NSK

MEGATHRUST® MOTOR SYSTEM

User's Manual

(ESA13 Driver Unit)

M–E099SA0T2–011

NSK Ltd.

Document Number: T20011-03

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.

In order to use the Megathrust Motor System properly, observe the following notes.

1. Matters to be attended to use the Driver Unit of the Megatorque Motor System

1 Temperature

- Keep the ambient temperature of the Driver Unit within 0 to 50°C. You cannot put the Driver Unit in an atmosphere over 50°C. Keep a clearance of 100 mm in upper and lower side of the Driver Unit when it is installed in the enclosure. If heat is build up on upper side of the Driver Unit, provide the ventilation openings on the top of the Driver Unit or equip an air cool unit to take the heat out of the Driver Unit. (Measures against contamination are required for the ventilation openings.)

2 Protection against contamination and water

- Put the Driver Unit in an enclosure of which protection code is IP54 or better. Protect the Driver Unit from oil-mist, cutting oil, metal chips and paint fume etc. Otherwise it may result in failures of electric circuits of the Driver Unit.
  (IP code is in IEC standard. This is to specify the protection level of enclosures from solid contamination and water.)

3 Wiring / Ground

- Refer to User's Manual for proper wiring.
- Take appropriate measures not to contaminate the Driver Unit when wiring or installing it.

4 Storing

- Store the Driver Unit in a place at where it is not exposed to rain, water and harmful gas or liquid.
- Store the Driver Unit in a place at where it is not exposed to direct sun light. Keep ambient temperature and humidity as specified.

2. Matters to be attended to use the Motor of the Megathrust Motor System

1 Dustproof and Waterproof of the Motor

- You cannot use the Megathrust Motor in atmosphere at where paint fumes or chemicals exist.
  The Motor is not made for dust-proof or waterproof. You cannot use the Motor in humid or oily atmosphere.

2 Use condition

- Keep the ambient temperature of the Motor between 0 to 40°C. Install thermal sensor circuit to turn off the main AC power when temperature exceeds the limit.
- The allowable load mass and the transportable moment load differ depending on the Motor size. Reconfirm that the using conditions are in the specified limits of the Motor.
- An excessive offset load or load mass may cause permanent deflection on a part of Motor body, slider, and Linear Guides. Be careful not to give a shock to the Motor caused by an external interference in transit or in the process of installation.
- Do not collide the slider to the stroke ends. We recommend providing over travel limit switches with the stroke ends.
- Install shock absorber to protect the work that is put on the slider.
- Flatness of the Motor mounting surface shall be 0.05 mm or less
- Take sufficient measures not to dry up the Linear Guides. We recommend to replenish the grease periodically. (Dried up Linear Guides may cause unstable operation.)

- The Linear Guides equip with NSK K1 lubrication unit. Life of K1 lubrication is 5 years or 10 000 km running, whichever comes first. Be sure to give periodical replenishment with grease thereafter.
- It is possible to replace the K1 lubrication unit when it comes to its life.

3 Periodical check

- Puncture of the Motor, cable shorting or snapping may occur depending on using condition and environment. If the Motor is left in such conditions, it cannot exhibit its capability 100 % and will lead to the trouble of the Driver Unit. We recommend the periodical check in order to detect the problem in its early stage.

3. Before concluding that the system is defective, check the matters again.

1 Alarm arises.

- Did you take proper action to the alarm? Refer to the manual for the remedy again.

2 Power does not turn on. Indication lamp does not turn on.

- Check voltage of main and control power by a tester if the voltage is in the range of specification described in the User's manual.

3 The Motor does not function.

- Turn the power off, disconnect the connector CN4 of the Driver Unit, and then move the slider manually. Does it operate smoothly? Any unevenness in motion? (Never disassemble the Motor.)
  (If the connector CN4 remains connected, the motion of the slider will be heavier due to dynamic brake.)
- Are the control Input/Output signals functioning properly?
  → Monitor status of SVON, RUN and IPOS signals by I/O command through the Handy Terminal.
  → Check if the voltage of input signal and 24 V power source are stable using an oscilloscope etc.

4 Uncontrollable Driver Unit

- Compare the current setting of parameters with the original setting at the installation.

5 The Motor vibrates. Positioning is inaccurate. Alarm of software thermal arises frequently.

- Are servo parameters VG, VI, PG, FP and NP adjusted properly
- Do you fasten the fixing bolts of load and the Motor securely? Check and fasten them tightly if necessary.
- Connect FG terminal of the Driver Unit to one point grounding. Ground the Motor and the Driver Unit respectively. (Refer to the User's Manual for wiring.)
- Is any external interference to the direction of motion in Servo lock state? (It leads to the Motor overheat if external force is applied to the Motor in servo lock state.)
- Do you use shielded cable for input signals? Is the shield perfect?

6 Fuses are blown. Breaker trip occurs frequently.

- When the system recovers by remaking the power, take the following action.
  ◊ Install a delay type breaker.
  (Select the breaker that has enough capacity for power consumption of the Driver Unit.)

4. Others

- Combination of the Motor and the Driver Unit shall conform to the specification.
- Be sure to write down the setting of parameters.
- Never modify the cable set.
- Lock the connectors securely and check for loose fixing screw(s).
- Please keep expendable parts and backup parts. (the Motor, the Driver Unit and Cable set for replace)
- Use isoplopyl alcohol for cleaning. Do not apply the thinner.

MEGATHRUST®
MOTOR
SYSTEM

User's Manual

NSK Ltd.

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About This Manual

- Before operating the Megathrust Motor System, this manual should be read thoroughly. The Megathrust Motor System is a unique device, so ‘common sense’ based upon experience with servo motor may not apply here. Careful consideration of the mechanical design as described in “Chapter 6” is especially important.

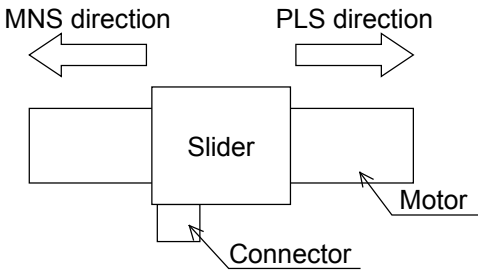
- This manual describes the interface, function and operation of the Megathrust Motor System with YS Motor and ESA13 Driver Unit. If your model is not one of these, refer to respective information.

Technical Information

- For technical assistance and sales information, please contact your local NSK office. A list of NSK offices is provided in the back cover.

Terminology

It will be necessary to be familiar with some terms used in this document.



bps	bit per second; the unit of communication speed.
closed	logic output state; output current will flow.
Driver Unit	means Megathrust Motor System's driver unit when capitalized.
Home Return	a built-in sequence program for setting the home position.
kpps	kilo pulse per second; the unit of pulse frequency.
MNS	direction of Motor motion, minus (negative); see figure above.
Motor	means Megathrust Motor System's motor when capitalized.
OFF (all capital)	logic input state; input will see an open circuit.
ON (all capital)	logic input state; there will be a current path to the common DC supply.
open	logic output state; no output current
P control	proportional-only control; the servo algorithm.
PI control	proportional and integral control; the servo algorithm.
PLS	direction of Motor motion, plus (positive); see figure above.
position gain	shorter name for position loop proportional gain
position integrator frequency	shorter name for position loop integrator cutoff frequency
position loop control mode	a control mode within the position control loop; P control or PI control available.
Programmable Indexer	Driver Unit's built-in indexing ability.
pulse train	a series of pulses used as a position command.
quadrature output	two pulse train outputs with 90° phase difference.
rated stall force	the rated force available at zero speed.
rated force	the force not to exceed the maximum Motor winding temperature.
servo-lock	one typical state of servo-on; the Motor provides force and remains in position.
servo-off	the state where the Driver Unit provides no current to the Motor, and the Motor provides no force. The Motor slider can be moved easily.
servo-on	the state that the Driver Unit is ready to control the Motor, or is controlling the Motor.
shipping set	a parameter setting or a Driver Unit function setting at shipping.
stall force	the force available at zero speed.
System means	Megathrust Motor System when capitalized.
velocity gain	shorter name for velocity loop proportional gain
velocity integrator frequency	shorter name for velocity loop integrator cutoff frequency
velocity loop control mode	a control mode within the velocity control loop; P control or PI control available.

Contents

1. Introduction

- This section is to introduce the Megathrust Motor System in general. Some part of explanations are not applicable to all Driver Unit and/or Motors. Refer to respective specifications when ordering.

1.1. Overview

- The Megathrust Motor System is a unique actuator with special capabilities. The System consists of almost all elements that are needed for a complete closed loop servo motor system. With conventional technology these parts must be purchased and installed separately, but the Megathrust Motor System incorporates them all into two units; the Motor and the Driver Unit.

Motor

- The Motor consists of a high thrust force brushless actuator, a high resolution brushless resolver, and heavy duty precision NSK Linear Guides. The high thrust force actuator has a simple structure, while the built-in resolver usually makes feedback components, such as encoders unnecessary. Finally the heavy duty Linear Guides eliminates the need for separate mechanical support since the Motor case can very often support the load directly in most applications.

Driver Unit

- The Driver Unit consists of a power amplifier, resolver interface, and digital motor control circuits. The Driver Unit provides everything that is needed to control the Motor's force, velocity, or position; for interface to any standard motor position controller or to act as a stand-alone digital motion control system with its built-in zero backlash position control capability.

High Speed

- The Driver Unit features higher speeds than ever before... with less force drop-off at the intermediate speeds. As a result, smaller Motors may be used for high speed positioning applications when the thrust requirement is primarily for acceleration.

Ease of Use

- The digital control makes the System easy to use, for more than one reason:
  - ◊ The circuit parameters can be changed by an RS-232C command, rather than by attempting to adjust a multi-turn pot or changing capacitor values. The parameter changes are not only a breeze to make, but they are measurable and repeatable, so that every System behaves the same way, every time.
  - ◊ The versatile design means that significant changes in the Driver Unit function can be made with little or no hardware changes. Numerous options are available at little or no extra cost.
  - ◊ Stand-alone capability means that the Megathrust Motor System can be operated in position control mode without the need for a separate CNC or position controller. Built-in software for flexible motion control means that the complexity of the electronic system can be cut in half. This reduction of the controls circuitry to one component saves time and money.

Universal Interface

- Because of the extreme versatility of the Driver Unit design, a wide variety of interface methods are possible. The Megathrust Motor System can be interfaced to virtually any control system. It is very easy to control the Megathrust Motor System with a CNC, a servo motor controller, a robot controller, or an positioning controller. You can operate the Megathrust Motor System with a stepper motor controller or with a personal computer or dumb terminal. Versatile position control can even be implemented with a single switch!

High Repeatability

- With zero backlash, direct drive and a high resolution resolver, the Megathrust Motor System offers repeatability as high as 1 micron, or approximately 0.000039 inch. With no mechanical contact or moving parts other than the Linear Guides, this repeatability will never degrade.

Easy to Maintain

- With all adjustments, indicators, and test points accessible by the front panel, service or maintenance is easy. LED (light-emitting diode) and logic diagnostic outputs identify the nature of any error condition quickly and accurately.

- Together, the Motor and the Driver Unit provide the ultimate in simplicity for precise and reliable motion control.

Single Component Servo System

- A conventional brushless servo system requires at least several separate components which must be selected and packaged together, often at great expense. Furthermore, many of these components introduce problems of their own to degrade the entire system's performance. Ball Screw type actuators, for example, introduce mechanical irregularities such as windup, backlash, and mechanical inaccuracy. The same functions can be accomplished with just two components using the Megathrust Motor System; all of the circuits needed to implement a position or velocity control servo loop (digital motion controller, servo compensation, brushless commutation logic, power amplifier) are included in the Driver Unit, and all of the mechanical components that were required (motor, couplings, ball screw, linear guides and encoder) are either replaced or made unnecessary by the Motor.

Long Stroke and Small Cross Section Area

- Different from the ball screw system, the cross section area of the Megathrust Motor does not depend on the stroke. By jointing unit rack bases, up to 30 meters rack base length can be represented while maintaining the same cross section area. In addition, because the rack base length does not affect to the repeatability, precise positioning is possible over the full stroke.

Multi Slider System

- One of the other unique merit of the Megathrust Motor is that several sliders can be mounted on the same rack base and can be controlled independent of the others. This also will contribute to design versatile system simple.

- A conventional brushless servo system requires at least several separate components which must be selected and packaged together, often at great expense.

1.2. Functional Principle

1.2.1. Motor

- By virtue of its unique design, the Megathrust Motor System is capable of producing extremely high thrust force at low speeds suitable for direct drive applications. Furthermore, it can produce these force levels without using an undue amount of power, so it can sustain these torque levels indefinitely under most conditions without overheating.

Motor Construction

- This Motor is of a stator and a rack base construction. The stator is constructed of laminated iron sheets with several poles stamped into the laminations. Each pole has one set of copper windings around it which provide the magnetic field. The windings are wired in series so that there are three sets of windings seen by the power amplifier, each winding consisting of some pole pieces. The face of each pole piece has many teeth, resembling a stepping motor (in appearance, not in function). The teeth serve to focus the magnetic energy into a series of discrete points along the pole face. In total there are hundreds of these points along with the stroke of the Motor. (The number depends upon the rack base length.) The rack base is an iron plate with the same tooth structure, but without windings or pole pieces. The rotor serves to conduct the magnetic field from the stator through the rack base, and back again to the adjacent pole piece on the stator. The rack base teeth also serve to focus the magnetic field into discrete points along with the stroke of the rack base, and the combined effect of these points of focused magnetic field around both the stator and the rotor act like electronic gear reduction, multiplying the force hundreds of times while reducing the speed by the same amount.

Brushless Microprocessor Commutation

- For each full electrical cycle of commutation, the Motor moves through one magnetic cycle which is the distance between adjacent teeth. There is one(1) electrical cycle per 4.096 mm stroke. The commutation of the Motor phases is performed without brushes by direct control of a high speed microprocessor in the Driver Unit, and it is the phase relationship of the three Motor phases, not current polarity, that determine the direction of move.

Why No Magnets?

- No magnets are used in the Motor, since the Motor uses the teeth to focus the magnetic field. This contributes to the robustness of the Motor and to the high force levels which are produced. Since demagnetization is not a worry, it is possible to develop high magnetic flux densities within the Motor which would weaken permanent magnets. Unlike motors which use permanent magnets, the Megathrust Motors do not weaken with age.

1.2.2. Driver Unit

- All of the circuits that are needed to operate the Megathrust Motor System in position, velocity or force control modes are contained in the Driver Unit. These circuit functions are:
  - ◊ Digital microprocessor
  - ◊ Power amplifier
  - ◊ Resolver interface
- The resolver interface and the digital microprocessor are on the control board, a single printed circuit board which is accessible to you on the right side of the Driver Unit.

Digital Microprocessor Subsystem

- The digital microprocessor subsystem is a part of the control board. All analog signals are converted to digital form, and the 16-bit microprocessor on the control board handles all Motor control functions in the digital domain. Since analog circuits are eliminated, there are no pots to adjust, no operational amplifier circuits to tweak, and no soldering or component changes are required. The digital microprocessor receives commands from the outside world in either analog or digital form, depending upon the selected interface option. The command parameter can be position, velocity, or force. The digital microprocessor compares the commanded variable with the actual measured value of the controlled variable, and makes small corrections continuously so that the Motor always obeys the command. The digital microprocessor receives its feedback information from the Motor's built-in resolver via the resolver interface circuit subsystem. Digital filters may be applied which alter Motor behavior to improve the repeatability, or to eliminate mechanical resonances:
    - ◊ A digital integrating function may be selected which improves the repeatability of the Motor by making it respond to very small command signals. With the integrator, the Motor can provide zero position error even under full load torque.
    - ◊ A digital notch filter may be employed to cut out certain frequencies from the Motor response so that mechanical resonances will not cause the Motor to oscillate. If the Motor is attached to a load which has a strong natural frequency of oscillation, the Motor can be made insensitive to it merely by setting the notch frequency to the same frequency. A 100Hz resonance can be eliminated, for instance, simply by initializing the Driver Unit with the RS-232C command "NP100."
    - ◊ A digital low-pass filter may be employed to modify Motor frequency response and make the Motor smooth and quiet. Again, the low-pass filter is implemented digitally, and setting up the filter frequency is as simple as asking for it. There are two independent low-pass filters available.

Brushless Microprocessor Commutation

- The digital microprocessor uses the digitized position information obtained from the resolver interface to determine when to apply current to the Motor phases, and how much. The amount of current applied to each Motor phase is determined by a mathematical function that takes into account the force command level, the Motor position, and the Motor velocity. These factors are taken into account to compensate for the Motor non-linearlities and to produce a smooth output force.

Power Amplifier Subsystem

- The Motor windings are driven by a current regulated unipolar switching power amplifier that delivers the current designated by the commutation logic circuits to each of the Motor phases. The power amplifier monitors its internal voltages to protect itself from damage. If the AC line is too high or too low, the power amplifier will disable itself and activate alarm indicators. If the amplifier's internal DC bus voltage is too high as a result of Motor regeneration, the monitor circuits will switch on a power resistor to dissipate some of that excess energy. If the power amplifier temperature is too high, it will activate an alarm signal. For any of the alarm conditions, the type of the alarm is communicated back to the digital microprocessor, which activates the alarm condition indicators to identify the specific nature of the alarm condition.

Resolver Interface Subsystem

- Position and velocity feedback signals are provided by the resolver interface circuit. This circuit provides the excitation signal to the resolver, and receives the three phase resolver analog signals. These signals are decoded by the resolver-to- digital converter (RDC) to produce digital cyclic absolute position and velocity feedback signals. The cyclic absolute position data is used by the commutation circuits and is used internally to maintain absolute position data.

2. Notes to Users

- This manual describes the interface, function and operation of ESA13 Driver Unit .
- Especially when you use Megathrust Motor System for the first time, please thoroughly read this manual.
- For the explanations of Motor, only standard Y Motor series is described in this manual. If your Motor is not Y series, please refer to respective specifications or applicable document.
- Special-order ESA13 Driver Units are made in compliance with this manual. When the Unit design is prescribed separately in another specification document, priority is given to the specification.
- Following notice is added to the clause of safety precautions to get your attention.

  ⚠ Danger : Might cause serious injuries.

  ⚠ Warning : Might result in injuries.

  ⚠ Caution : Might damage the equipment (machine) and/or the load (work).

2.1. Operational Remarks

- Pay special attention to the following precautions when installing, adjusting, checking and trouble-shooting Megathrust Motor System.

  ⚠ *Caution : Make sure that Motor size and maximum force number of Motor and Driver Unit are the same. Refer to "3.2. Reference Number Configuration" for the details.*

  ◊ If the numbers are different, the system does not operate properly.

  ⚠ *Caution : Do not make Cable Set shorter or longer. Changing the length may worsen Motor and Driver Unit performance.*

  ⚠ *Caution : Do not disassemble the Motor since it is precisely adjusted and assembled. If disassembled, it may cause abnormalities such as deterioration in accuracy and rigidity as well as noise.*

  ⚠ *Caution : Do not touch Driver Unit. Touching the Driver Unit just after the power is turned off may cause electric shock.*

  ◊ Driver Unit has high capacity conductors in its internal circuits and there is high residual voltage for few minutes after the power is turned off.

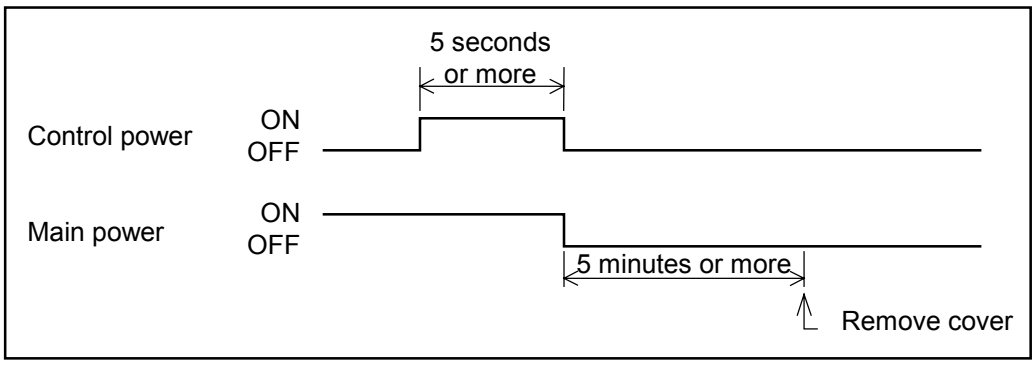
  ◊ Do not detach Driver Unit cover unless it is necessary. When the cover has to be removed, follow procedures described below.

  (1) Turn off the control and main power. If only main power has been turned on, turn the control power on for more than 5 seconds, then turn off both powers.

  Neglecting this procedure is very dangerous. The procedure is to reduce residual voltage of capacitors.

  (2) Wait for 5 minutes or more, then remove the cover.

Figure 2-1



Caution : Using an optional regenerative dump resistor shall be considered for heavy duty operation .

- *◊ When Motor is decelerating, rotational energy is dissipated by internal dump resistor. Excessive rotational energy causes very high regeneration of Motor, the dump resistor is overheated, then the alarms goes off and Motor stops.*
- *◊ Gentler deceleration rate or decreasing duty cycle prevents overheating of the dump resistor.*
- *◊ If heavy duty operation is still needed, installation of optional "Regenerative Dump Resistor" is recommended. Refer to "Appendix 5" for the details.*

Danger : Never apply any water or oil to Driver Unit. Take appropriate measures to protect Driver Unit from water, oil, slag , dust and corrosive gas.

Warning : Do not conduct an "Isolation test" or "Megger test" on Driver Unit. It may damage the internal circuit.

Caution : Be sure to adjust the servo parameters according to conditions of actual use. In most cases, the Direct Drive Motor System cannot exhibit its full performance unless the shipping set of these parameters are altered. Refer to "8. Trial Running and Adjustment" for the details about parameter setting.

2.2. Version Number

- Version number applicable to this manual is upgraded to 21 from 11.
- The number noted on the seal affixed to the Driver Unit is shown below.

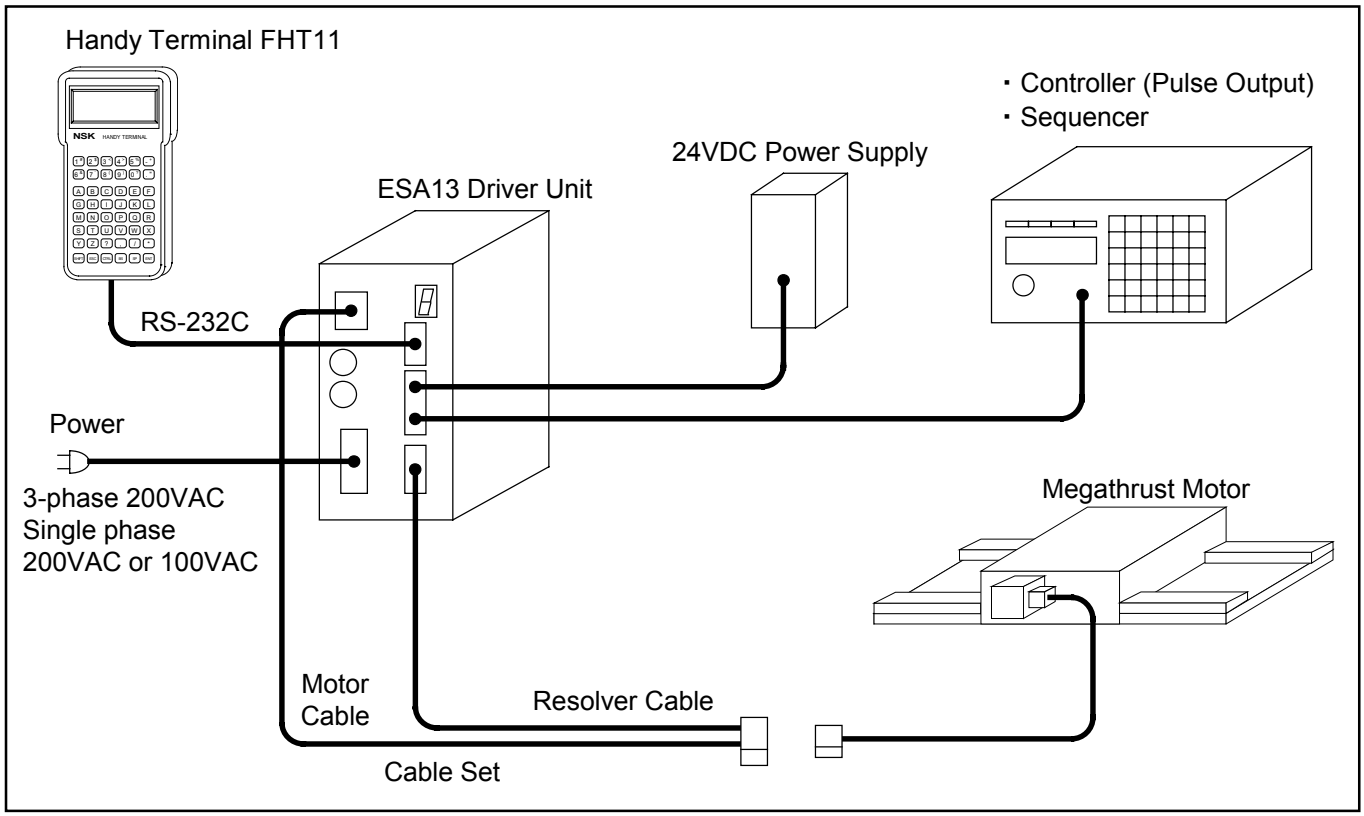
<Example of version number>

ESA-LYA2A13-21

3. System Outline

3.1. System Configuration

Figure 3-1



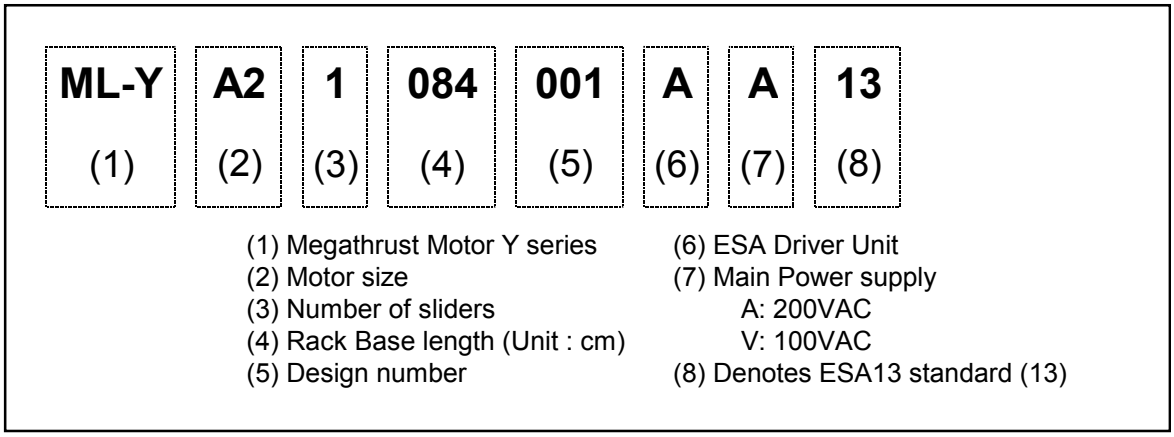
Components Supplied by NSK

- NSK can supply the ESA13 Driver Unit, Megathrust Motor, Cable Set (resolver cable and Motor cable) and Handy Terminal. Users are requested to acquire other equipment and wiring from other sources.

3.2. Reference Number Configuration

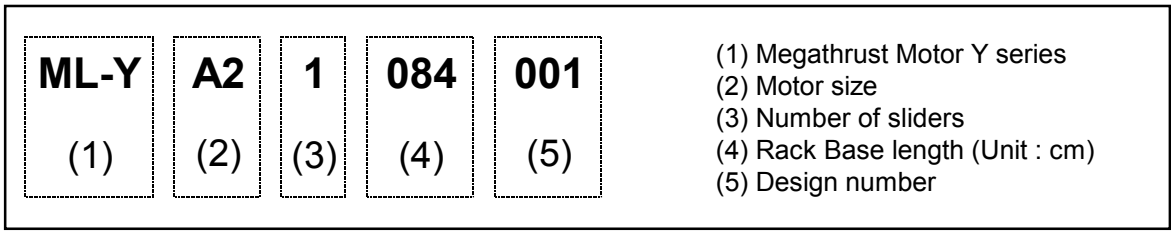
3.2.1. System

Figure 3-2



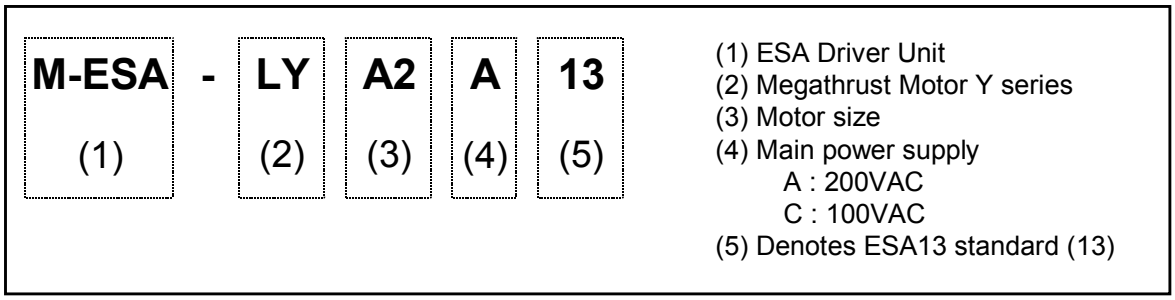
3.2.2. Motor

Figure 3-3



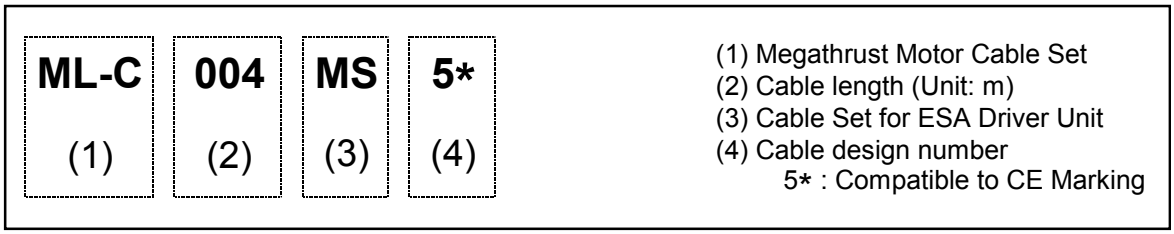
3.2.3. Driver Unit

Figure 3-4



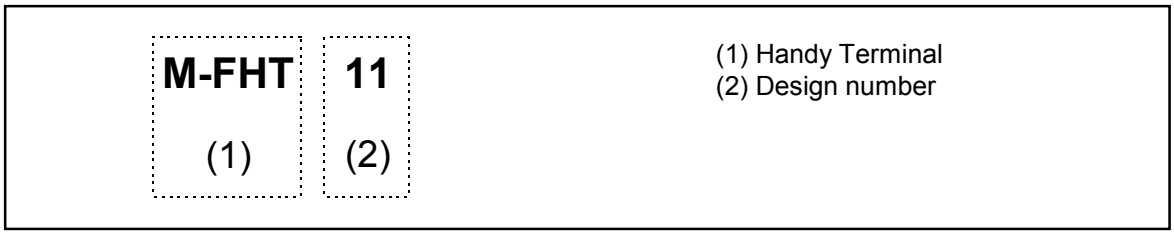
3.2.4. Cable Set

Figure 3-5



3.2.5. Handy Terminal

Figure 3-6



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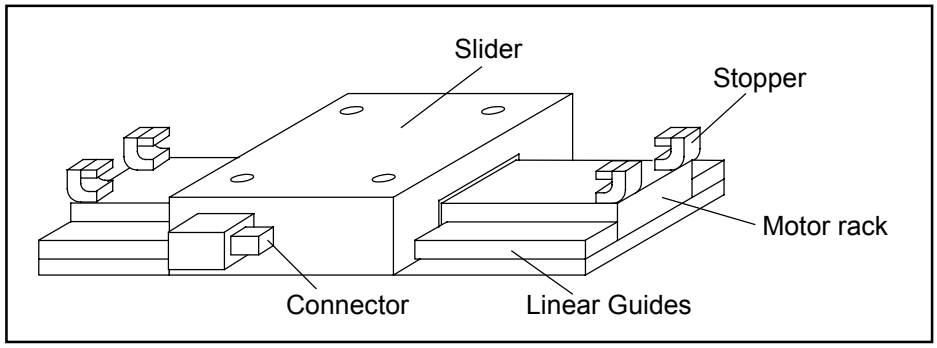
4. Specifications

4.1. Motor Specifications

4.1.1. Y Series Motor

4.1.1.1. Name of Each Parts

Figure 4-1



4.1.1.2. Specifications

Table 4-1: Y Motor Specifications

			Resolver feedback type					
Motor model			YZ1	YA1	YA2	YB1	YB2	YB3
Max. Static holding force		(N)	50	100	200	200	400	600
Transpotable load at 0.5G		(kg)	10	20	40	40	80	120
Slider mass		(kg)	2	4	6	7	10	15
Rack base length vs. stroke	Effective stroke(mm) / Rackbase length (mm)							
	480		310	310	205	310	205	100
	600		430	430	325	430	325	220
	840		670	670	565	670	565	460
	1200		1030	1030	925	1030	925	820
	1560		1390	1390	1285	1390	1285	1180
	2040		-	1870	1765	1870	1765	1660
Connection system(1)			-	-	✓	-	✓	✓
Transpotable moment								
	Rolling	(N·m)	16	40	75	95	140	200
	Pitching	(N·m)	13	55	125	120	250	420
	Yawing	(N·m)	13	60	140	130	280	460
Operating conditions			IP20 (Internal Protection Level) Temperature : 0 ~ 50°C , Humidity : 20 ~ 90% Use indoors in a dust-free location					
Max. Speed		(mm/s)	1800					
Resolution		(μm)	1					
Repeatability		(μm)	±1					

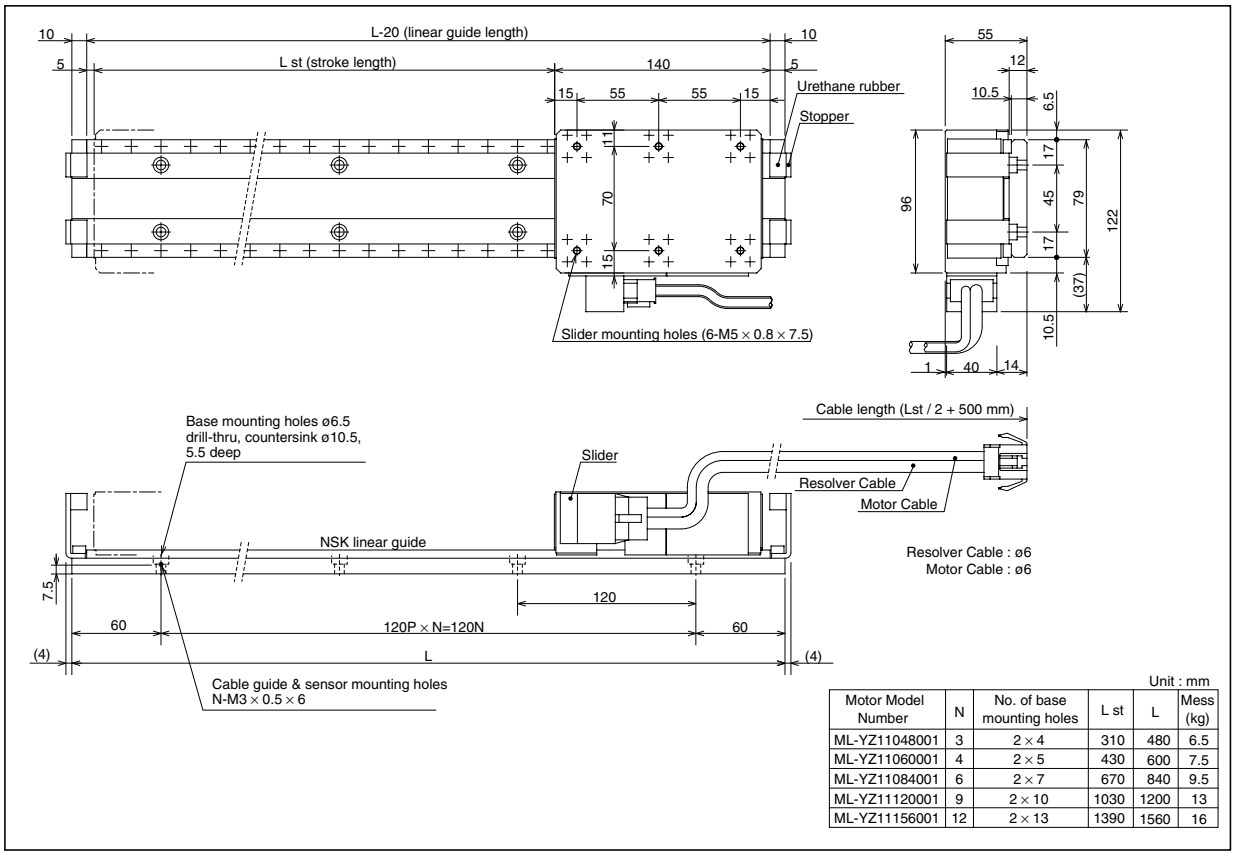
(1) Models marked with "✓" are available with a long stroke of up to 30 m by the connection.

- Y Series Megathrust Motors can be run on either 100V/110V or 200V/220V AC.

- SI unit System: 1 N = 0.102 kgf = 0.225 rb
  1 N·m = 0.102 kgf·m = 0.738 ft·rb

4.1.1.3. Dimensions

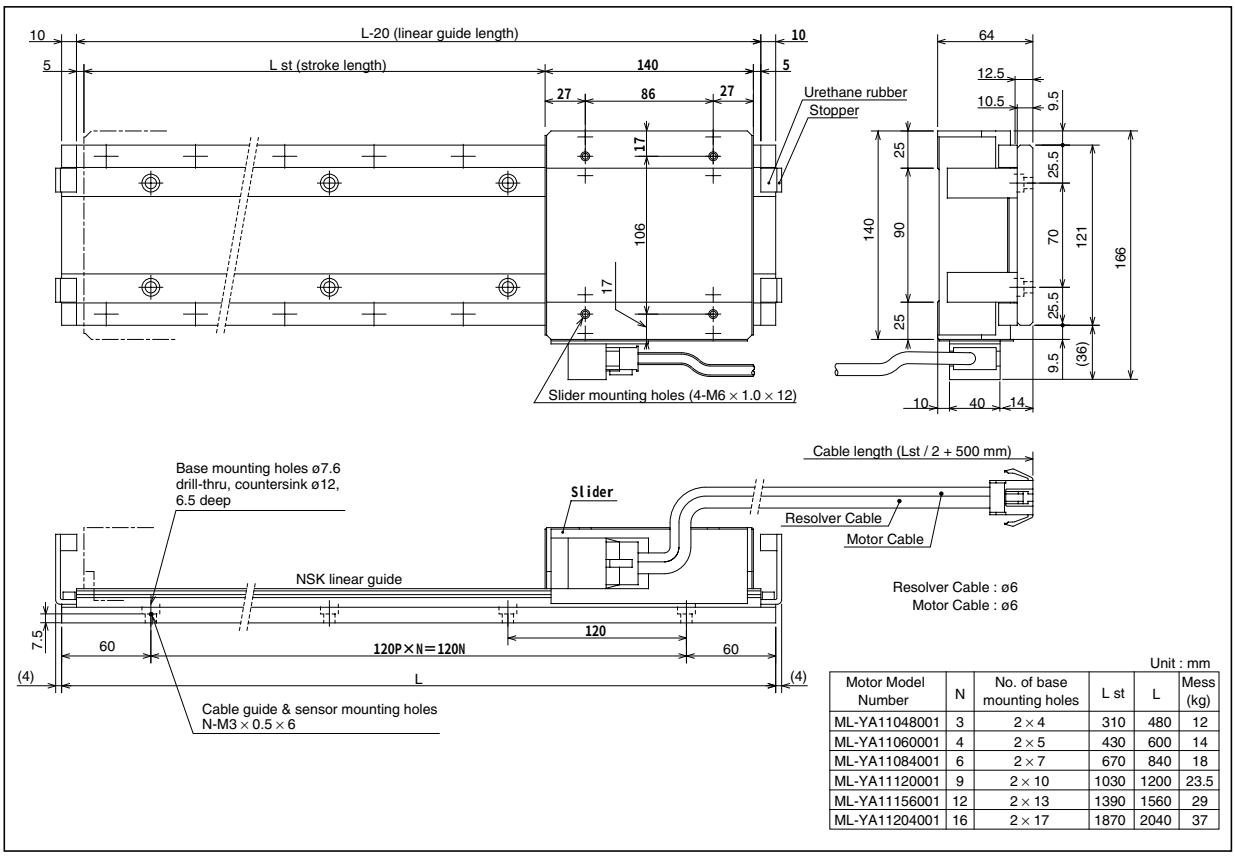
Figure 4-2: YZ1 type



Unit : mm

Motor Model Number	N	No. of base mounting holes	L st	L	Mess (kg)
ML-YZ11048001	3	2 × 4	310	480	6.5
ML-YZ11060001	4	2 × 5	430	600	7.5
ML-YZ11084001	6	2 × 7	670	840	9.5
ML-YZ11120001	9	2 × 10	1030	1200	13
ML-YZ11156001	12	2 × 13	1390	1560	16

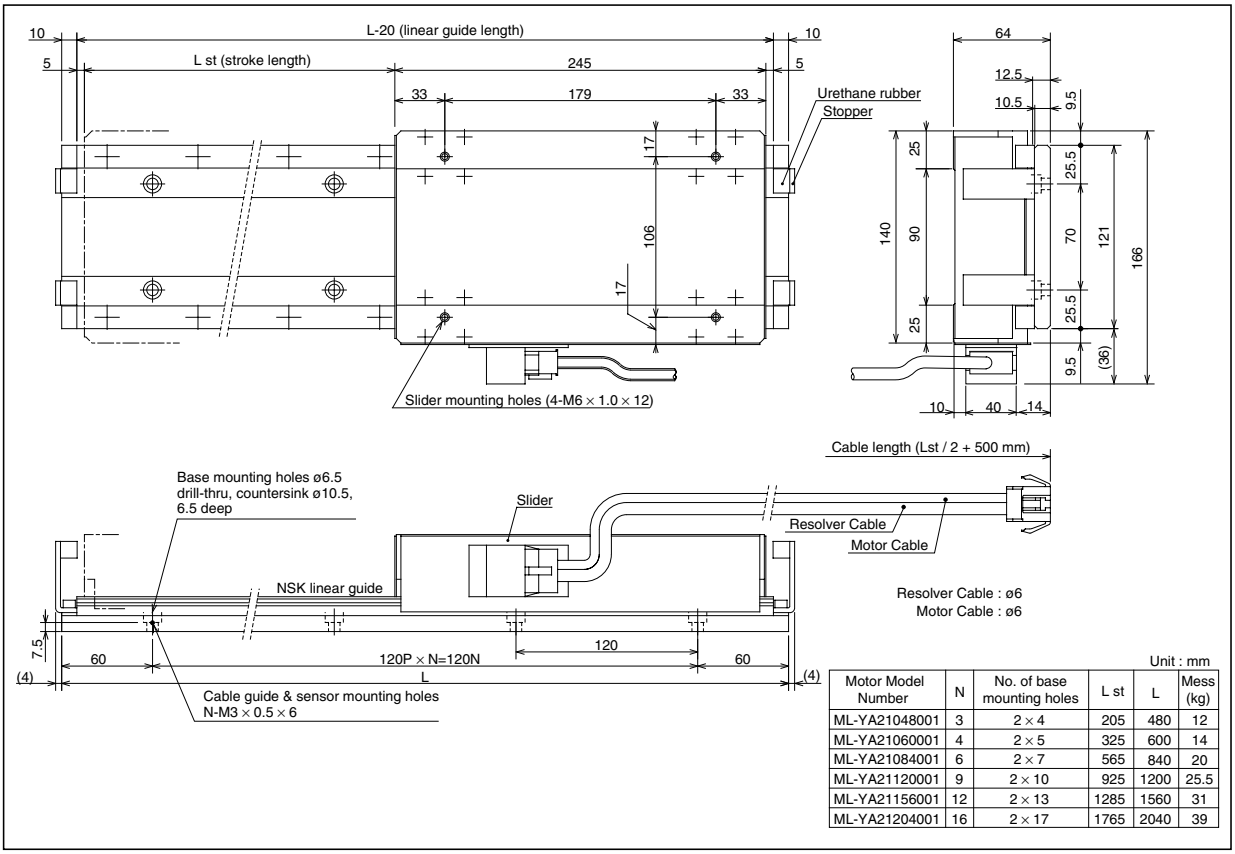
Figure 4-3: YA1 type



Unit : mm

Motor Model Number	N	No. of base mounting holes	L st	L	Mess (kg)
ML-YA11048001	3	2 × 4	310	480	12
ML-YA11060001	4	2 × 5	430	600	14
ML-YA11084001	6	2 × 7	670	840	18
ML-YA11120001	9	2 × 10	1030	1200	23.5
ML-YA11156001	12	2 × 13	1390	1560	29
ML-YA11204001	16	2 × 17	1870	2040	37

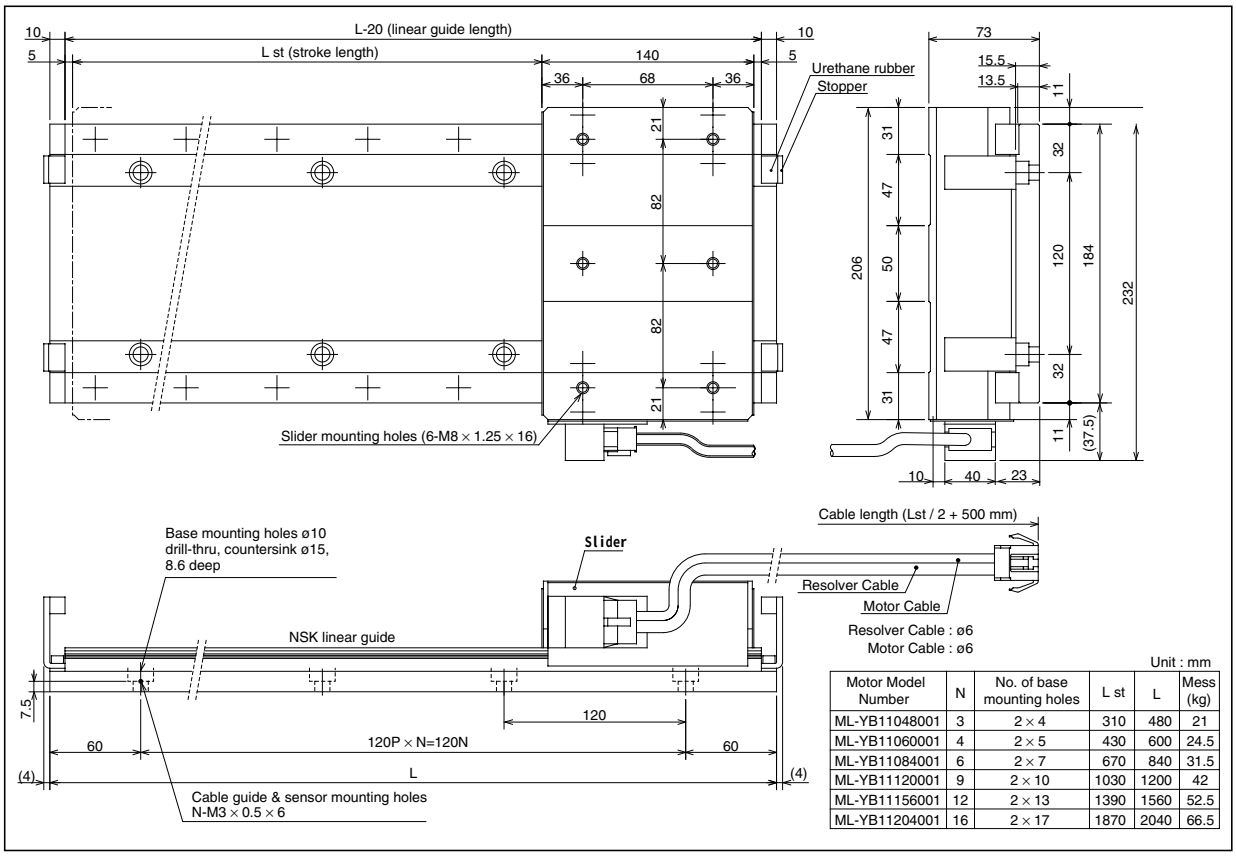
Figure 4-4: YA2 type



Unit : mm

Motor Model Number	N	No. of base mounting holes	L st	L	Mess (kg)
ML-YA21048001	3	2 × 4	205	480	12
ML-YA21060001	4	2 × 5	325	600	14
ML-YA21084001	6	2 × 7	565	840	20
ML-YA21120001	9	2 × 10	925	1200	25.5
ML-YA21156001	12	2 × 13	1285	1560	31
ML-YA21204001	16	2 × 17	1765	2040	39

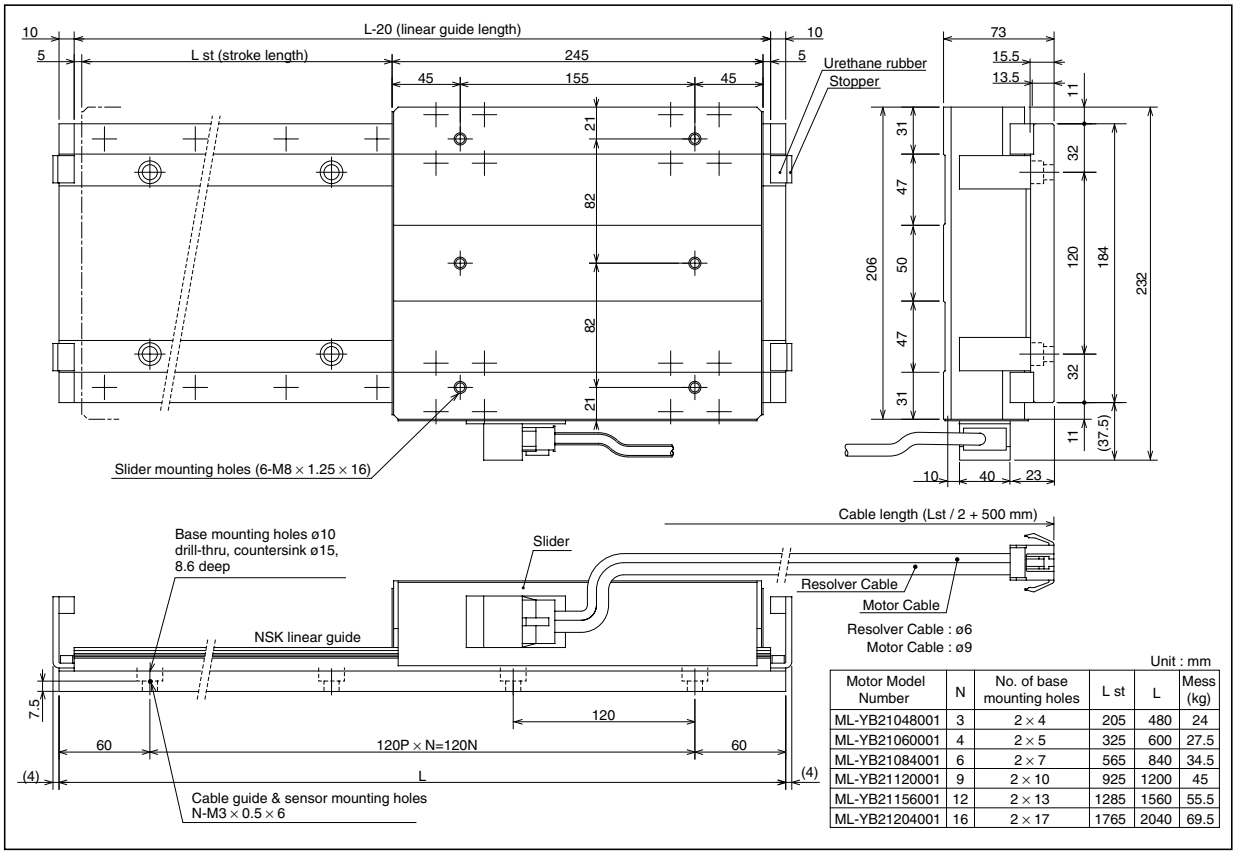
Figure 4-5: YB1 type



Unit : mm

Motor Model Number	N	No. of base mounting holes	L st	L	Mess (kg)
ML-YB11048001	3	2 × 4	310	480	21
ML-YB11060001	4	2 × 5	430	600	24.5
ML-YB11084001	6	2 × 7	670	840	31.5
ML-YB11120001	9	2 × 10	1030	1200	42
ML-YB11156001	12	2 × 13	1390	1560	52.5
ML-YB11204001	16	2 × 17	1870	2040	66.5

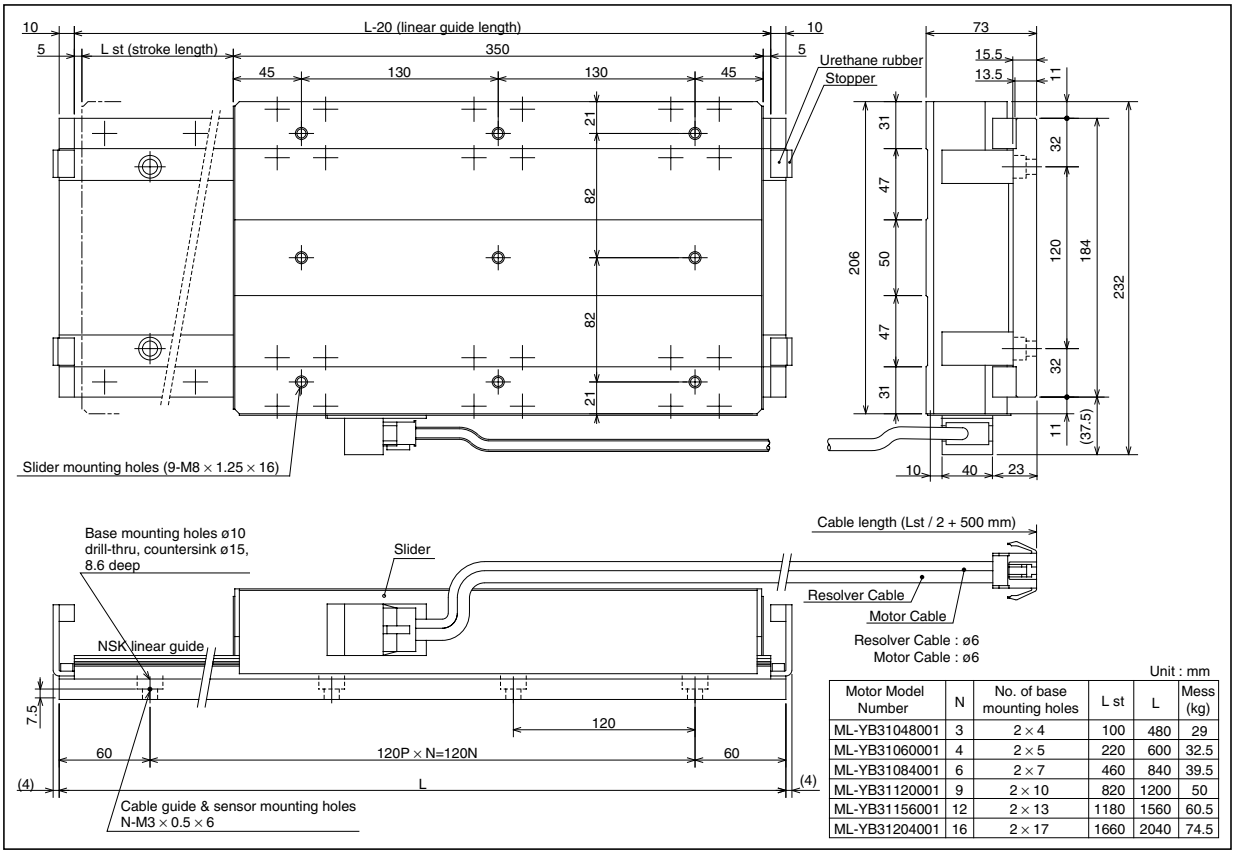
Figure 4-6: YB2 type



Unit : mm

Motor Model Number	N	No. of base mounting holes	L st	L	Mess (kg)
ML-YB21048001	3	2 × 4	205	480	24
ML-YB21060001	4	2 × 5	325	600	27.5
ML-YB21084001	6	2 × 7	565	840	34.5
ML-YB21120001	9	2 × 10	925	1200	45
ML-YB21156001	12	2 × 13	1285	1560	55.5
ML-YB21204001	16	2 × 17	1765	2040	69.5

Figure 4-7: YB3 type



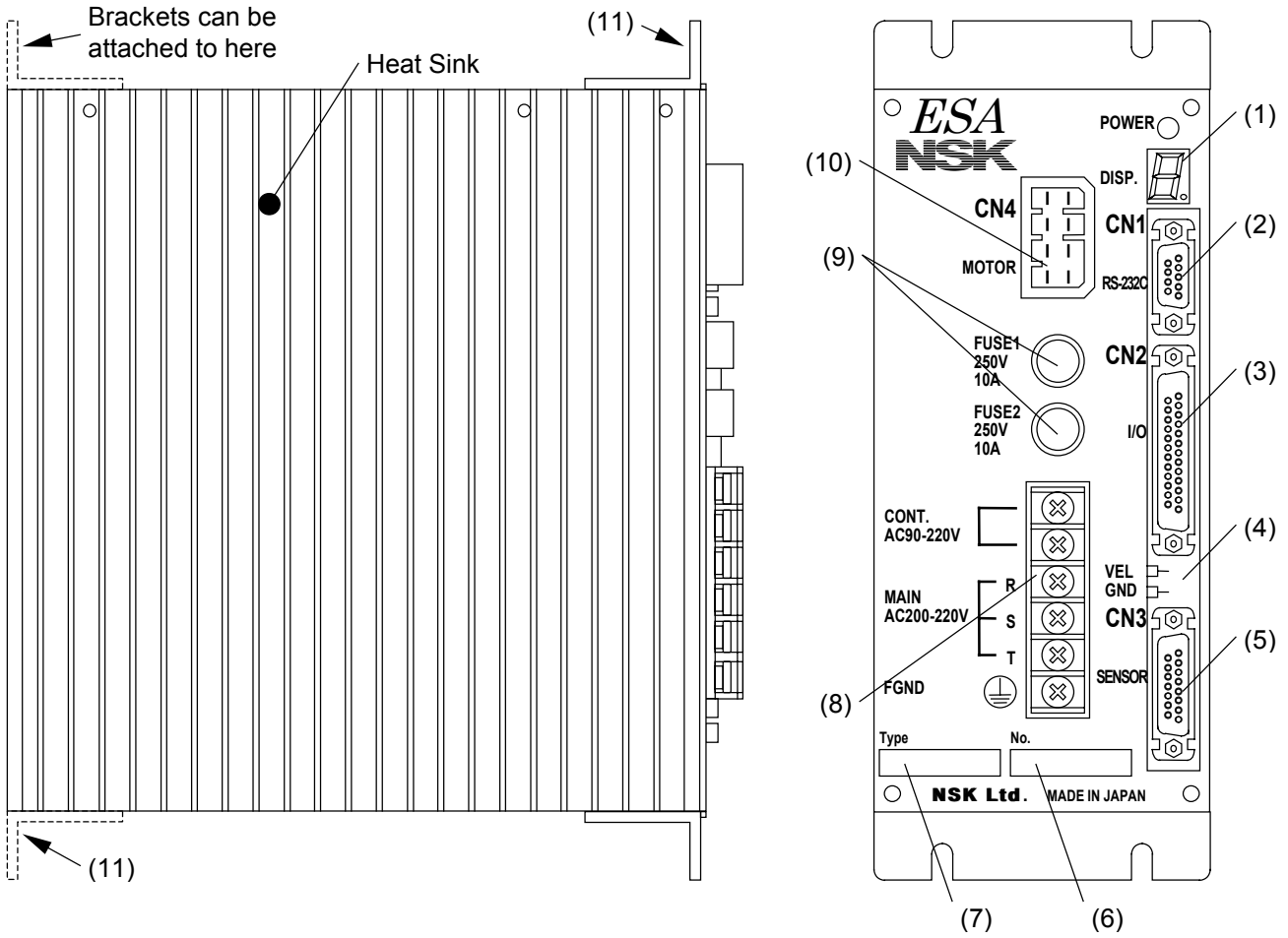
Unit : mm

Motor Model Number	N	No. of base mounting holes	L st	L	Mess (kg)
ML-YB31048001	3	2 × 4	100	480	29
ML-YB31060001	4	2 × 5	220	600	32.5
ML-YB31084001	6	2 × 7	460	840	39.5
ML-YB31120001	9	2 × 10	820	1200	50
ML-YB31156001	12	2 × 13	1180	1560	60.5
ML-YB31204001	16	2 × 17	1660	2040	74.5

4.2. Driver Unit

4.2.1. Name of Each Parts

Figure 4-8



(1) **7 segments LED (7 seg)**
(2) **CN1 (9 pins)** : RS-232C serial communication connector for Handy Terminal FHT11
(3) **CN2 (25 pins)**: Motor control signal Input / Output
(4) **Monitor pins** : Analog velocity monitor pins
(5) **CN3** : Resolver cable connector
(6) **No.** : Serial number plate
(7) **Type** : Reference number plate
(8) **TB** : Terminal block for power supply
(9) **FUSE1, 2** : Fuse holder
(10) **CN4** : Motor cable connector
(11) **Bracket**

⚠ *Caution : Be sure to turn off the power supply to replace the fuses.*

4.2.2. Specifications

4.2.2.1. General Specifications

◆ Control Mode

- Fully closed loop, P·EPI position control

◆ Position control mode

- Pulse train position command, RS-232C serial communication command, Internal program control

◆ Power supply

(1) AC 200V/ 220V ±10%

Table 4-2: Power supply capacity

Motor type	Max. Capacity (Except surge current)
YZ1	0.2 kVA
YA1,YA2	0.9 kVA
YB1,YB2,YB3	1.2 kVA

Table 4-3

		Control power	Main power
Inrush current		14A	140A
Leakage current	(40Hz ~1kHz)	5mA rms	
	(~ 1MHz)	35mA rms	

(2) AC 100V/110V ±10%

Table 4-4: Power supply capacity

Motor type	Max. Capacity (Except surge current)
YZ1	0.2 kVA
YA1,YA2	0.7 kVA
YB1,YB2,YB3	1.0 kVA

Table 4-5

		Control power	Main power
Inrush current		7A	80A
Leakage current	(40Hz ~1kHz)	3mA rms	
	(~ 1MHz)	20mA rms	

◆ Environmental condition

Table 4-6

Vibration resistance		0.5G (Conform to JIS C0911)
Line noise resistance		1500V 1μS (by noise simulator)
Mass		2.5kg
Environmental condition	In operation	Temperature: 0 ~ 50°C Humidity: 20 ~ 90% (no condensation)
	Storage	Temperature: -20 ~ 70°C Indoor (Free from dust)

4.2.2.2. Functional Specifications

◆ Position control

- Maximum input pulse frequency : 800 kpps
- Input pulse format is selected by a parameter.
- PLS & MNSP
- Pulse and direction
- øA and øB quadrature pulse

◆ Resolver resolution

Table 4-7 *[μm]*

Motor type \ Resolver resolution	Automatic resolution setting or set to 12 bit	Set to 10-bit
Y type Megathrust motor	1	4

- Automatic resolution setting, 10bit and 10 bit setting may be selected by a parameter.

◆ Maximum speed

Table 4-8 *[mm/s]*

Motor type \ Resolver resolution	Set to 12-bit	Automatic resolution setting or set to 10 bit
Y type Megathrust motor	600	1800

- Automatic resolution setting, 12bit and 10 bit setting may be selected by a parameter.

◆ Position feed back signal øA, øB, øZ (MSB)

- Output signal format: Line driver

Table 4-9: Resolution *[μm]*

Motor type \ Resolver resolution	øA	øB	øZ (MSB)
	Set to 12-bit	Set to 10-bit	
Y type Megathrust motor	4	16	4096

- 12bit and 10 bit maybe selected by parameter.

◆ Control I/O signal

- Input signal : Emergency stop, Servo-on, Home position limit switch, Run move, Program channel switching (64 channel), Over travel limit, Home return start, Clear, Jog and Jog direction.
- Output signal : Driver ready, In-position and Home return complete

◆ Alarms

- Excess position, Velocity error, Software thermal limit, Over travel limit, controller error, RS-232C communication error, Resolver error, Over current, Amplifier overheat
  Abnormal voltage error and Control power low voltage.

◆ Monitor output

- Analog velocity and RS-232C serial communication : Current position, alarm status and servo parameters

◆ Communication

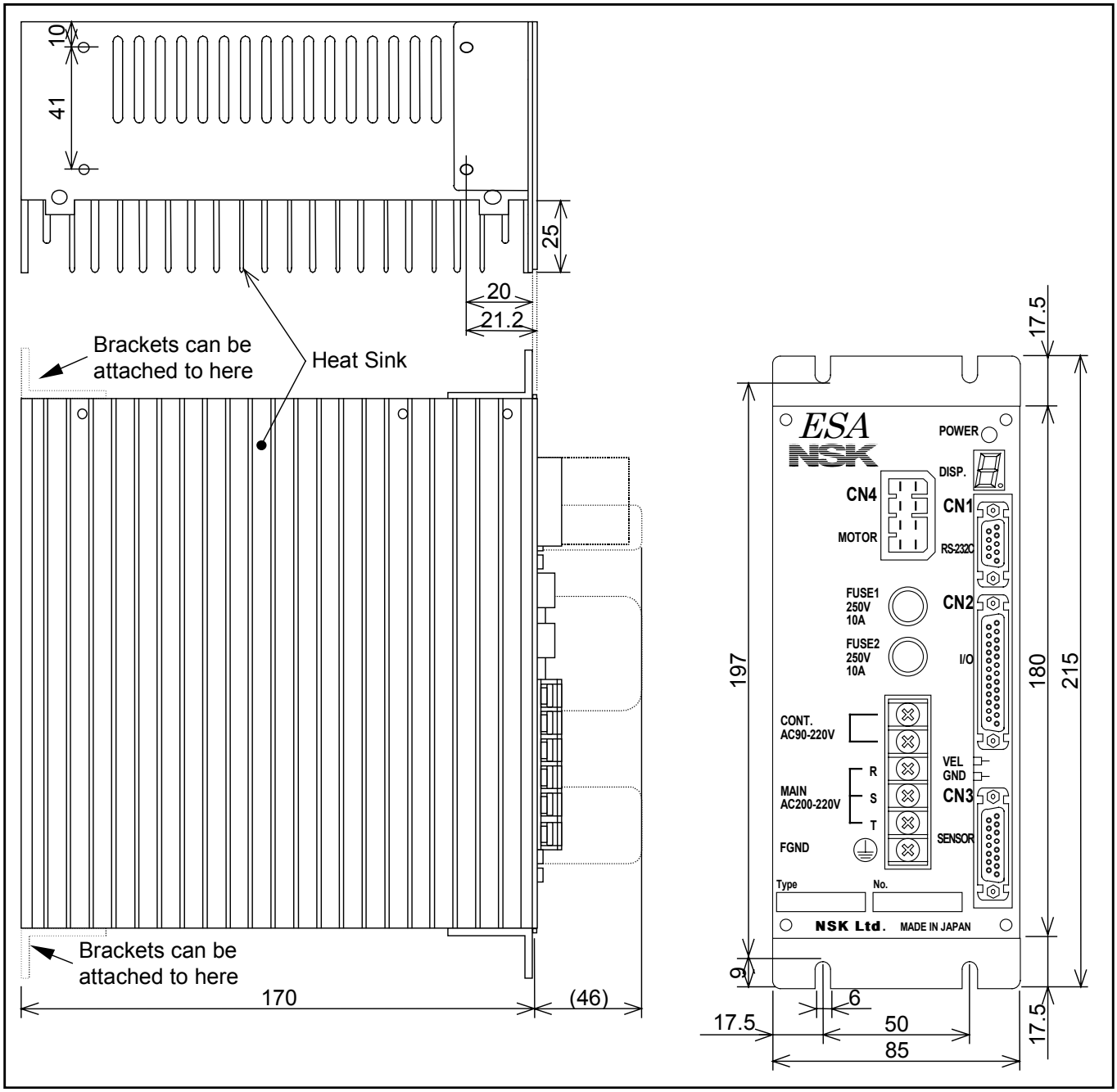
- Asychronous RS-232C communication. Baud rate: 9600 bps.

◆ Data backup

- Backed up by EEPROM.
- Possible to overwrite 500 thousand times.

4.2.2.3. Driver Unit Dimensions

Figure 4-9

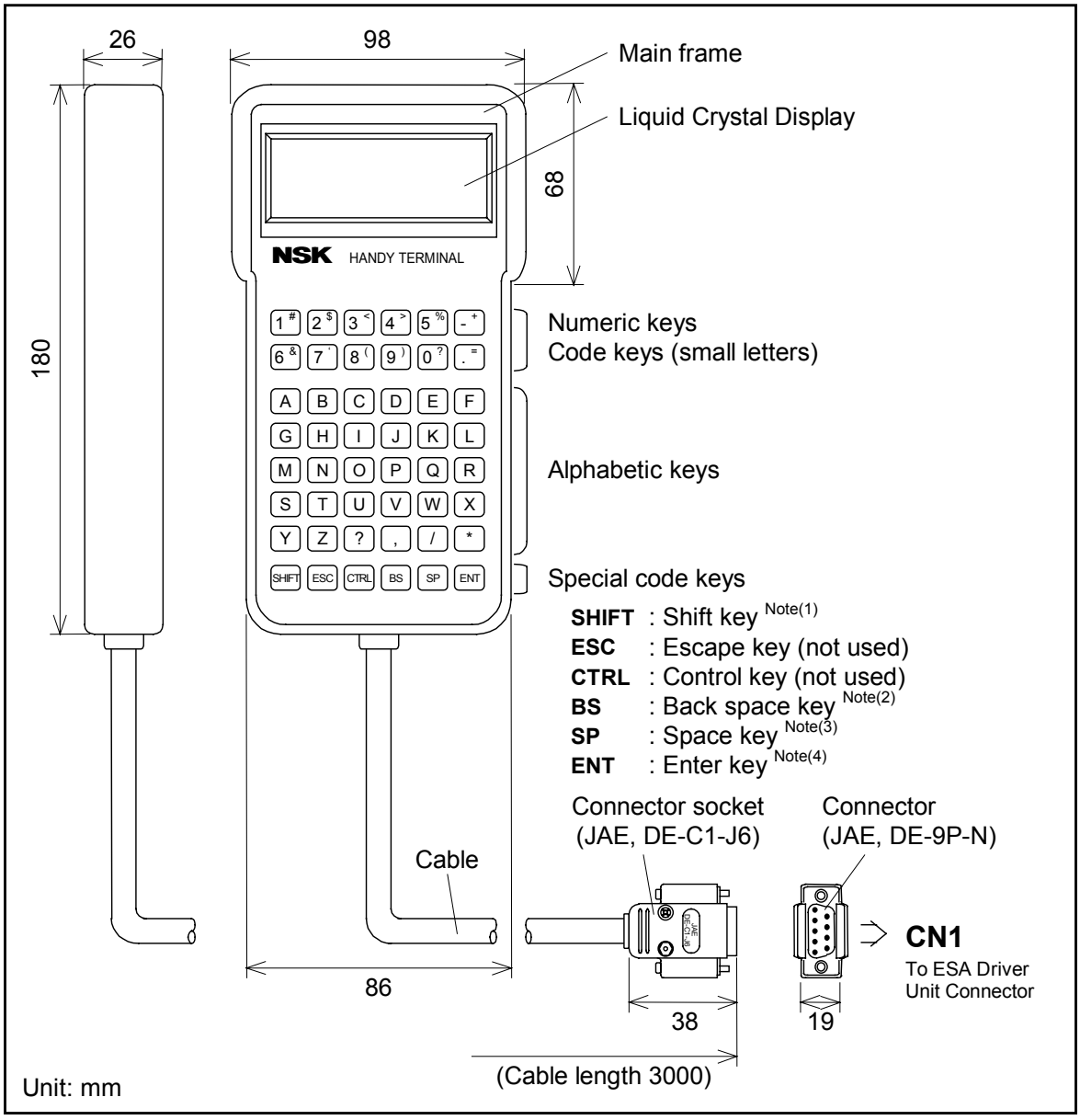


4.3. Handy Terminals

- FHT11 Handy Terminal is an easy to use hand held terminal with an RS-232C communication interface for Megathrust Motor System Driver Unit. FHT11 terminal connects directly to the CN1 connector on the ESA13 Driver Unit.

4.3.1. Name of Each Part and Dimensions

Figure 4-10



Note (1) [SHIFT] : Press the code key while holding [SHIFT] key. (Small characters)

(2) [BS] : When correcting logged-in mistakes, press [BS] key.

(3) [SP] : Press [SP] key to have space between characters

(4) [ENT] : Press [ENT] key at the end of the command or the parameter setting.

4.3.2. Specifications

Table 4-10

Item	Specification	
Power source valtage	DC 5V ±5%	
Power consumption	200 mW	
Environment	Temperature	• Operating : 0~50°C • Storage : -10~+65°C
	Humidity	35~85% (Non condensing)
RS-232C Interface	Data code	ASCII code
	Communication speed	9600 b.p.s
	Data bit	8 bit
	Stop bit	2 bit
	Start bit	1 bit
	Parity check	None
Mass	250g (exclude cable)	

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5. Connector Specifications

5.1. CN1: RS-232C Serial Communication Connector

- NSK's Handy Terminal FHT11 (sold separately) can be used as an RS-232C terminal.
- If another RS-232C terminal is used, refer to "5.2. CN2: Control I/O Connector" for the wiring precautions.

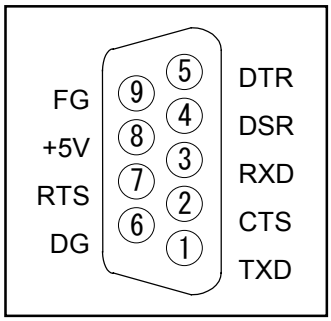
Table 5-1

Driver Unit connector	Japan Aviation Electronics Industry, Limited DELC-J9SAF-13L6
Mating connector type (user device side)	Japan Aviation Electronics Industry, Limited DE-9PF-N (to be prepared by the user)*
Mating connector shell type (user device side)	Japan Aviation Electronics Industry, Limited DE-C1-J6 (to be prepared by the user)*

* These connectors are not necessary when NSK Handy Terminal FHT11 is used.

5.1.1. CN1 Pin-Out

Figure 5-1: CN1 Pin-out



5.1.2. CN1 Signal List

Table 5-2: CN1 Signal List

Pin	Signal Name	I/O	Function
1	TXD	Output	Transmit data
2	CTS	Input	Clear to send
3	RXD	Input	Receive data
4	DSR	Input	Data set ready
5	DTR	Output	Data terminal ready
6	SG	-	Digital signal ground
7	RTS	Output	ø Ready to send
8	+5V	Output	Never connect
9	FG	-	Frame ground (shield)

5.1.3. RS-232C Communication Specifications

Table 5-3: RS-232C Communication Specification

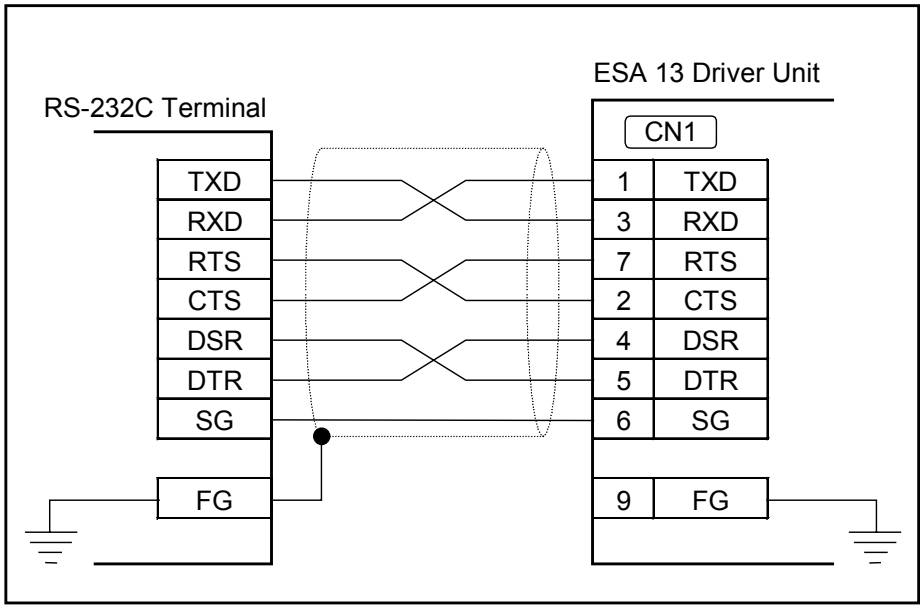
Item	Specification
Transmission	Asynchronous, full duplex
Communication speed	9600 b.p.s.
Word length	8 bit
Stop bit	2 bit
Parity	No
Character code	ASCII code
Communication procedure	• X-On/Off Protocol :No • RTS/CTS Control :Yes

5.1.4. Sample Wiring Diagram

- Connect the ESA13 Driver Unit with the controller (e.g., personal computer) in accordance with its RS-232C control signal specification.

◆ RTS Control / CTS Monitoring Active (standard wiring)

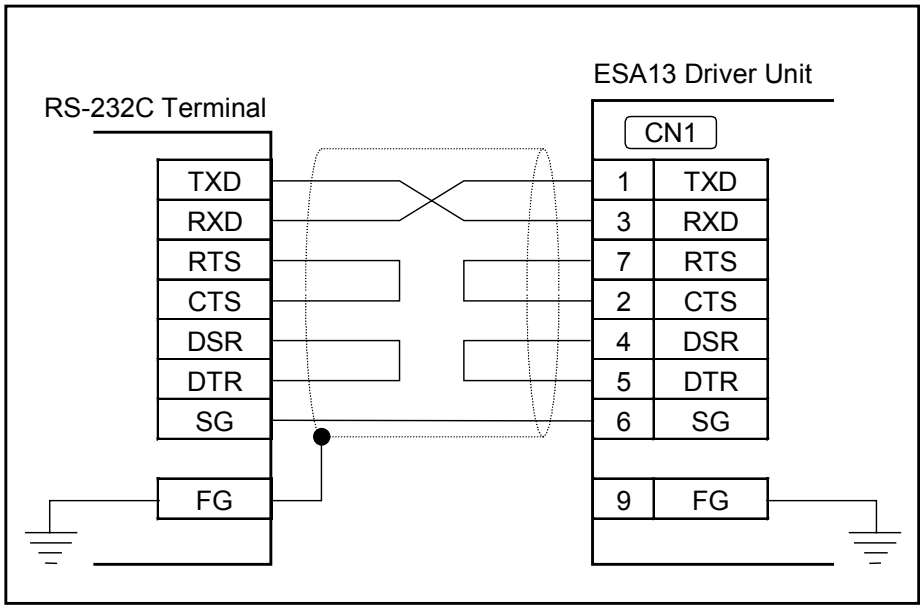
Figure 5-2



◆ RTS Control / CTS Monitoring Inactive

Important : When wired as shown below, always confirm the echo-back from Driver Unit or send the data slowly. With this wiring, Driver Unit may not accept the whole data when data is sent at high speed and large amount.

Figure 5-3



5.2. CN2: Control I/O Connector

- The table below shows connector types for the CN2.

Table 5-4

Connector type (Driver Unit side)	Japan Aviation Electronics Industry, Limited	DBLC-J25SAF-13L6
Mating connector type (user device side)	Japan Aviation Electronics Industry, Limited	DE-25PF-N (supplied with the Driver Unit)
Mating connector shell type (user device side)	Japan Aviation Electronics Industry, Limited	DB-C2-J9 (supplied with the Driver Unit)

◆ Wiring Precautions

- Use the shielded cable for CN2 and a twisted pair cables for the pulse train input and position feedback signals. (Maximum length: 2m)
- These cables should be laid in an independent duct separate from the power line.
- Connect one end of the cable shield to the frame ground (FG).

⚠ *Caution : Check for wiring mistake of external power supply polarity and shorting between connector pins.*

5.2.1. Setting of I/O type

- There are 5 combination types of Input/Output of CN2 connector as shown in Table 5-5.
- The user can select one combination by parameter "TY".
- The password is necessary when setting the "TY" parameter.
- Shipping set is Type 4.

Table 5-5: Type of I/O combination

Type 1 (TY1)	• Pulse train input	• 16 channels		
Type 2 (TY2)	• Pulse train input	• 4 channels	• Jog	
Type 3 (TY3)	• Pulse train input	• 4 channels	• Overtrabel limit	
Type 4 (TY4)	• Pulse train input	• Clear input	• Home return start	• Overtravel limit
Type 7 (TY7)	• Pulse train input	• Overtravel limit	• Jog	

- When TY is inputted, the polarity of all input ports is set to A contact. (When TY is the same as the current setting, the polarity is not changed but maintained.)
- Contact type of some Inputs/Outputs for CN2 connector of ESA13 Driver Unit may be switched.
- Polarity change is only allowed for four input signals listed below.
  - ◊ EMST : Emergency stop
    HLS : Home limit switch
    OTP : + direction, overtravel limit switch
    OTM : - direction, overtravel limit switch
  - ◊ (Refer to “Chapter 5.2.4” for details.)

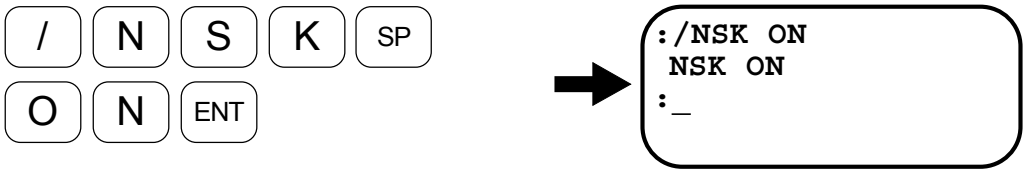
⚠ *Caution : Type 1 and 2 do not have over travel limit input. Set software over travel limit for “off-limit” area.*

- Refer to “9.1.4.2. Software Overtravel Limit.”

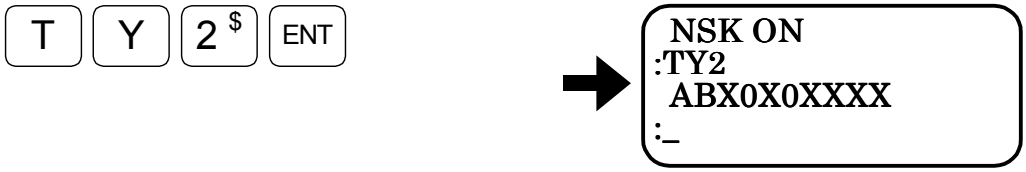
◆ Setting Example

- Set the I/O signals of Connector CN2 to Type 2.

(i) Input the password. (/NSK ON)
The password acknowledgment message appears on the display.



(ii) Input the command to set Type 2. (TY2)
The message indicates that the polarity of all the input ports has been set to A contact.



(Refer to "5.2.4. Setting Polarity (A or B contact) of Input Ports" for more details.)

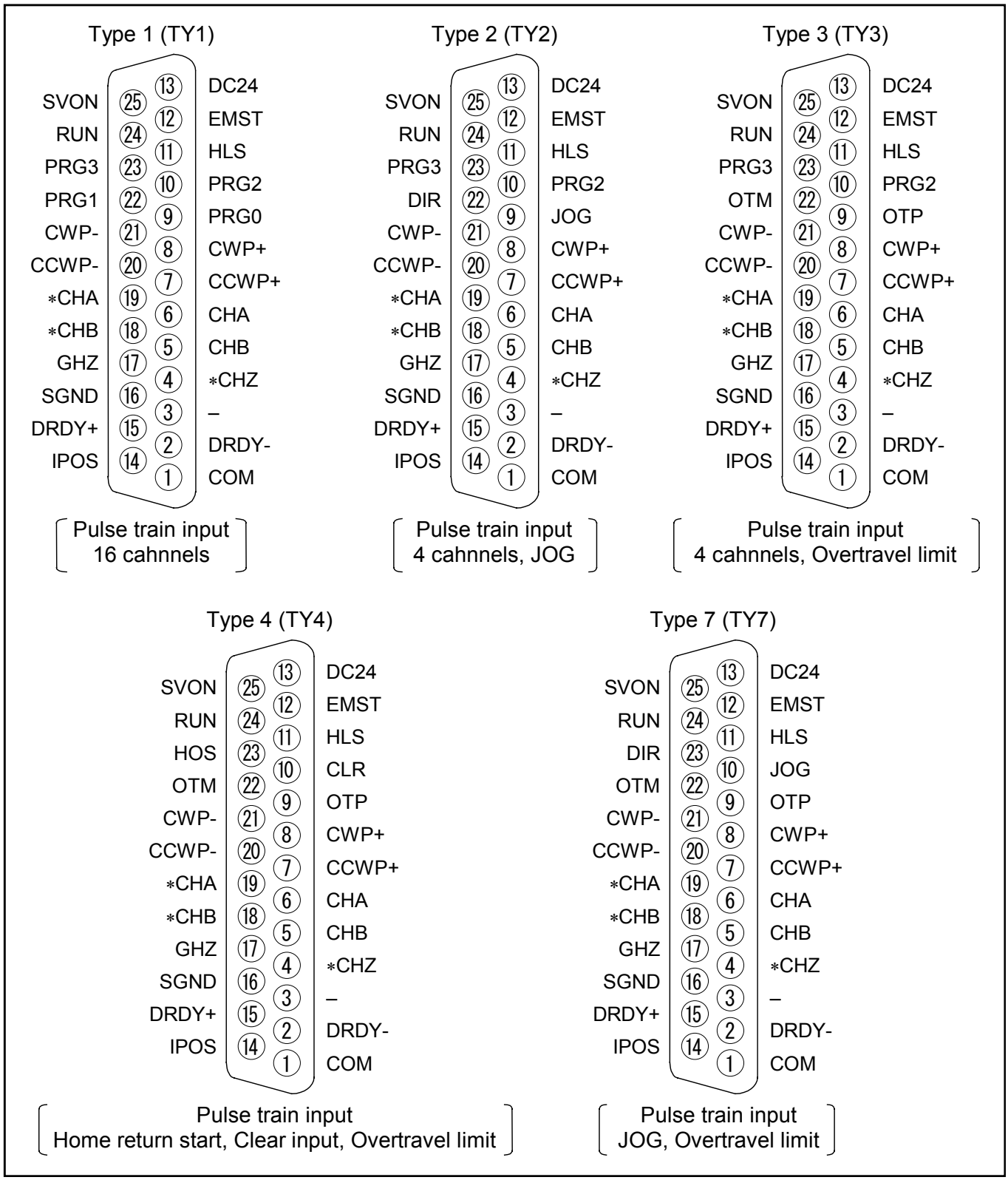
Table 5-6: I/O and Parameter TY.

CN2 No.	25	12	24	11	23	10	22	09
TY1	SVON	EMST	RUN	HLS	PRG3	PRG2	PRG1	PRG0
TY2	SVON	EMST	RUN	HLS	PRG3	PRG2	DIR	JOG
TY3	SVON	EMST	RUN	HLS	PRG3	PRG2	OTM	OTP
TY4	SVON	EMST	RUN	HLS	HOS	CLR	OTM	OTP
TY7	SVON	EMST	RUN	HLS	DIR	JOG	OTM	OTP
AB*	×	0	×	0	×	×	× (0)	× (0)

5.2.2. CN2 Pin-Out

- The input /output signals of CN2 connector are the following 5 types, and the user can select one of them by setting the TY parameter. This parameter is set to Type 4 before shipment.

Figure 5-4



5.2.3. CN2 Signal List

Table 5-7: Type 1

Pin	Signal Name	I/O	Function
1	COM	Output	Output COMMON
2	DRDY-	Output	Driver Unit ready (-)
3	–	–	–
4	∗CHZ*	Output	Position feedback ∗øZ/digital position data ∗MSB*
5	CHB	Output	Position feedback øB
6	CHA	Output	Position feedback øA
7	MNSP+	Input	Minus direction pulse (+)
8	PLSP+	Input	Plus direction pulse (+)
9	PRG0	Input	Programmable move bit 0
10	PRG2	Input	Programmable move bit 2
11	HLS	Input	Home limit switch
12	EMST	Input	Emergency stop
13	DC24	Input	24 VDC external supply
14	IPOS	Output	In□position
15	DRDY+	Output	Driver Unit ready (+)
16	SGND	–	Signal ground
17	CHZ*	Output	Position feedback øZ /digital position data MSB*
18	∗CHB*	Output	Position feedback ∗øB
19	∗CHA*	Output	Position feedback ∗øA
20	MNSP-	Input	Minus direction pulse (-)
21	PLSP-	Input	Plus direction pulse (-)
22	PRG1	Input	Programmable move bit 1
23	PRG3	Input	Programmable move bit 3
24	RUN	Input	Run move
25	SVON	Input	Servo-on

Table 5-8: Type 2

Pin	Signal Name	I/O	Function
1	COM	Output	Output COMMON
2	DRDY-	Output	Driver Unit ready (-)
3	–	–	–
4	∗CHZ*	Output	Position feedback ∗øZ/digital position data ∗MSB*
5	CHB	Output	Position feedback øB
6	CHA	Output	Position feedback øA
7	MNSP+	Input	Minus direction pulse (+)
8	PLSP+	Input	Plus direction pulse (+)
9	JOG	Input	Jog
10	PRG2	Input	Programmable move bit 2
11	HLS	Input	Home limit switch
12	EMST	Input	Emergency stop
13	DC24	Input	24 VDC external supply
14	IPOS	Output	In□position
15	DRDY+	Output	Driver Unit ready (+)
16	SGND	–	Signal ground
17	CHZ*	Output	Position feedback øZ /digital position data MSB*
18	∗CHB*	Output	Position feedback ∗øB
19	∗CHA*	Output	Position feedback ∗øA
20	MNSP-	Input	Minus direction pulse (-)
21	PLSP-	Input	Plus direction pulse (-)
22	DIR	Input	Direction
23	PRG3	Input	Programmable move bit 3
24	RUN	Input	Run move
25	SVON	Input	Servo-on

Table 5-9: Type 3

Pin	Signal Name	I/O	Function
1	COM	Output	Output COMMON
2	DRDY-	Output	Driver Unit ready (-)
3	–	–	–
4	∗CHZ*	Output	Position feedback ∗øZ/digital position data ∗MSB*
5	CHB	Output	Position feedback øB
6	CHA	Output	Position feedback øA
7	MNSP+	Input	Minus direction pulse (+)
8	PLSP+	Input	Plus direction pulse (+)
9	JOG	Input	+ direction overtravel limit switch (PLS direction)
10	PRG2	Input	Programmable move bit 2
11	HLS	Input	Home limit switch
12	EMST	Input	Emergency stop
13	DC24	Input	24 VDC external supply
14	IPOS	Output	In-position
15	DRDY+	Output	Driver Unit ready (+)
16	SGND	–	Signal ground
17	CHZ*	Output	Position feedback øZ / digital position data MSB*
18	∗CHB*	Output	Position feedback ∗øB
19	∗CHA*	Output	Position feedback ∗øA
20	MNSP-	Input	Minus direction pulse (-)
21	PLSP-	Input	Plus direction pulse (-)
22	OTM	Input	- direction overtravel limit switch (MNS direction)
23	PRG3	Input	Programmable move bit 3
24	RUN	Input	Run move
25	SVON	Input	Servo-on

Table 5-10: Type 4

Pin	Signal Name	I/O	Function
1	COM	Output	Output COMMON
2	DRDY-	Output	Driver Unit ready (-)
3	–	–	–
4	∗CHZ*	Output	Position feedback ∗øZ/digital position data ∗MSB*
5	CHB	Output	Position feedback øB
6	CHA	Output	Position feedback øA
7	MNSP+	Input	Minus direction pulse (+)
8	PLSP+	Input	Plus direction pulse (+)
9	OTP	Input	+ direction overtravel limit switch (PLS direction)
10	CLR	Input	Clear
11	HLS	Input	Home limit switch
12	EMST	Input	Emergency stop
13	DC24	Input	24 VDC external supply
14	IPOS	Output	In-position
15	DRDY+	Output	Driver Unit ready (+)
16	SGND	–	Signal ground
17	CHZ*	Output	Position feedback øZ /digital position data MSB*
18	∗CHB*	Output	Position feedback ∗øB
19	∗CHA*	Output	Position feedback ∗øA
20	MNSP-	Input	Minus direction pulse (-)
21	PLSP-	Input	Plus direction pulse (-)
22	OTM	Input	- direction overtravel limit switch (MNS direction)
23	HOS	Input	Home return start
24	RUN	Input	Positioning start
25	SVON	Input	Servo-on

Table 5-11: Type 7

Pin	Signal Name	I/O	Function
1	COM	Output	Output COMMON
2	DRDY-	Output	Driver Unit ready (-)
3	–	–	–
4	⁎CHZ*	Output	Position feedback ⁎øZ/digital position data ⁎MSB*
5	CHB	Output	Position feedback øB
6	CHA	Output	Position feedback øA
7	MNSP+	Input	Minus direction pulse (+)
8	PLSP+	Input	Plus direction pulse (+)
9	OTP	Input	+ direction overtravel limit switch (PLS direction)
10	JOG	Input	Jog
11	HLS	Input	Home limit switch
12	EMST	Input	Emergency stop
13	DC24	Input	24 VDC external supply
14	IPOS	Output	In-position
15	DRDY+	Output	Driver Unit ready (+)
16	SGND	–	Signal ground
17	CHZ*	Output	Position feedback øZ /digital position data MSB*
18	⁎CHB*	Output	Position feedback ⁎øB
19	⁎CHA*	Output	Position feedback ⁎øA
20	MNSP-	Input	Minus direction pulse (-)
21	PLSP-	Input	Plus direction pulse (-)
22	OTM	Input	- direction overtravel limit switch (MNS direction)
23	DIR	Input	Jog direction select
24	RUN	Input	Positioning start
25	SVON	Input	Servo-on

* The FZ parameter (RS232C communication) is used to select between the position feedback signal øZ and the digital position signal MSB.

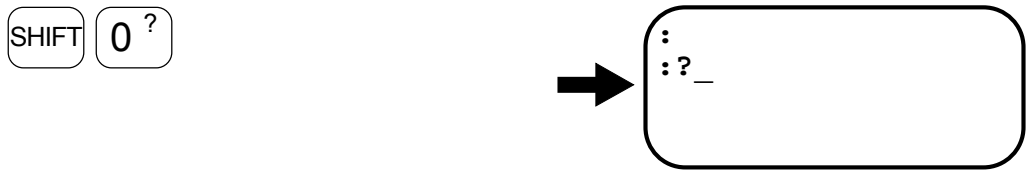
Caution : For the Input / Output signals of a special-order Driver Unit, refer to its specification document.

5.2.4. Setting Polarity (A or B contact) of Input Ports

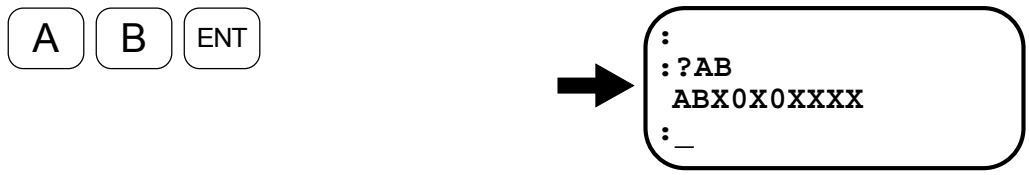
◆ Setting Example

- Set the polarity of the EMST (emergency stop) input port to B contact.

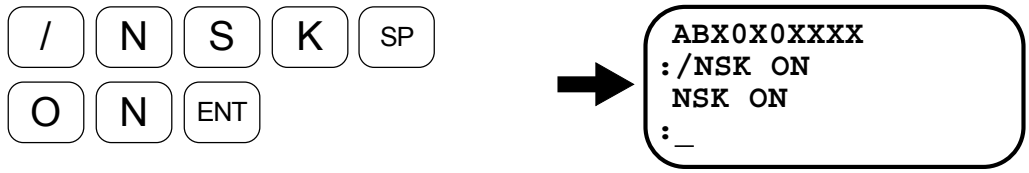
(i) Press the code key while holding down the SHIFT key.



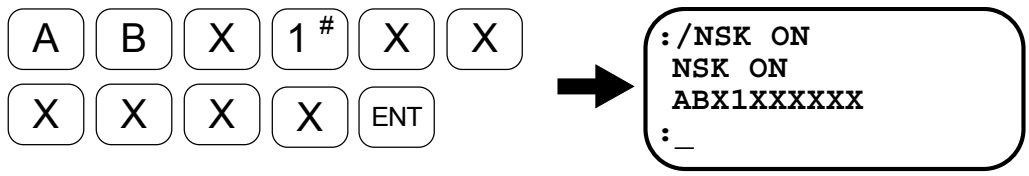
(ii) Input the command to read the setting of the AB parameter. Check the present polarity setting (in this example, all the input ports are set to A contact.)



(iii) Input the password.
The password acknowledgment message appears on the display.



(iv) The second bit following AB represents EMST. Set this bit to "1", and the other bits to "X" (no change).



◆ Explanation

- Data is in the bit map format. Refer to Table 5-12 for the correspondence between bits and signals.
  (EMST is the second bit from the left, HLS the fourth bit from the left, OTM the seventh bit from the left and OTP the eighth bit from the left.)

Table 5-12

Pin No.	25	12	24	11	23	10	22	09
Bit No.	7	6	5	HLS	3	2	1	0
TY1	SVON	EMST	RUN	HLS	PRG3	PRG2	PRG1	PRG0
TY2	SVON	EMST	RUN	HLS	PRG3	PRG2	DIR	JOG
TY3	SVON	EMST	RUN	HLS	PRG3	PRG2	OTM	OTP
TY4	SVON	EMST	RUN	HLS	HOS	CLR	OTM	OTP
TY7	SVON	EMST	RUN	4	DIR	JOG	OTM	OTP

- Meaning of data

  0 = A Contact setting (normally open)
  1 = B Contact setting (normally close)
  X = During input: Indicates no change.
  On display (data read command): Indicates that change of polarity is inhibited (the port is set to A contact).

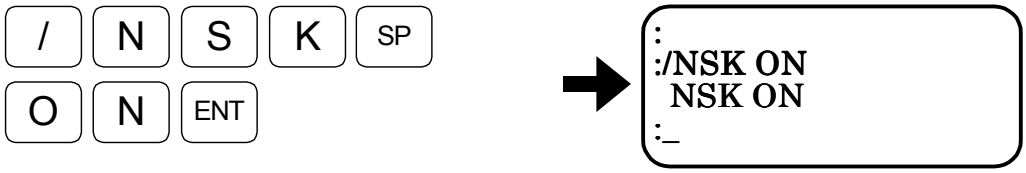
- All the bits of the AB parameter are set to A contact before shipment.

5.2.5. Changing I/O Type and Contact Polarity at Once

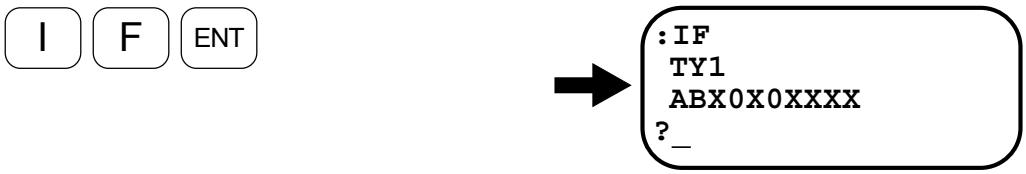
◆ Setting Example

- Set the I/O type to TY3 (SVON, EMST, RUN, HLS, PRG3, PRG2, OTP, OTM). Set EMST, OTP and OTM to B contact, and the rest to A contact.

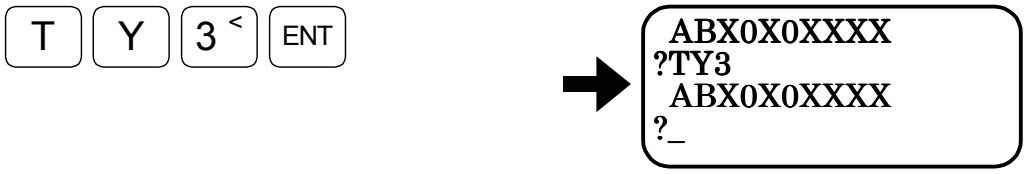
(i) Input the password.
The password acknowledgment message appears on the display.



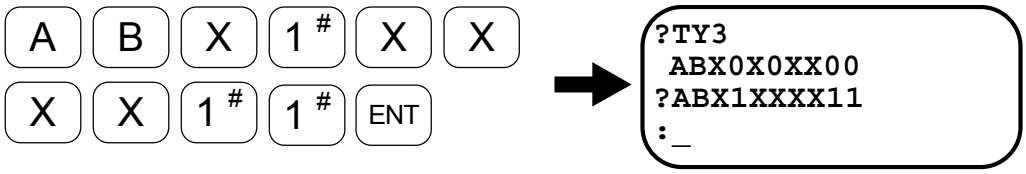
(ii) Input the "IF" command to display the present I/O type and the polarity of the input ports.
Then the data input prompt appears to wait for the input.



(iii) Set the I/O type to type 3 (TY 3).
The message indicates that the polarity of all the input ports is set to A contact.



(iv) Set EMST (second bit following AB), OTM (seventh bit), and OTP (eighth bit) to "1" and the remaining bits to "X" (no change).



◆ Explanation

- The IF command is the auxiliary command used to set the TY and AB parameters at once.
- The password is necessary before inputting the IF command.

5.2.6. CN2 Electrical Specifications

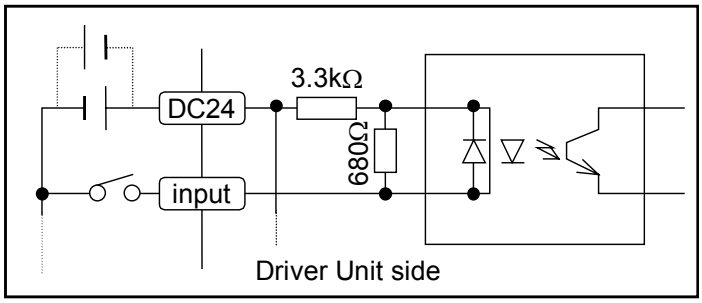
5.2.6.1. General Input Signal

Applied Inputs: SVON, EMST, PRG0~3, RUN, HOS, HLS, JOG, DIR, OTP, OTM, CLR

Table 5-13

Item	Specification
Input voltage	24 VDC ±10%
Input impedance	3.3 kΩ
Maximum current	10 mA (per input)

Figure 5-4



* The polarity of DC24V external supply may be reversed.

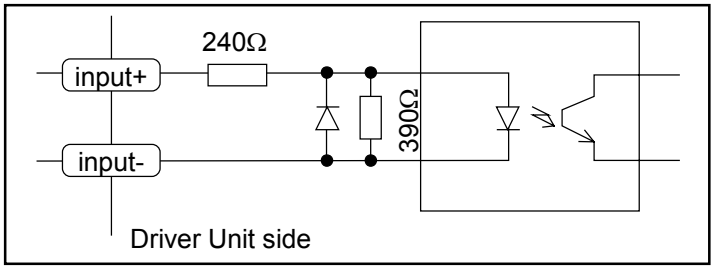
5.2.6.2. Pulse Train Input

Applied Inputs: PLSP+, PLSP-, MNSP+, MNSP-

Table 5-14

Item	Specification
Input voltage	5 VDC ±10%
Input impedance	240 Ω
Maximum current	25 mA

Figure 5-5



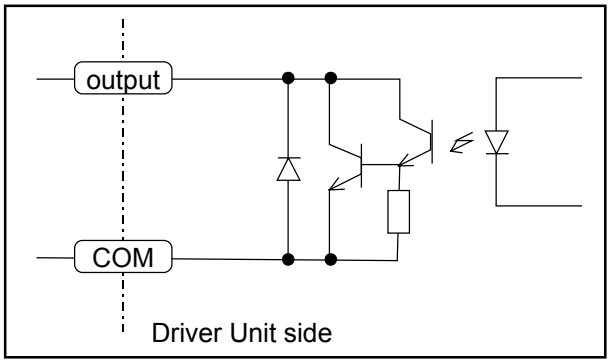
5.2.6.3. General Output Signal

Applied Outputs: IPOS

Table 5-15

Item	Specification
Maximum load capacity	24 VDC/100 mA
Maximum saturated voltage	2 V

Figure 5-6



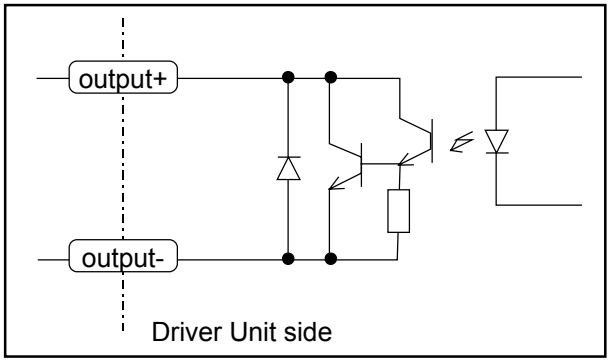
5.2.6.4. Control Output Signal

Applied Outputs: DRDY+, DRDY-

Table 5-16

Item	Specification
Maximum load capacity	24 VDC/100 mA
Maximum saturated voltage	2 V

Figure 5-7



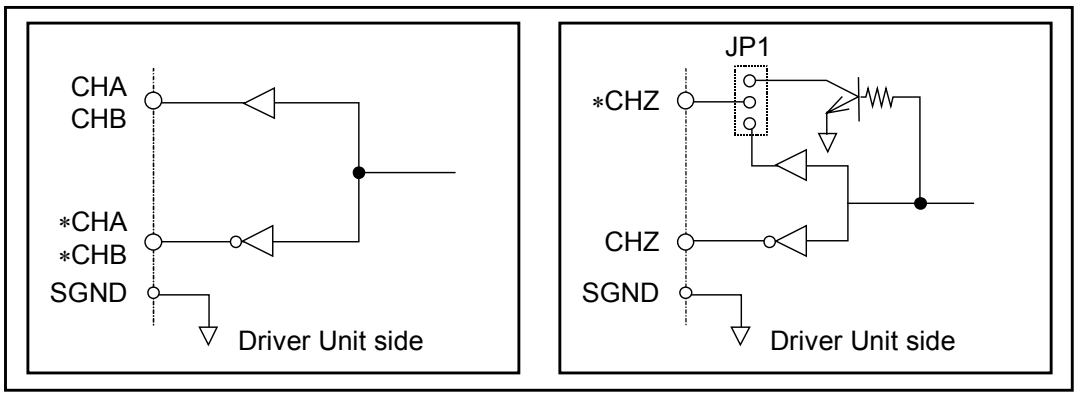
5.2.6.5. Position Feedback Output Signal

Applied Outputs: CHA, CHB, CHZ, ∗CHA, ∗CHB, ∗CHZ

Table 5-17

Item	Specification	
Output format	Line driver (CHA, CHB, ∗CHA, ∗CHB) Line driver or open collector (CHZ, ∗CHZ) (Can be selected by Jumper 1. Refer to next page for the setting.)	
Output device	Texas instruments SN75ALS192	
Recommended receiving devise	Texas instruments SN75ALS193 or AM26L32 equivalent	
Maximum collector current	100mA	For open collector
Maximum open collector voltage	24V	
Saturated voltage	1V or less	

Figure 5-8



◆ How to Set Jumper (JP1)

- Jumper (JP1) is for selecting output format of øZ position feedback signal.
- Jumper is inside of the Driver Unit. When setting Jumper, remove the side cover of the Driver Unit. Follow the procedure in Appendix 4: How to replace ESA13 Driver Unit.
- Figure 5-9 indicates the Jumper location.

Figure 5-9

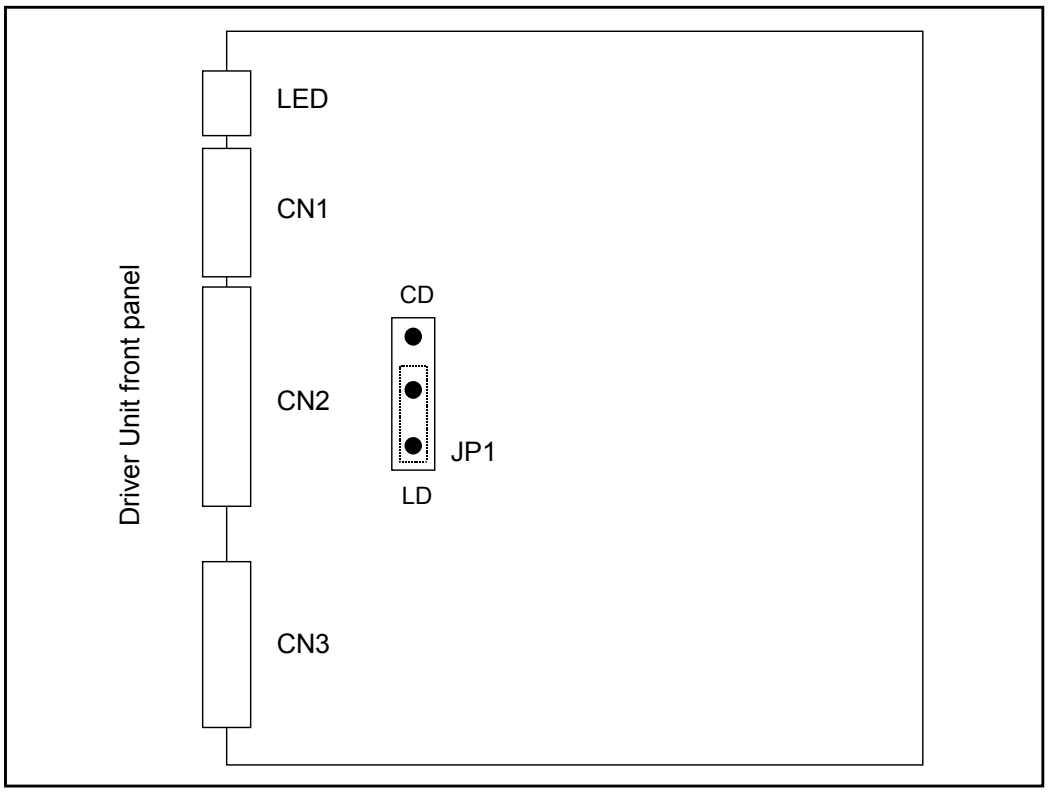


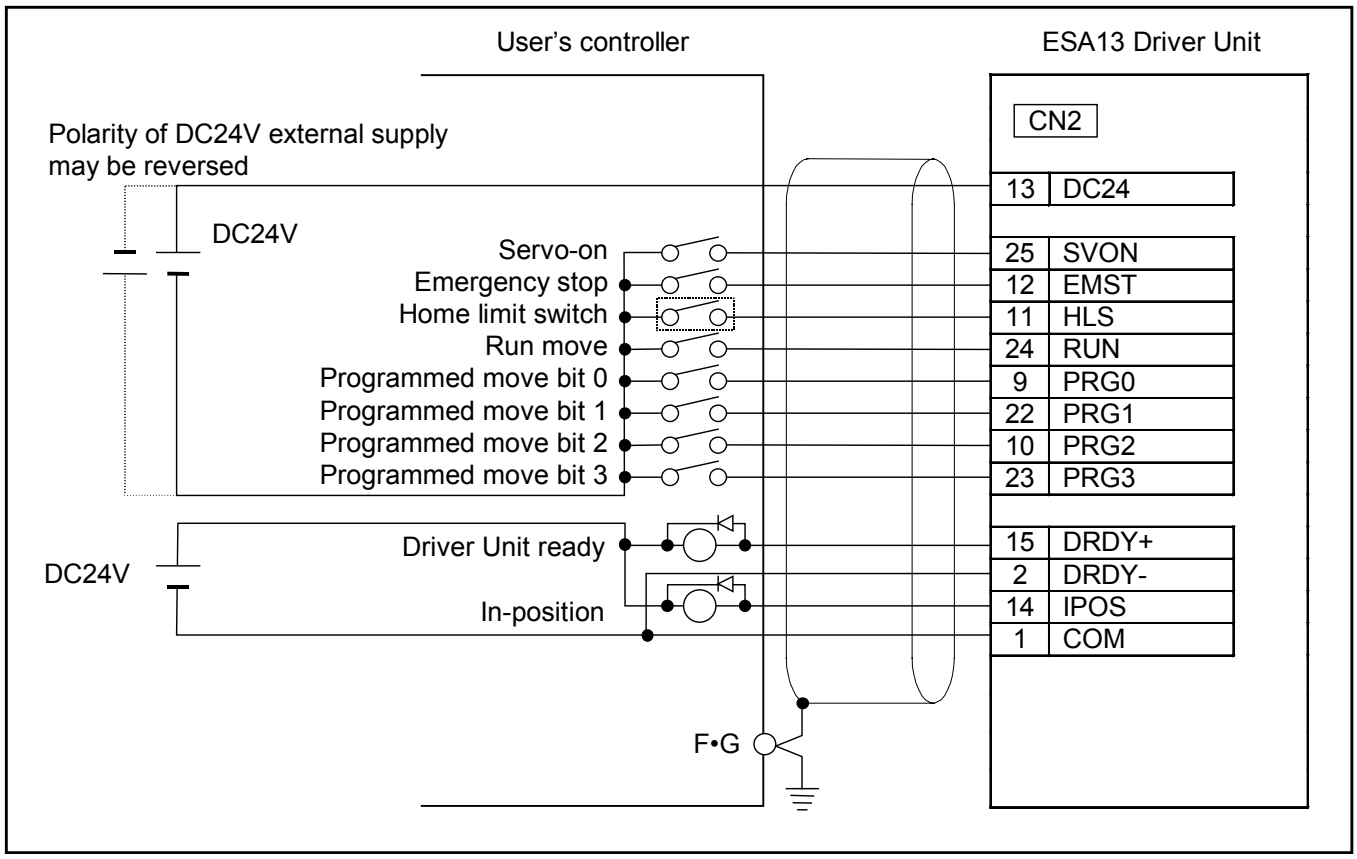
Table 5-18: Jumper setting.

Setting	øZ output format
LD-Out short	Line driver (Shipping set)
OC-Out short	Open collector

5.2.7. Wiring Diagram (CN2)

◆ **Wiring Example 1: Type 1.**

Figure 5-10: 16 Channels selection



Note: (1) Home Return

◊ For example, program the HS command in CH0.

◊ Immediately after turning on the power, select CH0 and turn on the RUN input to execute the home return operation.

(2) Pulse train operation

◊ Add the connections of the PLSP± and MNSP± signals if you want to use the pulse train operation.

(3) Off-limit area

◊ Set software over travel limit as this combination type does not have overtravel limit input.

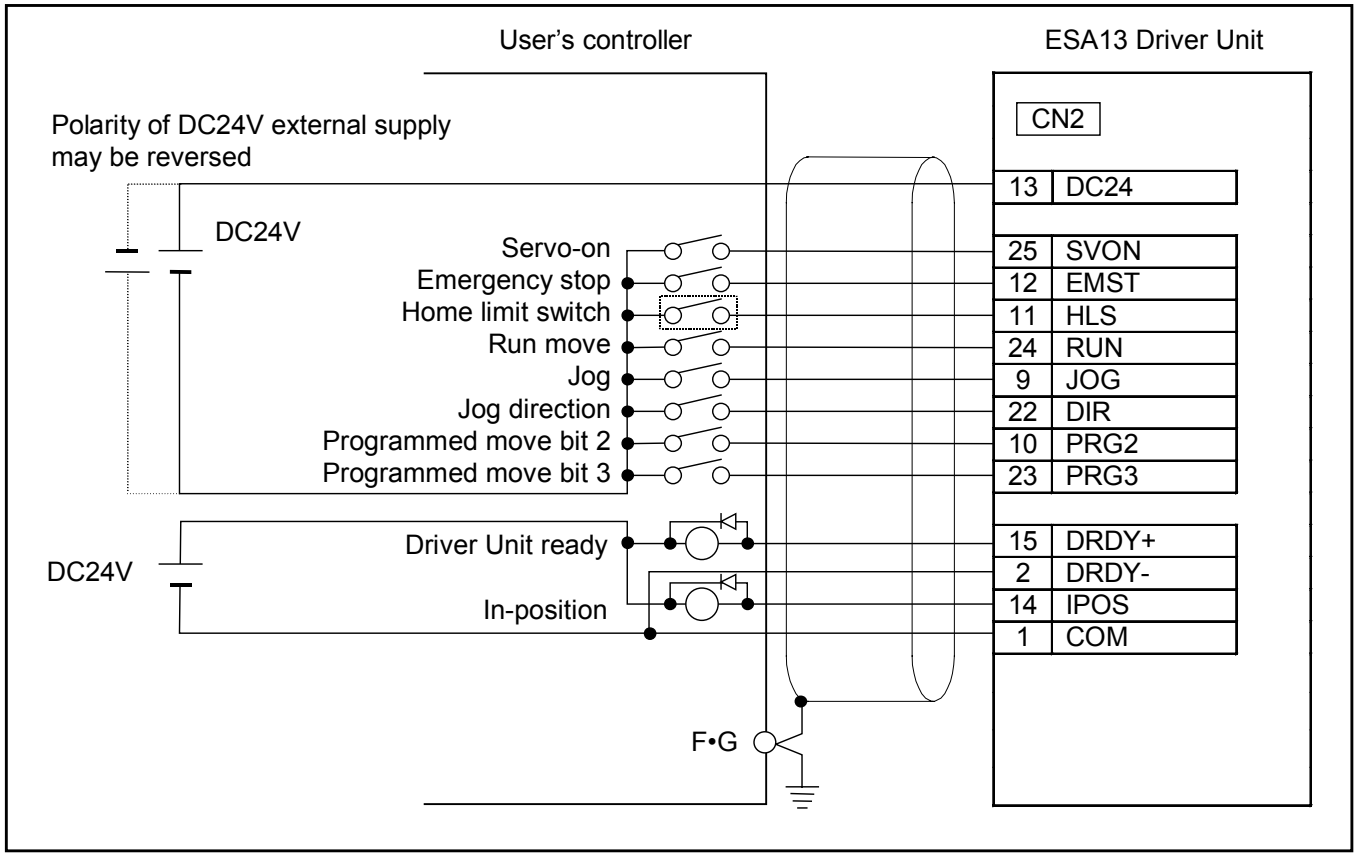
• Refer to "9.1.4.2. Software Overtravel Limit."

⚠ *Caution : • When using an inductive switch (e.g., relay), be sure to insert a surge killer circuit.*

• When the user installs a sensor as the home limit switch, connect its output directly to the input port of the Driver Unit, not via the controller.

◆ Connection Example 2: Type 2.

Figure 5-11: Jog operation and 4 channels selection



Note: (1) Home Return

◊ For example, program the HS command in CH0.

◊ Immediately after turning on the power, select CH0 and turn on the RUN input to execute the home return operation.

(2) Pulse train operation

◊ Add the connections of the PLSP± and MNSP± signals if you want to use the pulse train operation.

(3) Off-limit area

◊ Set software over travel limit as this combination type does not have overtravel limit input.

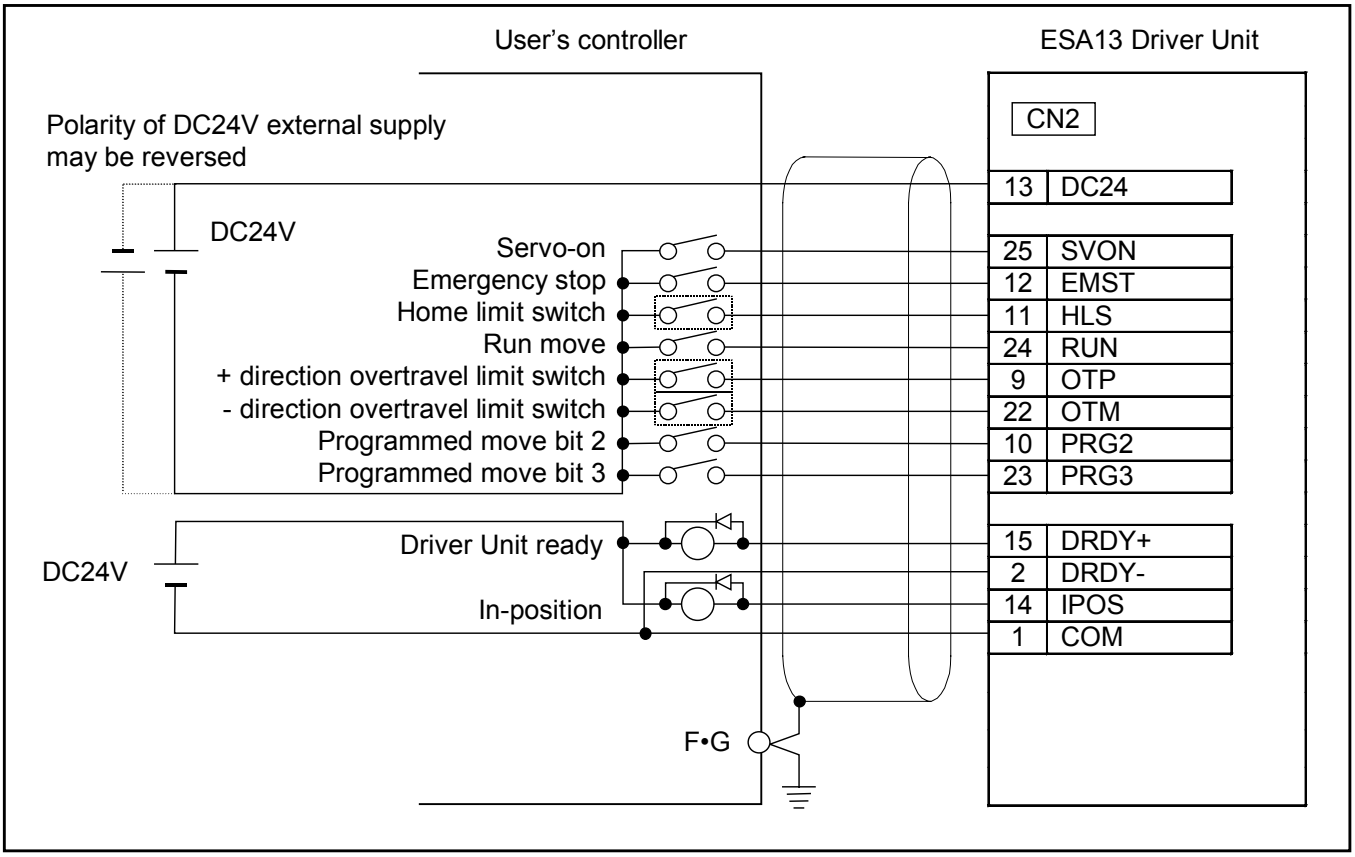
• Refer to "9.1.4.2. Software Overtravel Limit."

⚠ *Caution : • When using an inductive switch (e.g., relay), be sure to insert a surge killer circuit.*

• When the user installs a sensor as the home limit switch, connect its output directly to the input port of the Driver Unit, not via the controller.

◆ Connection Example 3: Type 3.

Figure 5-12: Motion limit range setting and 4 channels selection



Note: (1) Home Return

◊ For example, program the HS command in CH0.

◊ Immediately after turning on the power, select CH0 and turn on the RUN input to execute the home return operation.

(2) Pulse train operation

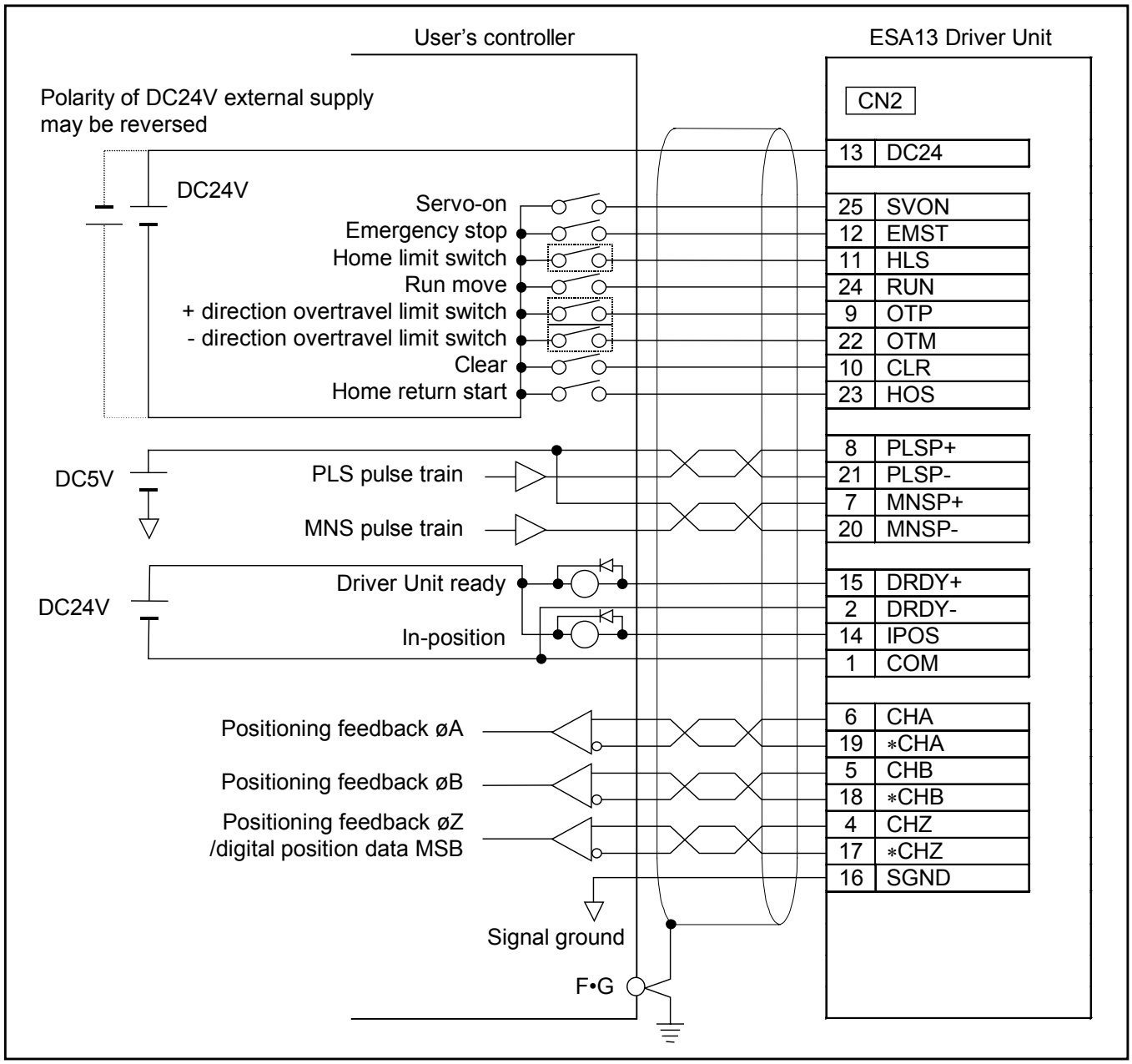
◊ Add the connections of the PLSP± and MNSP± signals if you want to use the pulse train operation.

⚠ *Caution : • When using an inductive switch (e.g., relay), be sure to insert a surge killer circuit.*

• When the user installs sensors as the home limit switch, + direction overtravel limit switch and - direction overtravel limit switch, connect sensor outputs directly to the input ports of the Driver Unit, not via the controller.

◆ Connection Example 4: Type 4.

Figure 5-13: Pulse train, motion limit, home return start and clear input

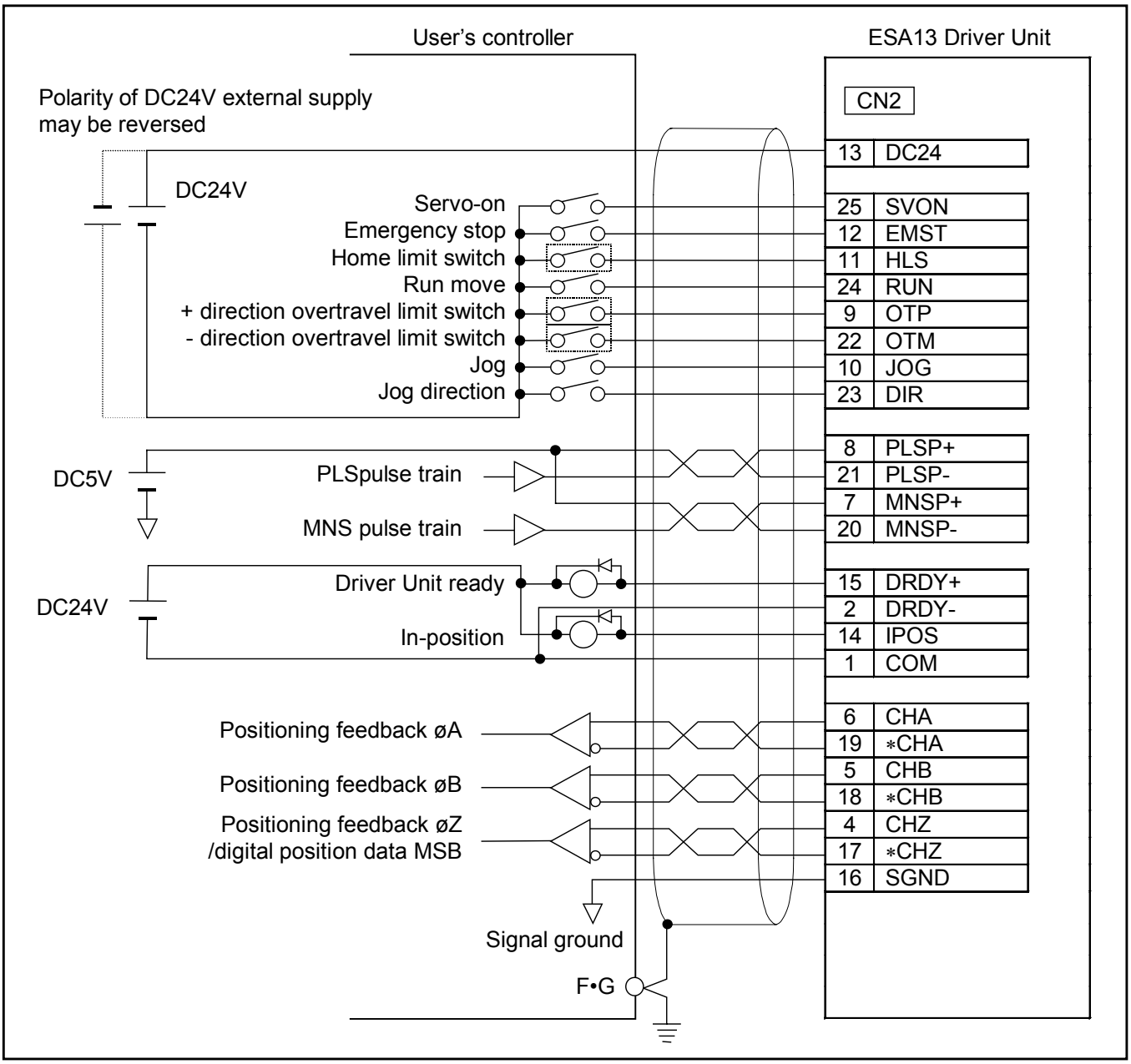


⚠ *Caution : • When using an inductive switch (e.g., relay), be sure to insert a surge killer circuit.*

• When the user installs sensors as the home limit switch, + direction overtravel limit switch and - direction overtravel limit switch, connect sensor outputs directly to the input ports of the Driver Unit, not via the controller.

◆ Wiring Example 5: Type 7.

Figure 5-14: Pulse train, motion limit range setting and Jog operation



Note: (1) Home Return

◊ For example, program the HS command in CH0.

◊ Immediately after turning on the power, select CH0 and turn on the RUN input to execute the home return operation.

⚠ *Caution : • When using an inductive switch (e.g., relay), be sure to insert a surge killer circuit.*

• When the user installs a sensor as the home limit switch, connect its output directly to the input port of the Driver Unit, not via the controller.

5.3. CN3: Resolver Cable Connector

- Since the resolver cable supplied with the Megathrust Motor System should always be used, you need only plug the resolver cable connector into CN3. Knowledge of the pin assignment or signal names is not necessary. This section is offered for reference.

⚠ *Caution : • Do not change the length of the cable.*

• Do not use other connector between the Resolver cable and CN3.

⚠ *Danger : • Never connect pins not listed below.*

• Insert the connector being careful of its orientation. Tighten the screws for fastening the connector so that it will not be loosened by shock.

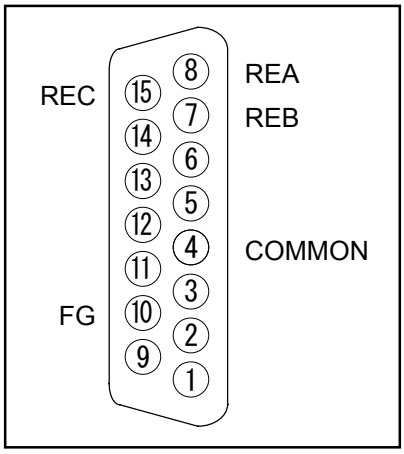
• Never connect/disconnect the CN3 connector with the Driver Unit power turned on.

Table 5-19

Driver Unit connector	Japan Aviation Electronics Industry, Limited	DALC-J15SAF-13L9
Mating connector type	Japan Aviation Electronics Industry, Limited	DA-15P-N
Mating connector shell type	Japan Aviation Electronics Industry, Limited	DA-C1-J10

5.3.1. CN3 Pin-out

Figure 5-15: CN3 Pin-out



5.3.2. CN3 Signal List

Table 5-20: CN3 Signal List

Pin	Signal Name	Function
8	REA	Resolver signal phase A
7	REB	Resolver signal phase B
15	REC	Resolver signal phase C
4	COMMON	Common
10	FG	Frame ground

5.4. CN4: Motor Cable Connector

- Since the Motor cable supplied with the Megathrust Motor System should always be used, you need only plug the Motor cable connector into CN4. Knowledge of the pin assignment or signal name is not necessary. This section is offered for reference.

⚠ *Caution : • Do not change the cable length.*

• Do not use other connector between the Motor cable and CN4.

⚠ *Danger : • Insert the connector being careful of its orientation. The connector is of a self-locking type. Insert the connector until it bottoms; otherwise, it will not lock.*

• Never connect/disconnect the CN4 connector with the Driver Unit power turned on.

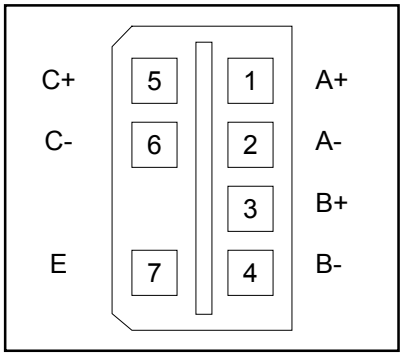
• A high voltage is applied to this connector after the power is turned on. Be very careful not to cause short-circuit.

Table 5-21

Driver Unit connector	AMP 172039-1
Mating connector type (user device side)	AMP 172495-1 (to be prepared by the user)
Mating connector shell type (user device side)	AMP 172774-1 (to be prepared by the user)

5.4.1. CN4 Pin-out

Figure 5-16: CN4 Pin-out



5.4.2. CN4 Signal List

Table 5-22: Signal Name and Function

Pin	Signal Name	Function
1	A+	Motor winding phase A (+)
2	A-	Motor winding phase A (-)
3	B+	Motor winding phase B (+)
4	B-	Motor winding phase B (-)
5	C+	Motor winding phase C (+)
6	C-	Motor winding phase C (-)
7	E	Motor grounding wire

5.5. TB: Terminal Block for Power Supply

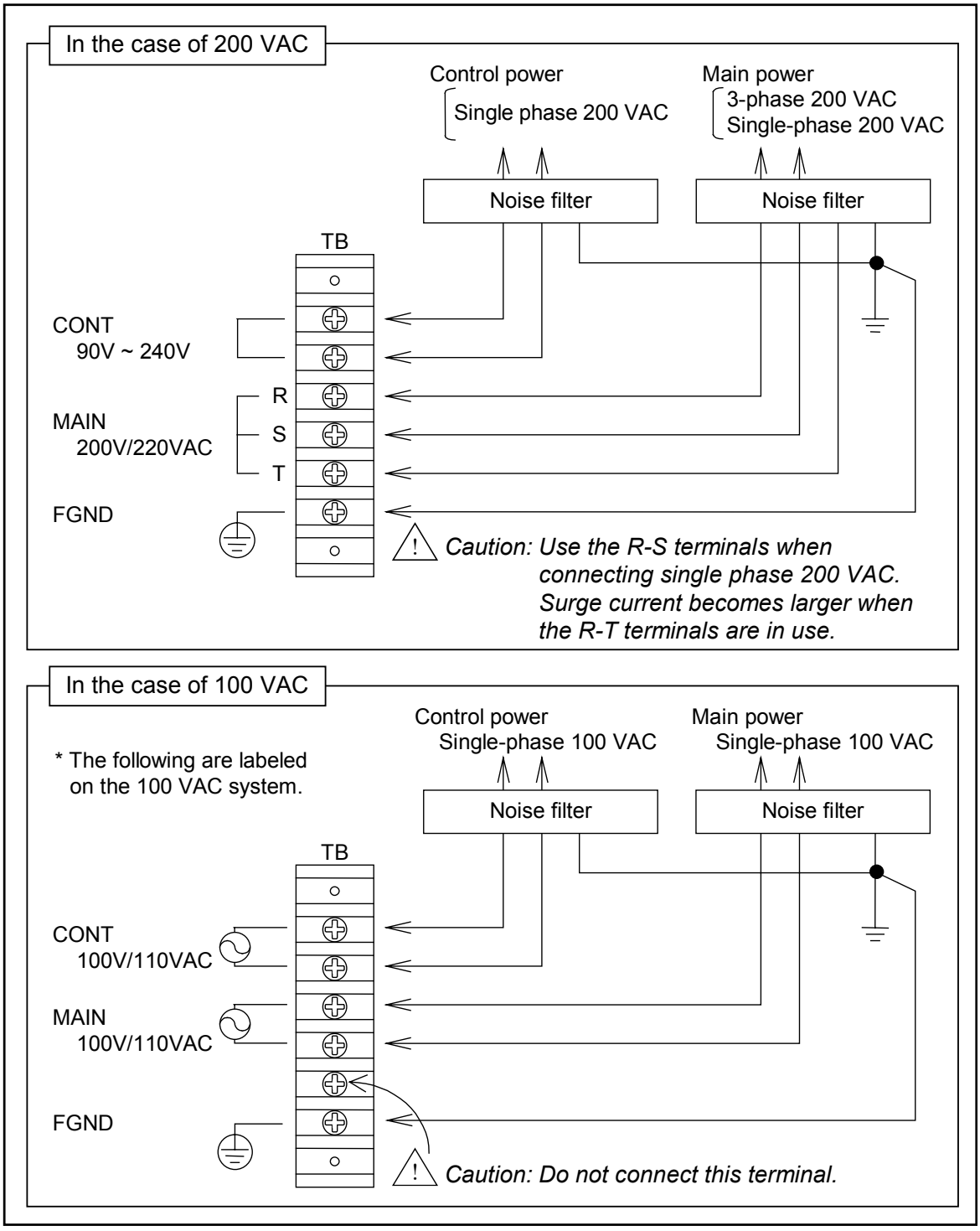
5.5.1. Terminal List

Table 5-23: Terminal Labels and Functions

Terminal Label	Function
CONT	Control power input
MAIN	Main power input
FGND	Frame ground

5.5.2. Wiring Diagram (TB)

Figure 5-17: Wiring diagram (TB)



- Refer to “6.4.1. Connecting Power” for the wiring precautions.
- For the power supply cable, use a heat-resistant vinyl cable of 2 mm^2 or more thick.
- Wire the power supply cables separately from the signal cables. Never bind them together or route them in the same duct.
- To prevent external noise, insert an isolation transformer and a noise filter between the power supply and the Driver Unit.

6. Installation

6.1. Unpacking and Inspection

- Make sure that you have received following units.

  (1) Megathrust Motor

  (2) Driver Unit (CN2 mating connector and 2 fuse holders are included)

  (3) Cable Set (Motor and Resolver cable unit)

- Inspect shipping containers for damage as an indication that the System might have been mishandled in transit.

- When unpacking the System, save all packing materials for reuse in the event that the System needs to be shipped or require service.

  ⚠ *Danger : Inspect the Motor and the Driver Unit very closely for damage which might have occurred in shipment. The Driver Unit is particularly fragile and should be inspected for warped or bent sheet metal, broken standoffs, and loose or damage electric components.*

- Move Motor's slider by hand, without AC power. The motion should be smooth.

- If you suspect damage, do not apply power to the System, since this can cause immediate catastrophic damage to the Driver Unit. Furthermore, a damaged system could be a potential electric shock hazard. Notify the carrier immediately, and call your NSK representative.

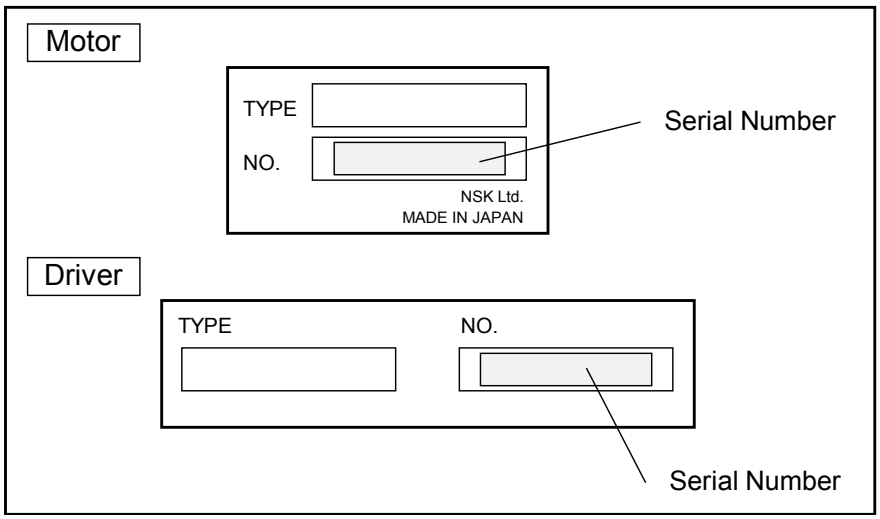
6.2. Motor and Driver Unit Combination

Caution : Make sure that the combination of Motor and Driver Unit conforms to your requirements.
Check and record the Motor and Driver Unit reference number and serial number.

- Combination
  - ◊ The Motor series, size and serial numbers in both Motor and Driver Unit reference number must be same.

- A nameplate is attached to individual Motor and Driver Unit. Configuration of each plates are shown in Figure 6-1. Refer to "3.2. Reference Number Configuration" for the more details.

Figure 6-1



6.3. Motor Mounting

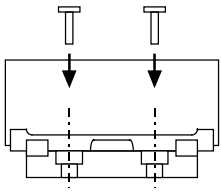
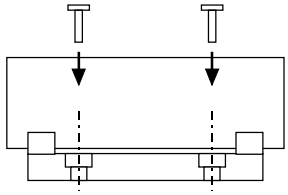
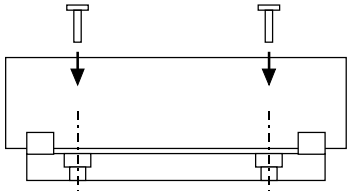
6.3.1. Mounting Location

- Please check that the following environment is given to the System
  - ◊ Ambient Temperature : 0 ~ 40°C.
  - ◊ Relative Humidity : 20 ~ 80 % (Non-condensing)
  - ◊ Indoor use only
  - ◊ The area where the Motor is mounted must be free of corrosive gas, dirt, dust, water, oil and any other contamination.

6.3.2. Mounting

- Refer to Table 6-1 to mount the Motor.

Table 6-1:Mounting method

Motor	YZ1	YA1, YA2	YB1, YB2, YB3
Mounting method			
	• Use bolts at the holes on the rack base to mount the Motor		
Bolt size	M5	M6	M8
Hole span	120 mm	120 mm	120 mm

- The high acceleration/deceleration characteristic of a direct drive mechanism requires the system to have high mechanical rigidity. Therefore, it is essential to maximize rigidity of the Motor and the load system.

- The Motor will work best if all of the elements have a natural frequency between them of at least 100 Hz, and preferably more than 200 Hz.

⚠ *Warning : • Fully fasten all the mounting holes (mounting tap holes) of the Motor.*

• Fasten a load using all of the tapped holes of the slider.

⚠ *Warning : The flatness of the surface where the Motor is mounted affects Motor operation. About less than 0.1 mm/1000 mm flatness is needed for smooth operation. When mounting, minimize the looseness between Motor and the mounting surface.*

6.4. Driver Unit Mounting

- The ESA13 Driver Unit may be mounted by the holes in brackets.

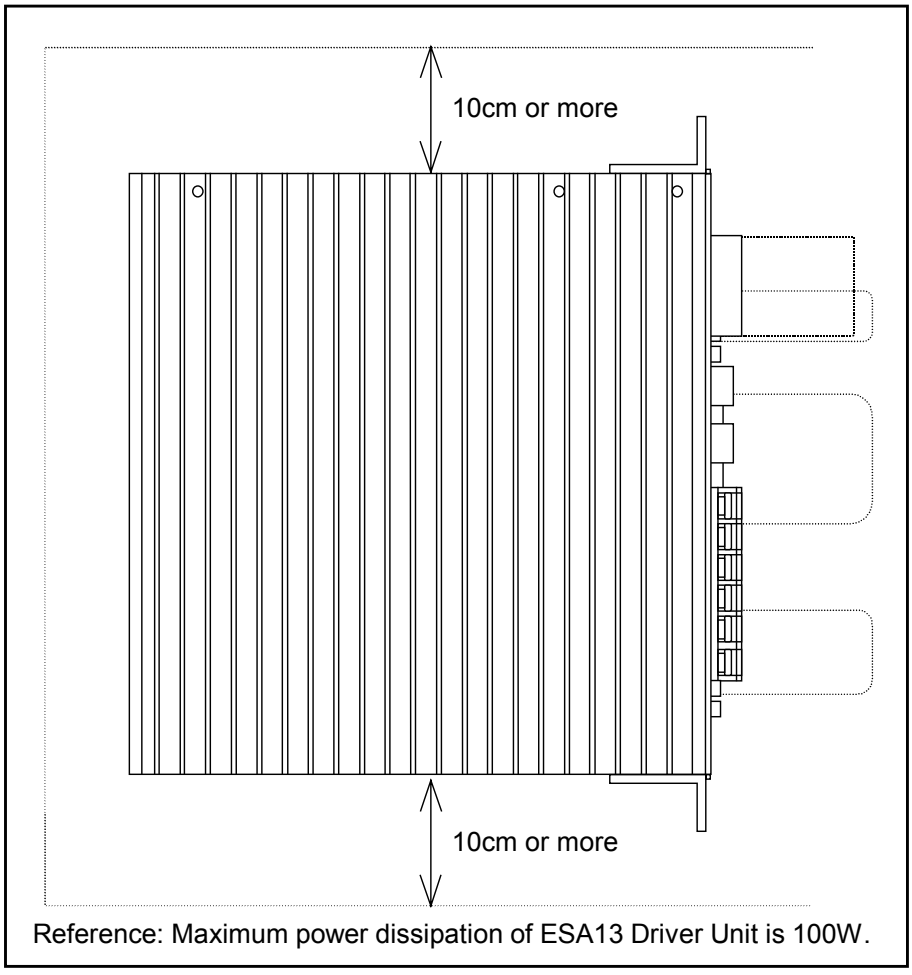
  ⚠ *Caution : For proper air circulation, clearance is required above, below, and at the back of the unit (see Figure 6-7).*

- When the Driver Unit is installed in the control panel, keep the panel internal temperature within the range from 0°C to 50°C. If the heat sink overheat alarm (see "14. Alarms") arises frequently, cool the heat sink using a fan, etc.

  ⚠ *Caution : When installing two or more Driver Units for multi-axis combinations, give a space of about 10 cm between adjacent Driver Units.*

- ESA13 Driver Unit has brackets for easy fixing to the control box or enclosure.

Figure 6-2



- The area where the Driver Unit is mounted must be free of water, corrosive gas, dirt, dust and any other contamination.

6.4.1. Connecting Power

- The main power AC line input supplies the power to the high voltage supply for driving the Motor.
- The control power AC line input supplies power to the internal low voltage switching power supply for the logic and signal circuits. The internal switching power supply will operate from any single phase AC voltage from 90 up to 240 volts.
- The AC power for the control power input may be obtained from the same supply that is connected to the main power AC line input.
- The AC line power consumption varies with the Motor size, the Driver Unit type and the load. The Megathrust Motor System requires very little power when it is moving at zero or low speed, even at maximum torque output. The power consumption is highest when the Motor is producing significant amounts of force at elevated speed, more than 20% of the maximum rated speed.
- Use 2.0 mm^2 (14AWG) or larger wire with heat-proof vinyl for power line.
- The electrical noise from outside sources and from the System itself can interfere with proper operation. The protection from electrical noise must be designed into the installation. Use a line noise filter on the AC supply. A suitable noise filter may be obtained from NSK. If you supply your own, it should meet these requirements in Table 6-3.

Table 6-2: Noise Filter Requirement

Driver Unit AC Line	Noise Filter Voltage Rating	Current Rating
220VAC, 3ø	250V AC/DC	15A AC/DC
220VAC, 1ø		
110VAC, 1ø		
Control Power	250V AC/DC	5A AC/DC

- Do not tie wrap the input and output sides of the AC line filter together, or place them in close proximity. Do not tie wrap the ground wires with signal wires.
- The noise filter must be installed on control power AC line, separately from the main power line.
- Do not place the main power AC line input supplies and signal wires in close proximity. Do not tie wrap them and not put in the same duct.
- The Driver Unit and the noise filters must be close to each other and wiring must be of minimal length. Do not insert contacts like a magnetic switch or a relay between them.
- Install a circuit breaker on the main power AC line. When the power is turned “ON”, an inrush current to the circuit will occur because of the capacitive load connected to the main power supply circuit.
- When inserting contacts into the power supply circuit, the specification of the contact should be greater or equal to ones in the following table:

Table 6-3: Contact Requirements

Contacts	For ESA Type
No-Fuse Breaker	Current Rating 15A
Short-Circuit Breaker	Contact Capacity 15A Sensitivity 15mA
Magnetic Switch	Contact Capacity 30A

Table 6-4: Inrush Current

Item	Inrush Current (TYP)	
	AC100v	AC200V
Control Power	7A	14A
Main Power	40A	140A

- Install a surge killer circuit for magnet switches, relays and solenoids.
- When replacing the fuse F1 or F2 of the Driver Unit, use the fuse packed with the Driver Unit when it is shipped.

⚠ *Caution : • Use the R-S terminals when connecting single-phase 200 VAC for the main power supply. Surge current becomes larger when the R-T terminals are in use.*

• During wiring, be careful not to loose terminal block screws, etc.

⚠ *Danger : Install the plastic protection on TB Terminal Block after wiring. The terminals on TB will be at high voltage when power is turned on. Removing the protection and touching terminals may cause extreme electrical shock.*

Note: Refer to “5. Connector Specifications” for the connector wiring.

6.4.2. Ground Connection and Wiring

- For grounding Driver Unit, use heavy gage cable as possible, such as a flat braided copper cable or a wire 3.5mm^2 (AWG 10) or larger.

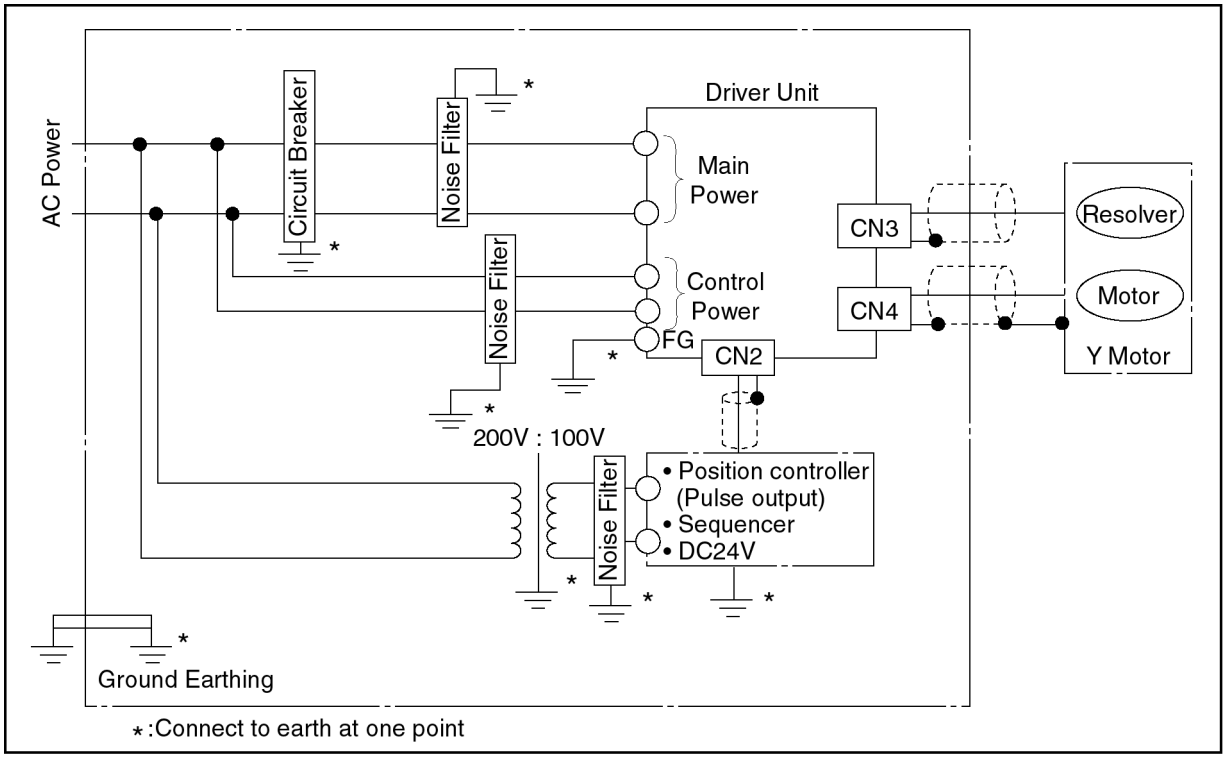
  ⚠ *Caution : • All the ground lines must be connected at one point and the grounding resistance must be under or equal to 100 λ.*

  • Connect the shield of the signal shielded cable (CN2) to the FG terminals (or SG terminals) of the user's controller. If runaways are caused by noise, connect the shield to the FG terminal of the Driver Unit.

  • Earth the rack base by bolts when the Motor is electrically isolated from the other machines.

- Figure 6-3 shows the wiring example. (This is provided as an example, not the instruction.)

Figure 6-3: Wiring Example



6.5. Connecting Motor and Driver Unit

- User must specify the Cable Set length when ordering.

⚠ *Caution :*

- *Do not make the Cable Set length longer or shorter. Changing cable length may worsen Motor and Driver Unit performances, typically resolver and resolver repeatability. When ordering, check carefully required cable length.*
- *Do not place the power lines (AC power supply and Motor cable) and the signal lines (CN2 and Resolver cable) in close proximity. Do not tie wrap them and not put in the same duct.*
- *Connect the Cable Set to Motor connector and Driver Unit connectors CN3 and CN4.*

6.6. Power On and Servo On

6.6.1. Precautions

Caution : Before turning on the main power, check the following.
(1) Wiring of connectors
(2) Connecting Cable of Motor and Driver unit.
(3) Safety

Danger : Always stay in a safe place.

Warning : Confirm that the Motor is securely fixed to the mounting base and the load is fixed to the Motor. Fully fasten all the mounting bolts.

Danger : The working area of the Motor should be protected from the operator.

6.6.2. Turning Power On

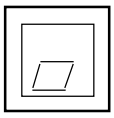
(1) Turn on the power

(2) Make sure that the LED of the Driver Unit and the Handy Terminal display are indicating that the system is ready for operation.

(i) Normal state

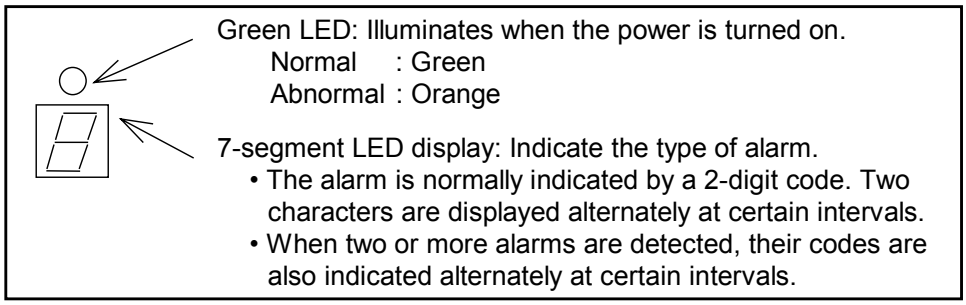
◊ Figure 6-5 shows the LED indicator in normal condition.

Figure 6-4



(ii) Abnormal

Figure 6-5

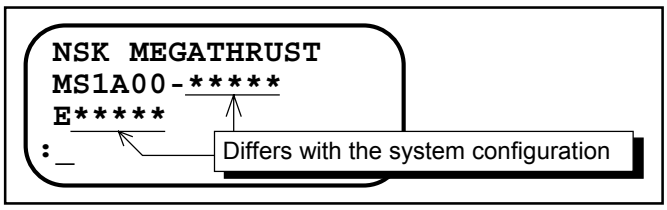


◊ Refer to “14. Alarms” for more details.

(iii) Handy Terminal display

◊ If a message “NSK MEGA...” is displayed on the Handy Terminal, the system is ready for operation. A colon (:) indicates that a command can be entered.

Figure 6-6: Handy Terminal display (In normal state)



(3) If the system is normal, input SVON signal.

⚠ *Caution : Turn on the main power supply first, then the SVON input, when turn off the main power supply, turn off SVON first. If the main power supply is turned off in the servo-on state, the Driver Unit outputs the AC Line under-voltage alarm. Once this alarm occurs it will not recover unless the power is turned on again.*

◊ Figure 6-7 and 8 show timing of power "ON" and SVON.

Figure 6-7: Power "ON" sequence

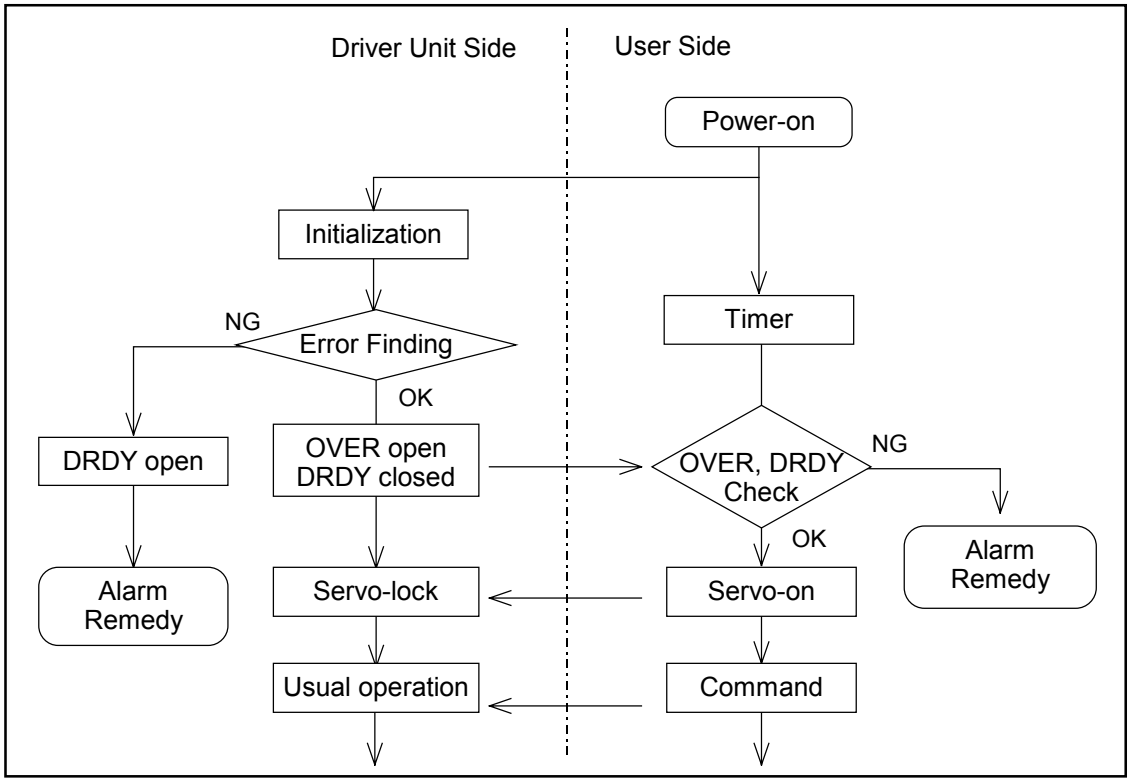
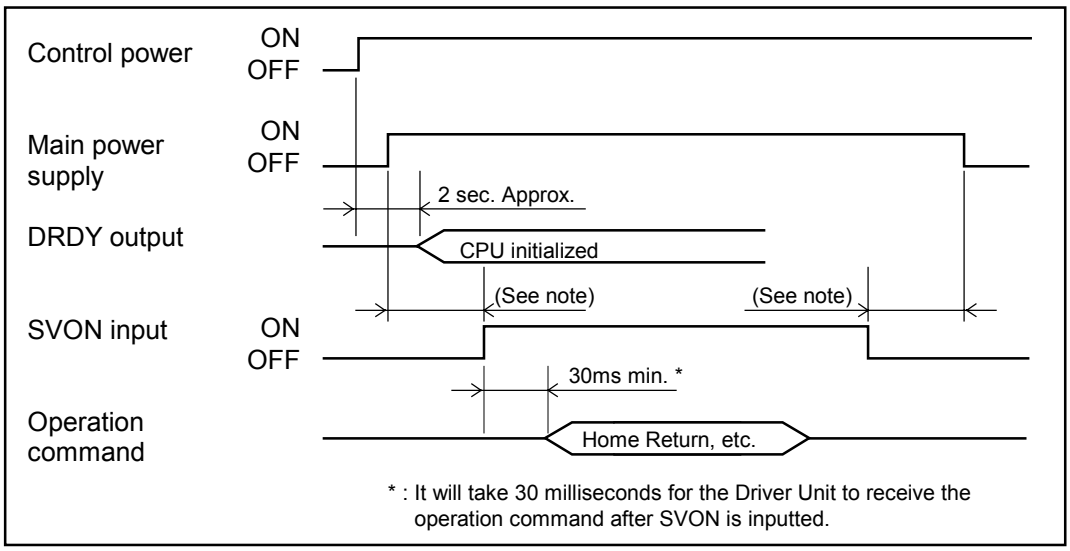


Figure 6-8: Power ON / SVON timing



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7. Handy Terminal Communication

- Setting of various parameters, trial running, and adjustment are enabled by issuing commands to the Driver Units through NSK Handy Terminal FHT11. (i.e., communication through the RS-232C interface).
- The Driver Unit has CN1 as the Input/Output ports for RS-232C communication.
- FHT11 Terminal can be a daisy chain communication terminal. Refer to "9.3.3. Daisy Chain Communication" for details.

⚠ *Caution : Always turn off the Driver Unit when plugging on/off the CN1 connector.*

◊ *Turn off the Driver Unit, if it has been turned on.*

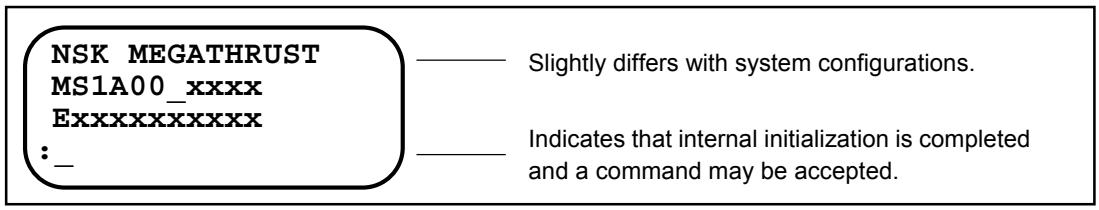
◊ *Connect FHT11 and the Driver Unit at connector CN1.*

◊ *The communication will automatically begin when you turn on the control power of the Driver Unit.*

7.1. When Power is Turned ON

- If the terminal (NSK Handy Terminal FHT11) is connected to CN1 and the Driver Unit power is turned on, the message shown below is displayed.
- The contents (and the number of characters) of this message may differ with Driver Unit setting and system versions.
- When the Driver Units are initialized, a colon (:) is displayed and the system waits for a command to be entered. The colon (:) is called a prompt. If the colon (:) is not displayed, press ENT key.

Figure 7-1: Power-On Message



7.2. Command Entry

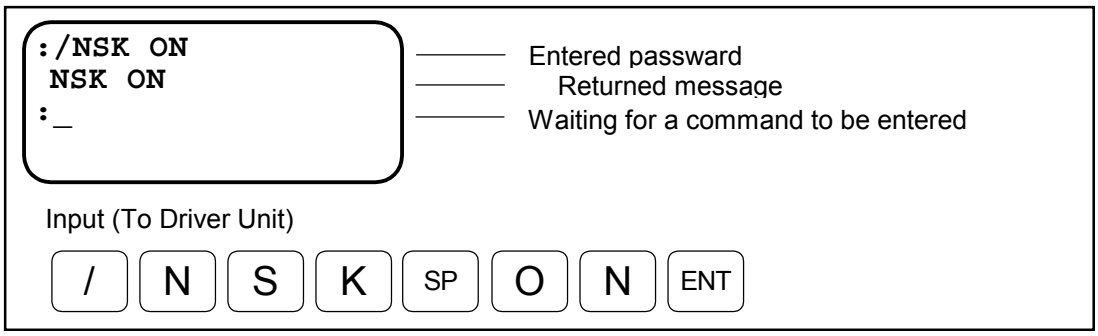
- Communication command shall consist of "a command (character string) + data (if necessary) + [ENT] "
- If the velocity gain is to be set to 0.5, for example, "VG0.5" should be entered by adding data of 0.5G to a VG command.
- Every time a character is input, the Driver Unit echoes the character back to the terminal. (The Driver Unit returns same character it receives.)
- When [ENT] code is input, the Driver Unit decodes a character string which it has received (VG0.5 in the example above) and executes it. Therefore, a command is not executed unless it ends with [ENT] .

> ⚠ *Caution : When turn off the Driver Unit power, make sure that a colon (:) is displayed. If not, an alarm "Memory error" might be detected when you turn on the power next time.*

7.3. Password

- Among the communication commands used for this System, some special commands (such as AB, PA, SI, etc.) require password entry for preventing erroneous entries. These commands cannot be entered in the same manner as other commands.
- The password is /NSK ON (a space between K and O) as shown below. If the Driver Unit accepts it, it returns an "NSK ON" message. Refer to "11. Command and Parameter" for details.
- A command requiring password entry may only be executed immediately after the password is entered.

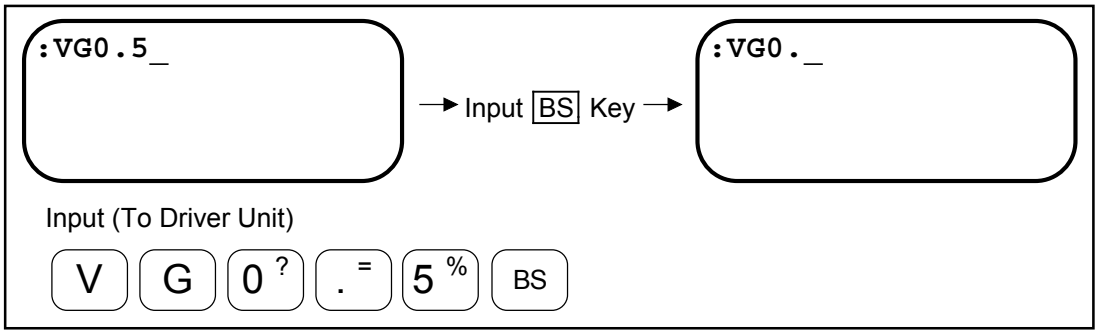
Figure 7-2: Password Input



7.4. Cancelling Command

- To cancel a command which has been entered halfway, enter a backspace code.
- For example, when the backspace code is input following VG0.5, the cursor moves one space back to the position where 5 was input and thereby deletes 5.

Figure 7-3: Canceling Example

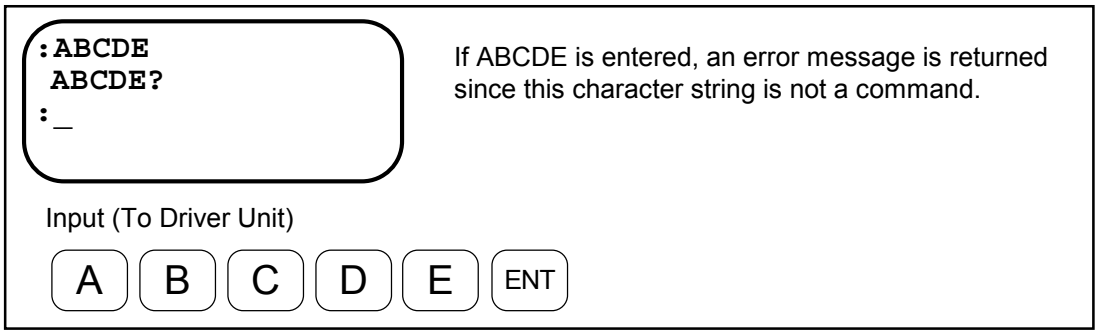


7.5. Error

- Note that an error occurs in any of the following cases:
  - (1) If a nonexistent command (i.e., character string) is entered (If an entered character string cannot be decoded).
  - (2) If data or subscript out of the allowable range is entered.
  - (3) If a command requiring the password is entered without the password.
- In any of these cases, the entered character string with a '?' mark is returned as an error message.

For example,

Figure 7-4: Input Error Example 1



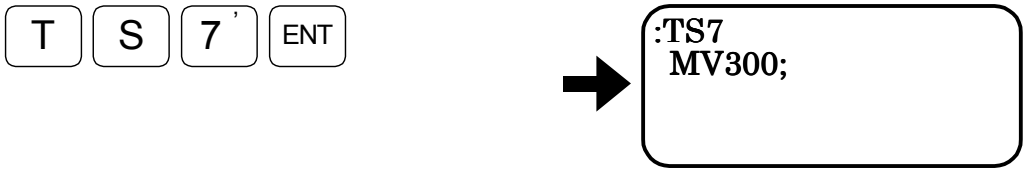
7.6. Readout Command

- If a command for reading initial setting or current state is entered, the Driver Unit returns data.
- The following is an example for checking "JOG Velocity JV" set value.

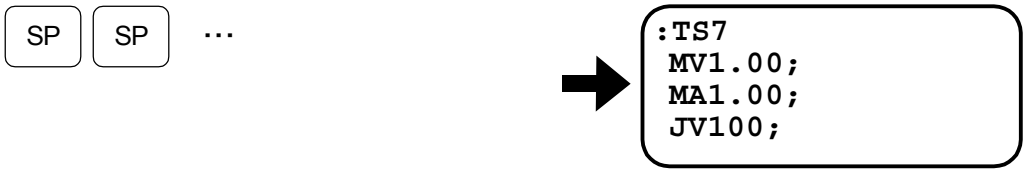
1 TS command for reading set value

(1) Refer to "11. Command and Parameter" "TS"

(2) "JV" command is in the group of TS7, input



(3) Press SP key to scroll display to find out JV value.



(4) When finishing the readout,

(i) Keep pressing SP key until display stops scrolling.

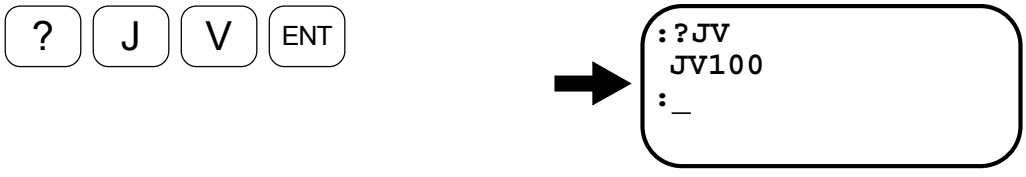
or

(ii) Press BS key.

(5) The colon (:) is displayed to indicate the system is waiting for next command.

2 If the set value reading function "?" is used

(1) Enter "?" before inputting JV.
Display shows the value of "JV".



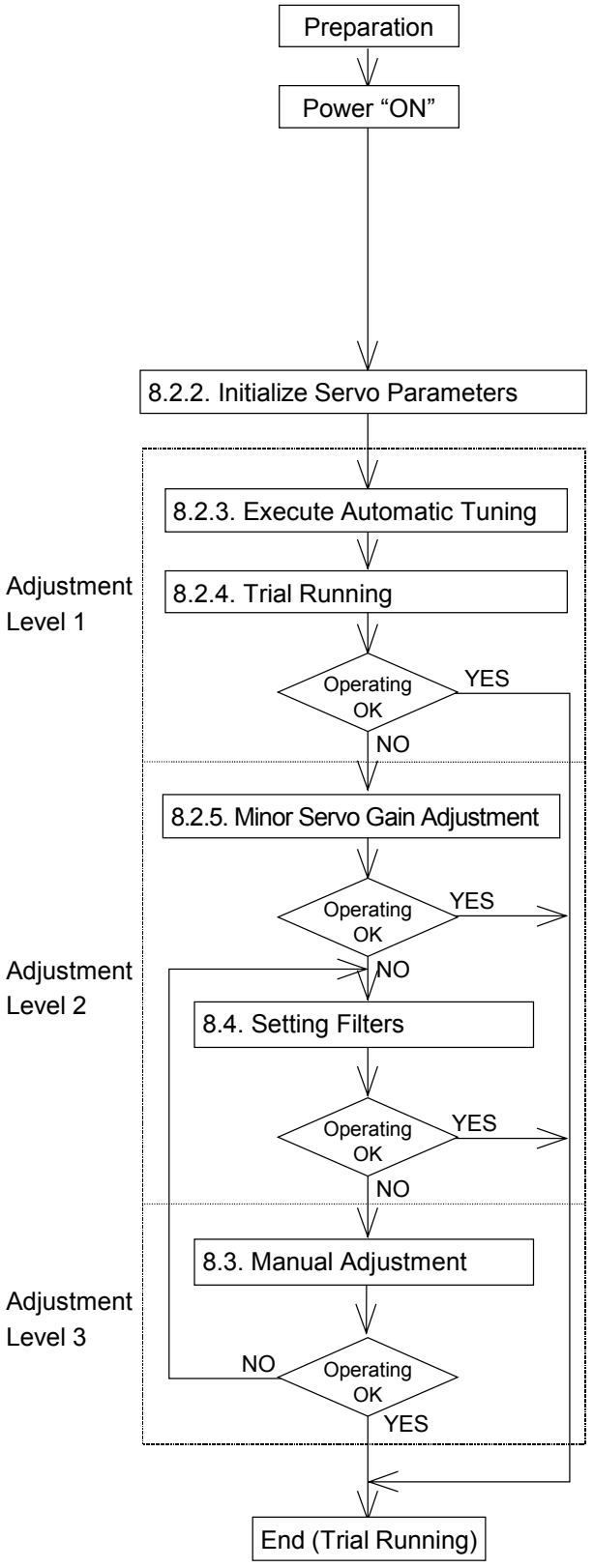
(2) A colon (:) is displayed.

Caution : When reading out set value, using TS command is recommended. When using "?" command make sure to input "?" before parameter characters. If not, and pressing ENT key after the characters may change the set value.

8. Trial Running and Adjustment

8.1. Adjustment Sequence

Figure 8-1: Adjustment Sequence



- Install Motor and wire Driver Unit.

⚠ *Caution:* • *Make sure that the LED of the Driver Unit is indicating [▱] (normal).*
• *Turn control power "ON" and confirm that Handy Terminal display shows the message as shown below.*

```
NSK MEGATHRUST
MS1A00_***
E********
:_
```

Initialize servo parameters.

- Execution of automatic tuning.
  ◊ Automatic estimation of load enertia and automatic servo-parameters setting will be executed in this stage.
- Trial running
  ◊ Confirm the parameter set values obtained from automatic tuning. You may refer to the setting for Level 2 and Level 3 adjustment.

Adjustment Level 1	• Basic function of Automatic tuning. • The adjustment is completed if trial running is satisfactory.
Adjustment Level 2	• Execute additional adjustment to the Level 1 when trial running is not satisfactory.
Adjustment Level 3	• Execute final adjustment manually when Level 1 and 2 are not successful.

8.2. Automatic Tuning (Adjustment Level 1)

⚠ *Caution : Automatic tuning cannot be performed if the following conditions are not met.*

- ◊ *The load inertia must be under the limit of the Motor. (Refer to "4.1. Motor Specifications")*
- ◊ *The motor axis must be horizontal. (The load conditions to the Motor must not be affected by the gravity.)*
- ◊ *Mechanical rigidity of the Motor mounting base and attached load is sufficient enough.*
- ◊ *There must be no backlash or play caused by gears and couplings.*
- ◊ *Frictional load to the Motor shall be minimal.*

8.2.1. Preparations

● The following preparation should be carried out in advance to start the automatic tuning.

- ◊ Mounting the Motor onto the mounting base.
- ◊ Mounting the load onto the slider.
- ◊ Mounting of the Driver Unit.
- ◊ Wiring between the Motor and the Driver Unit by specified Cable set.
- ◊ Connecting Handy terminal to CN1 connector on the Driver Unit.
- ◊ Power supplying line wiring.
- ◊ Wiring SVON and EMST signal to specified pins of CN2 connector on the Driver Unit.

◆ Precautions

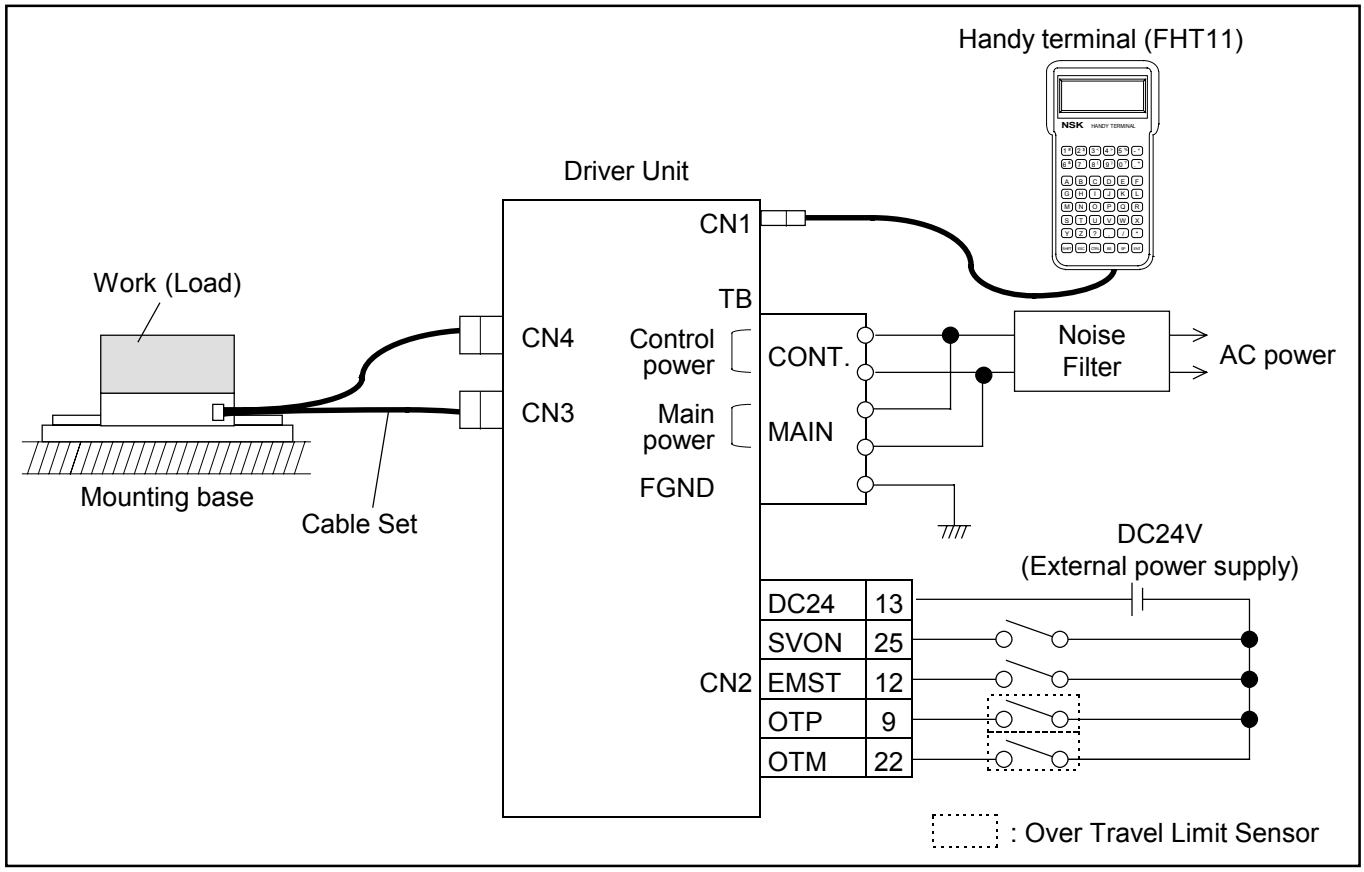
⚠ *Danger : • Wire "EMST" (Emergency Stop, CN2) signal to stop the Motor immediately when an accident is foreseen.*

• If the Motor moving range is restricted, set overtravel limits (OTP, OTM).

• The Motor moves ±20 (mm) when executing automatic tuning. Always stay in safe position.

⚠ *Caution : If mechanical rigidity of the load (work) is not sufficient enough, the Motor may vibrate. Turn "SVON" signal off or turn off the power when the Motor starts to vibrate. Execute manual adjustment in chapter 8.3 or increase the rigidity of the load.*

Figure 8-2: Example of Automatic Tuning Preparation



8.2.2. Initialize Servo Parameters

(1) Turn off the servo-on (SVON, CN2) signal.

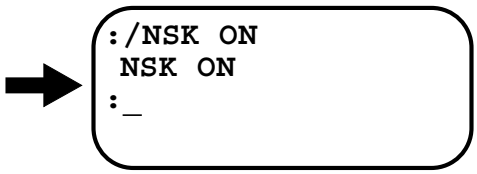
(2) Enter

T S 1 # ENT and T S 2 $ ENT

to check the parameter settings. Note down all values.

(3) Log in the password.

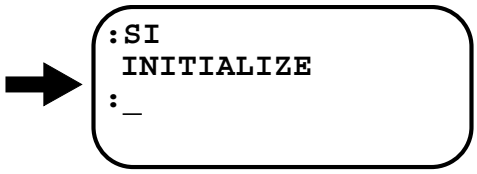
/ N S K SP
O N ENT



Display indicates the confirmation.

(4) Log in SI (Set Initial Parameters) command.

S I ENT



"INITIALIZE" is displayed as the confirmation, and the initializing parameter begins. It takes few seconds and a colon " : " is displayed for next command.

⚠ *Caution : When "SVON" signal (CN2) is "ON" and "SI" command is input, Driver Unit rejects to execute the command. "SI INHIBITED" message will appear in the display.*

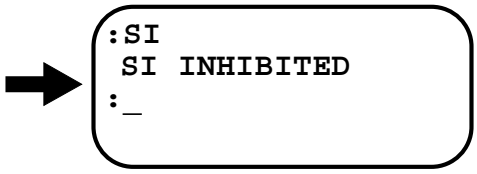


Table 8-1: Servo Parameter List

TS1 Reading			TS2 Reading		
Parameter	Initial Setting	Set Value	Parameter	Initial Setting	Set Value
PG	0.100		FO*	0.000	
VG	1.0		FP	0	
VI	1.00		FS	0	
VM	1		NP	0	
LG*	50		DBP*	0	
TL*	100		ILV*	100	
			FF*	0.000	
			FC*	0	

* These parameters are not necessary to adjust in Level 1 and 2 adjustment.

8.2.3. Execute Automatic Tuning (Adjustment Level 1)

- Between the cases that the load weight is known and unknown, the procedure of automatic tuning differs.

8.2.3.1 When the load weight is known.

- Set the load weight by parameter LO. The unit of LO is [kg] and 0.1 kg step setting is possible.
- For example, when the load weight is 5.5 [kg], the setting procedure will be as follows;
  (1) Input the password.
  (2) Set the load weight.
- Input LO data that differs from the present setting. Otherwise automatic tuning will not be carried out.

8.2.3.2 When the load weight is not known.

⚠ *Caution : Make sure the work (or Motor) does not hit any obstacle when the Motor makes a motion. Always stay in safe position.*

◊ *The Motor needs to move at least ±20 mm when executing the automatic tuning. If the application restricts the Motor movement, keep room for ±20 mm Motor movement. The overtravel limits (OTP, OTM) must be used to restrict the Motor moving range.*

(1) Turn SVON (CN2) signal "ON" and inputting "SV" command makes the Motor in servo-on states.

S V ENT

```
:SV
:_
```

(2) Confirm that Driver Unit's "LED" is indicating "▱" for normal condition.

(3) Input "Automatic Tuning" command.

A T ENT

```
:AT
 AT ready OK
?_
```

If a message is different from the display shown right, try procedures (i) and (ii) again.

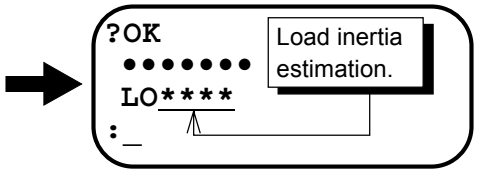
(4) Confirm the message "AT ready OK" then input "OK".

O K ENT

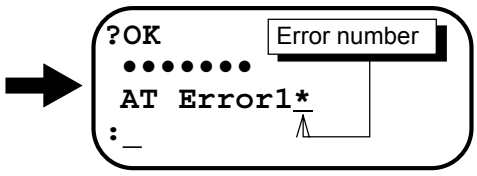
```
:AT
 AT ready OK
?OK
 •••
```

The Motor moves 10~20 mm back and forth to estimate the load inertia. When executing estimation, a dot (.) keeps appearing in the display till the Motor stops.

(5) After the estimation of load weight, the display indicates the weight value “LO”.



Caution : When executing the automatic tuning, if an error message is “ON” refer to “14. Alarms” and take a proper remedy. Driver Unit’s LED indicates “F8” for “AT” error.

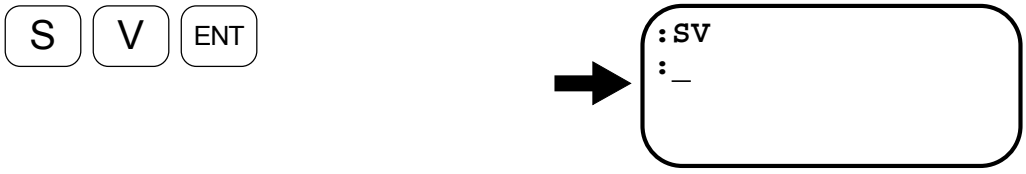


8.2.4. Trial Running (Adjustment Level 1)

Danger : Confirm that the work (or Motor) does not hit any obstacle when the Motor makes a motion. Always stay in safe position.

◊ For this adjustment, ESA13 Driver Unit's demonstration program is used as an example. The program is originally set before it is shipped.

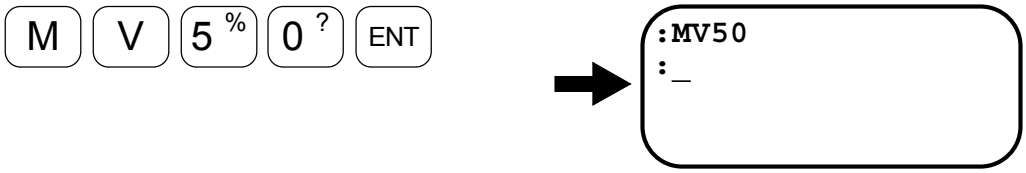
(1) Turn SVON (CN2) signal "ON" and inputting "SV" command makes the Motor in servo-on states.



(2) Confirm that Driver Unit's "LED" is indicating "▱" for normal condition.

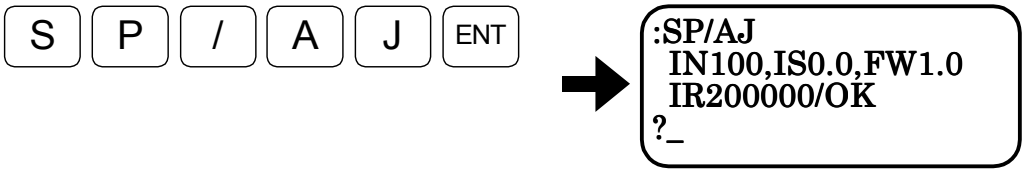
(3) Confirm an emergency stop (ESTM) and over travel limits (OTP, OTM) are "OFF".

(4) After the automatic tuning the rotational speed "MV" has been initialized to 500 mm/s. Change "MV" to 50 rps for trial running.



Note : After the adjustment, change "MV" to the actual use.

(5) Display the demonstration program.



◊ The message indicates the conditions of positioning and rotation angle.

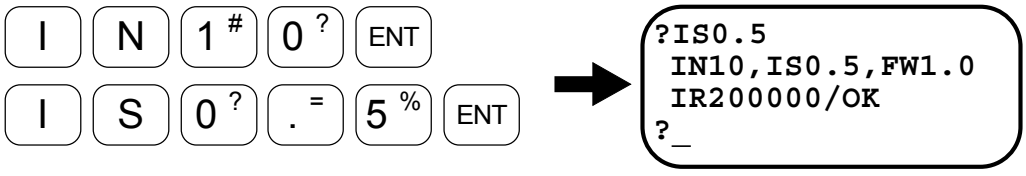
IN : In-position, IS : In-position stability timer.

FW : FIN Width.

ID : Incremental Positioning, Degree.

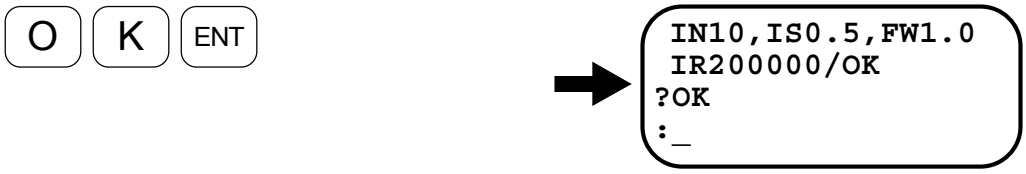
(Refer to "11. Command and Parameter")

(6) To make the adjustment simple, set IN "10" (pulse) and IS "50" (m sec).



Check the display for confirmation.

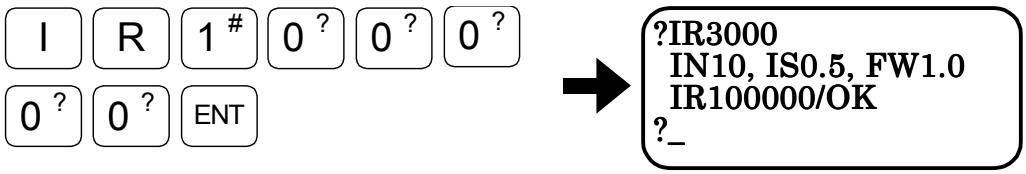
(7) When moving stroke (IR) 200000 (200 mm) is feasible, input “OK”.



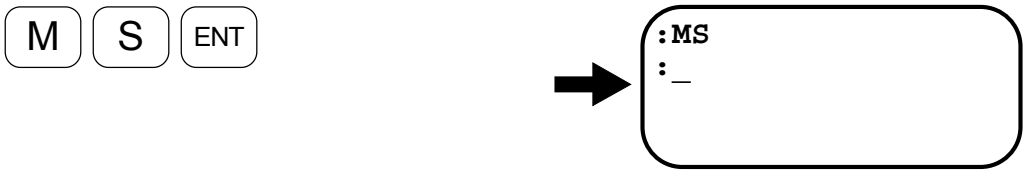
The motor starts the cycles as soon as “OK” is logged in.
(Firstly the Motor moves to PLS direction.)

- For changing moving stroke while “?” prompt is displayed, input desired IR, then input “OK”.

  ◊ Example for moving stroke : 100 (mm)



(8) When the trial running is completed, type



to stop the Motor.

- If the Motor is operating satisfactrily, complete the trial running.
- When the Motor operation is not stable, try further adjustment in chapter 8.2.5 and 8.3.
- If you want to get out from the demonstration program, press the enter key after “?”.

8.2.5. Minor Servo Gain Adjustment (Adjustment Level 2)

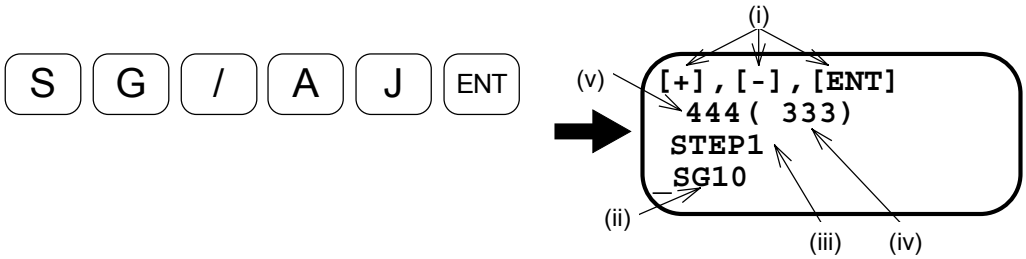
⚠ *Danger : Confirm that the work (or Motor) does not hit any obstacle when the Motor makes a motion. Always stay in safe position.*

◊ *This section describes minor servo-gain adjustment as the next step when the Motor operation is not satisfactory with the automatic tuning.*

◊ *Servo-gain can be adjusted by the parameter "SG".*
- *Setting higher "SG" value improves response to the programmed motion profile. However, if "SG" is too high, the Motor starts to vibrate.*

◊ *The same demonstration program in chapter 8.2.4 is used as the example for adjusting "SG" value. (Execute same procedure a ~ j in chapter 8.2.4 and keep operate the Motor.)*

(1) Start "SG" adjusting program.



The message is displayed as shown below. Press plus (+) or minus (key) to change "SG" value. (The display shown below is an example. Those values shall be set to the conditions for actual use.)

● Explanation of the messages

(i) Key function

SHIFT and - + : Pressing key one time increases 1 resolution of "SG".

- + : Pressing key one time decreases 1 resolution of "SG".

ENT : Store "SG" value to the memory.

(ii) Indicates present "SG" value.

(iii) Indicates "SG" value changed by pressing plus (+) or minus (-) key.

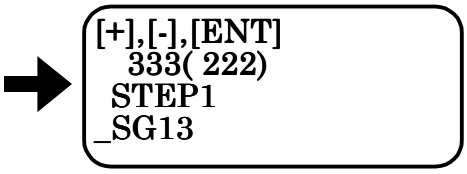
(iv) Response index number : The lower numbers denotes better response.

(v) Positioning index number : The lower number denotes quicker response.

Note: Do not use space key or back space key. When it is used, the "SG" changing resolution (ii) may be altered.

(2) Observing the Motor operation, press the plus (+) key several times.

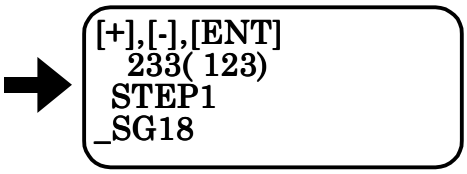
Pressing SHIFT , - + - + •••



As the response index decreases, the movement of the Motor is getting crisply.

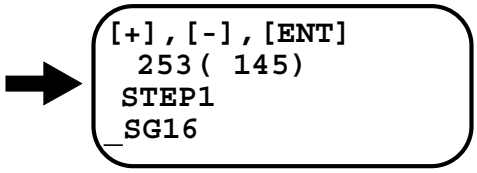
(3) Keep pressing the plus (+) key, eventually the Motor starts hunting and stops.

Pressing SHIFT , - + - + •••

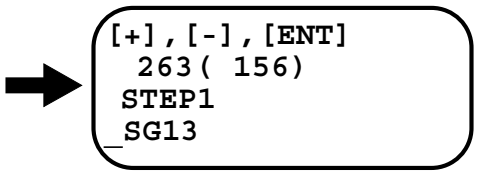


(4) Keep pressing the minus (-) key until the Motor stops hunting and starts moving.

- + - + •••

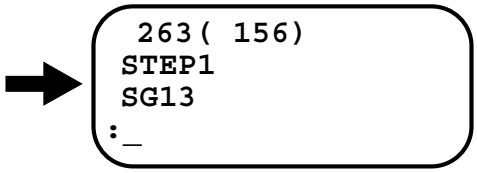


(5) Set "SG" value 80% of "SG" value at when the Motor stopped hunting. The Motor operates stable in any position.



(6) Type the enter key to complete the adjustment.

ENT



8.3. Manual Adjustment

⚠ *Danger : Confirm that the work (or Motor) does not hit any obstacle when the Motor makes a motion. Always stay in safe position.*

◊ *Manual adjustment is needed when the automatic tuning did not work.*

8.3.1. Precautions

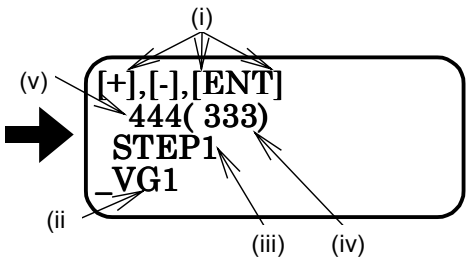
(1) Initialize servo parameters. Follow procedures in "8.2.2. Initialize Servo Parameters".

(2) Execute the demonstration program referring to "8.2.4. Trial Running (Adjustment Level 1)". At the beginning, Motor operation is unstable due to insufficient adjustment.

8.3.2. Adjustment of the Velocity Gain (VG)

(1) Start "VG" adjusting program.

V G / A J ENT



The display shows the message as shown on the left.

- Explanation of the messages

(i) Key function

SHIFT and - + : Pressing key one time increases 1 resolution of "VG".

- + : Pressing key one time decreases 1 resolution of "VG"

ENT : Store "VG" value in the memory and completes the adjustment.

(ii) Indicates present "VG" value.

(iii) Indicates "VG" value changed by pressing plus (+) or minus (-) key.

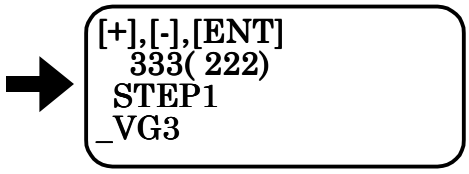
(iv) Response index number : The lower number denotes better response.

(v) Positioning index number : The lower number denotes quicker positioning.

Note: Changing "VG" step (iii).
If you want to change the resolution of step, press space key or back space key.
Space key : Changes the step to 1/10 of present resolution. (Pressing twice makes 1/100.)
Back space key : Changes the step to 10 times of present resolution. (Pressing twice makes 100 times.)

(2) Observing the Motor operation, press the plus (+) key several times.

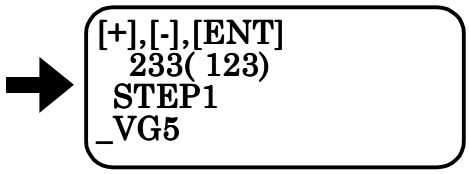
Pressing [SHIFT] , [- +] [- +] •••



As the response index decreases, the movement of the Motor is getting crisply.

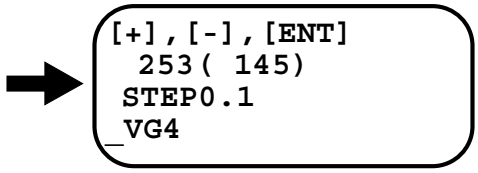
(3) Keep pressing the plus (+) key, eventually the Motor starts hunting and stops.

Pressing [SHIFT] , [- +] [- +] •••



(4) Keep pressing the minus (-) key until the Motor stops hunting and starts moving.

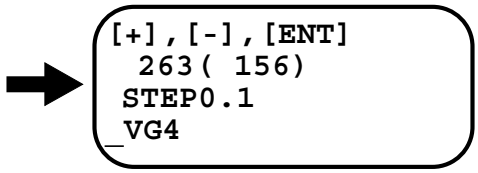
[- +] [- +] •••



(5) Set the "VG" value to 80% of displayed "VG" when a hunting is stopped.
$4 \times 0.8 = 3.2$

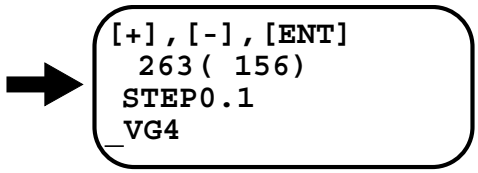
(6) Press the space key to change the resolution of "VG" setting value from 1.0 to 0.1.

[SP]



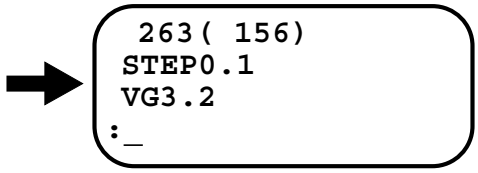
(7) Press the minus key till "VG" value reaches to 3.2.

[- +] [- +] •••



(8) Press the enter key to store the "VG" value.

[ENT]

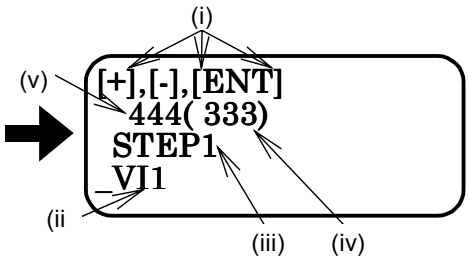


A colon (:) will appear to comfirm the input.

8.3.3. Adjustment of Velocity Integrator Frequency

- The adjustment of velocity integrator frequency (VI) shall be conducted after the velocity gain (VG) is adjusted.

(1) Start "VI" adjusting program.



The messages are shown on the left.
Inputting the plus (+) or minus (-) key changes "VI" value
(The "VI" value varies with an actual load inertia and revolution speed.)

- Explanation of the messages

(i) Key function

SHIFT and - + : Pressing key one time increases 1 resolution of "VI".

- + : Pressing key one time decreases 1 resolution of "VI".

ENT : Store "VI" value in the memory and completes the

(ii) Indicates present "VI" value.

(iii) Indicates "VI" value changed by pressing plus (+) or minus (-) key.

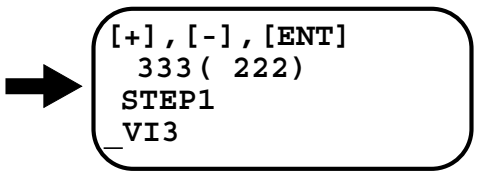
(iv) Response index number : The lower number denotes better response.

(v) Positioning index number : The rower number denotes quicker positioning.

Note: Changing "VI" step (3).
If you want to change the resolution of step, press space key or back space key.
Space key : Changes the step to 1/10 of present resolution.
(Pressing twice makes 1/100.)
Back space key : Changes the step to 10 times of present resolution.
(Pressing twice makes 100 times.)

(2) Observing the Motor operation, press the plus (+) key several times.

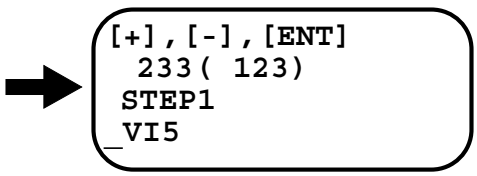
Pressing SHIFT , - + - + •••



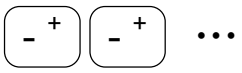
As the response index decreases, the movement of the Motor is getting crisply.

(3) Keep pressing the plus (+) key, till the Motor starts hunting and stops.

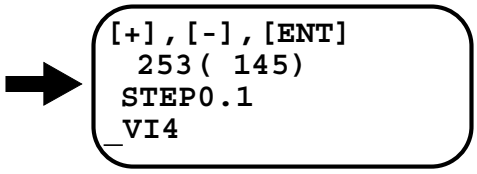
Pressing SHIFT , - + - + •••



(4) Keep pressing the minus (-) key until the Motor stops hunting and starts moving.



•••

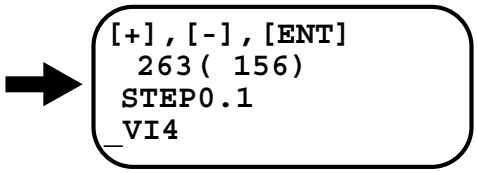


(5) Set the "VI" value to 80% of displayed "VI" when a hunting us stopped.

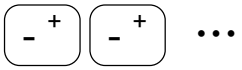
$4 \times 0.8 = 3.2$

Input the space key to change the resolution of "VI" setting value from 1.0 to 0.1.

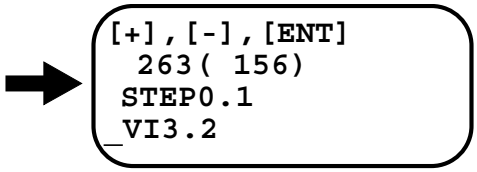
(6) Press the minus key till "VI" value reaches to 3.2.



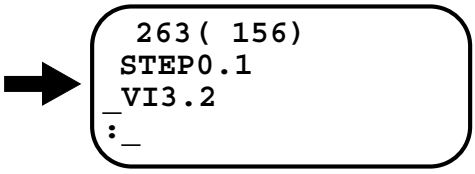
(7) Input the enter key to store the "VI" value.



•••



(8) A colon (:) will appear to comfirm the input.



8.4. Setting Filters (Adjustment Level 2)

- When positioning, the Motor may resonate mechanically and generate a noise of certain frequency. Using Megathrust Motor's software "low-pass filters" (Parameter FP and FS), the noise can be reduced.

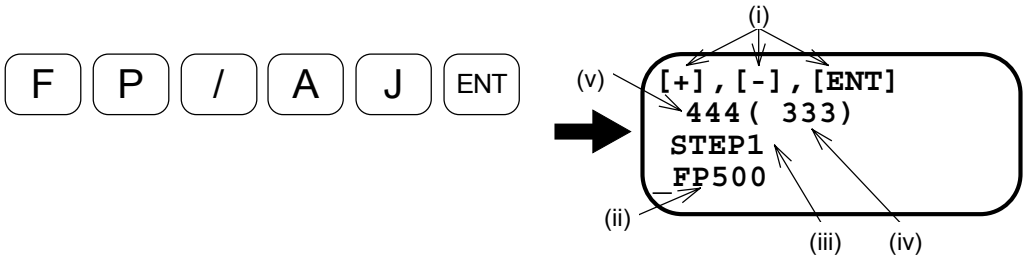
  The unit of parameters of FP and FS is cycles / second (Hz).

  ◊ If low frequency less than 100Hz is set to parameters "FP" and "FS", hunting or unstable positioning may occur.

- Before using filters, make sure that all adjustments of gain (VG) and integrator frequency (VI) are completed.

- Use same demonstration program (SA/AJ) for adjusting filters. Follow the procedures a ~ j in "8.2.4. Trial Running (Adjustment Level 1)".

(1) Start "FP" adjusting program.



The message is displayed as shown below. Press plus (+) or minus (key) to change "FP" value. (The display shown below is an example. Those values shall be set to the conditions for actual use.)

- Explanation of the messages

  (i) Key function

  SHIFT and - + : Pressing key one time increases 10 resolution of "FP".

  - + : Pressing key one time decreases 10 resolution of "FP".

  ENT : Store "FP" value in the memory and completes the

  (ii) Indicates present "FP" value.

  (iii) Indicates "FP" value changed by pressing plus (+) or minus (-) key.

  (iv) Response index number : The lower number denotes better response.

  (v) Positioning index number : The lower number denotes quicker positioning. positioning.

Note: Changing "FP" step (3).
If you want to change the resolution of step, press space key or back space key.
Space key : Changes the step to 1/10 of present resolution.
(Pressing twice makes 1/100.)
Back space key : Changes the step to 10 times of present resolution.
(Pressing twice makes 100 times.)

(2) Decrease low-pass filter frequency (FP) to lower noise level by typing minus (-) key several times.

[-] [-] ...

```
[+],[-],[ENT]
 333( 222)
STEP10
_FP500
```

(3) If the Motor starts to work unstably, increase "FP" value by typing plus (+) key several times.

Pressing [SHIFT] , [-] [-] ...

```
[+],[-],[ENT]
 233( 123)
STEP1
_FP120
```

(4) Type the enter key to complete the adjustment.

[ENT]

```
 233( 123)
STEP1
_FP120
:_
```

Note : To deactivate the filter, input the filter command with "0" data. For example type as :

[F] [P] [0 ?] [ENT]

```
:FP0
:_
```

Note : Setting "Notch Filter"

◊ When setting notch filter, you can connect the ocsilloscope to monitor pins on Driver Unit front panel to know the resonance frequency.

・ Example

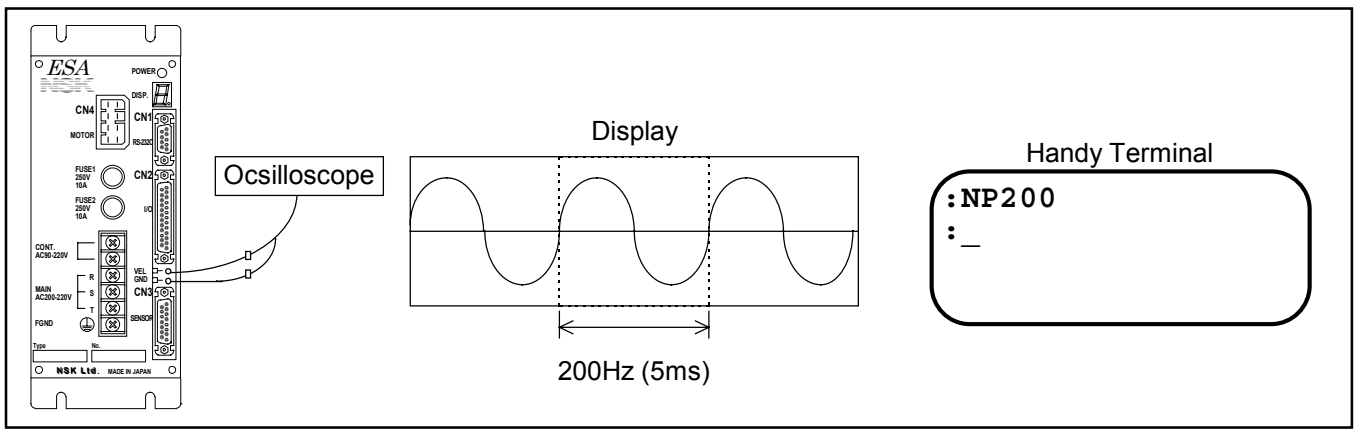
(1) Check the resonance frequency as shown in Figure 8-3.

(2) If the resonance frequency is 200 Hz, input

[N] [P] [2 $] [0 ?] [0 ?] [ENT]

to set notch filter frequency.

Figure 8-3



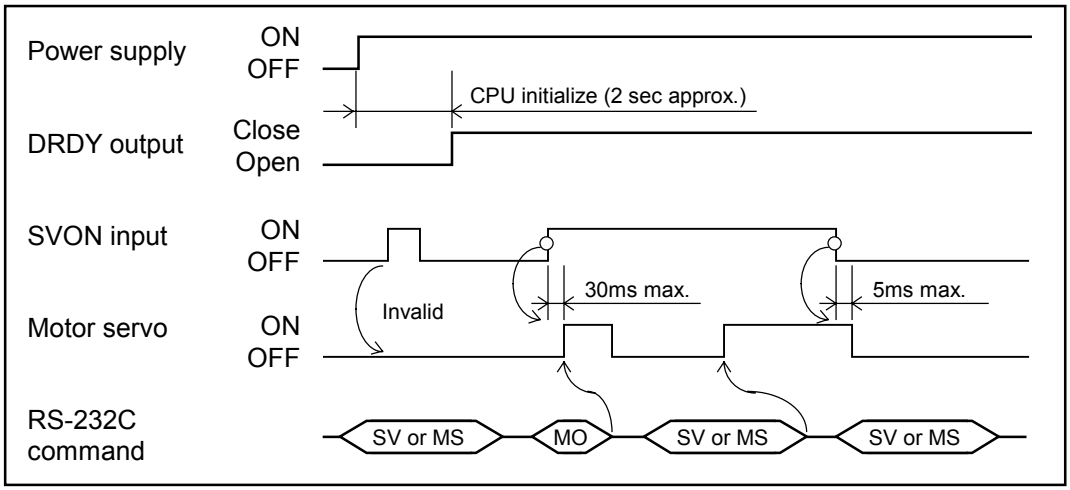
9. Operational Function

9.1. General Operation and Function

9.1.1. Servo “ON”

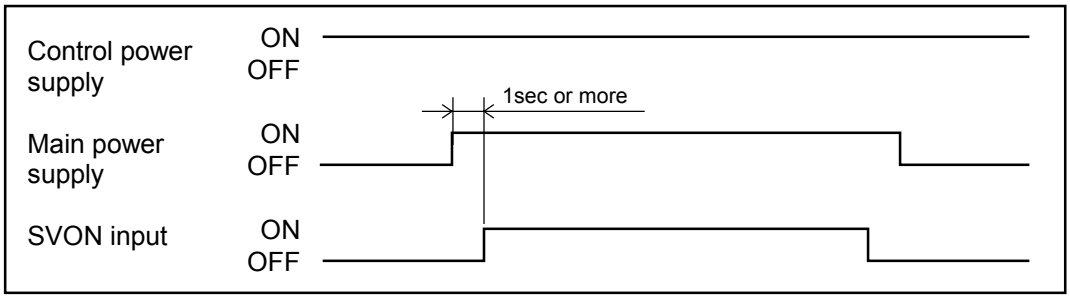
- After the Driver Unit power is turned on and its DRDY output circuit becomes closed, making SVON input ON should make motor servo-on.
- The position error counter will be cleared when SVON input is OFF.
- When SVON input is ON, the MO command results in servo-off.
- The SV or MS command will cancel this MO command effect.

Figure 9-1



- Take the following precaution when turning ON/OFF the main power supply and the control power supply separately :
  - ◊ When turning on the main power supply with the control power supply turned on : Turn on the main power supply first, then the SVON input.
  - ◊ When turning off the main power supply with the control power supply turned on : Turn off the SVON input first, then the main power supply.
  - * When the main power supply is turned off in the servo-on state, the Driver Unit outputs the AC Line under-voltage alarm. (Once this alarm occurs, it will not recover unless the power is turned on again.)

Figure 9-2



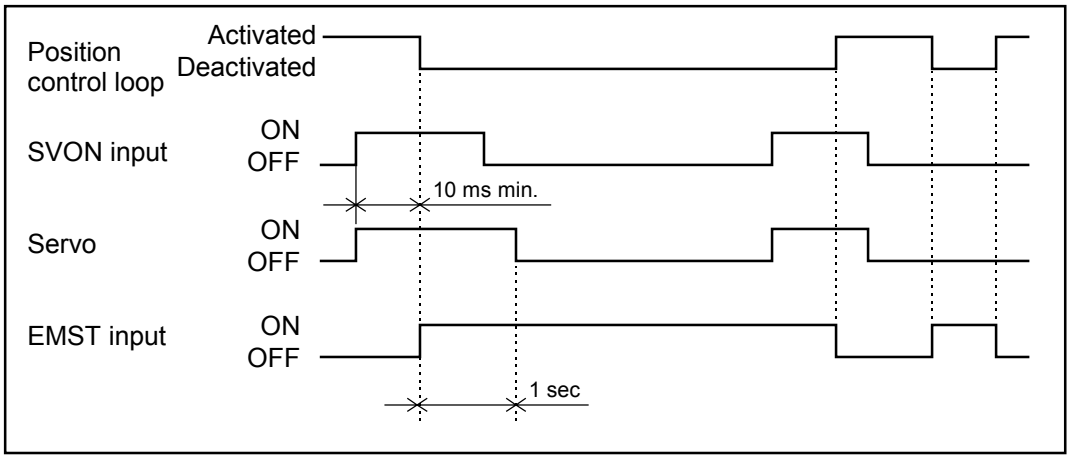
9.1.2. Emergency Stop

- Turning on the EMST input stops the position loop control function and stops the Motor in the servo-lock state* under velocity loop control.
- No motion commands will be accepted while EMST input is on.
- In the EMST state, the LED on the front panel indicates “F4”. The DRDY output remains unchanged (closed).

* The polarity of the EMST signal input port is set to A contact before shipment, but it can be changed to B contact (refer to the AB parameter).

    * Position loop control is not performed this time. If the possibility exists of an external force being applied to the Motor in this state, use a mechanical brake. When the SVON input is OFF after EMST input is ON, the Motor remains servo ㄱ on for one second after the EMST input went on. If the EMST input is ON when the SVON input off, motor will be servo-off.

Figure 9-3



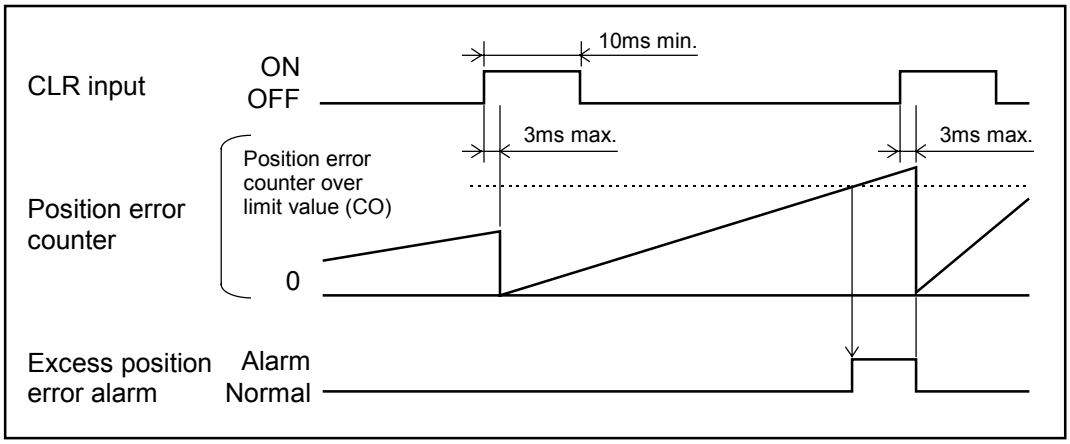
- The Driver Unit may not accept EMST input unless it stays on for 10 ms or longer.

9.1.3. Position Error Counter Clear Input

- If the CLR input is on, position loop error will be cleared.
- When the excess position error alarm occurs, turning on the CLR input clears the position error counter and recovers from the alarm state.

* The Driver Unit detects the rising edge of the CLR input pulse and clears the position error counter to zero. Then, the counter continues its operation regardless of the state of the CLR input (even when it remains on).

Figure 9-4



* Software thermal and program error alarms can be cleared by inputting “CLR” on. (Other alarms cannot be cleared using “CLR”.)

9.1.4. Overtravel Limit

9.1.4.1. Hardware Overtravel Limit

- Hardware overtravel limit is effective when I/O type is set to TY3, TY4 or TY7.
- Use the OTP and OTM inputs to restrict the range of Motor movement.
- If the OTP input is activated, the Motor motion will stop immediately and remain in servo-on. The Motor can be moved to the minus direction only.
- If the OTM input is activated, the Motor motion will stop immediately and remain in servo-on. The Motor can be moved to the plus direction only.

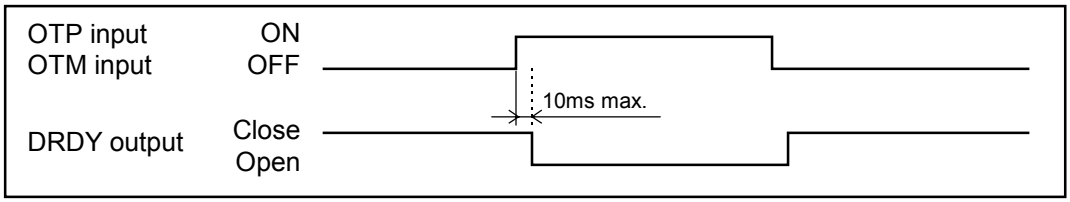
* The polarity of the OTP and OTM input ports is set to A contact before shipment. It can be changed to B contact (refer to the section on the AB parameter).

* Besides the OTP and OTM inputs, the Motor rotation can also be limited by software (software overtravel limit function) in the Driver Unit. Refer to "9.1.4.2. Software Overtravel Limit".

◊ When the overtravel error occurs, the DRDY output will be open and displays the following on the front panel.

OTP or OTM limit : F3
Software overtravel limit : F2

Figure 9-5



* When the OTP or OTM input works in the middle of the home return operation, the Motor completes the home return operation after performing the following :

(1) When the Motor is moving to the minus direction

Caution : • The OTP input is invalid (the Motor continues to move).

• Turning on the OTM input makes the Motor decelerate, then move in reverse.

(2) When the Motor is moving to the plus direction

Caution : • The OTM input is invalid (the Motor continues to move).

• Turning on the OTP input makes the Motor decelerate, then move in reverse.

9.1.4.2. Software Overtravel Limit

Notes to be taken in overtravel limit setting

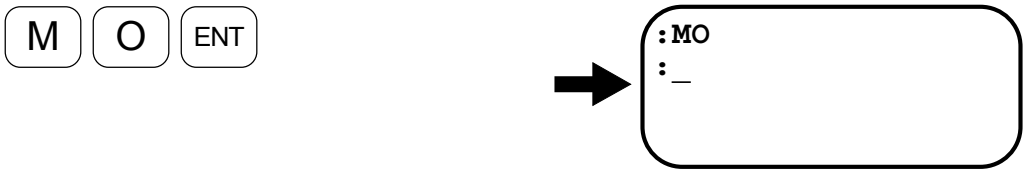
⚠ *Caution : • The overtravel area should be 1000 [pulses] or wider. When the overtravel area is too narrow the Motor may move through the prohibited area.*

• Set the overtravel limits with ample margin, giving consideration to the overshoot of the mechanism controlled by the Motor.

- This function becomes valid after the origin is determined by home return or AZ command.
- Use the OTP and OTM commands to set the overtravel limit values.

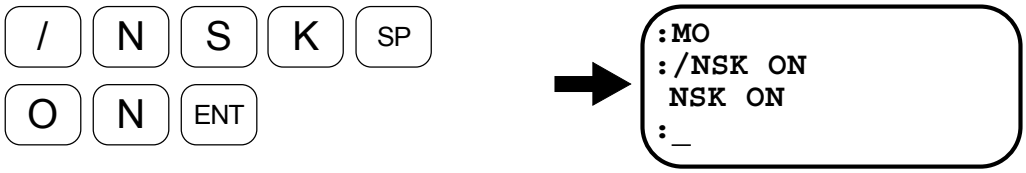
<Operation> Setting by teaching

(1) Turn off the Motor servo.

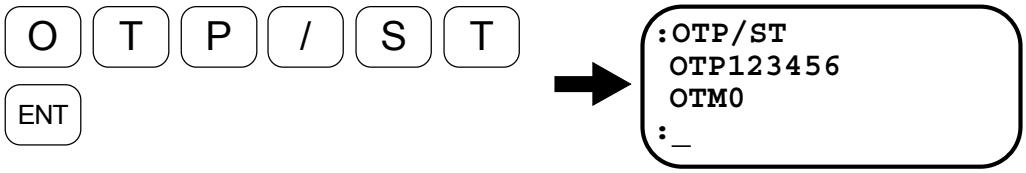


(2) Move the Motor's slider manually to a point to be the overtravel limit on the plus side.

(3) Input the password.

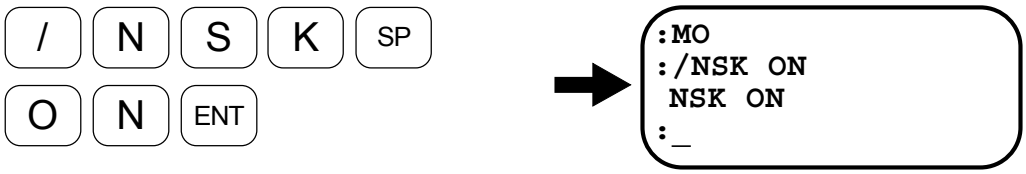


(4) Register the present position as the overtravel limit on the plus side. The registered overtravel limit value appears on the display.

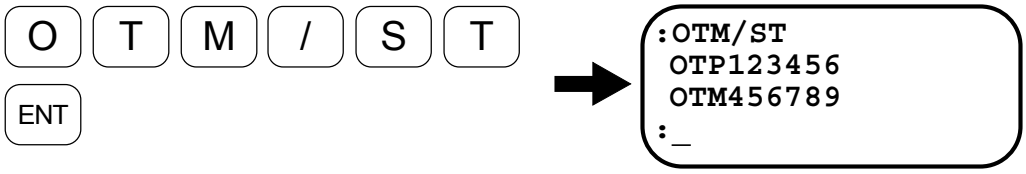


(5) Move the Motor's slider manually to a point to be the overtravel limit on the minus side.

(6) Input the password.



(7) Register the present position as the overtravel limit on the minus side. The registered overtravel limit value appears on the display.



(8) Move the Motor's slider into the overtravel area. Check that the Driver Unit outputs the F2 alarm (check the alarm indicated on the LED or input the TA command).

- After the home return is completed, take the following steps :
- If the F2 alarm is not output this time, check the following :
  - ◊ Is the position scale home position located between OTP and OTM?
  - ◊ Is OTP a positive value, and OTM a negative value?

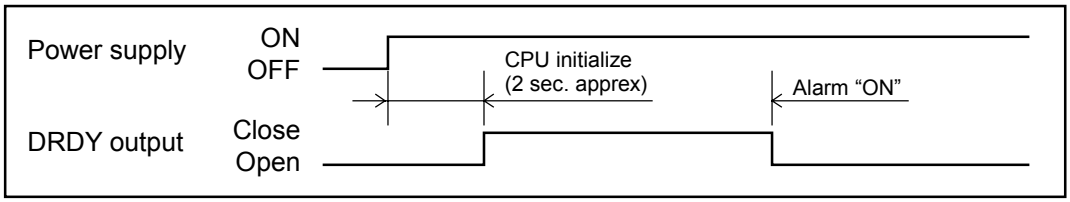
Setting by position scale data

- When the overtravel limit values are already known, users can directly set these values in the OTP and OTM command parameters.

9.1.5. Alarm Output

- After the power is on and "CPU" is initialized, "DRDY" output is closed when alarms are not detected.
- The "DRDY" output opens when the alarm is detected.
- Alarm signal shall be connected to "alarm input" of user ヤ s controller.

Figure 9-6



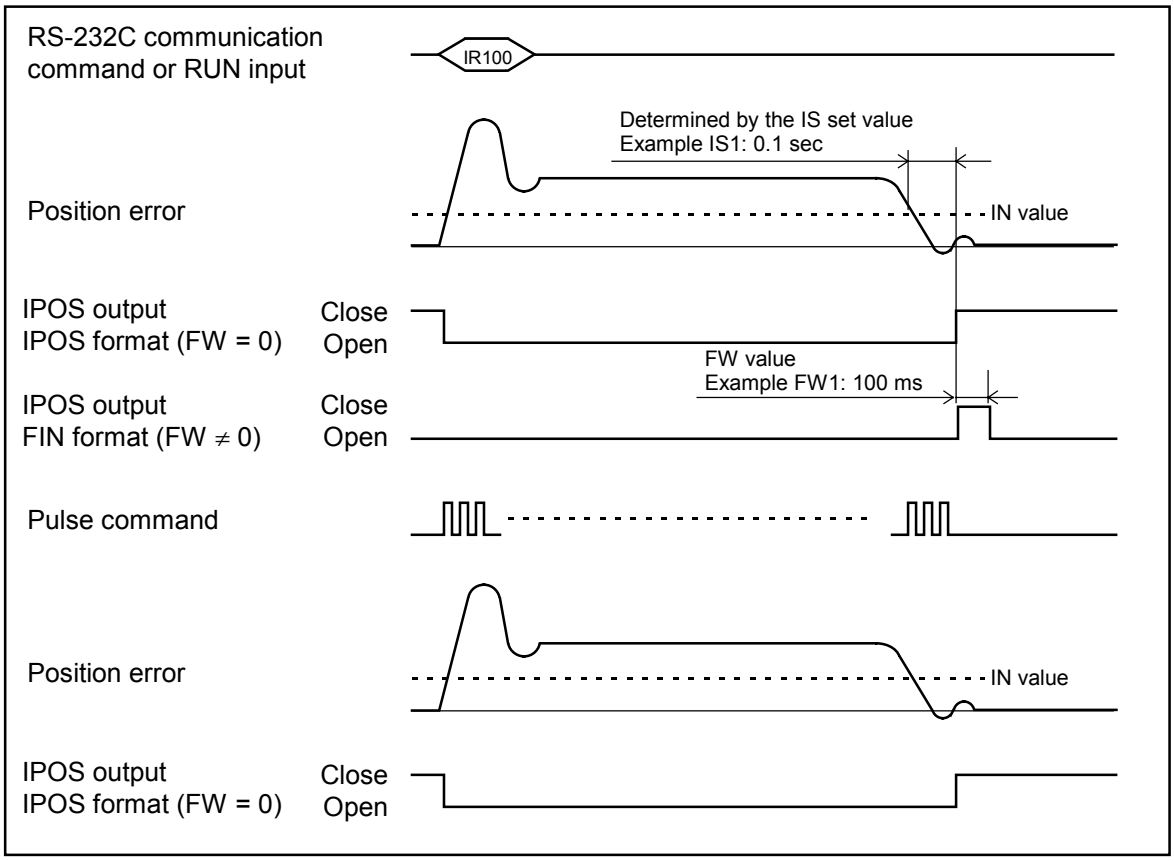
9.1.6. In-Position Output

- In-Position output condition is determined by the following parameters.

Table 9-1

Parameter	Function (Name)	Shipping set
FW	IPOS outputting time range (Output mode)	FW1
IN	In-Position limit value	IN100
IS	In-Position stability timer	IS0

Figure 9-7



9.1.6.1. Output Signal Format

- The output signal format --- either IPOS format or FIN format --- can be selected by setting the FW parameter.
    - ◊ FW data : FIN format is selected when data ≠ 0 (shipping set : FW1)
    - ◊ FW0 : IPOS format

(1) When data of parameter "FW" is not "0" (Zero) (FIN format)

- "IPOS" output indicates that the positioning has completed.
- IPOS will be output for every positioning start command such as RUN and HOS .
- Out put format
    - ◊ IPOS output is always open and it closes only for the moment set by "FW" when completion of positioning. (Closing time unit in "FW" is 100m sec. Shipping set FW1 : 100m sec.)
- Recommendation
  We recommend to use FIN format when you use the programmable indexer in the Driver Unit.
- "IPOS" will not be output for pulse train operation and jogging operation.
- When the positioning is stopped in the middle of operation by the emergency stop or overtravel limit, "IPOS" will not be output.

(2) When "data" of parameter "FW" is 0 (Zero) (IPOS format)

- The format is to indicate if there is an error between position command and present position.
- Basically "IPOS" output will be closed only when residual pulses in the position error counter is within the range set by "IN" parameter. In other state, it is open.
- However, even residual pulses in the position error counter is within the "IN" value, output is forced to open during pulses are generated internally when executing programmable indexer, home return, jogging and operations via RS-232C.
  (Executing programmable indexer, home return, jogging and operation through RS-232C.)
- Recommendation
  Select "IPOS" format for pulse train operation or RS-232C operation.
- When the positioning is stopped in the middle of the operation by emergency stop or overtravel limit signal, IPOS output will stay closed if residual pulses of position error counter are within the "IN" value.
- When executing pulse train input operation, even pulses are being input, IPOS output is closed if residual pulses in the position error counter are within "IN" value.
  [This state tends to occur when executing low speed operation or feed forward compensation is applied ("FF" parameter).]

9.1.6.2. Parameter “IN”

- Parameter “IN” is to decide positioning accuracy.
- “IPOS” output will be closed when residual pulses of position error counter are within the range of “IN” parameter.
- The unit of parameter “IN” value is the maximum resolution (pulses) of the motion detector (resolver).

9.1.6.3. Parameter “IS”

- “IS” is to confirm the stability of the positioning. When the in-position output signal is IPOS format, if the parameter “IN” value is smaller (roughly less than IN10), “IPOS” output will be instable in the moment of positioning settling, even all servo gains are adjusted properly.
- “IS” parameter should be set to eliminate above instability.
- When “IPOS” output is in “FIN” format, “IS” parameter prevents to output IPOS signal before the Motor complete the positioning.
- “IS” parameter is not effective for pulse train input operation and jogging operation.

9.1.6.4. “IPOS” Output for Special Occasion.

(1) When 0 (Zero) moment operation is executed.

◆ **Example**

When [AR0] is executed even the Motor is in the home position, movement of the Motor is 0 (Zero). Followings show “IPOS” output states.

(i) “IPOS” format IS = 0

◊ There is no internal pulse output and “IPOS” output remains close if residual pulse of position error counter are within “IN” value.

(ii) “IPOS” format IS ≠ 0

◊ Even no pulse is internally generated, “IPOS” output will be opened for the moment set by “IS” value to check positioning stability.

(iii) “FIN” format

◊ Even no pulse is generated internally, “IPOS” output signal shall always be returned for positioning start command.

(2) Sequential operation (BCD mode) for Programmable Indexer.

(i) “IPOS” format

◊ After the positioning is completed, execute next channel program, while “IPOS” output remains close.

(ii) “FIN” format

◊ After the positioning is completed, “IPOS” output closes for the moment which is set by the parameter “FW”, then execute the next channel ㄱs program after “IPOS” output is opened again.

9.1.7. Position Feedback Signal

● Resolution

Set the øA/øB resolution using the FR parameter (via RS-232C).

Table 9-2

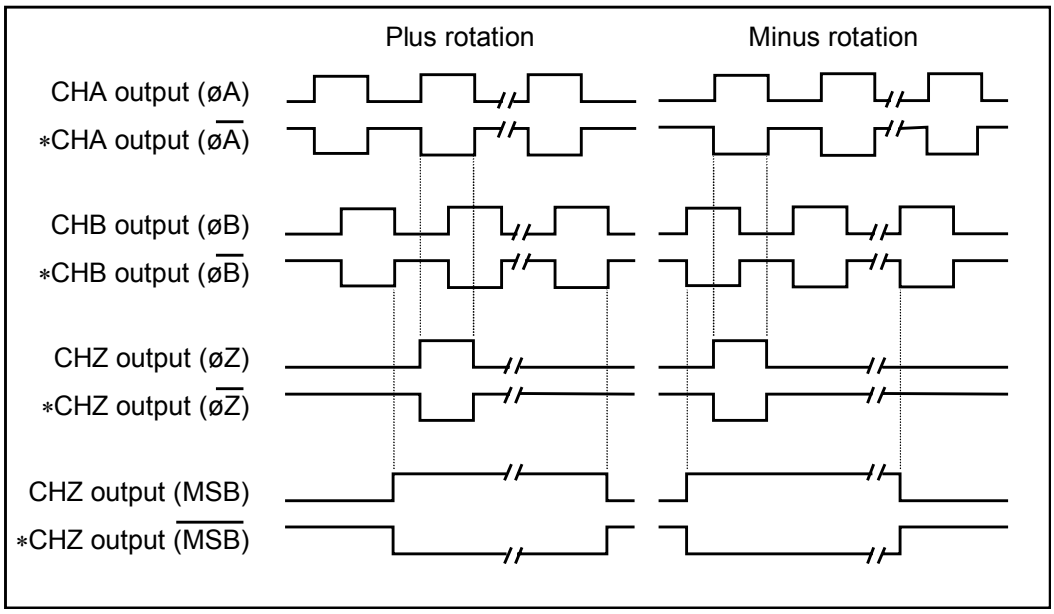
Unit: µm/pulse

Feedback signal	øA, øB		øZ
	FR1	FR0	
Resolution	4	16	4096

* When the resolver resolution is set to the automatic resolution switching or 10-bit setting, set the FR parameter to FR0. When it is set to FR1, øA/øB will not be output.

● Output timing

Figure 9-8



* The phase can be reversed by the FD parameter (set via RS-232C).
FD0 : Standard; at Plus direction movement, øA becomes ON before øB (Shipping set)
FD1 : Reverse; at Plus direction movement, øB becomes ON before øA

* The output specification of the CHZ signal–whether to output øZ or MSB–is selected by the FZ parameter (set via RS-232C).
FZ0 : øZ (Shipping set)
FZ1 : MSB

9.1.8. Monitor Functions

- The Motor operation can be monitored by using the analog velocity monitor pins, which are provided in the front panel of Driver Unit, and RS-232C communication.

Table 9-3

Item	RS-232C communication command	Monitor output	Description
Velocity	–	VELOCITY check pin on the front panel	• Monitors the Motor velocity in forms of analog voltage output.
Position error	TE	CN1 via RS-232C terminal	• Monitors value of the position error counter. • For the details, refer to "11. Commands and Parameters."
Input/output	IO		• Monitors the input/output status (on/off) of CN2. • For the details, refer to "11. Commands and Parameters."
Present position	TP		• Monitors the present position in the position scale. • For the details, refer to "11. Commands and Parameters."
Parameter value	TS		• Monitors the set values of parameters. • For the details, refer to "11. Commands and Parameters."
Alarm	TA		• Monitors the alarm status. • For the details, refer to "13.1.2. TA Command."
Channel program	TC		• Monitors the program stored in the channels. • For the details, refer to "11. Commands and Parameters."

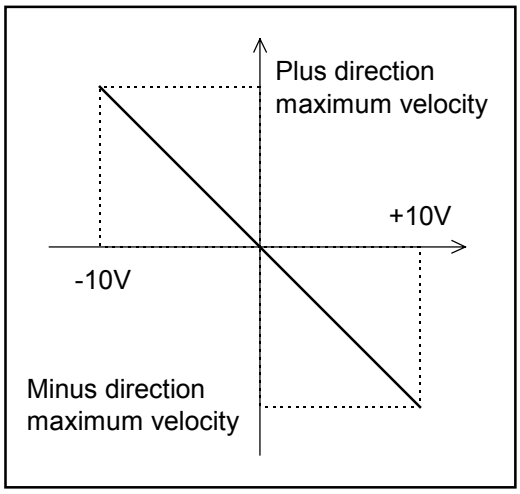
9.1.8.1. Velocity Monitor

- The user can monitor the velocity of the Motor by measuring the voltage between VELOCITY and GND check pins on the front panel.

◆ When the resolver is set to 12-bit resolution

Note: ±10 V is only a typical value; actual values vary slightly. The voltage is not a precise representation of the velocity.

Figure 9-9



◆ When the resolver is set to 10-bit resolution or automatic resolution switching

Note: ±7.5 V is only a typical value; actual values vary slightly. The voltage is not a precise representation of the velocity.

Figure 9-10

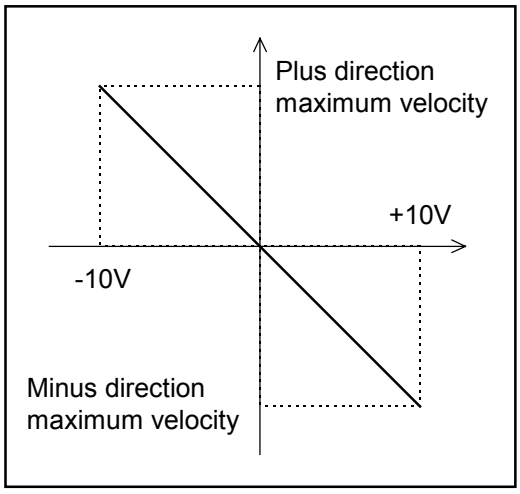


Table 9-4 : Maximum velocity

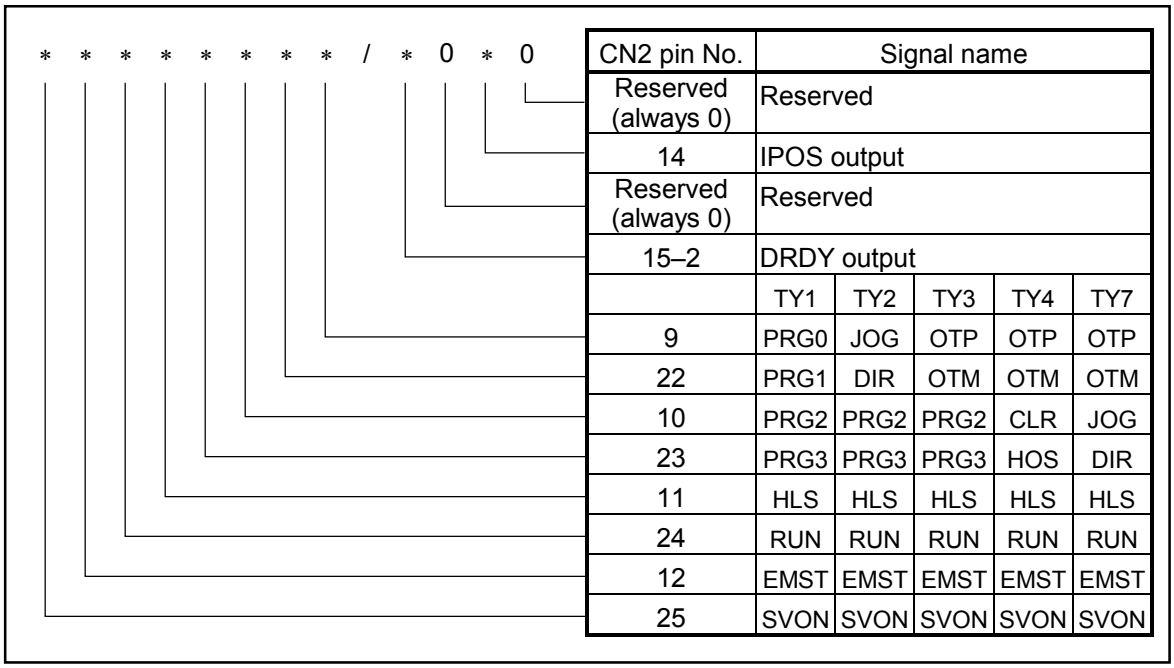
Resolver resolution	12-bit setting	Automatic resolution switching or 10-bit setting
Maximum velocity	600 mm/s	1800 mm/s

- Automatic resolution switching, 12-bit setting and 10-bit setting are selected by the RR parameter.

9.1.8.2. Monitoring the I/O State

- The Input/Output state of CN2 connector can be monitored using the I/O command.
- Use this monitoring to check the wiring.
  - ◊ Input format IO/RP
    Without/RP : One-shot display
    With /RP : Real-time display
  - ◊ Display format
    Bit map representing Input/Output in one-line. (See Figure 9-11)

Figure 9-11 : Display format

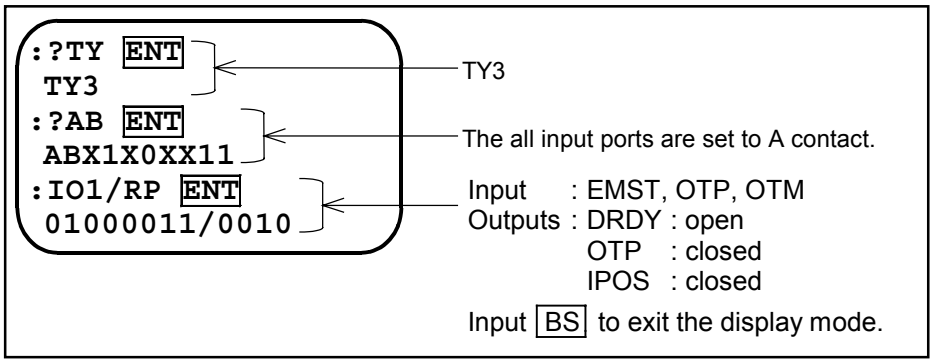


CN2 pin No.	Signal name				
Reserved (always 0)	Reserved				
14	IPOS output				
Reserved (always 0)	Reserved				
15–2	DRDY output				
	TY1	TY2	TY3	TY4	TY7
9	PRG0	JOG	OTP	OTP	OTP
22	PRG1	DIR	OTM	OTM	OTM
10	PRG2	PRG2	PRG2	CLR	JOG
23	PRG3	PRG3	PRG3	HOS	DIR
11	HLS	HLS	HLS	HLS	HLS
24	RUN	RUN	RUN	RUN	RUN
12	EMST	EMST	EMST	EMST	EMST
25	SVON	SVON	SVON	SVON	SVON

Table 9-5 : Meaning of display data

	Display: 1	Display: 0
Input port	ON	OFF
Output port	Close	Open

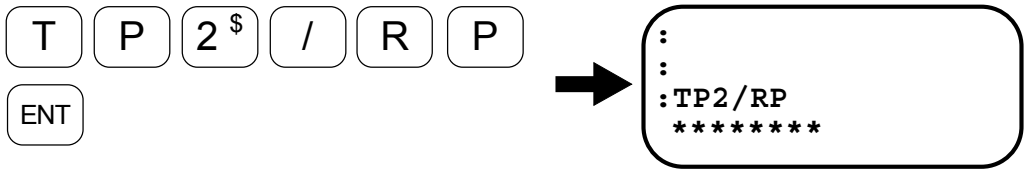
Figure 9-12



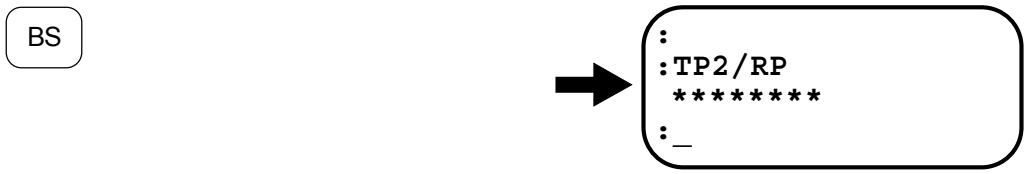
9.1.8.3. Reading the Present Position

◆ Reading the position scale live value in the units of pulse

(i) The position scale value is displayed continuously in the units of pulse.
Moving the Motor's slider changes the value on the display.



(ii) Press the BS key to end the display.



9.2. To Have More Advanced Operation

9.2.1. Position Scale

- The ESA13 Driver Unit has a position scale for positioning and overtravel limit.

9.2.1.1. Resolution

- The Motor resolver has teeth for detecting its position, and each tooth, whose pitch is 4.096 mm, is digitally divided into 4096. In other words, the resolution of Motor position detection is 1 micrometer per pulse.

9.2.1.2. Direction of Position Scale

⚠ *Caution : For your safety, the direction of the hardware overtravel limits are fixed to the following regardless the DI setting :*
OTP : PLS direction
OTM : MNS direction

- The direction of position scale counting can be switched by the DI command.

Table 9-6

DI setting	PLS direction	MNS direction
DI0*	Plus direction	Minus direction
DI1	Minus direction	Plus direction

* : Shipping set

Figure 9-13 : DI0 (shipping set)

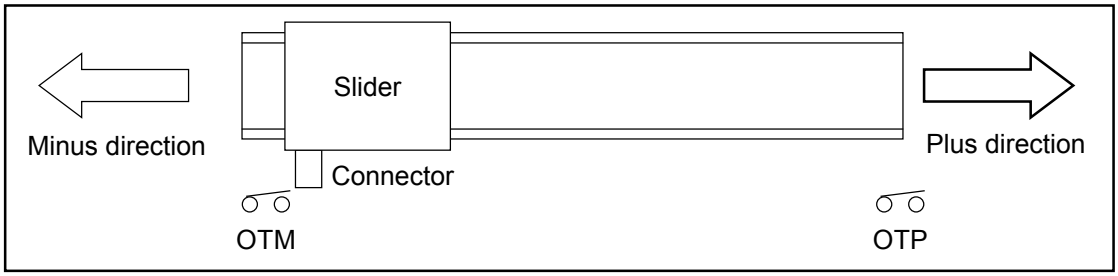
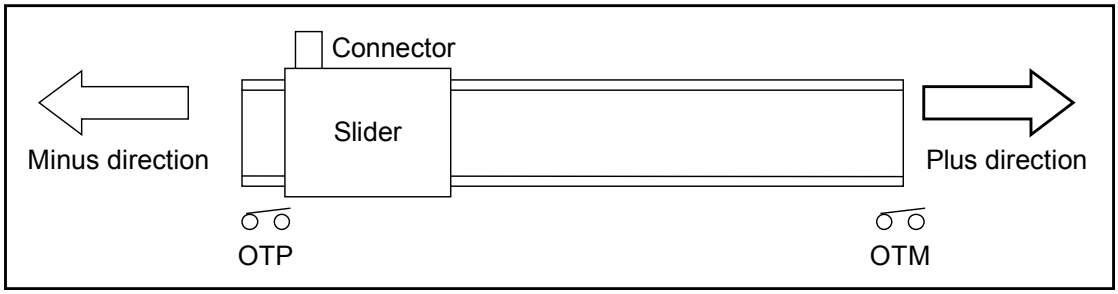


Figure 9-14 : DI1



- When the position scale direction is set, the directions of operations performed by the following functions are also determined.

  ◊ Pulse train operation
  ◊ Positioning via communication (IR, AR, HS)
  ◊ Programmable indexer
  ◊ Home return
  ◊ Jog
  ◊ Software overtravel limit

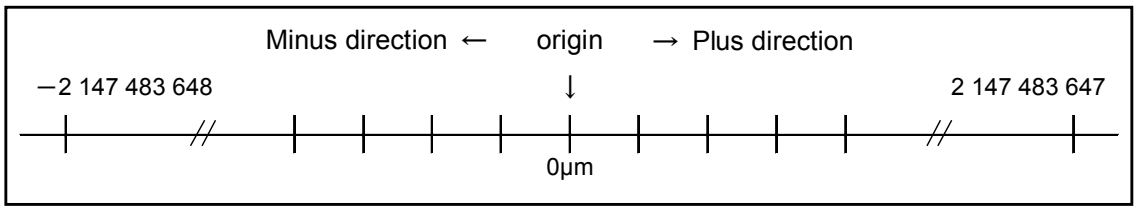
- Direction of the hardware overtravel limit switch is not reversed by DI setting. Be careful when setting DI1.

9.2.1.3. Position Scale Coordinate

- The position coordinate extends linearly from the origin in both plus and minus direction.

- Position coordinate increases in plus direction. When it exceeds +2 147 483 647 (pulses), the coordinate returns to - 2 147 483 648 (pulses) then decreases minus direction. Falling below -2 147 483 648 (pulses), the coordinate returns to + 2 147 483 647 (pulses).

Figure 9-15: Coordinate



9.2.1.4. Position Scale Reset

Caution : • The position scale value is not decided immediately after the power is turned on. Be sure to reset the position scale before positioning.

• The position scale value is reset to 0 by the following operations.

◊ Home return finish

◊ AZ command input

9.2.1.5. Position Readout

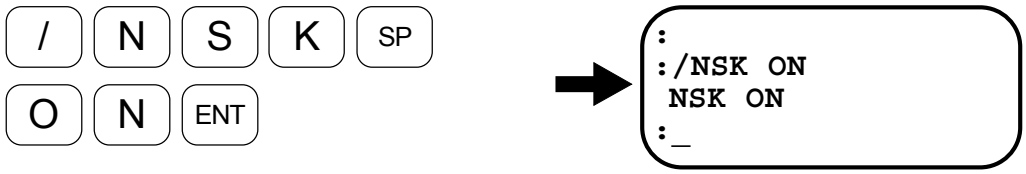
- You can read out the current position by inputting TP command through RS-232C serial communication terminal such as the Handy terminal.

- Command format: TR2/RP ENT
  With /RP : One shot readout
  Without /RP : Real time readout

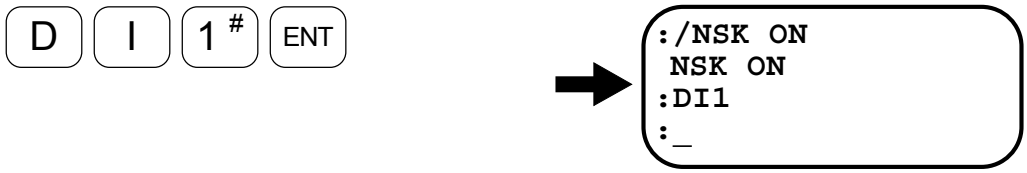
9.2.1.6. Position Scale Setting Example

(1) Set the MNS direction of the position scale as the plus direction.

(i) Input the password.
The password acknowledgment message appears on the display.

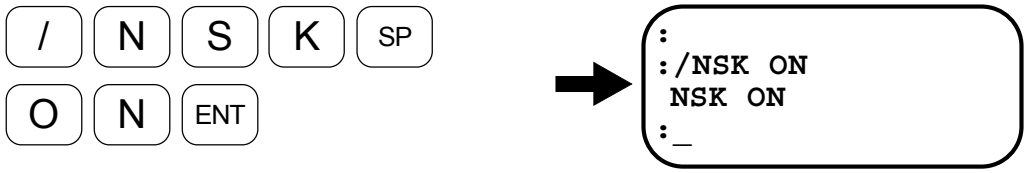


(ii) Input the DI command to determine the position scale direction.

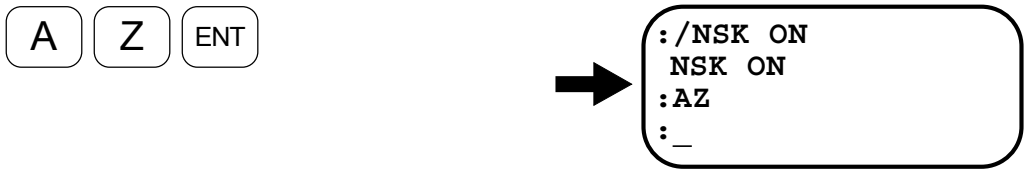


(2) Resetting the position scale value

(i) Input the password.
The password acknowledgment message appears on the display.



(ii) Input the AZ command to reset the position scale value.



9.2.2. Digital Filter

Caution : • Inserting multiple filters may cause phase inversion in some systems, resulting in unstable operation.

• Do not insert more than two filters. Setting a filter frequency too low may cause hunting, etc.; set the frequency to 100 Hz or above.

Parameters for digital filter setting

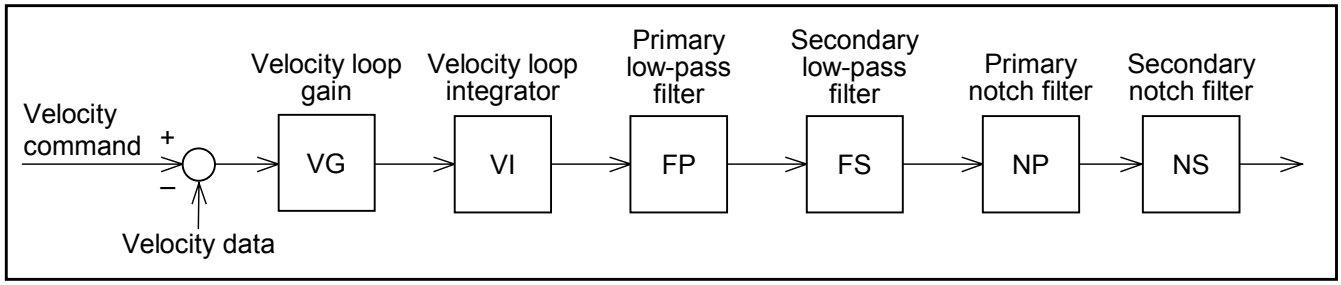
- Parameters : FP, FS, NP, NS
  - ◊ Sets filter frequency in the velocity loop.
  - ◊ The filters are useful for eliminating audible noise and vibration due to mechanical resonances.

Table 9-7 : Parameter function

Parameter	Function	Shipping set
FP	Sets the primary low-pass filter frequency.	FP0
FS	Sets the secondary low-pass filter frequency.	FS0
NP	Sets the primary notch filter frequency.	NP0
NS	Sets the secondary notch filter frequency.	NS0

- Refer to Chapter 12 “Command and Parameter” for more details.

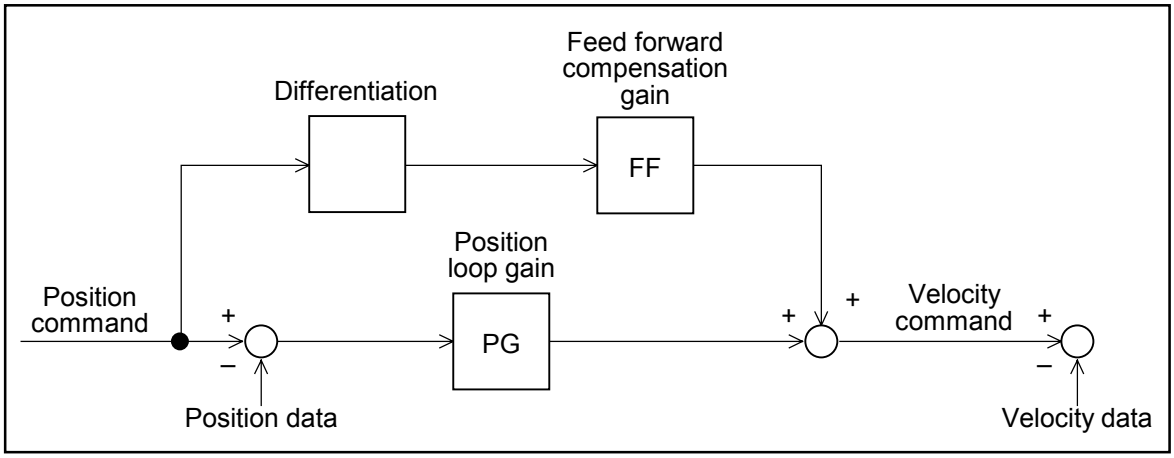
Figure 9-16: Digital filter block diagram



9.2.3. Feed Forward Compensation

- Parameter “FF” sets feed forward compensation gain. The password is necessary when setting.
- Shipping set of “FF” is FF0.
- The feed forward compensation function generates a velocity command by differentiating the position command, then adds it to the velocity loop in the forward direction.
- Feed forward compensation improves follow-up delay during acceleration/deceleration.
- Setting the FF parameter to a higher value improves follow-up delay, but overshoot becomes more likely to occur. It is generally recommended that the parameter be set to 0.5 or below.

Figure 9-17: Feed Forward Compensation Block Diagram



9.2.4. Integrator Limiter : ILV

- Parameter “ILV” sets the upper limit to the velocity gain. Shipping set is ILV100.
- The password is necessary when setting “ILV”.
- Integrator limiter reduces overshoot caused by the integral action during high acceleration / deceleration.
- The integral action is indispensable for high-precision positioning. However, when a high-speed acceleration/deceleration is specified, errors are likely to accumulate so that integration often results in an overshoot. To prevent this, an integrator limiter is provided to restrict an excessive integration.

* For more details about the parameter, refer to “12.1. Command and Parameter.”

Figure 9-18: Integrator limiter block diagram

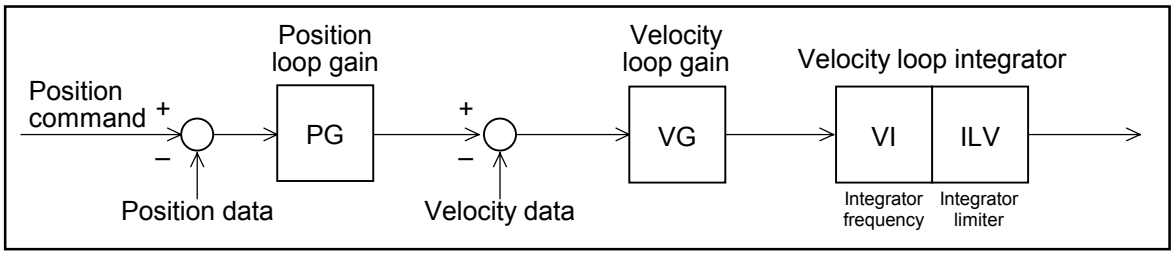
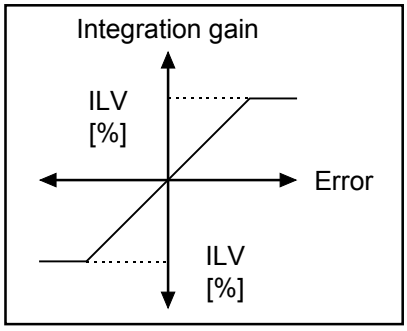


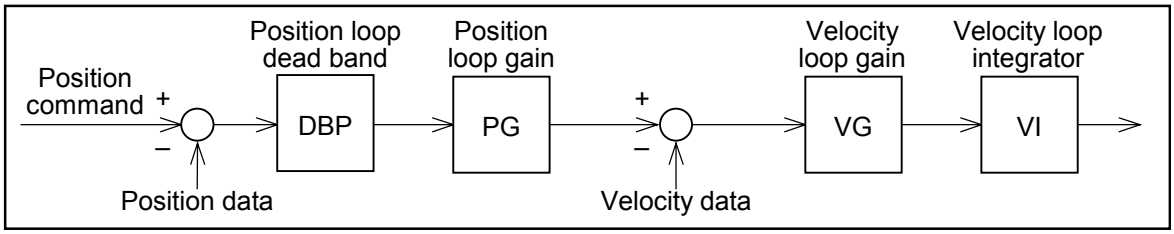
Figure 9-19



9.2.5. Dead Band Setting : DBP

- The DBP parameter sets a dead band, centered at “0” to error in the position loop. When the position error value is below the specified dead band value, the position command is set to 0.
- In some systems, micro vibrations may be caused by a slight error in positioning. In this case, micro vibrations can be prevented by setting a dead band.
- Setting a dead band reduces micro vibrations but lowers repeatability by the set value.
- The dead band is set in the units of pulse (equivalent to the resolver resolution with 12-bit specification : refer to “4.2.2.2. Function Specifications, resolver resolution.”) When the resolver resolution setting is 10-bit, set the dead band value by a multiple of 4.

Figure 9-20: Dead Band Setting Block Diagram



9.3. RS-232C Communication

9.3.1. Communication Specification

- Setting of various parameters, trial running, and adjustment are enabled by issuing commands to the Driver Units through serial communication (i.e., communication through the RS-232C interface).

- The Driver Unit has CN1 as the input/output ports for RS□232C communication.

- When the Handy Terminal (FHT11) is not in use, set the MM parameter to 0.
  MM1 : Standard setting (for the Handy Terminal)
  MM0 : For connection with a personal computer

Table 9-8 : RS-232C communication specification

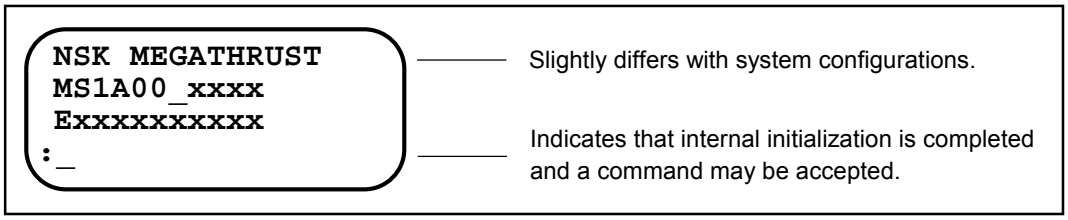
Item	Specification
Transmission	Asynchronous, full duplex
Communication speed	9600 b.p.s.
Word length	8 bit
Stop bit	2 bit
Parity	No
Character code	ASCII code
Communication procedure	• X-On/Off Protocol: No • RTS/CTS Control: Yes

9.3.2. Communication Procedure

9.3.2.1. When Power is Turned ON

- If a terminal (such as NSK Handy Terminal FHT11) is connected to CN1 and the Driver Unit power is turned on, the message shown below is displayed.
- The contents (and the number of characters) of this message may differ with Driver Unit setting and system versions.
- When the Driver Units are initialized, a colon (:) is displayed and the system waits for a command to be entered. The colon (:) is called a prompt.

Figure 9-21: Power-on message



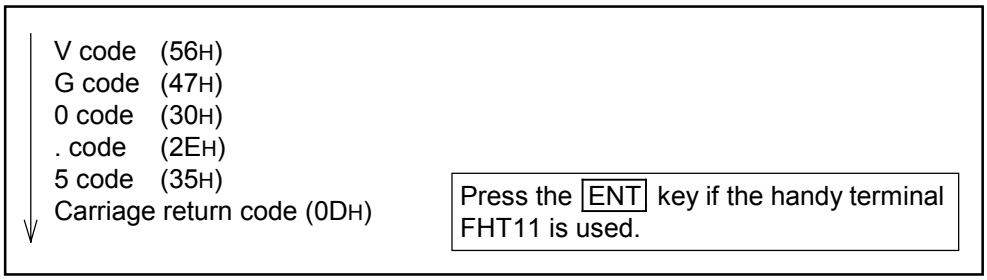
Caution : Turn the power of Driver Unit off when connecting or disconnecting the communication cable (CN1).
(It may lead to RS-232C error alarm or break down of Driver Unit.)

9.3.2.2. Command Entry

- A communication command shall consist of "a command (character string) + data (if necessary) + carriage return code (0DH)."

- If the velocity gain is to be set to 0.5, for example, "VG0.5" should be entered by adding data of 0.5 to a VG command. The characters of this command with data are transmitted to the Driver Unit as shown below :

Figure 9-22: Example Of VG0.5



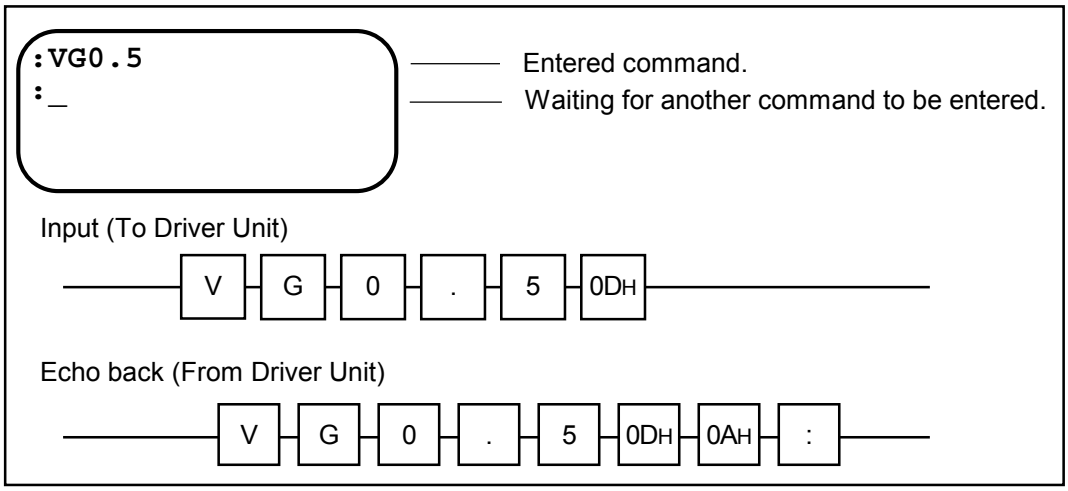
- Every time a character is input, the Driver Unit echoes the character back to the terminal. (The Driver Unit returns the same character that it receives.)

- However, the Driver Unit converts carriage return code to "carriage return code (0DH) + line feed code (0AH)," then returns it to the terminal.

- When a carriage return code is input, the Driver Unit decodes a character string which it has received (VG0.5 in the example above) and executes it. Therefore, a command is not executed unless it ends with a carriage return code.

- If the Driver Unit can decode an entered command, it returns " : " immediately after the line feed code. If it receives an internal data read command, etc., it returns the data before " : ".

Figure 9-23: Successful input example



9.3.2.3. Password

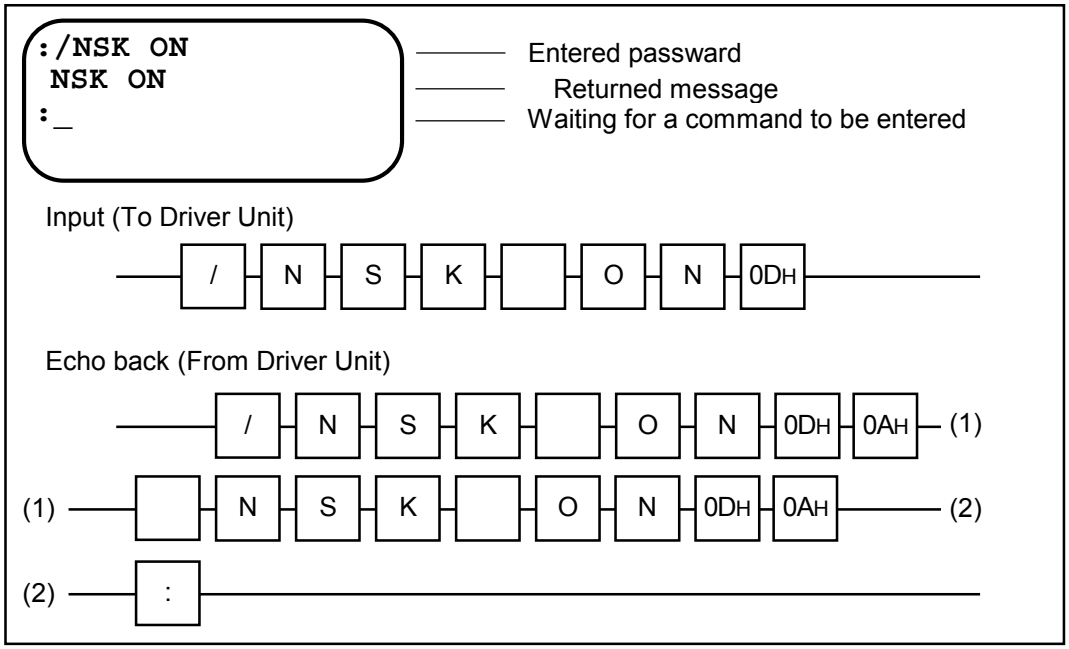
- Among the communication commands used for this System, some special commands (such as AB, PA, SI, etc.) require password entry for preventing erroneous entries. These commands cannot be entered in the same manner as other commands.

- The password is /NSK ON (a space between K and O) as shown below. If the Driver Unit accepts it, it returns an "NSK ON" message.

  ◊ Applicable commands : DB, FC, FF, IL, OG, OL, PA, RC, SI, and ZA

- A command requiring password entry may only be executed immediately after the password is entered.

Figure 9-24: Password Example



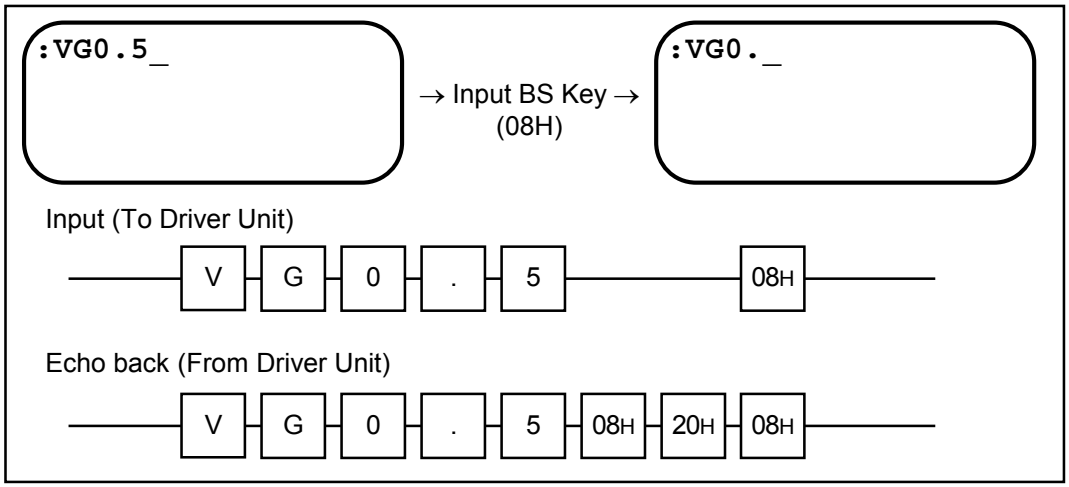
9.3.2.4. Cancelling Command

- A command which has been entered halfway, entering a backspace code (08H) can cancel a character or an entered full character string. Parameter “backspace mode” (BM) sets the cancelling method.
  BM0 : a backspace code cancels an entered character string.
  BM1 : a backspace code cancels a character.
  [When the Handy Terminal FHT11 is used, press the backspace (BS) key.]

(1) Parameter “BM1” (Shipping set)

- For example, when the backspace code is input following VG0.5, the cursor moves one space back to the position where 5 was input and thereby deletes 5.

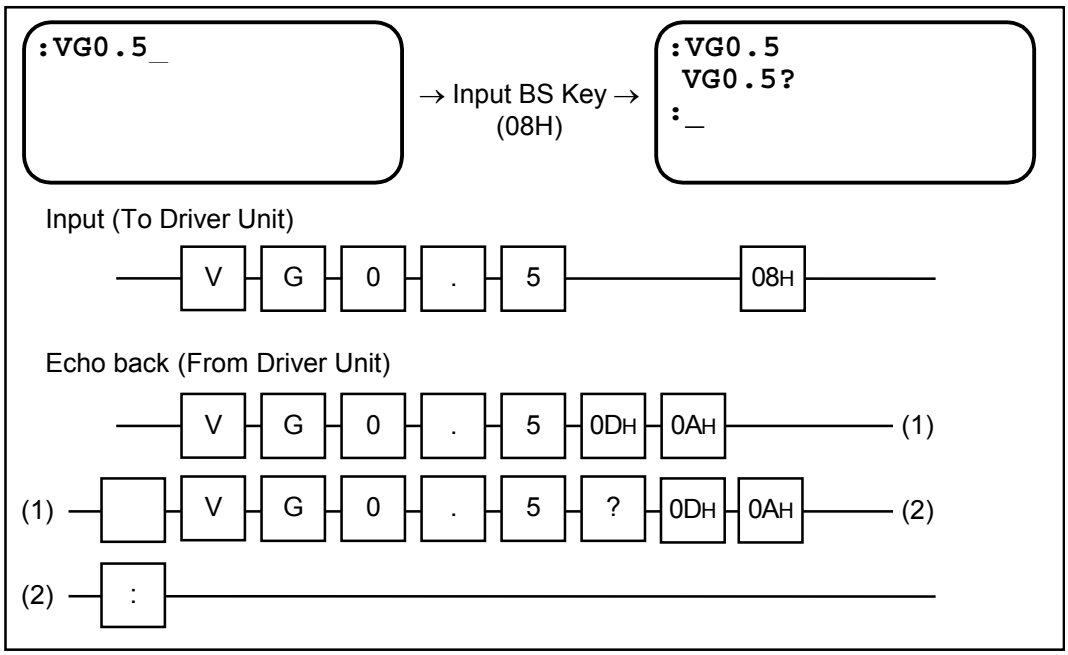
Figure 9-25: Canceling example (BM1)



(2) Parameter “BM0” (Shipping set)

- For example, when the backspace code is input following VG0.5, a message “VG0.5?” and a colon “ : “ are displayed and thereby “VG0.5” is ignored.

Figure 9-26: Cancelling example (BM0)

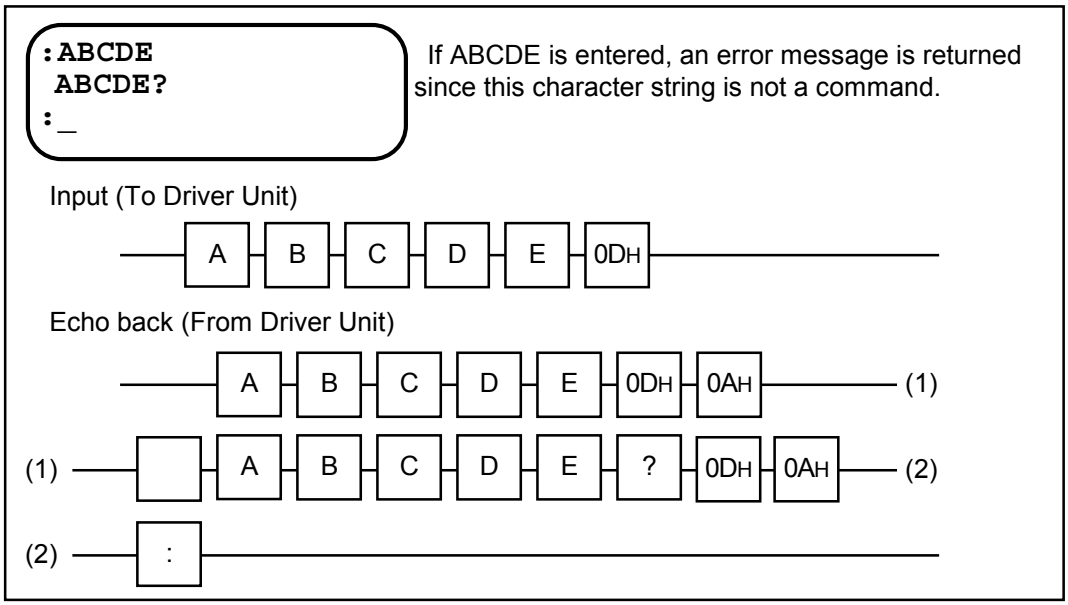


9.3.2.5. Error

- Note that an error occurs in any of the following cases :
  - (1) If a nonexistent command (i.e., character string) is entered (If an entered character string cannot be decoded).
  - (2) If data or subscript out of the allowable range is entered.
  - (3) If a command requiring the password is entered without the password.
- In any of these cases, the entered character string with a '?' mark is returned as an error message.

◆ Example 1

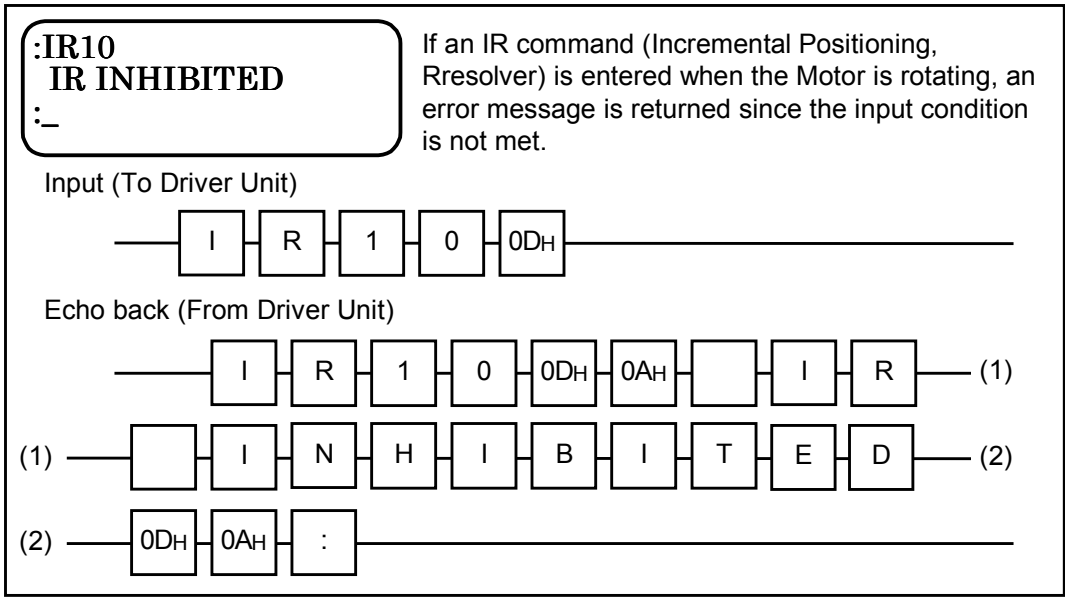
Figure 9-27: Input error example 1



- (4) If the input condition is not met when entering a command.
  - ◊ In this case, the entered character string with "INHIBITED" is returned.

◆ **Example 2**

Figure 9-28: Input error example 2



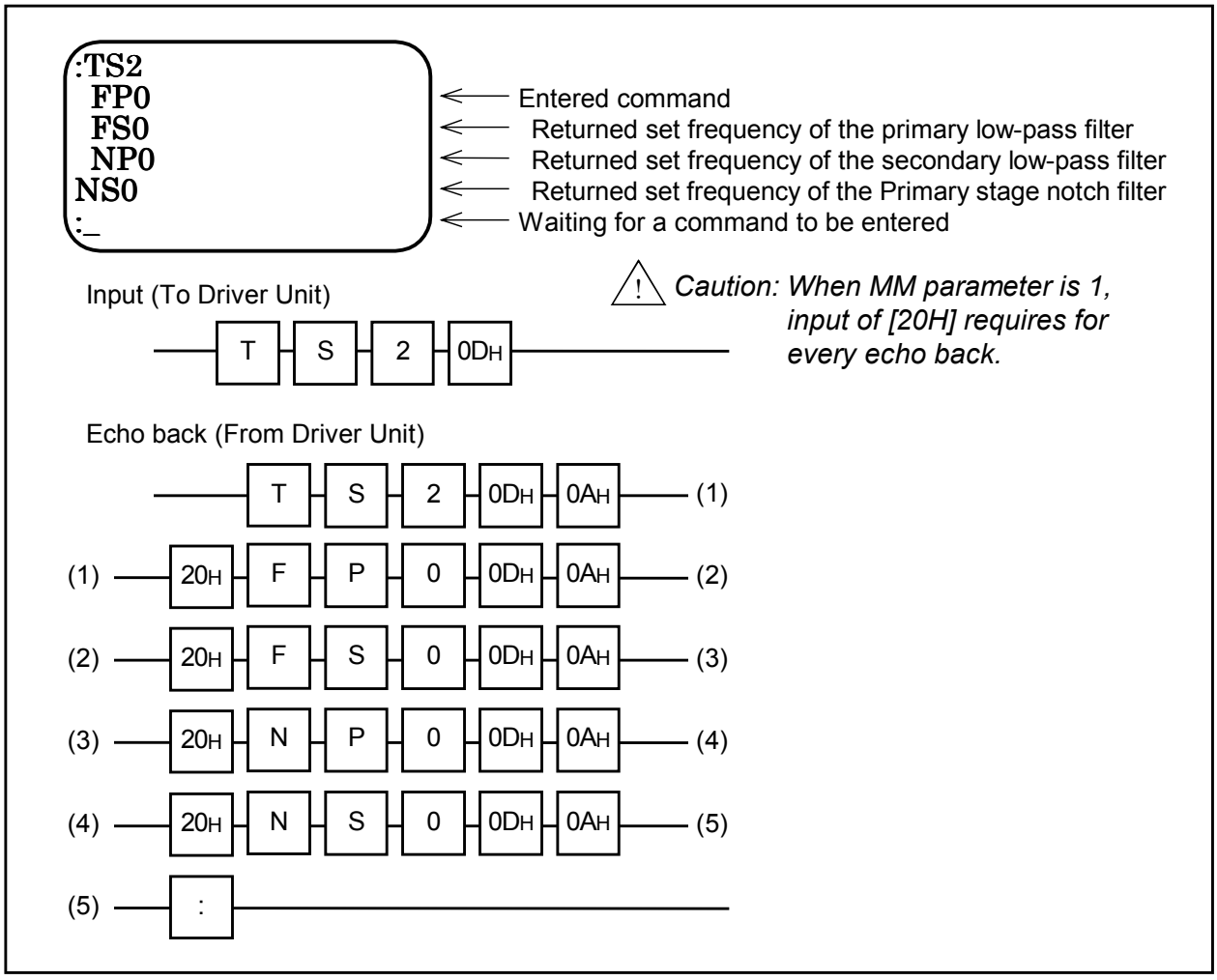
9.3.2.6. Readout Command

- If a command for reading the internal state (i.e., parameter set values, current position, etc.) of the Driver Unit among the communication commands of this system is entered, the Driver Unit returns data, etc.

- Returned data consists of "space code (20H) + read value, data + carriage return (0DH) + line feed code (0AH)".

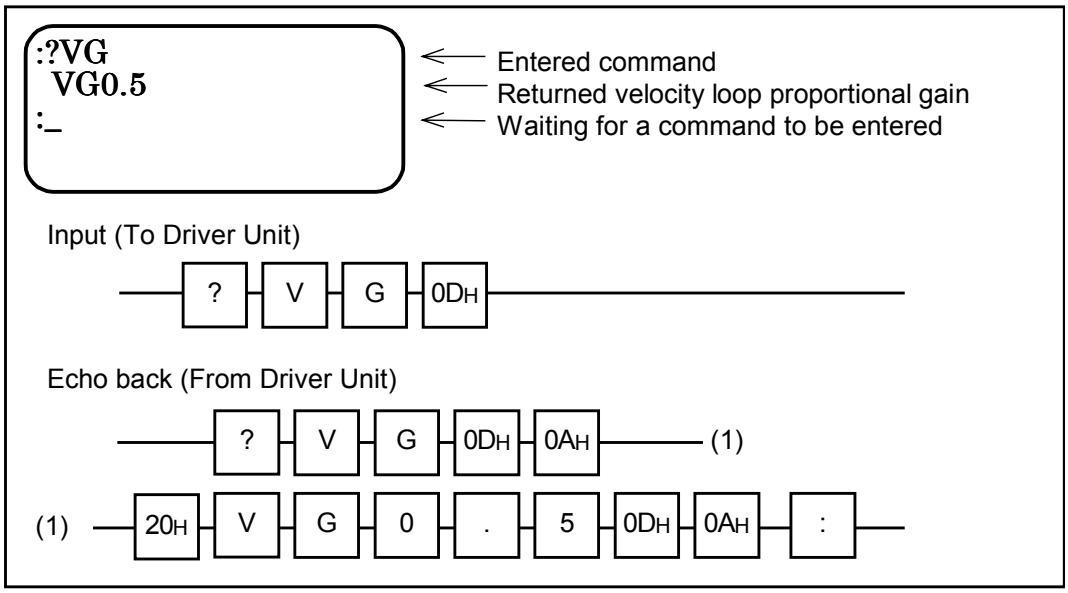
(1) TS command for reading set value

Figure 9-29: TS command example



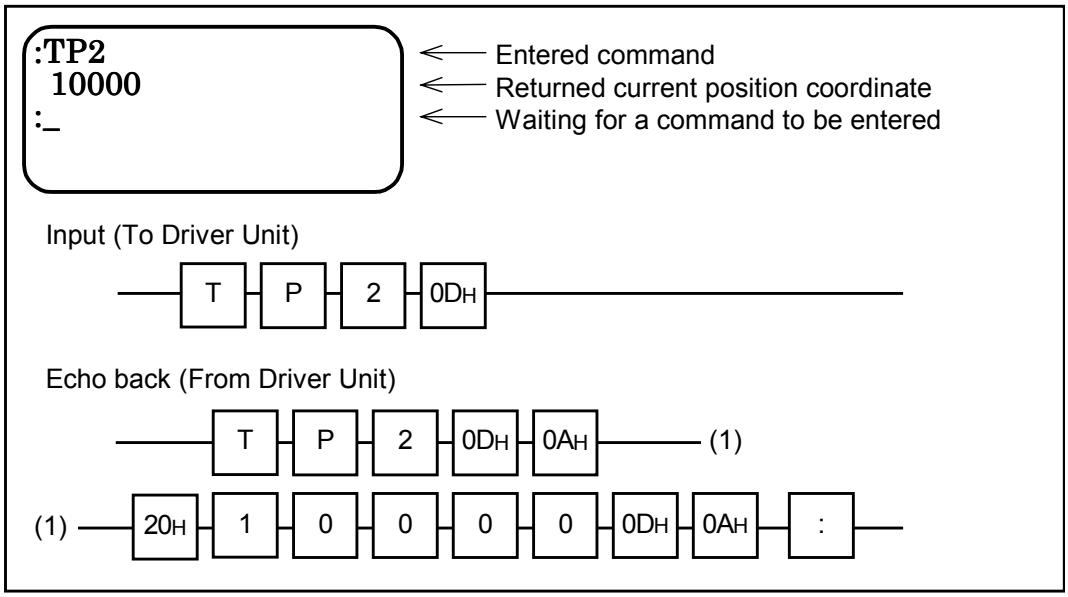
(2) If set value reading function "?" is used

Figure 9-30: "?" function example



(3) TP command for reading current position data

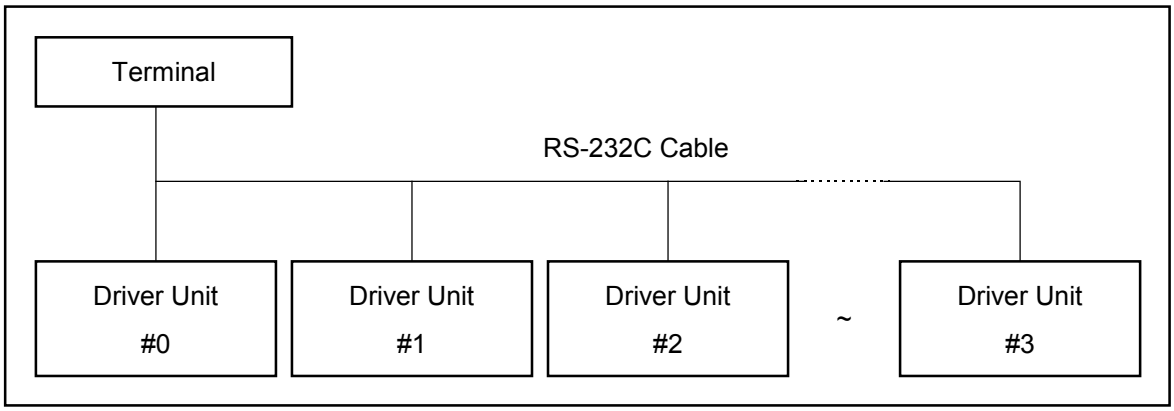
Figure 9-31: TP command example



9.3.3. Daisy-Chain Communication

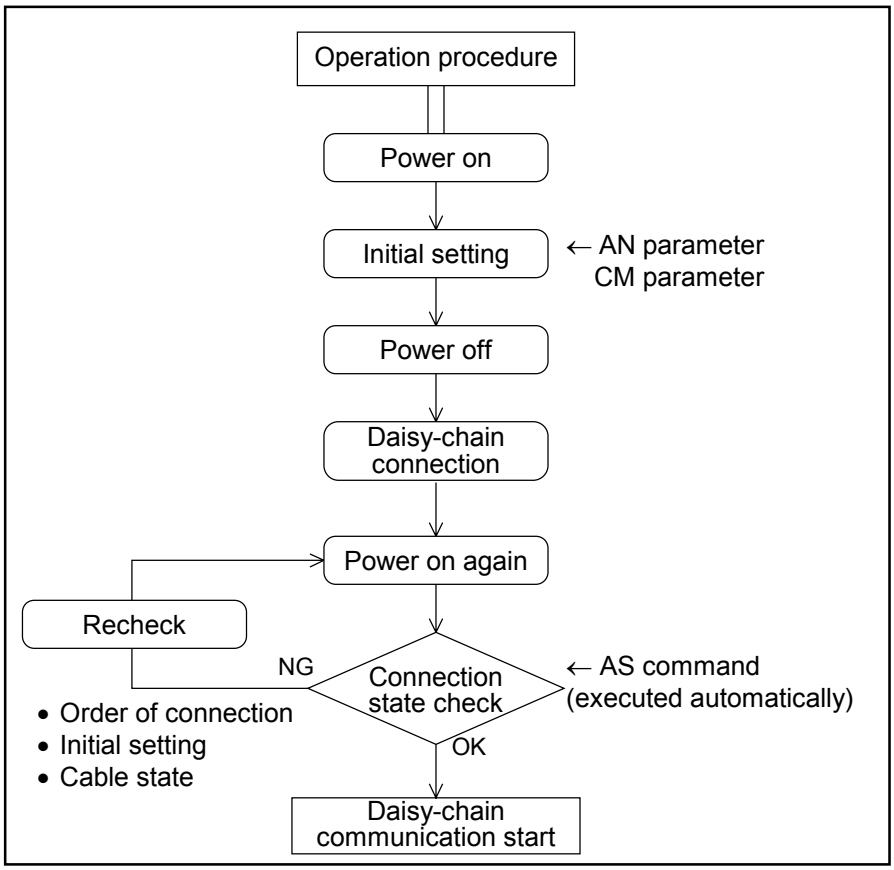
- Daisy-chain communication allows multiple Driver Units (up to 16 units) to be connected with a single RS-232C terminal.

Figure 9-32: Daisy chain communication overview



9.3.3.1. Procedure to Set Daisy-chain Communication

Figure 9-33: Daisy-chain communication setting procedure



9.3.3.2. Initial Setting

- The password is necessary for inputting initial setting parameters.
- The initial setting values become valid when the power is turned on next time.
- Perform initial setting before making multi-axis connection.

Table 9-9 : Initial setting

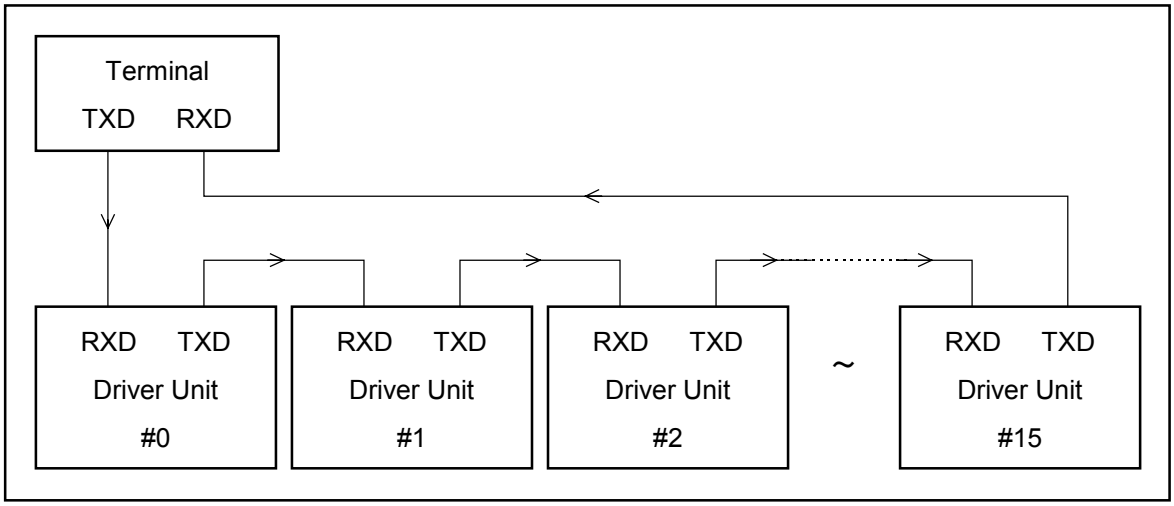
Item	RS-232C parameter	Data range	Shipping set	Function
Daisy-chain communication, axis number setting	AN data	0~15	0	The set data becomes the axis number of multi-axis communication.
Daisy-chain communication mode selection	CM data	0, 1	0	CM0: standard (single driver) communication, CM1: daisy-chain communication

9.3.3.3. Interfacing

(1) Connecting data communication lines

- Connect data communication lines sequentially : First connect the output of the terminal with the input of axis 0, then connect the output of axis 0 with the input of axis 1 and so forth. (See Figure 9-34.)
- Connect the output of the final axis with the input of the terminal.

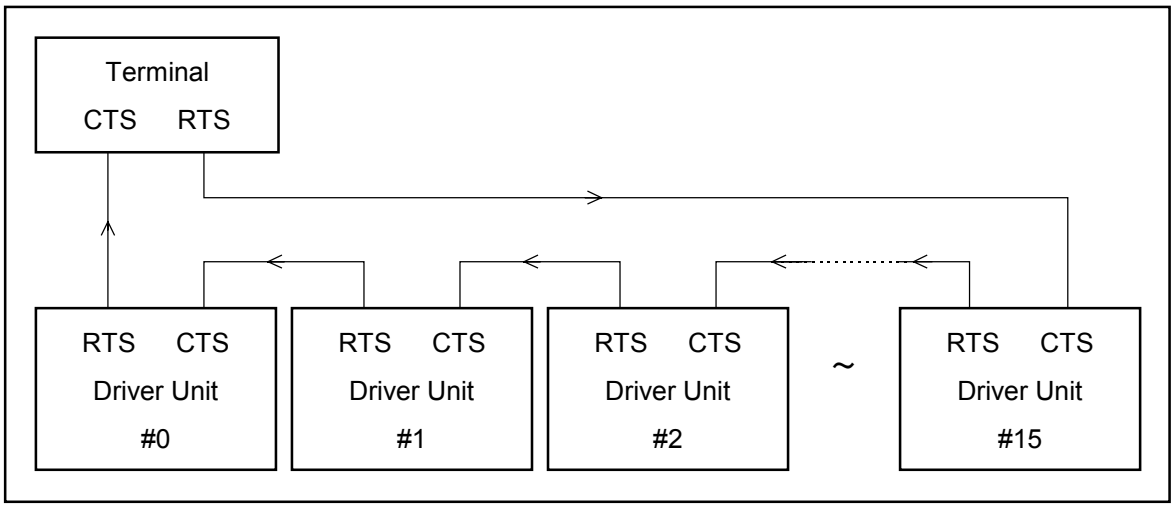
Figure 9-34: Data line connection



(2) Connecting data transmission request lines

- Connect data transmission request lines sequentially : First connect the input of the terminal with the output of axis 0, then connect the input of axis 0 with the output of axis 1 and so forth. (See Figure 9-34.)
- Connect the input of the final axis with the output of the terminal.

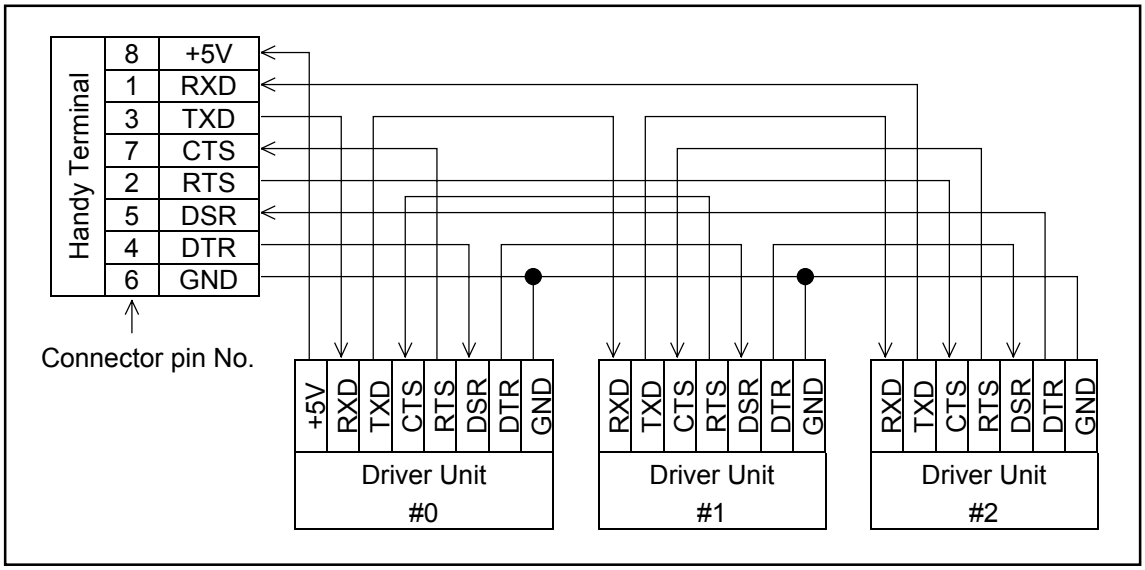
Figure 9-35: Request-to-send Line Connection



Actual Connection Example

- When NSK's Handy Terminal is in use, connect the lines as shown in Figure 9-35.
- Refer to "5.1. CN1 : RS□232C Serial Communication Connector" for the specification of CN1.

Figure 9-36: Handy Terminal Connection Example



* : The communication signal name on the Handy Terminal is opposite to that on the Driver Unit (e.g. RXD–TXD).

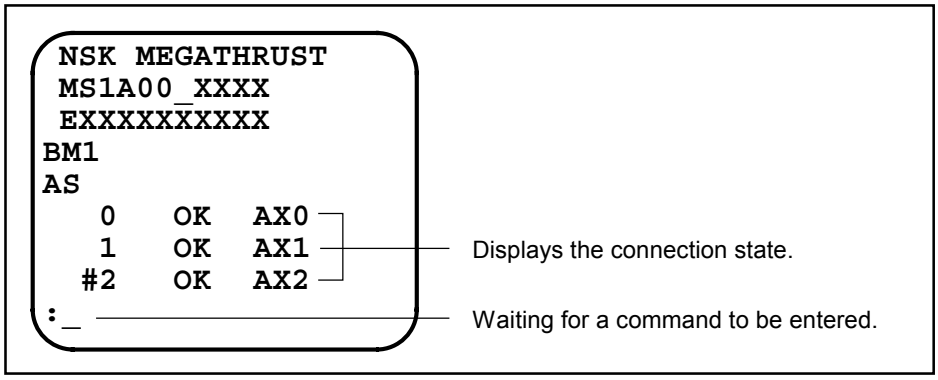
9.3.3.4. Power On

Caution : • If the Handy Terminal is not used, turn on power in the order of the RS□232C terminal and Driver Units.

• Turn on the power for all Drivers simultaneously. (If all the axes cannot be turned on at once, be sure to design the system so that the power of the Driver Unit axis No. 0 turns on at the end.)

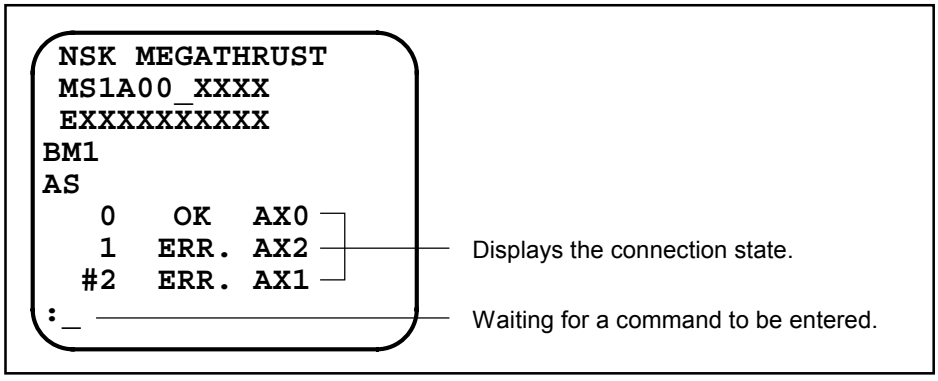
- When the Driver Unit of axis No.0 is turned on, an AS command is executed to check for connection.
- If all the terminal and units are connected properly, the following message is displayed (the following examples shows a 3-axis configuration)

Figure 9-37



- If connection is improper, the following message may be displayed.
- The following message example shows a case where axis No.1 and axis No.2 are connected improperly.

Figure 9-38



- If the proper message is not displayed, check for connection order, initial settings (AN parameter, CM parameter), and cable connection.

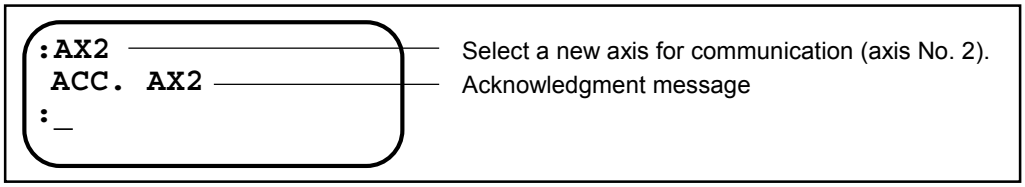
9.3.3.5. Operation

Selection of Driver Unit to Communication

- In daisy-chain mode, the RS-232C terminal is capable of communication through a single driver unit.
- Use an AX command to select one of the Driver Units connected for daisy-chain communication.

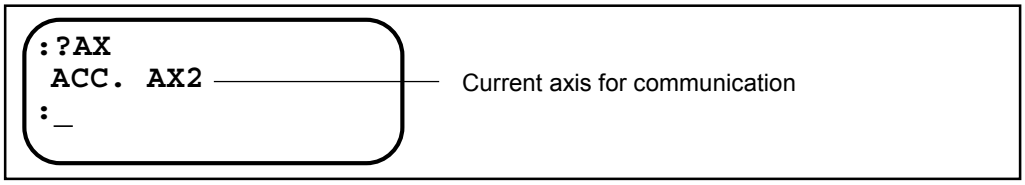
> ⚠ *Caution : Do not select any unit that is not connected. Otherwise, operation may hang up. To return to the normal state, press the BS key, then select the number of a connected driver unit.*

Figure 9-39



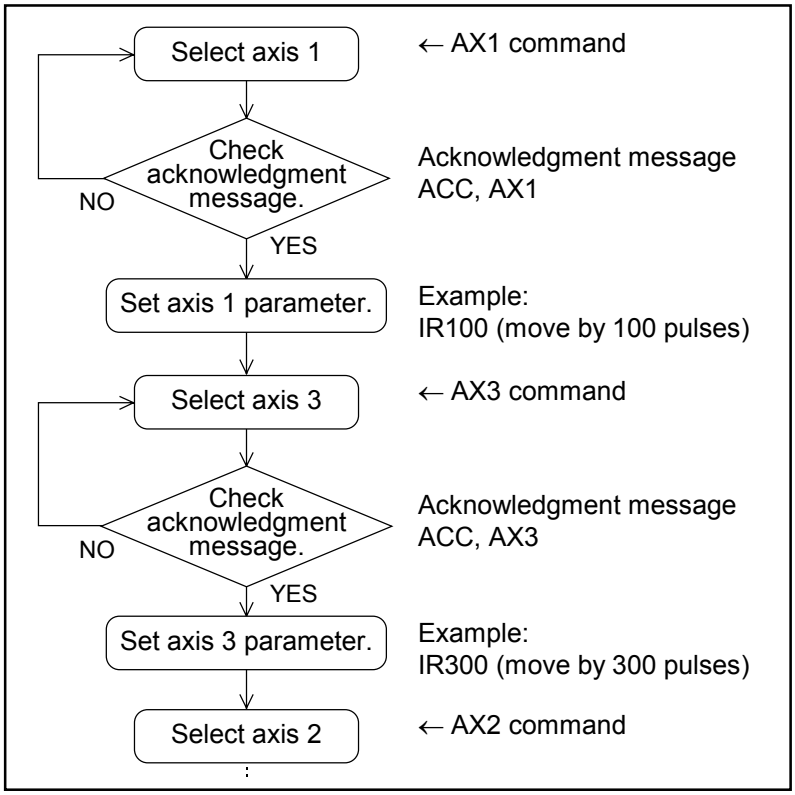
- An axis selected for communication may be checked by issuing a ?AX command. The axis is displayed in the same manner as it i selected.

Figure 9-40



Example of Daisy-chain Communication

Figure 9-41: Example of Daisy-chain Communication



10. Positioning

10.1. Preparation

10.1.1. Wiring Check

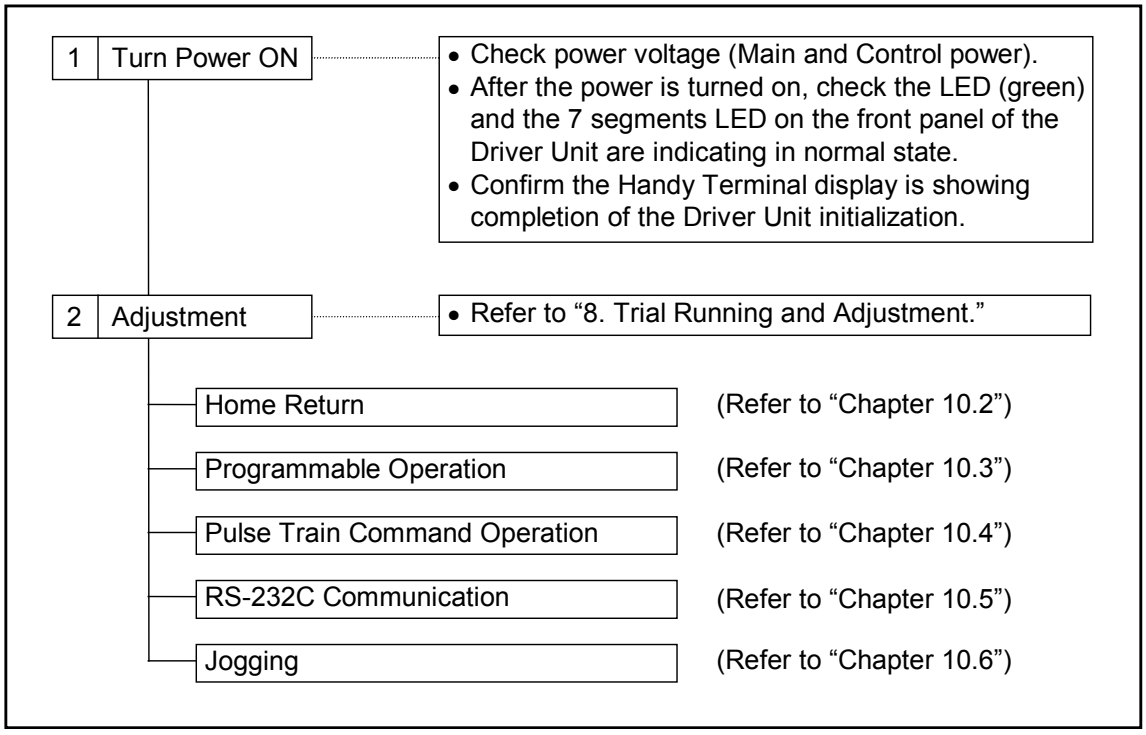
⚠ *Caution : Before operation, check the followings.*

Table 10-1: Check list

	Check item	Confirmation
1	Connection of Main power and Input/Output cables	• All wiring is properly arranged and completed. • Terminal block screws are securely fastened. • All connectors are connected and locked properly.
2	Cable Set	• Cable Set (Motor and Resolver cables) is connected and locked properly.
3	Handy Terminal	• Handy Terminal (FHT11) is connected and locked to CN1 connector.

10.1.2. Procedure

Figure 10-1

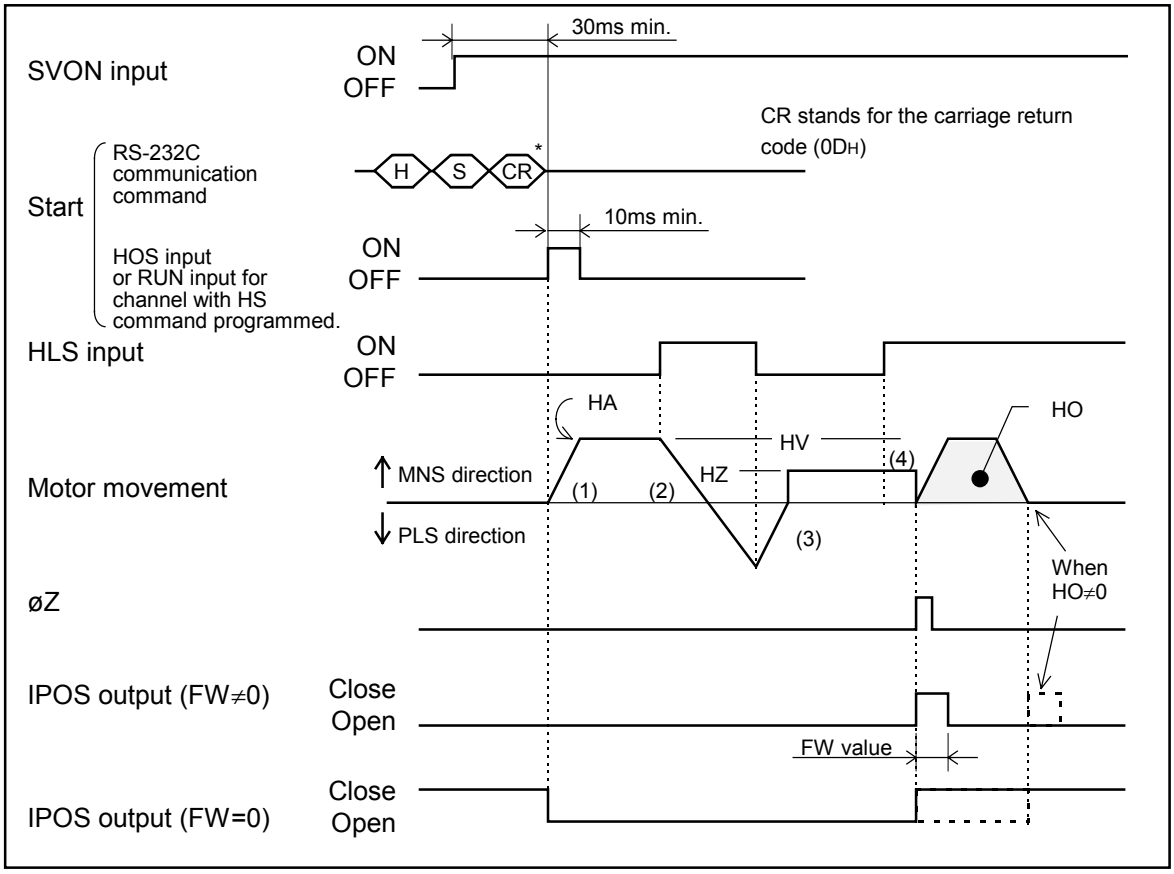


10.2. Home Return

- Be sure to perform the home return at all times except when user's controller is performing coordinate system control. The origin cannot be determined unless the home return is performed.
- The positioning and software overtravel limits are set in the position scale determined by the home return operation.
- The origin of the position scale is set to the point at where the home return completes.

⚠ *Caution : Position data disappears after the power is turned off, so perform the home return each time you turn on the Driver Unit power.*

Figure 10-2: Home Return sequence



- Make the Motor Servo-on. (SVON input on)
- Turning the HOS input ON will start the home return. (1)
- The Motor moves to MNS (minus) direction*. When it enters HLS (Origin proximity) area (2), it decelerates and stops momentarily, then reveres its move direction. (3) The Motor goes out HLS range once, then reverses again and enters HLS area at the origin search velocity. (4) It moves to the first point where the resolver value becomes 0 (= rising edge of the øZ) and completes the home return.

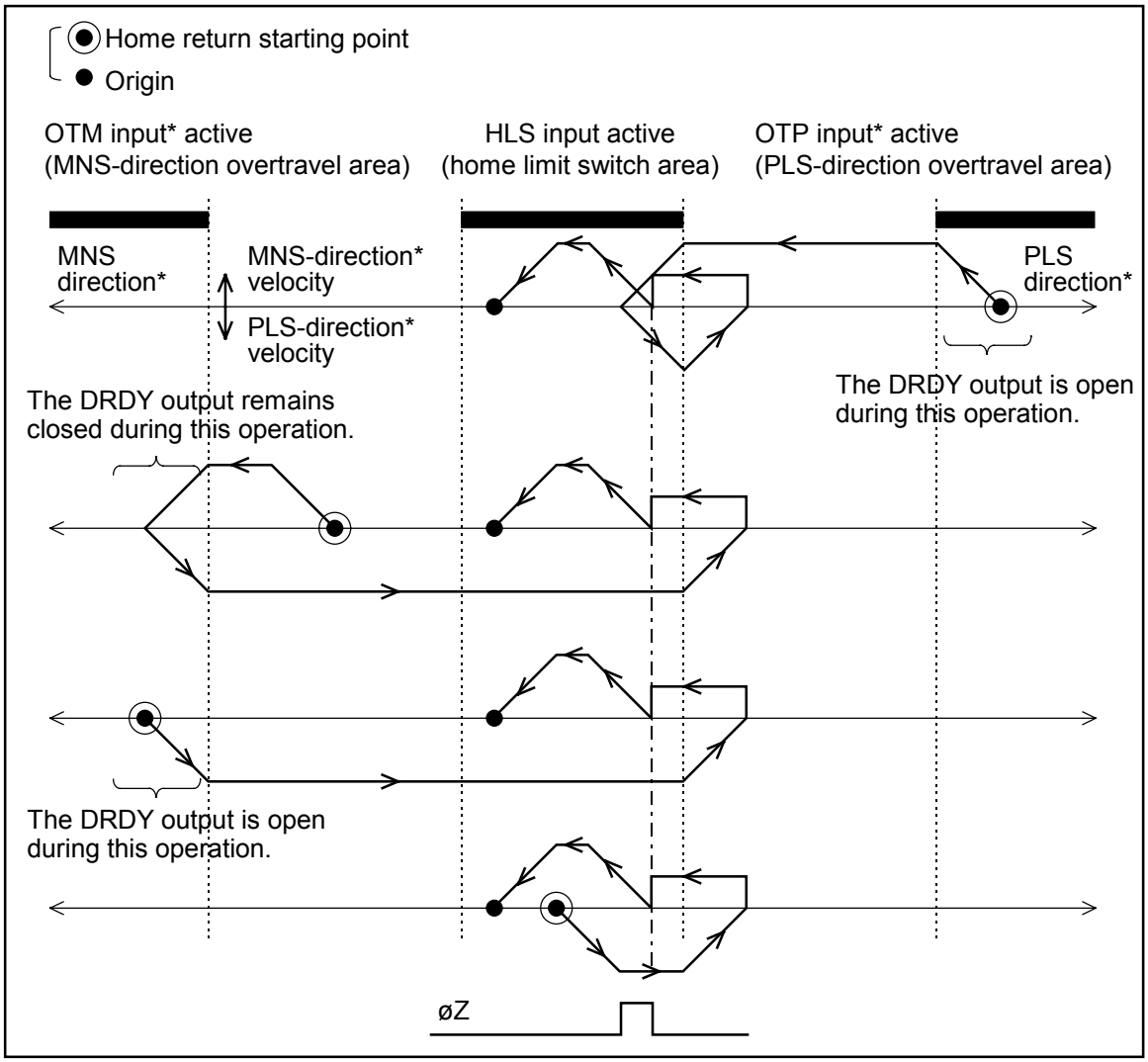
  * The direction of move can be changed with the parameter HD (Home return direction).
    HD0: PLS (Plus direction)
    HD1: MNS (Minus direction, Shipping set)

- If the home offset value HO is set, the Motor moves farther past the resolver 0 point by the offset value, then completes the home return operation.

- Home return can be also executed with the following ways.
  - ◊ Select the channel where HS command is set and input RUN command.
  - ◊ Execute RS command through RS-232 communication.

- The home return movement differs as shown in Figure 10-3 according to the starting point of home return.

Figure 10-3



*: When the home return direction is reversed by the HD parameter, PLS and MNS as well as OTP and OTM are reversed as follows: PLS → MNS, OTP → OTM.

10.2.1. Home Return Parameter List

Table 10-2: Parameter list

Parameter function	RS-232C Parameter	Unit	Data input range	Shipping set
Home Return Acceleration	HA	G	0.01 ~ 5.00	HA0.05
Home Return Velocity	HV	mm/s	1 ~ 1800	HV100.0
Home Return Near-Zero Velocity	HZ	mm/s	1 ~ 100.0	HZ5.0
Home Position Offset	HO	-	-30 000 000 ~ +30 000 000	HO0
Home Return Direction	HD	pulse	0: PLS, 1: MNS	HD1
Home Return Mode	OS	-	1, 3, 4, 5	OS4
Automatic Home Return	PH	-	0: Invalid, 1: valid	PH0

10.2.2. Adjusting the Home Limit Switch and Home Offset Value

- To accurately perform the home return, the home position sensor (sensor and dog) must be adjusted properly.

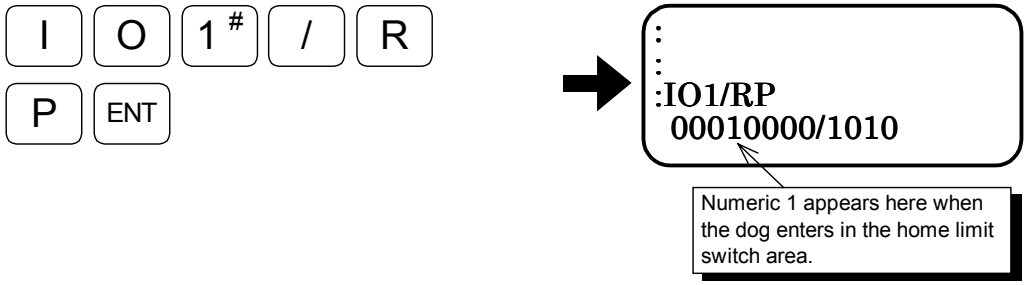
- The resolver has teeth for detecting its position and the rising edge of HLS is to define a tooth. To make precise detection of øZ, the home limit switch position must be adjusted so that the HLS input goes high when the switch is at the middle center of the tooth width. Design the home limit switch position so that it can be adjusted ±2.048 mm.

♦ Take the following steps to adjust the position of the home limit switch.

<Procedure> Adjusting the home limit switch position

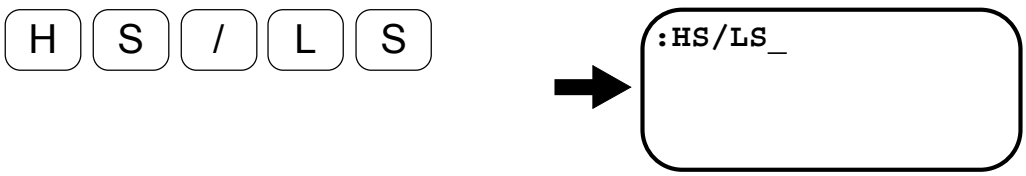
(1) Loosely mount the HLS sensor (home limit switch) slightly preceding a point to be the origin.

(2) Check the wiring of the HLS sensor. Execute the IO command and check if the ESA13 Driver Unit is reading the HLS input correctly. Press [BS] key to terminate the reading.

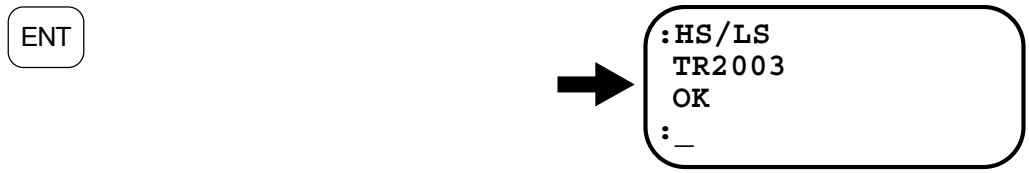


(3) Adjust the position of the home position sensor. First, make the Motor servo-on, then execute the HS/LS command. At this time, be careful that the Motor starts the home return operation and thereby moves. By using Handy Terminal, take the following steps:

(i)

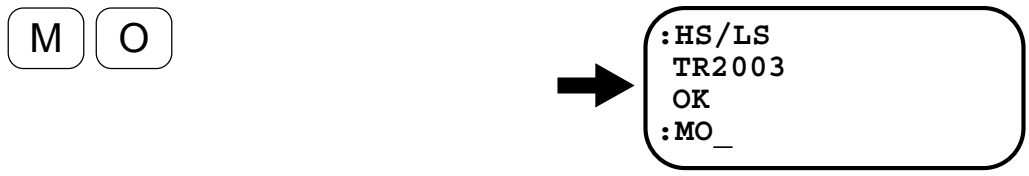


(ii) Press the ENT key to start Motor rotation.

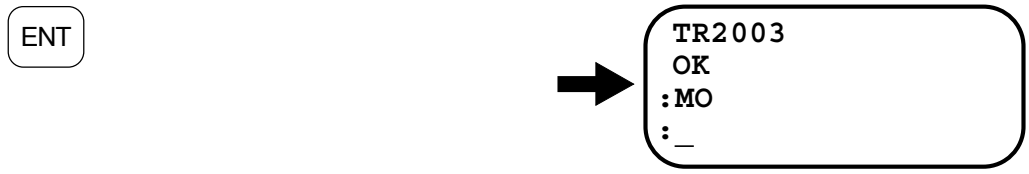


The Motor stops as soon as the HLS sensor goes on. The Handy Terminal displays the TR value (i.e., number of pulses from the closest øZ rising edge) of the Motor's present position.
Check that this value is in the following range : between 1000 and 3000
If the TR value is not in this range, loosen the HLS sensor and move it to PLS or MNS direction.
Repeat steps (i) and (ii) until the TR value is within the above range.

(iii) Input the MO command (servo-off command).

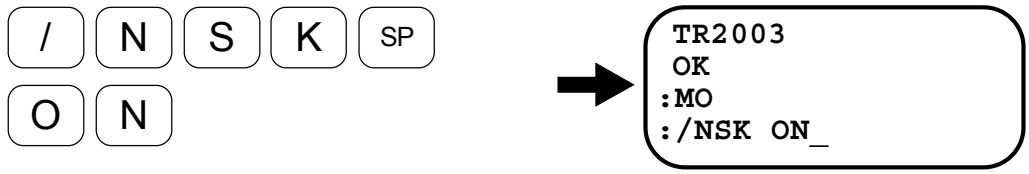


(iv) Press the ENT key to execute the command and thereby turn off the Motor servo.

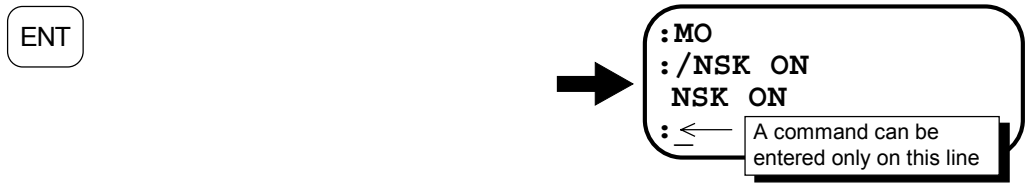


At this time, the Motor can be moved easily by hand. Move the Motor to the desired position.

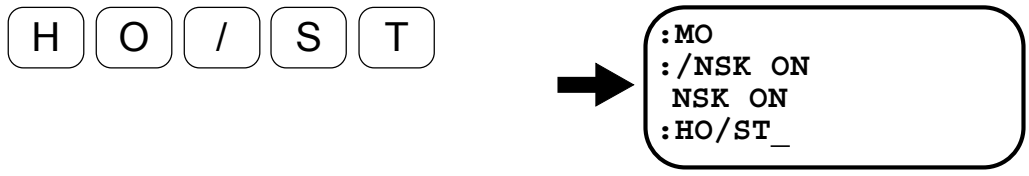
(v) Input the password.



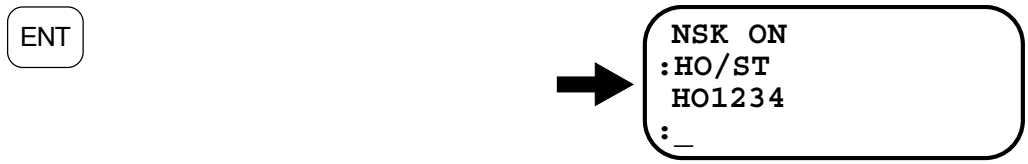
(vi)



(vii) Input the HO/ST command.

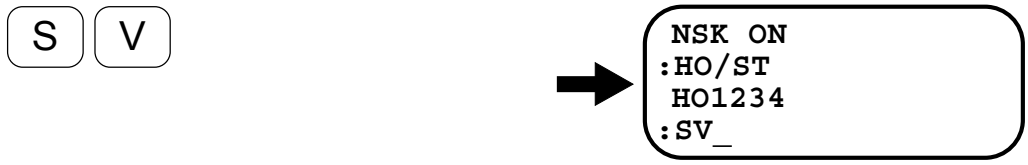


(viii) Press the ENT key to execute the command.

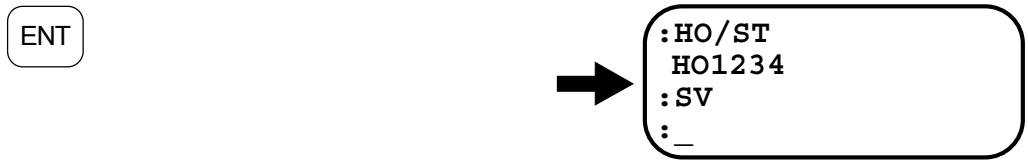


When the ":_" prompt appears on the display, Home offset HO value is automatically calculated and set.

(ix) Input the SV command (servo-on command.)

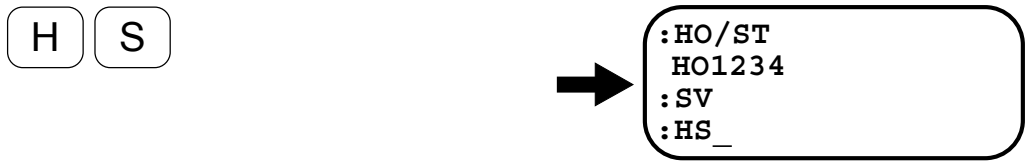


(x) Press the ENT key to execute the command and there by turn on the Motor servo.

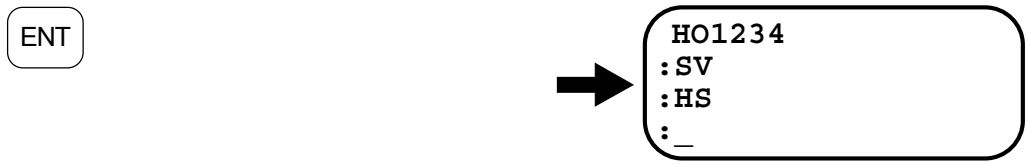


The ":_" prompt appears when the Driver Unit is ready to accept another input.

(xi) Input the HS command (home return start command).



(xii) Press the ENT key to execute the command and there by start the home return operation.



Check that the Motor stops at the desired origin point.

10.2.3. Programming the Home Return Operation (example)

(1) Programming the home return command in channel 0 (CH0)

- When the I/O type is not TY4, there is no home return start (HOS) input in the CN2 connector. In this case, program the home return command in a Programmable Indexer channel. Then, start the operation by activating the channel (i.e., RUN input ON).

  (i) Input the CH0 channel select command.

  C H 0 ? ENT

  The "?" prompt appears to wait for data input. If data is already programmed in CH0, the registered data appears on the display.

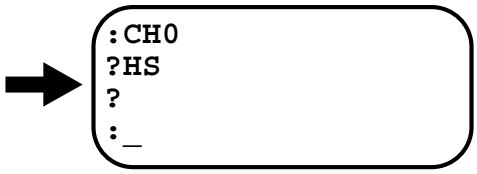
  (ii) Enter the home return start command.

  H S ENT

  (iii) When the "?" prompt appears again, press the ENT key.

  ENT

  This completes the programming in CH0.

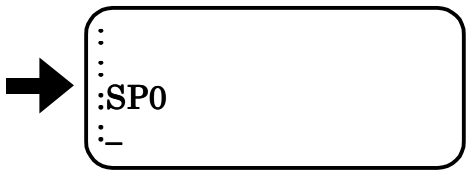
(2) Home return trial operation

- Set the home return acceleration HA, home return velocity HV or home return offset HO.
- Then take the following steps to perform the trial operation.

  (i) Make the Motor servo-on.

  (ii) Following the prompt ":" input the programmable indexer channel indexer execution command.

  S P 0 ? ENT

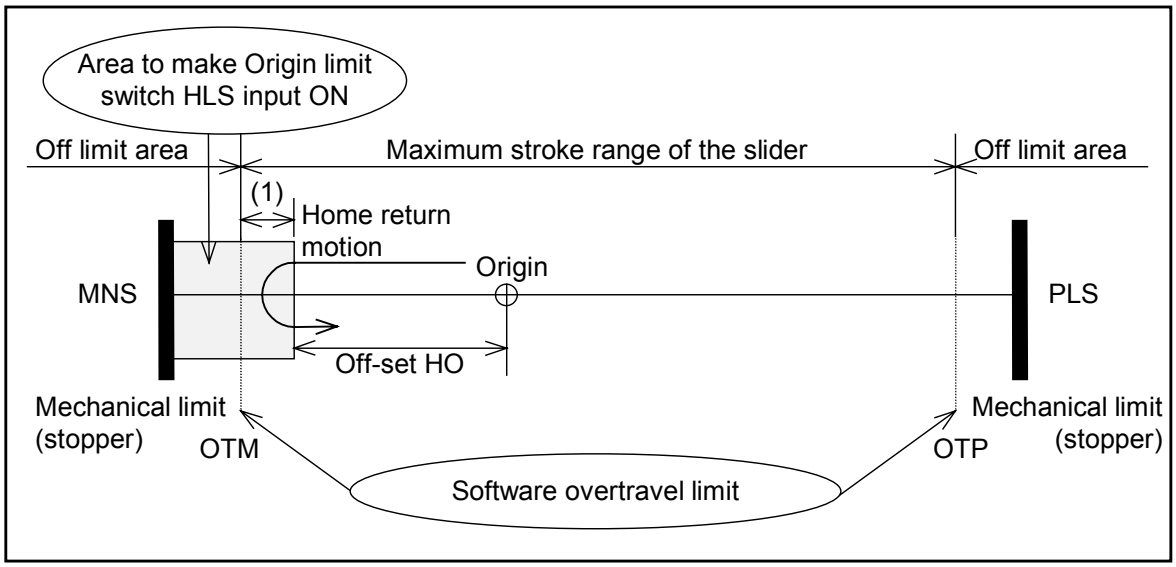
  

  The Motor starts the home return operation.

10.2.4. Position of Origin Limit Switch in TY1 and TY2 I/O Combination

- There is not an input of “overtravel limit” in I/O combination of TY1 or TY2. Use software overtravel (parameter OTP and OTM) to set off-limit area. However the software overtravle limit does not function until completion of Home return after the power is turned on. The slider may hit mechanical limit in Home return operation for the first time after power on. In order to avoid this kind of accident, set the positions of Origin limit switch and software overtravle las shown in Figure 10-4.

Figure 10-4: Position of Origin limit switch in TY1 and TY2 combiantion



- Set the Home position limit switch to MNS side so that there is no clearance between HLS input ON area and the mechanical limit (stopper).

- The slider may collide into the mechanical limit if the clearance exists.

- Software overtracel limit must be set in both sides of Origin. Refer to “9.1.4.2. Software Overtravel Limit” for setting procedure.

- The area (1) shown in Figure 10-4 requires for deceleration in Home return operation. Be sure to give a substantial allowance for this area.

- Check if the parameters related to Home return operation are OS4 and HD1 (shipping set).

10.3. Programmed Operation

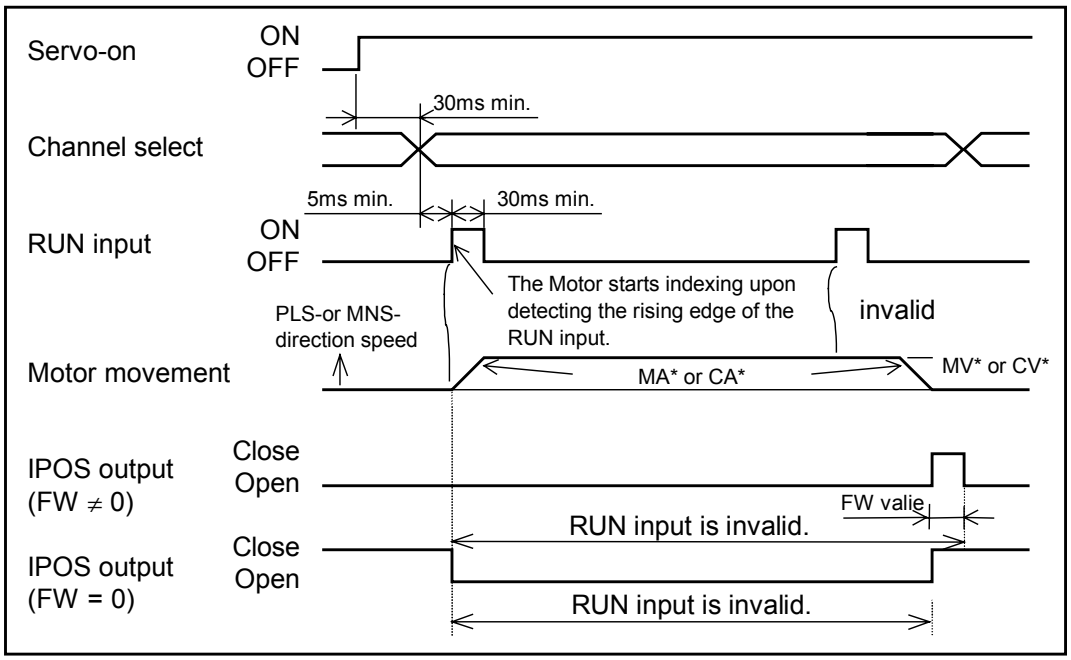
- Positioning command can be stored to the channel of the Driver Unit. Programmed operation is to execute the stored positioning program by selecting the channel via PRG0~PRG3 input and RUN command.
- Set the system to servo-on. (SVON input ON)
- Select the channel (Input PRG0~PRG3, CN2 signal)
- By inputting RUN command ON, the Motor execute stored positioning program while IPOS output is closed. (When FW=0)
- While the Motor is performing the positioning operation, the RUN input is ignored.
- Input the command "SP" to execute the Programmed operation. (Same function as inputting RUN command ON.)

  Type

  S P m ENT

  to execute the channel "m" program. (m: channel number)

Figure 10-5: Programmable indexer command timing



- When a non-programmed channel is selected, the program error alarm will be ON. (Refer to "14. Alarms")

10.3.1. Programmable Indexer Channel Switching

(1) I/O type: TY1

- The channel to be executed is selected by combining the on and off states of the PRG0 to PRG3 inputs.

Table 10-3: 16-Channel selection

PRG3 input	PRG2 input	PRG1 input	PRG0 input	Selected channel No.
off	off	off	off	CH0
off	off	off	on	CH1
off	off	on	off	CH2
off	off	on	on	CH3
off	on	off	off	CH4
off	on	off	on	CH5
off	on	on	off	CH6
off	on	on	on	CH7
on	off	off	off	CH8
on	off	off	on	CH9
on	off	on	off	CH10
on	off	on	on	CH11
on	on	off	off	CH12
on	on	off	on	CH13
on	on	on	off	CH14
on	on	on	on	CH15

(2) I/O type: TY2 and TY3

- The channel to be executed is selected by combining the on and off states of the PRG2 and PRG3.

Table 10-4: 4-Channel selection

PRG3 input	PRG2 input	PRG1 input	PRG0 input	Select channel No.
off	off	(Always off)		CH0
off	on			CH4
on	off			CH8
on	on			CH12

- The channels other than CH0, 4, 8 and 12 remain in the program area. These channels can be used for channel step function (&) and jump command (JP).

(3) I/O type: TY4 and TY7

- Only channel CH0 is available for storing positioning program.

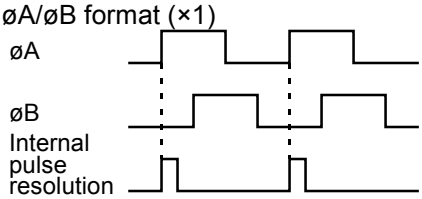
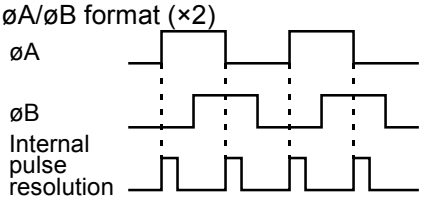
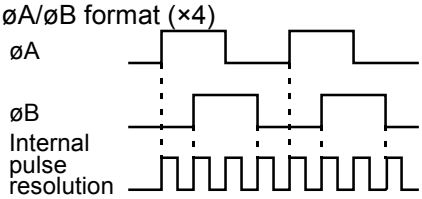
- The channel other than CH0 remain in the program area. These channels can be used for channel step function (&) and jump command (JP).

10.4. Pulse Train Command

10.4.1. Pulse Train Signal Format

- Input a pulse train from PLSP and MNSP of CN2 signal.
- Set the pulse train input signal format with the PC parameter (via RS-232C communication). (The password must be input prior to the PC parameter setting.)

Table 10-5: Signal format

PC Parameter	PLSP input	MNSP input	Function
PC0 (shipping set)	• Input PLS pulse.	• Input MNS pulse.	PLS & MNS format
PC1	• Input the direction. ON: MNS OFF: PLS	• Input pulse train	Pulse & direction format
PC2	• Input øB	• Input øA	øA/øB format (×1) 
PC3			øA/øB format (×2) 
PC4			øA/øB format (×4) 

Note: Maximum frequency of input pulse
PLS & MNS format and Pulse & Direction format : 800 kpps.
øA/øB input format : 200 kpps.

10.4.2. Pulse Train Resolution

- Set the resolution of the pulse train with the CR parameter (via RS□232C).
- In the case of øA/øB input, the pulse train resolution is multiplied by the PC parameter value, then by the CR parameter value.
- Refer to Table 10-3, 4 and 5 for the concrete data of resolution.

Figure 10-6: Pulse train resolution setting

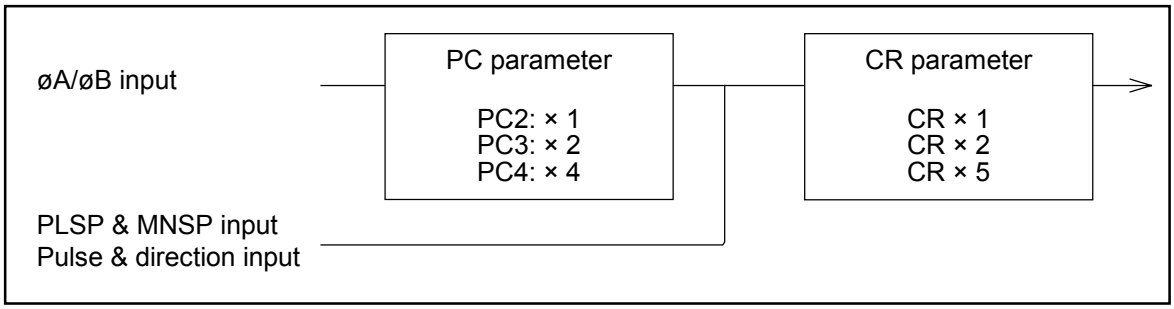
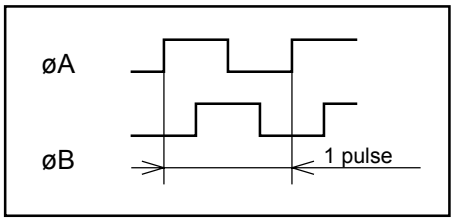


Table 10-6: Pulse train resolution

CR Parameter	Resolver resolution	PLS&MNS format, pulse & direction format	øA/øB format	
CR × 1 (Shipping set)	12-bit or 12-bit/10-bit automatic resolution switching	1µm/pulse	×1	1µm/pulse
			×2	2µm/pulse
			×4	4µm/pulse
	10bit	4µm/pulse	×1	4µm/pulse
			×2	8µm/pulse
			×4	16µm/pulse
CR × 2	12-bit or 12-bit/10-bit automatic resolution switching	2µm/pulse	×1	2µm/pulse
			×2	2µm/pulse
			×4	4µm/pulse
	10bit	8µm/pulse	×1	8µm/pulse
			×2	16µm/pulse
			×4	32µm/pulse
CR × 5	12-bit or 12-bit/10-bit automatic resolution switching	5µm/pulse	×1	5µm/pulse
			×2	10µm/pulse
			×4	10µm/pulse
	10bit	20µm/pulse	×1	20µm/pulse
			×2	40µm/pulse
			×4	80µm/pulse

Note: ◊ In the øA/øB format, one cycle of either øA or øB is defined as “one pulse”.

Figure 10-7



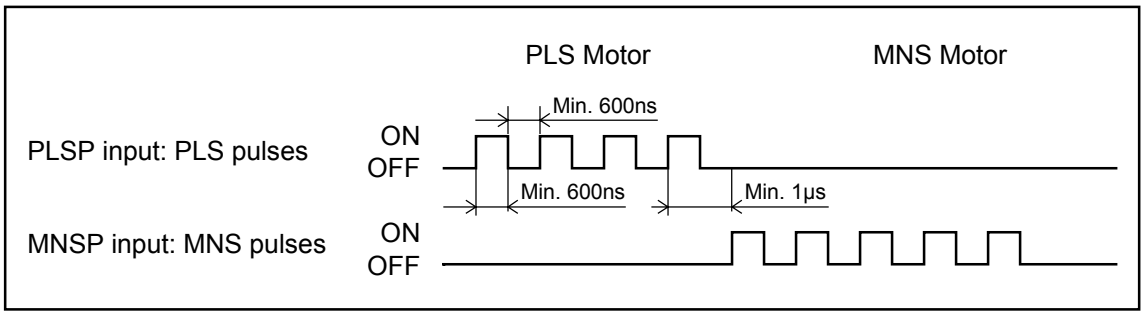
◊ The resolver resolution is set by the RR parameter (via RS-232C).

10.4.3. Input Timing

Caution : The following specifies the conditions of pulse acceptance timing. Besides these conditions, the Motor operation is restricted by the maximum velocity. Do not input pulses faster than Motor's maximum velocity.

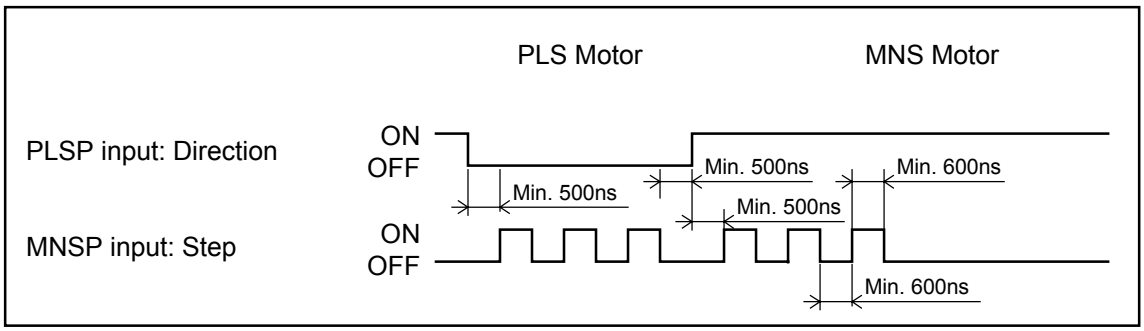
(1) When PC is set to "0" (PC0)

Figure 10-8



(2) When PC is set to 1 (PC1)

Figure 10-9



(3) When PC is set to 2~4 (PC2~PC4)

Figure 10-10

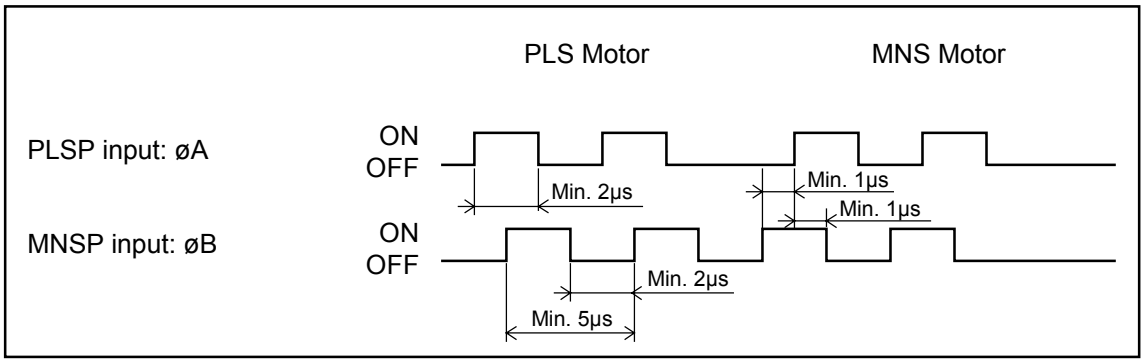


Table 10-7

Pulse train format	CR	Resolver resolution	Motor maximum velocity	Maximum pulse freqnency	Moving velocity
PLS & MNS format	×1	12bit (1um)	600 mm/s	600 kpps	600 mm/s
	×2			300 kpps	600 mm/s
	×5			120 kpps	600 mm/s
	×1	10bit (4um)	1800 mm/s	450 kpps	1800 mm/s
	×2			225 kpps	1800 mm/s
	×5			90 kpps	1800 mm/s
	×1	Automatic resolution switching (1um)	1800 mm/s	800 kpps	800 mm/s
	×2			800 kpps	1600 mm/s
	×5			360 kpps	1800 mm/s
Pulse & direction format	×1	12bit (1um)	600 mm/s	600 kpps	600 mm/s
	×2			300 kpps	600 mm/s
	×5			120 kpps	600 mm/s
	×1	10bit (4um)	1800 mm/s	450 kpps	1800 mm/s
	×2			225 kpps	1800 mm/s
	×5			90 kpps	1800 mm/s
	×1	Automatic resolution switching (1um)	1800 mm/s	800 kpps	800 mm/s
	×2			800 kpps	1600 mm/s
	×5			360 kpps	1800 mm/s
øA/øB format (×1)	×1	12bit (1um)	600 mm/s	200 kpps	200 mm/s
	×2			200 kpps	400 mm/s
	×5			120 kpps	600 mm/s
	×1	10bit (4um)	1800 mm/s	200 kpps	200 mm/s
	×2			200 kpps	400 mm/s
	×5			200 kpps	1000 mm/s
	×1	Automatic resolution switching (1um)	1800 mm/s	200 kpps	200 mm/s
	×2			200 kpps	400 mm/s
	×5			200 kpps	1000 mm/s
øA/øB format (×2)	×1	12bit (1um)	600 mm/s	200 kpps	400 mm/s
	×2			150 kpps	600 mm/s
	×5			60 kpps	600 mm/s
	×1	10bit (4um)	1800 mm/s	200 kpps	400 mm/s
	×2			200 kpps	800 mm/s
	×5			180 kpps	1800 mm/s
	×1	Automatic resolution switching (1um)	1800 mm/s	200 kpps	400 mm/s
	×2			200 kpps	800 mm/s
	×5			180 kpps	1800 mm/s
øA/øB format (×4)	×1	12bit (1um)	600 mm/s	150 kpps	600 mm/s
	×2			75 kpps	600 mm/s
	×5			30 kpps	600 mm/s
	×1	10bit (4um)	1800 mm/s	200 kpps	800 mm/s
	×2			200 kpps	1600 mm/s
	×5			90 kpps	1800 mm/s
	×1	Automatic resolution switching (1um)	1800 mm/s	200 kpps	800 mm/s
	×2			200 kpps	1600 mm/s
	×5			90 kpps	1800 mm/s

10.5. RS-232C Position Commands

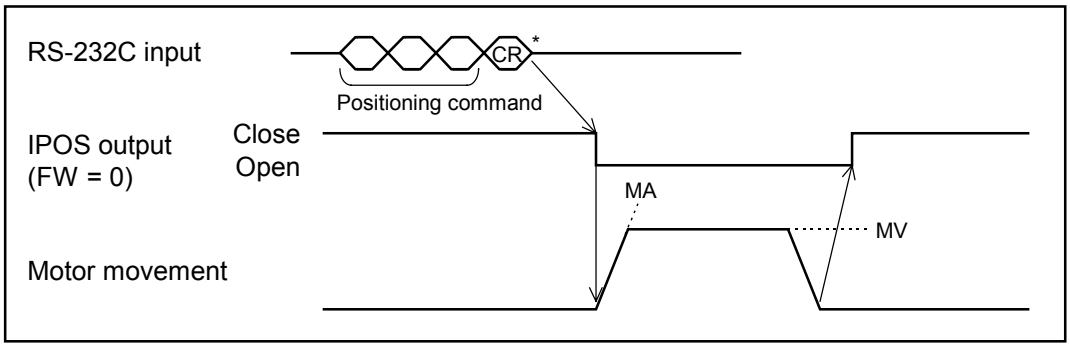
- You can execute indexing using RS-232C commands. The commands/parameters are shown below. Refer to “12. Command and Parameter” for more details.

Table 10-8

Command/parameter	Function
IR command	Sets the amount and executes motion (incremental/in the units of pulse)
AR command	Sets the target and executes motion (absolute/in the units of pulse)
HS command	Starts the home return.
HV parameter	Sets the home return velocity.
HA parameter	Sets the home return acceleration.
HO parameter	Sets the home offset value.
HD parameter	Specifies the home return direction.
MA parameter	Sets the acceleration, for indexing.
MV parameter	Sets the velocity, for indexing.

- Indexing Timing

Figure 10-11: Indexing timing



*: CR stands for the carriage return code (0DH).

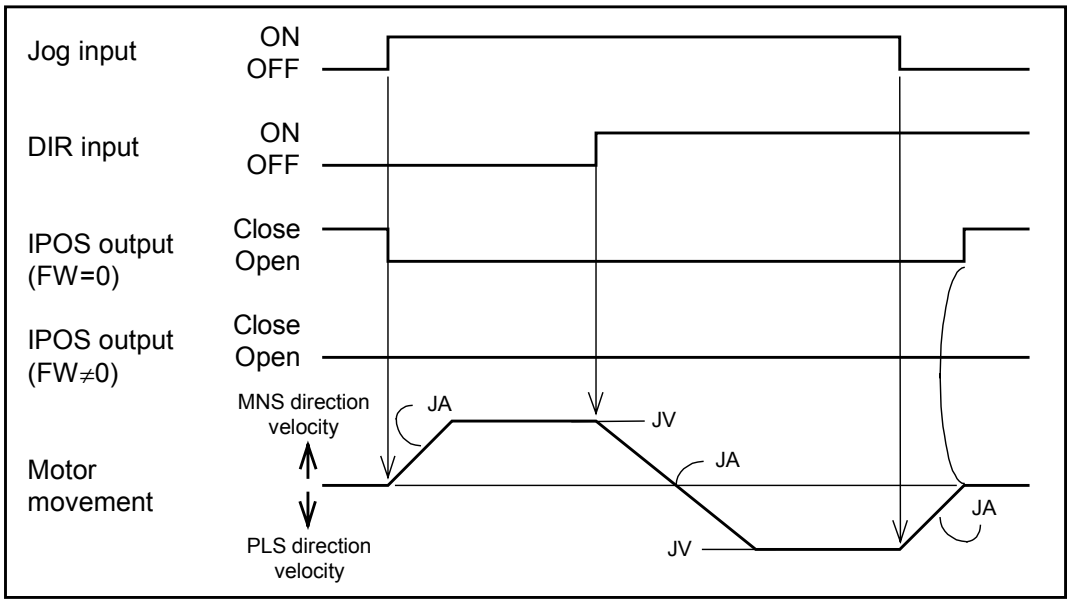
- Under SVON state, as soon as the command is input, the Motor starts indexing. The acceleration and velocity follow the settings of parameters “MA” and “MV”.

- If the position error counter value is within the in-position limit (set by IN parameter) after indexing, the IPOS output should be closed.

10.6. Jog Operation

- Jog operation is available when the Driver Unit is set to Type 7.
- Set system to servo-on. (SVON input ON)
- Turning on the Jog input makes the Motor start acceleration and moving. The Motor keeps moving while the Jog input remains on. When the Jog input is off, the Motor starts decelerating, then stops.
- When the DIR input is off, the Motor moves to PLS direction. When the DIR input is on, it moves to MNS direction.
- Jog operation parameter
  JA: Jog acceleration
  JV: Jog velocity

Figure 10-12: Jog operation timing



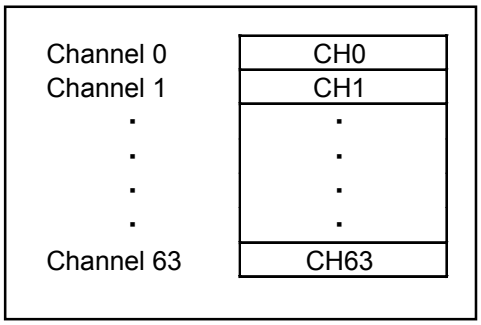
Note: When the DIR input is switched during Motor moves as shown in the above chart, the Motor decelerates, then reverses the direction of motion.

11. Programming

- The program for programmed operation can be made through RS-232C serial communication. You can input the program only when the Motor is stopping.

- Program aria is shown in Figure 10-1. Channel 0 ~ 63, totally 64 channels, are available.

Figure 11-1: Program area



11.1. Commands and Parameters

◆ **Home return**

Command : HS
Condition setting : None

- This is to program Home return operation.

- Command format HS seq.
  seq : sequence code (*, &)

- The motor executes Home return under the conditions set by HV (moving velocity), HA (acceleration) and HZ (home position searching speed)

  [Reference] Home position moving direction may be changed by HD parameter.
  HD0 : PLS direction
  HD1 : MNS direction (shipping set)

  [Program example]

```
:CH0
 HS
```

◆ Positioning

Command : AR, IR
Conditions : CV, CA are may be omitted.

- This is to program positioning.

Table 11-1

Command format	Description	Optional
AR d1 seq	• Absolute format in unit of pulses. • The motor moves to reach the d1 (pulse) position of absolute position scale.	Optional code d2 / n : (n≤99) ◊ This makes one operation unit by dividing d1 into n. ◊ Default is not to divide d1.
IR d1 d2 seq	• Incremental positioning in unit of pulses. • The motor moves to the d1 distance from current position.	

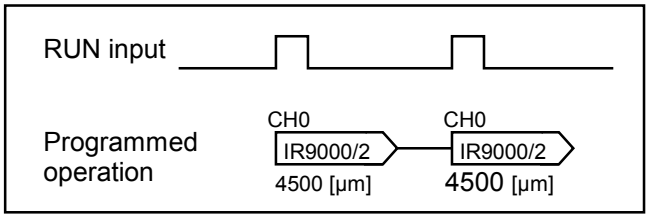
- seq stands for the sequence code (*, &),which sets next operating instruction conditions of the next channel in the sequence.

- You may set CV (motion velocity) and CA (motion acceleration) in the same channel. If these are omitted, velocity and acceleration follow the setting of MV and MA.

[Program example]

```
:CH0
 IR9000/2
 CV300
 CA0.5
```

Figure 11-2



◆ **Jump**

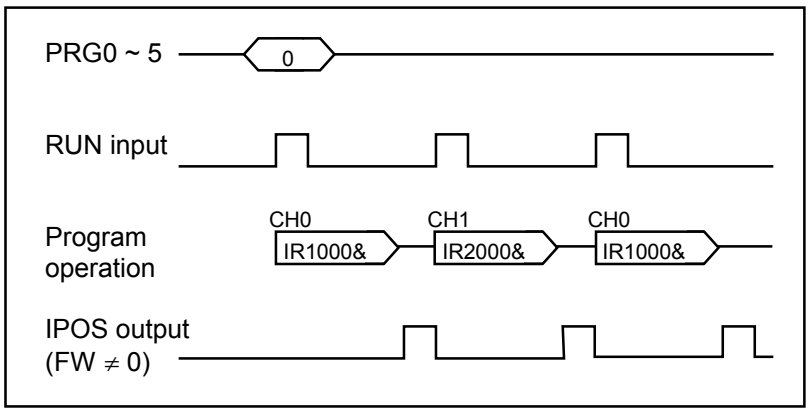
Command : JP
Conditions : None

- This is the command for unconditional jump.
- A program jumps to specified channel and continues operation.
- Command format Jp m
  m : Channel number to jump (default: 0)

[Program example]

```
:CH0
 IR1000&
:CH1
 IR2000&
:CH2
 JP0
```

Figure 11-3



◆ Sequence code

Command : (HS), (AR), (R)
Conditions : *, &

- When a sequence code is added to a command, a program executes the next channel continuously without selecting a channel externally.

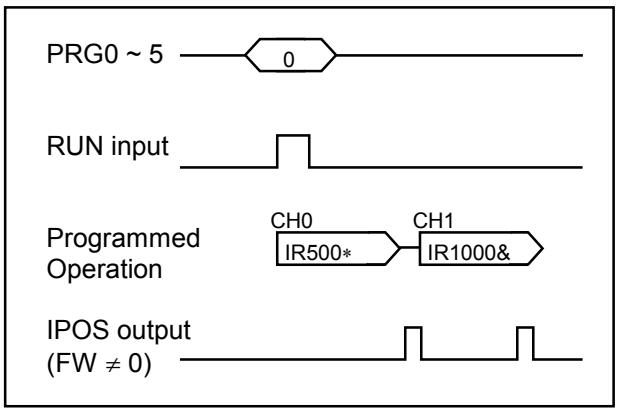
Table 11-2

Sequence code	IPOS output	Execution of the next channel
*: asterisk	Yes	Executes next program continuously after positioning is finished.
& : ampersand	Yes	Stops after positioning, then waits for RUN command.

[Program example]

```
:CH0
 IR5000*
:CH1
 IR1000&
```

Figure 11-4



◆ Sequence code change

Conditions : OE

- OE seq makes possible to change a currently set sequence code.

[Program example]

```
:CH0 --------------- Specify an objective channel.
 AR9000&
 CV300
                          input
?OE* ---------------  O  E  *  ENT
?
:TC0 --------------- Confirm a changed channel.
 AR9000* ----------- Sequence code is changed from "&" to "*".
 CV3000
:
```

11.2. Program Editing Command

Table 11-3: Program editing command

Editing	Command	Function
Change program settings	CH	• Typing C H m ENT declares the channel to be changed. (m: desired channel number) • The display shows the present program and waits for the changes. (The prompt is in "?" state.) • The last input program or data always becomes valid.
Display program	TC	• Typing T C m ENT displays the program in desired channel. (m: desired channel number) • When checking the program in all channels, type T C / A L ENT. • Type SP key to scroll to next channel.
Deleting program	CC	• Typing C C m ENT deletes the program in the desired channel. (m: desired channel number)

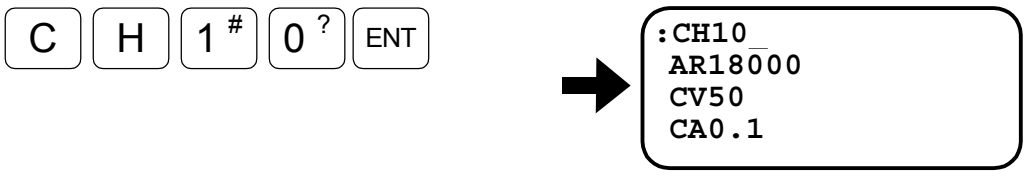
11.3. Inputting a Program

◆ Program setting

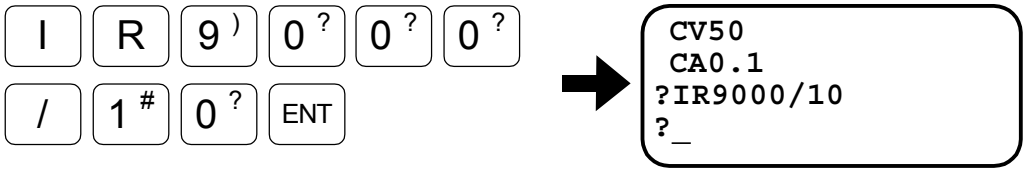
(i) Declare a channel to be programmed.

◊ When a channel is selected, the programmed contents is display.

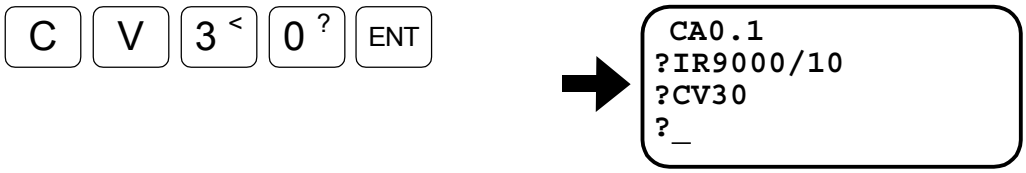
◊ Then prompt "?" appears to wait for an instruction.



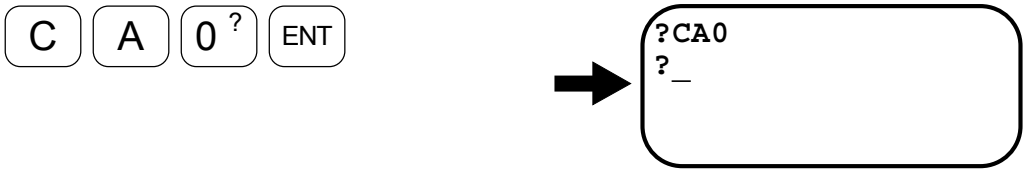
(ii) Program a command.



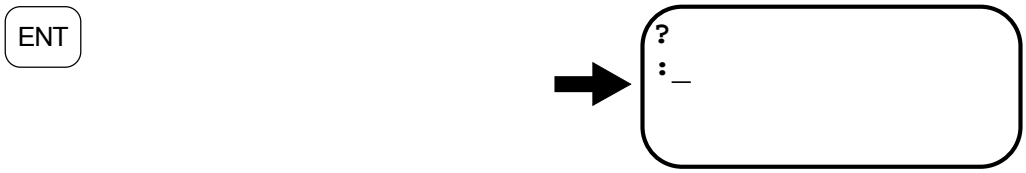
(iii) Set conditions according to the command.



(iv) Enter "0" to cancel the input condition.
(When incorrect data is input, re-enter the correct data. When the same command with different data is input twice, the last input data becomes valid.)

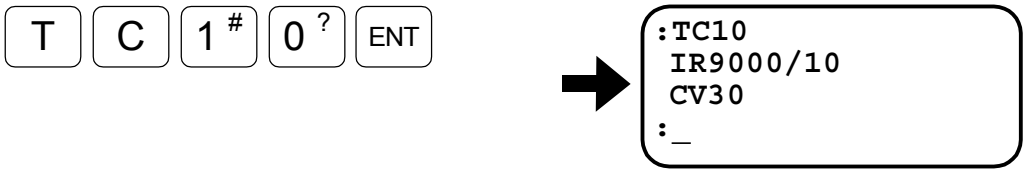


(v) Pressing only ENT displays the ":" prompt and ends program setting.



◆ Readout data

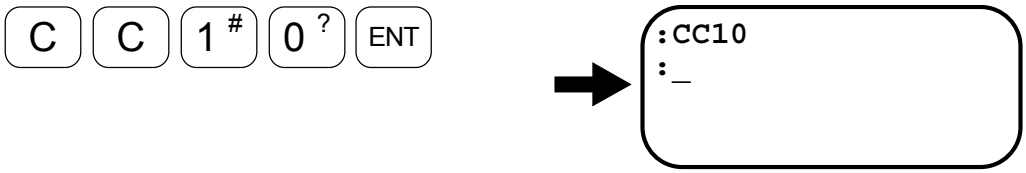
(i) Declare the channel to be read out. The contents of the channel are displayed.



◆ Delete data

(i) Declare the channel whose data is to be deleted.

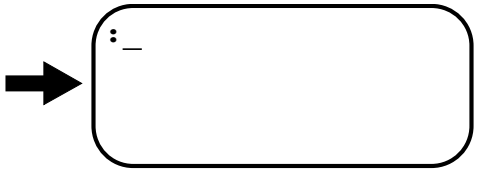
◊ Press ENT key to delete the data.



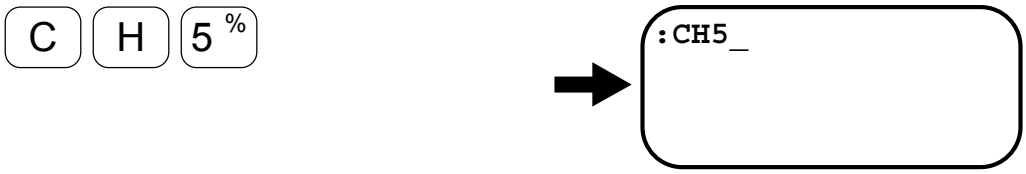
11.4. Program Example

- Write the following motion profile in Channel 5.
  - ◊ Travel stroke 30000 pulses (30mm) to the MNS direction
  - ◊ Acceleration CA: 0.1 [G]
  - ◊ Velocity CV: 100 [mm/s]

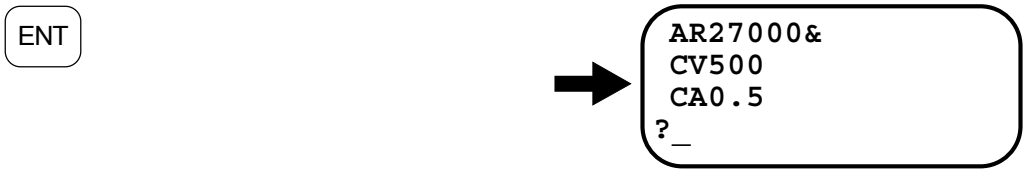
(i) Check that the ":" prompt is displayed on the screen.



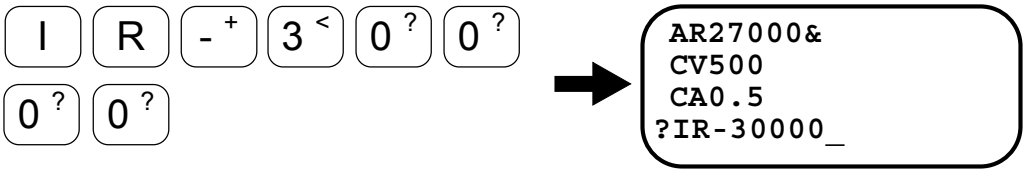
(ii)



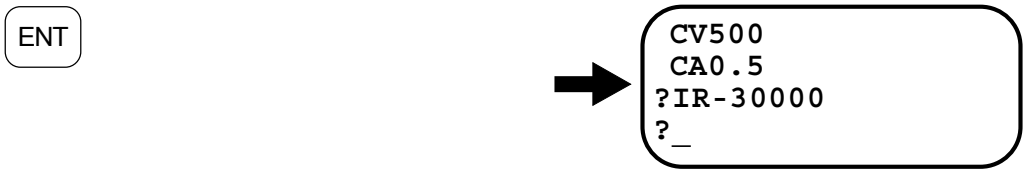
(iii) After pressing the ENT key, the data presently programmed in Channel 5 will be shown on the display.



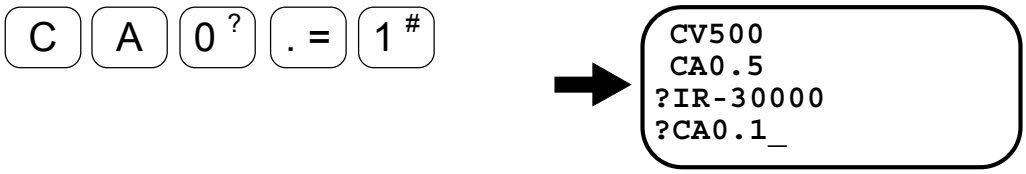
(iv)



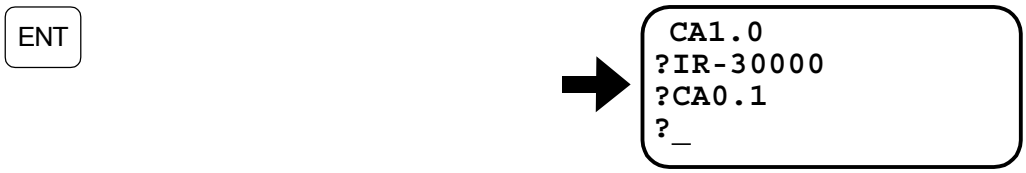
(v) Press the ENT key to input value, and the "?" prompt appears again.



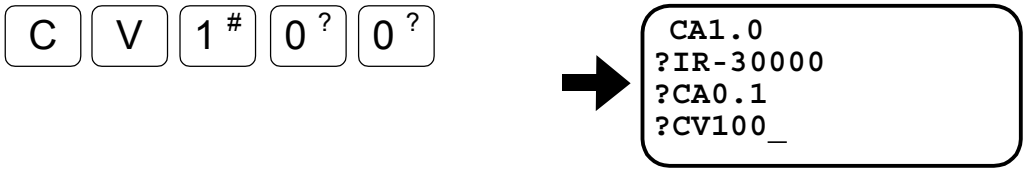
(vi)



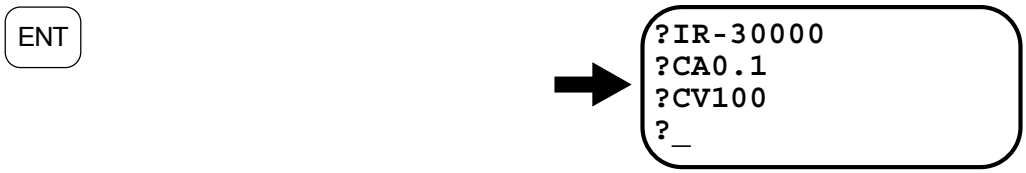
(vii) Press the ENT key to input value, and the "?" prompt appears again.



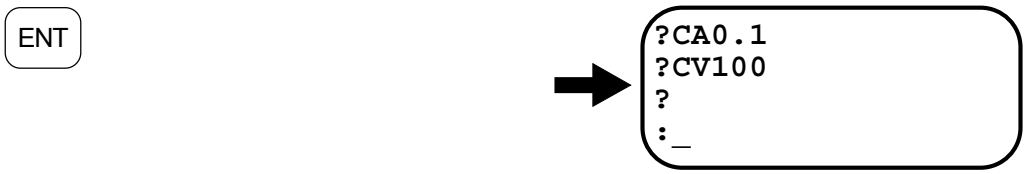
(viii)



(ix) Press the ENT key to input value, and the "?" prompt appears again.



(x) Press the ENT key again to escape programming. This completes programming.



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12. Command and Parameter

12.1. Command and Parameter List

- Connect the Handy Terminal FHT11 to CN1 connector of the Driver Unit. When the display shows “NSK MEGA•••” the system is in the normal state.

- Some parameters shown in Tables 12-1 shall be changed according to the actual operating condition from the shipping setting.

- Parameters in a parenthesis ( ) are set at the factory before shipment and are normally fixed. If the setting is to be changed, contact NSK.

  * Current Setting

    ◊ We recommend writing down the current settings for your future reference. You may need to refer to them when changing the operating conditions or readjusting the system. For your convenience, a parameter and program setting list provided in the last page of this manual.

  **

    ◊ The setting value varies with the Motor size. These are set at the factory. Do not change the settings.

Table 12-1: Megathrust Motor standard setting

Parameter	Name	Password	Shipping set	Data range	Current setting *
PG	Position gain	No	0.1	0.010 ~ 1.000	
VG	Velocity gain	No	1.0	0.10 ~ 255.0	
VI	Velocity integrator frequency	No	1.00	0.10 ~ 63.00	
VM	Velocity integrator mode	Yes	1	0, 1	
LG	Low-velocity gain	No	50	10 ~ 100	
TL	Torque limit	Yes	100	0 ~ 100	
FO	Low-pass filter off velocity	No	0	1 ~1 800	
FP	Low-pass filter, Primary	No	0	0, 10 ~ 500	
FS	Low-pass filter, Secondary	No	0	0, 10 ~ 500	
NP	Notch filter, Primary	No	0	0, 10 ~ 500	
NS	Notch filter, Secondary	No	0	0, 10 ~ 500	
DBP	Dead band	Yes	0	0, 1 ~ 4 095	
ILV	Integration limit	Yes	100	0 ~ 100.0	
FF	Feed forward gain	Yes	0	0.000 ~ 1.0000	
FC	Friction compensation	Yes	0	0 ~ 2 047	
CO	Position error counter over limit	No	50 000	1 ~ 99 999 999	
IN	In 氵position	No	100	0 ~ 99 999 999	
IS	In-position stability timer	No	0	0, 0.3 ~ 100	
FW	FIN width	No	0	0, 0.3 ~ 100	
VO	Velocity error over limit	Yes	1 365	1 ~ 4 095	
VW	Velocity error over limit width	Yes	100	0 ~ 1 000	
CR	Circular resolution	Yes	×1	×1, ×2, ×5	
PC	Pulse command	Yes	0	0 ~ 4	
RR	Resolver resolution	Yes	-1	-1, 0, 1	
FD	Feedback direction mode	Yes	0	0, 1	
FZ	Feedback phase Z configuration	Yes	0	0, 1	
FR	Feedback signal resolution	Yes	0	0, 1	
PS	Position scale	Yes	0	0	
DI	Direction inversion	Yes	0	0, 1	
OTP	Overtravel limit switch position	Yes	0	-99 999 999 ~ 99 999 999	
OTM	Overtravel limit switch position	Yes	0	-99 999 999 ~ 99 999 999	
MV	Move velocity	No	500	1 ~ 1 800.0	
MA	Move acceleration	No	0.05	0.01 ~ 5.00	
JV	Jog velocity	No	50	1 ~ 1 800.0	
JA	Jog acceleration	No	0.05	0.01 ~ 5.0	
HV	Home return velocity	No	100	1 ~ 1 800.0	
HA	Home return acceleration	No	0.05	0.01 ~ 5.0	
HZ	Home return acceleration	No	5	0.1 ~ 100.0	
OS	Origin setting mode	Yes	4	1, 3, 4, 5	
HD	Home return direction	Yes	1	0, 1	
HO	Home offset	Yes	0	-30 000 000 ~ +30 000 000	
(PA)	Phase adjust	Yes	*	24~1048	
(OL)	Overload limit	Yes	**	0~100	
(RC)	Rated current	Yes	**	0~100	
LR	Low torque ripple	Yes	0	0, 1	
TY	I/O type	Yes	4	1, 2, 3, 4, 7	
AB	I/O polarity	Yes	X0X0XX00	0, 1, X	
SM	[SVON] function switching	Yes	1	1, 2, 3	
NW	Neglect width	Yes	2	0 ~ 4	
MM	Multi 氵line Mode	Yes	1	0, 1	
BM	Backspace mode	Yes	1	0, 1	
CM	Communication mode	Yes	0	0, 1	
AN	Axis number	Yes	0	0 ~ 15	
WM	Data back-up	Yes	0	0, 1	
SE	Serial error	Yes	0	0, 1	
LO	Load inertia	No	0	0.0 ~ 500.0	
SG	Servo gain	No	0	0 ~ 30	
(MT)	Factory use only	Yes	**	1~2000	
(RI)	Factory use only	Yes	**	1.0~100.0	
(ZP)	Factory use only	Yes	1.00	0.50~1.80	
(ZV)	Factory use only	Yes	1.4	0.1~4.0	

12.2. Command and Parameter

- "Shipping set" denotes a value which is set at the factory before shipment.
- "Default" denotes a value which is adopted by entering a command and parameter with no data.
- The password must be entered before inputting a command marked with ★. Refer to "9.3.2.3. Password" for more details.

★ *AB : I/O polarity*

Format : AB n1 n2 n3 n4 n5 n6 n7 n8
Data : nn=0 A contact (Normally open)
nn=1 B contact (Normally closed)
nn=X ◊ At the time of input:
The port set to X does not change polarity.
◊ At the time of read-out:
For the port which is shown as "X" the polarity can not be change. (A contact is fixed.)
Shipping set : ABX0X0XX00 (all A contacts)
Default : Not omissible (input all 8 digits)

- Set the polarity of input command port.
- The ports of which the polarity can be changed are EMST, HLS, OTP and OTM. The other ports are fixed to A contact.
- Set "X" for the port of which polarity can not be changed. If "0" or "1" is input, the display shows "?" indicating the fault input.
- If the parameter "TY" is changed, all polarity settings return to the shipping set (all A contacts).
- Polarity setting can be read by "TS" or "?AB" command.
- The table below shows the data and port.

Data digit	n1	n2	n3	n4	n5	n6	n7	n8
CN2 pin No.	25	12	24	11	23	10	22	9
TY1	SVON	EMST	RUN	HLS	PRG3	PRG2	PRG1	PRG0
TY2	SVON	EMST	RUN	HLS	PRG3	PRG2	DIR	JOG
TY3	SVON	EMST	RUN	HLS	PRG3	PRG2	OTM	OTP
TY4	SVON	EMST	RUN	HLS	HOS	CLR	OTM	OTP
TY7	SVON	EMST	RUN	HLS	DIR	JOG	OTM	OTP

★ *AN : Axis Number*

Format : AN data
Data range : 0 ~ 15
Shipping set : 0
Default : 0

- Sets the axis number in the daisy-chain communication mode.
- "TS" command or "?AN" command reports the current setting.
- For more details, refer to "6.2. Daisy-chain Communication."

AR : Absolute Positioning, Resolver

Format : AR data
Data :-99 999 999 ~ +99 999 999
Default : 0

- 'data' indicates the position of the destination. This position complies with user absolute position scale (which may be read out by issuing "TP").
- If the current position is the same as the destination position, the Motor does not move.
- This command has two functions, which depend on the usage.
  (1) If it is entered under the condition where a channel to be programmed is selected with a CH command, the Driver Unit outputs "?," and the system waits for a command to be entered, it specifies the rotational amount of the Programmable Indexer channel.
  (2) If it is entered in the normal standby condition, it serves as a positioning command.

AS : Ask Daisy-Chain Status

Format : AS

- When communication in daisy-chain style, AS reads out the status of each axis connected to Driver units.
- The "AS" command is executed automatically when power is turned on in the daisy-chain communication mode.
- After the "AS" command is executed, the Driver Unit of axis 0 is always selected.

AT : Automatic Tuning

Format : AT

- Execute "automatic tuning" to set proper servo parameters and acceleration.

AX : Axis Select

Format : AX data
Data : 0 ~ 15
Shipping set : 0
Default : 0

- When communicating in daisy-chain, AX selects the one of the Driver Unit. Selected Driver Unit sends a confirmation signal back to the RS-232C terminal.
- Confirmation message "ACC. AXn " (n=selected Driver Unit number). The Driver Unit of axis 0 is always selected when power is turned on.
- Report command "TS" or "?AX" is valid when daisy-chain communication is active.
- If "AX" is input when daisychain is not active, an error message will be given back.
- Also if "TS" or "?AX" command is input when daisy-chain is not active, an error message will be given.

Caution : Do not select any unit that is not connected. Otherwise, operation may hang up. To return to the normal state, press the BS key first, then the number of a connected Driver Unit.

★ *AZ : Absolute Zero Position Set*

Format : AZ

- If the AZ command is executed with the Motor stationary at any position, the position is adopted as user absolute home position.

★ *BM : Backspace Mode*

Format : BM data
Data : 0 or 1
Shipping set : 1
Default : 0

- BM changes the function of the BS key.

  BM0: A press of the [BS] key cancels an entered character string.

  BM1: A press of the [BS] key deletes a character.

- TS or ?BM command reports the current setting.

CA : Channel Acceleration

Format : CA data
Data : 0.05 ~ 2.50 [G]
Default : 0

- This command is used to specify the acceleration of a given channel of the Programmable Indexer.
- The "CA" command may be input under the condition where a channel to be programmed is selected with a "CH" command, the Driver Unit outputs "?," and the system waits for a command to be entered. If it is entered in the normal stand-by state, an error occurs.
- If no setting is made in a channel (or 0 is specified), the acceleration specified with an "MA" command is valid.

CC : Clear Channel

Format : CC data
Data : 0 ~ 15
Default : 0

- CC deletes the program data of a channel specified in ㅓ data.ㅗ

CH : Channel Select

Format : CH data
Data : 0 ~ 15
Default : 0

- This command is to select the channel to be programmed.
- The input program can be read with "TC" command.

⚠ *Caution : Input program when the system is servo-off state.*

CL : Clear Alarm

Format : CL

- "CL" command clears "excess error", "software thermal" and "program error" alarms. (Other alarms can not be cleared with "CL" command.)

★ *CM : Communication Mode*

Format : CM data
Data : 0 or 1
Shipping set : 0
Default : 0

- CM Selects the RS□232C communication mode.
  CM0: Standard
  CM1: Daisy-chain communication
- The CM parameter set at the time of power-on is valid.
- To change the communication mode, change the CM parameter, turn off the power, then turn it on again.
- "TS" or "?CM" command reports the current setting.

CO : Position Error Counter Over Limit

Format : CO data
Data : 0 or 1 ~ 99 999 999 [pulse]
Shipping set : 50000
Default : 0

- CO sets the position error counter value at which the excess position error alarm is to be detected.
- When the position error counter exceeds the set value, the Driver Unit outputs the excess position error alarm and opens the DRDY output circuit.
- If 0 is specified, the excess position error alarm detection is invalidated (i.e., no alarm function).
- "TS" or "?CO" command reports the current setting.

★ *CR : Circular Resolution*

Format : CR data
Data : X1, X2, X5
Shipping set : X1
Default : Not omissible

- Use to specify the pulse train resolution.
- For the details about the resolution, refer to "10.4. Pulse Train Command."
- The resolution changes immediately after CR data is specified.
- "TS" or "?CR" command reports the current setting.

CV : Channel Velocity

Format : CV data
Data : 1 ~ 1800 [mm/s]
Default : 0

- This command is used to specify the velocity of each channel of the Programmable Indexer.
- The "CV" command may be input under the condition where a channel to be programmed is selected with a CH command, the Driver Unit outputs "?," and the system waits for a command to be entered. If it is entered in the normal stand-by state, an error occurs. (normal stand-by state: when the colon " : " is displayed while waiting for input.)
- If no setting is made in a channel (or 0 is specified), the velocity specified with an MV command is valid

★ *DBP : Dead Band*

Format : DBP data
Data : 0 or 1 ~ 4095
Shipping set : 0
Default : 0

- Sets a dead band for detecting errors in the position loop.
- For more details, refer to "9.2.5. Dead Band Setting: DBP."
- "TS" or "?DBP" command reports the current setting.

★ *DI : Direction Inversion*

Format : DI data
Data : 0 or 1
Shipping set : 0
Default : 0

- Switches the position scale counting direction.
- For more details, refer to "9.2.1. Position Scale."

★ *FC : Friction Compensation*

Format : FC data
Data : 0 ~ 2047
Shipping set : 0
Default : 0

- "FC" is used to specify a compensation value to cancel rotational static friction of the Motor.
- If 0 is specified in 'data' the function is deactivated.
- Parameter FC can be obtained with the formula shown below.

$$\text{FC 'data'} = 2047 \times \frac{\text{Static friction force}}{\text{Motor maximum force}}$$

- The setting can be read with "TS" or "?FC" command.

★ *FD : Feed Back Direction Mode*

Format : FD data
Data : 0, 1
Shipping set : 0
Default : 0

- Reverses the output timing between øA and øB of the position feedback signal.

  FD0: Standard ; øA signal is ahead of øB signal when Motor moves toward PLS direction.

  FD1: Reverse ; øB signal is ahead of øA signal when Motor moves toward MNS direction.

- "TS" or "?FD" command reports the current setting.

★ *FF : Feed Forward Gain*

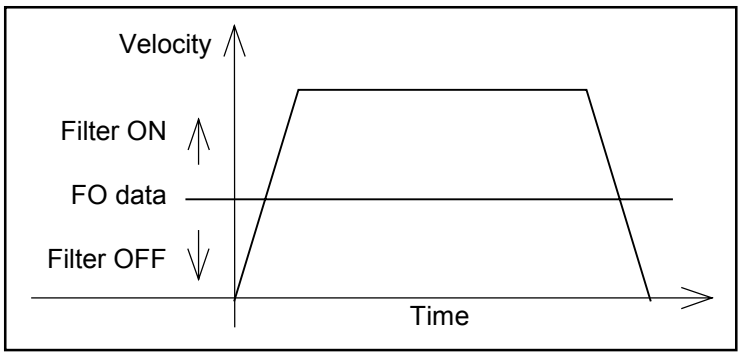
Format : FF data
Data : 0.0000 ~ 1.0000
Shipping set : 0
Default : 0

- FF sets the feed forward compensation gain.
- For more details, refer to "9.2.3. Feed Forward Compensation."
- Setting 0 cancels the feed forward compensation function.
- "TS" or "?FF" command reports the current setting.

FO : Low-pass Filter OFF Velocity

Format : FO data
Data : 0, 1~1800 [mm/s]
Default : 0

- Sets the low pass filters (parameter FP and FS), depending upon velocity.
- FO data sets the velocity threshold which turns ON and OFF the low pass filters.



- When this function is set, it is possible to lower the resonance noise level without affecting on the settling time.
- When "FO" is set to 0 the function is invalid. (The low-pass filters are always active.)

FP : Low-pass Filter, Primary

Format : FP data
Data : 0, 10 ~ 500 [Hz] or /AJ (Adjusting mode)
Shipping set : 0
Default : 0

- FP sets the frequency of the primary low-pass filter of the velocity loop.
- When 0 is input, the velocity-loop primary low-pass filter is set to "off". At this time, [PRI.LPF OFF] appears on the display.
- When data other than 0 (i,e, 10 ~ 500) is input, the frequency specified by the data is set.
- The set value can be read by the "TS" command and "?FP".
- Inputting FP/AJ can set to adjusting mode.

★ *FR : Feed Back Signal Resolution*

Format : FR data
Data : 0 or 1
Shipping set : 0
Default : 0

- Sets the resolution specification of the position feedback signal øA and øB.

  FR0 : 10-bit resolution specification

  FR1 : 12-bit resolution specification

- For more details about the resolution, refer to "4.2.2.2. Function Specification."
- Set FR0 when the resolver resolution is set to 10-bit or automatic resolution switching by the RR parameter. If FR1 is set, øA and øB will not be output.
- Both FR0 and FR1 can be selected when the resolver resolution is set to 12-bit specification by the RR parameter.
- "TS" or "?FR" command reports the current setting.

FS : Low-pass Filter, Secondary

Format : FS data
Data : 0, 10 ~ 500 [Hz] or /AJ (Adjusting mode)
Shipping set : 0
Default : 0

- Sets the frequency of the secondary low-pass filter of the velocity loop.
- When 0 is input, the velocity-loop secondary low-pass filter is set to "off". At this time, [SEC.LPF OFF] appears on the display.
- When data other than 0 (i,e, 10~500) is input, the frequency specified by the data is set.
- The set value can be read by the "TS" command and "?FS".
- Inputting FS/AJ can set to adjusting mode.

FW : FIN Width

Format : FW data
Data : 0 or 0.3 ~ 100 [0.1 second]
Shipping set : 1
Default : 0

- Sets the width (length) of IPOS output. Unit is 0.1 sec.
- If it is set to FW1, the time length of the IPOS output will be 0.1 sec.
- If it is set to FW0, IPOS output is in standard state and always closed when the position error counter value is less than the "IN" setting.
- When it is set to FW0.3 ~ FW100, IPOS output is closed for the moment as set when the position error counter value is less than the "IN" value.
- Refer to "9.1.6. In-Position Output" for the output timing.
- "TS" or "?FW" command reports the current setting.
- Set FW0 when the system is performing the pulse train command operation.

★ *FZ : Feedback Phase Z Configuration*

Format : FZ data
Data : 0 or 1
Shipping set : 0
Default : 0

- FZ selects the output type of the position feedback signal CHZ (CN2 output).

  FZ0: Outputs the øZ signal from CHZ.

  FZ1: Outputs MSB of the digital position signal from CHZ.
- Refer to "9.1.7. Position Feedback signal" for the output timing of the øZ signal or MSB.
- "TS" or "?FZ" command reports the current setting.

HA : Home Return Acceleration

Format : HA data
Data : 0.01 ~ 2.50 [G]
Shipping set : 0.05
Default : Not omissible

- Sets the home return acceleration.
- "TS" or "?HA" command reports the current setting.

★ *HD : Home Return Direction*

Format : HD data
Data : 0 or 1
Shipping set : 1
Default : 0

- For more details about the home return operation, refer to "10.2. Home Return."

HD0: Home return in the PLS direction

HD1: Home return in the MNS direction

★ *HO : Home Offset*

Format : HO data
Data : 0~7 30 000 000 [pulse]
Shipping set : 0
Default : 0

- Specifies an offset from the point where the position error counter reaches 0 for the first time, after the home position limit switch input (HLS on CN2) goes inactive, to the point where the Motor stops.
- "TS" or "?HO" command reports the current setting.
- Refer to "10.2. Home Return" for more details.

HS : Home Return Start

Format : HS

- Starts the home return.
- Input HS/LS to adjust the installation position of the home limit switch (sensor).
- For more details, refer to "10.2.2. Adjusting the Home Limit Switch and Home Offset Value."

HV : Home Return Velocity

Format : HV data
Data : 1 ~ 1800 [mm/s]
Shipping set : 100
Default : Not omissible

- Sets the home return velocity.
- "TS" or "?HV" command reports the current setting.

HZ : Home Return Near-Zero Velocity

Format : HZ data
Data : 1 ~ 100 [mm/s]
Shipping set : 5
Default : Not omissible

- Sets the home return near-zero velocity.
- "TS" or "?HZ" command reports the current setting.

★ *ILV : Integration Limit*

Format : ILV data
Data : 0.0 ~ 100.0 [%]
Shipping set : 100

- Provides the velocity loop integration with a limiter.
- For the details, refer to "9.2.4. Integrator Limiter: ILV."
- "TS" or "?ILV" command reports the current setting.

IN : In-position

Format : IN data
Data : 0 ~ 99 999 999 [pulse]
Shipping set : 100
Default : 0

- Specify an in-position width (criterion of detecting completion of positioning.) If the position error counter reads a value below the IN set value, the IPOS is output.
- "TS" or "?IN" command reports the current setting.
- When the resolver is set to 10-bit resolution, the resolution becomes one-fourth of the 12-bit setting. Therefore, only a multiple of 4 can be set (valid) as IN data.

IO : Input/Output Monitor

Format : IO data opt.
Data : 0 or 1
Opt (option code) : /RP

- Verifies on/off (closed/open) of the control input and output signals on CN2.
- The status of the inputs and outputs is indicated as 1's or 0's.

  'data' = 0 or omitted
  Input : 0: off, 1: on
  Output : 0: open, 1: close

  'data' = 1: For the B contact input, the meaning of 1 and 0 are reversed.

- Option code /RP

  opt = omitted : Indicates the present status.

  opt = /RP : Reading is repeated automatically.

- To terminate automatic reading, press the BS key.
- Method of indication

  ◊ The reading will be shown in 13 digits. All 1's and 0's represent the status of each signal as shown in the table below.

  I_1 I_2 I_3 I_4 I_5 I_6 I_7 I_8 / O_1 O_2 O_3 O_4
  (For each I_1 I_2 I_3 I_4 I_5 I_6 I_7 I_8 / O_1 O_2 O_3 O_4 , 1's or 0's will be indicated. O_2 and O_4 are always 0.)

	Input signal									Output signal			
	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8		O_1	O_2	O_3	O_4
TY1	SVON	EMST	RUN	HLS	PRG3	PRG2	PRG1	PRG0	Input/ Output separation	DRDY	-	IPOS	-
TY2	SVON	EMST	RUN	HLS	PRG3	PRG2	DIR	JOG		DRDY	-	IPOS	-
TY3	SVON	EMST	RUN	HLS	PRG3	PRG2	OTM	OTP		DRDY	-	IPOS	-
TY4	SVON	EMST	RUN	HLS	HOS	CLR	OTM	OTP		DRDY	-	IPOS	-
TY7	SVON	EMST	RUN	HLS	DIR	JOG	OTM	OTP		DRDY	-	IPOS	-

IR : Incremental Positioning, Resolver

Format : IR data
Data :-99 999 999 ~ +99 999 999 [pulse]
Default : 0

- Executes the incremental positioning command (in the units of pulse) in the RS□232C communication operation.
- The data sign specifies the direction of rotation (movement).
  data > 0: plus direction (PLS direction)
  data < 0: minus direction (MNS direction)

IS : In-position Stability Timer

Format : IS data
Data : 0 or 0.3 ~ 100.0 [0.1 sec]
Default : 0

- Specifies the output condition of the positioning completion signal (IPOS).

  IS0 : The IPOS output closes in positioning if the value of the position error counter is within the IN set range.

  IS data (data≠0) : The IPOS output closes in positioning if the value of the position error counter is stable within the IN set range for the time specified in IS. The timer value is specified in 'data' in units of 0.1 second. It may be 0.03 to 10 seconds if data is specified as 0.3 to 100.

- "TS" or "?IS" command reports the current setting.

- This parameter is invalid in the pulse train operation mode.

JA : Jog Acceleration

Format : JA data
Data : 0.01 ~ 2.50 [G]
Shipping set : 0.05
Default : Not omissible

- Sets the acceleration for Jog operation.

- "TS" or "?JA" command reports the current setting.

JP : Jump

Format : JP data
Data : 0 ~ 15
Default : 0

- "JP" is used to specify the destination of unconditional jumping in a channel.

- If a channel with a "JP" command is executed, processing jumps to channel 'data' unconditionally.

- The "JP" command may be input under the condition where a channel to be programmed is selected with a "CH" command, the Driver Unit outputs "?," and the system waits for a command to be entered. If it is entered in the normal stand-by state, an error occurs. (normal stand-by state: a colon ":" is displayed)

JV : Jog Velocity

Format : JV data
Data : 1 ~ 1800 [mm/s]
Shipping set : 50
Default : 0

- Sets the velocity for Jog operation.

- "TS" or "?JV" command reports the current setting.

LG : Lower Gain

Format : LG data
Data range : 0 ~ 100 [%]
Shipping set : 50
Default : Not omissible

⚠ *Caution : Factory use only. Do not change the setting.*

★ *LO : Load Inertia*

Format : LO data
Data range : 0.0 ~ 500.0 [kg]
Shipping set : 0
Default : 0

- LO sets actual load inertia automatically when AT command (automatic tuning) is executed.
- "TS" or "?LO" command reads out the current setting.
- Data of PG, VG, VI, and MA parameters will be automatically reset when LO is changed.
- Change of PG and VI data will clear LO data.

★ *LR : Low Torque Ripple*

Format : LR data
Data range : 0, 1
Shipping set : 0
Default : 0

- Sets force specification.

  0: Standard

  1: Low force ripple. (the maximum Motor force will be lowered)

- "TS" or "?LR" command reports the current setting.

MA : Move Acceleration

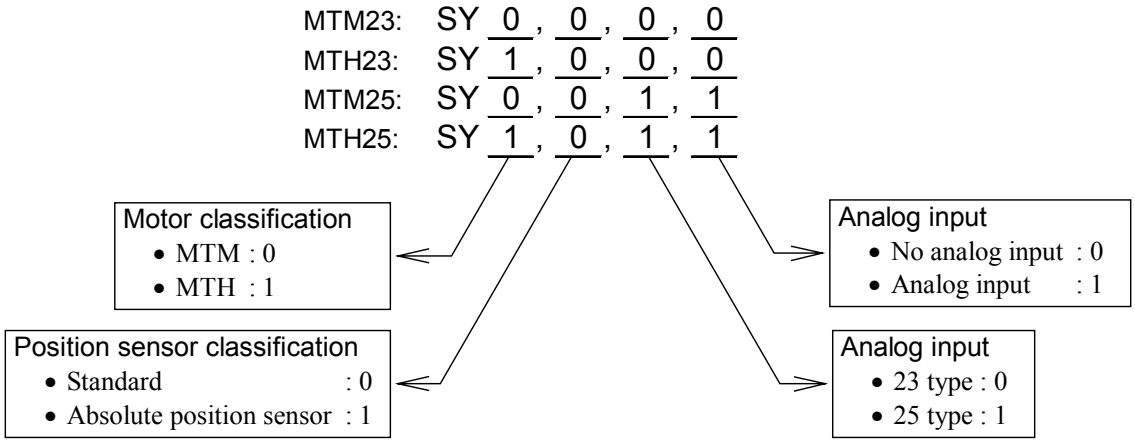
Format : MA data
Data : 0.01 ~ 2.50 [G]
Shipping set : 0.05
Default : Not omissible

- Sets the rotational acceleration of the RS-232C communication positioning.
- "TS" or "?MA" command reports the current setting.
- "MA/AJ" command gets into adjusting mode.

MI : Read Motor ID

Format : MI

- MI indicates reference number of the system ROM and the torque ROM.
- SY data that are read out by MI command have the meaning as shown below.



★ *MM : Multi-line Mode*

Format : MM data
Data : 0, 1
Shipping set : 1
Default : 0

- Sets the display format of commands or parameters settings with “TA” , “TC” and “TS” commands.
- “MM0” reports all contents continuously.
- When “MM1” is input, the display reports the setting pausing at each item. At this time, the colon “ : “ appears the end of command or parameter.

  [Example: MA0.01:]

  ◊ To step to the next report, press the space key.

  ◊ To quit from the report, press the backspace key. The colon “ : ” appears in the display and the system waits for next command.
- “TS” or “?MM” reports the current setting.

MO : Motor Off

Format : MO

- When the SVON input (CN2) is ON and the Motor is in the servo-on state, inputting the MO command turns the Motor servo off.
- To active the Motor servo, input the “SV” command or the “MS” command.
- When the “MS” command is input, the Motor stops in the servo-on state. This also clears the previously input operation command.

MS : Motor Stop

Format : MS

- When the "MS" command is input during the execution of an operation, the Motor abandons the instruction and stops. At this time, the Motor is in the servo-on state.
- The operation instruction specified before the Motor stop is cleared. If the "MO" command is input to turn off the Motor servo, inputting the "MS" command sets the Motor to servo-on again. This also clears the operation instruction executed preceding the input of the "MO" command.

MT : Factory Use Only

Shipping set : Already set properly for every system.

⚠ *Caution : Do not change the setting since the parameter is properly set at the plant.*

- "TS" or "?MT" command reports the current setting.

MV : Move Velocity

Format : MV data
Data : 1~1800 [mm/s]
Shipping set : 500
Default : Not omissible

- Sets the moving velocity of the Motor in the RS□232C communication positioning command.
- "TS" or "?MV" command reports the current setting.
- "MV/AJ" command sets to adjusting mode.

NP : Notch Filter, Primary (primary notch filter frequency)

Format : NP data
Data : 0 or 10 ~ 500 [Hz]
Shipping set : 0
Default : 0

- NP is used to specify the frequency of the 1st stage notch filter of the velocity loop.
- If 0 is specified, the 1st stage notch filter of the velocity loop is deactivated. In such a case, "PRI.NF OFF" is displayed.
- If a value other than 0 (i.e., 10~500) is entered, the value is adopted as the frequency.
- "TS" or "?NP" command reports the current setting.
- "NP/AJ" command sets to adjusting mode.

NS : Notch Filter, Secondary (secondary notch filter frequency)

Format : NS data
Data : 0, 10 ~ 500 [Hz] or /AJ (adjust mode)
Shipping set : 0
Default : 0

- NS data sets frequency of secondary notch filter.
- If "0" is specified, the 2nd stage notch filter will be set to OFF. In such a case the display shows "SEC.NF.OFF."
- If the data other than "0" (i.e., 10 ~ 500) is specified, the frequency sets to data.
- Command "TS" or "?NS" reports the frequency setting.
- "NS/AJ" starts adjusting program.

★ *NW : Neglect Width*

Format : NW data
Data : 0 ~ 4
Shipping set : 2
Default : 0

- RUN and HOS are edge-triggered inputs. To protect against multiple inputs due to contact chattering, the NW parameter sets a timer length to confirm the receipt of that input; when NW data is specified, the input pulse is detected a specified time after it initially went high (rising edge).

  Timer = data × 2.8 [ms]

- "TS" or "?NW" command reports the current setting.

OE : Sequence Option Edit

Format : OE data
Data : * or &
Default : Not omissible

- OE changes the sequence code of a program already specified in a channel.
- If this command is entered under the condition where a channel whose sequence code shall be changed is selected with a CH command, the Driver Unit outputs "?," and the system waits for a command to be entered, the sequence code of the program already specified in the channel is changed into 'data.' If OE is entered in the normal stand-by state, an error occurs.
- "Data" indicates the sequence code. Adding the sequence code enables to execute the positioning of next channel without selecting channel externally.

  * After the positioning is over, "IPOS" signal is output and execute next channel's program.

  & After the positioning is over, output "IPOS" signal and stops. Then execute the next channel's program when "RUN" command is input.

★ *OG : Origin Set*

Format : OG

⚠ *Caution : This "OG" command is for factory use only. Do not change the setting.*

★ *OL : Overload Limit*

Format : OL data
Data : 0 ~ 100
Shipping set : Unique value for each System
Default : 0

- Do not change the OL setting. OL is properly set for each System. If it needs to be changed, contact NSK.
- If 0 is specified, "THERMAL OFF" is displayed and this function is deactivated.
- "TS" or "?OL" command reports the current setting.

★ *OS : Origin Setting Mode*

Format : OS data
Data : 1, 3, 4, 5
Shipping set : 4
Default : Not omissible

- Sets the "Home return" mode.

  OS1: Completes "Home return" at where "HLS" input goes OFF after entering "HLS" ON range.

  OS3: Completes "Home return" at where the Motor advances "HO" value after going out from "HLS" ON range.

  OS4: Completes "Home return" at where the Motor advances for "HO" value after entering "HLS" ON range.

  OS5: Completes "Home return" at where "HLS" input goes ON.

- Refer to "10.2. Home Return" for more details.
- The home return setting can be checked with "TS" or "?OS" command.

★ *OTP : Overtravel Limit Switch Position*
★ *OTM*

Format : OTP data, OTM data
Data : -99 999 999 ~ +99 999 999 [pulse]
Shipping set : OTP0, OTM0
Default : 0

- Sets the software overtravel limit values in the position scale.

  OTP : Sets the overtravel limit value in the plus direction in the units of pulse.

  OTM: Sets the overtravel limit value in the minus direction in the units of pulse.

- "OTP/ST" and "OTM/ST" command enables to set the position by teaching.

  * For more details, refer to "9.1.4.2. Software Overtravel Limit".

- "TS" or "?OTP", "?OTM" command reports the current setting.

★ *PA : Phase Adjust*

Format : PA data
Data : 24 ~ 1048
Shipping set : Unique value for each System
Default : 0

- Sets the compensation value of the resolver installation position.
- The resolver is set to the optimum installation position before shipment. Do not input PA in normal use.
- "TS" or "?PA" command reports the current setting.

★ *PC : Pulse Command*

Format : PC data
Data : 0 ~ 4
Shipping set : 0
Default : 0

- Sets the format of the pulse train input.

  PC0: PLS & MNS format

  PC1: Pulse & direction format

  PC2: øA/øB input × 1 format

  PC3: øA/øB input × 2 format

  PC4: øA/øB input × 4 format

- "TS" or "?PC" command reports the current setting.

PG : Position Gain

Format : PG data
Data : 0.001 ~ 1.000 or /AJ (Adjust mode)
Shipping set : 0.1
Default : Not omissible

- Specifies a position gain.
- "TS" or "?PG" command reports the current setting.

★ *PH : Program Home Return*

Format : PH data
Data : 0, 1, 2
Shipping set : 0
Default : 0

- Sets when the Home return shall be executed.

  PH0: Program Home return invalid.

  PH1: Execute Home return only once when the power is turned on and the home position is not certain.

  PH2: Execute Home return every time when the programmable indexer positioning is performed.

- "HS" command saves one channel program area.
- "TC/AL" or "?PH" reports the current setting.

★ *RC : Rated Current (Software Thermal)*

Format : RC data
Data : 0 ~ 100
Shipping set : Unique value for each System
Default : 0

- Do not change the RC setting. RC is properly set for each System. If it needs to be changed, contact NSK.
- "TS" or "?RC" command reports the current setting.

★ *RI : Factory Use Only*

Shipping set : Set properly to each Motor.

⚠ *Caution : Do not change setting. It is properly set for each Motor at the factory.*

- "TS" or "?RI" reports the current setting.

★ *RR : Resolver Resolution*

Format : RR data
Data : 0, 1, -1
Shipping set : -1
Default : 0

- Sets the resolution of the resolver.

  RR0 : 10-bit setting

  RR1 : 12-bit setting

  RR-1 : Automatic resolution switching

- For the details about the resolution, refer to "4.2.2.2. Functional Specifications."
- "TS" or "?RR" command reports the current setting.

★ *SE : Serial Error*

Format : SE data
Data range : 0, 1
Shipping set : 0
Default : 0

- Set DRDY output format when RS-232C serial communication is abnormal.

  SE0: DRDY output close (Motor state: normal)

  SE1: DRDY output open (Motor state: servo lock)

- TS or ?SE reads out the setting.
- Bs sure to use "SE1" for RS-232C communication command operation.

SG : Servo Gain

Format : SG data
Data : 0 ~ 30 [Hz] or /AJ (Adjust mode)
Shipping set : 0
Default : Not omissible

- Sets the band of position loop.

  ◊ Automatic tuning sets "SG" value.

- When "SG" value is changed, "PG" (position gain), "VG" (velocity gain) and VI (velocity integrator frequency) settings will be automatically revised.
- "SG/AJ" command sets the adjusting program.
- "TS" or "?SG" reports the current setting.

★ *SI : Set Initial Parameters*

Format : SI/data
Data range : None, AL, SY
Default : None

- Resets parameters to the shipping set value.
- The SI command can be input only immediately after inputting the password and when the Motor is servo-off.
- The following parameters will be initialized by SI:

  SI : Initializes servo-related parameters (PG, VG, VI, DBP, ILV, FF, FP, FS, NP, LG, TL, SG, LO, FO, FC))

  SI/AL: Initializes all the parameters.

  SI/SY: Initializes all the parameters excluding PA.

  * Executing "SI/AL" entails resolver phase adjustment. Be careful that the Motor is not locked by an external force. Do not perform initializing only to the Driver Unit.

  ⚠ *Caution : System initialization takes about 30 seconds. Do not turn off the power while initialization is being performed; otherwise, the memory will become faulty.*

  * When the memory is faulty, SI/AL will be executed even if SI or SI/SY is input.

★ *SM : Servo On Mode*

Shipping set : 1

⚠ *Caution : "SM" is properly set at the factory. Do not change the setting.*

SP : Start Program

Format : SP data
Data range : 0 ~ 15 or /AJ (Adjust mode)
Default : 0

- Execute Programmable Indexer of a channel which number is specified in ｹ data ｺ.
- "SP/AJ" command executes the demonstration program (back and forth operation).

SV : Servo-on

Format : SV

- When the Motor servo is turned off by "MO" command, executing the "SV" command will turn the Motor servo on.
- To turn the Motor servo on by the "SV" command, the SVON input of CN2 must be on.

TA : Tell Alarm Status

Format : TA
Data : None /HL/CL
Default : None

- TA : Reports alarms currently given.
- TA/HL : Displays history of alarms. Refer to "14.2.5. History of Alarms."
- TA/CL : Clears history of alarms. Password is required to execute the command.
- There will be no indication when no alarm is reported.
- Indication below is displayed when the alarm is reported.

Alarm	7 segments LED	Terminal Display
Memory error	E0	E0>Memory Error
EEPROM error	E2	E2>EEPROM Error
System error	E7	E7>System Error
Excess Position error	F1	F1>Excess Position Error
Software Over Travel Limit	F2	F2>Software Over Travel
Hardware Over Travel Limit	F3	F3>Hardware Over Travel
Emergency Stop	F4	F4>Emergency Stop
Program error	F5	F5>Program Error
Automatic Turing error	F8	F8>AT Error
RS-232C error	C2	C2>RS-232C Error
CPU error	C3	C3>CPU Error
Resolver Circuit error	A0	A0>Resolver Circuit Error
Software Thermal Sensor	A3	A3>Overload
Velocity error over	A4	A4>RUN away
Heat Sink Overheat	P0	P0>Over Heat
Abnormal Main AC Line Voltage	P1	P1>Main AC Line Trouble
Over Current	P2	P2>Over Current
Control AC Line Under Voltage	P3	P3>Control AC Line Under Voltage

- When an alarm is reportd, it is identified as shown below.
- When multiple alarms are reported, a pause between the alarms will start a mew line.
- Switching display format by MM os effective.
- Example of display: Hardware travel limit and emergency stop are display bu MM1 format.

```
:TA
 F3>Hardware Over Travel;
 F4>Emergency Stop;
:_
```

TC : Tell Channel Program

Format : TC data
Data : 0 ~ 15 or /AL
Default : 0

- Reports the program contents of a channel specified on ヤ data ユ.
- No data is displayed if program is not set to the channel.
- "TC/AL" command is to scroll all channels with pressing the space key.

TE : Tell Position Error Counter

Format : TE/RP

- Reads the value of the position error counter. The displayed value is between –2 147 483 648 and +2 147 483 647. If it exceeds or lowers below the upper or lower limit, it is changed into the lower or upper limit with a reversed sign.
- If an /RP option is added to a TE command, reading is repeated automatically.
- In automatic reading, a value consisting of up to six figures is read out. If a value consists of more than six figures, "*******" is displayed.
- To terminate automatic reading, press the BS key.
- When only "TE" is entered, the display shows the value at the moment.

★ *TL : Torque Limit Rate*

Format : TL data
Data : 0 ~ 100 [%]
Shipping set : 100
Default : 0

- Sets the torque limit.
- The Motor torque will be reduced to a percentage (%) of the maximum torque immediately after "TL" is input and the Motor torque is controlled not to exceed the limit.
- "TS" or "?TL" reads the current setting.

TP : Tell Position

Format : TP2/RP
Shipping set : None
Default : Not omissible

- "TP2" command reads the current position of the Motor in the pulse scale.
- If /TP is executed with an /RP option, reading is repeated automatically.
- If only "TP2" is executed, the display shows the position at the moment.
- To terminate automatic reading, press the BS key.

TR : Tell RDC Position Data

Format : TR/RP

- TR reads data of RDC position data.
- Data is between 0 and 4095.
- If "TR" command is executed with /RP option, reading is repeated automatically.
- To terminate automatic reading, press the BS key.
- "TR" command reads out the status at the moment.

TS : Tell Settings

Format : TS data
Data : 0 ~ 12
Default : 0

- Reads the parameters. The parameters to be read vary with data.

TS0 : All the following parameters
TS1 : PG, VG, VI, VM, LG, TL
TS2 : FO, FP, FS, NP, NS, DBP, ILV, FF, FC
TS3 : CO, IN,IS, FW, VO, VW
TS4 : CR, PC, RR
TS5 : FD, FZ, FR
TS6 : PS, DI, OTP, OTM
TS7 : MV, MA, JV, JA, HV, HA, HZ
TS8 : OS, HD, HO
TS9 : PA, OL, RC, LR
TS10 : TY, AB, SM, NW
TS11 : MM, BM, CM, AN, WM, SE
TS12 : LO, SG, MT, RI, ZP, ZV

★ *TY : I/O Type*

Format : TY data
Data : 1, 2, 3, 4, 7
Shipping set : 4
Default : Not omissible

- Sets the input/output signal type of the CN2 connector.
- The set value can be read by the "TS" command or "?TY".
- The input/output signals of each type are shown below.

CN2 connector pin No.	Input signal								Output signal	
	25	12	24	11	23	10	22	9	2 15	14
TY1	SVON	EMST	RUN	HLS	PRG3	PRG2	PRG1	PRG0	DRDY	IPOS
TY2	SVON	EMST	RUN	HLS	PRG3	PRG2	DIR	JOG		
TY3	SVON	EMST	RUN	HLS	PRG3	PRG2	OTM	OTP		
TY4	SVON	EMST	RUN	HLS	HOS	CLR	OTM	OTP		
TY7	SVON	EMST	RUN	HLS	DIR	JOG	OTM	OTP		

- For more details,, refer to "5.2.1. Setting I/O Type".

VG : Velocity Gain

Format : VG data
Data : 0.1 ~ 255.0 or /AJ (Adjust mode)
Shipping set : 1.0
Default : Not omissible

- Sets the velocity loop gain.
- "VG/AJ" command sets to adjusting mode.
- "TS" or "?VG" reports the current setting.

VI : Velocity Integrator Frequency

Format : VI data
Data : 0.10 ~ 63.00 [Hz] or /AJ (Adjust mode)
Shipping set : 1.00
Default : Not omissible

- Specifies velocity integrator frequency.
- "VI/AJ" command sets to adjusting mode.
- "TS" or "?VI" command reports the current setting.

★ *VM : Velocity Integrator Mode*

Format : VM data
Data : 0, 1
Shipping set : 1
Default : 0

- Changes the velocity loop integrator control as shown below.

  VM0: Velocity loop P control.

  VM1: Velocity loop PI control.

★ *VO : Velocity Error Over Limit*

Format : VO data
Data : 1 ~ 4 095
Shipping set : 1 365
Default : Not omissible

- This is to set the error limit to detect velocity error over alarm.
- Velocity error over alarm will be given when the deviation of velocity exceeds the setting.
- Correspondence between velocity error and data depends on Motor type.

★ *VW : Velocity Error Over Limit Width*

Format : VW data
Data : 1 ~ 4 095
Shipping set : 100
Default : Not omissible

- This is to set the time length to detect velocity error over limit.
- When velocity error limit is over for VW (time length), velocity over limit alarm is given.

★ *WD : Write Data to EEPROM*

Format : WD

- Writes all current settings of programs and parameters to EEPROM.
- Use this command when “WM1” (data back-up invalid) is set.

⚠ *Caution : • Approximately 30 seconds are required to execute this command.*

• Do not turn the power off while executing this command.

• Otherwise, memory error alarm may be issued.

★ *WM : Write Mode to EEPROM*

Format : WM data
Data : 0 or 1
Shipping set : 0
Default : 0

- 500 000 times of resetting/deleting parameters to EEPROM are possible as data back-up. However, frequent resetting/deleting of parameters may exceed the expected life of EEPROM. "WM" is to select data back-up mode to reduce frequency of parameter resetting/deleting

  WM0 : Data back-up valid

  WM1 : Data back-up invalid

  ⚠ *Caution : • When the setting is changed from "WM1" to "WM0", it takes approximately 30 seconds for storing all data.*

  • Do not turn the power off while executing the command.

  • If the power is turned off, memory error alarm may be issued.

- When "SI" is executed, all initialized parameters are stored to EEPROM even "WM" command is set to invalid.

- "TS" or "?WM" reports the current setting.

★ *ZP : Factory Use Only*

Shipping set : 1.00

⚠ *Caution : • The parameter is for the automatic tuning function and is set at the factory.*

• Do not change the setting.

• "TS" or "?ZP" command reports the current setting.

★ *ZV : Factory Use Only*

Shipping set : 1.4

⚠ *Caution : • The parameter is for automatic tuning function and to be set at the factory.*

• Do not change the setting.

• "TS" or "?ZP" command reports the current setting.

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13. Maintenance

13.1. Precautions

- Back-up Motor and Driver Unit
  - ◊ We recommend to prepare a back up Motor and Driver Unit for unexpected shut down of the system.
- Parameter and program back-up
  - ◊ For an unexpected shut down of the Driver Unit, all parameters and programs should be recorded.
  - ◊ For your convenience, the list of parameter and program is provided in the last page of this manual.
- How to replace the driver Unit.
  - ◊ When replacing the Driver Unit, refer to “Appendix 4. How to replace ESA13 Driver Unit”.
- ESA13 Driver Unit has EEP-ROM and does not need a battery for memory back up. (Life of EEP-ROM: approximately 500 000 cycles of writing on and off.)

13.2. Maintenance Check

13.2.1. Motor

- Since a Megathrust Motor does not have any parts which will wear out, a daily maintenance check should be enough.
- The table below shows the maintenance check and intervals. The checking interval shown in the table is reference only. It should be decided according to the actual use conditions.

⚠ *Caution : Do not disassemble the Motor and resolver. If disassembling Motor is necessary, contact your local NSK representative.*

Table 13-1: Motor maintenance check

Item	Checking interval	How to check	Remarks
Appearance	According to environment	• Wipe off dust/slag. • Blow off slag.	–
Greasing	Every 6 months	• Check dirt and contamination. • Supply grease via the grease nipples on both ends of the slider every 6 months approximate. In case of HZ type Motor, grease directly onto the rail grooves.	• Grease : AV2
Insulation	Once/year	• Resistance test (Motor coil and ground earth) (Disconnect Driver Unit)	• Resistance ≥ 10MΩ

13.2.2. Driver Unit and Cable Set

- As a Driver Unit does not have any contact point and highly reliable semiconductors are used, the daily check is not necessary. Checks as shown in Table 13-2 are necessary at least once a year.

Table 13-2

Item	Interval	Check point	Remarks
Retighten screws	Once/year	• Terminal block screw. • Connector fixing screw.	–
Cleaning	Once/year	• Remove dust or contaminants inside of Driver Unit.	–

13.3. Periodical Replacement of Parts

13.3.1. Motor

- There is no parts which is required to be replaced periodically.
- Refer to “13.2. Maintenance Check”.

13.3.2. Driver Unit

- Electrolytic condenser
  - ◊ The gradual chemical change of electrolytic condensers will deteriorate system function and it may result in the system failure.

Table 13-3

Parts	Function	Life	How to replace
Electrolytic condenser	Equalize power voltage	10 years	• Replace *PCB. • Replace whole unit.

*PCB: Printed circuit boad

Note: Life of electrolytic condenser relies on the operating conditions. The 10 years of life is rough estimation under continuous operation in normal room environment.

13.4. Storing

- Store the Motor and Driver Unit in clean and dry indoor condition.
- A Driver Unit has a lot of ventilation holes and should be covered properly to protect from dust.

Table 13-4

Storing condition		Remarks
Temperature	-20°C ~ +70°C	–
Humidity	20% ~ 80%	No condensation

13.5. Warranty Period and Covering Range

13.5.1. Warranty Period

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

13.5.2. Range of Warranty

(1) The items to be warranted are the supplied products by NSK Ltd.

(2) The supplier will repair the supplied products free of charge within the warranty period.

(3) The supplied products will be repaired with cost and fees paid by the customer after the warranty period.

13.5.3. Immunities

- The product is not warranted in one of the following cases even within the warranty period:

(1) Failure of the unit due to installation and operation not in accordance with the instruction manual specified by the supplier.

(2) Failure of the unit due to improper handling and use, modification, and careless handling by the user.

(3) Failure of the unit due to the causes other than those attributable to the supplier.

(4) Failure of the unit due to modification or repair which is conducted by a person(s) or party(ies) other than the supplier.

(5) Other types of failures due to natural disasters and accidents (causes not attributable to the responsibility of the supplier).

(6) Designated consumables (fuses for ESA13 Driver Unit).

- Damages induced by a failure of the supplied unit are not covererd.

13.5.4. Service Fee

- NSK Ltd. reserves the right to charge to a user for the service such as dispatch of engineer(s).
- Startup, maintenance and adjusting of the unit under the supervision of our engineer(s) is a paid service even if it is to be provided during the warranty period.
- Service fees shall be billed to the customer according to the rules on paid services.

14. Alarms

14.1. Identifying Alarms

- The DRDY output opens when error occurs in ESA15 Driver Unit.
- The front panel is provided with a 7-segment LED display to indicate the type of alarm. Also the TA command can be used to identify alarms.

14.1.1. Using LED

Figure 14-1

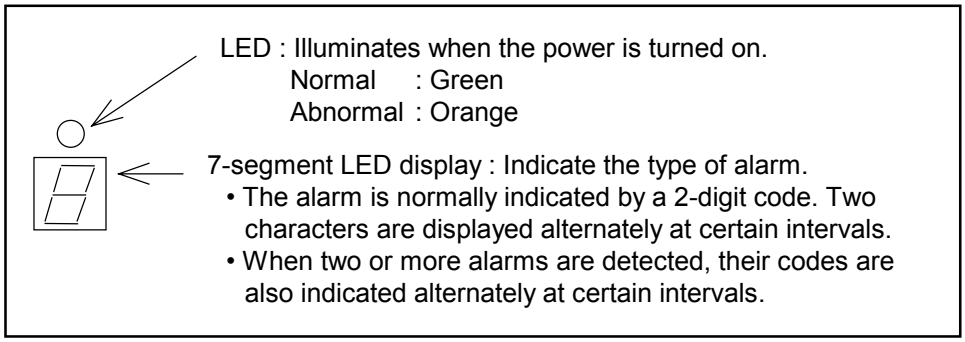
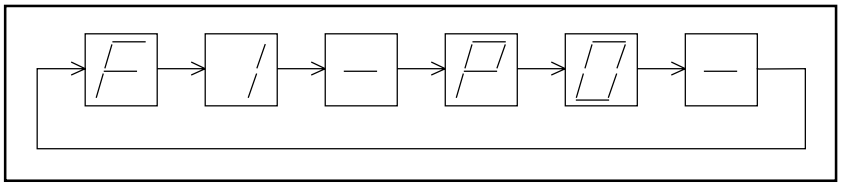
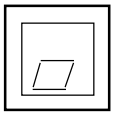


Figure 14-2: Abnormal (example)



(Example) Excess position error F1 + Heat Sink Over-Temperature P0

Figure 14-3: Shows that the LED is indicating normal state.



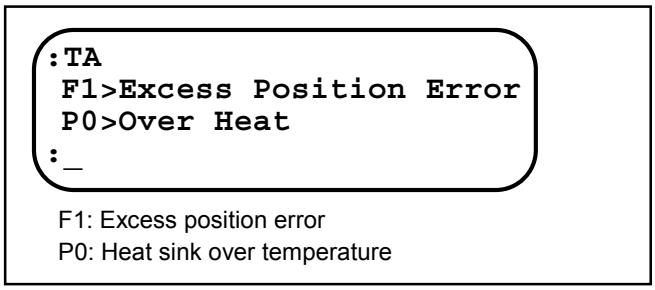
14.1.2. Using TA Command

- "TA" command displays the same alarm code as that is displayed on the 7-segment LED display.
- In this case, the code is not displayed at different time as the LED display.

◊ Example

Excess position error and heat sink over temperature alarms will be displayed as shown in Figure 14-4.

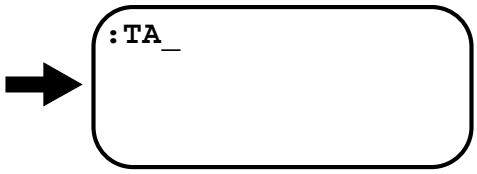
Figure 14-4: Alarm display



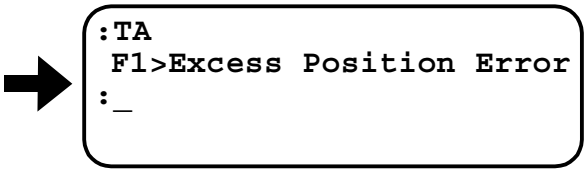
[Example 1] Identify a detected alarm.

(1)

(2)



(3) Press ENT key to exeute and the display identifies the alarm.



- Thus the alarm is identified as "Excess position error".

14.1.3. Alarm List

- Alarms and their codes are listed in Table 14-1.

Table 14-1: Alarm code list

Alarm	7 segments LED	Terminal Display
Memory error	E0	E0>Memory Error
EEPROM error	E2	E2>EEPROM Error
System error	E7	E7>System Error
Excess Position error	F1	F1>Excess Position Error
Software Over Travel Limit	F2	F2>Software Over Travel
Hardware Over Travel Limit	F3	F3>Hardware Over Travel
Emergency Stop	F4	F4>Emergency Stop
Program error	F5	F5>Program Error
Automatic Turing error	F8	F8>AT Error
RS-232C error	C2	C2>RS-232C Error
CPU error	C3	C3>CPU Error
Resolver Circuit error	A0	A0>Resolver Circuit Error
Software Thermal Sensor	A3	A3>Overload
Velocity error over	A4	A4>RUN away
Heat Sink Overheat	P0	P0>Over Heat
Abnormal Main AC Line Voltage	P1	P1>Main AC Line Trouble
Over Current	P2	P2>Over Current
Control AC Line Under Voltage	P3	P3>Control AC Line Under Voltage

- TA commend identifies an alarm.
- The display shows nothing when there is no alarm.
- When two or more alarms are detected, each alarm is displayed in a separate line.
- Display mode changed by “MM” parameter is valid.
- Display example : Emergency stop and hardware over travel limit alarms are detected in MM1 setting.

```
:TA
 F3>Hardware Over Travel;
 F4>Emergency Stop;
:_
```

14.2. Description of Alarm

⚠ Caution : The DRDY output is normally closed. It opens on abnormal condition.

14.2.1. Normal State

- When the Motor does not operate even in normal state, following causes should be considered as shown in Table 14-2.

Table 14-2

Status	Motor condition	DRDY	Cause	Remedy
Power-off	Servo-OFF	open	Power is not supplied.	Turn on power.
CPU Initializing	Servo-OFF	open	Initializing the CPU.	Wait for the CPU to be initialized.
SVON Input OFF	Servo-OFF	closed	SVON input is not active.	Activate the SVON input.

14.2.2. Alarms Related to Power Amplifier

14.2.2.1. Heat Sink Over Temperature

[Output] DRDY: Open
[TA] P0 > Over Heat
[LED] P0
[Motor Condition] Servo-OFF

Table 14-3: Cause and Remedy: Heat sink over temperature

Cause	Remedy
(1) Duty cycles of the Motor is too high. (2) Excessive load is applied.	• Reduce the load and/or operation duty. Readjust acceleration/deceleration. (Stop operation, air-cool the Driver Unit.)
(3) Ambient temperature is above 50°C. (4) Heat sink temperature exceeds 90°C due to continued heavy duty.	• Check surrounding condition of the Driver Unit. • Stop the operation and air-cool the Motor and driver Unit. Then check followings. ◊ Whether the duty cycle is too high. ◊ Whether excessive load is applied. • If no troubles are found in the above check and this alarm occurs frequently, contact NSK.
(5) Defective PCB. (As soon as the control power is turned on, the alarm is activated.)	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit".)

Notes: (1) Stop operation immediately.

(2) Even the alarm goes off, it is activated again when the thermal sensor is still on.
• Take a time to cool the Motor and Driver Unit.

14.2.2.2. Abnormal Main AC Line Voltage

[Output] DRDY: Open
[TA] P1 > Main AC Line Trouble
[LED] P1
[Motor Condition] Servo-OFF

Table 14-4: Cause and Remedy: Abnormal main AC line voltage (Over/Under)

Cause	Remedy
(1) Abnormal power supply voltage. (2)◊ Main circuit voltage is excessive due to high acceleration/deceleration under heavy load. ◊ Defective power source gives over 290V to the main power supply for power amplifier main circuit. (3) Defective power source gives under 40V to power amplifier main circuit.	• Check main power supply. (Excessive voltage, low voltage and power source capacity.) • Check fuse, power source and the cable, then turn power on again.
(4) Blown fuse. (Motor over temperature, abnormal power supply wiring, Driver Unit abnormal.)	• Check blown fuse. • Check the fuse, power supply and cables, then turn on power again.
(5) Excessive regeneration voltage.	• Readjust operation duty, the load and acceleration/deceleration.
(6) Defective PCB. (When the alarm is on after the Motor stops even power source and fuse are normal.)	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit".)

Note: (1) When the regeneration dump resistor can not process regenerative current, the voltage of direct current to main circuit will be too high and the alarm will be on.

(2) Decrease acceleration/deceleration.

14.2.2.3. Over Current

[Output] DRDY: Open
[TA] P2 > Over Current
[LED] P2
[Motor Condition] Servo-OFF

Table 14-5: Cause and Remedy: Over current

Cause	Remedy
(1) Poor insulation of the Motor. (Refer to "Appendix 2. How to Check Motor Condition".)	• Replace Motor.
(2) Defective Motor Cable. (Refer to "Appendix 2. How to Check Motor Condition".)	• Replace Cable.
(3) Defective FET of Power Amplifier. (When the alarm is on even the Motor and Motor cable are normal.)	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit.".)

Note: The alarm may be accompanied with abnormal main AC line voltage (blown fuse) alarm due to excessive current flow.

14.2.2.4. Control AC Line Under-Voltage

[Output] DRDY: Open
[TA] P3 > Control AC Line Under Voltage
[LED] P3
[Motor Condition] Servo-OFF

Table 14-6: Cause and Remedy: Control AC line under-voltage

Cause	Remedy
(1) Low voltage of control power input.	• Check control power voltage. (Low voltage due to over current or output shorting.)
(2) Control circuit voltage for the power amplifier falls below 70V due to faulty power supply.	• Turn off power check the power supply and power cable, then turn on power again.
(3) Faulty PCB. (When the alarm is on after control power is turned on.)	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit".)

14.2.3. Alarms Related to Motor

14.2.3.1. Resolver Circuit Error

[Output] DRDY: Open
[TA] A0 > Resolver Circuit Error
[LED] A0
[Motor Condition] Servo-OFF

Table 14-7: Cause and Remedy: Resolver circuit error

Cause	Remedy
(1) Resolver cable disconnected. (Refer to "Appendix 2. How to Check Motor Condition".)	• Turn off power, check the resolver cable and connector.
(2) Breakage of resolver cable. (Refer to "Appendix 2. How to Check Motor Condition".)	• Replace resolver cable.
(3) Faulty resolver. (Refer to "Appendix 2. How to Check Motor Condition".)	• Replace Motor.
(4) Faulty PCB. (When the alarm is on even when the resolver and the cable are normal and the connector is properly secured.)	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit".)

Note: (1) Check the resolver cable for disconnection and shorted of wires.

(2) Check the connector for contact failure.

(3) When the resolver Cable is forced to move and bend, the bending radius and frequency will affect on the life of cable. It is necessary to have a insulation and continuity tests periodically.

(4) When an excessive current is applied to the resolver, which is induced by internal contact or collision of Motor and motor base, the fuse protecting the existing circuit of resolver may blow out. Replace of Motor and Driver Unit is required in such a case.

14.2.3.2. Software Thermal Sensor

[Output] DRDY: Open
[TA] A3 > Overload
[LED] A3
[Motor Condition] Servo-OFF

Table 14-8: Cause and Remedy: Overload

Cause	Remedy
(1) Excessive Motor duty cycle.	• Reduce duty cycle and the load. Re-adjust acceleration/deceleration. • The Motor is overheated and air-cooling is necessary after the Motor stops. Then turn on power. (After stopping operation, keep control power on.)
(2) Mechanical restraint to the Motor such as brake or an obstacle.	• Remove mechanical restraint.
(3) Improper gain setting.	• Readjust gain. (Refer to "8. Trial Running and Adjustment".)
(4) Unmatched combination of Motor and Driver Unit.	• Check the combination. (Reference number of Motor and Driver Unit.)

Note: Do not change a parameter "CL" setting. It is properly set before shipment.

14.2.3.3. Velocity Error Over

[Output] DRDY: Open
[TA] A4> Run away
[LED] A4
[Motor Condition] Servo-OFF

Table 14-9: Cause and Remedy: Run away

Cause	Remedy
(1) Velocity of Motor has reached to the limit due to external disturbance.	• Clear the alarm.
(2) Velocity of Motor has reached to the limit due to overshooting.	• Reduce setting of acceleration rate. • Reduce rotational speed.
(3) Motor tends to vibrate due to poor servo tuning.	• Tune Motor properly.
(4) Motor runs away. (out-of-control)	• Confirm PA data (parameter) for abnormality. • Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA 13 Driver Unit.")

14.2.4. Alarms Related to Control

14.2.4.1. Memory Error

[Output] DRDY: Open
[TA] E0 > Memory Error
[LED] E0
[Motion Condition] Servo-OFF

Table 14-10: Cause and Remedy: Memory error

Cause	Remedy
(1) Parameters stored in the memory have been rewritten by noise or other cause.	• Initialize the memory then reenter the parameters. (Refer to "12. Command and Parameter".)
(2) Faulty PCB. (When the memory is not functioning after initialized.)	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit".)

◊ Command "SI" initializes the memory. After initializing, some parameters are reset to shipping set. Resetting parameters are necessary.

◊ When the memory error occurs, read out of a parameter with "TA" command will be all "0" (Zero).

14.2.4.2. EEPROM Error

[Output] DRDY: Open
[TA] E2 > EEPROM Error
[LED] E2
[Motor Condition] Servo Free

Table 14-11: Cause and Remedy: EEPROM error

Cause	Remedy
(1) Faulty EEPROM of control circuit.	• Turn the power on again. • Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit".)

14.2.4.3. System Error

[Output] DRDY: Open
[TA] E7>System Error
[LED] E7
[Motor Condition] Servo-OFF

Table 14-12: Cause and Remedy: System error

Cause	Remedy
(1) Faulty ROM on PCB. (2) Faulty EEPROM on PCB.	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit".)

14.2.4.4. CPU Error

[Output] DRDY: Open
[TA] Disabled
[LED] Unstable
[Motor Condition] Servo-OFF

Table 14-13: Cause and Remedy: CPU error

Cause	Remedy
(1) CPU is out of control due to noise.	• Turn power on again. • The alarm is deactivated when the power is turned on again. If the alarm occurs frequently, contact NSK.
(2) Faulty PCB. (When the alarm is not deactivated after the power is turned on.)	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit".)

Notes : (1) CPU is not functioning. RS-232C communication and other controls are disabled.

(2) Contact NSK if the alarm occurred.

14.2.4.5. Excess Position Error

[Output] DRDY: Open
[TA] F1 > Excess Position Error
[LED] F1
[Motor Condition] Servo Lock

Table 14-14: Cause and Remedy: Excess position error

Cause	Remedy
(1) Position error counter value is over "CO" setting due to mechanical restraint such as brake.	• Remove mechanical restraint.
(2) Improper gain setting.	• Readjust gain. (Refer to "Chapter 8. Trial Running and Adjustment".)
(3) Excessive acceleration/deceleration.	• Decrease acceleration/deceleration.
(4) "CP" setting is too low.	• Increase "CO" setting. • Activate the "CLR" input to cancel alarm, then position error counter is cleared to 0 (Zero). • Adjust servo parameters (VG, VI, PG). • Adjust acceleration/deceleration (MA). • Check the applied load.
(5) Unmatched combination of Motor and Driver Unit.	• Check reference number of Motor and Driver Unit.
(6) Improper "PA" setting.	• Refer to "6.2. Motor and Driver Unit Convination".
(7) Faulty PCB. When the alarm is on even "RUN" command is not executed.)	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit".)

14.2.4.6. Software Over Travel Limit

[Output] DRDY: Open
[TA] F2 > Software Over Travel
[LED] F2
[Motor Condition] Servo Lock in one direction.
(The Motor will only move in a direction opposite to that of the rotation limit.)

Table 14-15: Cause and Remedy: Software over travel

Cause	Remedy
(1) The Motor enters the inhibited area set by OTP and OTM	• Get out of inhibited area.

Note: The limit must be set to the position so that the Motor can stop before it is locked or obstructed by mechanical obstacle.

14.2.4.7. Hard ware Over Travel Limit

[Output] DRDY: Open
[TA] F3 > Hardware Over Travel
[LED] F3
[Motor Condition] Servo Lock in one direction.
(The Motor will only move in the direction opposite to that of the rotation limit.)

Table 14-16: Cause and Remedy: Hardware over travel

Cause	Remedy
(1) Motor activated travel limit switch.	• Get out of the restricted area.
(2) Mistaken setting of input port polarity.	• Confirm the parameter “AB”.
(3) Faulty travel limit switch or wiring.	• Check the limit switch and wiring.

14.2.4.8. Emergency Stop

[Output] DRDY: Closed
[TA] F4 > Emergency Stop
[LED] F4
[Motor Condition] Servo Lock

Table 14-17: Cause and Remedy: Emergency stop

Cause	Remedy
(1) Mistaken setting of input port polarity.	• Confirm the parameter “AB”.
(2) EMST is input. (A contact)	• Clear EMST input after the Motor stops.
(3) EMST is input. (B contact)	• Input EMST on after the Motor stops.
(4) Faulty wiring.	• Check wiring.

14.2.4.9. Program Error

[Output] DRDY: Closed
[TA] F5 > Program Error
[LED] F5
[Motor Condition] Servo Lock

Table 14-18: Cause and Remedy: Program error

Cause	Remedy
(1) A non-programmed channel is started.	• Check the program. • Check wiring of PRG0~PRG3 input. • Confirm sequence.

14.2.4.10. Automatic Tuning Error

[Output] DRDY: Closed
[TA] F8 > AT Error
[LED] F8
[Motor Condition] Normal Servo State

Table 14-19: Cause and Remedy: Automatic tuning error

Cause	Remedy	Terminal display
(1) System is in Servo-OFF when executing automatic tuning (2) EMST or Over Travel Limit is input when executing automatic tuning.	• Check input signal and execute automatic tuning again.	AT Error 1
(3) Automatic tuning can not be executed due to unbalanced load.	• Check the load condition. • Set parameters manually.	AT Error 2
(4) Resonant vibration occurs due to low rigidity of the load or the mounting base.	• Check the load or the mounting base. Increase rigidity. • Set parameters manually.	

14.2.4.11. RS-232C Error

◆ **When parameter is SE "0,"**

[Output] DRDY: Close
[TA] C2 > RS232C Error
[LED] C2
[Motor Condition] Normal

◆ **When parameter is SE "1,"**

[Output] DRDY: Open
[TA] C2 > RS232C Error
[LED] C2
[Motor Condition] Servo lock

Table 14-20: Cause anr Remedy: RS-232C error

Cause	Remedy
(1) Connect or disconnect the communication cable with power on.	• Connect or disconnect the communication cable when the power is off.
(2) Attempted to transmit large volume of data without the flow control by CTS and RTS command.	• Wire CTS and RTS signal and apply the flow control.
(3) Wrong Baud rate is set to the terminal.	• Set Baud rate to 9 600 bps.
(4) Fault	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit.")

Note : (1) Parameter SE can set DRDY output and condition of Motor servo when RS-232C communication is abnormal. Refer to "12. Command and Parameter."

(2) RS-232C error may be cleared by input of CRL or CL command.

14.2.4.12. CPU Error

[Output] DRDY: Open
[TA] C3 > CPU Error
[LED] C3
[Motor Condition] Servo-OFF

Table 14-21: Cause and Remedy: CPU error

Cause	Remedy
(1) A wrong program is called due to noise.	• Apply the remedy for noise.
(2) Memory is fault.	• Change Driver Unit.
(3) CPU is faulty.	• Replace Driver Unit. (Refer to "Appendix 4. How to Replace ESA13 Driver Unit.")

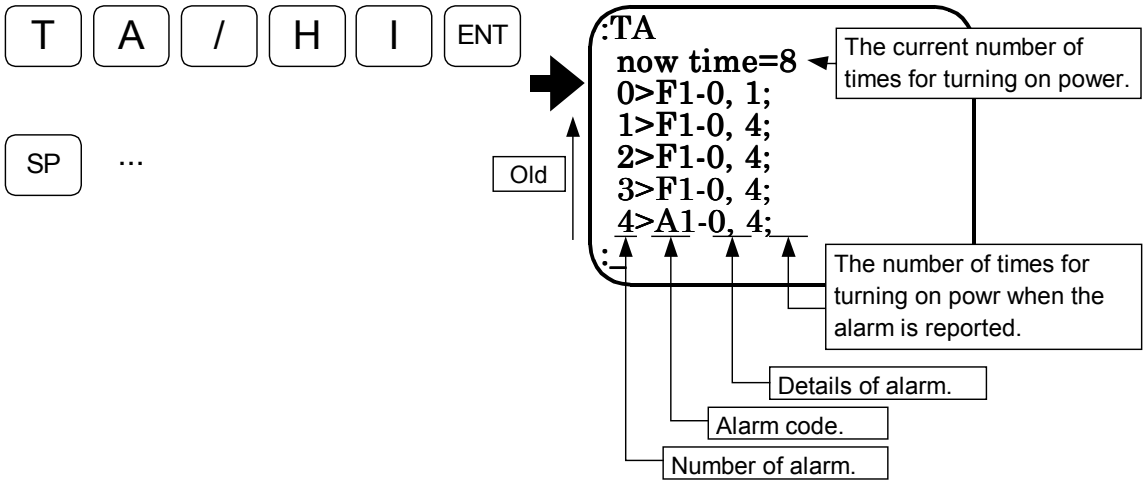
14.2.5. History of Alarm

- Store the occurrence of alarms to EEPROM.
- It keeps the record of alarms up to 32nd befor.
- It does not overwrite more than 32nd alarm. Clear the alarm history to keep the record for new alarms.
- This history records the alarm which makes the DRDY output open.
- Contents of record are as follow.
  (1) Alarm code that is shown on LED.
  (2) Details of alarm for analysis of alarm.
  (3) The number of times the power is turned on.

⚠ *Caution : History of alarm may not be stored properly when the power is shut off right after the alarm is reported.*

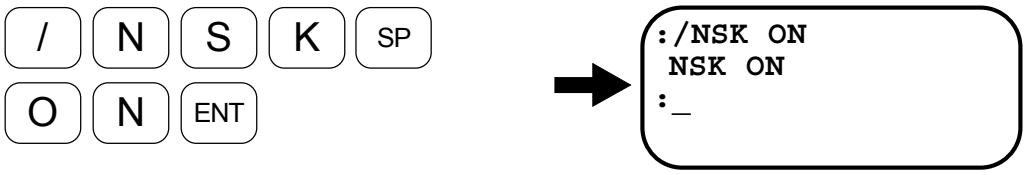
14.2.5.1. Indication of History of Alarm

(1) Input TA command. Press [SP] key to scroll next line.

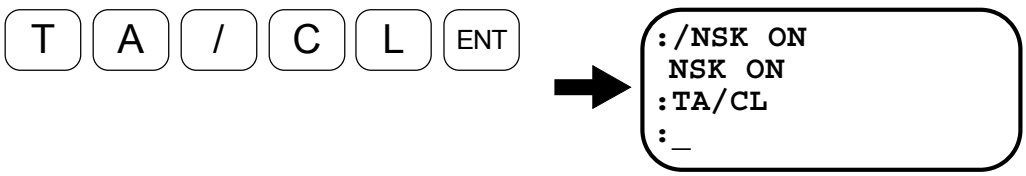


14.2.5.2. Clear History of Alarm

(1) Input password.



(2) Input TA command.



15. Troubleshooting

15.1. Identifying Problem

- If problems do occur, check the items shown in Table 15-1.
- When reporting problems to the manufacturer, explanation of the items in Table 15-1 will help to identify the problem.

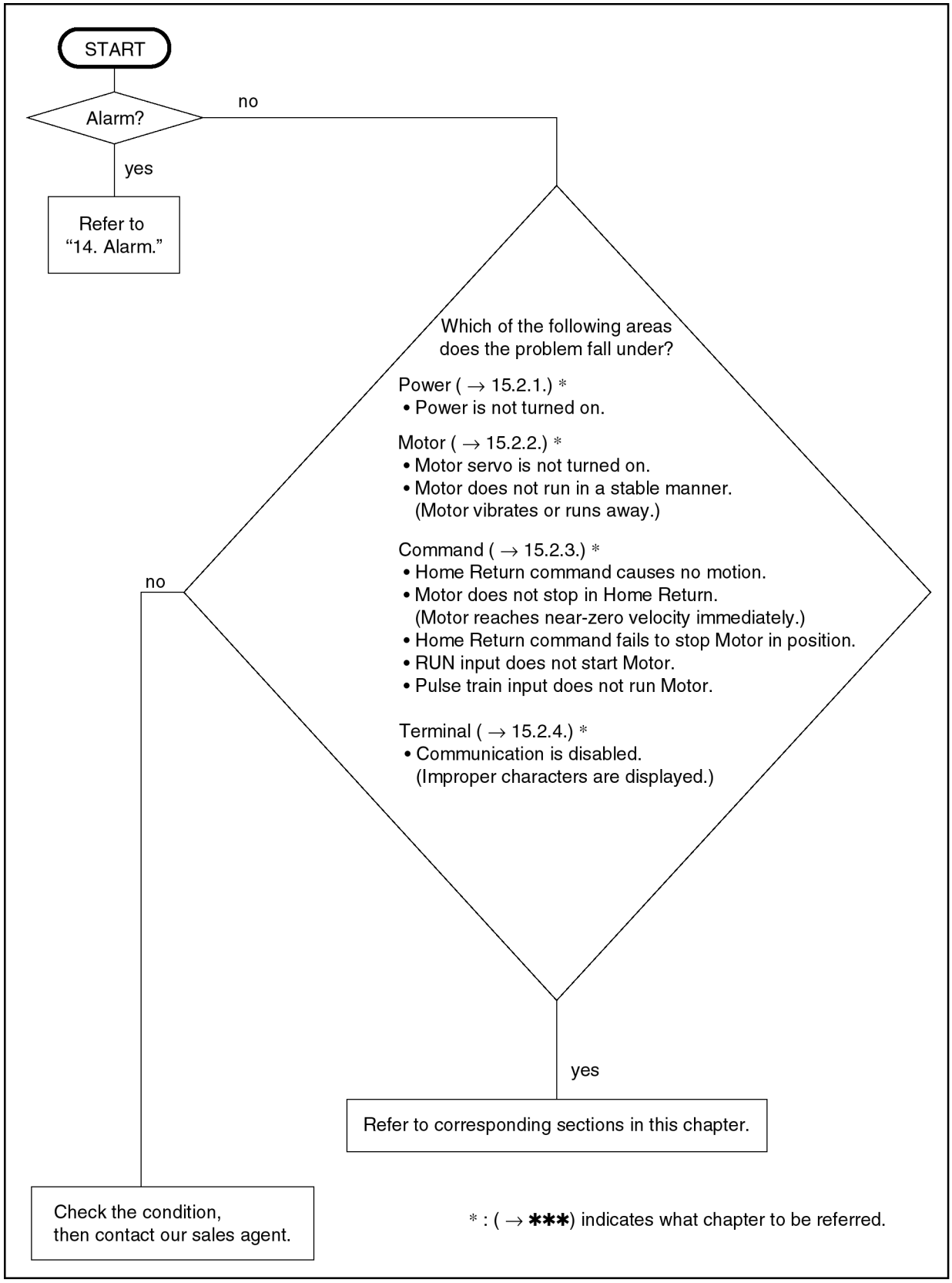
Table 5-1

	Items	Point to be checked
1	Combination of Motor and Driver Unit	• Whether Motor and Driver Unit combination is proper or not.
2	Power supply voltage	• Voltage variation of power source is in specification.
3	Trouble recurrence	• Frequency
4	Occurrence in special occasion	• When a particular command is executed. • A particular equipment is in operation.
5	Occurrence under a particular operation	• Same position/direction • Accelerating/decelerating
6	Alarm Code	• Check alarm code by TA command. (Refer to “14.1.2. Using TA Command.”)

15.2. Troubleshooting

- When troubleshooting, refer to the flow chart shown below.

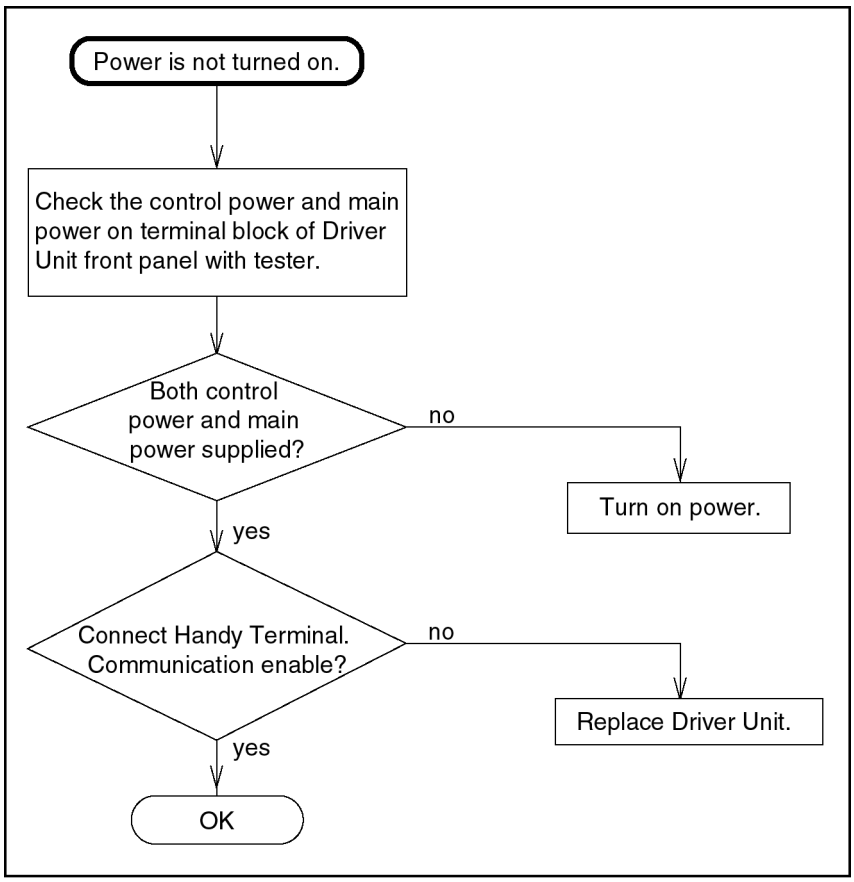
Figure 15-1: Troubleshooting flow



15.2.1. Power Trouble

Power is not turned on.

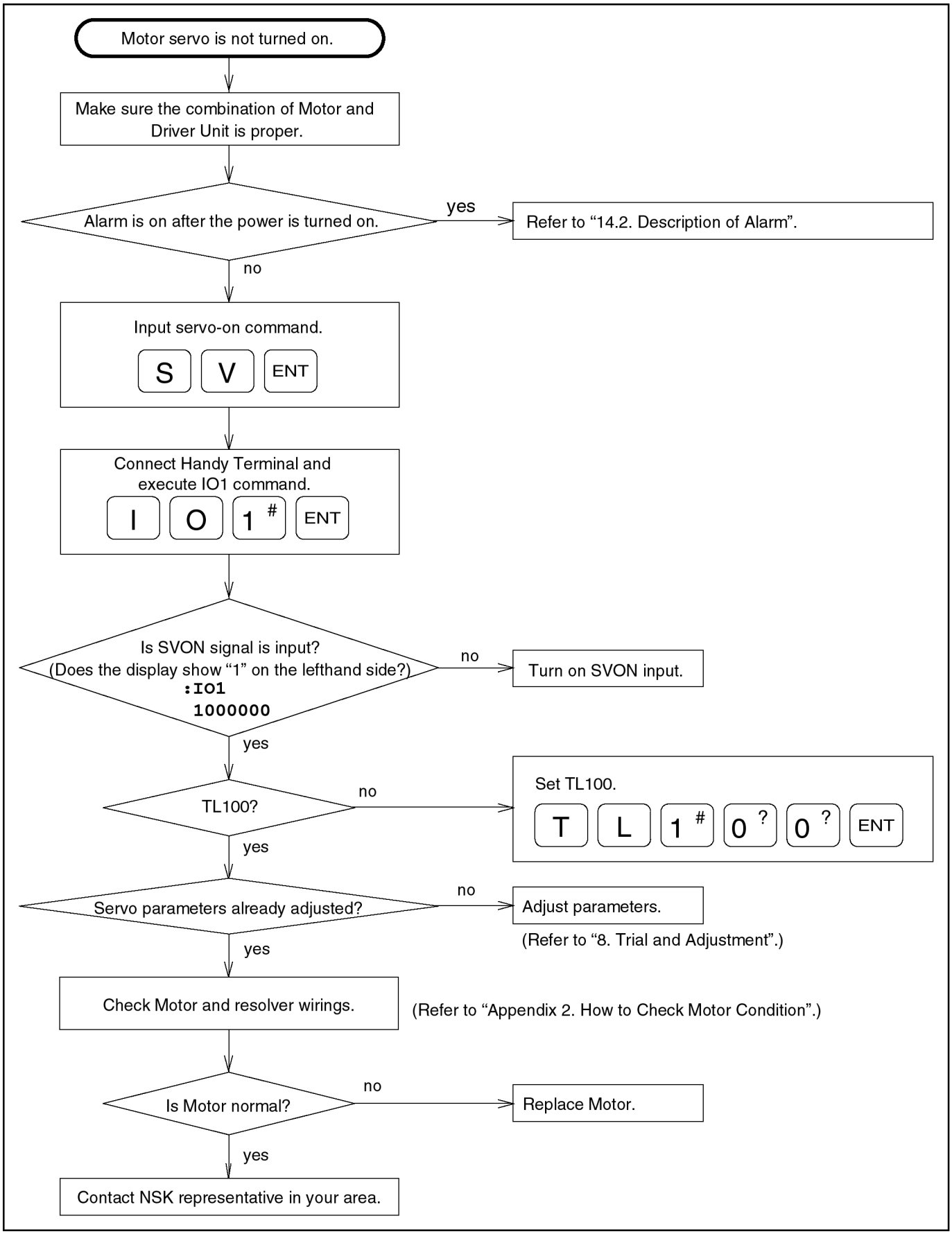
Figure 15-2: Power trouble



15.2.2. Motor Trouble

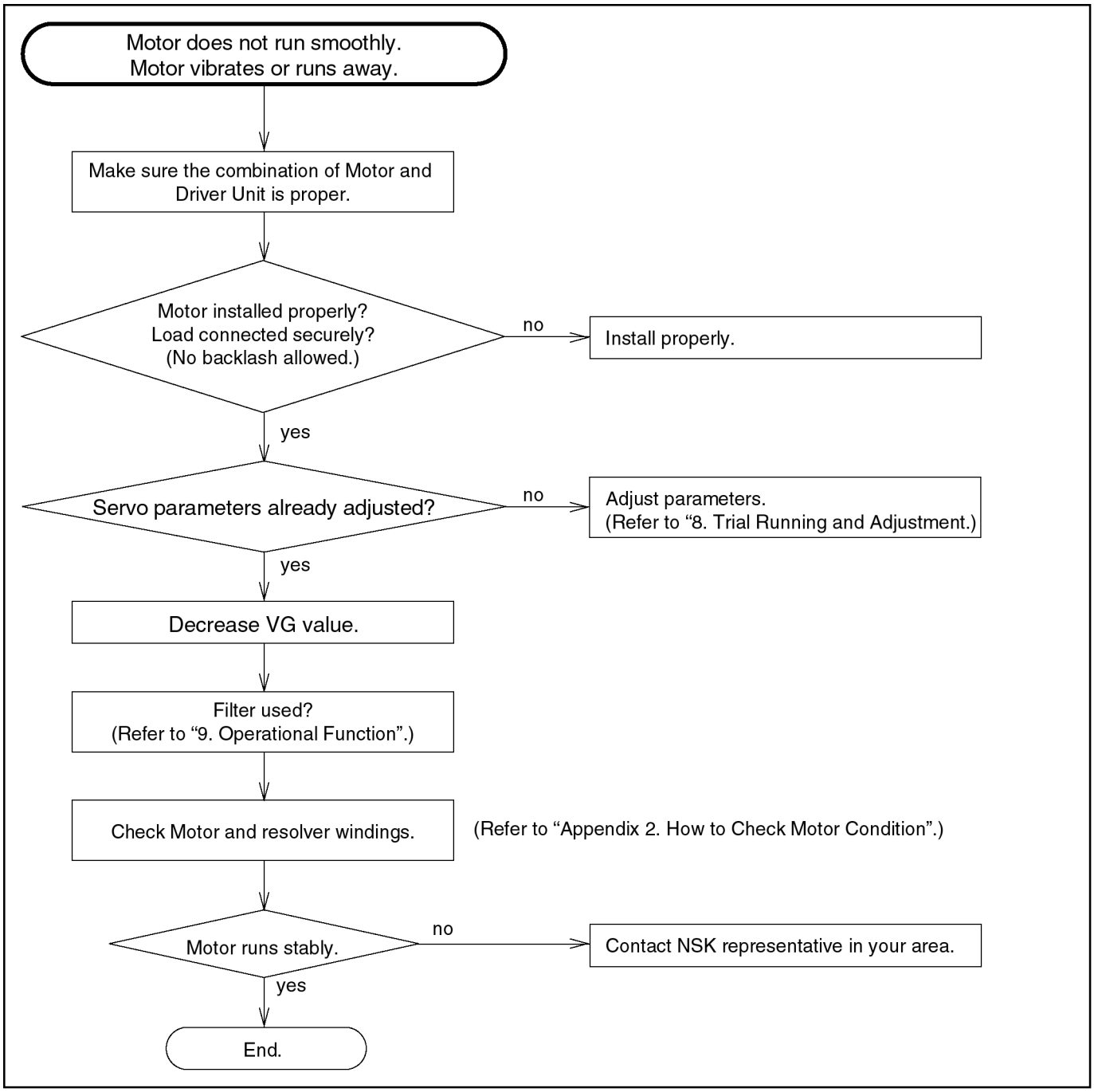
(1) Motor servo is not turned on.

Figure 15-3: Motor trouble 1



(2) Motor does not run smoothly. / Motor vibrates or runs away.

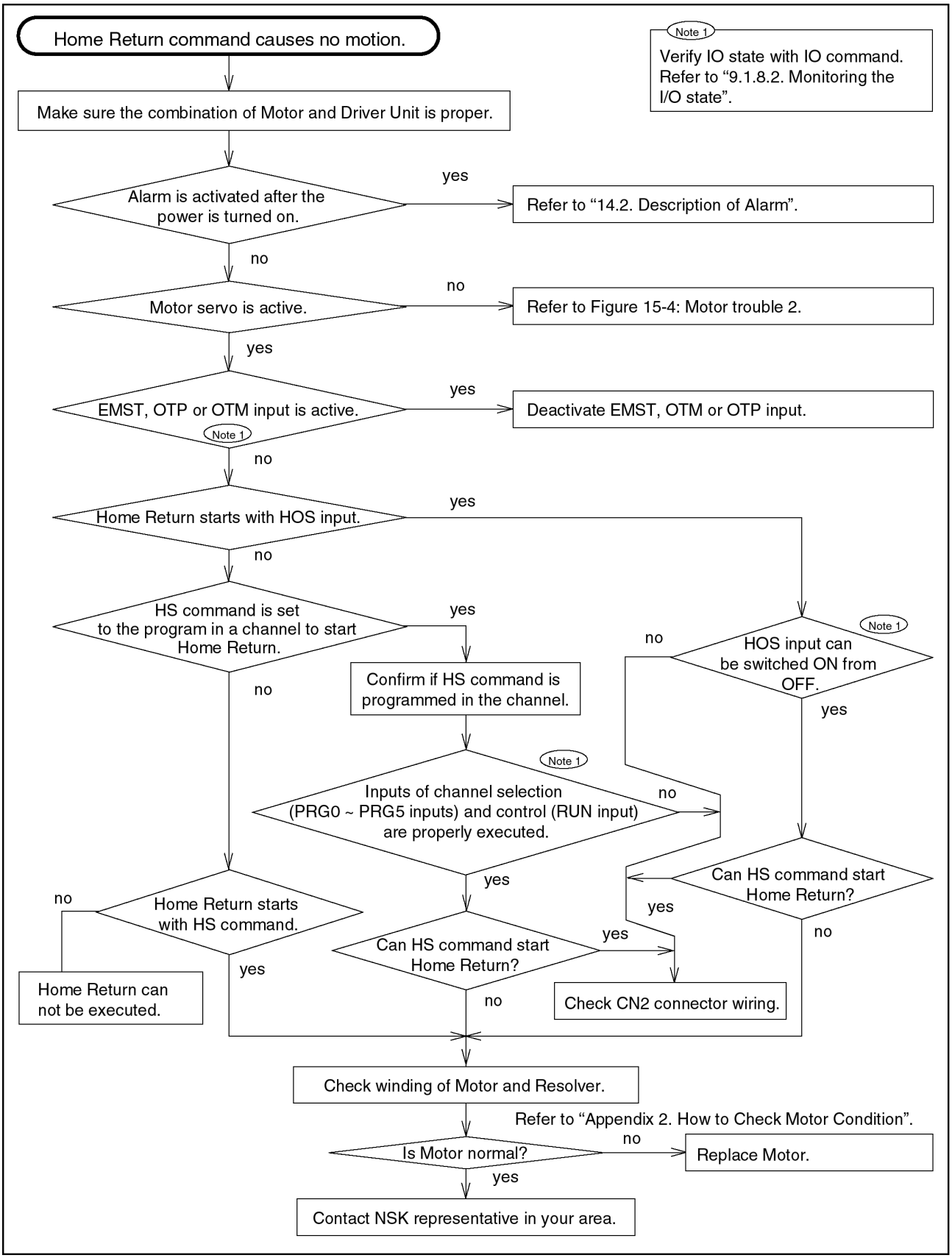
Figure 15-4: Motor trouble 2



15.2.3. Command Trouble

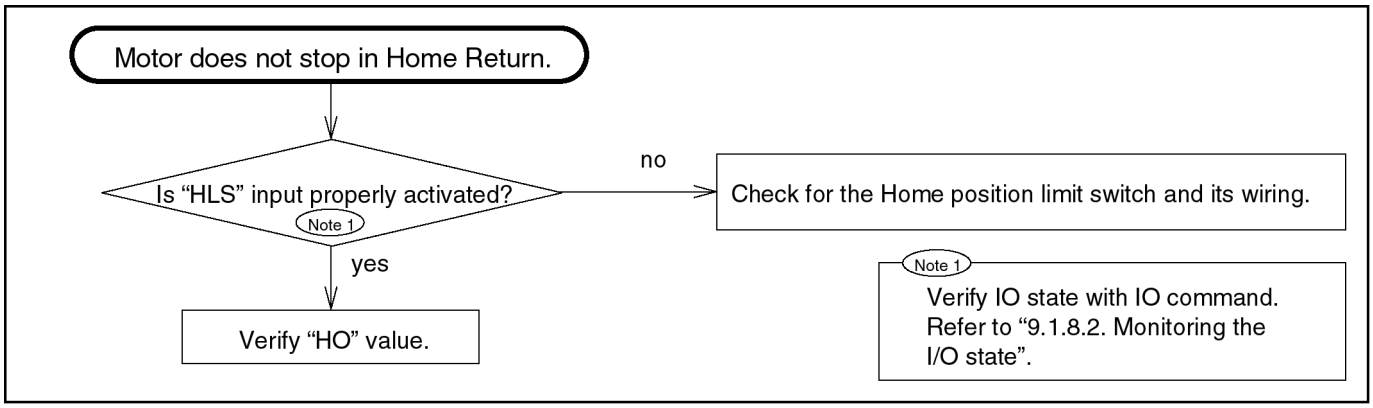
(1) Home Return command causes no motion.

Figure 15-5: Command trouble 1



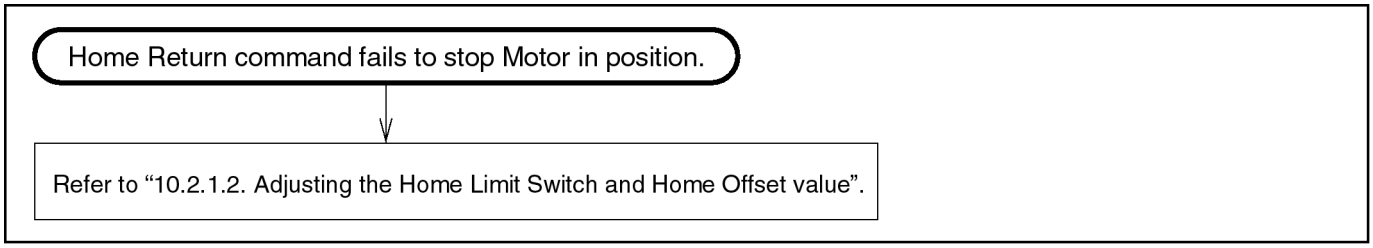
(2) Motor does not stop in Home Return.

Figure 15-6: Command trouble 2



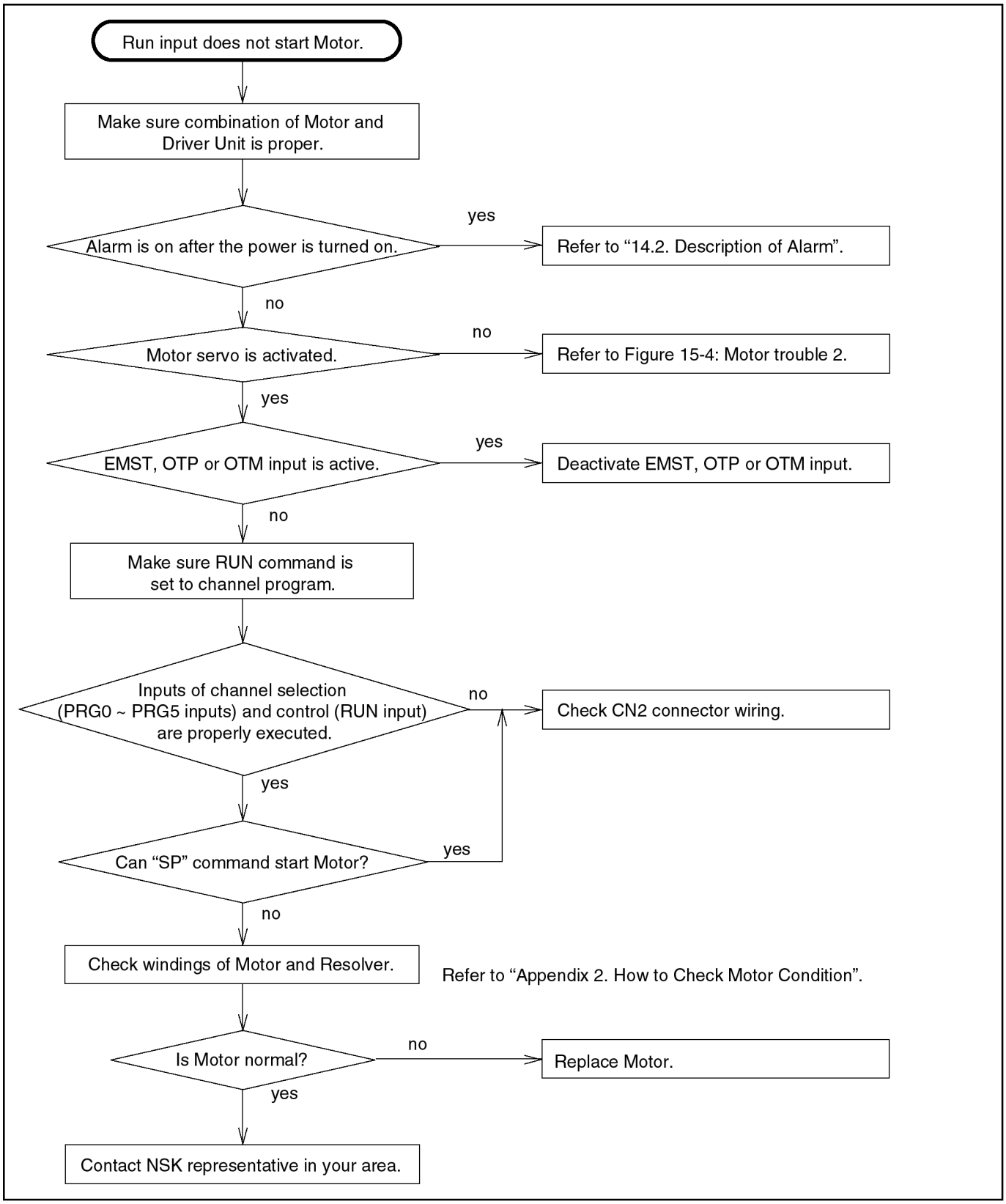
(3) Home Return command fails to stop Motor in position.

Figure 15-7: Command trouble 3



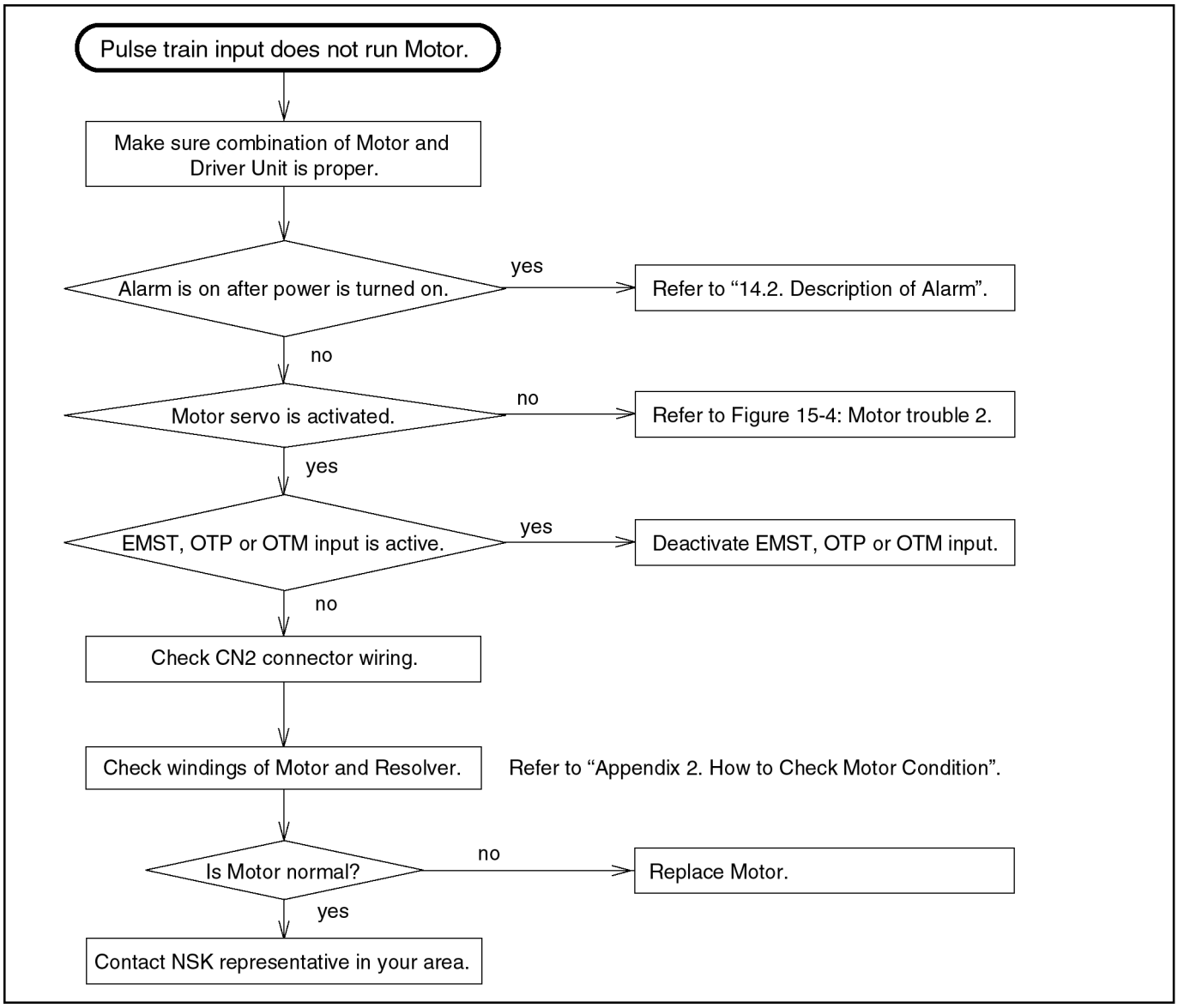
(4) Run input does not start Motor.

Figure 15-8: Command trouble 4



(5) Pulse train input does not run Motor

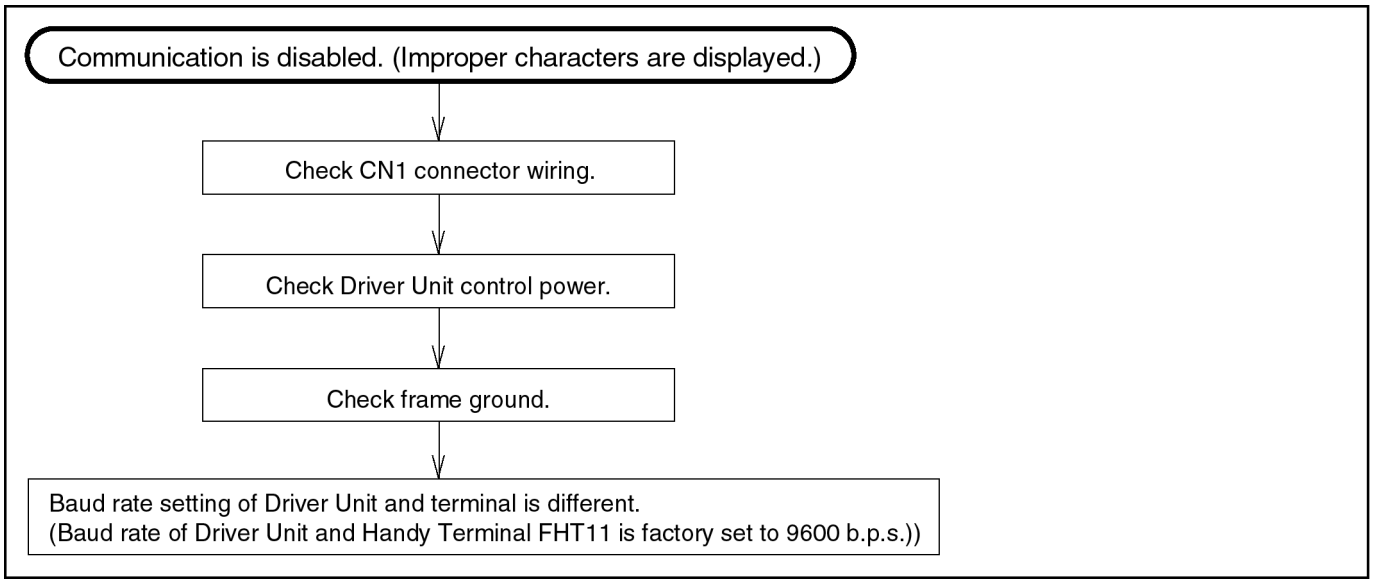
Figure 15-9: Command trouble 5



15.2.4. Terminal Trouble

Communication is Disabled

Figure 15-10: terminal trouble



Appendix 1: Verify Input/Output Signal

IO: Read Out Input/Output Signal Status.

Format : IO/opt. ENT (opt.: option)

Option Code : /RP

- Verifies on/off (open/closed) status of the control Input and Output signals on CN2 connector.
- When IO command is executed with option code /RP, reading is repeated automatically on the display. This means that the Driver Unit is repeatedly outputting signals as follow.

  Space code (20H) + Read Out + Carriage Return Code (0DH)

  Input the back space code (08H) to get out the automatic reading.
- Read Out format is shown in Table A-1.

Table A-1: Input/Output signal table

	Input signal								/	Output signal			
	Input signal is ON when “1” is displayed.									Output signal circuit is closed when “1” is displayed.			
Display	0	0	0	0	0	0	0	0		0	0	0	0
TY1	SVON	EMST	RUN	HLS	PRG3	PRG2	PRG1	PRG0	Input/output separation	DRDY	–	IPOS	–
TY2	SVON	EMST	RUN	HLS	PRG3	PRG2	DIR	JOG					
TY3	SVON	EMST	RUN	HLS	PRG3	PRG2	OTM	OTP					
TY4	SVON	EMST	RUN	HLS	HOS	CLR	OTM	OTP					
TY7	SVON	EMST	RUN	HLS	DIR	JOG	OTM	OTP					

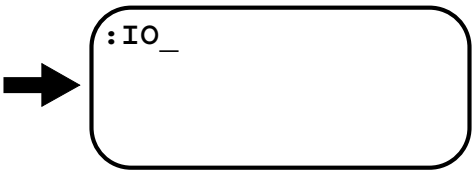
Input signals vary with the setting of the TY parameter (I/O Type).
Refer to “5.2.3. CN2 Signal List”.

[Example] Verify the channel program start command "RUN" is ON.

(i)

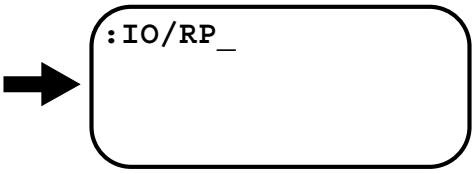
(ii)

I O



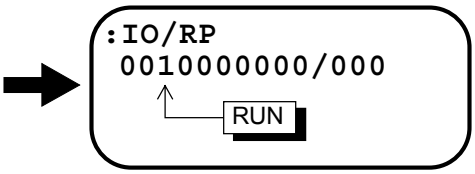
(iii)

/ R P



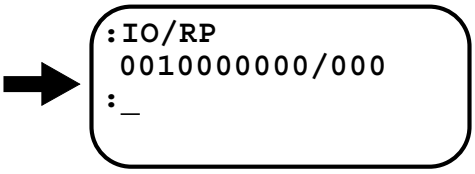
(iv) Press the enter key to execute.
Read-out starts immediately after the input.

ENT



(v) Press the back space key to discontinue read out. If it is not pressed, read out will be repeated and the next command can not be accepted.

BS



- Above example shows that read out of RUN input is "1", which indicates "RUN" input is ON.

  [Reference]

  ◊ Read-out follows the changes of signal status while repeating reading-out.
  (Signals ON and OFF are followed by 1 and 0 in the display.)

  ◊ If the option code "/RP" is not entered, the read-out at the moment will be displayed for only once.

Appendix 2: How to Check Motor Condition

- Check resistance and insulation resistance of Motor winding in order to confirm Motor condition.
- Firstly, examine the Motor with the cable set. If something is wrong, then examine the Motor itself.

(1) Resistance check of Motor winding

Figure A-1: With the cable set

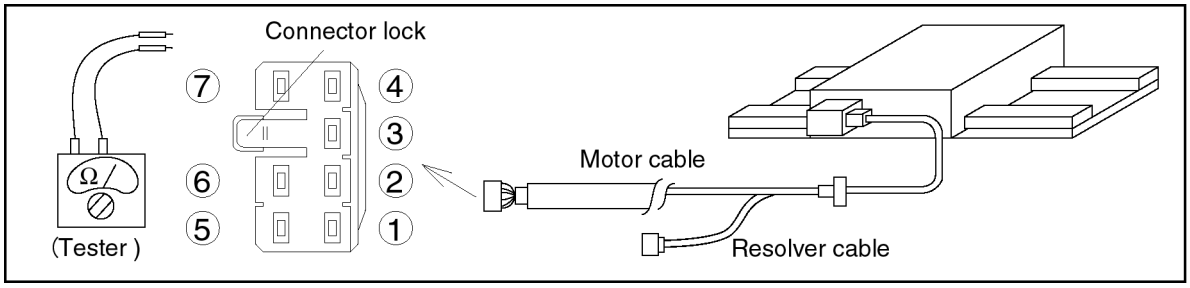


Figure A-2: Motor only

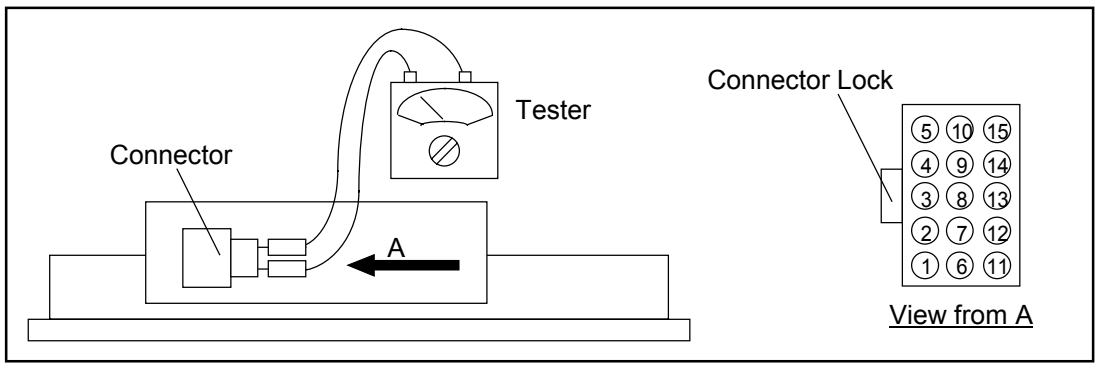


Table A-2: Pin number to be checked.

	Cable connector	Motor connector	Result
Phase A	1 pin ↔ 2 pin (A+) (A-)	5 pin ↔ 4 pin (A+) (A-)	
Phase B	3 pin ↔ 4 pin (B+) (B-)	10 pin ↔ 9 pin (B+) (B-)	
Phase C	5 pin ↔ 6 pin (C+) (C-)	15 pin ↔ 14 pin (C+) (C-)	

Table A-3: Specification

Motor number	Motor winding resistance (Ω)	Tolerance
YZ1 (100VAC)	2.1	1. Allowance : ±30% 2. Variations between each phase (øA, øB, øC) : 1Ω or less
YZ1 (200VAC)	9.5	
YA1	2.8	
YA2	5.6	
YB1	4.6	
YB2	2.6	
YB3	3.8	

- If your motor is a specially ordered one, or the cable is longer than 4m, contact NSK for specification.

(2) Resistance check of resolver winding

Figure A-3: With the cable seet

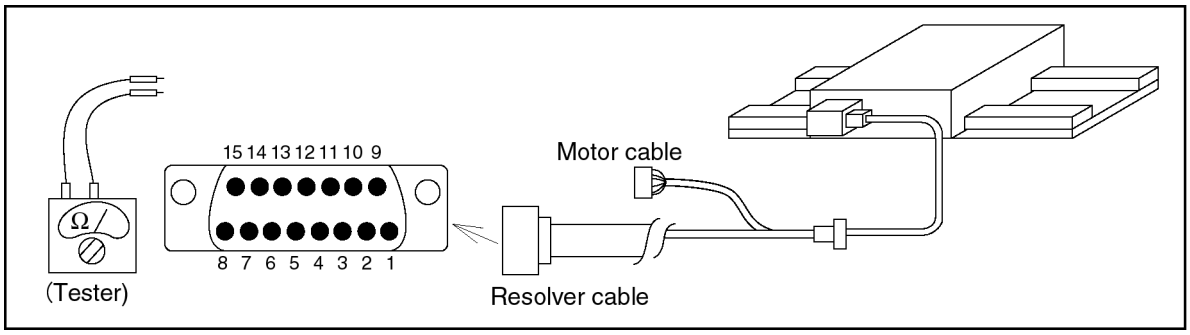


Figure A-4: Motor only

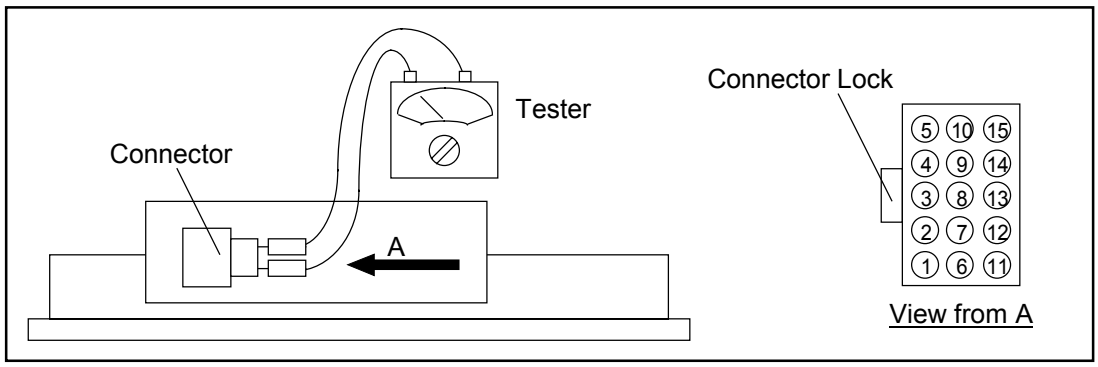


Table A-4: Pin number to be checked

	Cable connector	Motor connector	Result
Phase A	8 pin ↔ 4 pin (REA) (COM)	1 pin ↔ 2 pin (REA) (COM)	
Phase B	7 pin ↔ 4 pin (REB) (COM)	6 pin ↔ 2 pin (REB) (COM)	
Phase C	15 pin ↔ 4 pin (REC) (COM)	11 pin ↔ 2 pin (REC) (COM)	

Table A-5: Specification

Motor number	Motor winding resistance (Ω)	Tolerance
YZ1	1.7	1. Allowance : ±20% 2. Variations between each phase : 1Ω or less
YA1, YA2 YB1, YB2, YB3	3.4	

- If your motor is a specially ordered one, or the cable is longer than 4m, contact NSK for specification.

(3) 3 Insulation resistance of Motor winding

⚠ *Caution : Disconnect Driver Unit from the Motor when conducting megger test.*

⚠ *Caution : Do not apply more than DC 500 V.*

Figure A-5: With cable set

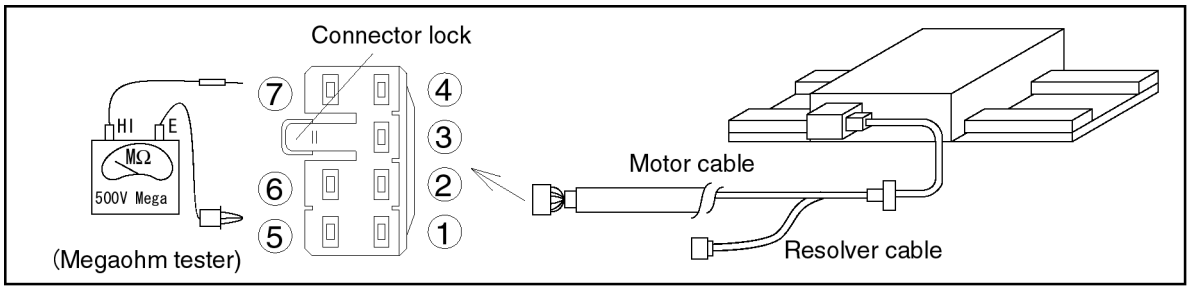


Figure A-6: motor only

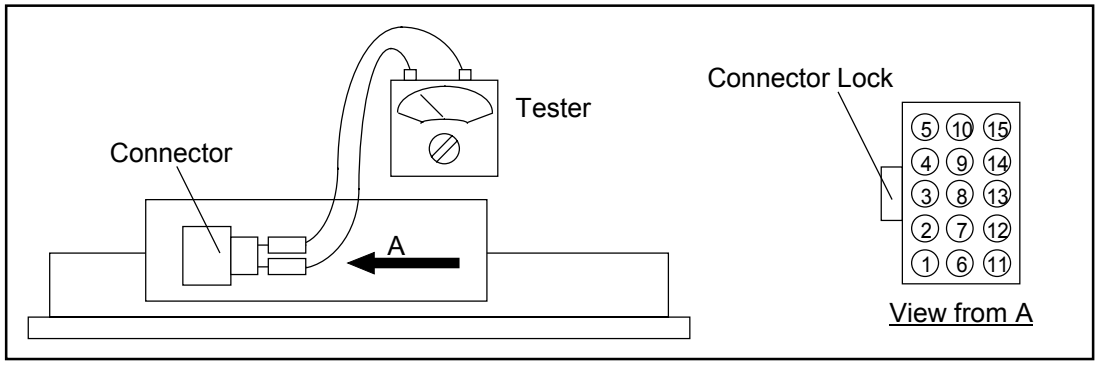


Table A-6: Pins to be checked

	Cable connector	Motor connector	Result
Phase A - FG	1 pin ↔ 7 pin (A+) (FG)	5 pin ↔ 13 pin (A+) (FG)	
Phase B - FG	3 pin ↔ 7 pin (B+) (FG)	10 pin ↔ 13 pin (B+) (FG)	
Phase C - FG	5 pin ↔ 7 pin (C+) (FG)	15 pin ↔ 13 pin (C+) (FG)	
Phase A - Phase B	1 pin ↔ 3 pin (A+) (B+)	5 pin ↔ 10 pin (A+) (B+)	
Phase B - Phase C	3 pin ↔ 5 pin (B+) (C+)	10 pin ↔ 15 pin (B+) (C+)	
Phase C - Phase A	5 pin ↔ 1 pin (C+) (A+)	15 pin ↔ 5 pin (C+) (A+)	

Table A-7: Specification of insulation resistance (common to all motors)

	Specification
With cable	1MW or over
Motor only	2MW or over

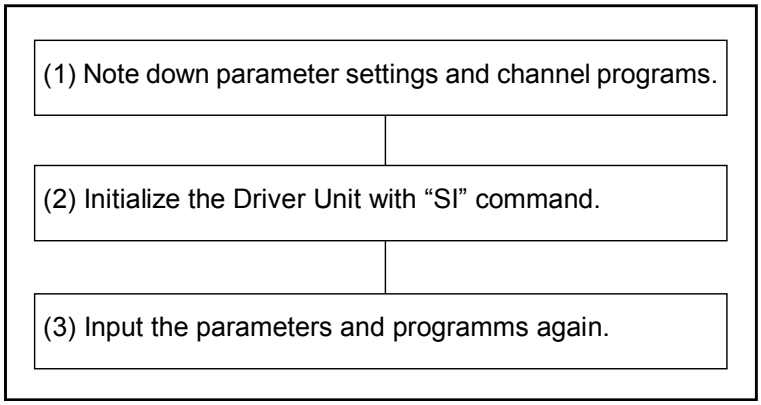
(4) 4 Appearance (Motor and Cable set)

- Check for damages on the motor.
- Check damages on shield of the cable.

Appendix 3: Initializing Driver Unit

- When troubleshooting or replacing Motor or Driver Unit, initializing Driver Unit may be necessary.
- When initializing Driver Unit, follow procedures described hereafter.
- Use Handy Terminal FHT11 for inputting command.
- Procedures

Figure A-7



Explanations

1 Read out parameter settings and channel programs and note down them. Especially “PA” value is important.

(1) Connect the Handy Terminal FHT11 to CN1 connector of the Driver Unit and turn on the power.

↓

(2) Monitor the parameters with “TS0” command.

↓

(3) After monitoring, turn the power off.

2 Initialize the Driver Unit.

(1) Connect the Handy Terminal FHT11 to CN1 connector of the Driver Unit.

↓

(2) Turn on the control power only.

↓

(3) Input the password. When the colon " : " is displayed,

Press. [/] [N] [S] [K] [SP] [O] [N] [ENT]

↓

(4) The Driver Unit echoes back "NSK ON".

↓

(5) Input "SI/AL" command.

Press. [S] [I] [/] [A] [L]

↓

(6) The Driver Unit echoes back "INITIALIZE". A colon " : " will be displayed to indicate completion of initializing.

3 Input the noted parameter settings and channel programs.

(1) Firstly set "PA" parameter.

- Input the password.

Press. [/] [N] [S] [K] [SP] [O] [N] [ENT]

The Driver Unit echoes back "NSK ON".

↓

(2) Press [P] [A] [*] [*] [ENT]

(** must be the same data as noted.)

↓

(3) Set other parameters and programs accordingly.

↓

(4) Make sure that all parameters and programs are set properly.

- Monitor the settings with "TS0" and "TCn" commands.

↓

(5) Turn off the power.

Appendix 4: How to replace ESA13 Driver Unit

Danger : Make sure the power is turned off when replacing ESA13 Driver Unit.

- In the reference number of ESA13 Driver Unit, second digit from the last denotes whether it is interchangeable or not.

Figure A-8

- When replacing the Driver Unit which is not interchangeable, the compensation ROM of the old Driver Unit must be transferred to the new Driver Unit. When transferring the ROM, ESA13 Driver Unit must be disassembled. To disassemble the Driver Unit, follow the procedures described hereafter.
  - ◊ For a special Driver Unit, contact your local NSK representative.
  - ◊ Before replacing the Driver Unit, record all parameters and channel programs. The record list is provided in the last page of this manual.
  - ◊ Especially, following items shall be recorded.
    - PA, VG, VI, PG, CO, MA, MV, and HO
    - Programs and other settings in channels.
  - ◊ When replacing Driver Unit, following tools and Handy Terminal FHT11 are necessary.
    - (1) A screwdriver (cross recessed, 4mm)
    - (2) A ROM remover

Dissemble ESA13 Driver Unit

1 Remove side panel

Figure A-9

Unfasten screws
- Top and bottom (2 places each, countersunk head)
- Front panel (2 places, countersunk head, black oxide)

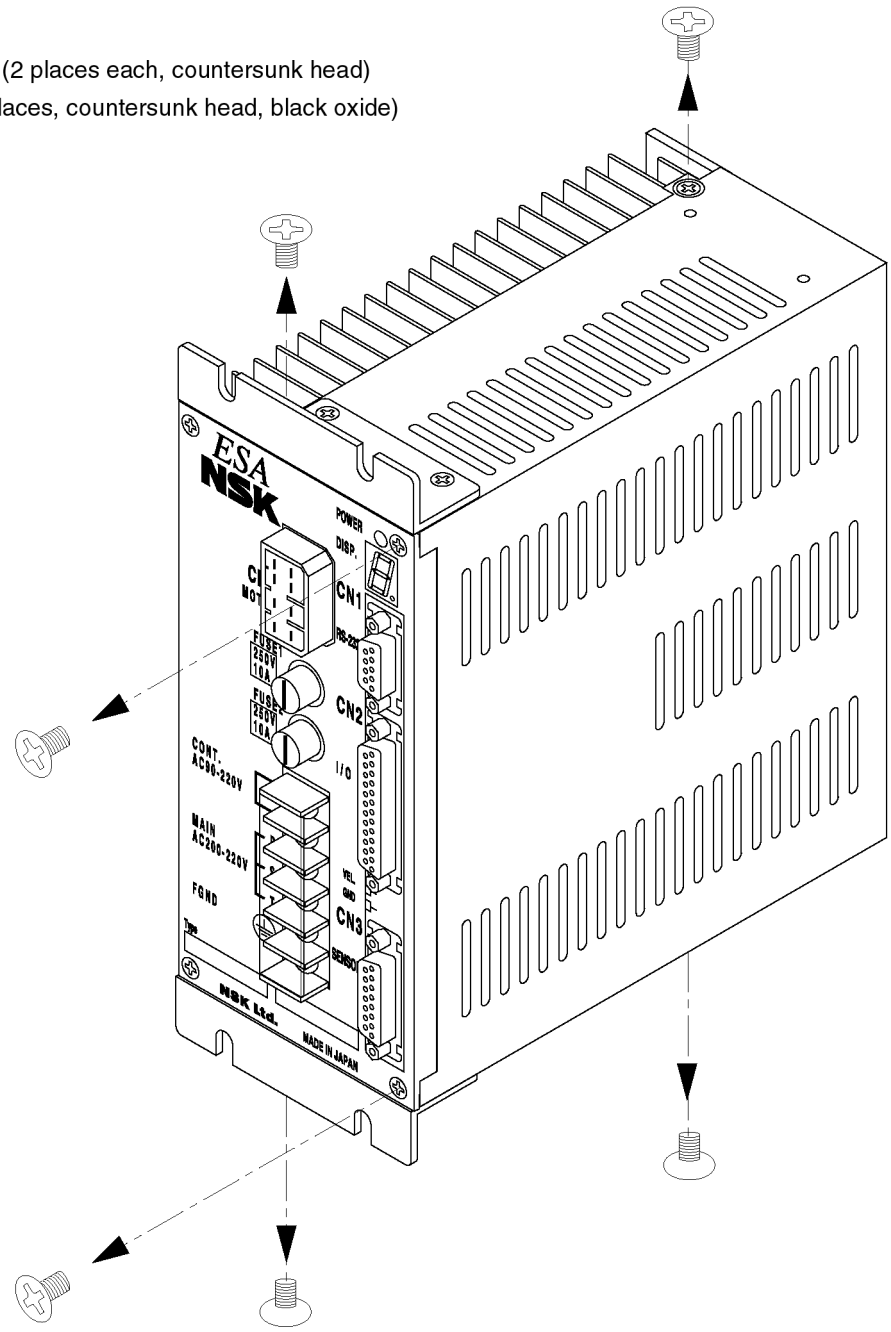
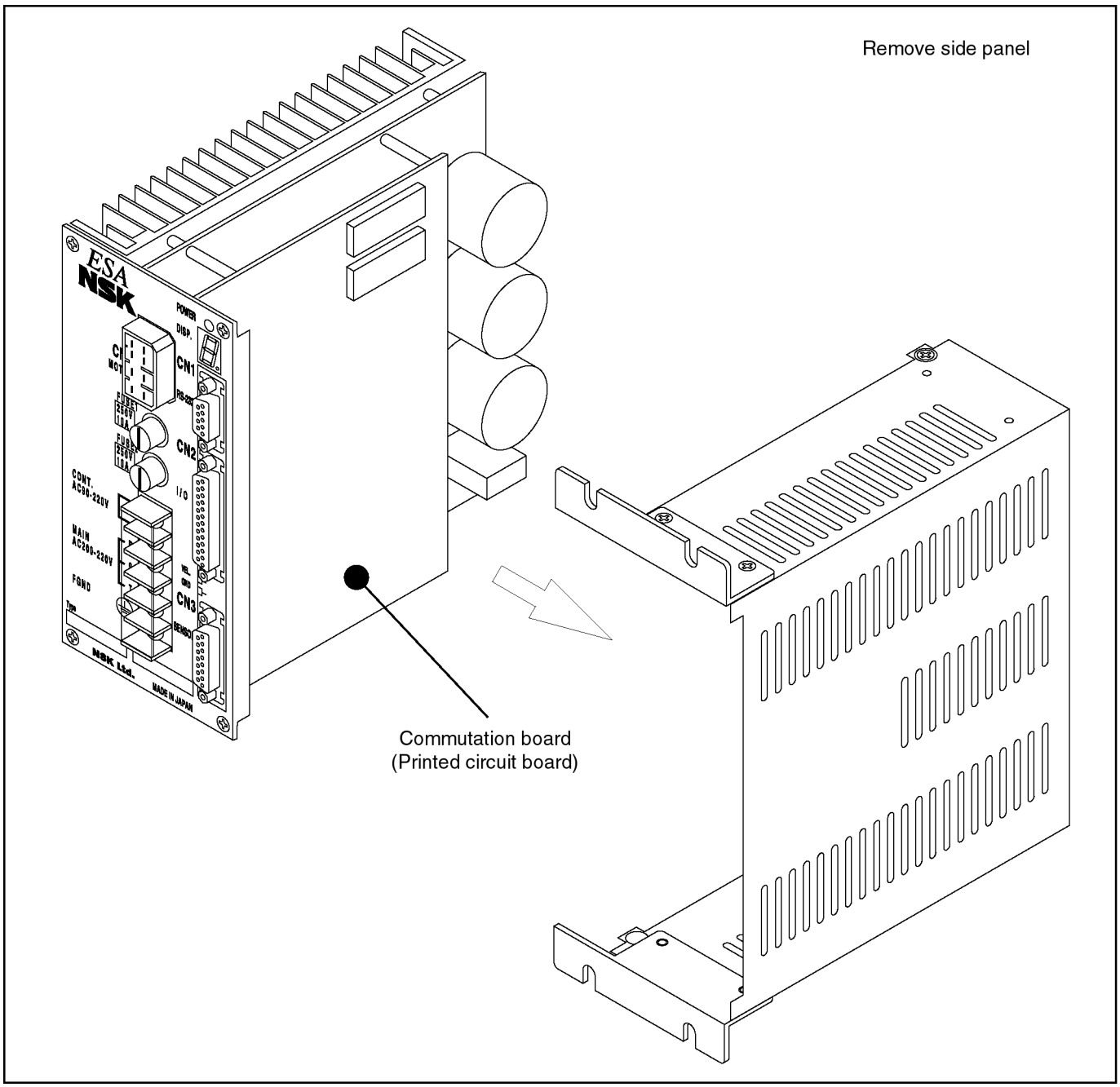


Figure A-10



2 Remove the compensation ROM (U21) from the commutation board of old Driver Unit. (Use a ROM remover.)

Figure A-11

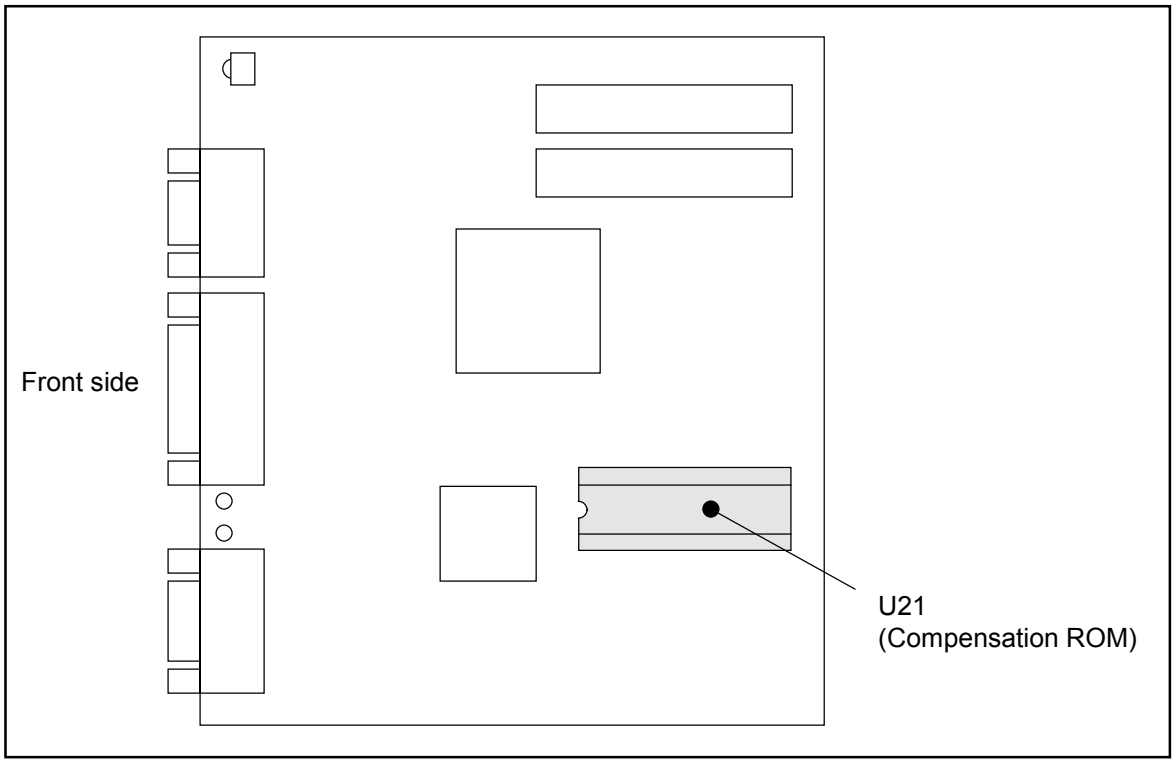
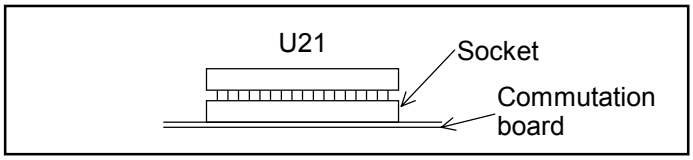


Figure A-12



3 Insert the ROM to new Driver Unit commutation board.

- Be careful of the orientation of the ROM. Make sure the ROM is securely set to the socket.

Figure A-13

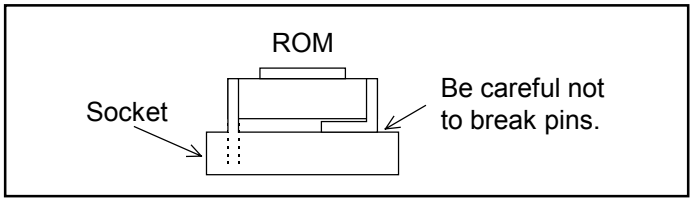
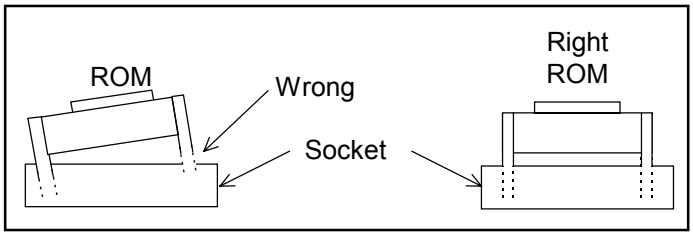


Figure A-14



4 Assemble the side panel

Figure A-15

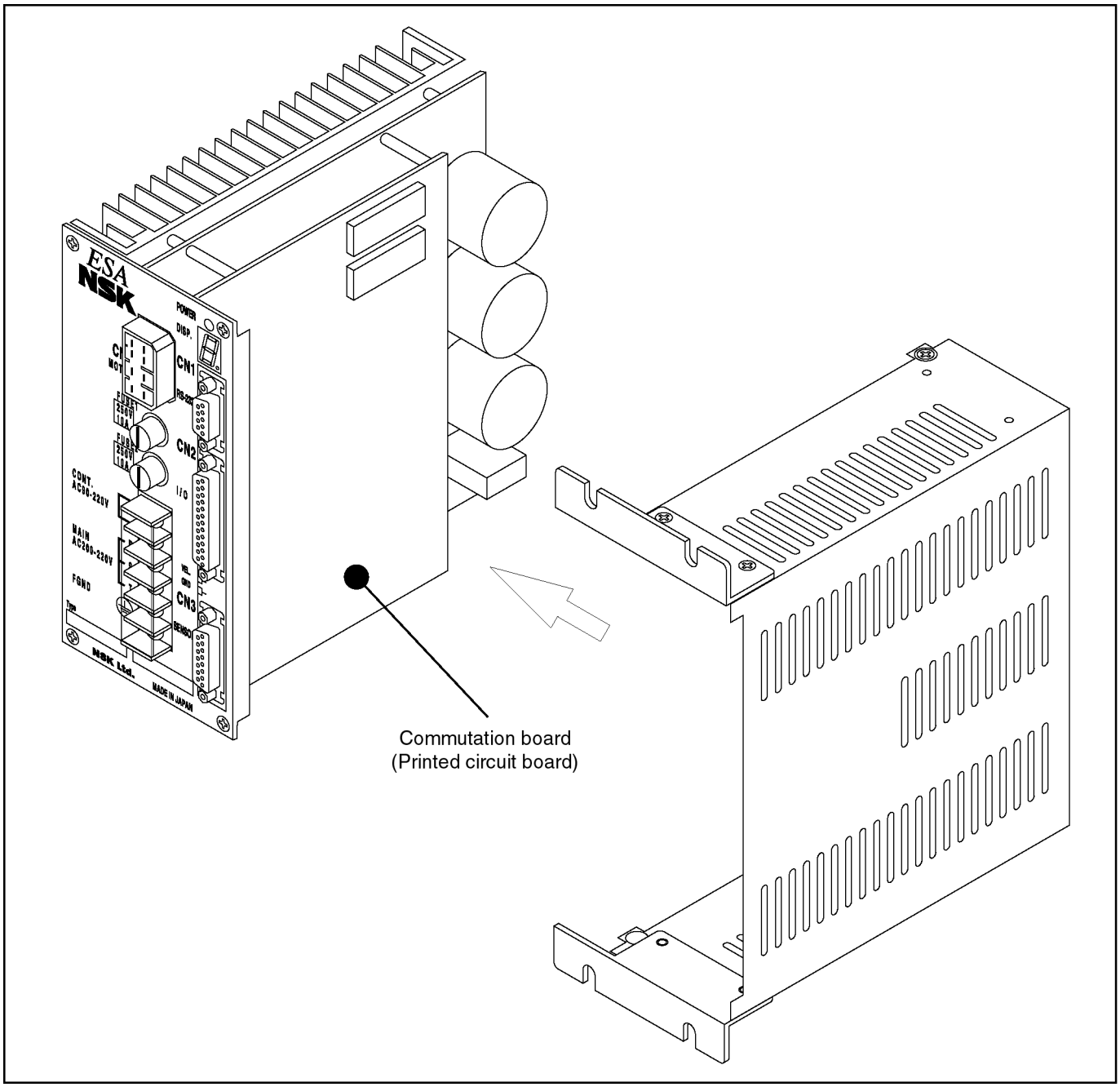
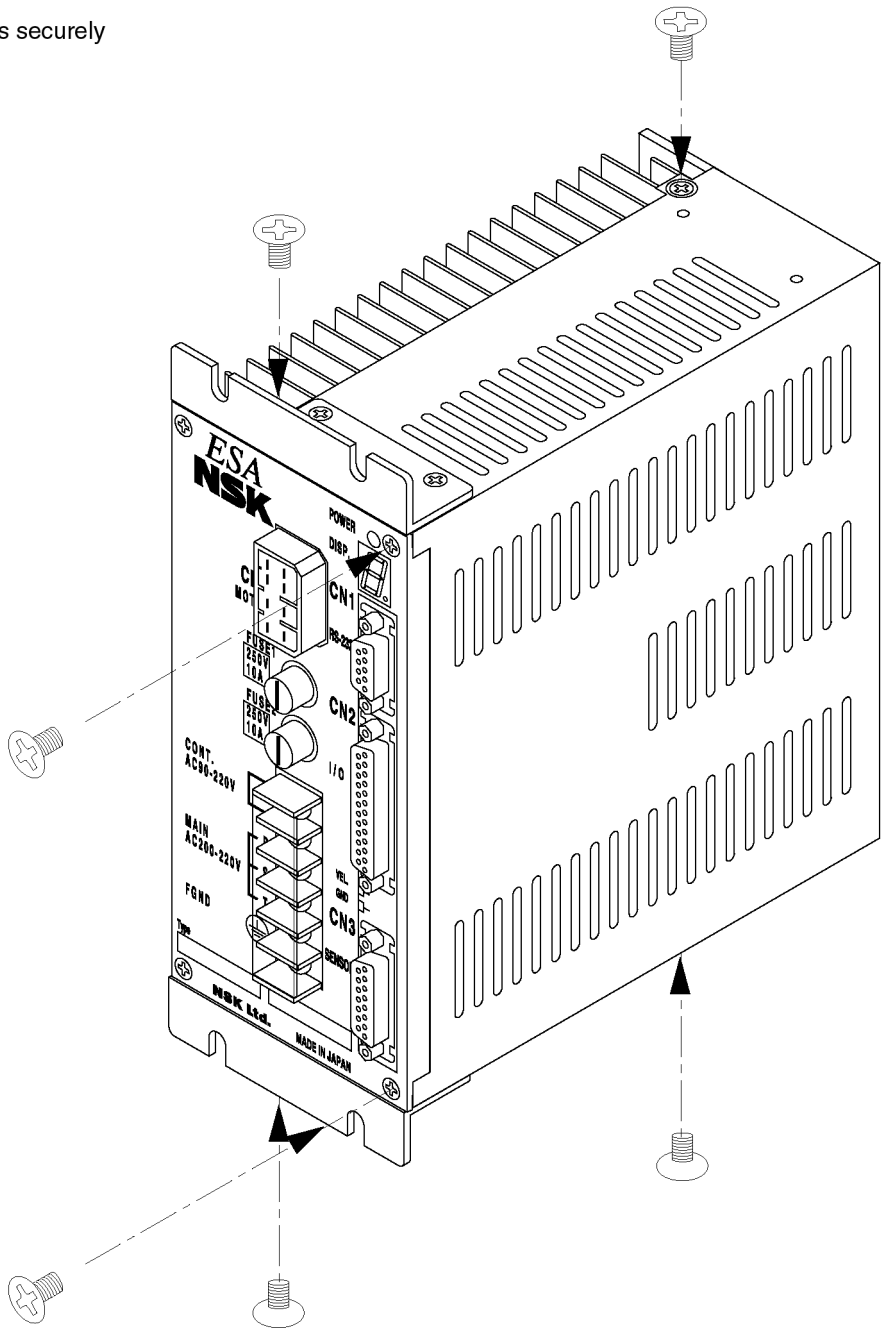


Figure A-16

Fasten all screws securely



5 After replacing the compensation ROM, initialize new Driver Unit.

(1) Connect Handy Terminal FHT11 to CN1 connector.

(2) Turn on the control power only.
(Control power input ports are indicated as "CONT" on the terminal block.)

◊ If the main and control power can not be turned on and off separately, disconnect CN2 connector. If CN2 connector is not disconnected, the parameters can not be input properly and the Motor may run away. (Make sure that CN2 connector is disconnected.)

(3) When control power is turned on, Handy Terminal displays "NSK MEGATHRUST ・・・".

◊ After the display shows a colon " : ", input

/ N S K SP O N ENT

and

S I / A L ENT

Initialization will take about 30 seconds.

(4) After the display shows a colon " : ", log in all parameters and channel program referring the recorded value and settings.

Parameter • Program Setting List

Reference No. :
S/N :

Parameter List

• A blank part remains the shipping set.

Date :

Parameter	Setting		Parameter	Setting		Parameter	Setting	
	Factory set	Your setting		Factory set	Your setting		Factory set	Your setting
PG	0.1		CR	×1		OL	**	
VG	1.0		PC	0		RC	**	
VI	1.0		RR	−1		LR	0	
VM	1		FD	0		TY	4	
LG	50		FZ	0		AB	X0X0XX00	
TL	100		FR	0		SM	1	
FO	0		PS	0		NW	2	
FP	0		DI	0		MM	1	
FS	0		OTP	0		BM	1	
NP	0		OTM	0		CM	0	
NS	0		MV	500		AN	0	
DBP	0		MA	0.05		WM	0	
ILV	100		JV	50		SE	0	
FF	0		JA	0.05		LO	0	
FC	0		HV	100		SG	0	
CO	50 000		HA	0.05		MT	*	
IN	100		HZ	5		RI	*	
IS	0		OS	4		ZP	1.00	
FW	0		HD	1		ZV	1.4	
VO	1 365		HO	0				
VW	100		PA	*				

(* : Setting deiffers with Motor size.)

(** : Setting deiffers with each Motor.)

Channel Program

- For channels not in use, leave in blank.

Data : _____

CH	Program	CH	Program	CH	Program	CH	Program
0	Command : CV : CA :	16	Command : CV : CA :	32	Command : CV : CA :	48	Command : CV : CA :
1	Command : CV : CA :	17	Command : CV : CA :	33	Command : CV : CA :	49	Command : CV : CA :
2	Command : CV : CA :	18	Command : CV : CA :	34	Command : CV : CA :	50	Command : CV : CA :
3	Command : CV : CA :	19	Command : CV : CA :	35	Command : CV : CA :	51	Command : CV : CA :
4	Command : CV : CA :	20	Command : CV : CA :	36	Command : CV : CA :	52	Command : CV : CA :
5	Command : CV : CA :	21	Command : CV : CA :	37	Command : CV : CA :	53	Command : CV : CA :
6	Command : CV : CA :	22	Command : CV : CA :	38	Command : CV : CA :	54	Command : CV : CA :
7	Command : CV : CA :	23	Command : CV : CA :	39	Command : CV : CA :	55	Command : CV : CA :
8	Command : CV : CA :	24	Command : CV : CA :	40	Command : CV : CA :	56	Command : CV : CA :
9	Command : CV : CA :	25	Command : CV : CA :	41	Command : CV : CA :	57	Command : CV : CA :
10	Command : CV : CA :	26	Command : CV : CA :	42	Command : CV : CA :	58	Command : CV : CA :
11	Command : CV : CA :	27	Command : CV : CA :	43	Command : CV : CA :	59	Command : CV : CA :
12	Command : CV : CA :	28	Command : CV : CA :	44	Command : CV : CA :	60	Command : CV : CA :
13	Command : CV : CA :	29	Command : CV : CA :	45	Command : CV : CA :	61	Command : CV : CA :
14	Command : CV : CA :	30	Command : CV : CA :	46	Command : CV : CA :	62	Command : CV : CA :
15	Command : CV : CA :	31	Command : CV : CA :	47	Command : CV : CA :	63	Command : CV : CA :

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