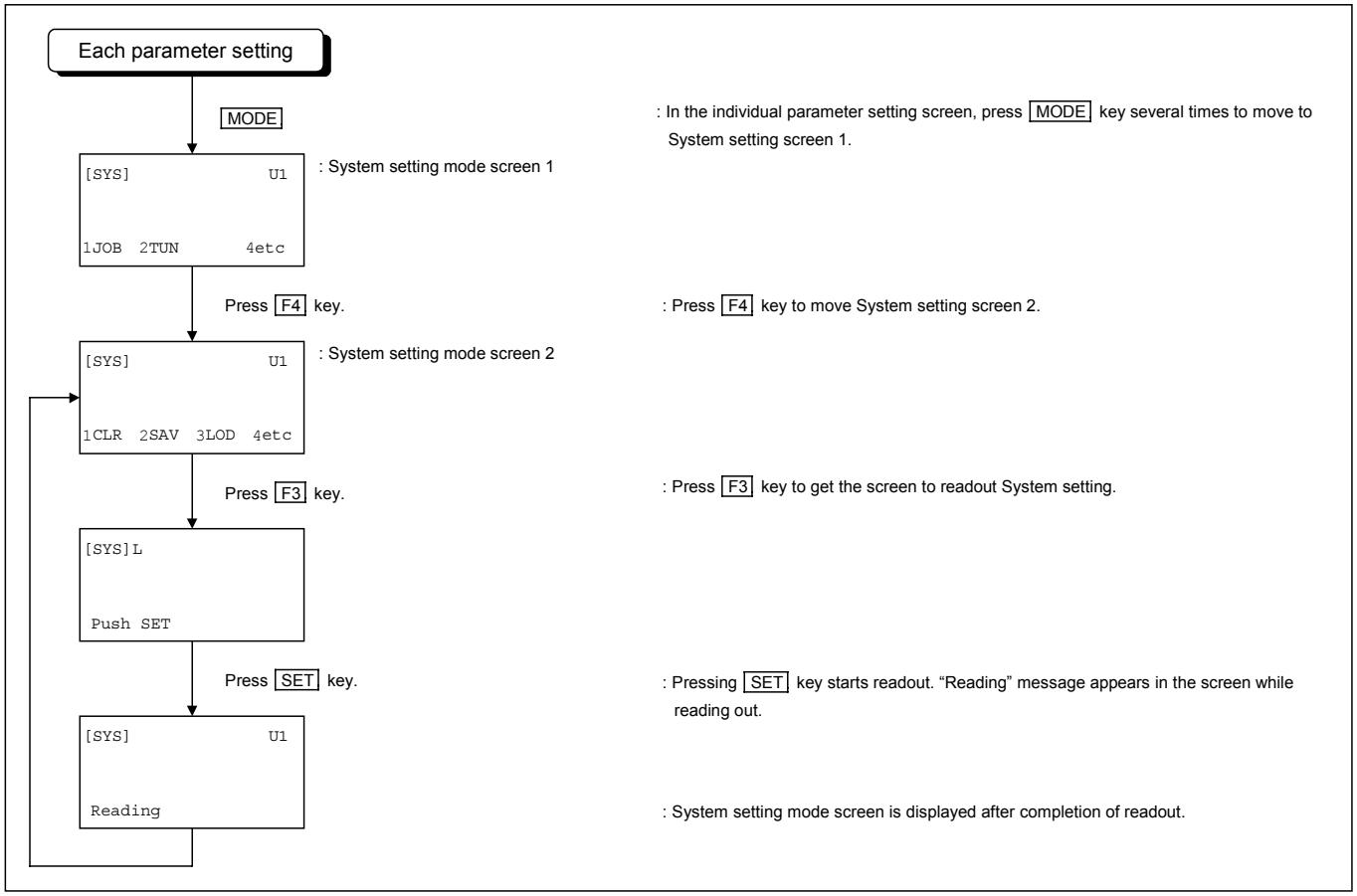
9.12.1. Readout of System Setting Parameters

- This section describes how to read out stored parameters of system settings listed blow.

1) Programmed operation
2) Home return
3) Jog
4) Position • Coordinates
5) Pulse train input (Single axis system only.)
6) Servo
7) Filter
8) Manual tuning
9) Function setting

9.12.1.1. Readout Procedure: System Setting Parameters

Figure 9-25: Parameter readout: System setting



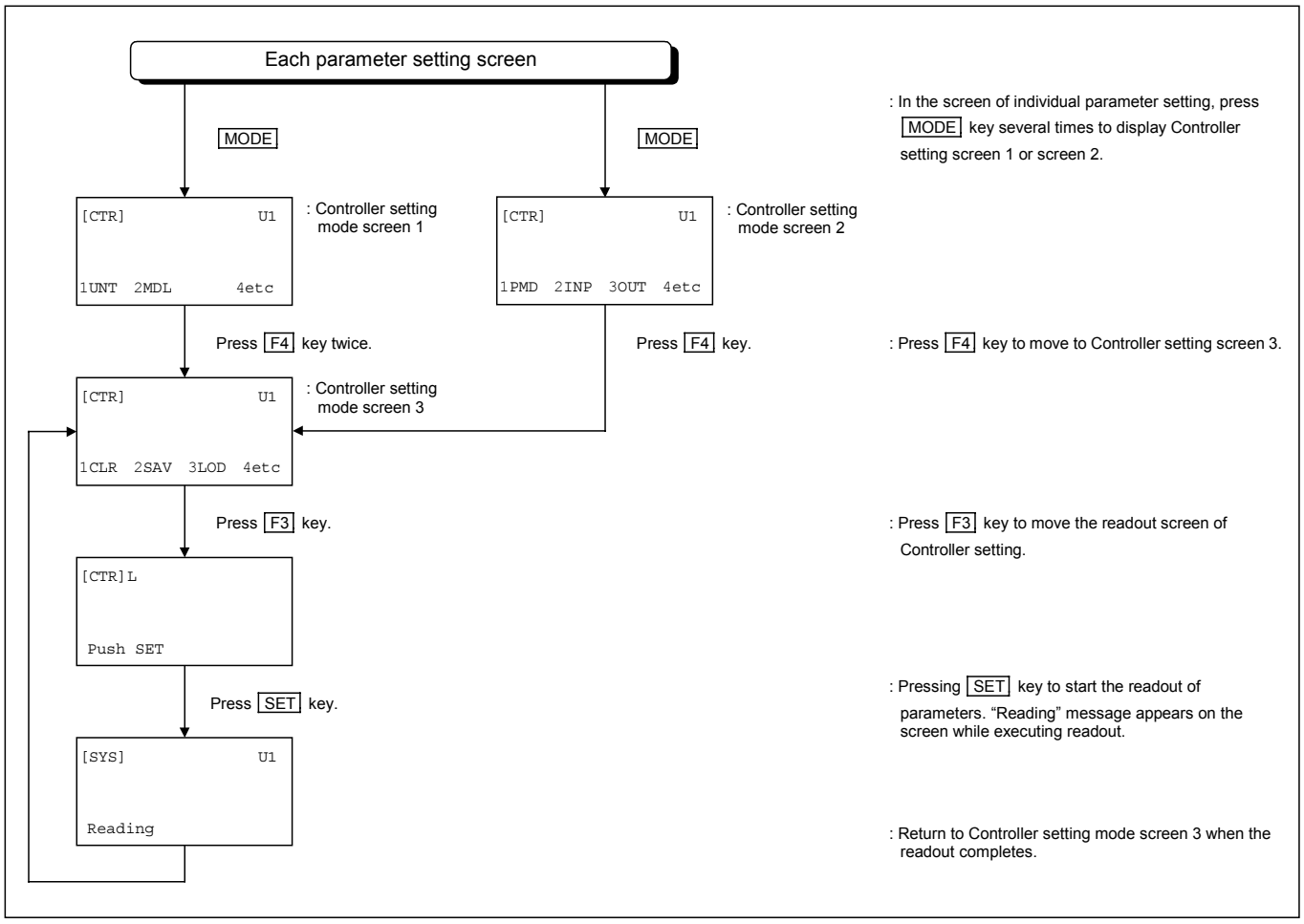
9.12.2. Readout of Controller Setting Parameters

- This section describes how to readout the stored parameters of Controller setting listed below.

  1) Unit number
  2) Module setting
  3) PMD setting (Program mode)
  4) Input signal format
  5) Output signal format

9.12.2.1. Readout Procedure: Parameters of Controller Setting

Figure 9-26: Readout procedure: Controller setting parameters



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10. Trial Running

- Conduct trial running following the procedures described hereunder when the initial setting for startup or the initialization of replaced main unit or EXEA controller is completed. (Refer to "9. Initial Setting.")

- Trial running is supposed to be a manual operation using the teaching box. You cannot operate Jog without the teaching box.

Procedure 1: Home return

- Execute Home return through either one of the teaching box operation, external control operation and the remote control operation.
- Refer to the following chapters for Home return.
  "17.3.1. Home Return" in the teaching box operation.
  "17.4.3. Home Return" in the external control operation.
- Alarm of Home return incomplete (A5) is off when the Home return is completed. If the alarm is still on, execute the home return again after checking the setting of EXEA controller and mounting condition of the module main units.

Procedure 2: Indication of the Home position

- Set the home position matching to the slider position after the Home return.
- Be sure that the module main unit does not move after turning off the servo. Then affix a seal (provided with a main unit) which indicates the positions of the home and the mechanical stopper. Affix them to all main units in case of a mult-axis combination.

Procedure 3: Trial running by jog operation

- Execute the jog operation through the teaching box. Refer to "17.3.2. Jog Operation" in the teaching box operation.
- Confirm that all module main units operate smoothly. If not, adjust the parameters again referring to "9. Initial Setting."

(Next page)

Procedure 4: Set detecting position of software over travel limit.

- Set detecting position of software over travel limit to all module main units in the vicinity of its stroke end checking the coordinates under the jog operation.
- Set the positions inside of mechanical stoppers on the motor side and opposite to the motor side.
- Set the position referring to the coordinates displayed on the screen of the teaching box in the jog operation mode.
  Be sure to set the home position in effective range as the standard home position is close to the mechanical stopper. Refer to "9.3.4. Parameters for Position and Coordinate" for the setting.

⇩

Procedure 5: Turn the power off.

- Turn off the servo, then power off after the trial running.

Caution : *The slider of a vertical axis may drop 5 ~ 10 mm when the power is turned while the servo remains on.*

- Do not input external control signal such as "servo on" or "Move" other than "emergency stop" through CN3 connector while executing the trial running.

Danger : *Before starting trial running, be sure nobody is in the working area of the robot.*

11. Protection and Safety

11.1. Guard Fence

- Provide the guard fence to prevent from entry of persons during operation of the robot.

  Danger *: Any person in the robot module working area may be crushed by, or caught in the robot module when the module unit or the EXEA controller fails or malfunctions. Such a hazard exists even when the system is running normally at a high speed.*

  1) For your safety in daily operation, provide guard fences and take action to prevent from entry of persons into the robot working area.

  2) When you must enter the area bound by the guard fences to adjust or conduct teaching of the system, keep off the robot working area and stand in a place where you can see the motion of the robot module clearly. The operating speed at this time should be lower than the safety speed of 250 mm/second.

  * Shipping set is 50 mm/second for jog and teaching speed.

11.2. Power Shut down and Recovery

- When the main power is shut off due to failure of the power line, the EXEA controller stops a programmed operation.

  Caution : *When the power is shut off in the middle of operation, EXEA controller gets into "Servo off" state. As though dynamic brake is incorporated, the slider (or main unit for the main unit stroke), other than that of a main unit with a motor incorporated with magnetic brake, may coast before it stops.*

- Even if the power is recovered, the programmed operation won't resume automatically. It needs normal procedures to start operation. When starting, the program begins from the top. You may not resume the operation from the point where it was interrupted.

- After the power recovers, it is possible to resume an interrupted programmed operation if RSTA command is set to execute initialization. (Refer to "15.2. Programming.")

  Caution : *If the master controller (a sequencer or a controller that controls the EXEA controller: it should be provided by the user.) does not detect the power failure and continues to supply operating commands, it leads to an unexpected malfunction.*

  ◊ When the power to the EXEA controller is interrupted, RDY output of the control input / output (CN3) is opened (= gets into alarm state). Be sure to monitor the RDY output in the master controller, and to stop giving the operating command to EXEA controller when the RDY output is opened.

  ◊ When the power recovers and the RDY output closes, remove the errors resulting from the interruption of programmed operation, then start the system from the beginning.

11.3. Protection and Function for Safety

11.3.1. Emergency Stop

- In case of system malfunction or an accident is foreseen, activate the emergency stop function to shut off the current to motors and stop all operations instantly.

11.3.1.1. State of Emergency Stop

- All operation commands are canceled and the motors get in servo-off state.
- The general outputs keep their status before the emergency stop is on until the power to the port is shut off or the OUT command is issued to change the output status.
- The internal registers such as data register will be reset.
- Indication: 1) Front panel LED : F4
  2) CN3 control output : RDY --- open, WRN --- Open
  (It closes if other minor alarm such as F5 arises simultaneously.)
  3) Teaching box : EMST

11.3.1.2. Execution of Emergency Stop

- There are three ways to execute the emergency stop as shown below. You may execute the emergency stop with one of the following ways.

1 Press EMG key on the teaching box.

Note: (1) As the emergency stop circuit is a B contact (= normally close), disconnection of the connector CN1 on the teaching box will create state of emergency stop.

(2) When operating the system without the teaching box, turn off the power and plug in the dummy connector (provided with EXEA controller as an accessory) to the CN1 connector of EXEA controller, then turn on the power again. Contacts of emergency stop circuit are shorted in the dummy connector.

2 Turn off the EMST input of the control inputs / outputs (Connector CN3)

Note: (1) As the emergency stop circuit is B contact (= normally close), turn on EMST input when the power is turned on, otherwise the system gets into emergency stop state.

3 Execute EMST command in the remote control mode.

11.3.1.3. Recovery from Emergency Stop

1 Call off the emergency stop state (Turn on an input of CN3 connector).

* This procedure is not necessary for recovery from emergency stop state caused by EMG key of teaching box and EMST command of remote control mode. Simply follow the procedures hereunder.

2 Turn the power on again.

* The emergency stop can be called off by resetting the alarm after executing the procedure described above.

- Recovery through the teaching box
  Press CLR then press SET key in "Teaching box control" mode.

  * Do not press CLR and SET keys simultaneously. Press SET key after clear your finger from CLR key, otherwise you won't be able to get out from emergency stop state.
  * This procedure is invalid in the remote control mode.

- Recovery by control input /output (External control mode)

  * In the remote control mode, turning on ACLR input of the control input / output (CN3) recovers the system from the emergency stop.

- Recovery by remote control

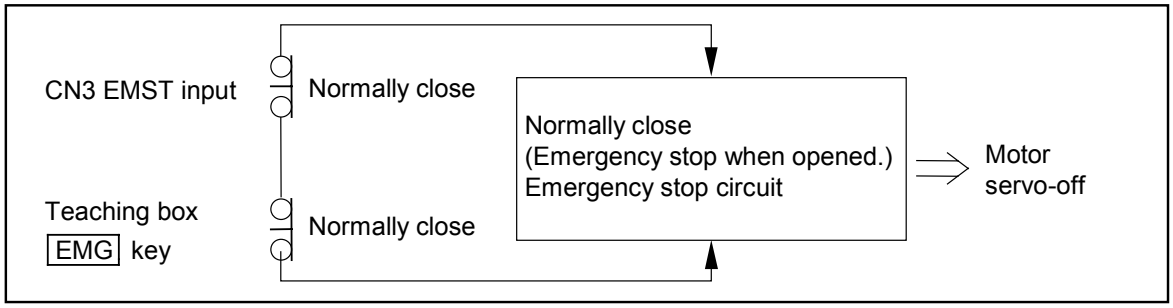
  * Inputting the commands ACLR△All makes to remove the emergency stop state. (△ is the space code (20H).)

Note: (1) Lifting the emergency stop state does not start operation automatically. It needs a normal procedure to start the operation from the beginning.

(2) Operation starts from the top of the program but not from the point at where the program was interrupted.

11.3.1.4. Emergency Stop Circuitry

Figure 11-1: Emergency stop circuitry



11.3.1.5. Required Distance to Stop for Emergency Stop

- When "Emergency stop" is on, the motors get in servo off state and dynamic brake functions.

- It requires approximately 100 mm (coasting distance) to come to complete stop after the emergency stop is on if each module main unit is carrying its allowable transporting load and is running under maximum speed.

11.3.2. Deadman Switch

- Keep pressing the deadman switch when executing jog operation or teaching.
- In jog operation and teaching by jog operation, releasing the deadman switch makes the motor servo off and the robot stops. (The magnetic brake incorporated in the motor engages.)

Warning : Deadman switch does not function other than jog operation or teaching in jog operation. Be sure to use the emergency stop switch in other operation mode.

11.3.3. Brake Control

- There are two types of braking function. One is the dynamic braking and the other is the magnetic brake incorporated into the motor.
  The magnetic brake is used for a vertical axis unit to prevent back drive of ball screw when the power is shut off.
- The magnetic brake is a negative type. The brake engages when the current to the brake is off.
- Refer to "Appendix 1. Motor Connector" for the wiring of the magnetic brake.
- The followings are the occasions when both dynamic brake and magnet brake function.
  1) Turn off EXEA controller power.
  2) Servo-off
  3) When an alarm which leads to servo-off arises.

Caution : The dynamic brake does not function if controller cable is disconnected. (EXEA controller and a main unit are not connected.)

- The magnetic brake can be switched on and off manually through the teaching box when conducting trial running or adjusting the robot. Refer to "14.2.6.5 Indication of Brake Status and Handling."
- Disconnect controller cable to cancel dynamic brake function.

Caution : Be sure to connect the controller cable properly when connect it again.

11.3.4. Detection of Over Travel

- You can set and monitor the software over travel limit based on the absolute coordinates defined by Home return. Refer to "Over travel (+) and (-)" in "9.3.4. Parameter for Position and Coordinates" and "10. Trial Running" for setting of software over travel limit.

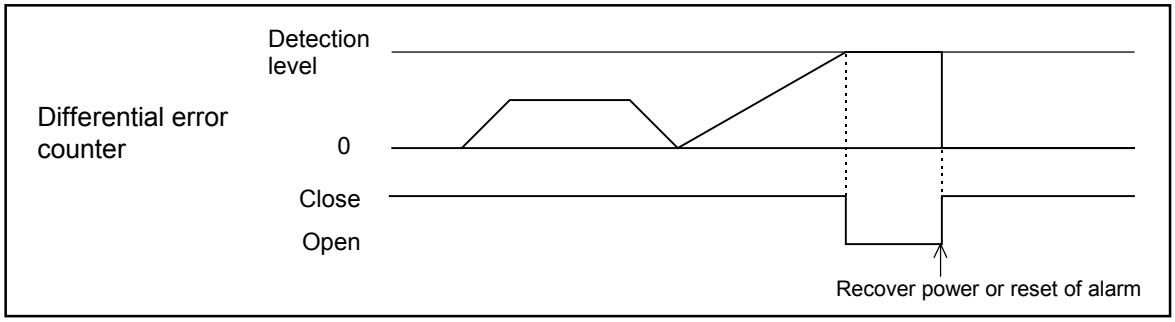
Caution : It is essential to set the software over travel limit as the robot module main unit does not have the over travel limit switch.

11.3.5. Detection of Excessive Position Error

- The position command is always subtracted by actual position of the slider in the differential error counter. If, for any reason, the slider cannot move or slow to respond to the position command, the subtraction in the differential error counter exceeds the set limit, and consequently, an excessive position error alarm arises. Refer to "position error over" in "9.4.4. Parameter for Function Setting" for detection level of the excessive position error.

- When the variation of differential error counter exceeds the set level, RDY output opens and the motor gets into servo-off state.

Figure 11-2: Detection timing of excessive position error



11.3.6. Software Thermal Limit Protection

- This is to protect the motor from burning by monitoring the mean value of current to motor and to give an alarm if it exceeds the rating of motor.

  Caution : This protection won't work if the main unit is miss-connected to improper motor driver unit.

  ◊ Example :

  If a main unit with 100 W motor is connected to 200 W output of the controller, EXEA controller gives the current for 200 W motor, twice of rating current of 100 W motor, and eventually results in burning motor.

  ◊ Connect the main unit to a proper driver unit.

- We set limit level of software thermal as a shipping set. Do not change the setting.

11.3.7. Protection from CPU Malfunction

- The alarms of EXEA controller is managed by software.

- The following measures are taken by the software to maintain safety and protection from CPU malfunction and failure.

  1) Two software systems are provided to watch malfunction and failure of CPU.

  2) Both systems stop the operation by making motor in servo-off and give an alarm when CPU fails to report to the monitoring systems.

12. Maintenance • Checking

12.1. Maintenance

- We recommend to prepare the back up parts for quick recovery from unexpected break down of the system.
- Write down all parameter settings and keep the notes in case of system failure.
- Refer to "9.2. Initial Setting List" for setting of the parameters.

12.2. Checking

- Check the parts periodically and replace them if necessary for prolonged use of the robot module.

12.2.1. Periodical Check

- The checking shown in Table 12-1 should be performed at least once a month.

Table 12-1: Check List

Check point	Inspection
Looseness of screws	• Inspect for loose screws of FGND terminal block and AC main power source connector. • Tighten screws if necessary.
Cleaning	• Clean dust and remove foreign substances from the controller.

Danger : Do not conduct the checking with main power on. Touching the controller is very dangerous as a high tension exists. Before checking, wait for five minutes approximately after turning power off.

Danger : Disconnected FGND terminal cable due to loose screws leads to a hazard of electric shock and short circuit. Be sure to fasten loose screws.

12.2.2. Replacement

- The parts listed in Table 12-2 below are subject to aging or deterioration because of repeated use, possibly affecting system performance and causing a system failure.
- Replace them when it reaches its criterion of life described in Table 12-2.

Table 12-2: Replacement parts

Item	Function	Criterion of life
Lithium battery	Memory back up (absolute position data)	• Total power shut-off time of EXEA controller: 50 000 hours (Approximately 5 years without turning power on.) However, if a main unit is moved manually without power on, it may shorten the battery life less than 50 000 hours as an encoder of motor consumes the battery power.
Relay	Contact point of motor brake.	• Total number of times of brake on/off: 100 000 times (Approximately 9 years when frequency of 30 times of on/off per day.)
Electric condenser	Smoothing voltage of main power	• Criterion: 5 to 10 years (varies according to environmental condition, especially sensitive to temperature.)

Danger : Do not charge the lithium batteries. If charged, they may burst or burn.

Caution : The battery may burst if it is not handled properly. Be sure to use an optional battery set (Reference number : M-FK123) when replace it. Observe the following for disposal of the battery.

1) *When dispose it, cover its part of connector with a friction tape so that the plus and minus electrodes are not shortened.*
2) *Dispose it as a general incombustible garbage.*
3) *Do not throw it into the fire or destroy it by an incinerator.*
4) *Do not pile them up rashly.*

How to replace the lithium battery

- Follow the procedures below when replace the lithium battery.

  Caution : *Be sure to turn off the power when replace the lithium battery.*

1 Preparation

- Philips screwdriver for M3 screw.
- Battery set (optional)
  Reference number: M-FK123 (Battery and fixing band)

2 Procedure

1) Remove the screws and detach the bottom cover of an EXEA controller.
   (1) Remove 8 screws as shown in Photo 12-1 and 12-2 for a single axis controller.

Photo 12-1: Indication of screws to be removed. <Single axis controller>

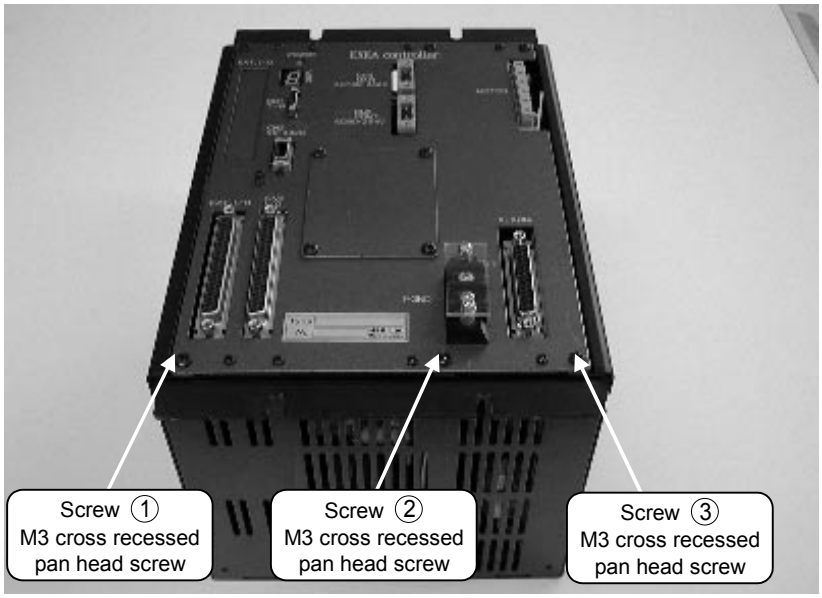
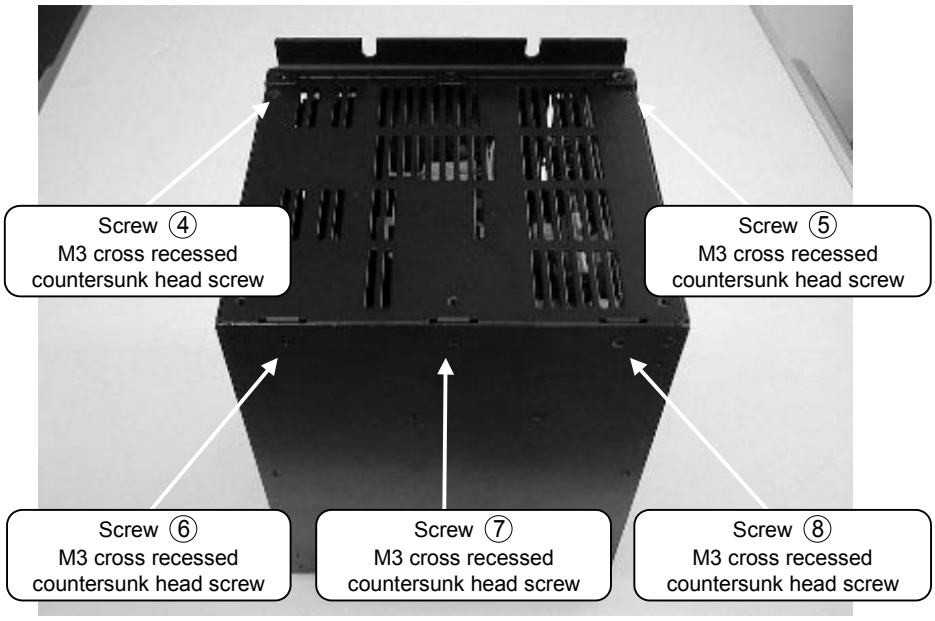


Photo 12-2: Indication of screws to be removed <Single axis controller>



(2) Remove 8 screws as shown in Photo 12-3 and 12-4 for a 2 axes controller.

Photo 12-3: Indication of the screws to be removed. (1) <2 axes controller>

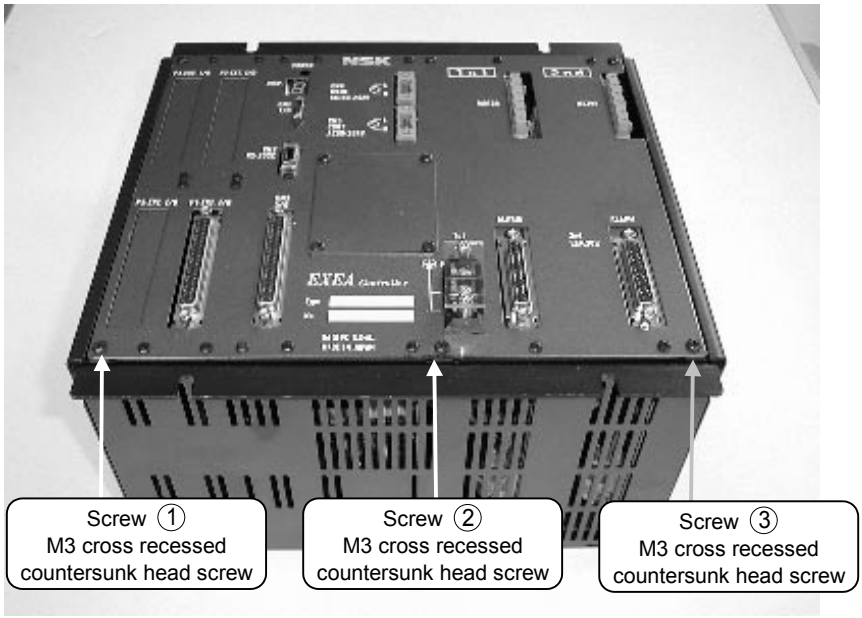
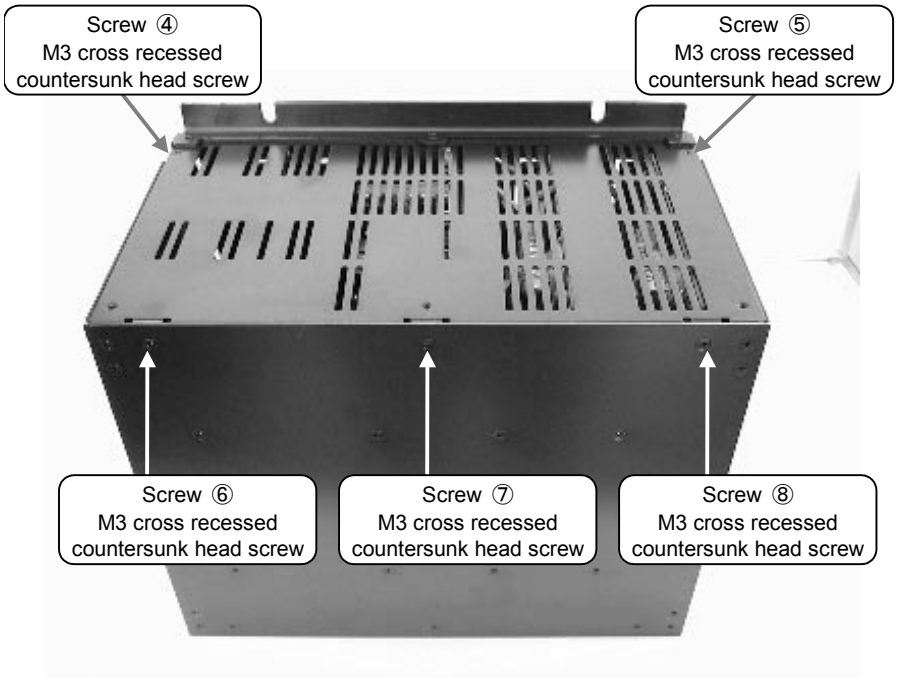


Photo 12-4: Indication of the screws to be removed (2) <2 axes controller>



(3) Remove 13 screws as shown in Photo 12-5 and 12-6 for a 3 and 4 axes controller.

Photo 12-5: Indication of screws to be removed (1)

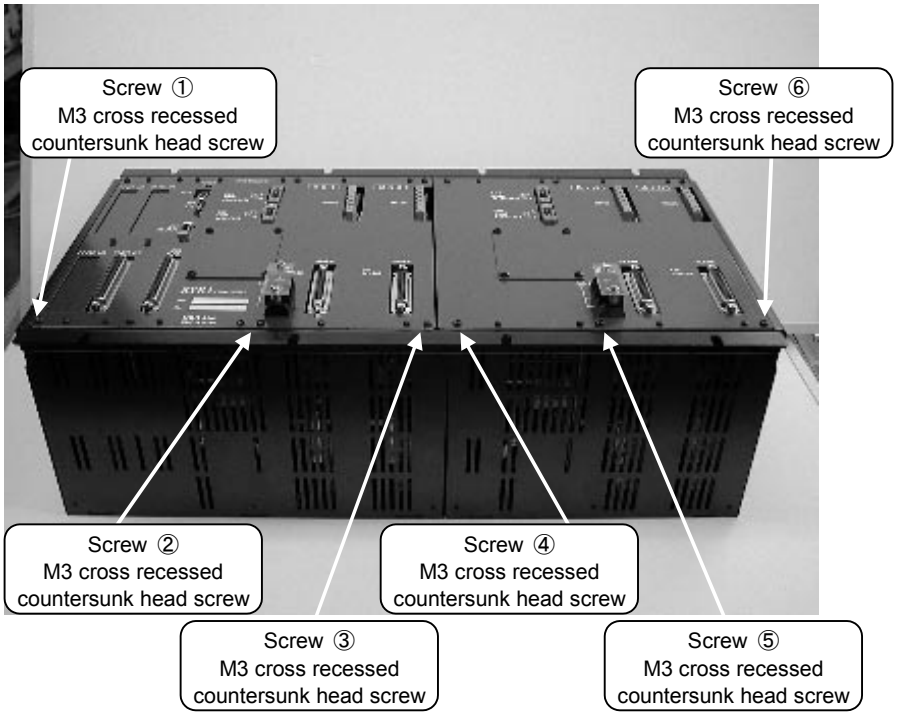
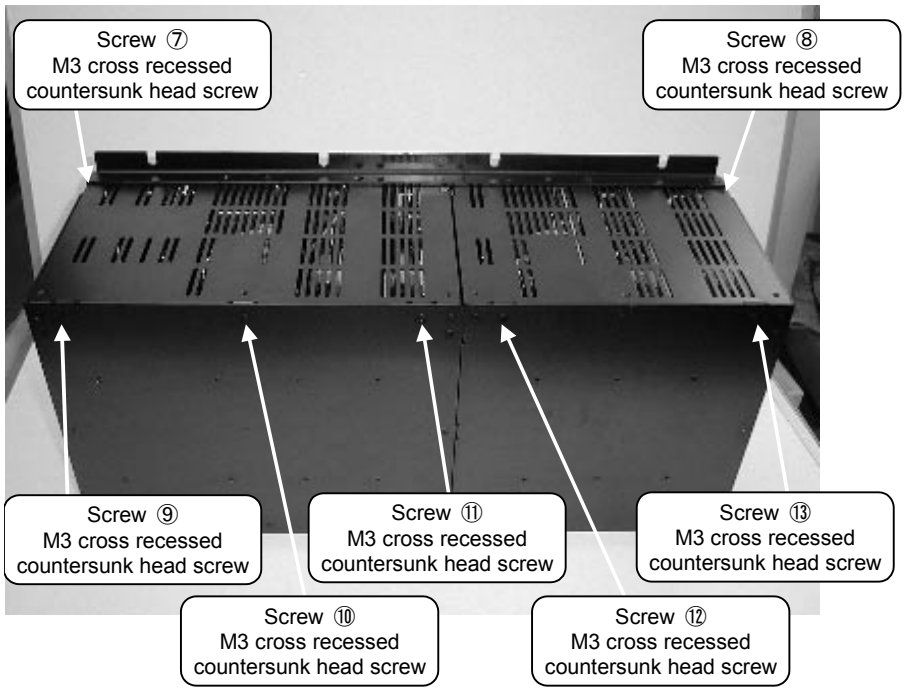
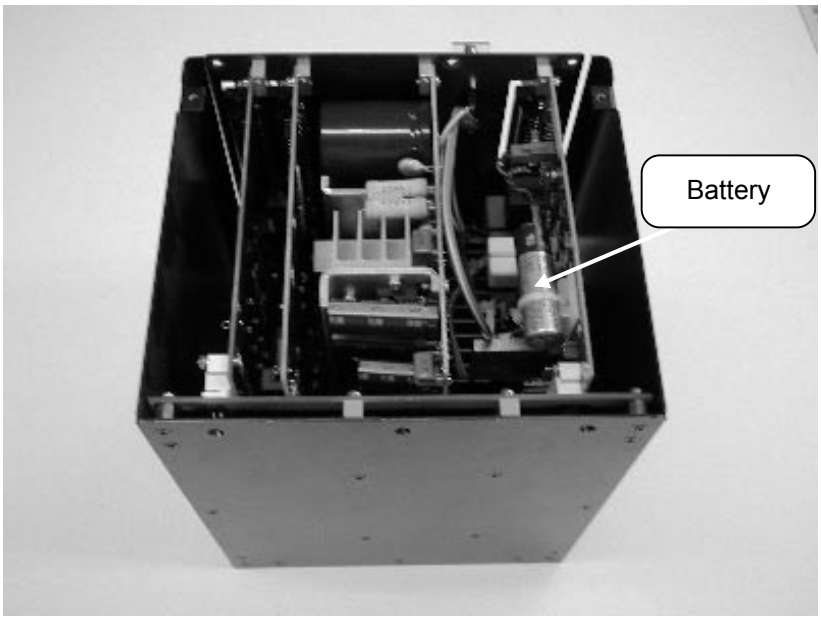


Photo 12-6: Indication of screws to be removed (2)



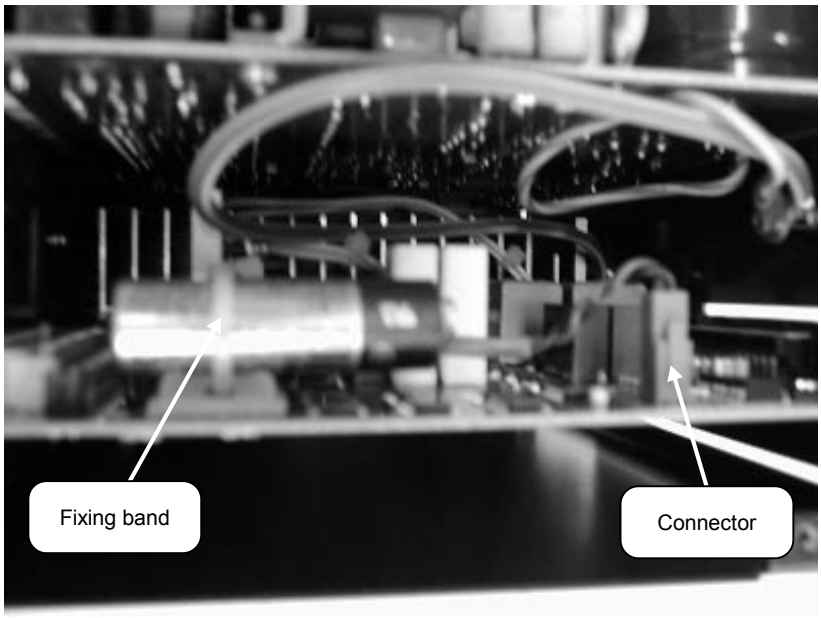
2) You can see the battery which is fixed on a circuit board when the cover is removed as shown in Photo 12-3.

Photo 12-7: A view when the cover is removed. <Single axis controller>



3) Cut the band which fixes the battery to a board, and disconnect the battery and circuit board connectors.

Photo 12-8: The way how the battery is fixed



4) Fix the new battery with the fixing band and connect the connectors firmly.

5) Attach the cover.

12.3. Warranty Coverage

12.3.1. Warranty Period

- The warranty is effective in one year from the delivery of the product or 2400 working hours whichever comes first.

12.3.2. Limit of Warranty

1) The warranty shall be given to the products which NSK Ltd. have manufactured and shipped to users.

2) NSK Ltd. will repair or replace any products which have been proved to the satisfaction of NSK Ltd. to have a defect in material and/or workmanship.

3) Repair cost will be charged to a user after the warranty period stated above has expired.

12.3.3. Immunity

- NSK Ltd. shall not be liable for any circumstances described bellow.
  - (1) Failure of a unit/system due to installation or operation not in accordance with the instruction manual specified by the supplier.
  - (2) Failure of a unit/system due to improper handling, operation, modification and careless handling by a user.
  - (3) Failure by modification and/or repair without manufactures consent.
  - (4) Damages caused by natural disaster or uncontrollable circumstances by the supplier.
  - (5) Designated parts as expendable.
    (Fuse of EXEA controller, cable support and timing belt)
- NSK Ltd. warrants for its products and, under no circumstances, is not liable for any consequential damages, loss of profits and/or injury of personal as a result of claim arising under this limited warranty.

12.3.4. Service Charge

- The price of the product does not include the engineering service charges incurred after the shipment.
- Service fee according to the supplier's standard will be charged for field service even in the warranty period.
- Service fee will be charged based on the relevant standard of NSK Ltd.

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13. Alarms

- This section describes the alarms of the EXEA controller.

13.1. Indication of Alarms

- EXEA controller indicates the alarms by the outputs of CN3 (control I/O connector), the seven segments LED on the front panel and the display of the teaching box.
- In remote control mode through RS-232C interface, the readout command is to report the state of alarms.

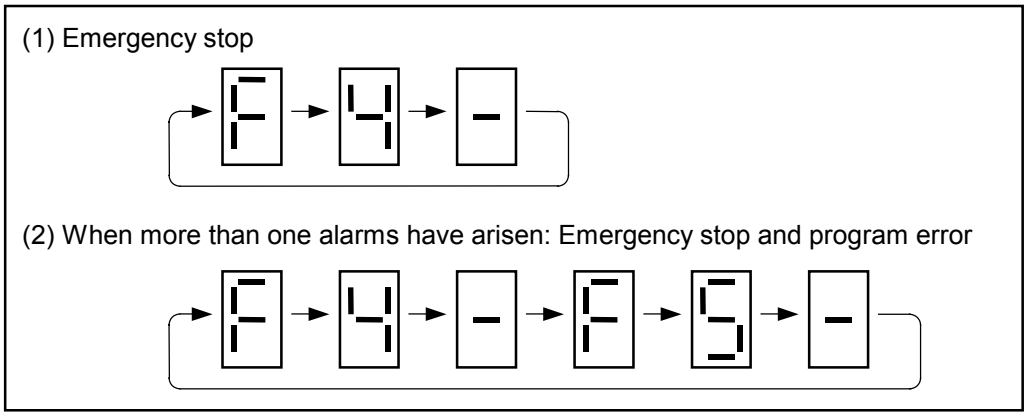
13.1.1. Output of CN3 Connector

- It outputs RDY and WRN. The meanings of each output are:
  - ◊ RDY (Ready) : Opens in case of a serious failure.
  - ◊ WRN (Warning) : Closes in case of a minor failure
- Alarm signals are always outputted regardless the control mode such as external control mode, teaching mode through the teaching box and remote control mode.

13.1.2. Seven Segments LED

- The seven segments LED displays alarm codes by time sharing as shown in examples below as it cannot indicate more than two letters simultaneously.

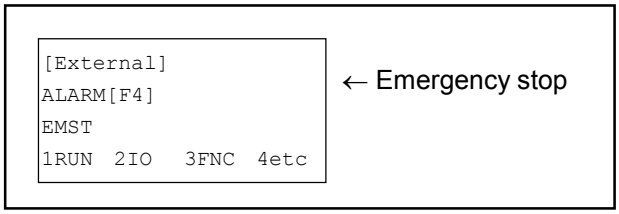
Figure 13-1: Example of alarm indication



13.1.3. Display of Teaching Box

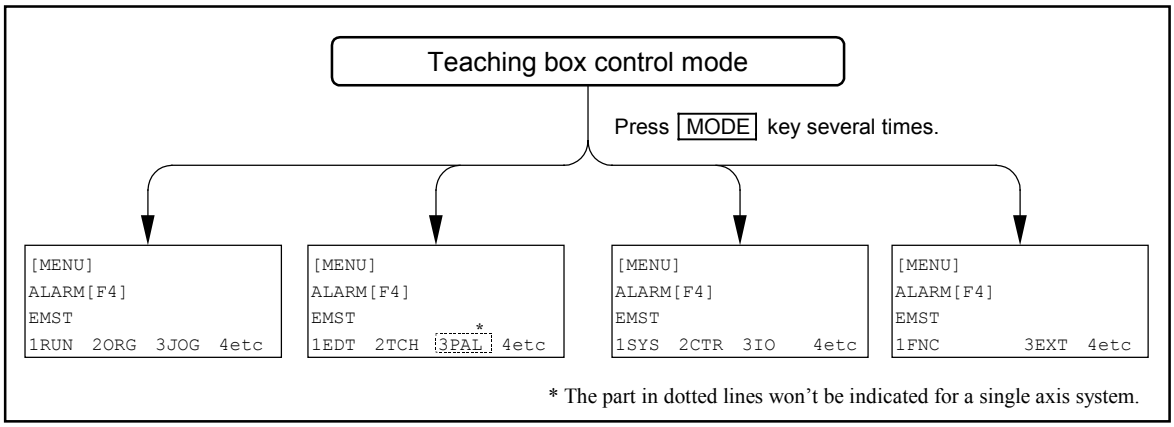
- It indicates an alarm on the third line of the screen.
- If there are two or more alarms, the indication comes on in turn in every one (1) second.

Figure 13-2: Example of the teaching box display



Note: The display does not indicate the contents of alarm in the teaching box control mode. In such a case, return to [MENU] screen and confirm content of alarm.

Figure 13-3: Return to [MENU] screen to confirm an alarm.



13.2. Motor Condition in Alarm State

- In case of a minor failure (WRN output closed), the motor gets in "servo-lock" state. (You can operate system in the state of "Home return incomplete" alarm. Complete the Home return.)
- In case of a serious failure (RDY output opened), the motor gets in "servo-off" state.

13.3. Alarm List

13.3.1. Normal State

- Table 13-1 shows the conditions in normal state.

Table 13-1: Normal state

7 segment LED	LED	RDY output	WRN output	Indication of teaching box
Off	Green	close	open	–

- Even the system is in the normal state, there may be no indication on 7 segments LED or the outputs of RDY may indicate the abnormality in some cases. In such a case, refer to the table below.

Table 13-2: Exceptions in normal state

Item	Motor	7 segments LED	LED	RDY output	WRN output	Cause	Remedy
Power is not on.	Servo off	Off	Off	Open	Open	Power off	Turn on power.
Initializing CPU (When the power is on.)	Servo off	Off	Orange	Open	Open	Initializing CPU.	Wait for a while.

13.3.2. Alarm List

- The alarms given by EXEA controller in abnormal conditions are listed in Table 13-3.

Table 13-3: Alarm List (1/2)

Alarm	Motor	7 segments LED	LED	RDY output	WRN output	Teaching box indication *1	Symptom • Cause
Overheat 1 (Heat sink)	Servo off	P0	Orange	Open	Open	Overheat 1 (heatsink)	Internal heat sink of power amplifier output circuit has overheated.
Overheat 2 (Regeneration resistor)	Servo off	P4	Orange	Open	Open	Overheat 2 (resistor)	Overheat of regeneration resister.
Abnormal Main power voltage	Servo off	P1	Orange	Open	Open	Main Power voltage	Voltage of main power is too high or low.
Excessive current	Servo off	P2	Orange	Open	Open	Overcurrent	Excessive current has applied to the motor.
Insufficient voltage to the control power	Servo off	P3	Orange	Open	Open	Ctrl. Power voltage	Control power voltage is too low.
Encoder circuit error	Servo off	A0	Orange	Open	Open	Encoder 1 (loss)	Snapped encoder wiring or abnormal signal.
Overload	Servo off	A3	Orange	Open	Open	Thermal	Motor operating duty exceeds the rated value.
Speed abnormal	Servo off	A4	Orange	Open	Open	Speed	Motor exceeded its maximum rotational speed.
Home return incomplete	Normal operation	A5	Green	Close	Close	Encoder 2 (Position)	Coordinate cannot be set as Home position is not defined.
Battery error	Servo off	A7	Orange	Open	Open	Encoder 3 (battery)	Encoder data is lost due to low voltage of battery for encoder back-up. (A0 is reported simultaneously.)
Memory error 1	Servo off	E0	Orange	Open	Open	Memory 1 (data)	Inrush noise has destroyed data of parameters or internal data.
Memory error 2	Servo off	E1	Orange	Open	Open	Memory 2 (backup)	External noise has destroyed memory back up for parameters and data.
Memory error 3	Servo off	E2	Orange	Open	Open	Memory 3 (write)	Failure to write back up data to the flash memory.
Memory error 4	Servo off	E3	Orange	Open	Open	Memory 4 (code)	External noise changed contents of system program.
CPU error	Servo off	Not settle or E6	Orange	Open	Open	Cpu (* * * * *) or ツウシンフノウ *2	External noise caused CPU malfunction.
System error	Servo off	E7	Orange	Open	Close	System	Combination of motor and power amplifier has changed.
Excessive position error	Servo off	F1	Orange	Open	Open	Position Error	Position error in the differential error counter have exceeded the set value to detect excessive error.

Table 13-3 (2/2)

Alarm	Motor	7 segments LED	LED	RDY output	WRN output	Indication of teaching box *1	Symptom • Cause
Travel limit (Set by user)	Servo lock for one direction	F2	Green	Close	Close	Soft. OT limit	The slider moved exceeding the limit position set by user. (Initial setting 'Over travel')
Travel limit (Mechanical lock)	Servo lock for one direction	F3	Green	Close	Close	Hard. OT limit	The slider collides with mechanical stopper.
Emergency stop	Servo off	F4	Orange	Open	Open	EMST	Emergency stop has been activated.
Program error	Servo on	F5	Green	Close	Close	Prg (* * * * *) *3	Syntax error in a program or input improper program.

*1. In case of teaching box control mode, contents of alarm might not be shown in some cases.
Return to [MENU] screen and identify an alarm in such a case. Refer to "13.1.3. Display of Teaching Box."

*2. "ツウシンフノウ" message, which means "communication disabled" in Japanese, may appear in some cases besides CPU error.

[Example] When a key is pressed :

- while saving the programs in Program mode.
- while initializing special function operating mode.

*3. (* * * * *) ----- Varies by the contents of Program error.

13.4. Description of Alarm

Danger *: Check the followings before attempting to investigate the cause of an alarm or take necessary action according to the description in this paragraph. If these items are not observed, the checking work itself can be dangerous and further critical accident may occur due to burning motor or the system malfunction.*

1 Matching of module main unit and power amplifier of the controller

- Check that the motor power output of the main module unit conforms with output of the driver unit in the controller.

  Example of error: Connect a 200 W controller to a 100 W module main unit.

2 Do you use the standard controller cable from NSK ?

- If you have modified the standard cable or you have made the cable by yourself, take a great care to have proper wiring.

  Example of error:
  Example 1: If you have faulty wiring on U, V, and W wires for motor power line, the motor may malfunction.
  Example 2: If you have faulty encoder wiring, it causes the system malfunction.

3 Check that the power supply voltage is correct.

- ◊ EXEA □ - □□□□ - A □□ : Single phase AC 180V ~ 242V
- ◊ EXEA □ - □□□□ - C □□ : Single phase AC 90V ~ 121V

- If the voltage exceeds the above range, the driver may be burned.

4 Make sure that the FGND terminal is not connected to the AC power line.

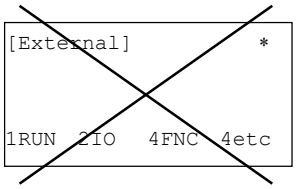
- If AC power is connected to the FGND terminal or the ground, the controller may function improperly and furthermore, the controller might be burned.

Danger *: Before attempting to investigate the cause of an alarm and, to take actions for recovery according to descriptions of this paragraph, check that the module main unit has completely stopped, then turn off the main power for your safety. This is necessary to prevent the operator from being crushed or being caught by the unit. If you must work with entire system active, take full safety measures referring to the following.*

(1) Do not enter the area bound by the guard fence.

(2) When working inside of the guard fence observe the following.

◊ Set the controller to the teaching operation mode and set the system to servo off state. Take possible means to prevent to turn servo on or operate the system from the out side of the guard fence.



: Confirm that the operation mode is not the external control. Do not operate the system with the display shown in the left.

: Confirm that the servo on indicator (∗) on upper right corner of the screen is off.

Indicates the servo is off.

◊ When operation of the system or making motor in servo-on state is necessary, make sure that no other person and no obstacle are in the motion range of robot. Then set the moving speed to 250 mm / sec. and start the work. Be sure to provide necessary means to prevent entry of other persons into the area while you are operating the system.

◊ Keep the teaching box handy to the operator for immediate termination of operation in an emergency.

◊ Before starting the work, check that the emergency stop circuit works when the emergency button is pressed. ('Emergency stop' circuit must be provided by the user.)

◊ Do not touch the primary power supplying area to avoid electric shock. Do not turn on the power before closing enclosure cover.

13.4.1. Overheat

Table 13-4

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	P0	Orange	Open	Open	Overheat1 (heatsink)
Servo off	P4	Orange	Open	Open	Overheat2 (resistor)

Warning : Be careful not to be burned as the heat sink and the dump resistor are hot when this alarm is given.

- There are two types of overheat alarm (P0 and P4). The alarm reports overheat when either one or both of thermal sensors installed on the following two points are turned off.
  1) P0: Internal heat sink on the output port of power amplifier.
  2) P4: Internal dump resistor.
  3) P4: External dump resistor for processing regeneration. (Optional)
- When this alarm arises, EXEA controller terminates its operation immediately and the motor enters servo off state. Turn the power off and cool the controller entirely, then investigate the cause and take actions for recovery.

Table 13-5

Classification	Cause	Action
Power amplifier output stage	• High ambient temperature.	• Lower ambient temperature. • Forcibly cool the heat sink with a fan.
	• High operation duty or load. * As these two factors shall be covered by software thermal, normally the overload alarm will be given before the overheat is detected.	• Relax the operation duty or the load. • Reduce acceleration / deceleration.
	• Defective thermal sensor or snapped internal wiring.	• Replace the controller. → Contact your local NSK representative.
Regenerative dump resistor	• High ambient temperature.	• Lower ambient temperature.
	• Regenerative energy is too much to be processed by the external dump resistor. This leads to overheat. → Long stroke and/or high load of the vertical. → High acceleration/deceleration and frequent accelerating/decelerating.	• Lower the load. • Decrease acceleration / deceleration. • Install external dump resistor. → Contact your local NSK representative.
	• Defective thermal sensor (optional) or snapped internal wiring.	• Replace the thermal sensor or the controller. → Contact your local NSK representative.

13.4.2. Abnormal Main Power Voltage

Caution : Turn off the power immediately when this alarm arises. Otherwise the internal circuit of EXEA controller might be burned due to high voltage exceeding AC 264 volts.

Table 13-6

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	P1	Orange	Open	Open	Main Power voltage

- This function is to monitor the voltage of the main power system and give an alarm if main power voltage exceeds the criteria.

- There are two types of main power voltage abnormality.
  (These are not discriminated by the alarm display.)

  1) Excess voltage: Main power voltage after rectification exceeds 400 V.

  2) Low voltage: Main power voltage after rectification drops below 60 V.

- When this alarm arises, EXEA controller terminates its operation immediately and the motor gets into the servo off state. Immediately turn off the main power, investigate the cause and take the necessary actions.

Table 13-7

Abnormality	Cause	Remedy
Excessive voltage	• Very high voltage is applied to the main power. : Example : 400 V • Faulty power source (very wide voltage variation)	• Rectify the problem of power source. (Change the source to normal power line.)
	• The source voltage is increased as the regenerative energy is too much to be processed by the internal regenerative dump resistor. * Normally the aforementioned overheat alarm should be given (regeneration) before this alarm is detected.	• Reduce the load. • Reduce acceleration and deceleration.
	• Defective internal dump resistor has resulted in high voltage of main power. • The monitoring circuit of excessive voltage is defective.	• Replace the controller. → Contact your local NSK representative.
Low voltage	• Snapped, defective electric contact or mistaken wiring of main power line.	• Check for defective wiring and correct it.
	• Defective power source. (too much voltage variation in the power line.)	• Use a normal power line with less voltage variation
	• The monitoring circuit of excessive voltage is defective, the internal power line is snapped or the line has defective electrical contact.	• Replace the controller. → Contact your local NSK representative.

13.4.3. Over Current

Table 13-8

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	P2	Orange	Open	Open	Overcurrent

- This function is to monitor the current to the motor and gives an alarm when it exceeds three times of rated current of the motor.
- Alarm will arise immediately after the power is turned on when the current detective circuit is not functioning normally.
- When this alarm arises, EXEA controller terminates its operation immediately and the motor gets in the servo off state. Turn off the main power, investigate the cause and take the necessary actions to rectify the problem.

Table 13-9

Cause	Remedy
• Motor windings or motor cable is short circuited (short circuit between two wires) and an excessive current is applied to the motor.	• Check the motor and motor cable and replace it if necessary.
• The motor winding or motor cable is grounded (short to the earth wire) and the excessive current is given.	• Check the motor and cable. Replace them if necessary.
• Over current is applied to the motor due to steep rise of current command from the controller. → Excessive acceleration/deceleration or load to the motor. → An acute angle in the path of continue path program.	• Reduce acceleration/deceleration and/or load. • Provide a radius to the acute direction change in the continue path program.
• The monitoring circuit of current is defective or internal wiring is snapped.	• Replace the controller. → Contact your local NSK representative.

13.4.4. Insufficient Voltage to Control Power

Table 13-10

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	P3	Orange	Open	Open	Ctrl. Power voltage

- The function of this alarm is to detect low voltage of the control power (70V or less after rectification) and terminate operation of the system to prevent malfunction of the control board due to unstable control power (DC 5V system).

- When the main power voltage drops, this alarm reports abnormality before the main power voltage alarm (low voltage) is detected.

- When this alarm arises, EXEA controller terminates the operation of the system immediately, and the motor gets in the servo off state. Turn off the main power, investigate the cause and take the necessary actions.

Table 13-11

Cause	Remedy
• Abnormal power supply. (too much voltage variation)	• Check the power line voltage and use a normal power supply.
• The power supply cable is too thin and too long. → Voltage drops when the maximum current is applied.	• Use more thicker and shorter cable.
• The power supply cable is snapped, or it has defective wiring.	• Check for the wiring
• The monitoring circuit of control power is defective or the internal wiring of power supply is snapped or has defective contacts.	• Replace the controller. → Contact your local NSK representative.

13.4.5. Encoder Circuit Error

Table 13-12

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	A0	Orange	Open	Open	Encoder1 (loss)

- This function is to monitor the signal level of line driver differential output from the encoder and an alarm arises when the encoder signal is none differential output and is considered to be abnormal.

- When this alarm is reported, EXEA controller terminates its operation immediately and the motor gets in the servo off state. Turn off the main power, investigate the cause and take the actions for recovery.

  Caution : *The coordinate data of EXEA controller and Encoder are off when this alarm arises. Be sure to operate Home return after turning on the power.*

Table 13-13

Cause	Remedy
• The encoder cable is shorted, grounded or disconnected. • Improper wiring.	• Check the controller cable and cable support for continuity. Check each signals for short circuit and grounding. Replace the cable if necessary.
• The line driver of encoder signal output is defective.	• Replace the module main unit. → Contact your local NSK representative.
• Monitoring circuit of encoder disconnection is defective. • Power source of switching in the controller is defective.	• Replace the controller. → Contact your local NSK representative.
• Error due to defective back up battery. (Low voltage, improper wiring of battery)	• Replace battery. • Check the wiring of battery.

* When the cable is shorted and/or grounded, the encoder as well as the receiving circuit of encoder signal may be damaged. If the system does not recover even after the cable is replaced, the damages on encoder and its signal receiving circuit are suspected to be defective.

- This alarm arises in case of "Encoder alarm" as well. The detailed code of encoder alarm is indicated by the 2 digits in hexadecimal notation when the power is turned on again after the alarm has arisen.

  Encoder 1 (loss) - ** (** : 2 digits code by hexadecimal notation)

- Confirm the contents of corresponding bit by converting the 2 digits code of hexadecimal notation to binary number.

Table 13-14: Details of Encoder alarm.

Bit	Contents	Remedy
7	Over speed of first or third axis	Take measures not to move a main unit when the power of EXEA controller is turned on again.
3	Over speed of second or fourth axis	
6	Absolute error of first or third axis	Replace the motor when the system does no recover by turning on the power again.
2	Absolute error of second or fourth axis	
5	Check sum error of first or third axis	
1	Check sum error of second or fourth axis	
4	Backup alarm of first or third axis	This alarm may arise simultaneously with "Battery error." Take the same measures against the "Battery error" alarm.
0	Backup alarm of second or fourth axis	

Note: Only the alarms of the first axis is indicated for a single axis system.

13.4.6. Overload (Protection by Software Thermal Switch)

Table 13-15

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	A3	Orange	Open	Open	Thermal

- This function is to monitor the average of current command to the motor and give an alarm when the current command exceeds rated current of the motor.
- When this alarm arises, EXEA controller terminates its operation immediately and the motor gets in the servo off state. Turn the power off, then investigate the cause and take necessary actions.

Table 13-16

Cause	Remedy
• Excessive motor duty, load and acceleration/deceleration.	• Relax motor duty and decrease load and acceleration/deceleration. • Air-cool the motor after terminate operation as it is overheated. (Keep the controller power turned on while cooling the motor.)
• Improper initial setting of software thermal switch.	• Set the software thermal switch properly.
• Continued operation without releasing the motor brake. → Disconnected brake line wiring of controller cable and support cable. → Built in DC24V power supply to EXEA controller is defective.	• Check DC24V power supply and wiring. Rectify the problems. • Investigate brake line wiring of controller cable and cable support. Replace defective cable. • Replace the controller. → Contact your local NSK representative.
• Snapped motor winding or motor cable.	• Check for motor winding and/or motor cable. Replace them if required.

13.4.7. Speed Abnormal

Table 13-17

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	A4	Orange	Open	Open	Speed

- This function is to monitor rotational speed of the motor and gives an alarm if it exceeds the allowable maximum speed.
- Rotational speed of the motor may exceed the limit due to influence of noise to motor cable and the controller.
- When this alarm arises, EXEA controller terminates its operation immediately and the motor gets in the servo off state. As though the alarm may be cleared by "alarm clear," investigate the cause and take necessary actions.

Table 13-18

Cause	Remedy
• Module main unit moved very fast due to an external load or gravity under servo off state.	• Take an appropriate measure not to move the module main unit exceeding its maximum speed criterion.
• Noise has caused an excessive motion command or too much position deviation.	• Take sufficient measures against noises. → Review all wiring of grounding. → Check the power line. ---- Do not use the same power line with the equipment such as a compressor which causes unstable power variation. → Do not install the robot module system near equipment such as an welding machine which generates noises. → Refer to "7.2.5. Measures against Noises."
• Encoder error or internal data error	• Replace the module main unit. → Contact your local NSK representative.

13.4.8. Home Return Incomplete

Table 13-19

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Normal operation	A5	Green	Close	Close	Encoder 2 (position)

- The controller gives this alarm when Home return is not completed in the following cases.
  1) After power is turned on.
  2) After initialization.
  3) When combination of module main unit and controller is changed.
- The alarm will be reported in the following cases even though the home return has been completed and no alarm has not arisen.
  1) When the type of a main unit is changed.
  2) The power is turned off without saving the change of a main unit type (in case of above example) after the home return was conducted again.
  3) Home return is interrupted by the stopping, an alarm or shutdown of the power when conducting the home return again.
  4) When an alarm of encoder error (A0) arises.
- You cannot perform positioning in absolute coordinate format or programmed operation during this alarm is active.
- This alarm may arise when EXEA controller and a module main unit are connected after their disconnection for transportation. This is caused by disconnection of the back up power to the encoder from EXEA controller.

Table 13-20

Cause	Remedy
• The coordinates of EXEA controller and encoder do no conform as the Home position is not defined yet.	• Execute home return.

13.4.9. Battery Error

Table 13-21

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	A7	Orange	Open	Open	Encoder 3 (battery)

- This function is to give an alarm for low voltage (2.8 V or less) of a battery for encoder back-up.
- This alarm may occur when wiring of battery has snapped wire or insufficient contact.

Caution : The controller cannot recover until the battery is changed when this alarm is given.
Be sure to change to a new battery.

Caution : After replace of battery, be sure to perform Home return operation.

Table 13-22

Cause	Remedy
• Low battery voltage.	• Replace a battery of an encoder that has lost coordinates data. → Refer to "12.2.2.2. Replacement" for procedures.
• Wiring of battery has snapped wire or insufficient connection.	• Replace the battery. Contact your local NSK representative if the alarm is given again after change of the battery.

13.4.10. Memory Error 1

Table 13-23

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	E0	Orange	Open	Open	Memory 1 (data)

- The EXEA controller checks the contents of memories after the power is turned on and periodically thereafter. This function gives the alarm when there is abnormality in the parameter data currently being used and the data of internal memories.
- When this alarm arises, the EXEA controller terminates its operation immediately and the motor gets in the servo off state.
- Turn on power again for recovery.

Table 13-24

Cause	Remedy
• A large inrush current intruded into the control board, caused memory circuit malfunction and resulted in the memory destruction.	• Take appropriate measures for noise. → Review ground wiring. → Look again the power line. Do not use the same power line with an equipment which tends to disturb the power line such as an air compressor. → Do not install EXEA controller close to a machine such as a welding machine which generates a lot of noises. → Refer to "7.2.5. Measures against Noises."

13.4.11. Memory Error 2

Table 13-25

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	E1	Orange	Open	Open	Memory 2 (backup)

- This function is to give an alarm on memory error of program/point register. EXEA controller conducts check of the memory when turning on the power. When abnormal results on check is observed, it gives the memory error alarm.
- When this alarm arises, EXEA controller terminates its operation immediately and the motor gets in the servo off state.
- Initialize the memory, then input program and conduct teaching data of point register. Refer to "13.6. Initialize Memory."
- It may give the alarm when turn off the power in the middle of saving the parameters and data to the memory. While saving the parameters and data, the teaching box display indicates "Writing" and the control output DATWT (CN3) is closed. Do not turn off the power when the display is indicating "Writing" and DATWT out put is closed.

Table 13-26

Cause	Remedy
• A large inrush noise intruded into the control board, caused the memory circuit to malfunction, and resulted in memory destruction.	• Take appropriate measures for noise. → Review ground wiring. → Check again the power source. Do not use the same power line with an equipment tends to disturb power source such as an air compressor. → Do not install EXEA controller close to a machine, such as a welding machine, which generates noises. → Refer to "7.2.5. Measures against Noises."
• The power is interrupted in the middle of rewriting memory.	• Connect to stable power supply line.

13.4.12. Memory Error 3

Table 13-27

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	E2	Orange	Open	Open	Memory 3 (write)

- This is to give an alarm when saving the parameters and data is not completed normally due to some disturbance.
- When this alarm arises, EXEA controller stops its operation immediately and the motor gets in servo off state.
- Initialize the memory, then input program and conduct teaching data of point register. (Refer to "13.6. Initialize Memory.")
- It may give the alarm when turn off the power in the middle of saving the parameters and data to the memory. During saving the parameters and data, the teaching box display indicates "Writing" and the control output DATWT (CN3) is closed. Do not turn off the power when the display is indicating "Writing" and DATWT out put is closed.

Table 13-28

Cause	Remedy
• A large inrush noise intruded into the control board, caused the memory circuit to malfunction, and resulted in memory destruction.	• Take appropriate measures for noise. → Review ground wiring. → Check again the power source. Do not use the same power line with an equipment tends to disturb power source such as an air compressor. → Do not install EXEA controller close to a machine, such as a welding machine, which generates noises. → Refer to "7.2.5. Measures against Noises."

13.4.13. Memory Error 4

Table 13-29

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	E3	Orange	Open	Open	Memory 4 (code)

- EXEA controller conducts check of the memory after turning on the power. This alarm function is to check the system ROM.
- When this alarm arises, EXEA terminates its operation immediately and the motor gets in the servo off state.
- Turn on power again for recovery. Replace EXEA controller when it does not recover by turning on power again.

Table 13-30

Cause	Remedy
• A large inrush noise intruded into the control board and lead to memory destruction due to memory circuit malfunction.	• Take appropriate measures against noise. → Review ground wiring. → Look again the power line. Do not use the same power line with an equipment which tends to disturb the power line such as an air compressor. → Do not install EXEA controller close to a machine such as a welding machine which generates a lot of noises. → Refer to "7.2.5. Measures against Noises."
• Defective hardware of controller.	• Replace the controller. → Contact your local NSK representative.

13.4.14. CPU Error

Table 13-31

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	Indefinite / E6	Orange	Open	Open	Hold previous display Cpu (* * * * *)

(* * * * *) --- Differs with contents of alarms.

- This function is to monitor CPU malfunction and data exchange between the CPUs through monitoring circuits such as watchdog timer.

- When this alarm arises, EXEA controller terminates its operation immediately and the motor gets in the servo off state. In case of momentary malfunction, remake main power for recovery. If the system does not recover, hardware circuit failure is suspected.

Table 13-32

Cause	Remedy
• A large inrush noise intruded into the control board and caused CPU malfunction.	• Remake the power. • Take appropriate measures for noise. → Review ground wiring. → Check again the power source. Do not use the same power line with an equipment tends to disturb to power source such as an air compressor. → Do not install EXEA controller close to a machine such as a welding machine which generates noises. → Refer to "7.2.5. Measures against Noises."
• CPU or the watchdog circuit has failed.	• Replace the controller. → Contact your local NSK representative.

13.4.15. System Error

Table 13-33

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	E7	Orange	Open	Open	System (* * * * *)

(* * * * *) --- Differs with contents of alarms.

- This function is to give an alarm when composition of system at initialization of controller differs with the one at the moment of turning on power after initialization.

  Power Amp : Composition of power amplifier of the controller differs with the one at the initialization.

  Motor : Type of motor set to power amplifier differs with setting at the initialization.

  Version : Version number of CB board differs with the one at the initialization.

  Cpu : Composition of CB board differs with the one at the initialization.

- It may occur for defective power amplifier or extend CB board for three/four axes, or also occur when power amplifier or CB board is replaced to repair the controller.

- Initialization of the controller will recover from the alarm. If not, defective circuit of hardware such as a power amplifier is suspected.

Table 13-34

Cause	Remedy
• Defective amplifier disturbs to identify the types.	• Replace the controller. → Contact your local NSK representative.
• System configuration has been changed due to replacement of controller, or exchanging hardware.	• Initialize EXEA controller.

13.4.16. Excessive Position Error

Table 13-35

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	F1	Orange	Open	Open	Position Error

- This function is to give an alarm when position error in differential error counter exceeds the preset limit. This limit may be specified by "POS over" parameter at initial setting.
- This alarm is to give the warning that the position control is disturbed for some reason (mechanical interruption to module main unit, etc.).
- EXEA controller terminates its operation immediately when this alarm arises and the motor gets in servo off state,

Table 13-36

Cause	Remedy
• Improper setting of POS.err over parameter.	• Set correctly. → Reset to the shipping set.
• Improper gain setting. * Generally this alarm tends to occur when position gain is set too low. However, it won't occur unless the gain setting is extremely deviated.	• Optimize gain setting. → Reset to the shipping set if the load is not heavy. → Increase gain for heavy load.
• Brake of module main unit is not released. • Refer to "14.2.2. Check Function of Brake Control." * In such a case, overload alarm may come up first. Refer to the clause for overload alarm.	• Release the brake.
• A module main unit is interfered or defective.	• Investigate back drive force, motor lock and interference of robot motion, then remove the cause or replace unit (parts) if necessary.
• Output of motor power does not conform to specification. → Example: 200 V module is connected to 100 V power line.	• Refer to specification then correct or replace the unit as required.
• The motor does not rotate. → Examples: Miss-wiring of motor cable and the snapped wire.	• Check the cables and correct or replace it as required.

13.4.17. Software Travel Limit Switch (Set by user.)

Table 13-37

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo is locked for one direction.	F2	Green	Close	Close	Soft. OT limit

- This function is to give an alarm if the slider travels (= motor rotates) beyond the software travel limit. Software travel limit is set by "Over travel" parameter as an initial setting.
- This alarm is invalid unless "Over travel" parameter is set numerically. The shipping set is "OFF."
- This function is invalid unless Home return is completed and the coordinates are set.
- When this alarm arises, EXEA controller terminates its operation immediately, and the motor gets in "servo lock" state for one direction not to execute the command to near further to the limit. The system accepts commands to move slider to opposite direction. Move the slide opposite direction by jog or other move command to get out from the limit area.

Table 13-38

Cause	Remedy
• Improper setting of parameter "Over travel."	• Set parameter properly.
• Current position is in software over-travel limit.	• Get out from the limit range.

13.4.18. Travel Limit (Mechanical lock)

Table 13-39

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo is locked for one direction.	F3	Green	Close	Close	Hard. OT limit

- This function is to give a warning when the slider gets in mechanically locked state and cannot move one direction because it hits a mechanical stopper at stroke end or it is interfered externally.
- This alarm may occur due to extremely heavy load exceeding specification limit as well.
- In such a case, relax acceleration and deceleration and lower the load to fit into specification.
- When this alarm arises, EXEA controller terminates its operation immediately, and the motor gets in "servo lock" state for one direction not to execute the command to near further to the limit. Check for cause of mechanical lock and remove the obstacles in motion range of slider. Relief the motor from servo lock state moving the slider in opposite direction, if necessary, by Jog or other motion command. Pay special attention for the slider of vertical axis.
- The system accepts command to move the slider to opposite direction in this alarm state. If there is no mechanical obstacles, you may move the slider into opposite direction of mechanical stopper by Jog or other motion command.
- When the slider hits the mechanical stopper on stroke end frequently, review the coordinate data of position and perform Home return.

Table 13-40

Cause	Remedy
• The coordinate setting does not meet stroke end position, or the relation of coordinates between the motor and encoder is shifted due to sudden noise disturbance.	• Execute Home return and check coordinates again.
• The slider is locked by external obstacle.	• Remove the obstacles by Jog or servo off.
• Load that brings torque exceeding the motor capacity is applied to the robot.	• Decrease load. • Relax acceleration and deceleration.

- If this alarm arises frequently even there is no problems on the load mass, the operational conditions and the motor is not overheated, set the travel limit timer (Hard OT Timer) manually. At this time, set the timer in the range not to arise an overload (A3) alarm.

Caution : Do not set the travel limit timer manually in the following conditions.

◊ when the motion of main unit is not smooth in Servo on or Servo off.

◊ when main unit shows unstable motion due to vibration or hunting.

13.4.19. Emergency Stop

Table 13-41

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo off	F4	Orange	Open	Open	EMST

- This function is to give an alarm when the emergency stop command is inputted to EXEA controller and the system gets in the emergency stop state.

Table 13-42

Cause	Remedy
• Execute an emergency stop operation.	• Call off the emergency stop state, execute alarm reset process or remake main power again. Refer to "11.3.1.3. Recovery from Emergency Stop" for recovery.
• Got in the emergency stop state without any command was called for, or cannot lift the emergency stop state.	
Example 1: Incorrect wiring, none wiring or disconnected wire of CN3EMST input	• Review all wiring and correct as required. • Check on wiring of DC 24V power supply and correct as required.
Example 2: EMST input is considered to be off as the rising of external DC 24V power supply for CN3 connector is slower than rising of EXEA controller. (when DC 24V is supplied externally.)	• Check on DC 24V power supply and review sequence of start up.
Example 3: Teaching box is disconnected, or EMST switch of teaching box is defective.	Replace teaching box.
Example 4: Malfunction of EMST line due to an external noise.	Take measures against noise. Refer to "7.2.5. Measures against Noises."
Example 5: Failure of internal circuit of EXEA controller.	* Refer to "14.1.8. Unable to Clear Emergency Stop."

13.4.20. Program Error

Table 13-43

Motor condition	7 segments LED	LED	DRDY output	WRN output	Display of teaching box
Servo lock	F5	Green	Close	Close	Prg (* * * * *)

- This function is to give an alarm when a program which has syntax mistake or, a program that is impossible to execute is inputted during the operation. This alarm is given when a programmed operation is interrupted by an emergency stop or servo-off command as well.

- When this alarm arises, EXEA controller terminates its operation immediately and motor gets in servo lock state. Cancel the alarm referring to "13.5. Clear Alarm", investigate the cause and correct the program as required. (Refer to "15.2. Programming" again.)

Table 13-44: Program Error (1/2)

Teaching box display Prg (* * * * *)	Cause
Prog not found	• Attempted to execute empty program.
Step not found	• Program is not written to the end. (= END command is not set to the end of the program.)
Axis mismatch *1	• In circular/circular arc interpolation and continue path, the data is not properly set. [Examples] ◊ Four axes coordinates data are set to the point registers. ◊ Required data is not specified. (Only one axis coordinates data is set, etc.) • Teaching data of axis unit is mismatched. (the combination of XY and XZ is mixed up, etc.)
Data range over	• The set data exceeds upper or lower limit. • Decimals are set to a data to which only an integer can be set.
Undefind TAG	• A TAG which is designated as the destination of Jump is not set in the same program.
Duplicate TAG	• Several TAGS with the same name exist in the same program.
Too many CALL	• The nesting of CALL command are 5 or more. (Allowable nesting loop is four or under.)
Without CALL	• Attempted to execute REP command before CALL command is set.
Too many REP	• The nesting of REP command are 5 or more. (Allowable nesting loop is four or under.)
Without REP	• Attempted to execute NXT command before REP command is set.
Can't make cir *1	Cannot execute circular / circular arc interpolation due to following reasons. • Attempted an interpolation which includes an moving axis in a multitask operation. • Designated three points are not on a circle or arc. (Example: They make a line.) • Starting point of circular / circular arc interpolation and current position are different in ABS coordinate format. • Omitted the starting point in INC coordinate format.
Servo off	• Attempted to execute MOVE command in servo off state. → Start operation again after turn on the servo.
Axis offline *1	• Attempted to execute a command to use an axis not specified.

Table 13-45: Program Error (2/2)

Teaching box display Prg (* * * * *)	Cause
Origin not exe.	• Attempted to execute motion command before completion of Home return. → Start operation again after Home return is completed.
Can't make path *1	Cannot execute continue path due to following reasons. • More than 101 steps are set between CPS and CPE. • The same settings which cause "Can't make cir" exist in the program of continue path.
Without CPS *1	• Attempted to execute CPE command without CPS command.
Undefined cmnd *2	• The program command that does not exist is set.
Can't restart	Cannot resume programmed operation due to following reasons. • Attempted to resume the programmed operation while the cycle stop has not been completed (= The step has not been completed.) after the interruption of the program. • Attempted to resume an interrupted program after execution of a command equivalent to END command mistakenly such as Emergency stop (EMST) or Forced stop (STOP). • Attempted to resume interrupted program not in accordance with the description of the instruction manual. • Attempted to resume the interrupted program before the conditions described in the instruction manual are not met.
R. Prg not found	• When resuming the interrupted program. nothing is set to the initializing program for resumption even it is set by RSTA command.
Task full	• More than 17 tasks are specified. (More than 5 tasks for a single axis system.)
Unit offline	• Attempted to operate a Unit that is not specified.
Axis overlap	• Attempted to operate an axis, that is used in a multitask, simultaneously in the other operation.
Over travel	• Stopped due to over travel.
Alarm	• Stopped because of an alarm.
Undefined PRG	• There is no program specified by the name.
Duplicate PRG	• There are several programs with the same name.
Undefined PAL *1	• There is no palletizing program with a specified name.
Duplicate PAL *1	• There are several palletizing program with the same name.
Not Init. PAL *1	• The palletizing program is not initialized: Attempted to execute a palletizing operation even PALI command is not set.
overlap PAL *1	• Tried to operate the same palletizing program which are under execution.
Without CHLD	• Attempted to execute ENDC command even CHLD command is not set.
Cmnd mismatch	• More than 101 steps are inserted between CPS and CPE. (for multi-axis combination only.) • A command other than MOV, MOVM, CIR, ARC, OUT and SPD is set between CPS and CPE. (for multi-axis combination only.) • Attempted to execute a special command such as "MOV RSTA," or "OUT OP ** = RSTA" even it is not in initializing program of resumption which is set by RSTA command.
Can't make mov *1	• Combination of motion which is impossible to make is set.

* 1. This function or indication does not exist for a single axis system.

* 2. This alarm does not arise in normal state. Memory initialization and re-programming are required when the alarm arises.

13.5. Clear Alarm

- Clearing an alarm is to set off a latch, which is set to EXEA controller internally, and this does not do anything with removing the cause of an alarm. Unless the cause has not been removed, the same alarm will arise.

Caution : When an alarm is reported, investigate the cause and remove it first. Repeating "clearing an alarm and alarm reporting" without removing the cause might damage the controller, the module main unit and ancillaries.

Table 13-45: Alarm that can be cleared

Classification	Alarm	LED indication	Teaching box display	Remarks
Alarm related to power amplifier	Abnormal main power voltage	P1	Main Power voltage	
Alarm related to servo motor	Over load	A3	Thermal	
	Speed abnormal	A4	Speed	
Alarm related to control	Excessive error	F1	Position error	
	Over travel limit	F3	Hard. OT limit	
	Emergency stop	F4	EMST	
	Program error	F5	Prg (* * * * *)	

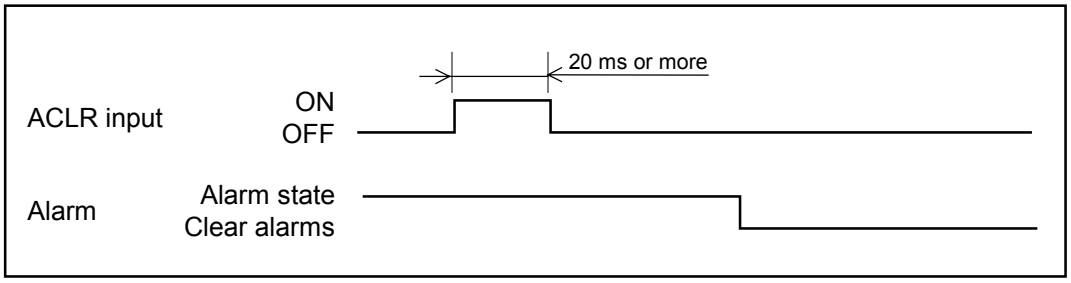
Table 13-46: Alarm that cannot be cleared

Classification	Alarm	LED indication	Teaching box display	Remarks
Related to power amplifier	Overheat 1 (heat sink)	P0	Overheat 1 (heatsink)	
	Overheat (regeneration dump resistor)	P4	Overheat 2 (resistor)	
	Excessive current	P2	Overcurrent	
	Insufficient voltage to control power	P3	Ctrl. Power voltage	
Alarm related to servo motor	Encoder circuit error	A0	Encoder 1 (loss)	Home return is necessary after recovery.
	Home return incomplete	A5	Encoder (Position)	
Alarm related to control	Battery error	A7	Encoder (battery)	Home return is necessary after battery is replaced.
	Memory error 1	E0	Memory 1 (data)	
	Memory error 2	E1	Memory 2 (backup)	Reset after initialization of memory.
	Memory error 3	E2	Memory 3 (write)	
	Memory error 4	E3	Memory 4 (code)	Replace EXEA controller.
	CPU error	E6 etc.	Cpu (* * * * *)	
	System error	E7	System	Reset after initialization of memory.
	Travel limit (set by user)	F2	Soft. OT limit	Alarm is automatically cleared when slider gets out the over travel limit range.

13.5.1. Clear Alarm in External Control Mode (Operation Mode through CN3 Control I/O)

- Alarm is cleared by rising signal from OFF to ON of ACLR input of CN3 pin No.23.

Figure 13-4



13.5.2. Clear Alarm by Teaching Box Operation Mode

- Return to Menu selecting screen by pressing MODE key. Confirm the indication of alarm.
- Clear alarm by CLR and SET keys.
- There are two types of alarms. One is cleared by pressing only CLR key and the other type is cleared by pressing SET key after CLR key.

∗ When pressing SET key after pressing CLR key, press SET key after removing your finger from CLR key. When CLR and SET keys are pressed simultaneously, an alarm cannot be cleared.

Table 13-47

Teaching box operation	CLR key	CLR key → SET key
Alarms that can be cleared.	• Program error	All alarms listed in Table 13-45.

13.5.3. Clear Alarm in Remote Control Mode (RS-232C Communication Mode)

- Alarms can be cleared by ACLR command and ACLR△ALL* command.
- See the table below for the distinction of alarms that can be cleared by ACLR command or ACLR△ALL* command.

Table 13-48

Remote control	ACLR command	ACLR△ALL* command
Alarms that can be cleared.	• Program error	All alarms listed in Table 13-45.

* :△ is a space code (20H).

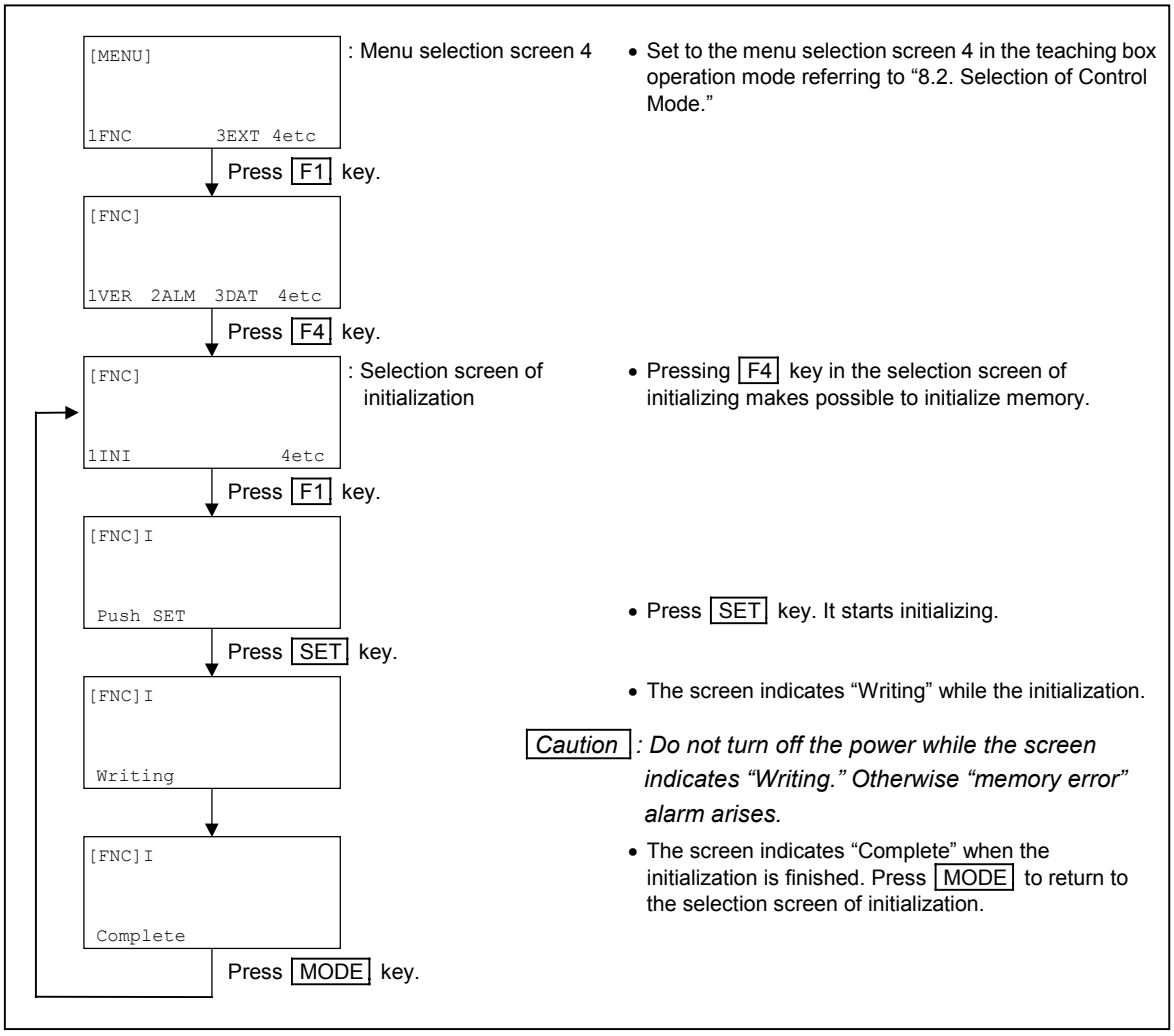
13.6. Initialize Memory

- When memory error arises, all data, such as initial setting data, program editing data, point data and palletizing data must be initialized.
  (Palletizing data is for multi-axis combination only.)

- You can initialize all memories of EXEA controller following the procedures in Figure 13-5 bellow. The initialization will set all memories to the shipping set.

- You must conduct the initial setting, programming, teaching, and making palletizing data again in case of a multi-axis combination.

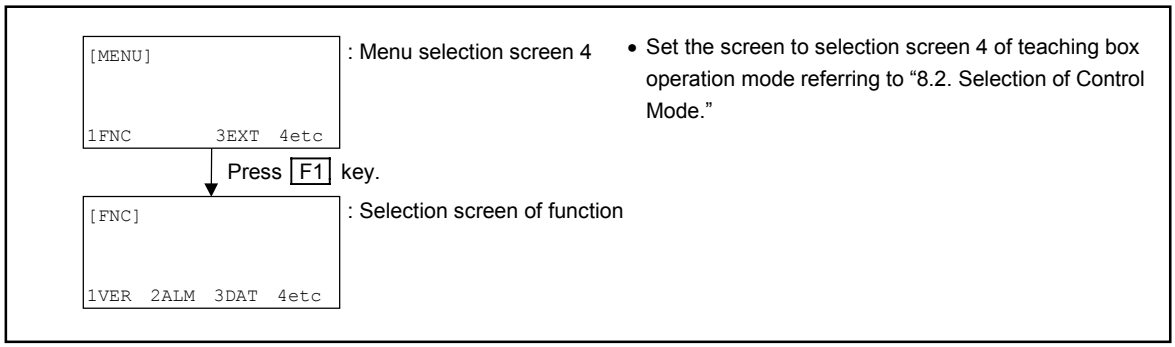
Figure 13-5: Procedure of initializing memory.



13.7. Monitoring Software Version and Alarm History

- You may check software version number and monitor history of alarm in the selection screen of function.
- The screen indicates software version number (VER) and history of alarm (ALM). Function of (DAT) is reserved.

Figure 13-6: Selection screen of function



13.7.1. Indication of Software Version Number

- The display indicates version number of software by pressing F1 key (VER) in the selection screen of function.

Figure 13-7: Screen indicating software version number. (Example of single axis system)

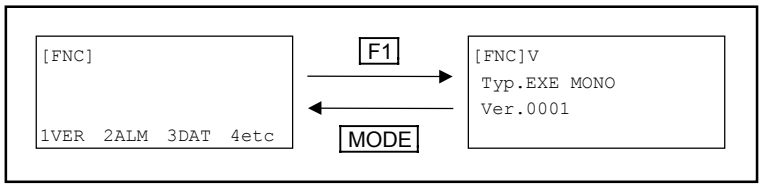
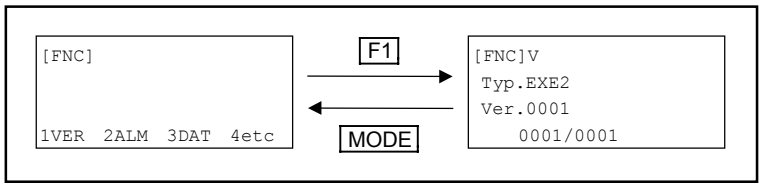


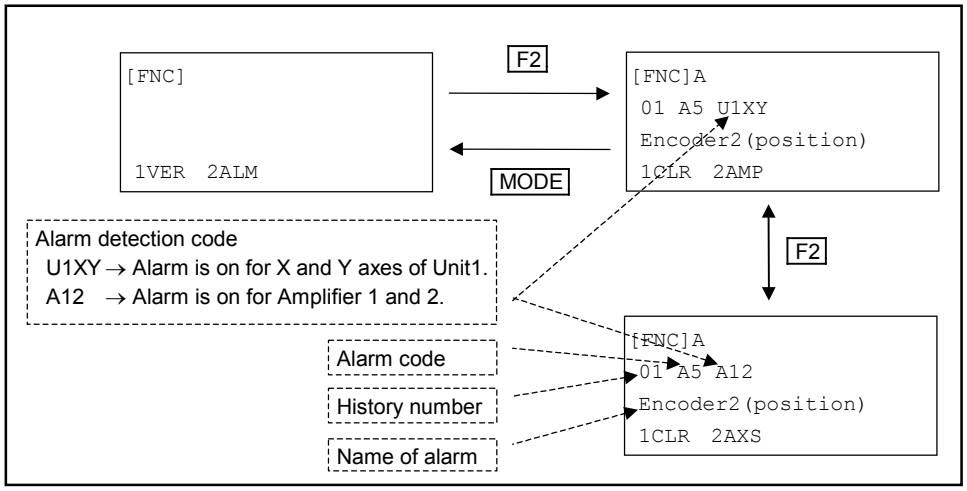
Figure 13-8: Screen indicating software version number. (Example of two axes combination)



13.7.2. Indication of Alarm History

- You can monitor history of alarm by pressing F2 key (ALM) in the selection screen of function.
- Indication of history: (Refer to Table 13-49 for details.)
  - ◊ In the second line: History number, alarm code and alarm detection code.
  - ◊ In the third line: Name of alarm
  - ◊ Smaller history number indicates newer alarm.
- Use ▼ to scroll history of alarm.
- Use F2 key to switch indication of an axis or a power amplifier number as the alarm detection code, on which alarm is reported.

Figure 13-9: Screen indicating alarm history (Example for two axes combination)



- Press F1 key (CLR) in the indication screen of alarm history to clear the alarm history.

Table 13-49: Contents of alarm history

<table>
<tr><th>Classification of indication</th><th>Contents</th></tr>
<tr><td>History number</td><td>
• The history number is assigned to detected alarms in the order so that the smaller number indicates newer alarm. The numbers can be 0 (zero), as the newest, to the maximum of 31.
• Following alarms will be listed on the alarm history every time these alarms are reported as they are critical ones.
F4: Emergency stop
P1: Abnormal power supply
P3: Abnormal control power
P4: Regeneration resistor overheat
E0 ~ E3 and E6: Memory error
A5: Home return incomplete
</td></tr>
<tr><td>Alarm code</td><td>• Reports an alarm code which is being indicated by 7 segments LED.</td></tr>
<tr><td>Alarm detection code</td><td>
1) Alarms which have arose from respective axis units
• An amplifier number is indicated on which an alarm has been reported when "AMP" is selected by [F2] key.
A****: Only number "1" is indicated in case of single axis system.
Numbers of amplifier "1" ~ "4" will be indicated in accordance with faulty axis units in multi-axis combination.
[Example]
A24: An alarm, of which nature is indicated by the alarm code, arises from the amplifier number 2 and 4 in four axes controller.
• A Unit number is indicated on which an alarm has been reported when "AXS" is selected by [F2] key.
U***** : Only "U1X" is indicated in case of single axis
In case of multi-axis combination,system.
U * * * * *
→ Name of axis (X ~ R)
→ Unit number.
[Example]
U3XZ: An alarm of which nature is indicated by alarm code arises from X and Z axes of Unit 3 of four axes controller.
2) In case of alarms which occur in no relation with axis unit
• It indicates a part of processing software on which an alarm is reported.
<table>
<tr><th>Controller</th><th>P***</th><th>Part on which alarm is reported</th></tr>
<tr><td rowspan="3">Single axis</td><td>1</td><td>Processing servo</td></tr>
<tr><td>2</td><td>Processing pulse</td></tr>
<tr><td>3</td><td>Processing main part</td></tr>
<tr><td rowspan="4">Multi-axis</td><td>1</td><td>Processing servo of first and second axes</td></tr>
<tr><td>2</td><td>Processing servo of third and forth axes</td></tr>
<tr><td>5</td><td>Processing pulse</td></tr>
<tr><td>7</td><td>Processing main part</td></tr>
</table>
[Example]
P27: Alarm occurs to the parts of three axes servo processing and main part processing of three axes controller.
</td></tr>
</table>

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14. Troubleshooting

14.1. Discription of Troubleshooting

Danger : *Before troubleshooting, take the following precautions. If these precautions are not observed, the troubleshooting itself can be dangerous as further critical accidents may occur due to secondary accidents such as motor burning or controller malfunction.*

1 Matching of module main unit and power amplifier

- Check that the motor output specification of the module main unit conforms to the specification of driver of the controller.

  Wrong example: EXEA controller (200W) and a main unit (100W) are incorrectly connected.

2 Do you use standard controller cable from NSK ?

- If you provide the cable by yourself or use a modified cable from NSK standard cable, be sure that the cable is correctly wired.

  Wrong example 1: The system may lose control of motor if U, V and W cables of motor power line are wired incorrectly.

  Wrong example 2: The system may lose control if encoder signal line is wired incorrectly.

3 Investigate specification of main power supply voltage

◊ EXEA□-□□□□T□□: single phase AC180V/264V

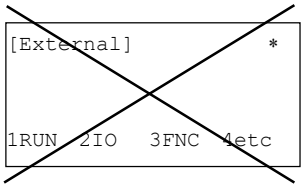
- If the power line voltage exceeds above specification, the motor driver may burn.

4 Check if the FGND terminal and AC power line is mistakenly connected.

- If the FGND terminal is connected to AC power supply line, or AC power supply terminals are grounded, the controller does not function properly and, further more, it may result in a trouble such as burning of controller.

Danger *: Before troubleshooting, make sure that the moving parts of a module main unit has completely stopped, turn the servo off, then turn off the power. This is necessary to prevent the operator from being crushed, caught or pulled in for an accident. If you must conduct troubleshooting with power on for an unavoidable reason, take the following measures for your safety.*

◊ Set the controller to teaching box operation mode and turn servo off so that the controller is not turned to servo on and not to be operated externally.



: Be sure that operation mode is not set to external control mode. Do not do troubleshooting when the display shows it is in the external mode as shown in the left.

: Make sure that the servo on indicator (∗) on the upper right corner of the display is off.

Indication of servo off.

◊ When you perform troubleshooting while turning servo on, make sure that no one and no obstacle is in the robot working range, then set speed of robot to 250 mm/sec. Furthermore, provide necessary measure to prevent from entry of other person while you are operating the system.

◊ The teaching box must be in the reaching area of operator so that it can be handled quickly in an emergency.

◊ Check that the emergency stop function is working before troubleshooting. (Perform troubleshooting after making sure the emergency stop function is surely functioning.)

◊ Do not touch the primary power supplying area to avoid an electric shock. Do not turn on main power leaving the enclosure cover opened.

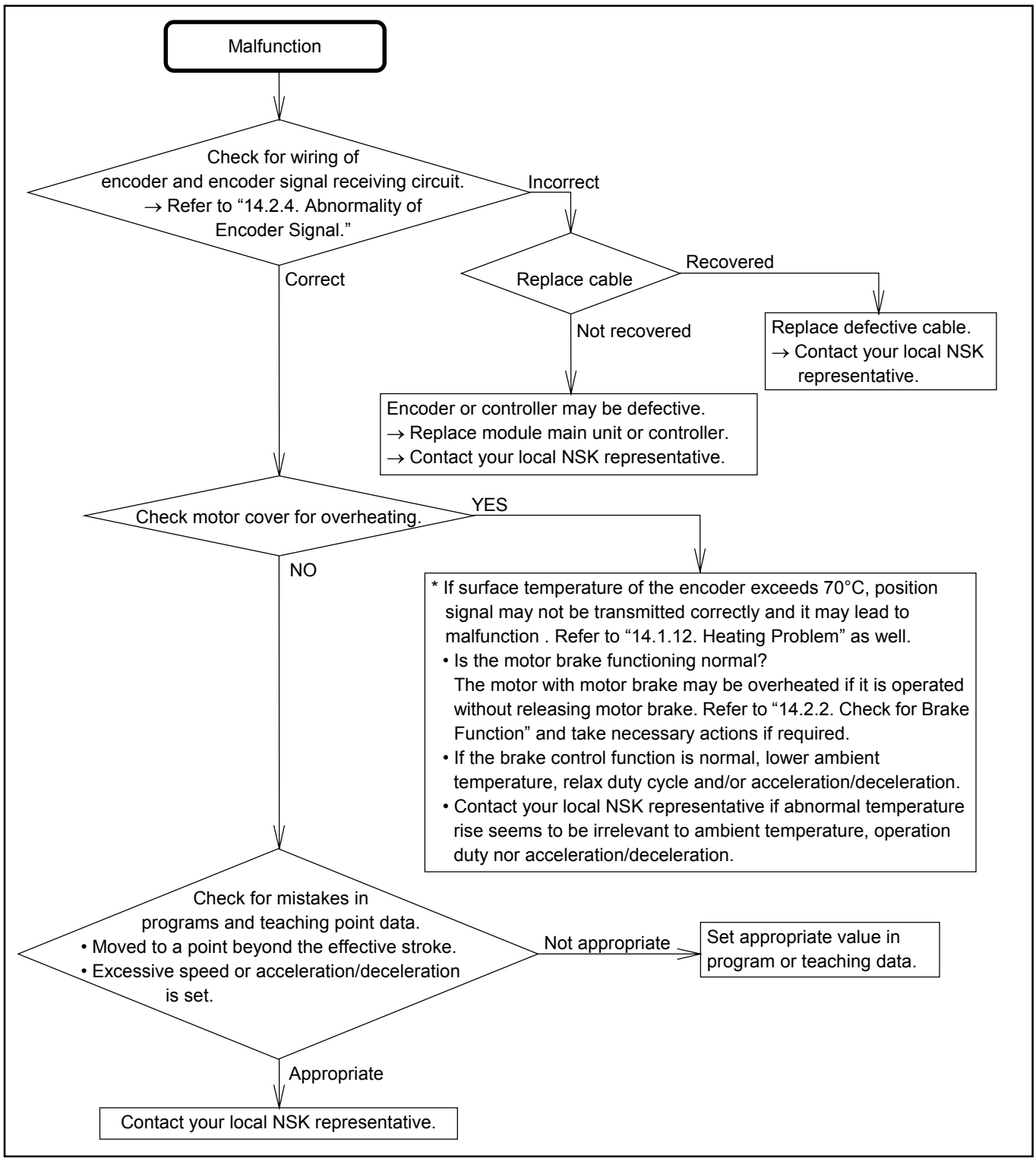
* The following descriptions in this paragraph have been made on the basis that all precautions aforementioned in the provisions of (1) to (4) have been observed.

Warning *: Move the slider of the vertical axis (main unit for moving main unit combination) to the bottom of stroke when motor brake of vertical axis is going to be released. When the slider (or main unit) has stopped in the middle of stroke, it may back-drive by its own weight as the brake is released.*

14.1.1. Malfunction

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.
- If, as a result of controller malfunction, a main unit should collide with the stroke end (or the work) severely, check the damage to the module main unit referring to "14.2.5. Measures for Malfunction and Collisions."

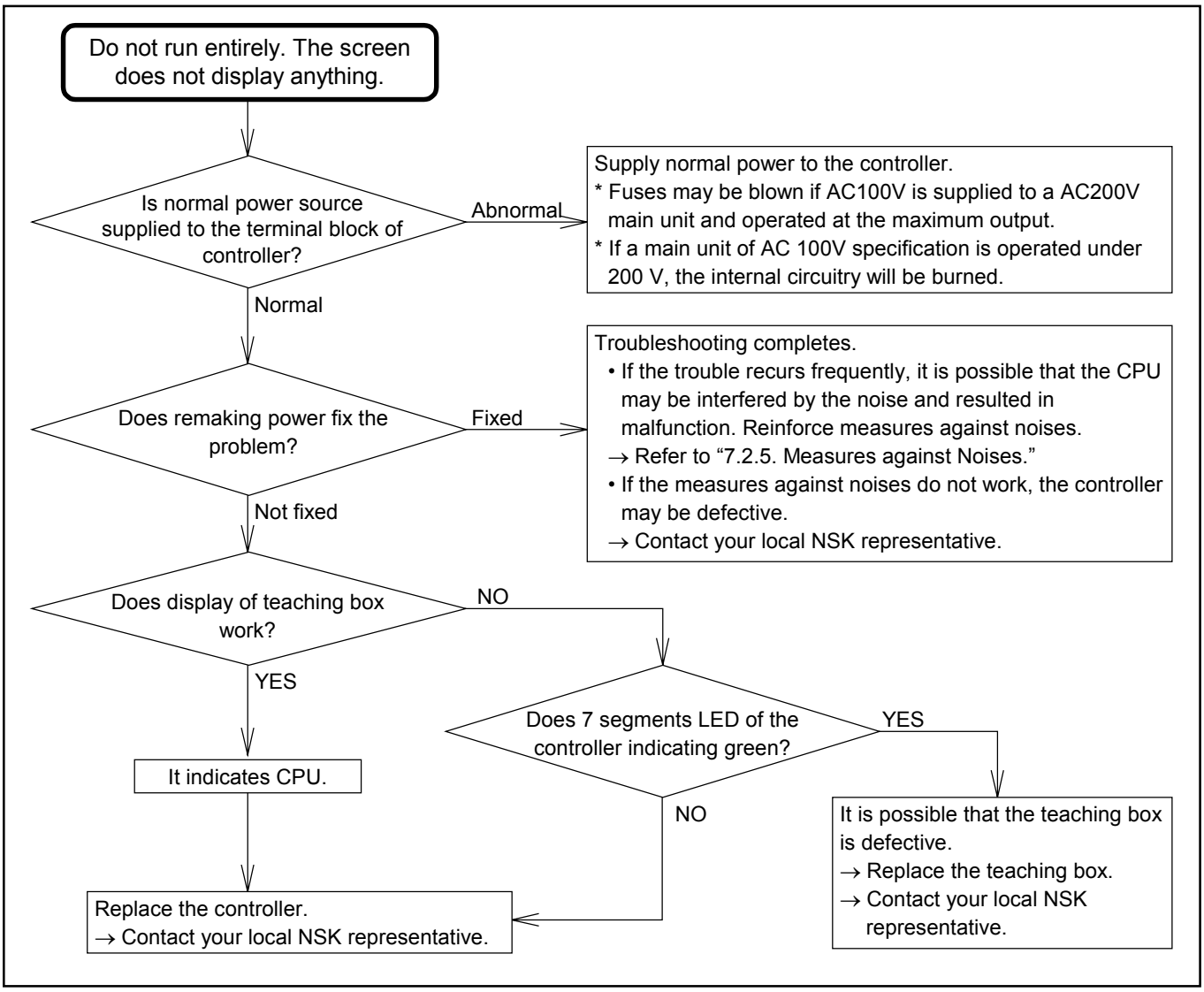
Figure 14-1: Troubleshooting for malfunction



14.1.2. Operation Problem of the System

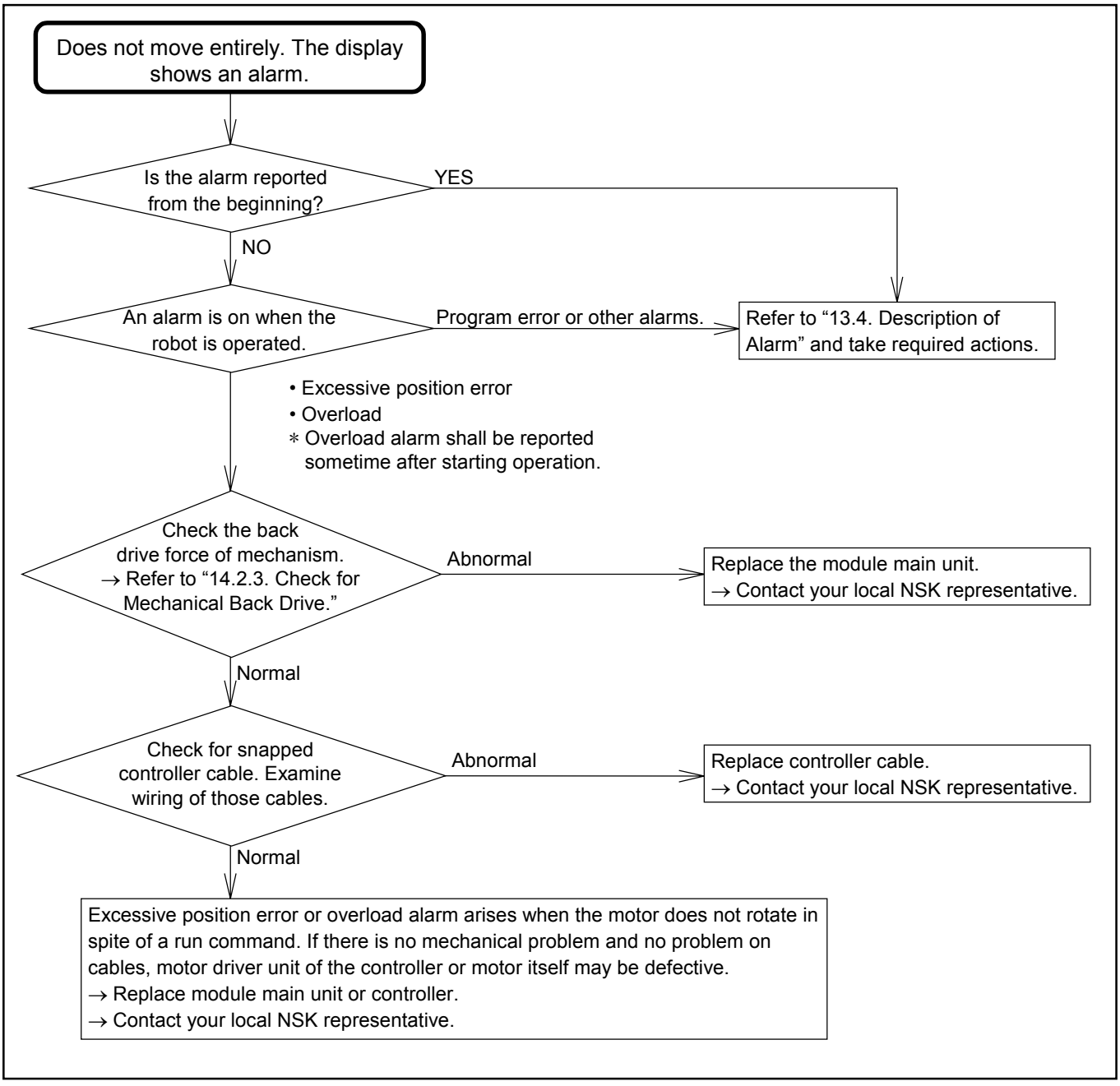
- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-2: Does not run entirely. Troubleshooting 1: Nothing is displayed on the screen.



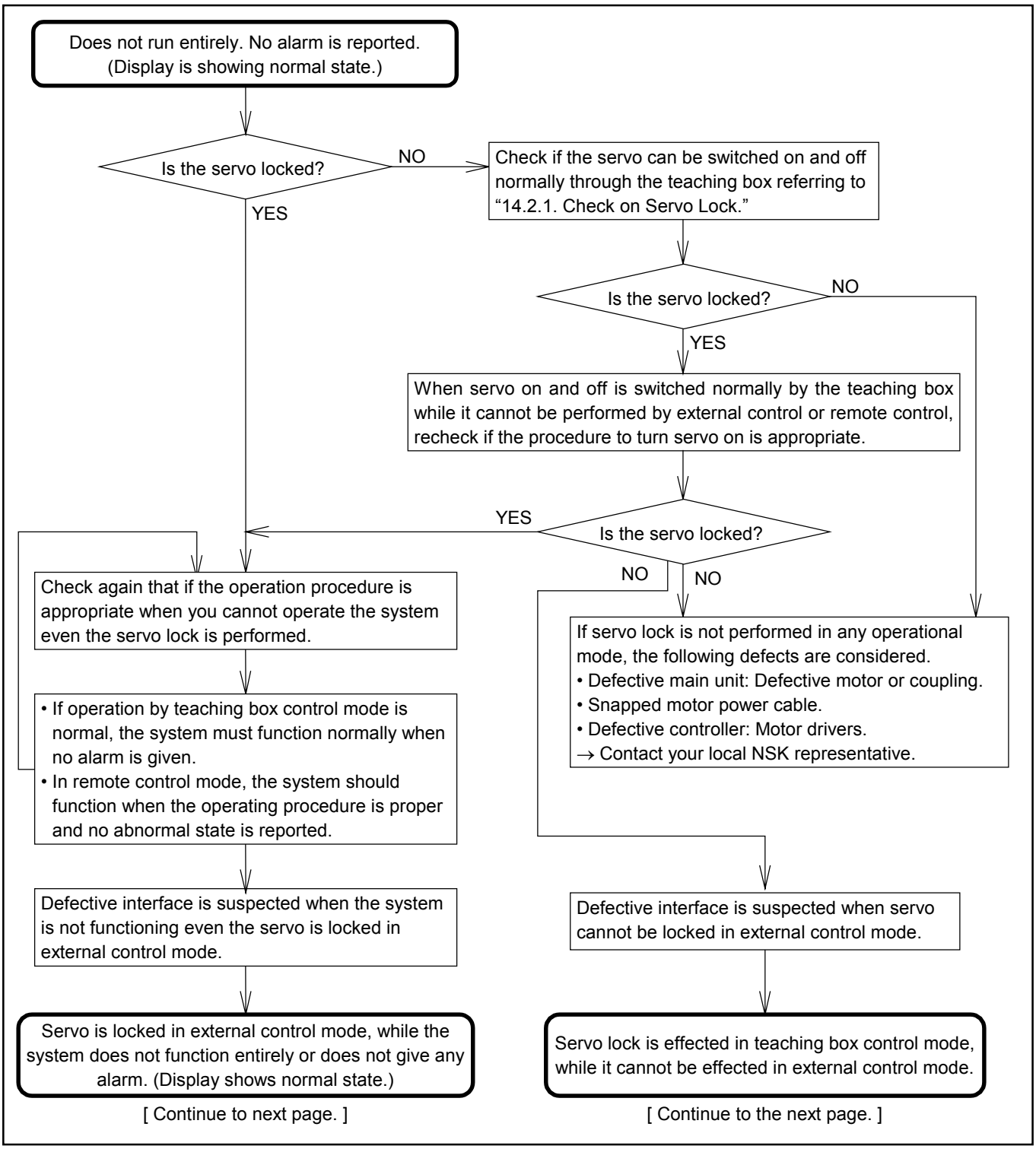
- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-3: Does not run entirely. Troubleshooting 2: Alarm is reported.



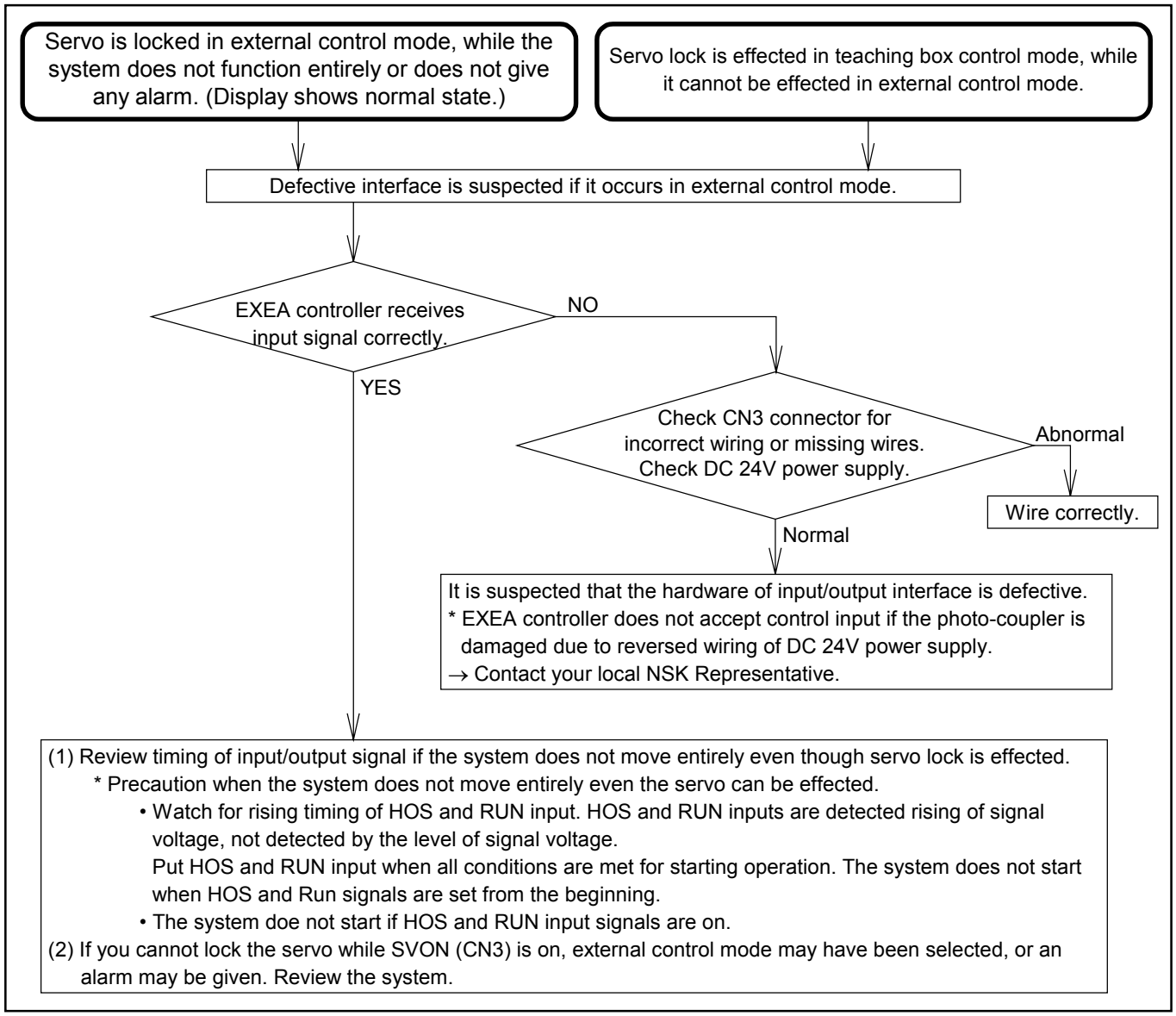
- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-4: Does not move entirely. Troubleshooting 3: Display shows the system is in normal state.



- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

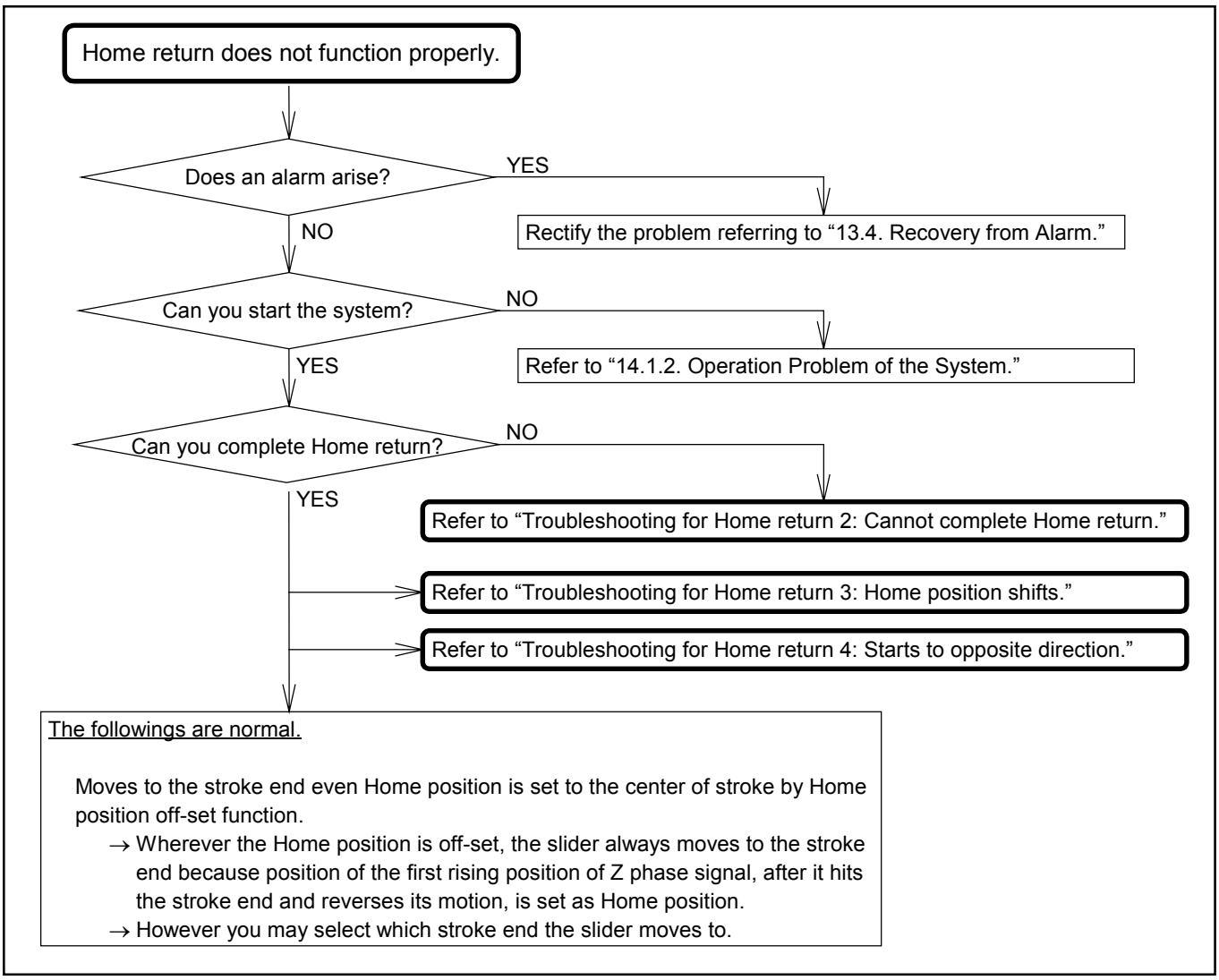
Figure 14-5: Troubleshooting when servo-lock is not effected



14.1.3. Troubleshooting for Home Return

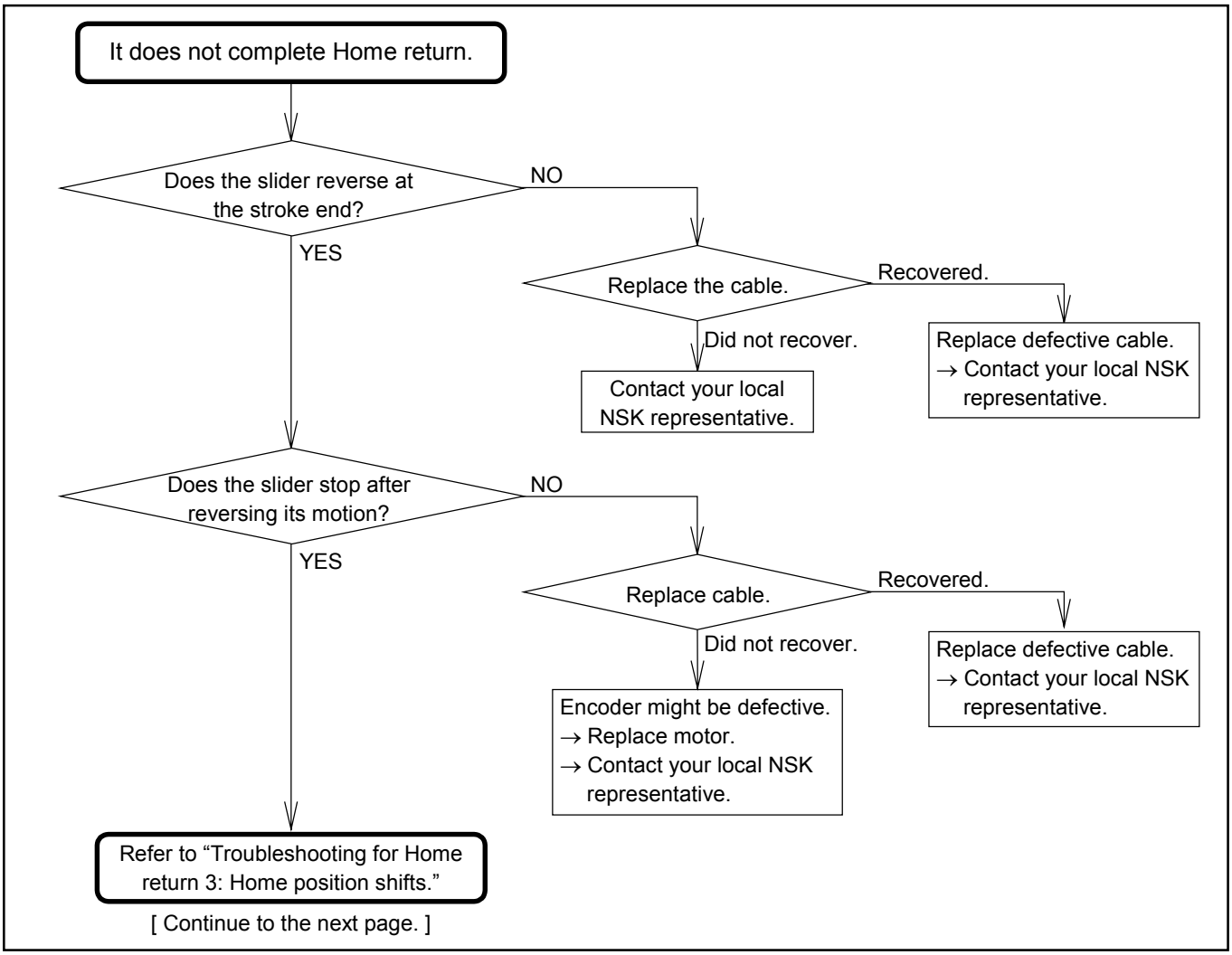
- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-6: Troubleshooting for Home return 1: Does not function properly.



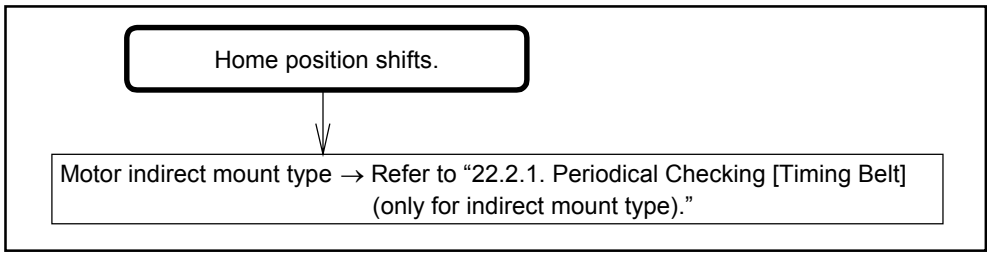
- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-7: Troubleshooting for Home return 2: Cannot complete Home return.



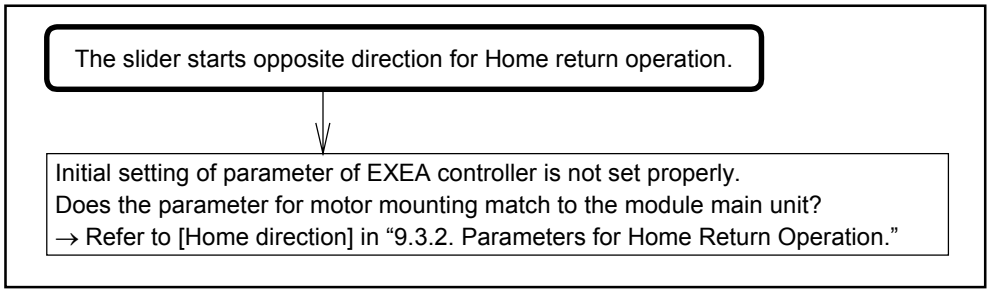
- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-8: Troubleshooting for Home return 3: Home position shifts.



- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

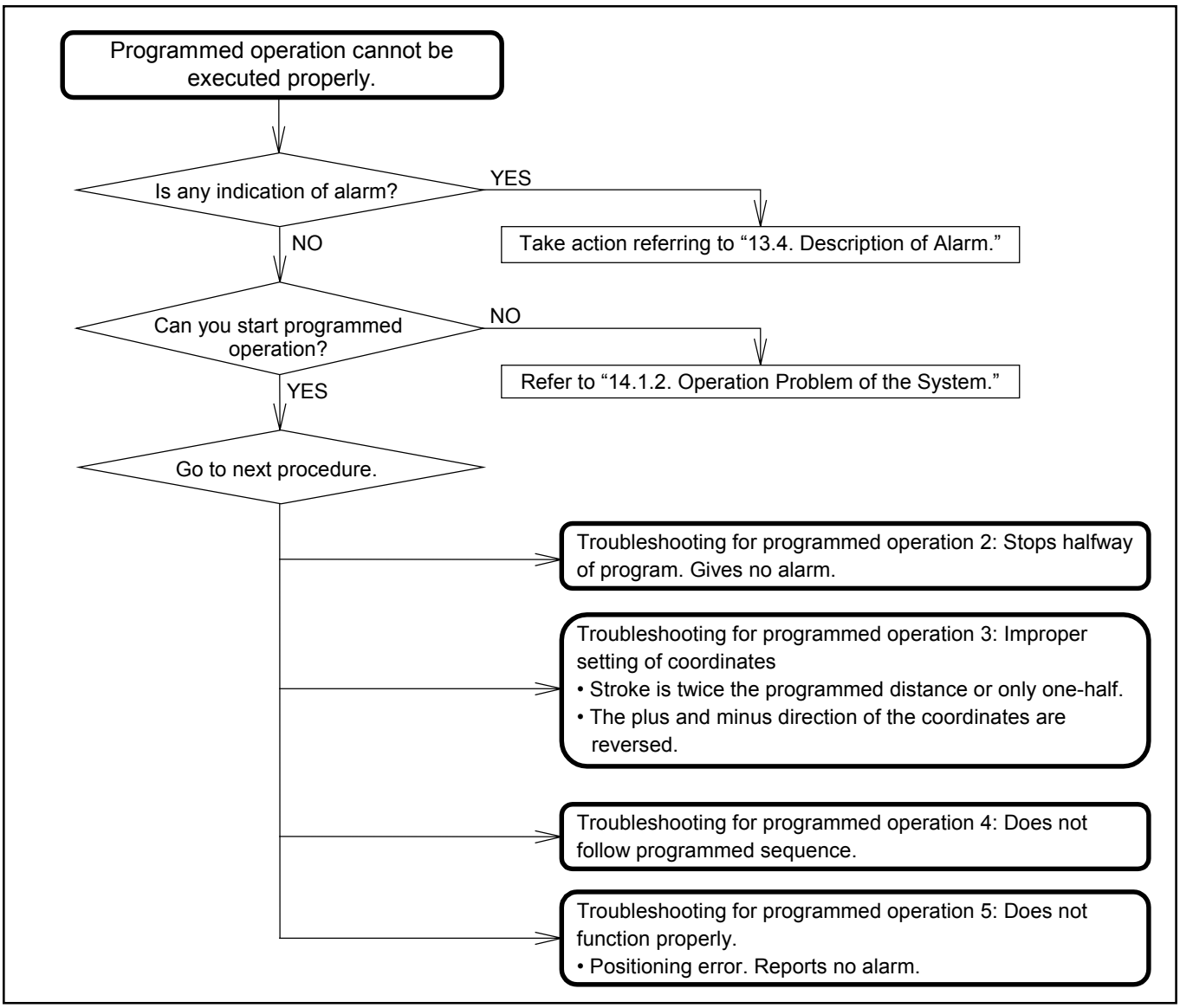
Figure 14-9: Troubleshooting for Home return 4: Starts to opposite direction.



14.1.4. Troubleshooting for Programmed Operation

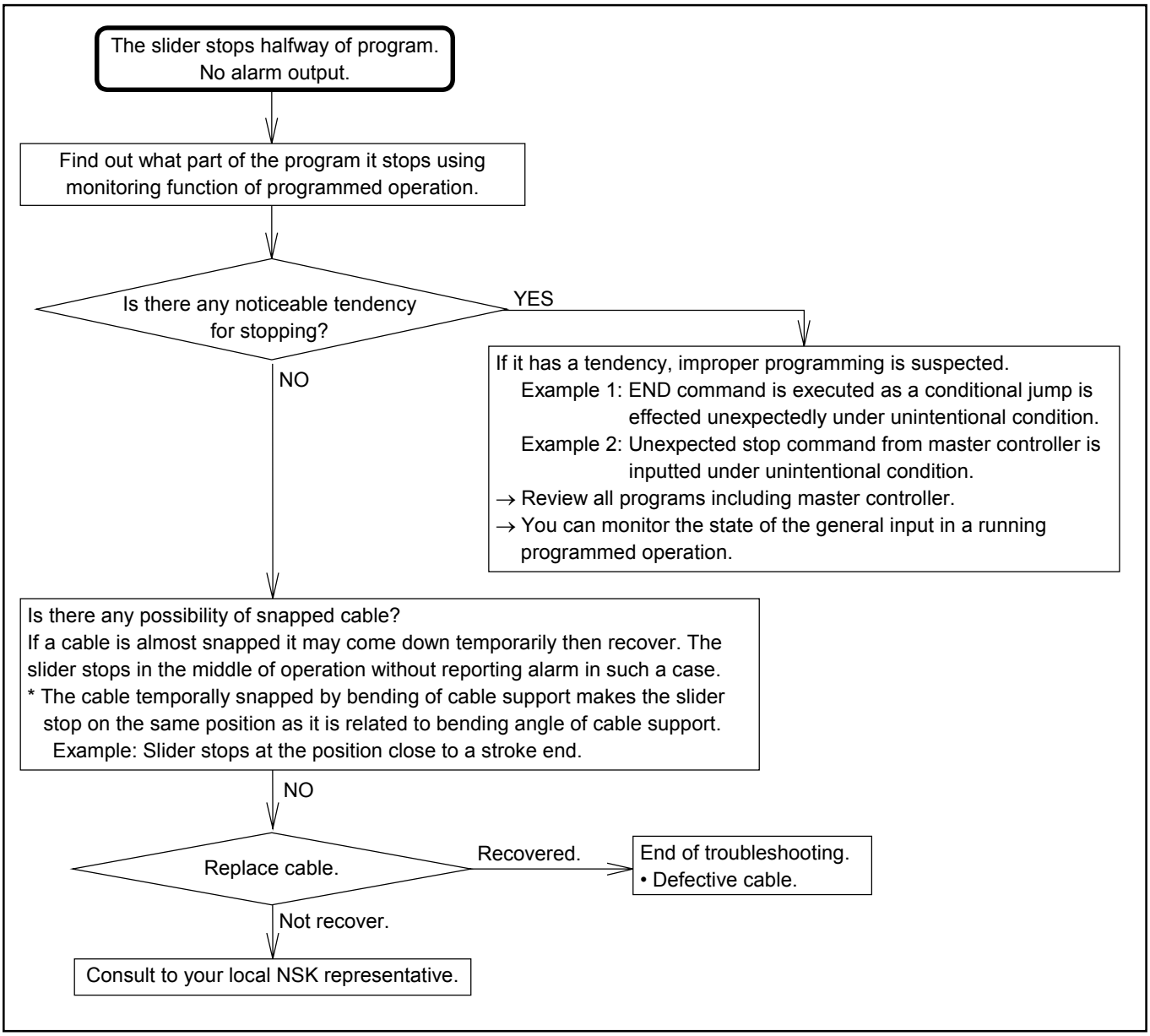
- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-10: Troubleshooting for programmed operation 1: Incomplete execution of program



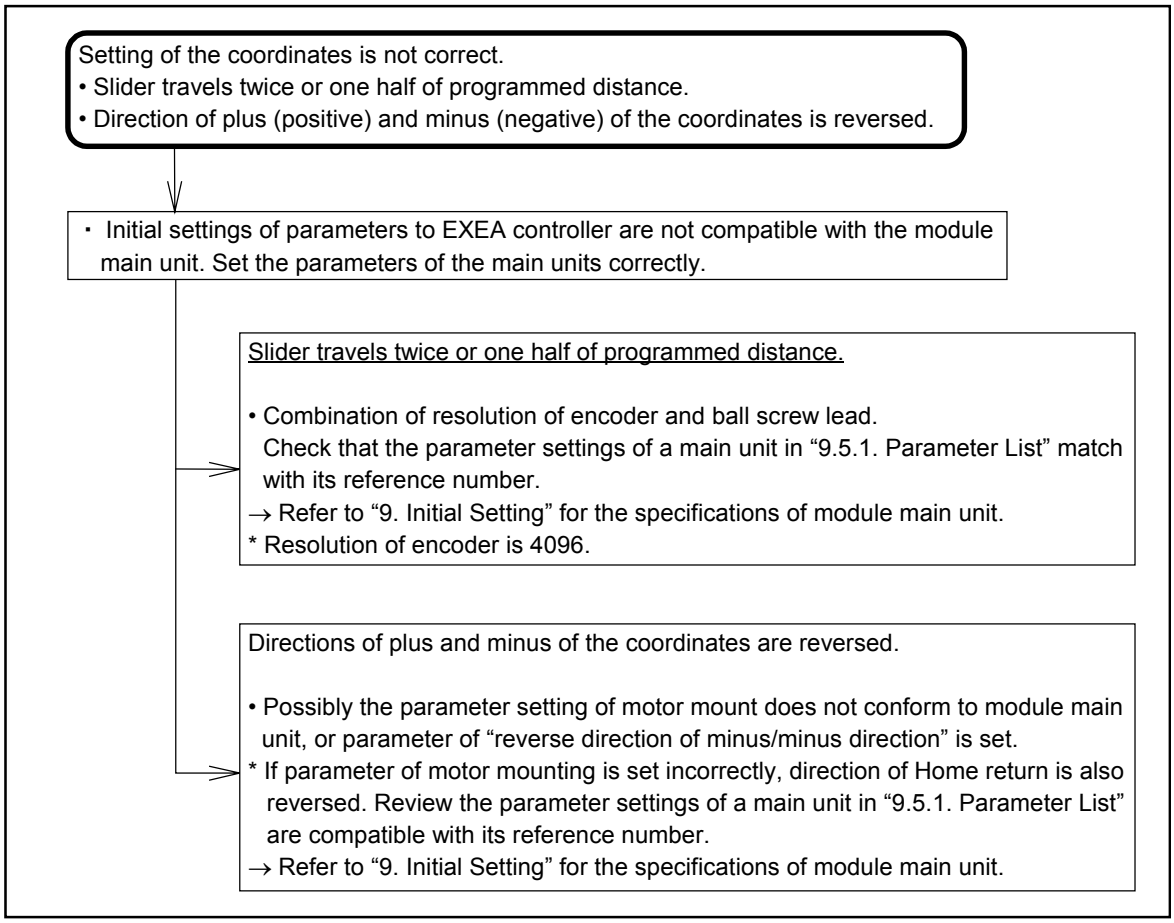
● Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-11: Troubleshooting for programmed operation 2: Slider stops halfway.



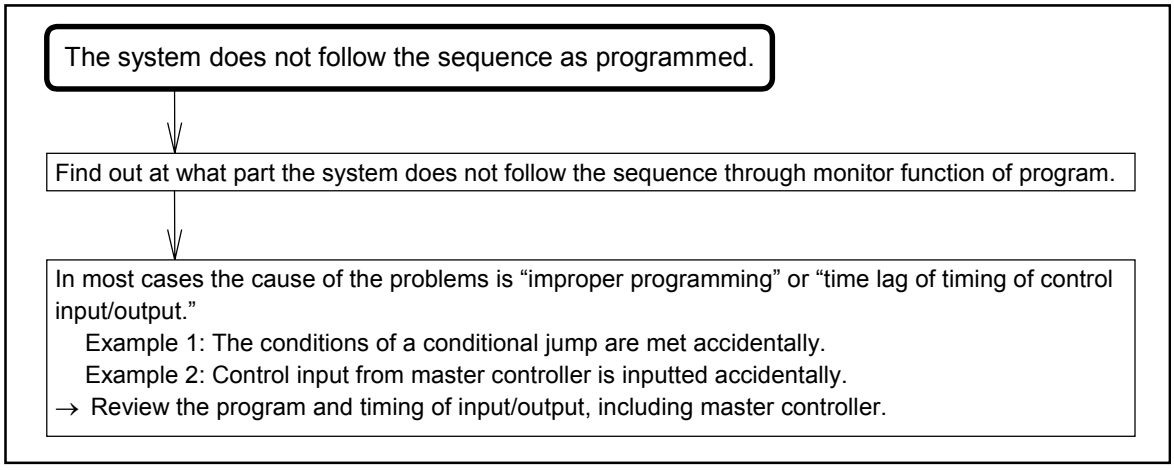
● Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-12: Troubleshooting for programmed operation 3: Incorrect setting of the coordinates



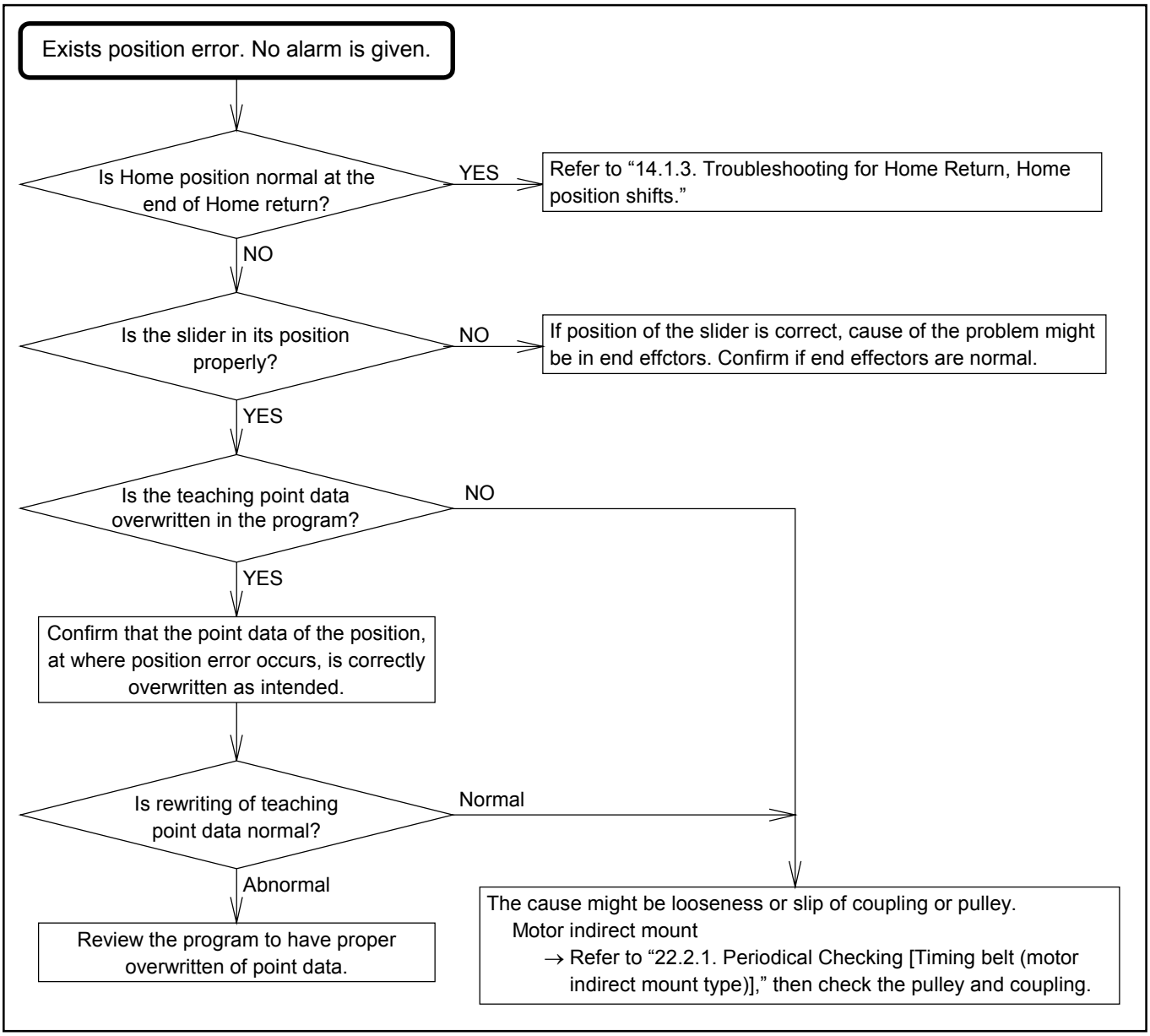
● Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-13: Troubleshooting for programmed operation 4: Does not follow the sequence as programmed.



- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

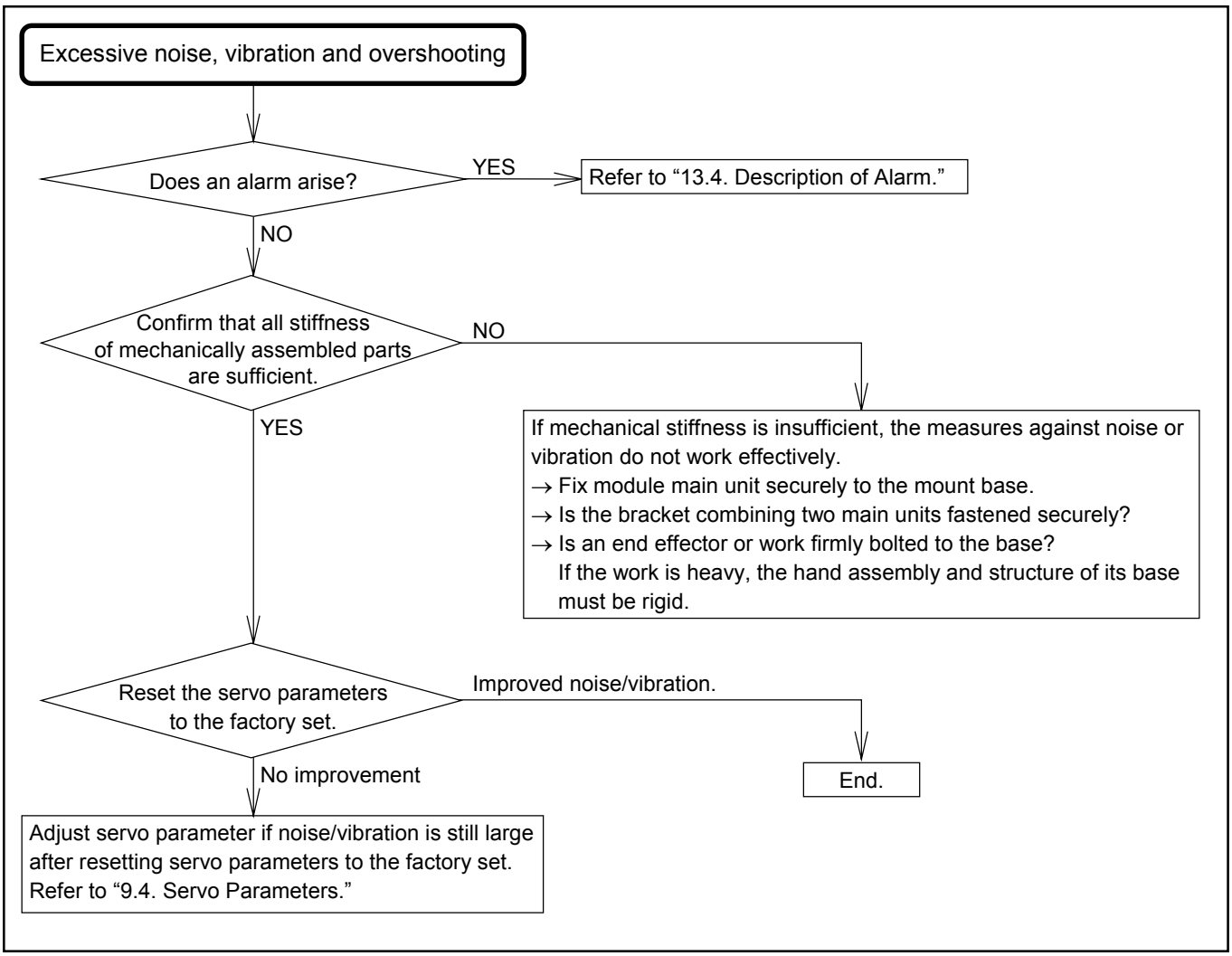
Figure 14-14: Troubleshooting for programmed operation 5: Cannot execute program properly.



14.1.5. Excessive Noise, Vibration and Overshooting

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

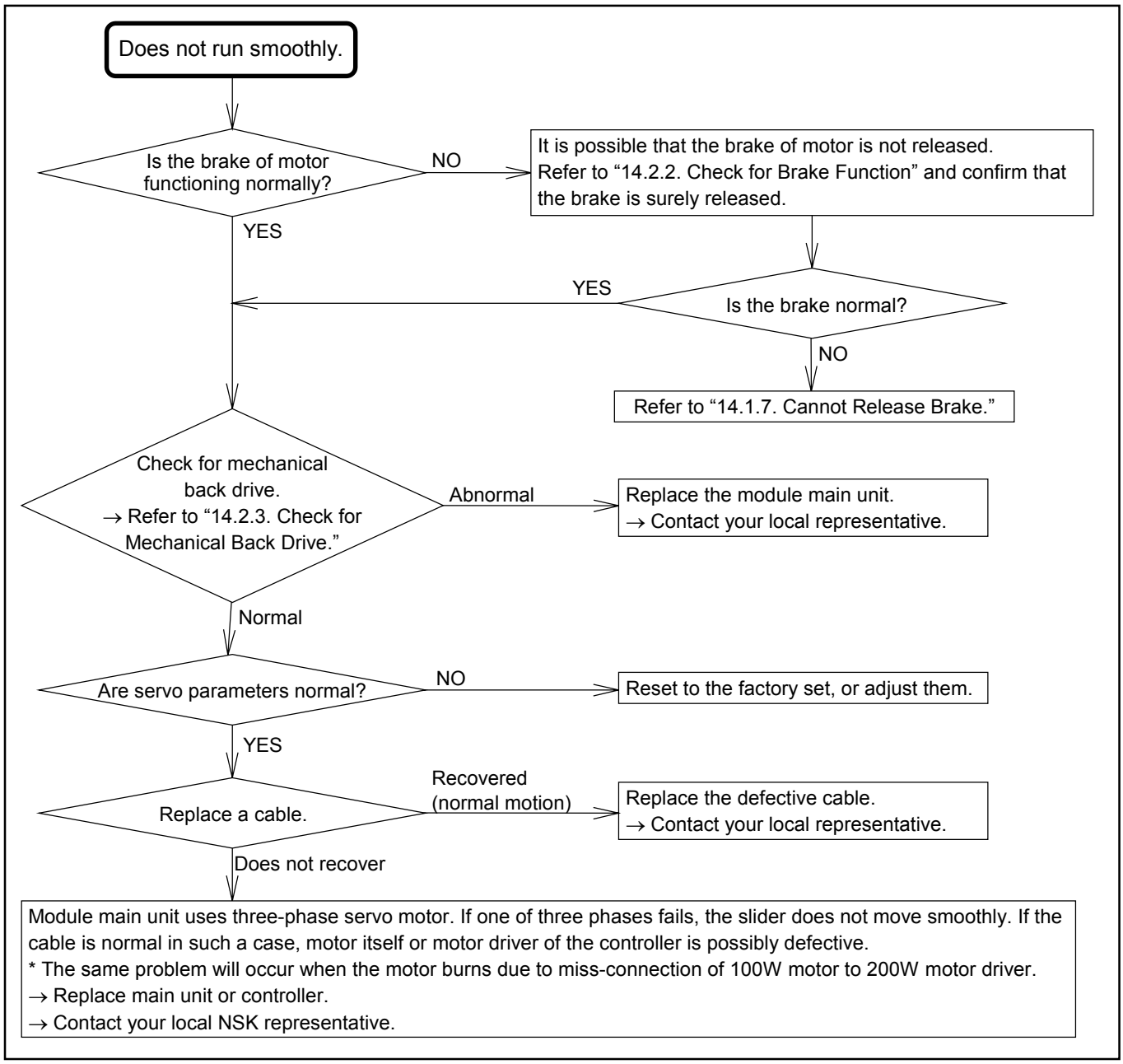
Figure 14-15: Troubleshooting for noise and vibration



14.1.6. Troubleshooting for Rough Motion

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

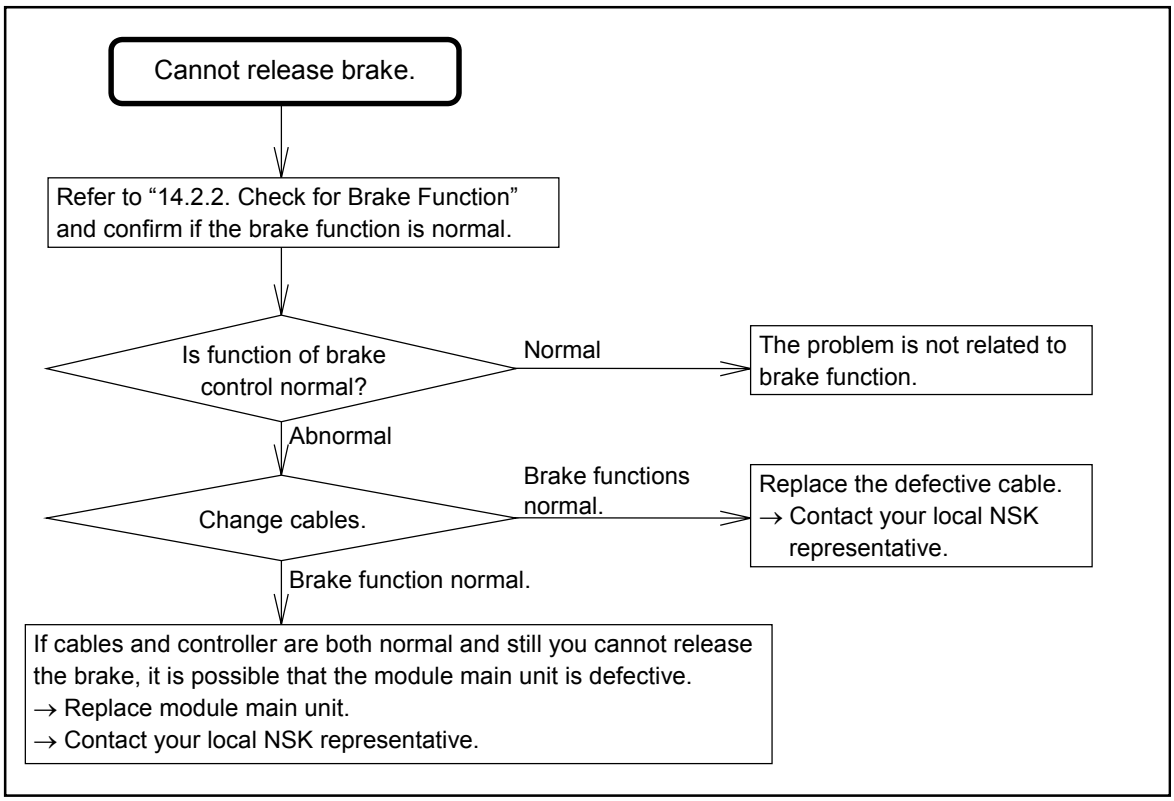
Figure 14-16: Troubleshooting for rough motion



14.1.7. Cannot Release Brake

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

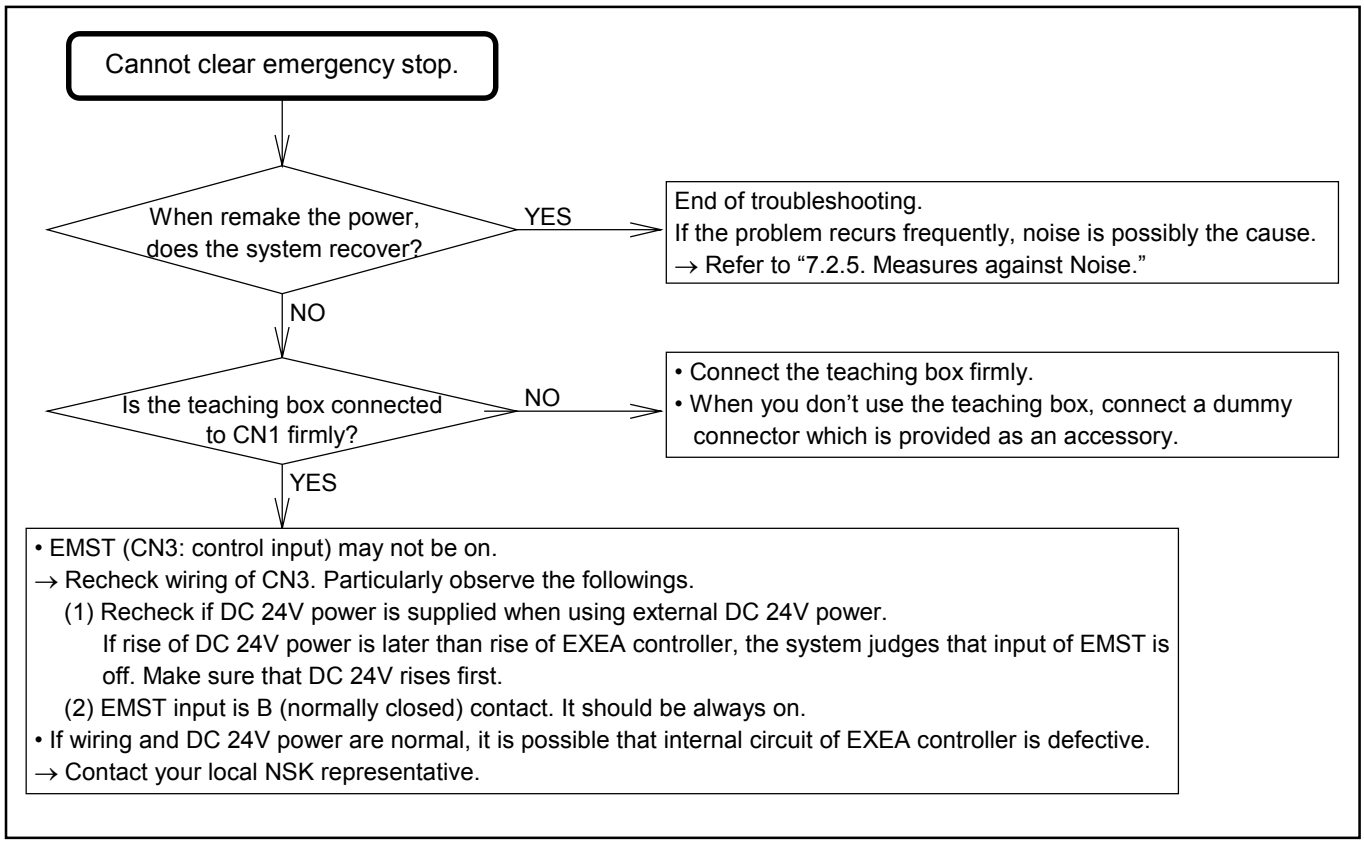
Figure 14-17: Troubleshooting for releasing brake



14.1.8. Unable to Clear Emergency Stop

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

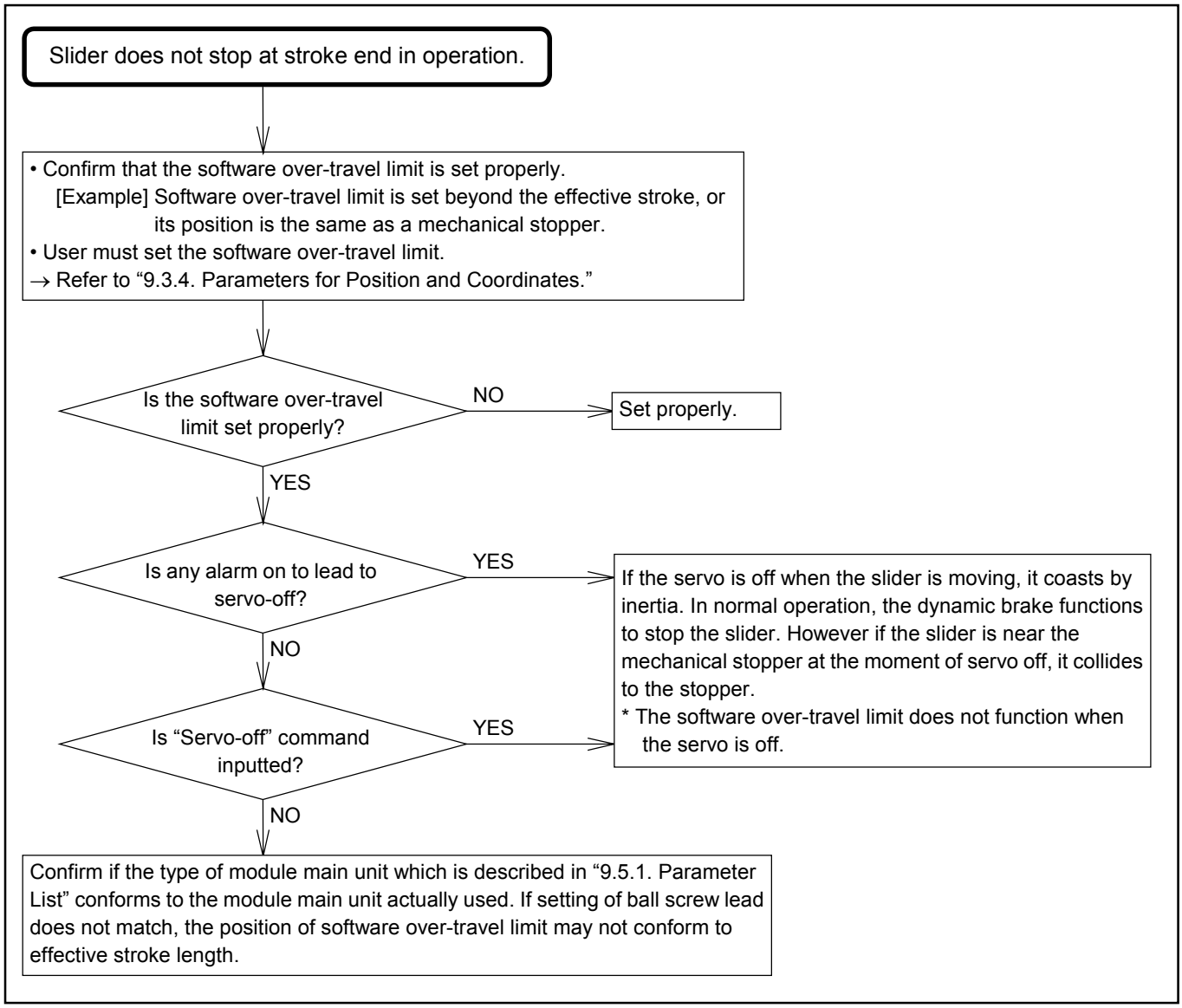
Figure 14-18: Troubleshooting for emergency stop



14.1.9. Trouble of Over-travel Limit

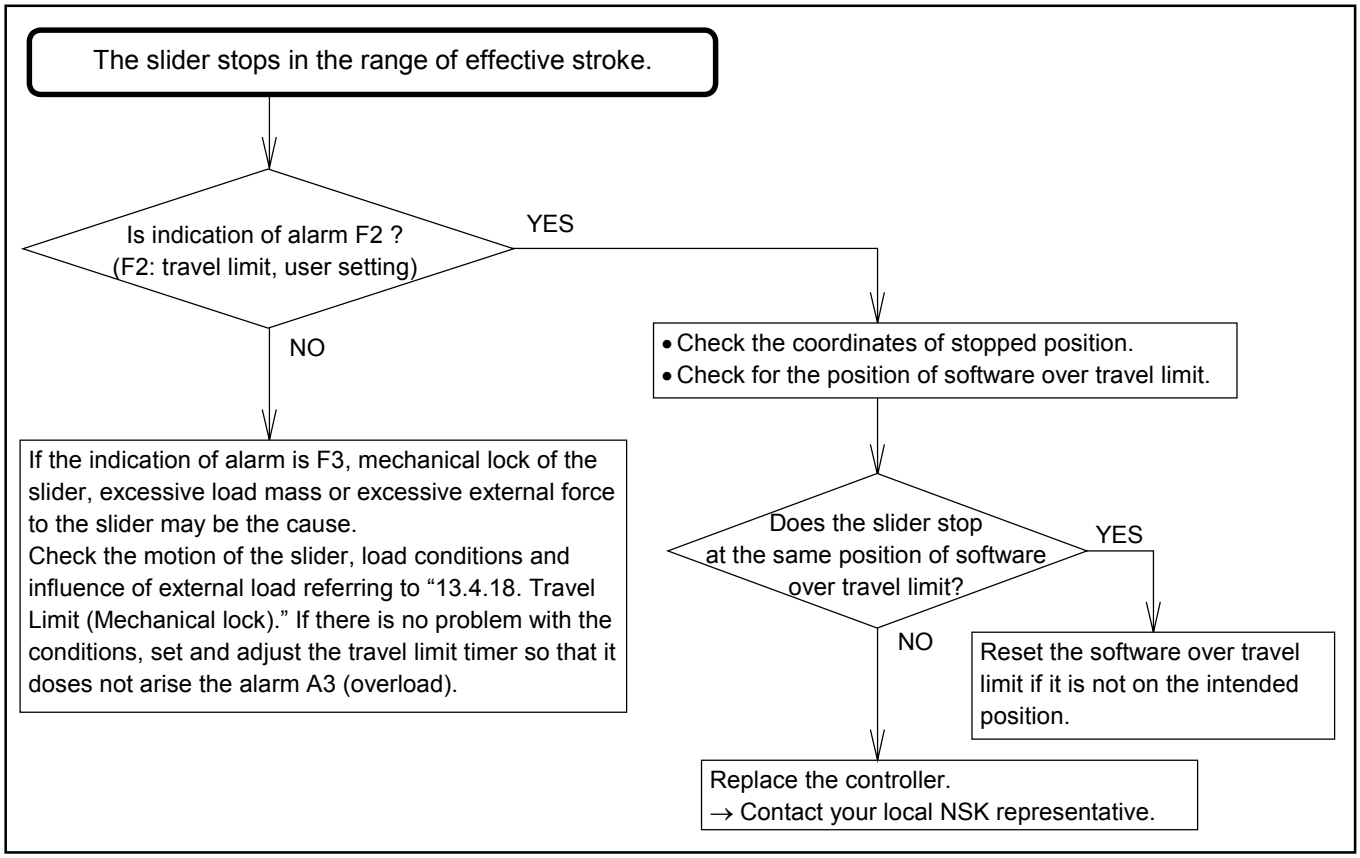
- Be sure to observe all safety precautions described on Page 14-1 and 14-2.
- When the slider does not stop and collide to the stroke end or an obstacle severely, check damages to the module main unit referring to "14.2.5. Action for Malfunction and Collisions."

Figure 14-19: Troubleshooting for over-travel limit 1: Does not stop at stroke end.



- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

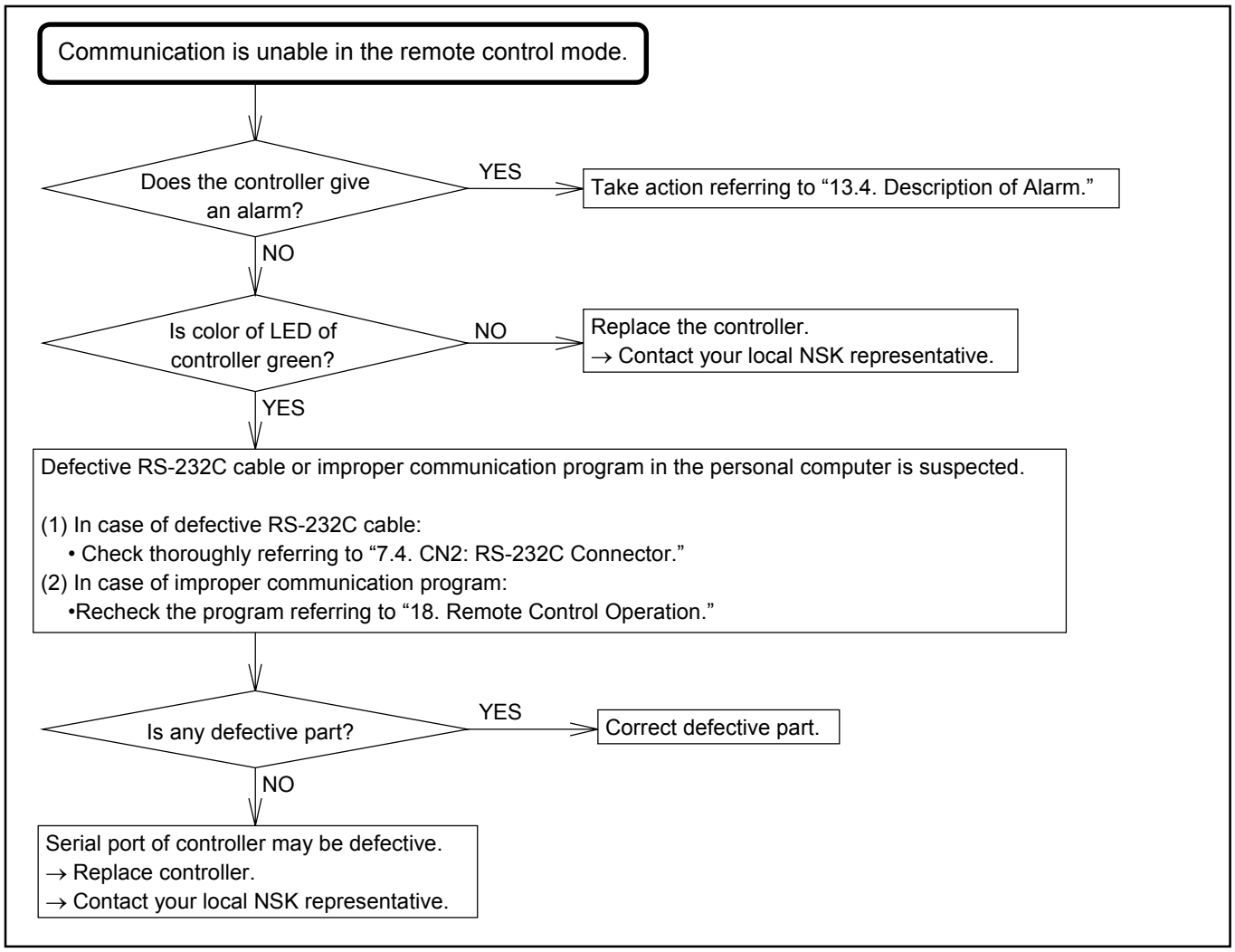
Figure 14-20: Troubleshooting for over-travel limit 2: Stops in the middle of stroke.



14.1.10. Communication Problem in Remote Control Mode

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

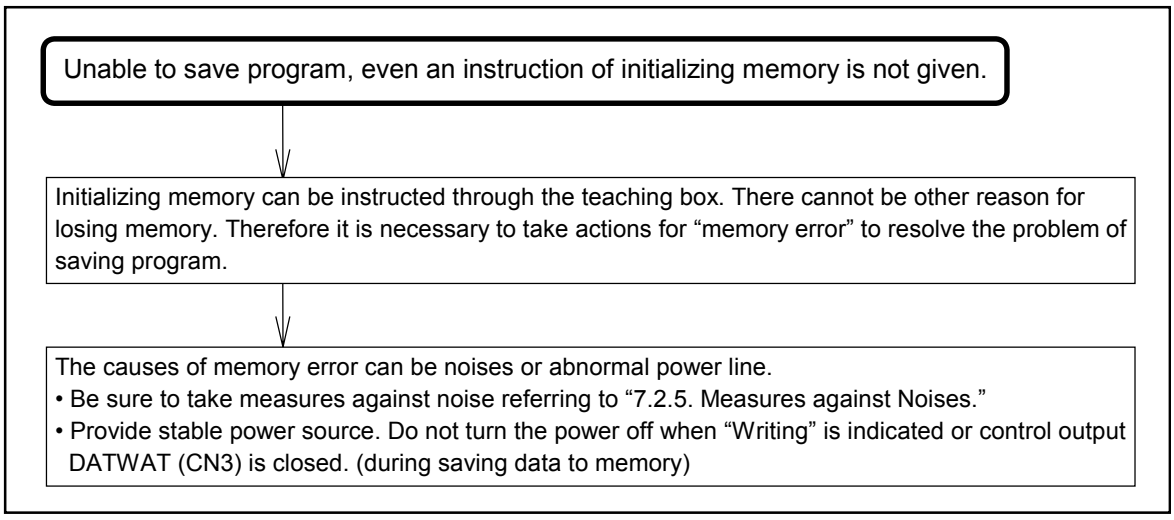
Figure 14-21: Troubleshooting for remote control mode



14.1.11. Problem of Saving Program

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

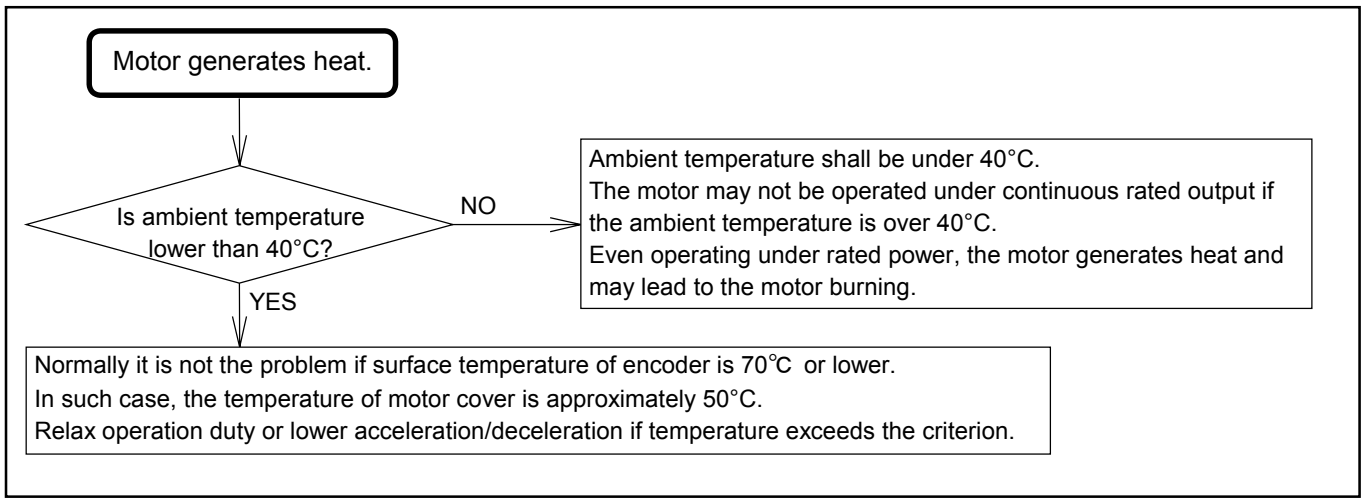
Figure 14-22: Troubleshooting for saving program



14.1.12. Heating Problem

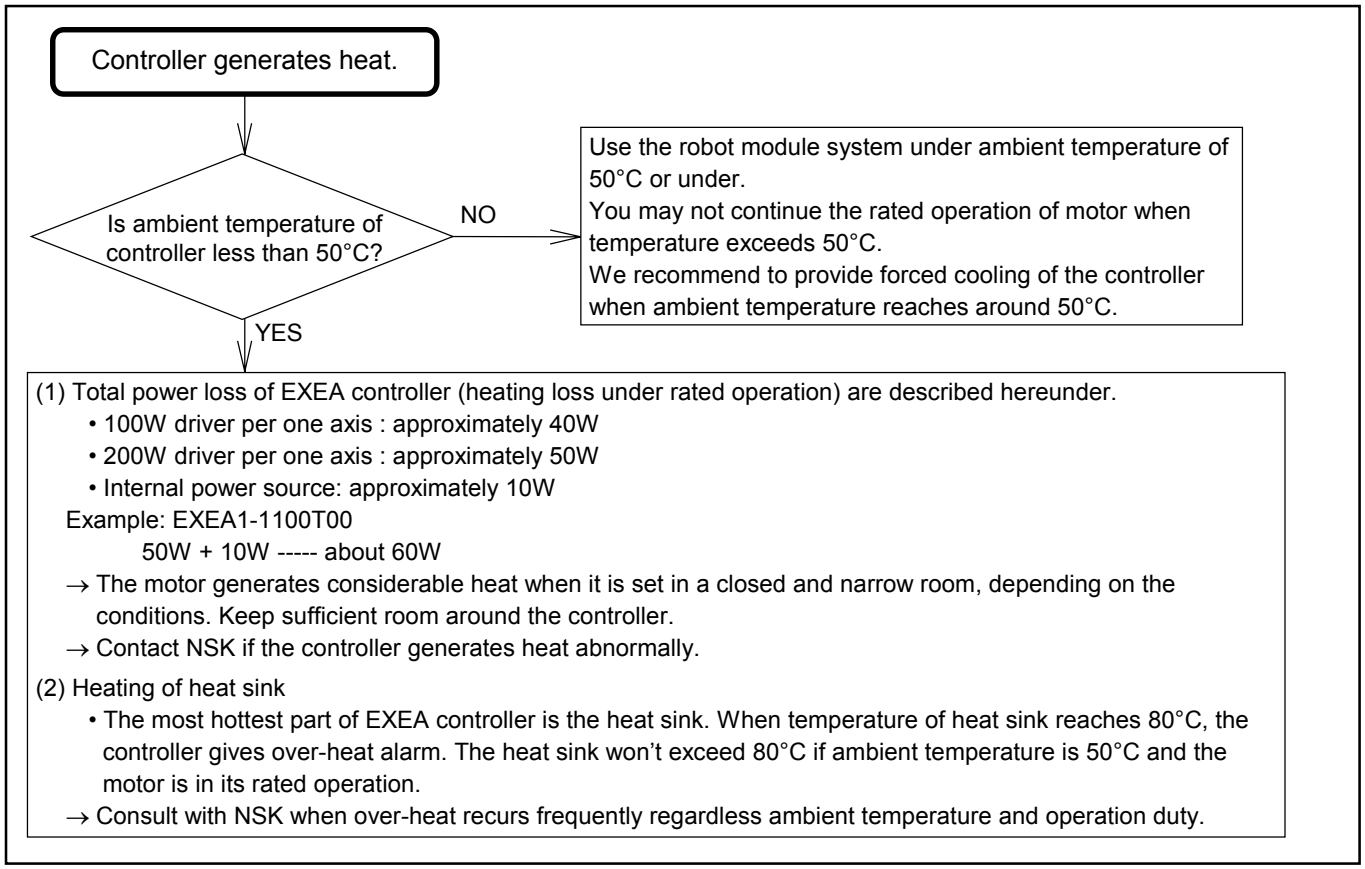
- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-23: Troubleshooting for heat generation of motor



- Be sure to observe all safety precautions described on Page 14-1 and 14-2.

Figure 14-24: Troubleshooting for heat generation of controller



14.2. Inspection of Trouble

Danger *: Observe the items described hereafter prior to troubleshoot. Otherwise the troubleshooting itself can be dangerous and further critical accident may occur due to secondary problems, such as burning motor or malfunction of the system.*

1 Check for matching of module main unit and power amplifier

- Make sure that power output of main unit motor conforms to the driver specification of controller.

  Incorrect example: Mistakenly connect EXEA controller (200W) to a main unit (100W).

2 Use NSK standard cable for the controller cable.

- Be sure not to miss-wire when you provide the controller cable by yourself or modify NSK standard cable.

  Incorrect example 1: Motor may malfunction if U, V and W phase wires are wired incorrectly.

  Incorrect example 2: Motor may malfunction if encoder signal wires are wired incorrectly.

3 Make sure that the power source voltage is compatible with the main unit.

◊ EXEA□-□□□□T□□ : Single phase AC180V ~ 264V

- The driver may burn when excessive voltage shown above is applied.

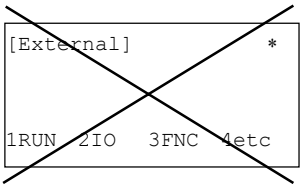
4 Check if FGND terminals and AC power line terminals are mistakenly connected.

- If AC power line is connected to FGND terminal, or earth the AC power terminal, the controller not only functions abnormally but induces troubles such as burning.

Danger *: 1) Before troubleshooting, be sure that the moving part of module main unit has completely stopped.*

2) The following must be observed when approaching to the main unit or adjusting the moving part of module main unit for troubleshooting.

◊ Set the controller to teaching box operation mode, turn servo off so that the controller is not turned on and not to be operated from outside.



: Be sure that the controller is not in external control mode.

: Check that the servo on indicator (∗) on upper right of screen is off.

Indicates servo is off.

◊ When it necessitates to turn servo on or to operate the robot during trouble shooting for an unavoidable reason, make sure no person and/or no obstacle which is possible to be broken by module main unit is in working area of the robot module. Furthermore provide necessary measures to prevent from entry of other person in the working area of robot module while you are operating the system.

◊ The teaching box must be put in your reaching area so that it can be handled immediately in an emergency.

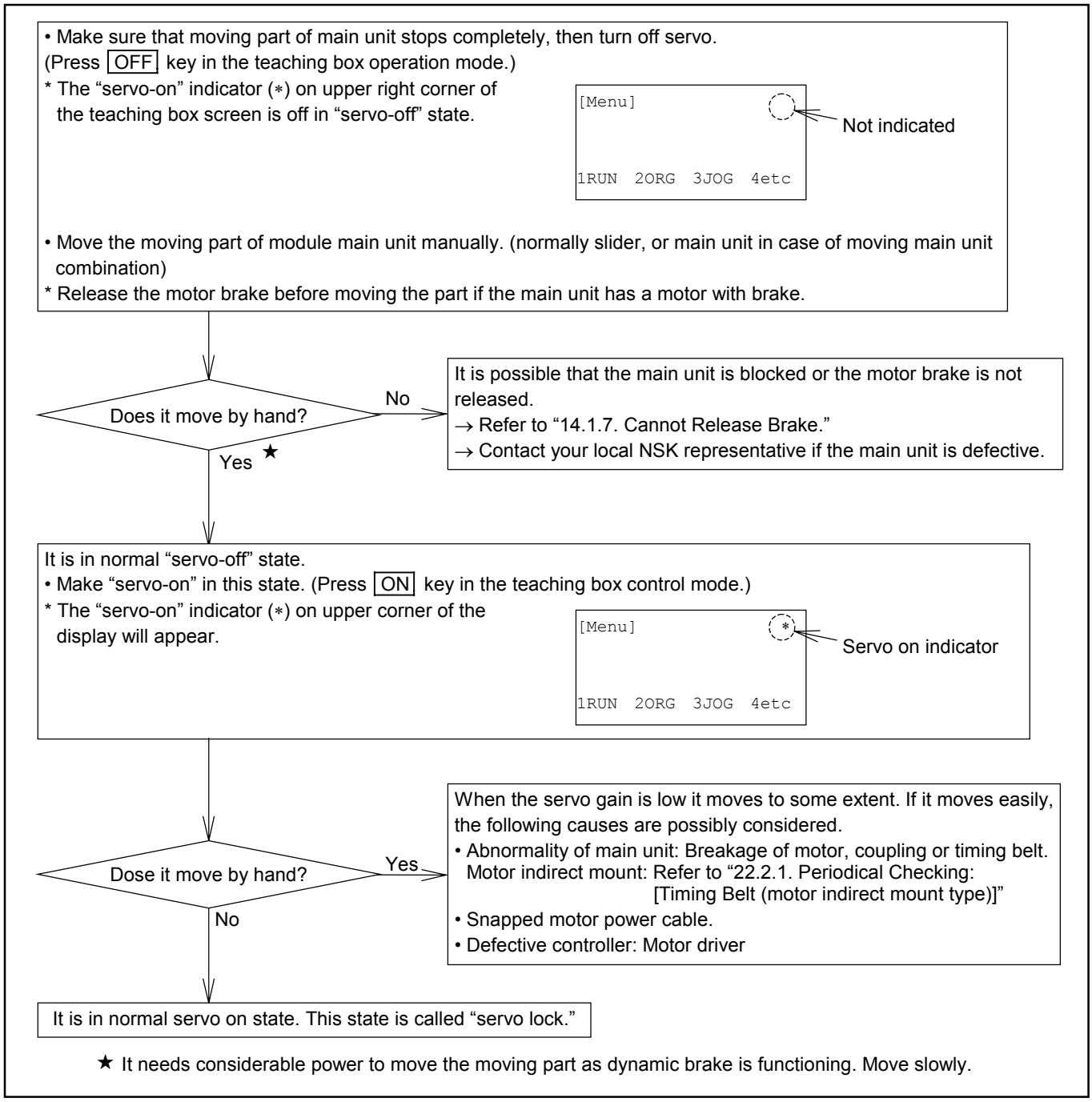
◊ Be sure to check the function of emergency stop works properly prior to get in troubleshoot.
(Adjusting or checking operation must be made after examination of emergency stop function surely works.)

3) When releasing motor brake of vertical main unit, move the slider to the bottom stroke end in advance, then release the brake to prevent injury of person and damage to the unit.

14.2.1. Check on Servo Lock

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.
- If an alarm arises, refer to "13.4. Description of Alarm" and remove the cause of alarm before troubleshooting.

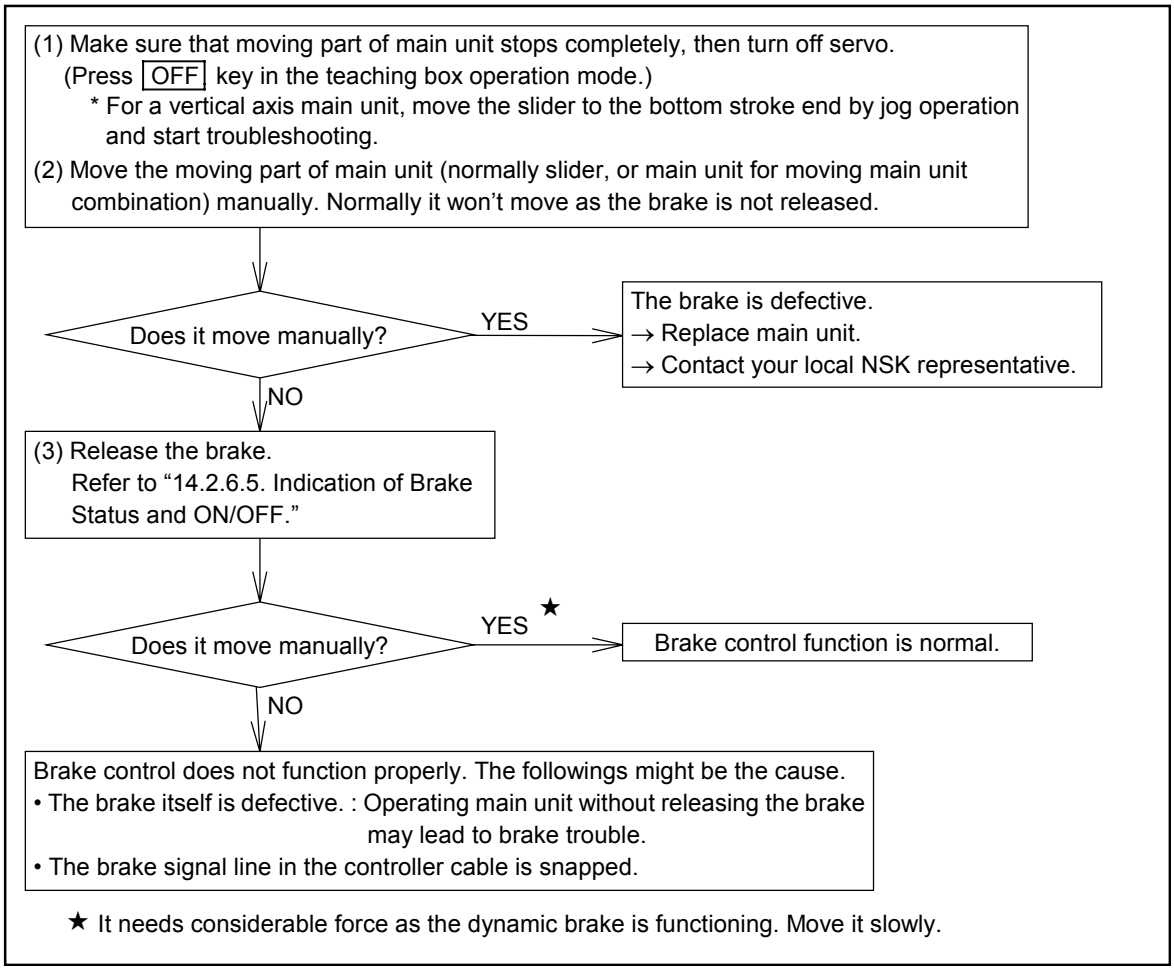
Figure 14-25: Procedure to check on servo lock state



14.2.2. Check for Brake Function

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.
- If an alarm arises, refer to "13.4. Description of Alarm" and remove the cause of alarm before troubleshooting.
- This section is only applicable to the main unit with motor brake.

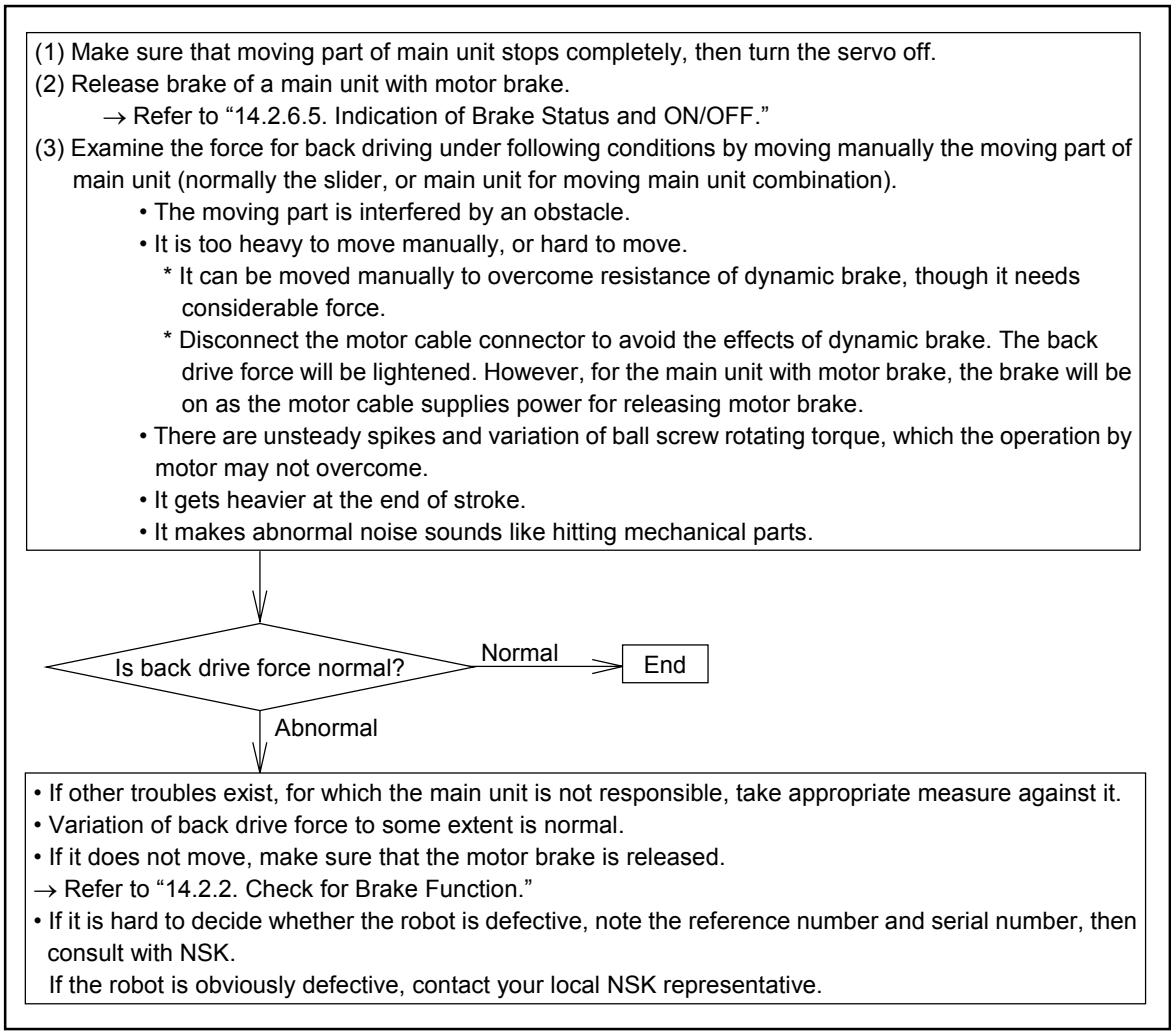
Figure 14-26: Procedure to check brake function



14.2.3. Check for Mechanical Back Drive

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.
- If an alarm arises, refer to "13.4. Description of Alarm" and remove the cause of alarm before troubleshooting.

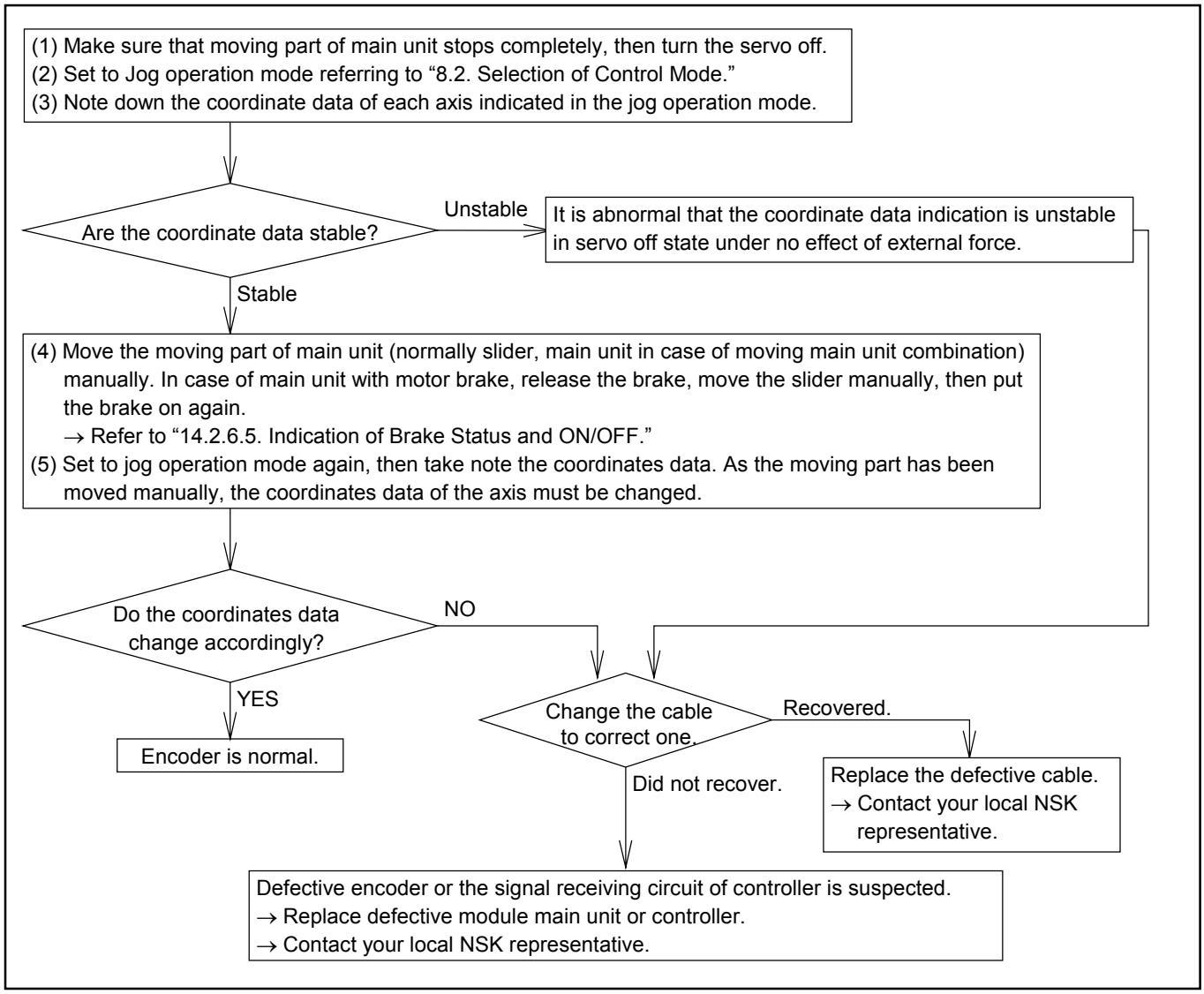
Figure 14-27: Procedure to check on mechanical back drive



14.2.4. Abnormality of Encoder Signal

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.
- If an alarm arises, refer to "13.4. Description of Alarm" and remove the cause of alarm before troubleshooting.

Figure 14-28: Procedure to check encoder condition

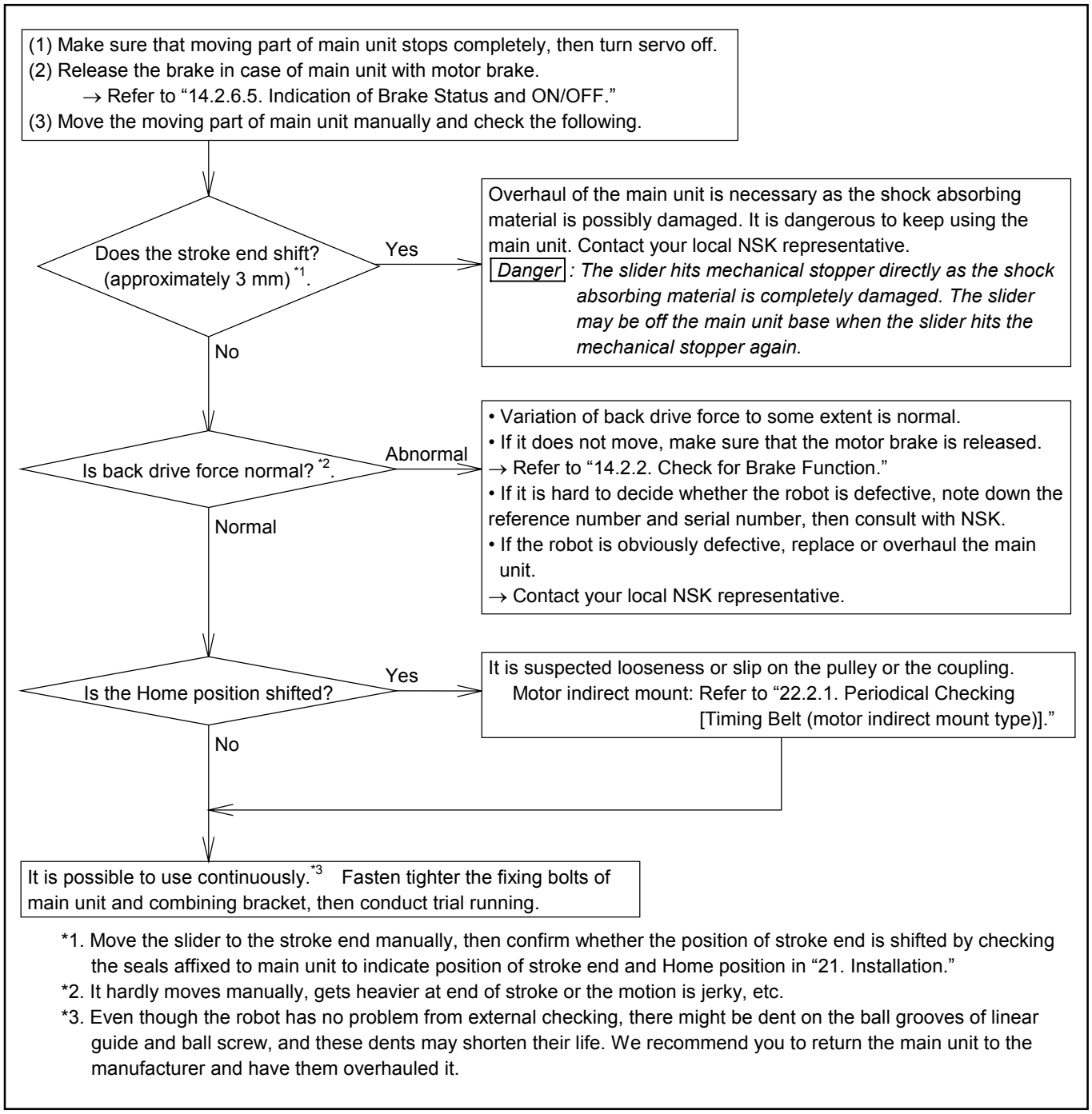


14.2.5. Action for Malfunction and Collision

■ Check for the damage following the procedure described in Figure 14-29, if severe collision occurs at the stroke end.

- Be sure to observe all safety precautions described on Page 14-1 and 14-2.
- If an alarm arises, refer to "13.4. Description of Alarm" and remove the cause of alarm before troubleshooting.

Figure 14-29: Procedure for checking damage by malfunction and collision



*1. Move the slider to the stroke end manually, then confirm whether the position of stroke end is shifted by checking the seals affixed to main unit to indicate position of stroke end and Home position in "21. Installation."
*2. It hardly moves manually, gets heavier at end of stroke or the motion is jerky, etc.
*3. Even though the robot has no problem from external checking, there might be dent on the ball grooves of linear guide and ball screw, and these dents may shorten their life. We recommend you to return the main unit to the manufacturer and have them overhauled it.

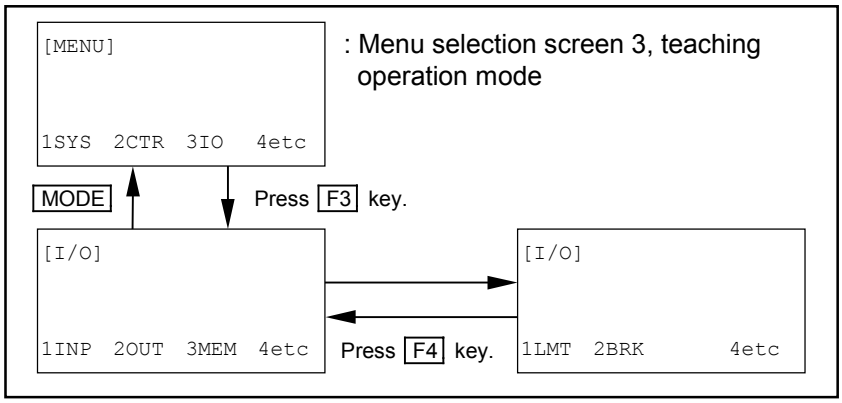
14.2.6. Monitoring I/O

- Get the menu selection screen 3 in the teaching box operation mode referring to "8.2. Selection of Control Mode."

- When F3 key (IO) is selected in the menu selection screen, the screen for indication/selection of I/O signal condition appears as shown in Figure 14-30. In the indication/selection screen, use F1 ~ F4 keys for selection.

- Subjects which can be indicated:
  INP : Input port
  OUT : Output port
  MEM : Virtual input/output port
  LMT : Limit port

Figure 14-30: I/O selecting screen

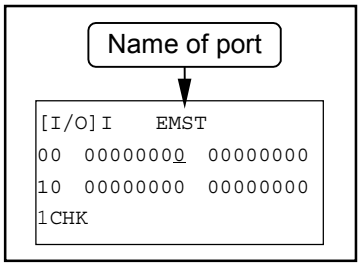


14.2.6.1. Indication of Input Port Condition

1 Monitor status of input port.

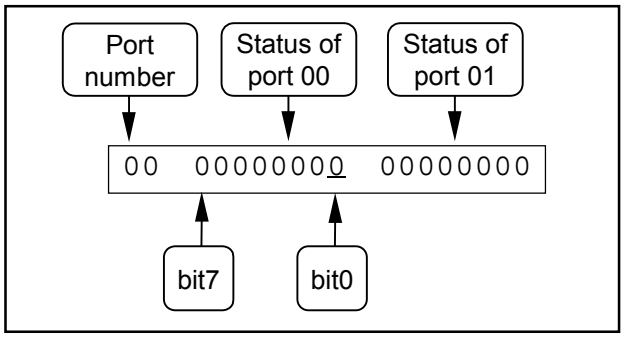
- Indication screen of Input port condition appears when F1 key (INP) in the I/O indication/selection screen is pressed.
- I is indicated next to the [I/O] in the screen.
- Status of four input ports are shown in the second and third line. Use ◀, ▶, ▲ and ▼ keys to scroll the cursor.
- The first line indicates the name of the port of which bit are selected by the cursor.
- When there are four or more input ports, use ▲ and ▼ keys to scroll the indication.

Figure 14-31: Screen indicating the input port condition



- Indications of status on the second and third lines are, from left to right, port number, status of the port, and status of next port (port number +1).
- Status of port is indicated by 8 bits. Left side is bit 7 and right side is bit 0.
- The status of the port is indicated by 0 (off) and 1 (on) regardless the logic of port (normally open/normally close).

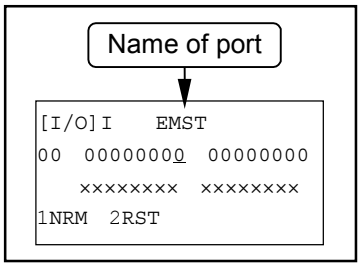
Figure 14-32: Example of input port indication



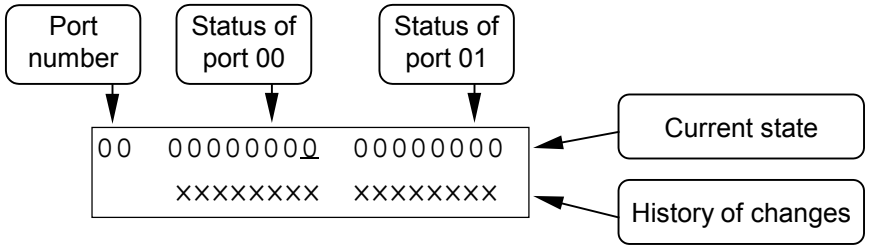
2 Checking input port status.

- The following screen of input port status appears when F1 key is pressed in the screen to indicate input port condition.
- Two conditions (current status and history of changes) of two different input port are indicated on the second and third line. Use ◀ and ▶ keys to move position of the cursor.
- The name of the port of which bit is indicated by the cursor is on the first line.
- Use ▲ and ▼ keys to scroll the indication if the input ports are more than two.

Figure 14-33: Example: Screen of setting input port

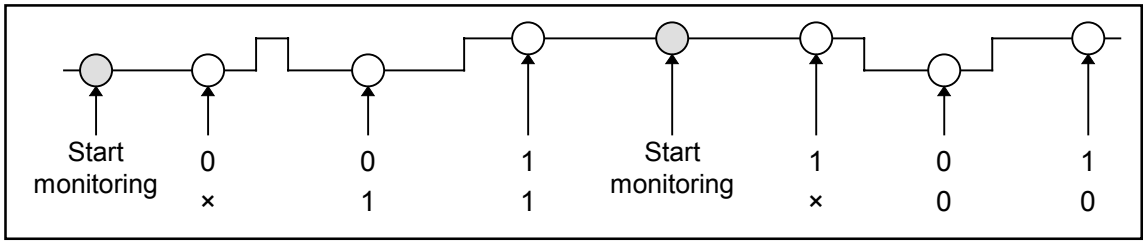


- The figure below shows the state of input port indicated on the second and third line.



- History on the third line indicates changes of input port status after DRDY is on, or after F2 (RST) key is pressed.
- Each bit is one to one correspondence to a bit on the second line.
- × changes to 1 when the port state changes to 1 from 0 after start of monitoring, while x changes to 0 when the state of the port changes to 0 from 1. The bit of which state is changed will keep its state till F2 key (RST) is pressed.
  (Current status on the second line changes in real time basis.)

Figure 14-34: Example: History of input port changes

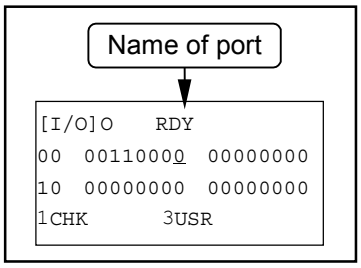


- Press F1 key (NRM) in the I/O indication/selection screen to return to the screen of input port status.

14.2.6.2. Indication of Output Port Condition

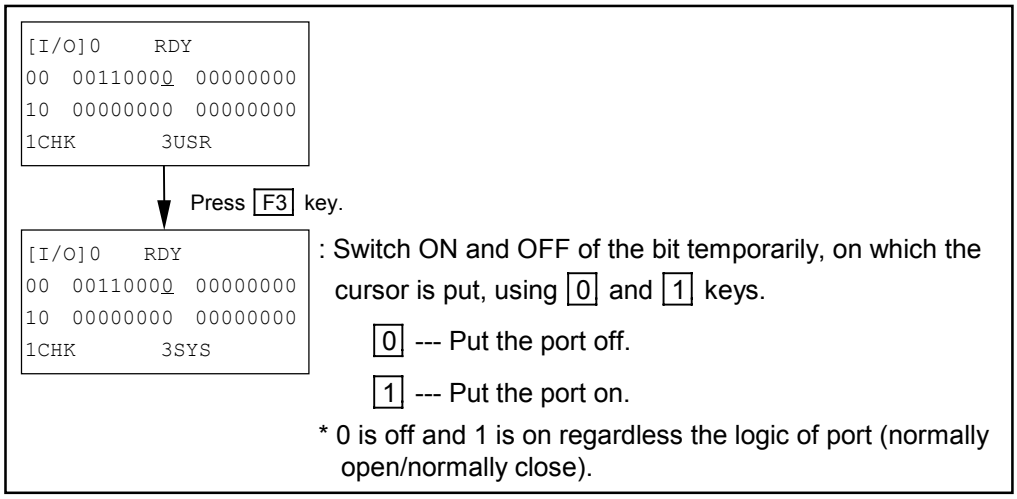
- Status screen of output port appears when F2 key (OUT) is pressed in the I/O indication/selection screen.
- O appears next to [I/O] in the screen.
- State of four output ports are shown in the second and third line. Use ◀, ▶, ▲ and ▼ keys to scroll the cursor.
- The first line indicates the name of the port of which bit are selected by the cursor.
- When there are four or more output ports, use ▲ and ▼ keys to scroll the indication.

Figure 14-35: Indication of output port status



- Functions and the composition of indications are the same as the screen of input port status. However, pressing F3 key (USR) makes it possible to switch ON and OFF of the bit temporarily, on which the cursor is put, by using 0 and 1 keys.

Figure 14-36



- Changed state are valid till pressing F3 (SYS) key again or MODE key. These keys make the state to the previous setting.

14.2.6.3. Monitor Status of Imaginary Input / Output Port

1 Monitoring Status of Imaginary Input/ Output Port

- Press F3 key (MEM) in the I/O monitor screen to get in the monitoring screen of imaginary input/output port.
- "M" appears on the side of [I/O] in the monitoring screen as shown in Figure 14-37.
- Current status of two imaginary ports will be displayed on the second line of the screen. Use ◀ and ▶ keys to move the cursor.

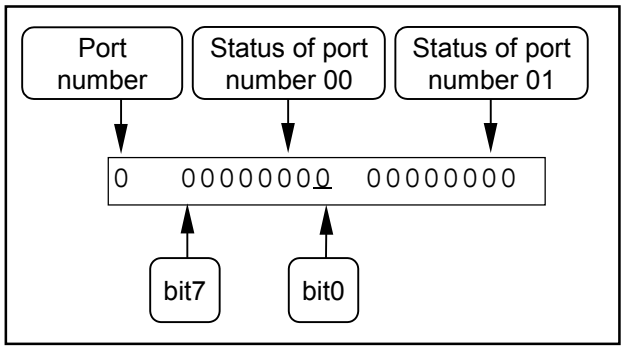
Figure 14-37: Monitoring screen of imaginary port of Input / Output

```
[I/O]M
0   0000000_0   00000000

1CHK
```

- Indications of the second line are, from left to right, a port number, status of the port (designated by the port number), and status of a port (of which number is +1 of the previous one).
- The status of a port is indicated by a unit of 8 bit, the left side is bit 7 and the right side is bit 0.
- Indication of status is 0 (zero) for OFF and 1 (one) for ON regardless logic of port (normally open /normally close).

Figure 14-38: Monitoring example of input / output port



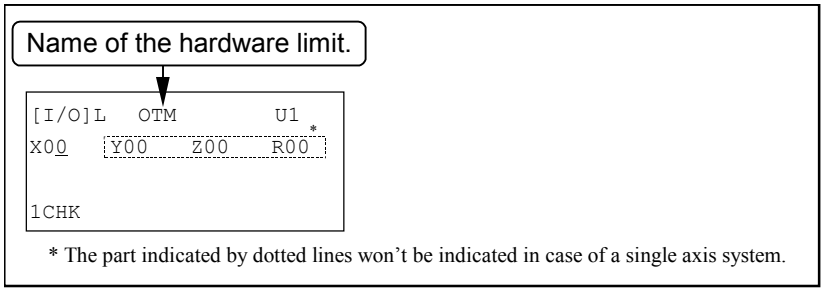
2 Checking imaginary input / output port status

- Press F1 key (CHK) in the monitoring screen of imaginary input / output to get in the screen of status checking screen.
- Two kinds of status (current and history of change) for 2 imaginary input / output ports will be indicated on the second and third line. Use ◀ and ▶ keys to move the cursor for selection.
- Refer to "14.2.6.1. Indication of Input Port Condition . 2 Checking input port" for the way how to check the status of the port.

14.2.6.4. Monitor Status of Limit Sensor Port

- This is to indicate conditions of hardware travel limit.
- Status screen of limit sensor port appears when LMT is selected in the I/O indication/selection screen.
- L appears next to [I/O] in the screen.
- Current state of limit sensor of designated unit is indicated on the second line. Use ◀ and ▶ keys to move position of the cursor for selection. (in case of multi-axis combination)
- Name of the limit, on which bit the cursor is put, is indicated on the first line.
- Use ▲ and ▼ keys to switch the screen for a unit when two or more units are set to a multu-axis combination.
- Functions and composition of indication are the same as the input port.

Figure 14-39: Monitor limit sensor port



* The part indicated by dotted lines won't be indicated in case of a single axis system.

14.2.6.5. Indication of Brake State and ON/OFF

Warning : Move the slider of the vertical axis to the bottom stroke end when releasing the brake. (for moving main unit combination move the main unit)
The slider (or main unit for moving main unit combination) falls by its own weight (back drive) when it is in the middle of the stroke as the brake is released.

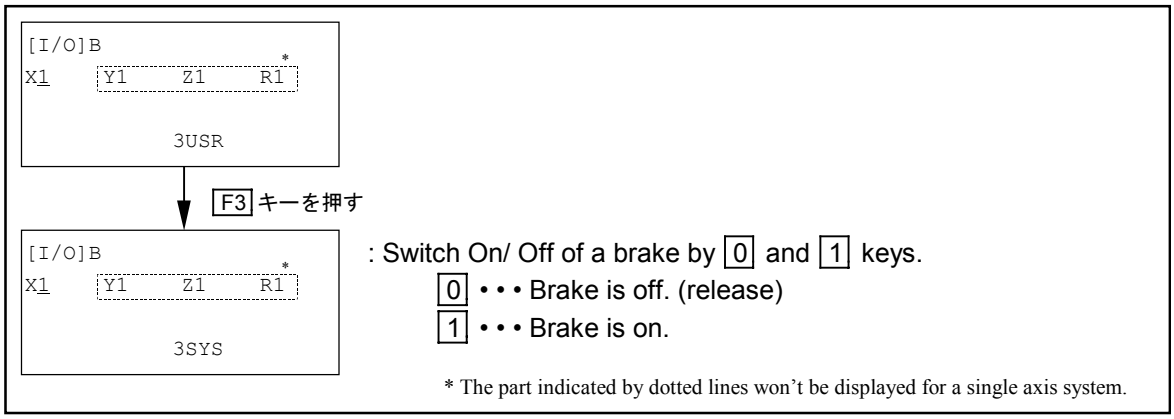
- Select BRK in the I/O indication/selection screen to lead the screen of brake status.
- B appears next to [I/O] in the screen.
- Current status of designated unit on the second line in for a multi-axis combination, and use ◀ and ▶ keys to move position of the cursor.
- Use ▲ and ▼ keys to scroll the indication when two or more unit are set to a multi-axis combination.

Figure 14-40: Monitor brake condition

* The part indicated by dotted lines won't be displayed for a single axis system.

- Pressing F3 key (USR) makes it possible to switch temporarily ON and OFF of the bit, on which the cursor is put, by using 0 and 1 keys.

Figure 14-41



- Settings are valid until F3 key (SYS) is pressed again or MODE key is pressed. Pressing either key makes to return to the setting of previous one.

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Appendix 1: Specification of Motor Connector

Table A-1: Used Connectors

EXEA controller side	Phoenix Contact: GIC2.5/6-GF-7.62
Mating connector (cable side)	Phoenix Contact: GIC2.5/6-STF-7.62
Mating connector shell type (cable side)	Phoenix Contact: KGS-MSTB2.5/9

Figure A-1: Pin out

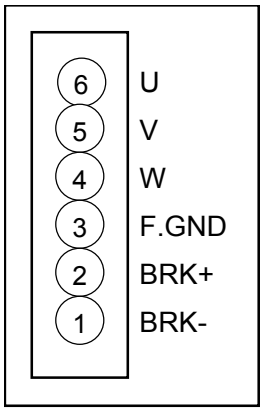

Table A-2: Pin out and signal

Pin	Signal name	Function
1	BRK-	Brake power: 0V output
2	BRK+	Brake power: 24V output
3	F.GND	Frame ground
4	W	Motor, Phase W
5	V	Motor, Phase V
6	U	Motor, Phase U

∗ The connector of EXEA controller indicates the name of axis as shown below.
First axis (X axis): 1st

Table A-3: Motor power specification

Motor output	100W	200W	400W
Output voltage	±280VPWM	±280VPWM	±280VPWM
Current for rated output	0.87Arms	2.0Arms	2.6Arms
Current for maximum output	2.8Arms	6.0Arms	7.8Arms

Table A-4: Brake power specification

Output voltage	DC24V
Rated output voltage	400mA
Output format	Relay contact
Type of brake	Negative activation

Appendix 2: Encoder Sensor Connector

Table A-5:Used connector

EXEA controller side	Japan Aviation Electronics Industries Ltd. : DBLC-J25SAF-13L9
Mating connector, cable side	Japan Aviation Electronics Industries Ltd.: DB-25PF-N
Mating connector shell type, cable side	Japan Aviation Electronics Industries Ltd.: DB-C4-J11-S1

Figure A-2: Pin out

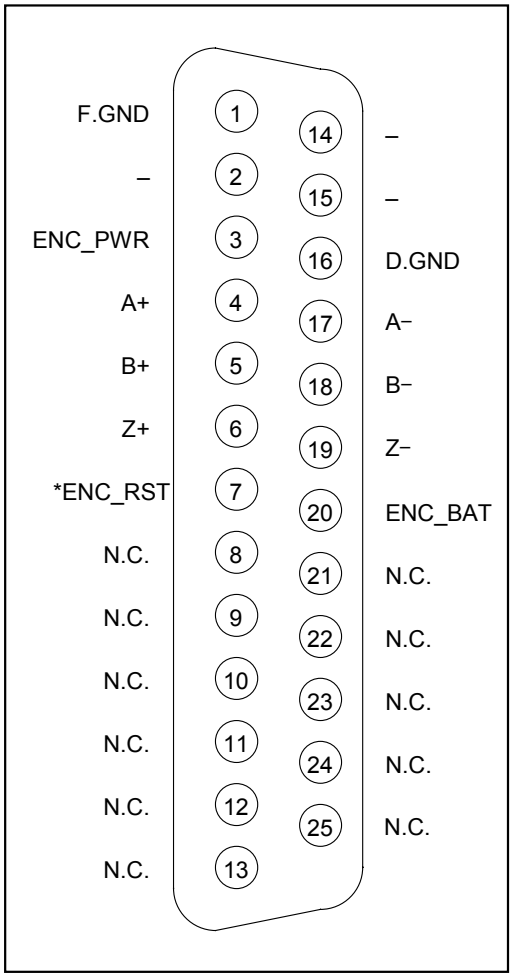

Table A-6: Pin out and signal

Pin	Signal name	Input/output	Function
1	F.GND	–	Frame ground
2	–	–	Do not connect.
3	ENC_PWR	output	Encoder power
4	A+	input	Encoder signal (A+)
5	B+	input	Encoder signal (B+)
6	Z+	input	Encoder signal (Z+)
7	*ENC_RST	output	Reset encoder
8	N.C.	–	Do not connect.
9	N.C.	–	Do not connect.
10	N.C.	–	Do not connect.
11	N.C.	–	Do not connect.
12	N.C.	–	Do not connect.
13	N.C.	–	Do not connect.
14	–	–	Do not connect.
15	–	–	Do not connect.
16	D.GND	–	Signal ground
17	A-	input	Encoder signal (A-)
18	B-	input	Encoder signal (B-)
19	Z-	input	Encoder signal (Z-)
20	ENC_BAT	output	Battery power
21	N.C.	–	Do not connect.
22	N.C.	–	Do not connect.
23	N.C.	–	Do not connect.
24	N.C.	–	Do not connect.
25	N.C.		Do not connect.

Table A-7: Encoder input signal

Item		Specification
DC5V power output	Power source voltage	DC5V ±10%
	Maximum current	250mA
Input format		Deferential line receiver
Used line receiver		TI SN75175NS or equivalent
Deferential-mode input thrush hold voltage		±0.2V
Input impedance		220Ω
Maximum common-mode input voltage		±12V

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Robot Module System

- **P Series Module Main Unit**
- **R Series Module Main Unit**
- **EXEA Controller**

User's Manual 1

= Installation and Maintenance of EXEA Controller =

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