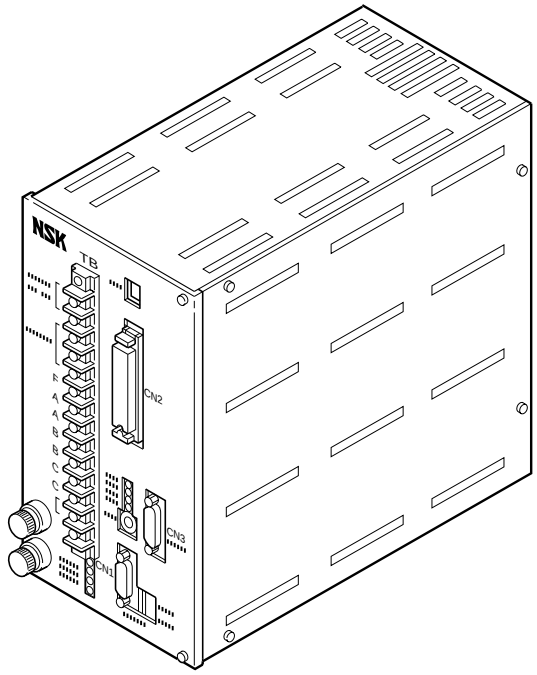
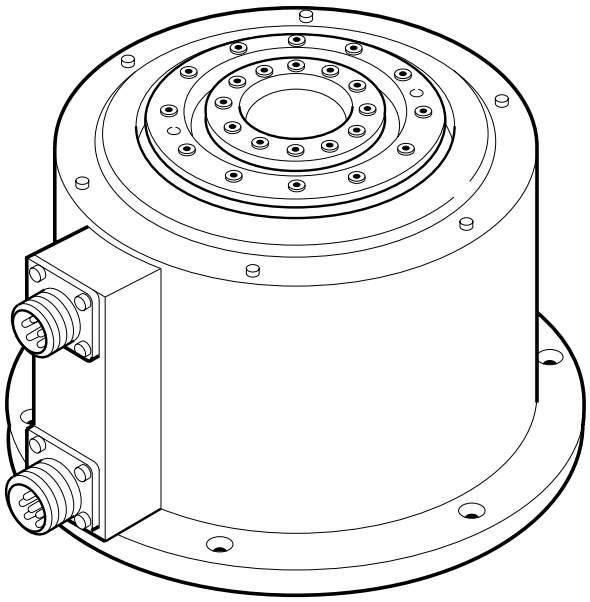
NSK

MEGATORQUE® MOTOR SYSTEM

User's Manual

(EM/EP Driver Unit System)





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NSK Ltd.

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User's Manual

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Notes To Users

☞ ***Before operating the Megatorque Motor System, this manual should be read thoroughly.*** The Megatorque Motor System is a unique device, so 'common sense' based upon experience with servo motors may not directly apply here. Careful consideration of the mechanical design, as described in Chapter 4, is especially important***.***

☞ ***Make sure that the serial numbers for Motor and Driver Unit are the same.*** *The Motor and Driver Unit of the Megatorque Motor System are marked with serial numbers that identify them. Motors and Driver Units may not be interchanged**.***

☞ *Spare parts should be ordered from any of the NSK offices. A list of NSK offices is provided in the back cover .*

About This Manual

This manual describes the interface, function and operation of the Megatorque Motor System. This manual provides information on the System with EM/EP Driver Unit; if your model is not one of these, contact NSK for supplemental information.

Version

The Driver Unit of the Megatorque Motor System is controlled digitally by a 16bit microprocessor. The program software of the Driver Unit is modified constantly to improve functions. The change of the Driver Unit program software is shown by the change of version number in the Driver Unit model number (see Appendix 2 to know your model number).

The information in this manual is applied to the Driver Unit version 05. If your Driver Unit is newer than version 05, there should be an addendum to this manual. Read the addendum before reading this manual. The addendum will be available from your local NSK office, and will be packed with your Megatorque Motor System. If your Driver Unit is older than version 05, some of this manual may not apply to your System. Contact NSK for details.

Technical Information

For technical assistance and sales information, 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.
CCW	Motor rotating direction, counterclockwise; seen from the outside of rotor.
closed	logic output state; output current will flow.
CW	Motor rotating direction, clockwise; seen from the outside of rotor.
Driver Unit	means Megatorque 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.
Motor	means Megatorque 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.
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 torque	the rated torque available at zero speed.
rated torque	the torque not to exceed the maximum Motor winding temperature.
rps	revolution per second; the unit of velocity.
rps/s	rps per second; the unit of acceleration.
servo-lock	one typical state of servo-on; the Motor provides torque and remains in position.
servo-off	the state where the Driver Unit provides no current to the Motor, and the Motor provides no torque. The Motor rotor can be rotated 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 torque	the torque available at zero speed.
System	means Megatorque 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.

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1. Introduction

1.1. Overview

The Megatorque 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 Megatorque Motor System incorporates them all into two units; the Motor and the Driver Unit.

Motor

The Motor consists of a high torque brushless actuator, a high resolution brushless resolver, and a heavy duty precision NSK bearing. The high torque actuator eliminates the need for gear reduction, while the built-in resolver usually makes feedback components, such as encoders or tachometers unnecessary. Finally the heavy duty bearing 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 torque, 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 torque drop-off at the intermediate speeds. As a result, smaller Motors may be used for high speed indexing applications when the torque 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 Megatorque 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 Megatorque Motor System can be interfaced to virtually any control system. It is very easy to control the Megatorque Motor System with a CNC, a servo motor controller, a robot controller, or an indexing controller. You can operate the Megatorque 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 614 400count/rev resolver, the Megatorque Motor System offers repeatability as high as approximately 2.1”, or approximately 0.00058˚. With no mechanical contact or moving parts other than the bearing, 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. Gears and flexible couplings, for example, introduce mechanical irregularities such as windup, backlash, and mechanical inaccuracy. The same functions can be accomplished with just two components using the Megatorque 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, gears, bearings, tachometer and encoder) are either replaced or made unnecessary by the Motor.

Gearless Advantage

There are many advantages to the gearless servo system. One advantage is to eliminate backlash, the angular play due to looseness of fit between two mating gears. The direct drive inherently eliminates backlash, so that repeatability is limited only by the resolution of the position sensor. The direct drive permits direct coupling of the Motor and the load, so that troublesome flexible couplings are not required. This permits tighter, more direct control of the load. The Megatorque Motor System has a very high torque to inertia ratio, so that very high acceleration rates can be achieved. When the load inertia is low, the Motor can accelerate a load as much as 10 times faster than comparable high performance servo systems using gears. The performance advantages of the Megatorque Motor System are demonstrated by many of the new class of the direct drive robots which have established repeatability and speed records in the robot industry and are the performance standards against which other robot systems are compared.

1.2. Operational Remark

- Drive the Motor with enough load inertia. The Motor output torque is too large for its rotor inertia. So additional inertia is needed when the Motor outputs increased torque. See Chapter 4 for details.
- Before using the Megatorque Motor System, adjust the servo parameters according to operating conditions. With a servo parameter set prior to delivery, the Megatorque Motor System cannot exhibit its original performance. See Chapter 5 for details.
- Never disassemble the Motor since it has been precisely assembled and adjusted. If disassembled, it may cause abnormalities such as deterioration in rigidity and precision as well as increase in noise.
- Never apply any water or oil to the Driver Unit in order to prevent electric shock.
- Do not remove the left panel of the Driver Unit so as not to cause an electric shock. It is extremely dangerous due to high voltage present.
- Do not conduct a withstand voltage test or a megger test on the Driver Unit. It may damage the internal circuits.

1.3. Functional Principle

1.3.1. Motor

By virtue of its unique design, the Megatorque Motor System is capable of producing extremely high torque at low speeds suitable for direct drive applications. Furthermore, it can produce these torque 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 dual stator construction with rotor between them. Each stator is constructed of laminated iron sheets with eighteen 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 six (four for 0408 type Motor) 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 around the full turn of the Motor. (The number depends upon the Motor size.) The rotor is a thin cylindrical ring, constructed of the same iron laminations and with the same tooth structure, but without windings or pole pieces. The rotor serves to conduct the magnetic field from the inner stator across the rotor to the adjacent pole piece on the outer stator, and back again. The rotor teeth also serve to focus the magnetic field into discrete points around the circumference of the rotor, and the combined effect of these points of focused magnetic field around both the stators and the rotor act like electronic gear reduction, multiplying the torque hundreds of times while reducing the speed by the same amount.

Brushless Microprocessor Commutation

For each full electrical cycle of commutation, the Motor rotates through one magnetic cycle which is the angular distance between adjacent teeth. In most Motor sizes, there are 150 electrical cycles per Motor revolution; some smaller sizes such as 0408 type have 100 cycles per revolution. 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 rotation.

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 torque 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 Megatorque Motors do not weaken with age.

1.3.2. Driver Unit

All of the circuits that are needed to operate the Megatorque Motor System in position, velocity or torque 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 torque. 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." Up to two independent digital notch filters can be employed.
- 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 torque command level, the Motor position, and the Motor velocity. These factors are taken into account to compensate for the Motor non-linearities and to produce a smooth output torque.

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 to generate quadrature position feedback for use with an external position controller. In addition, the cyclic absolute position is used internally to maintain absolute position data. This data is available to via RS-232C and is used with the internal position control functions.

2. Name and Function of Each Part

2.1. Packing List

Table 2-1

Packing List

No.	Name	Qty.	Note
1	Motor	1	The integrated actuator unit, consists of a high torque motor, a position sensor (resolver) and a bearing.
2	Driver Unit	1	A multi-functional controller with servo driver built-in
3	Motor Cable	1	These cables are directly wired in the Motor on bottom-cable type Motor.
4	Resolver Cable	1	
5	Standard Accessories: CN2 Connector Jumper Pin Fuse (20A)	 1 4 2	 Connector and connector shell For jumper setting
6	Inspection Sheet	1	
7	User's Manual	1	This document

2.2. Motor

Figure 2-1

Connector Type

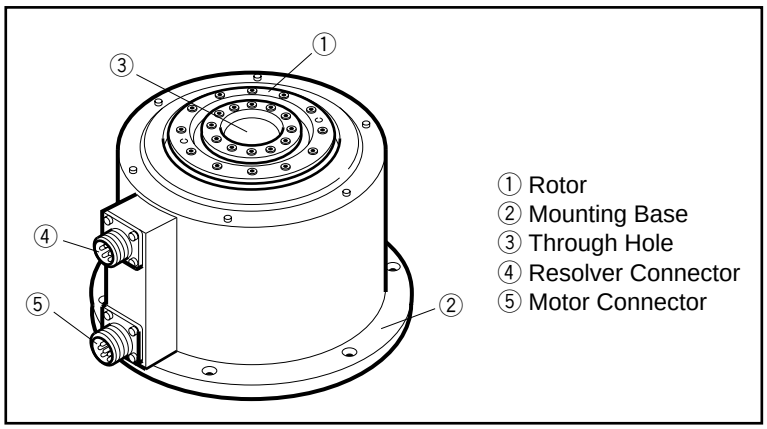


Figure 2-2

Direct-Cable Type (Rotor On Top)

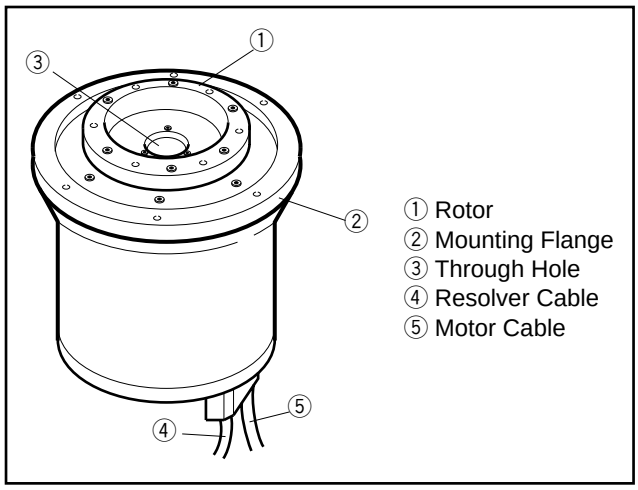
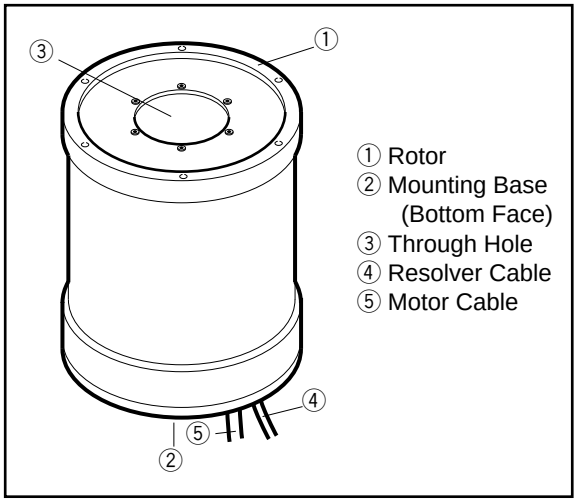


Figure 2-3

Direct-Cable Type
(Rotor On Outer Side)

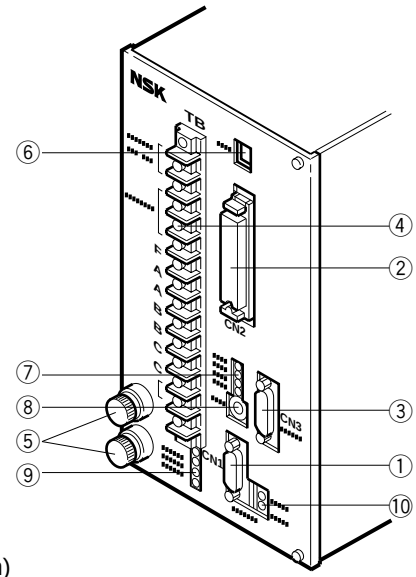


① Rotor
② Mounting Base
(Bottom Face)
③ Through Hole
④ Resolver Cable
⑤ Motor Cable

2.3. Driver Unit

Figure 2-4

Driver Unit



① CN1 (9-pin)
RS-232C serial communication connector for NSK Handy Terminal (optional accessory, sold spearately)

② CN2 (50-pin)
Motor control signal input/output connector

③ CN3 (15-pin)
Resolver connector for Resolver Cable

④ TB
Terminal block for main and control AC power, and for Motor cable

⑤ F1, F2
Fuse holder

⑥ VR1
Analog input offset adjuster

⑦ LEDs
Driver Unit status display

⑧ SW1
Driver Unit address setting switch for daisy chain communicatuion

⑨ LEDs
Power amplifer status display

⑩ VELOCITY, GND
Velocity waveform monitor

3. Driver Unit Specification

3.1. General Specification

3.1.1. Electrical Specification

Some specifications depend on the Motor size. In the table below, the following note-numbers are attached to the figure to specify the Motor size, if the item has different specification for every Motor size.

(1) 04××
(2) 06××
(3) 08××, 10××, 14××
(4) B014, B030
(5) B060, B090

Table 3-1 Electrical Specification

Item	Specification		
Control Power	1ø, 90 ~ 240VAC, 50/60Hz, Power Required: 900VA		
Main Power	220VAC Type	3ø or 1ø, 220V±10%, 50/60Hz Power Required: (EM Type) 2 (1)(2)(4) or 2.5 (3)(5) [kVA] (EP Type) 4 (1)(2)(4) or 5 (3)(5) [kVA] Current Leakage: 7mA	
	110VAC Type	1ø, 110V±10%, 50/60Hz Power Required: 1 (1)(2)(4) or 1.5 (3)(5) [kVA] Current Leakage: 7mA	
Maximum Current Output Per Phase	EM Type	6 (1)(2)(4) or 7.5 (3)(5) [A]	
	EP Type	6A parallel (1)(2)(4) or 7.5A parallel (3)(5)	
Resolver Resolution	12-bit Set	409 600 (1) or 614 400 (2)(3) or 491 520 (4)(5) [count/rev]	
	10-bit Set	102 400 (1) or 153 600 (2)(3) or 122 800 (4)(5) [count/rev]	
Maximum Velocity	Resolver Setting = 12-bit		1.5 (1) or 1.0 (2)(3) or 1.25 (4)(5) [rps]
	Resolver Setting = 10-bit		4.5 (1) or 3.0 (2)(3) or 3.75 (4)(5) [rps]
Driver Unit Weight	EM Type	4.6kg	
	EP Type	7.6kg	
Driver Unit Environment	Operation	Temperature: 0 ~ 50˚C Humidity: 20 ~ 90%, non-condensing	
	Storage	Temperature: –20 ~ +70˚C (6) Indoor storage only	

Note (1) for Motor size 04×× (2) for Motor size 06××
(3) for Motor size 08××, 10××, 14×× (4) for Motor size B014, B030
(5) for Motor size B060, B090
(6) If stored at –10˚C or lower place, the backed-up parameters data may be lost. Then you will have to set the parameters again.

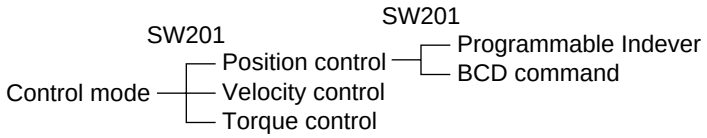
3.1.2. Function Specification

Table 3-2

Function Specification

Item		Specification
General Function		Emergency stop, rotation limit (CW/CCW), output torque limit, lower velocity gain, position/velocity integrator loop off, brake output
Position Control Mode Function (1)		RS-232C serial communication command positioning
		Programmable Indexer positioning (64 channels) (1)
		BCD (2) command positioning (serial) (1)
		Pulse train command positioning (CW-&-CCW, step-&-direction or øA/øB format)
		Jog move
		Home Return
		In-position detection
		Excess position error detection
Velocity Control Mode Function (1)		RS-232C serial communication command
		Analog ±10VDC voltage command (3)
Torque Control Mode Function (1)		RS-232C serial communication command
		Analog ±10VDC voltage command (3)
Position Feedback Signal øA, øB, øZ (MSB)		• Incremental position data • Line driver or open collector See Table 3-3 for the resolution.
Monitor Output		Velocity monitor by analog ±10VDC voltage
Error Detection	Warning	Excess position error (slight), rotation limit over (software control), battery life
	Alarm	Parameter error, resolver error, over-temperature (software control), excess position error (serious), switch setting error, control error, power amplifier error (4)

Note (1) One of these modes (and commands) can be used at one time. Selectable by internal switch SW201 as shown below:



(2) BCD = Binary Coded Decimal

(3) Only for analog interface model (specified in System number as shown below)

M-RS1410FN001MA15C

This digit must be "5."

(4) Power amplifier error is: heat sink over-temperature, TB connection error, regeneration resistor over-temperature, control circuit under-voltage, main circuit over-voltage, motor winding over-current, main circuit under-voltage, or control power fuse blown.

Table 3-3

Position Feedback Signal Resolution

Motor Size	Position Feedback Signal Resolution [count/rev]		
	øA/øB Output		øZ (MSB)
	Resolver Setting = 12-bit	Resolver Setting = 10-bit	Output
04××	102 400 or 25 600*	25 600	100
06××, 08××, 10××, 14××	153 600 or 38 400*	38 400	150
B×××	122 880 or 30 720*	30 720	120

Note * øA/øB resolution is changeable using jumpers JP403 and JP404.

3.2. Switch and Jumper

The Driver Unit of the Megatorque Motor System has many functions in one body. Some of the functions are switch- or jumper-selectable. Before using the Driver Unit, be sure to set necessary switches and jumpers. A list of switches and jumpers is indicated below, with shipping-sets in italic boldface.

Table 3-4

List Of Switch And Jumper

Function	Setting	Switch Jumper
Initialization At Power-On	• Yes • ***No***	SW201
Control Mode	• ***Position control*** • Velocity control • Torque control	SW201
Positioning Command Method	• ***Programmable Indexer*** • BCD command	SW201
Pulse Train Command Format	• ***CW & CCW*** • Step & Direction • øA/øB, ×1 • øA/øB, ×2 • øA/øB, ×4	SW201
Position Feedback Output Direction	• ***Normal*** • Reversed	SW202
CHZ Output Type	• ***øZ*** • Digital position data MSB	SW202
Daisy Chain Communication	• Yes • ***No***	SW202
RS-232C Communication Speed [bps]	• 300 • 1200 • 4800 • ***9600***	SW202
Position Feedback Output Driver Configuration	• ***Line driver*** • Open collector	JP201
Position Feedback øA/øB Output Resolution	• (Resolver resolution) ÷ 4 • ***(Resolver resolution) ÷16***	JP403 JP404
Resolver Resolution*	• 12-bit • ***10-bit*** • 10-bit/12-bit automatic switching	JP502 JP705
Analog Command Offset	***Optimized before shipping***	VR1

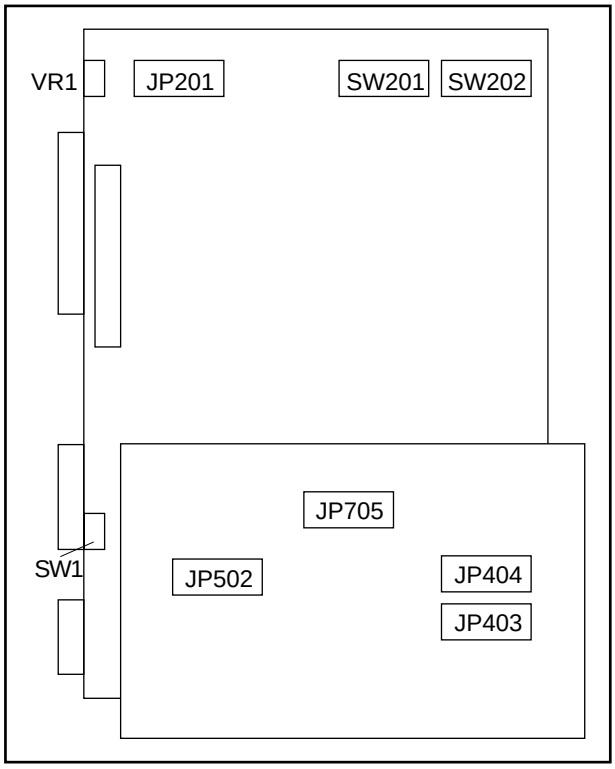
Note * The shipping set is “10-bit/12-bit automatic switching” for the System with built-in absolute position sensor.

3.2.1. Switch and Jumper Location

By removing the right side panel of the Driver Unit, you will find switches and jumpers as shown in the following figure.

Figure 3-1

Switch And Jumper Location



3.2.2. Front Panel Switch SW1

SW1 sets the Driver Unit address for daisy chain communication.

SW1 works only when daisy chain communication is active. To activate daisy chain communication, set SW202 #3 ~ 5 to all 'on' position.

See section 7.9. Daisy Chain Communication.

Table 3-5

Daisy Chain Address Setting

SW1 Position	Daisy Chain Address	SW1 Position	Daisy Chain Address
0	0	8	8
1	1	9	9
2	2	A	10
3	3	B	11
4	4	C	12
5	5	D	13
6	6	E	14
7	7	F	15

3.2.3. Internal Switch

The internal switches set a number of the Driver Unit parameters at power-on. The switches are read only at the time of power-on. You have to change the setting during power-off. The results shown below may be overridden by control inputs or RS-232C commands after power-on.

3.2.3.1. SW201

Caution *SW201 #1 must be set to 'on' position, and should not be changed without consulting NSK first. See the following description for details.*

SW201 Position 1

SW201 #1 should not be used without consulting NSK first. With this switch in the 'off' position at power-on, a 'cold initialization' is performed. All system variables will be reset to the shipping sets and the Driver Unit will automatically go through a Motor alignment procedure which may cause a slight rotation of up to 1.2°. If this is done while the Motor is not completely free of all external torque, improper Motor operation will result. The cold initialization procedure should not normally ever be necessary, but is required under the following special circumstances:

(a) When a new EPROM set is installed. This might be done to upgrade the Driver Unit to a new improved version.

(b) To recover from a 'crash' of the Driver Unit's internal microprocessor which corrupts variables stored in non-volatile memory. This may occur as a result of handling the internal microprocessor board, or because of excessive electrical noise from an unfiltered AC line, or because of severe mechanical shock to the Driver Unit. This condition may or may not be apparent from examination of RS-232C accessible parameters. The condition may manifest itself as a malfunctioning Driver Unit which is not curable by turning power off and back on.

If your Motor is to be installed where it cannot rotate freely without extensive disassembly of associated components, it would be prudent to write down the value of the PA parameter which is displayed in response to the TS4 command. Then if cold initialization is ever necessary, use the SI command and enter the proper PA value using PA command. (Password required)

Figure 3-2
SW201 Shipping Set

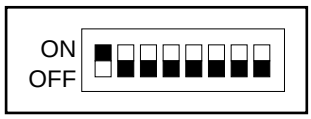


Table 3-6
SW201 #1: Initialization

#1	Initialization	Shipping Set
off	Initialization performed at power-on	
on	Normal power-on	✔

Table 3-7

SW201 #2 ~ #4: Control Mode & Position Control Command Mode

#2	#3	#4	Control Mode & Position Control Command Mode	Shipping Set
off	off	off	Position control mode, Programmable Indexer active	✔
on	off	off	Reserved (Never set!)	
off	on	off	Velocity control mode	
on	on	off	Torque control mode	
off	off	on	Position control mode, BCD command active	
on	off	on	Reserved (Never set!)	
off	on	on	Reserved (Never set!)	
on	on	on	Reserved (Never set!)	

Table 3-8

SW201 #5 ~ #7: Pulse Train Command Format

#5	#6	#7	Pulse Train Command Format	Shipping Set
off	off	off	CW & CCW	✔
on	off	off	Step & direction	
off	on	off	øA/øB, ×1	
on	on	off	øA/øB, ×2	
off	off	on	øA/øB, ×4	
on	off	on	Reserved (Never set!)	
off	on	on	Reserved (Never set!)	
on	on	on	Reserved (Never set!)	

Table 3-9

SW201 #8: Analog Command Polarity

#8	Analog Command Polarity	Shipping Set
off	'+' = CCW	✔
on	'+' = CW	

3.2.3.2. SW202

Figure 3-3

SW202 Shipping Set

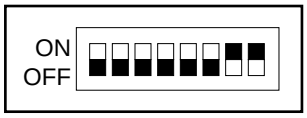


Table 3-10

SW202 #1: Position Feedback Output Direction

#1	Position Feedback Output Direction	Shipping Set
off	Normal	✔
on	Reversed	

Table 3-11

SW202 #2: CHZ Output Format

#2	CHZ Output Format	Shipping Set
off	Position feedback øZ	✔
on	Digital position data MSB	

Table 3-12

SW202 #3 ~ #5: SW1 Function

#3	#4	#5	SW1 Function	Shipping Set
off	off	off	No function assigned	✔
on	on	on	Driver Unit address setting	
on	off	off	Reserved (Never set!)	
off	on	off	Reserved (Never set!)	
on	on	off	Reserved (Never set!)	
off	off	on	Reserved (Never set!)	
on	off	on	Reserved (Never set!)	
off	on	on	Reserved (Never set!)	

Table 3-13

SW202 #6

No function is assigned to SW202 #6.

#6	Function	Shipping Set
off	Reserved	✔
on	Reserved (Never set!)	

Table 3-14

SW202 #7, #8: RS-232C Communication Speed

#7	#8	RS-232C Communication Speed	Shipping Set
on	on	9600bps	✔
off	on	4800bps	
on	off	1200bps	
off	off	300bps	

3.2.4. Jumper

The jumpers set resolver or position feedback output characteristics at power-on. The jumpers are read only at the time of power-on. You have to change the setting during power-off.

3.2.4.1. JP502 & JP705 — Resolver Resolution

JP502 and JP705 determine the resolver resolution. You can select 10-bit (higher velocity), 12-bit (precise resolution) or the 10-bit/12-bit automatic switching.

Caution *Do not set other combination setting than shown below.*

Table 3-15

JP502 & JP705: Resolver Resolution

Resolver Resolution	JP502	JP705	Shipping Set*
12-bit	1-2 installed	1-2 installed	
10-bit	All removed	1-2 installed	✔*
Automatic Switching	1-2 and 7-8 installed	2-3 installed	

Note * The shipping set is “automatic switching” for the System with built-in absolute position sensor.

3.2.4.2. JP201 — Position Feedback Output Driver Configuration

The position feedback outputs may be configured as either complementary TTL line drivers or complementary open collector outputs.

Caution *Do not set other combination setting than shown below.*

Table 3-16

JP201: Position Feedback Output Driver Configuration

Driver Configuration	Shorting Pin Setting	Shipping Set
Line Driver	All installed	✔
Open Collector	All removed	

3.2.4.3. JP403 & JP404 — Position Feedback Output Resolution

Resolution of position feedback outputs supplied at CHA, *CHA, CHB and *CHB outputs may be selected by JP403 & JP404. Select the position feedback output according to the setting of the resolver resolution. Resolution of CHZ and *CHZ is not affected by the setting of JP403 & JP404.

(1) When resolver resolution is set to 12-bit

Caution *Do not set other combination setting than shown below.*

Table 3-17

JP403 & JP404: Position Feedback Output Resolution (Resolver Resolution 12bit)

Motor Size	Resolution [count/rev]	JP403	JP404	Shipping Set
04××	102 400	3-4 installed	3-4 installed	
06××, 08××, 10××, 14××	153 600			
B×××	122 880			
04××	25 600	5-6 installed	5-6 installed	✔
06××, 08××, 10××, 14××	38 400			
B×××	30 720			

(2) When resolver resolution is set to 10-bit or 10-bit/12-bit automatic switching

Caution *Do not change the setting shown below.*

Table 3-18

JP403 & JP404: Position Feedback Output Resolution (Resolver Resolution 10bit Or 10bit/12bit Automatic Switching)

Motor Size	Resolution [count/rev]	JP403	JP404	Shipping Set
04××	25 600	5-6 installed	5-6 installed	✔
06××, 08××, 10××, 14××	38 400			
B×××	30 720			

3.2.5. Front Panel Volume VR1

When using the analog command in velocity or torque control mode, VR1 adjusts the analog command zero position. If the Motor does not stop at 0V command, then adjust VR1 to make the Motor stop at the 0V level.

4. Installation

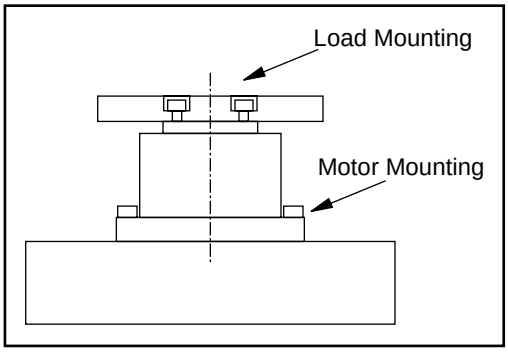
4.1. Motor Mounting

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.

- Fully fasten all the mounting holes (mounting tap holes) of the Motor.
- Fasten a load using all of the tapped holes of the rotor.
- Eliminate play between the load and the rotor.
- Eliminate play in the mechanism as much as possible.

Figure 4-1

Motor Mounting



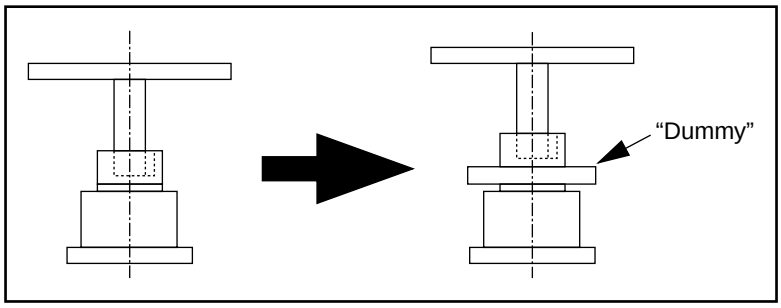
4.1.1. Using a “Dummy” Load

When you have to drive the Motor with a low-stiffness load, you may not be able to avail of the merits of the Megatorque Motor System. In some cases, a little rearrangement of mechanical design may help. Try to add some load (“dummy” inertia) to the rotor directly.

Example 1: Load is connected using keyway.

Figure 4-2

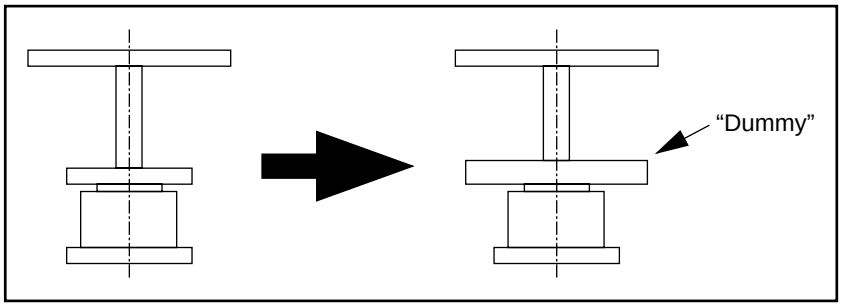
Using Keyway



Example 2: Load is directly attached but the shaft diameter is too small. (Torsional vibration may occur.)

Figure 4-3

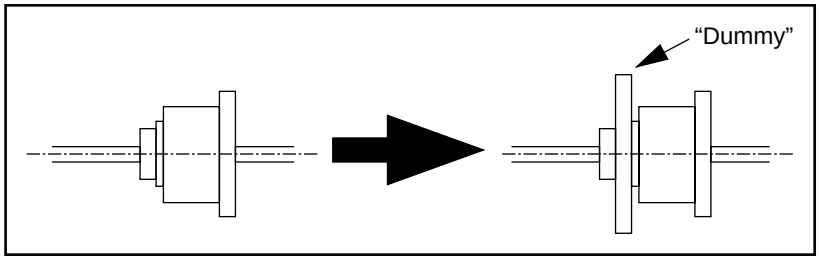
Using Small-Diameter Shaft



Example 3: Driving ball screw. (Inertia of the whole mechanism is very small.)

Figure 4-4

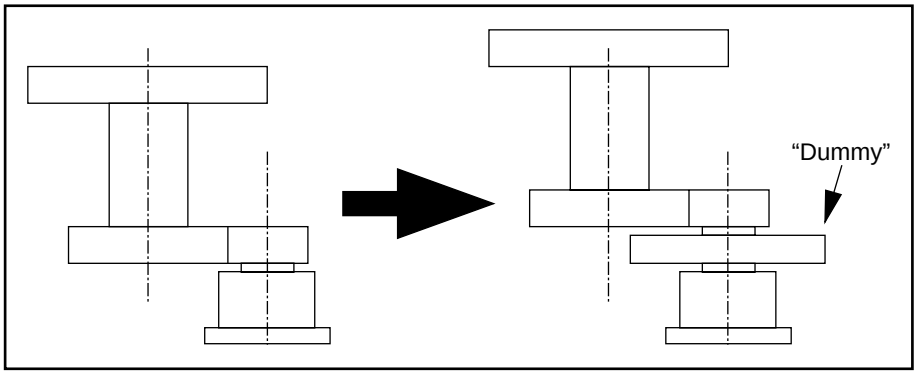
Driving Ball Screw



Example 4: Load is connected using sprocket chain or gear mechanism. (There may be backlash.)

Figure 4-5

Using Sprocket Chain Or Gear Mechanism



For smooth drive, the inertia of directly attached load should be:

$GD^2_d = GD^2_i \times 0.2$

(where GD^2_i = inertia of indirectly connected load, GD^2_d = inertia of directly attached load)

When driving a speed reduction;

$$\frac{GD^2_i}{r^2 \times GD^2_d} \leq 5$$

(where GD^2_i = inertia of indirectly connected load, GD^2_d = inertia of directly attached load, r = reduction ratio)

4.1.2. Load Inertia

Generally, the load inertia is much bigger than the rotor inertia of the Motor. The following table shows the approximate inertia capacity. (Inertia is shown as GD^2 in $kgf \cdot m^2$.)

Table 4-1

Inertia Capacity

Application	Motor Size				
	0408	0608	0810	1010	1410
High Speed Positioning	0.05 ~ 0.2	0.2 ~ 0.8	0.45 ~ 1.8	0.75 ~ 3	1.25 ~ 5
General	0.2 ~ 1	0.8 ~ 4	1.8 ~ 9	3 ~ 15	5 ~ 25
Large Inertia (Low Speed Positioning)	1 ~ 2	4 ~ 10	9 ~ 20	15 ~ 150	25 ~ 500

4.1.3. Fluctuating Load Inertia

Changes in the inertia load directly influence the performance and stability of direct drive motors. In the case of large changes in the load inertia it may be necessary to change the servo loop gain. To minimize the effect of load inertia fluctuations, the ratio of inertia fluctuation should be kept as small as possible, preferably less than 1:

$$R_i = \frac{GD^2_{max} - GD^2_{min}}{GD^2_{rotor} + GD^2_{min}}$$

(Where R_i = ratio of inertia fluctuation, GD^2_{max} = load inertia at maximum, GD^2_{min} = load inertia at minimum, GD^2_{rotor} = rotor inertia)

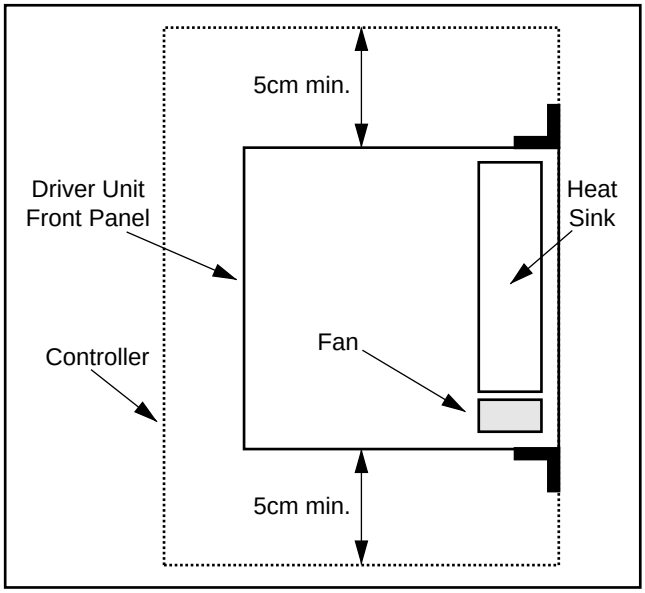
4.2. Mounting Driver Unit

4.2.1. Where to Mount

Important *For proper air circulation, 5cm clearance is required above and below the airflow ventilator tunnel illustrated in the following figure. The Driver Unit will overheat if adequate airflow is not maintained.*

Figure 4-6

Where To Mount Driver Unit



- The Driver Unit may be mounted by the holes in tabs which may be located either on the back or the front panel.
- The Driver Unit must have a minimum clearance of 5cm above and below for proper air circulation, as described above.
- Make sure that it is easy to obtain access to the circuitry on the right side of the Driver Unit while the system is wired and operating. This circuit board contains numerous jumpers and test points which might need to be accessed while the system is operating in the start-up phase. Re-adjustment of these controls may be required in the future if the operating requirements or load conditions of the system change significantly. If possible, mount the Driver Unit in an accessible place with provisions for supporting the chassis when the mounting screws are removed and the chassis is slid out. Ideally, it should be possible to see and touch Motor or load while making adjustments to the Driver Unit.

4.2.2. Operating Condition

- The area where the Driver Unit is mounted must be free of water, dirt, dust, and any other contamination.
- The air temperature must be low enough so that the Driver Unit temperature does not exceed 55°C. The Driver Unit temperature depends upon the ambient temperature, or provisions for air circulation over the chassis, and the torque profile being executed by the Motor. A fan is located inside the Driver Unit which starts automatically when the Driver Unit temperature reaches a threshold. It is important that the air passage through the fan area is not obstructed. If the Driver Unit temperature exceeds 55°C, a thermal switch will trip the internal alarm circuit. Your control system can be connected to the Driver Unit's alarm outputs to provide an indication of this condition.

Driver Unit Power Dissipation

The amount of power dissipated by the Driver Unit in the form of heat varies according to the Motor size and the application. The following table presents the Driver Unit power dissipation under the worst conditions; maximum torque at the highest rated speed. Under less severe operating conditions, the power dissipation can be considerably lower.

Table 4-2

Power Dissipation

Motor Size	Driver Unit Type	Maximum Power Dissipation (W)
04××, 06××	EM	130
08××, 10××, 14××	EM	150
	EP	200
B014	EM	120
B030 ~ B060	EM	180
B090	EP	360

4.3. Connecting Power

- The main power AC line input supplies the power to the high voltage supply for driving the Motor.
- The voltage supplied to the Motor may be three phase or single phase. If the application involves low speeds less than 0.5rps, then single phase power will be adequate. If the application requires high torque and at speeds greater than 0.5rps, then the best Motor torque/speed performance is obtained by supplying three phase power at a higher voltage.
- 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 Megatorque 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 torque at elevated speed, more than 20% of the maximum rated speed.
- Use 2.0mm^2 (14AWG) or larger wire with heat-proof vinyl for power line.
- 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 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:

Table 4-3

Noise Filter Requirement

Driver Unit AC Line	Noise Filter Voltage Rating	Current Rating
220VAC, 3ø	250V AC/DC	10A AC/DC
220VAC, 1ø	250V AC/DC	15A AC/DC
110VAC, 1ø	250V AC/DC	15A AC/DC

- The noise filter must be installed on control power AC line, separately from the main power line.
- An isolation transformer may also be used to reduce electrical noise. Contact NSK if you need information about isolation transformers.

- Use heavy gage (3.5mm^2 or larger, 10AWG) wire for the ground lines between line filter, isolation transformer and Driver Unit. All the ground lines must be connected at one point, preferably on the electronic system cabinet chassis.
- When inserting contacts like a magnetic switch into the supply circuit, the specification of the contact should be greater or equal to ones in the following table:

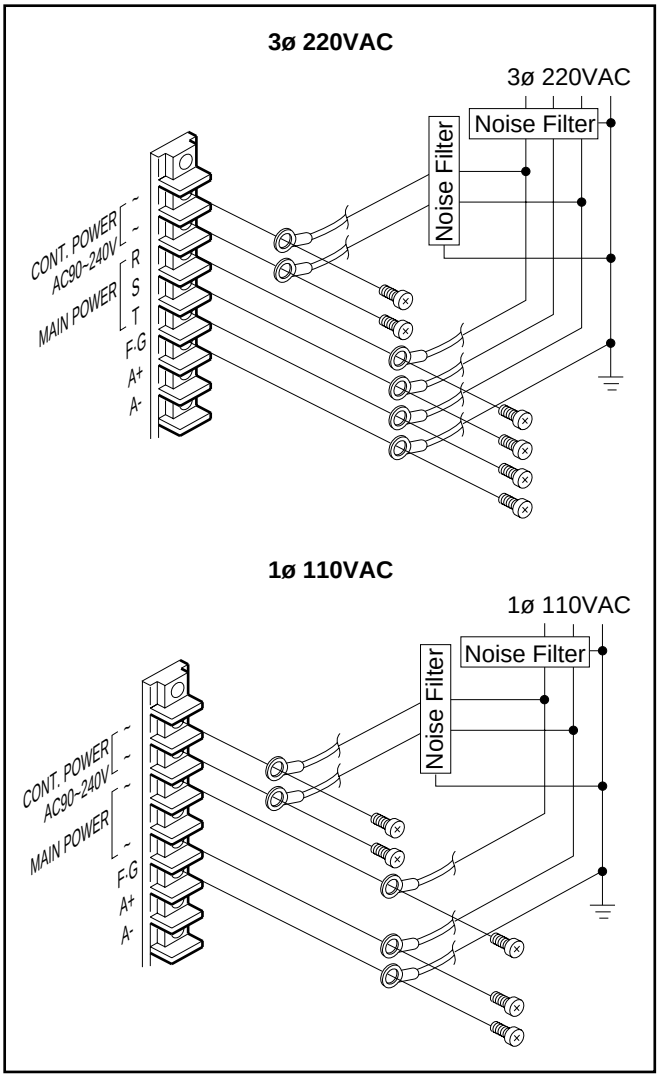
Table 4-4

Contacts Requirement

Contacts	For EM Type	For EP Type
No-Fuse Breaker	Current Rating 20A	Current Rating 30A
Short-Circuit Breaker	Contact Capacity 20A Sensitivity 15mA	Contact Capacity 30A Sensitivity 15mA
Magnetic Switch	Contact Capacity 35A	Contact Capacity 35A

Figure 4-7

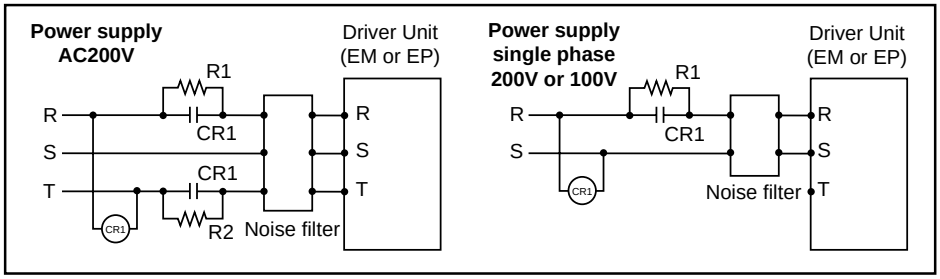
Power Wiring



Additional Notes

- When the power is turned on, an inrush current will occur because the capacitive load is connected to the power supply. If circuit breaker and fuse are affected by the inrush current, install the inrush current control circuit to the power supply circuit as shown in the figures below.
- The inrush current varies with the source impedance. When an inrush current is over 300A, the Driver Unit may be damaged. We recommend to install the circuit to protect the Driver Unit.
- When the power is turned on in the inrush current control circuit, the current is being charged initially to a capacitor of the Driver Unit through R1 and R2 resistors for 9 ~ 20 msec, which is required time to close the contact of magnetic switch, and thus, the inrush current is reduced.
- When a magnet switch CR1 is failed (failed to contact), the resistor R1 may overheat and result in a fire. We recommend to take the countermeasures by installing the thermal sensor circuit to turn main power off.
- Example of circuit to reduce inrush current

Figure 4-8



Resistor R1 • R2 : Cement resistor 15 ~ 20W 10Ω
or ceramic resistor
(Koa Ltd. HPC5 or equivalent)

Magnetic switch CR1 : Contact point capacity 200V 20A or more
(SC-03 type or equivalent , recommended
manufacturer; Fuji Electric)

- The optional “inrush current control circuit” is available. (Reference number M-FZ077)

[Checking Inrush Current]

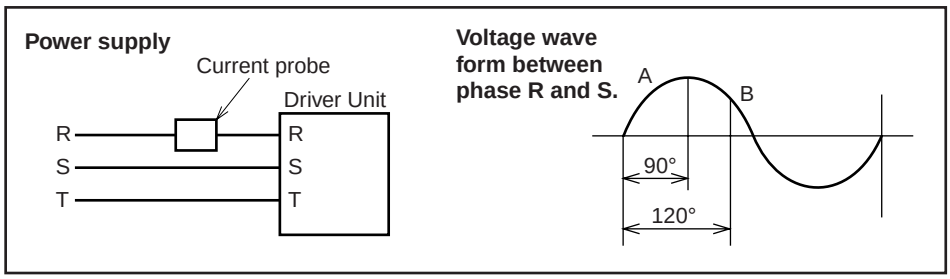
Follow the instructions below to check the maximum inrush current.

(1) Set the current probe to phase S of the Driver Unit power supply. (Response frequency of the monitor shall be 10 K Hz or more.)

(2) Inrush current shall be checked at the timing of A or B of the voltage wave form between phase R and S of power supply.

(3) The maximum current reading of phase R just after the power supply is turned on is the inrush current.

Figure 4-9



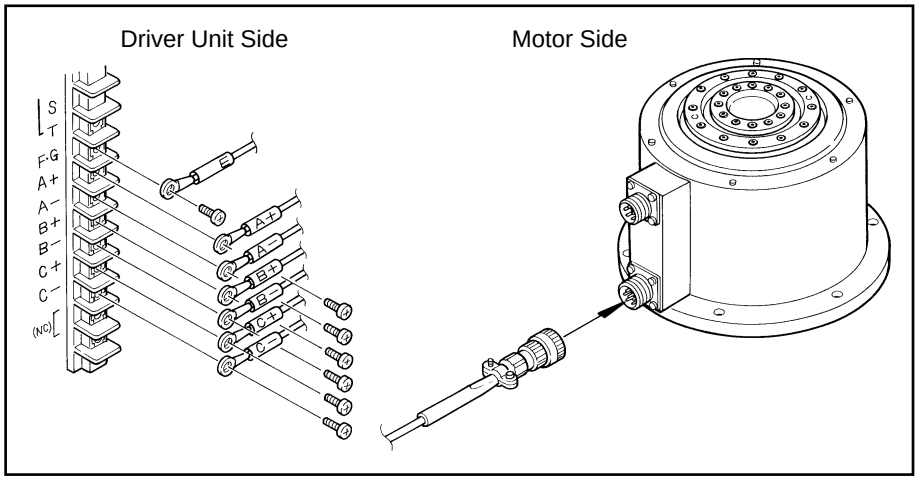
- When the dump resistor overheat alarm (Overheat 3: OH3) is detected, make sure to turn off the main power to protect the internal dump resistor from burning due to the defective Driver Unit or abnormal source voltage.

4.4. Motor Wiring

- Use the Motor cable of the Cable Set to connect the Motor and the Driver Unit terminal block TB.
- There is a twist type locking military style connector on the Motor side of the cable; Canon MS3106B16S-1S. It has seven contacts which are marked A to G. The Driver Unit end of the cable is terminated in seven spade lug terminations. Each wire is color coded and also has a marking band indicating the terminal to which it is to be attached on TB. The cable itself is a six-conductor cable with a braided shield. The shield is connected to cable terminations at both ends of the cable.
- Do not tie wrap the Motor cable with signal wires.
- Do not make the Cable Set longer or shorter. Changing cable length may worsen the Motor and Driver Unit performances, typically resolver accuracy and resolver repeatability.
- Do not remove the shorting plate installed on NC terminals. If removed, the Motor control will be disabled and an alarm will be given from the Driver Unit.
- Install the plastic protection on TB 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.

Figure 4-10

Motor Wiring

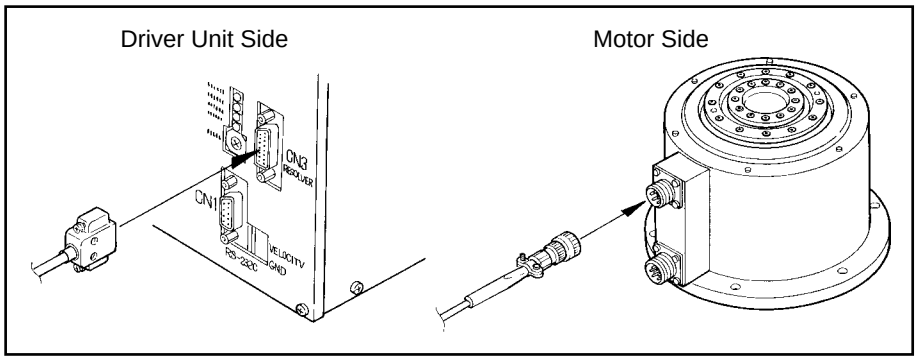


4.5. Connecting Resolver

- Use the resolver cable of the Cable Set to connect the Motor and the Driver Unit connector CN3.
- There is a twist type locking military style connector on the Motor side of the cable; Canon MS3106B14S-5S. It has five conductors which are marked ‘A’ to ‘E.’ The Driver Unit end of the cable is terminated with a 9-pin Subminiature D type connector, whose terminals are marked ‘1’ to ‘9’. This connector mates with connector CN3 on the Driver Unit front panel. The resolver cable itself is a four-conductor low-noise signal cable with a braided shield.
- Do not tie wrap the resolver cable with power line wires or motor cable.
- Do not make the Cable Set longer or shorter. Changing cable length may worsen the Motor and Driver Unit performances, typically resolver accuracy and resolver repeatability.

Figure 4-11

Resolver Wiring

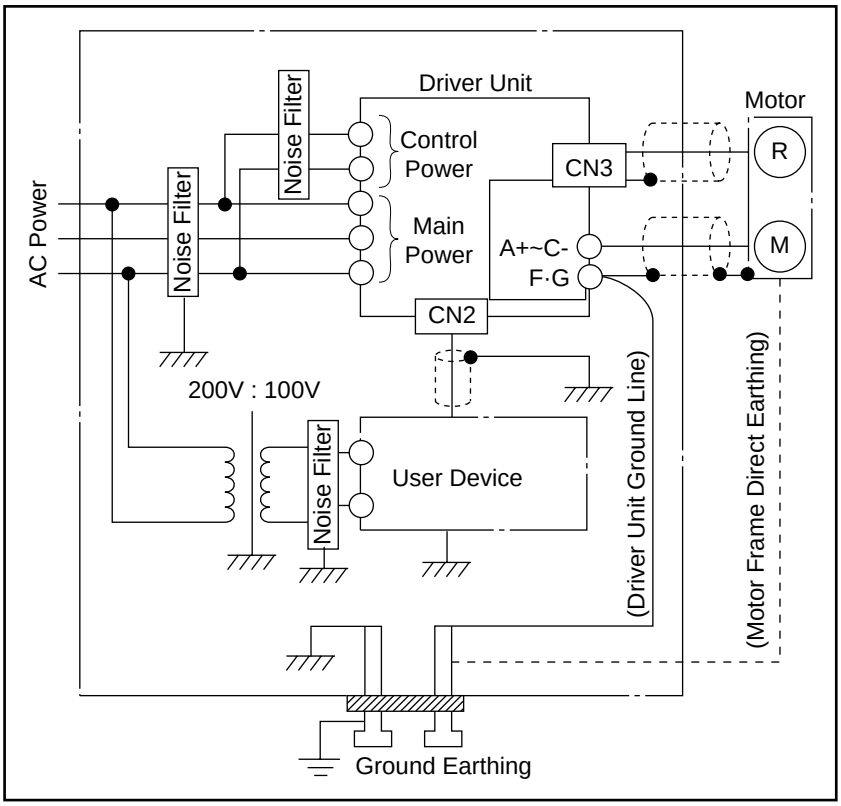


4.6. Ground Connection

- Use heavy gage (3.5mm^2 or larger, 10AWG) wire for the ground lines between line filter, isolation transformer and Driver Unit.
- All the ground lines must be connected at one point, preferably on the electronic system cabinet chassis.
- The grounding resistance must be less than or equal to 100Ω.
- If the Motor is isolated from the mother machine, then ground the motor separately.

Figure 4-12

Ground Wiring



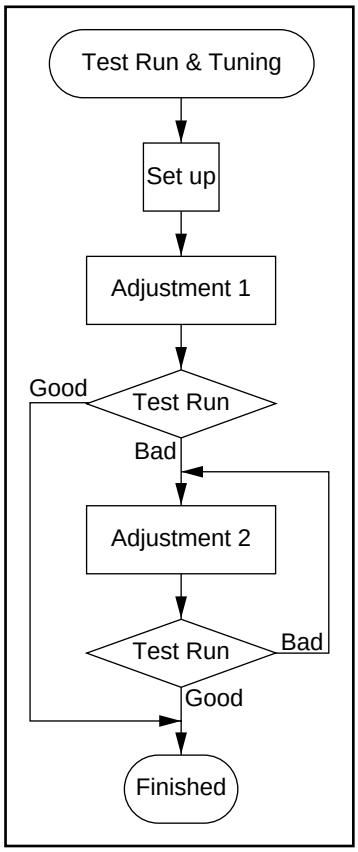
5. Trial Running and Adjustment

Carry out trial running and adjustment of the Megatorque Motor System as shown on Figure 5-1.

- If you use the System in torque control mode, you don't have to carry out adjustment.
- Even if you use the System in velocity control mode, carry out adjustment in position control mode. After the adjustment, set the mode to velocity control and use the System.
- To know how to change the control mode, see section 3.2. Switch And Jumper. The shipping-set is the position control mode.

Figure 5-1

Trial Running And Adjustment Flowchart



Proper setting and adjustment of the servo parameters, etc. are required to demonstrate the full performance of the Megatorque Motor System.

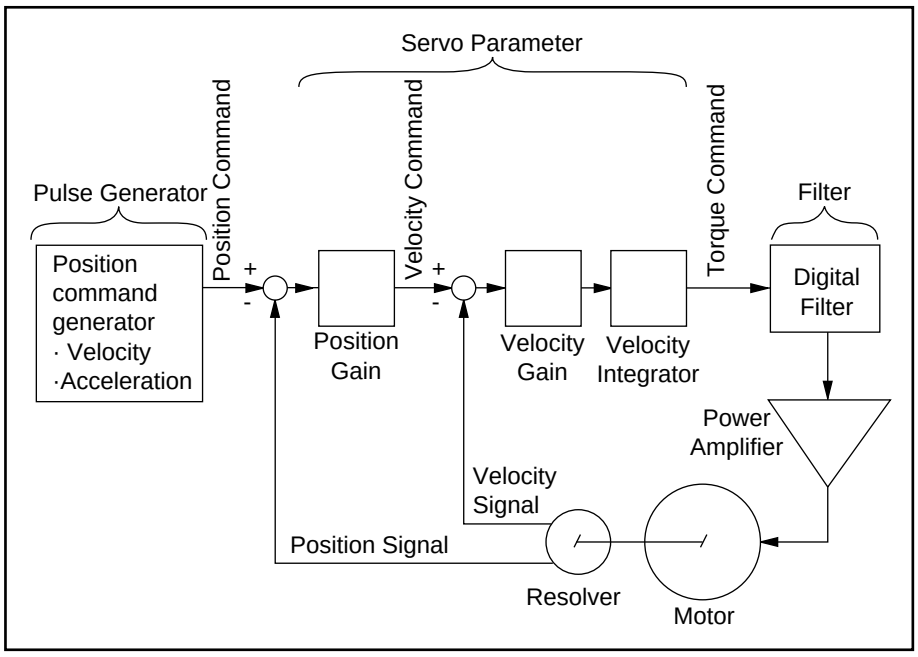
For setting and adjusting the servo parameters, the NSK Handy Terminal or equivalent terminal is required since they are set and adjusted through the RS-232C interface.

Figure 5-2 shows the servo block diagram of the Megatorque Motor System in position control mode.For the servo compensator circuit of each control mode, see section 7.8. Servo Compensator Circuit.

The following sections describe the details of adjustment and trial running.

Figure 5-2

Position Control Mode Servo Block Diagram



5.1. Preparation

5.1.1. Wiring Check

Wiring check is extremely important for smooth startup of the system. It is also useful for preventing noise trouble.

Precautions for wiring are described in chapter 4. Installation above. Refer to that chapter and check the following points:

(a) A noise filter should be incorporated in the control power supply.

(b) Do not modify or extend the Motor or resolver wiring without consulting NSK.

(c) Shielded cables should be used for input and output control signals.
- Twisted pair cables should be used for input pulse train inputs, position feed back signals, and analog signals.
- These cables should be laid in an independent duct separate from the power line.

(d) Use surge killer circuits for magnet i.e. switches, relays, etc.

(e) Use a wire of 3.5 mm^2 (12AWG) or larger for grounding the system.

5.1.2. Checking Internal Switch

Some functions of the Driver Unit are specified with the internal switches or jumpers. Refer to section 3.2. Switch And Jumper to check internal switch and jumper setting.

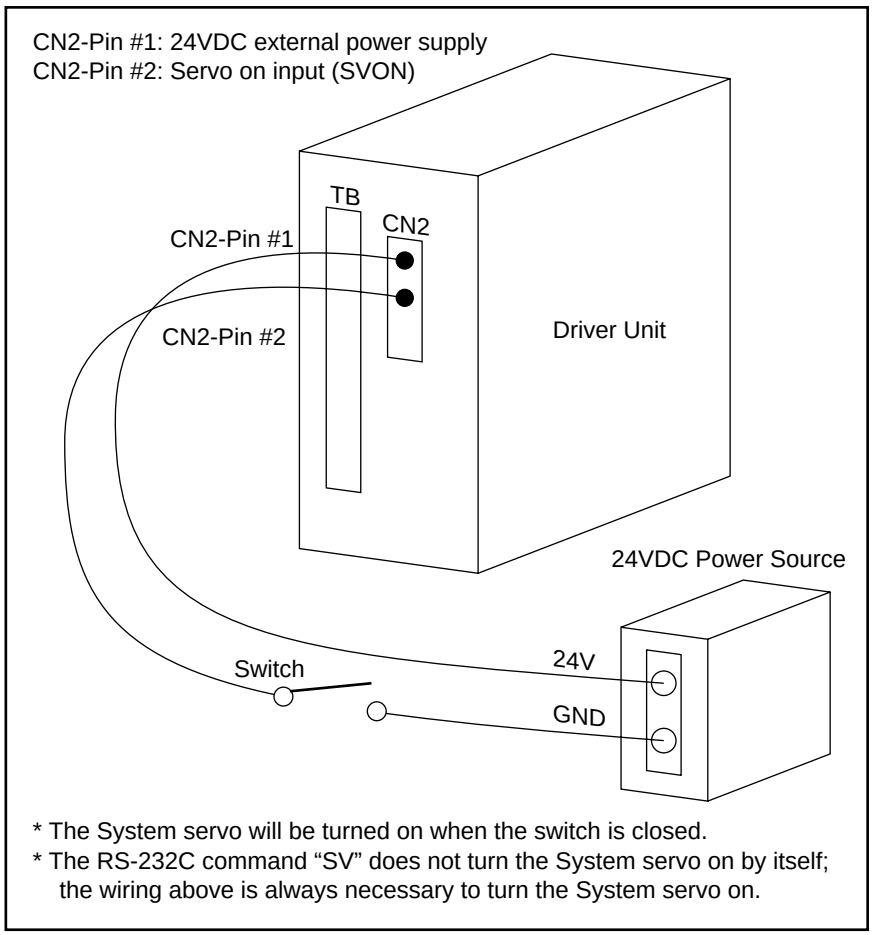
5.1.3. Wiring Servo on Signal to CN2

The Megatorque Motor System servo will be turned on when servo on signal from the external device is activated.

To carry out trial running and adjustment, the servo on signal is required. Before carrying out, wire the servo on signal to Driver Unit's connector CN2 using a 24VDC power source, a switch, and necessary cables.

Figure 5-3

Wiring Servo On Signal



5.1.4. Power On and Servo On

Preparation is completed through the operations shown below. The system starts operation if an external command is entered.

(1) Turn on the power.

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

```
NSK MEGATORQUE
SYSTEM
VER.xxxxxxxxx
xxxxxxxxx
:
```

(2) Check the DRDY (Driver Unit ready) and OVER (warning) output signals.

- If DRDY is closed and OVER is open, the System condition is normal.
- The output signal condition may be checked by inputting an IO2 command from the Handy Terminal. Type as shown below:

  I O 2$ ENT

  If “01××××” (× represents 0 or 1.) is displayed, the System condition is normal.

```
:IO2
 01xxxx
:
```

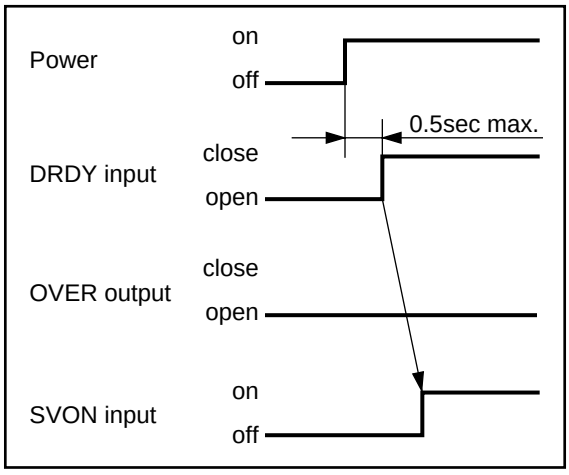
- The servo is still off in this condition.

(3) Turn on the SVON input.

- The Motor enters the servo lock condition.

Figure 5-4

Power On/Servo On Timing



5.2. Adjustment 1

5.2.1. Calculating “Load Inertia”

(1) Find the “load inertia” (moment of inertia of the load) directly coupled with the Motor (GD^2_I, in kgf·m^2) using the equation shown below. GD^2_I should include the “rotor inertia” (moment of inertia of the rotor).

GD^2_I = (rotor inertia) + (directly coupled load inertia) [kgf·m^2]

(2) Find the load inertia indirectly coupled with the Motor (GD^2_{II}, in kgf·m^2).

GD^2_{II} = (indirectly coupled load inertia) [kgf·m^2]

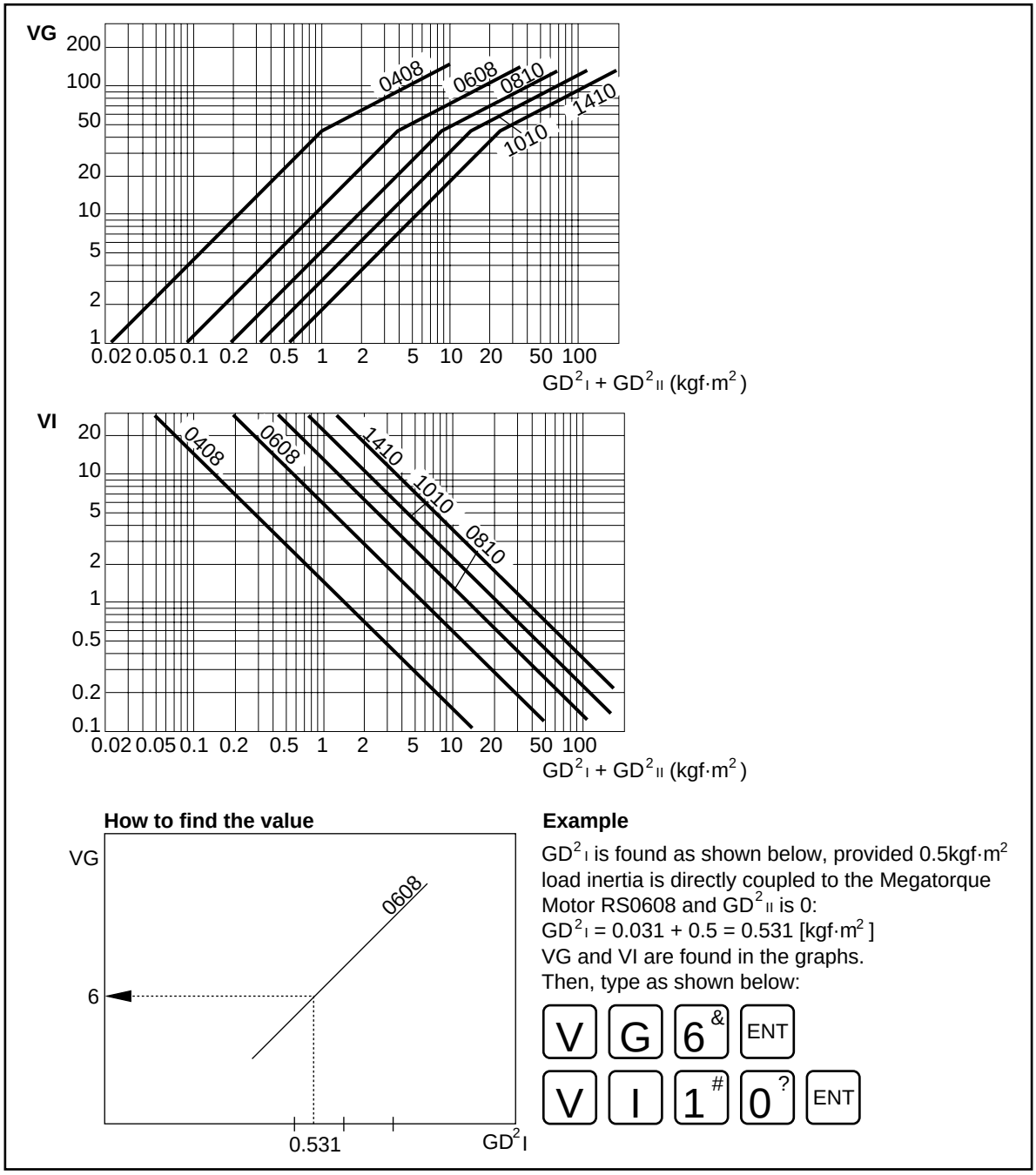
The indirectly coupled load inertia denotes the moment of inertia of the load connected to the end of a torque-transmitting element such as a gear, belt, ball spline, key coupling, elastic coupling, long drive shaft, etc. It shall be discriminated from the directly coupled load inertia since it moves in a vibration range in a different manner from the Motor due to backlash in the transmission and elastic deformation.

5.2.2. Setting Velocity Gain (VG) and Velocity Integrator Frequency (VI)

Find set values in the graphs shown below.

Figure 5-5

VG/VI Finding Graph

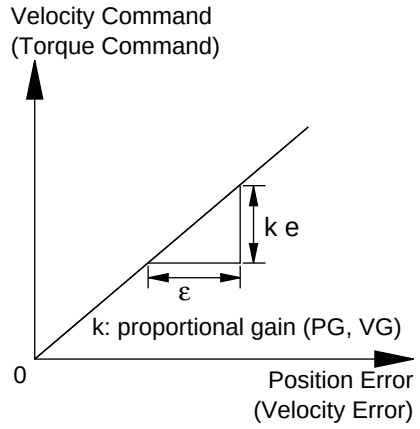


Proportional Gain • Integrator Frequency

The Megatorque Motor System employs proportional and integration control as a servo compensation circuit.

Proportional Control

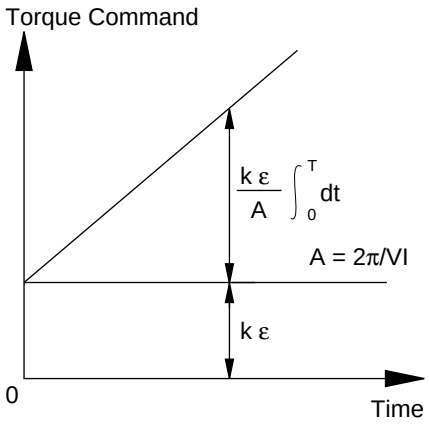
(See upper figure on the right.) In the position loop, the position error (the error between position command and position feedback) is amplified by a number defined as a proportional gain (set by PG in Megatorque Motor System), and is output as a velocity command. Also, in the velocity loop, the velocity error (the error between velocity command and velocity feedback) will be amplified by a number defined as a proportional gain (set by VG in Megatorque Motor System), and will be output as a torque command.



Integration Control

(See lower figure on the right.) In velocity loop, the velocity error is integrated over time and is output as a torque command.

- If a higher integrator frequency (set by VI in Megatorque Motor System) is input, the commanded output will be larger given the same error and time elapsed.
- The integration control can be deactivated using IOFF input in Megatorque Motor System.



5.2.3. Setting Position Gain (PG)

Normally, the velocity gain VG and velocity integrator frequency VI are set as found in the graphs shown above, but the position gain PG should be left as adjusted in the factory before shipment, i.e., PG0.1.

If greater holding power is required while the Motor is stationary, increase PG slightly. If PG exceeds 0.5, the Motor may overshoot while of positioning. Thus, use care not to increase PG excessively.

On completion of setting, push the connected load by hand. You will see that it moves back to the former position by resiliency. Make sure that the load is free from vibration.

Check the set value as:



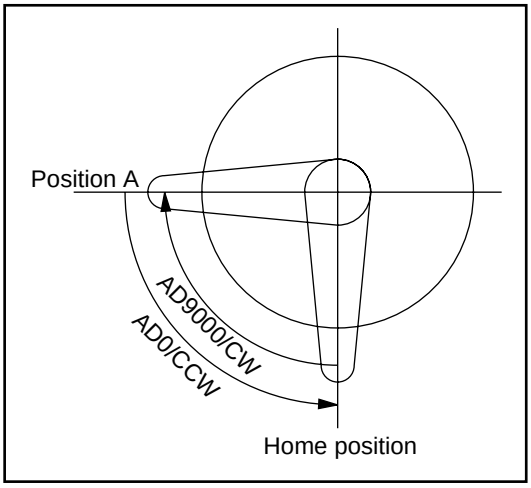

```
:TS1
 PG0.1[MEM,ON]
 PI1 [MEM, OFF]
 VG6[MEM,ON]
 VI10[MEM,ON]
 LG50
```

5.3. Trial Running and Operation Check

If adjustment is completed, check for correct operation using the procedures shown below. Rotate the Motor by 90° for checking operation.

Figure 5-6

Trial Running Motion



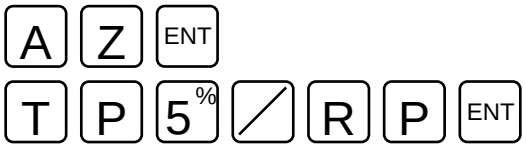
(1) If the Motor is fitted with an arm, etc., make sure that no obstacles are around the Motor and arm to avoid accidents when the Motor begins to rotate.

Danger *Always stay in a safe place when operating during the trial running. Since the Megatorque Motor System is not completely set up yet, the Motor may perform a unexpected strange motion.*

(2) Turn on the SVON input signal.

(3) Use the current position as the home position.

Type as:




```
:AZ
:TP5/RP
 0
```

Make sure that 0 is displayed on the Handy Terminal.

Variation by several pulses near position 0 (for example, 35999 → 0 → 1 → 0 → 35999 → ...) does not mean incorrect operation. It originates from the characteristics of the servo motor.

(Press the BS key to exit this mode.)

(4) Make sure that the velocity and acceleration are correct.

Type as:



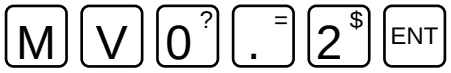

```
:TS5
 MA1
 MV1
:
```

MV: Velocity [rps]

MA: Acceleration [rps^2]

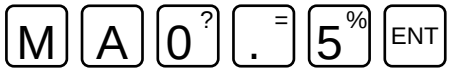
(5) Decrease the velocity for safety.

To set the velocity to 0.2rps, type as:




```
:MV0.2
:MA0.5
:
```

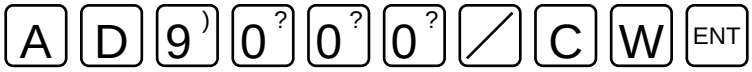
To set the acceleration to 0.5rps^2, type as:



(6) Execute positioning clockwise to position A.

Danger *The positioning starts as soon as the ENT key is pressed.*

Type as:



On completion of positioning, make sure that the current position is 90°.

```
:AD9000/CW
:TP5
 9000
```

Type as:



“9000” will be displayed. (90.00 degrees)

Variation by several pulses near position 0 does not mean incorrect operation. It originates from the characteristics of the servo motor.

(7) Execute positioning counterclockwise to the home position.

Danger *The positioning starts as soon as the ENT key is pressed.*

Type as:




```
:AD0/CCW
:TP5
 0
:
```

On completion of positioning, make sure that the current position is 0°.

Type as:



(8) Check the position error data.

Type as:




```
:TE/RP
 0
```

"0" will be displayed.

If you press the Motor by hand, the number of pulses corresponding to the movement of the Motor is displayed. Check to see whether the displayed number of pulses is reset to 0 if you release your hand. If 0 is displayed within 1 second, the Motor is normal. (This time depends on the Motor and inertia conditions.)

Variation by several pulses near position 0 does not mean incorrect operation. It originates from the characteristics of the servo motor.

(Press the BS key to exit this mode.)

(9) Specify the velocity and acceleration.

Specify the highest velocity to be actually used. If it is 2rps, type as follows:




```
:MV2
:
```

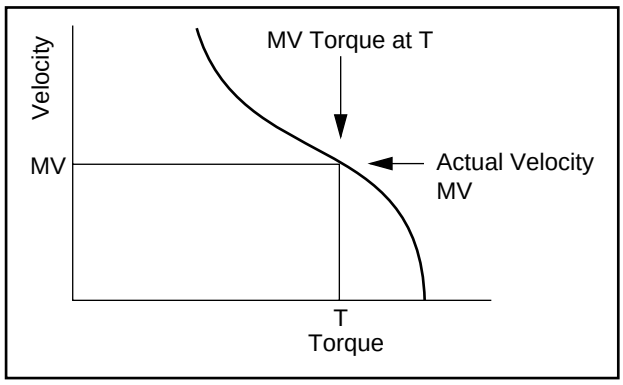
The maximum acceleration can be found from the load inertia ($GD^2_I + GD^2_{II}$) and velocity gain. The presentable maximum acceleration may be found as shown below. Specify proper acceleration within the allowable range.

(i) Find the Motor output torque T at the velocity specified by using MV.

(Refer to the torque-speed characteristic chart of the Motor, available on catalogs or System specification sheet.)

Figure 5-7

Finding Output Torque



Find the acceleration for the load inertia ($GD^2_I + GD^2_{II}$) at 80% of the output torque T using the following equations:

$$0.8T = \frac{GD^2_I + GD^2_{II}}{4g} \times 2\pi MA$$

$$MA = \frac{2g}{\pi} \cdot \frac{0.8T}{GD^2_I + GD^2_{II}} \cong 5 \frac{T}{GD^2_I + GD^2_{II}}$$

(ii) If the velocity gain VG is low (< 10) due to small load inertia or low rigidity of the mechanism, the output torque is also limited in proportion to VG. Therefore, we recommend that the acceleration should be less than the value found from the following equation:

$$MA \cong 0.5VG \frac{T}{GD^2_I + GD^2_{II}} \qquad \text{(where VG<10)}$$

Provided the acceleration is 10 rps^2, type as shown below:

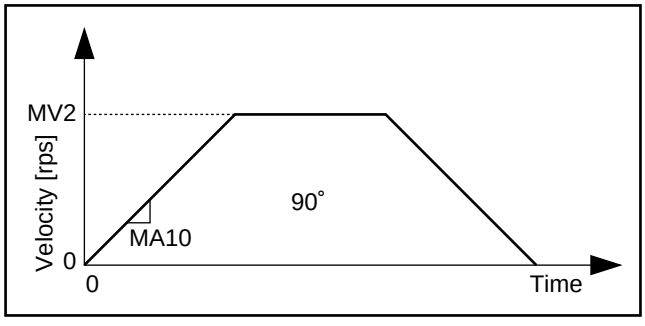
M A 1 # 0 ? ENT

```
:MA10
:
```

On completion of setting, try to move between the home position and position A. Motion is performed as shown below:

Figure 5-8

Sample Motion



If Motor Fails to Move in the Way You Want...

Check the Motor movement visually. If the Motor fails to move properly, adjust it as shown below:

(1) Excessive noises are generated when the Motor stops.

- Check to see whether the calculated load inertia GD^2_I and velocity gain VG are correct. (Try to decrease VG.)

(2) The Motor vibrates when it is stationary.

- Check to see whether the position gain PG is correct. (If PG is too high, decrease it.)

(3) Excessive noises are generated while the Motor is rotating.

- Incorporate a software digital filter if the Motor resonates with the mechanical system.

(4) Overshoot occurs.

- Check to see whether the calculated load inertia ($GD^2_I + GD^2_{II}$) is correct.
- Check to see whether the acceleration MA is set properly. (If MA is too high, decrease it.)
- Check to see whether the position gain PG is set properly. (If PG is too high, decrease it.)
- Check to see whether the velocity integrator frequency VI is set properly. (If VI is too high, decrease it.)

(5) An excess position error occurs. (A warning is given.)

- The excess position set value is too low.

(i) If the excess position error warning is used

An excess position warning is given if the condition $PG \times CO > 1365 \times MV$ is not met. Specify CO so that the following condition is met:

$$CO = \frac{1365MV}{PG} \times 1.5 \cong \frac{2000 \times MV}{PG}$$

(ii) If the excess position error alarm is used

An excess position alarm is given if the condition $PG \times CO \times 8 > 1365 \times MV$ is not met. Specify CO so that the following condition is met:

$$CO = \frac{1365MV}{PG \times 8} \times 1.5 \cong \frac{250 \times MV}{PG}$$

5.4. Adjustment 2

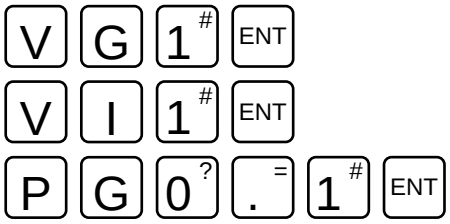
— If motor oscillates with conditions set in section 5.2. Adjustment 1 or to obtain quicker motor response

Important *If the Motor vibrates or oscillates though it is adjusted properly using the graphs, the mounting base or rotating load of the Motor may have low mechanical rigidity. Use rigid structure and load system to increase the characteristic frequency of the whole mechanism.*

5.4.1. Preparation for Adjustment

(a) Set the gains to the factory-set values.

Type as shown below:




```
:VG1
:VI1
:PG0.1
:
```

(b) Make sure that all the servo compensators are deactivated.

(1) Filters

Type as:

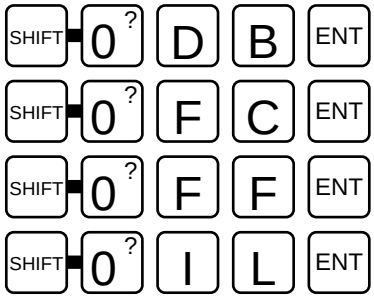



```
:TS2
 FP0
 FS0
 NP0
 NS0
:
```

Make sure that all filters are set to 0.

(2) Others

Type as:




```
:?DB
 DB0/VL
 DB0/PL
:?FC
 FC0
:?FF
 FF0
:?IL
 IL100/VL
 IL100/PL
```

Make sure that DB0, FC0, FF0 and IL100 are specified.

5.4.2. Adjustment of Velocity Gain (VG)

While pushing the load by hand, increase VG gradually until just before vibration occurs.

V G 2 $ ENT ··· V G 1 # 5 % ENT

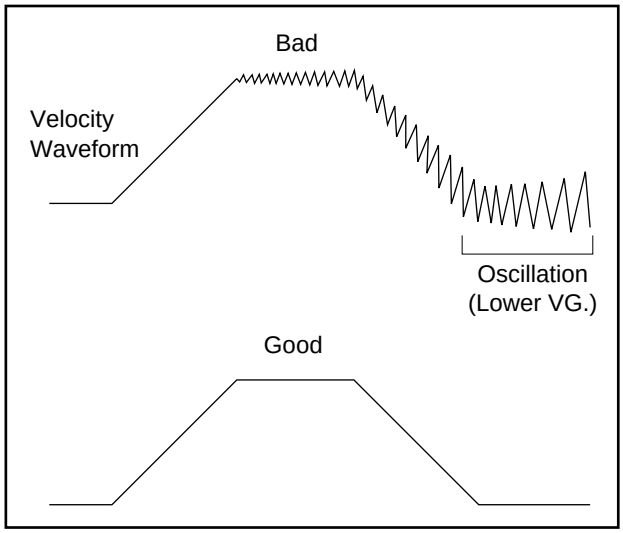
Increasing VG will increase the Motors rigidity and stiffness.

```
:VG2
:VG3
  ⋮
:VG14
:VG15
```

Repeat trial running several times and make sure that the Motor does not oscillate when it is stopping. The velocity waveform may be output through the monitor terminal on the front panel of the Driver Unit.

Figure 5-9

Typical Velocity Waveforms During VG Adjustment



5.4.3. Adjustment of Velocity Integrator Frequency (VI)

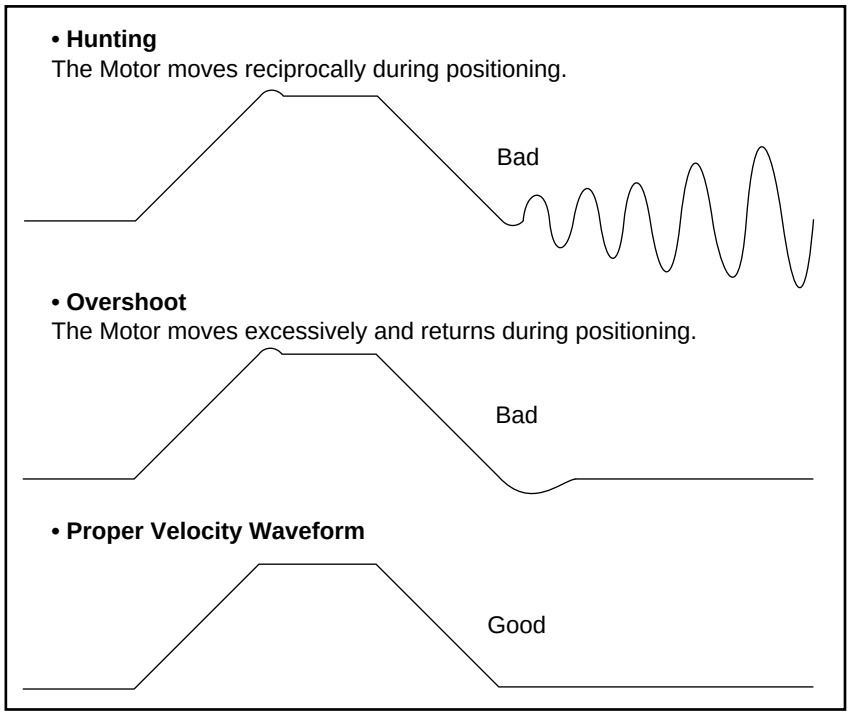
Then, increase VI in the same manner to a point where hunting or overshoot does not occur while positioning.

V I 2 $ ENT ··· V I 4 > ENT

```
:VI2
:VI3
:VI4
:
```

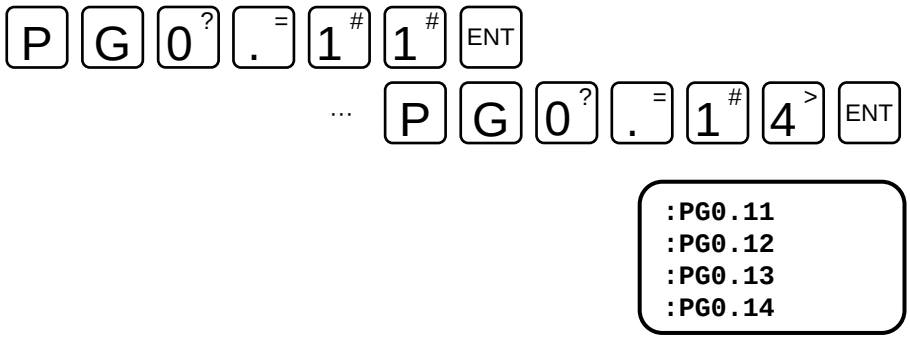
Figure 5-10

Typical Velocity Waveforms During VI Adjustment



5.4.4. Adjustment of Position Gain PG

If higher stiffness is required when stationary, increase PG slightly. Adjust PG so that overshoot is not caused. It should be set to a value between 0.07 and 0.5 normally. If the Motor overshoots and PG may not be increased, decrease VI.



5.4.5. Fine Adjustment of VG, VI and PG

If a heavy load is applied, the velocity gain VG may be set higher and the velocity integrator frequency VI is less than 1, in general. If a light load is applied, VG is lower and accordingly VI may be set higher.

Table 5-1
Servo Parameter Effects

	Too High	Too Low
VG	Subject to vibration.	Torque is low.
VI	Overshoot occurs.	Response is poor.
PG	Overshoot occurs.	Retaining force is low.

Adjust VG, VI and PG in the following order, in principle:

First: VG → Second: VI → Third: PG

If hunting or overshoot occurs, further adjustment is required. Set the parameters to the shipping-set values (VG1, VI1 and PG0.1), then adjust them in sequence properly. (If the load weight is changed considerably after adjustment, readjustment is required.)

Important *Adjust the Motor under the condition where all the filters and other servo compensators are deactivated. Otherwise, it cannot be adjusted properly.*

5.5. Reducing Motor Rotation Noise (How to Use the Filters)

When positioning, the Motor may resonate mechanically and generate a noise of a certain frequency. Using Megatorque Motor's software filters, the noise can be reduced.

Knowing the resonance frequency using oscilloscope connected to VELOCITY terminal on Driver Unit's front panel, you can apply the low-pass or notch filter to the resonance frequency.

5.5.1. Cautions for Using Filters

Caution *Do not use the filters when you need quick response, or stable motion with high repeatability (for example, ±1 pulse).*

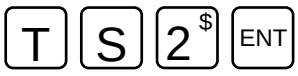
Caution *Before using filters, make sure that all adjustments of gains and integrator frequencies are completed.*

Caution *Do not use three or more filters at the same time; preferably, use FP (primary low-pass filter) alone, or only FP and NP (primary notch filter). Using three or more filters at the same time may effect the control system and make the Motor work unstably.*

Caution *If low frequency filters, typically under 100Hz, are used, hunting or oscillation may occur. When continuous oscillation occurs, immediately deactivate all filters.*

5.5.2. Checking Current Filter Setting

Type as:




```
:TS2
 FP
 FS
 NP
 NS
:
```

These filters are:

FP — Primary low-pass filter
FS — Secondary low-pass filter
NP — Primary notch filter
NS — Secondary notch filter

5.5.3. Reducing Resonance noise

Try to use the low-pass filter of a frequency that is lower than the resonance frequency.

If the resonance frequency is 350Hz, try to set the low-pass filter of 150Hz. Type as:




```
:FP150
:
```

5.5.4. Making Quieter

Try to use the notch filter of a same frequency as the resonance frequency.

If the resonance frequency is 350Hz, try to set the notch filter of 350Hz. Type as:




```
:NP350
:
```

5.5.5. Deactivating Filter

To deactivate filters, input the filter command with “0” data. For example, to inactivate the primary low-pass filter, type as:




```
:FP0
:
```

Other filters can be deactivated in the same manner; FS0, NP0 and NS0.

6. Connector

6.1. CN1: RS-232C Serial Communication Connector

If NSK Handy Terminal FHT01 is used as an RS-232C terminal, you need only plug the Handy Terminal connector into CN1. Knowledge of the pin assignment or signal names is not necessary. This section is offered for reference.

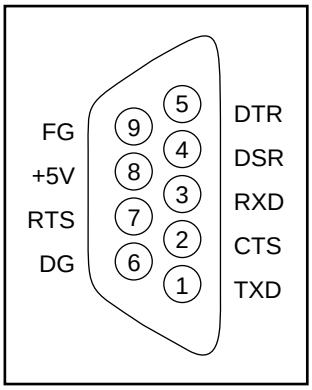
If another RS-232C terminal is used, refer to Appendix 4 for connection.

Table 6-1
CN1 Connector Type

Connector Type (Driver Unit Side)	JAE DE-9S-N
Mating Connector Type (User Device Side)	JAE DE-9P-N
Mating Connector Shell Type (User Device Side)	JAE DE-C1-J6

6.1.1. CN1 Pin-Out

Figure 6-1
CN1 Pin-Out



6.1.2. CN1 Signal List

Table 6-2
CN1 Signal List

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

6.2. CN2: Control I/O Connector

Table 6-3

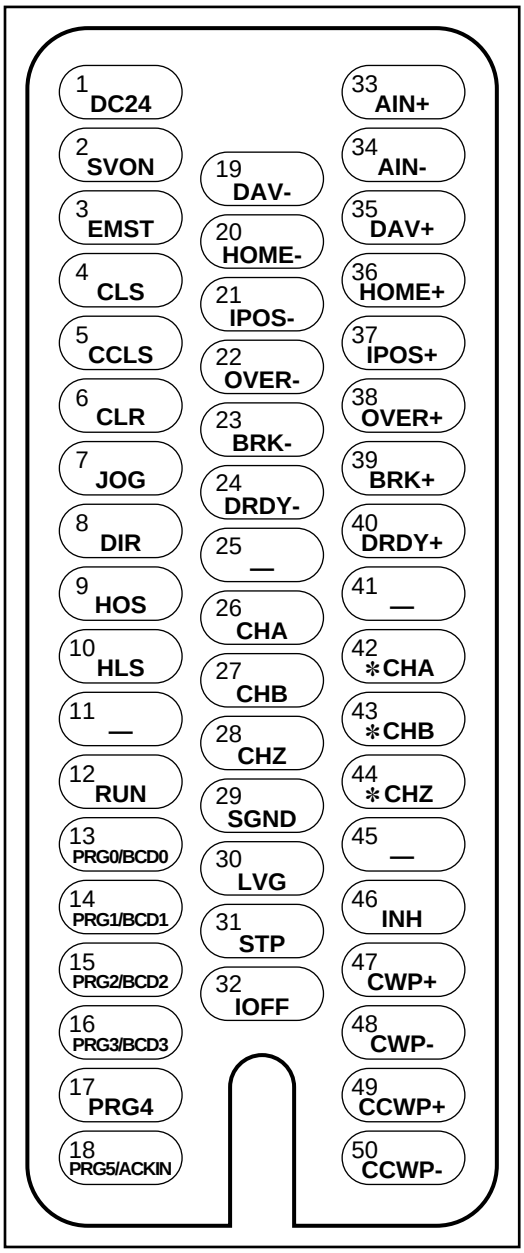
CN2 Connector Type

Connector Type (Driver Unit Side)	Honda MR-50RFA
Mating Connector Type (User Device Side)	Honda MR-50M
Mating Connector Shell Type (User Device Side)	Honda MR-50L

6.2.1. CN2 Pin-Out

Figure 6-2

CN2 Pin-Out



6.2.2. CN2 Signal List

Table 6-4

CN2 Signal List

Pin	Signal Name	I/O	Function	
1	DC24	Input	24VDC external power supply — Prepare a 24VDC external power supply. (0.2A or more)	
2	SVON	Input	Servo on — If SVON goes active, the servo turns on and the system waits for a command to be entered.	
3	EMST	Input	Emergency stop — If EMST goes active, the system does not accept any operation commands, and the Motor enters the servo lock state (zero velocity command state).	
4	CLS	Input	CW rotation limit switch — If CLS goes active, the Motor servo is locked in the clockwise direction only.	
5	CCLS	Input	CCW rotation limit switch — If CCLS goes active, the Motor servo is locked in the counterclockwise direction only.	
6	CLR	Input	OVER output clear — Clears (resets) the OVER output.	
7	JOG	Input	Jogging — If JOG goes active, the Motor rotates. If it goes inactive, the Motor decelerates and stops.	
8	DIR	Input	Rotation direction setting — If DIR goes active, the Motor rotates clockwise. If it goes inactive, the Motor rotates counterclockwise. DIR should be input for jogging, returning to the home position, etc.	
9	HOS	Input	Home Return start — If HOS goes active, Home Return starts.	
10	HLS	Input	Home position limit switch — If HLS goes active after Home Return starts, the Motor decelerates. If it goes inactive, the Motor stops.	
11	–	–	Reserved (Never Connect!)	
12	RUN	Input	Positioning start — Starts program operation.	
13	PRG0/BCD0*	Input	Channel select 0/BCD command 0	For Programmable Indexer operation: A channel to be executed (0 to 63) is selected according to combination of PRG0 to PRG5. For BCD operation: A command is created according to combination of BCD0 to BCD3. It is input to the Driver Unit when ACKIN is activated.
14	PRG1/BCD1*	Input	Channel select 1/BCD command 1	
15	PRG2/BCD2*	Input	Channel select 2/BCD command 2	
16	PRG3/BCD3*	Input	Channel select 3/BCD command 3	
17	PRG4	Input	Channel select 4	
18	PRG5/ACKIN*	Input	Channel select 5/BCD command acknowledge	
19	DAV–	Output	BCD command data entry enable — A Driver Unit check signal is output when a BCD command is input.	
20	HOME–	Output	Home Return completed — Closed when Home Return is completed.	
21	IPOS–	Output	Positioning completed — Closed if the position error falls below the in-position limit (specified by using parameter IN).	
22	OVER–	Output	Warning — Closed in any of the following conditions: • Excess position error • Battery voltage low • Software rotation limit over	

Table 6-4

CN2 Signal List (Continued)

Pin	Signal Name	I/O	Function	
23	BRK–	Output	Brake — Normally-closed brake signal	
24	DRDY–	Output	Driver Unit ready — The Motor is ready to rotate if these pins are closed.	
25	–	–	Reserved (Never Connect!)	
26	CHA	Output	Position feedback øA	A pulse signal indicating rotation of the Motor in line driver or open collector format
27	CHB	Output	Position feedback øB	
28	CHZ	Output	Position feedback øZ/Digital position data MSB	
29	SGND	–	Ground for position feedback signal — Used if the position feedback signal is open collector output.	
30	LVG	Input	Velocity gain reduction — If LVG goes active, the velocity gain is reduced at a rate specified by using parameter LG.	
31	STP	Input	Positioning forced termination — If STP goes active, positioning is discontinued.	
32	IOFF	Input	Integration control off — If IOFF goes active, velocity/position integration control is deactivated.	
33	AIN+***	–	Analog Command	Inputs analog voltage command in velocity or torque control mode.
34	AIN–***	–	Ground for analog command	
35	DAV+	Output	Used with DAV– (pin #19)	
36	HOME+	Output	Used with HOME– (pin #20)	
37	IPOS+	Output	Used with IPOS– (pin #21)	
38	OVER+	Output	Used with OVER– (pin #22)	
39	BRK+	Output	Used with BRK– (pin #23)	
40	DRDY+	Output	Used with DRDY– (pin #24)	
41	–	–	Reserved (Never Connect!)	
42	*CHA	Output	Position feedback øA	The reverse output if the position feedback signal is line driver output.
43	*CHB	Output	Position feedback øB	
44	*CHZ	Output	Position feedback øZ/Digital position data MSB	
45	–	–	Reserved (Never Connect!)	
46	INH	Input	Pulse train input disable — If INH goes active, pulse train inputs are ignored	
47	CWP–	Input	CW pulse train	5VDC pulse train position command should be given.
48	CWP+	Input	CW pulse train	
49	CCWP–	Input	CCW pulse train	
50	CCWP+	Input	CCW pulse train	

Note * Either the channel selection mode or BCD mode is selected with the internal switch SW201.

** Either the position feedback øZ or digital position data MSB is selected with SW202.

*** Only available on the models shown below.

M-RS1410FN001MA15C

This digit must be "5."

6.2.3. CN2 Electrical Specification

6.2.3.1. General Input Signal

Applied inputs: CCLS, CLR, CLS, DIR, EMST, HLS, HOS, INH, IOFF, JOG, LVG, PRG0/BCD0, PRG1/ BCD1, PRG2/BCD2, PRG3/BCD3, PRG4, PRG5/ ACKIN, RUN, STP, SVON

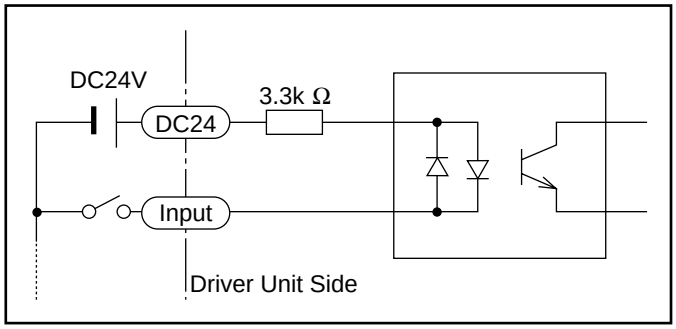
Table 6-5

General Input Specification

Item	Specification
Input Voltage	24VDC±10%
Input Impedance	3.3kΩ
Maximum Current Per Input	6mA

Figure 6-3

General Input Circuit



6.2.3.2. Pulse Train Input Signal

Applied inputs: CCWP, CWP

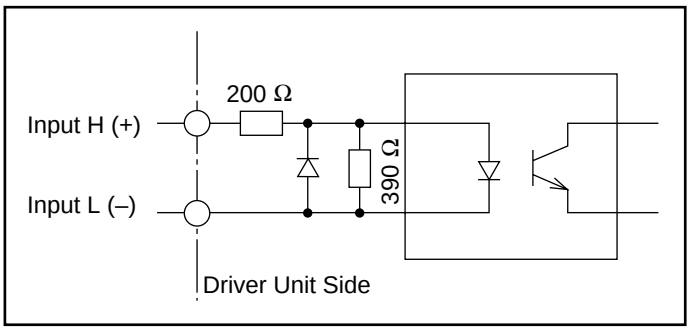
Table 6-6

Pulse Train Input Specification

Item	Specification
Input Voltage	5VDC±10%
Input Impedance	220Ω
Maximum Current Per Input	15mA

Figure 6-4

Pulse Train Input Circuit



6.2.3.3. General Output Signal

Applied inputs: BRK, DAV, DRDY, HOME, IPOS, OVER

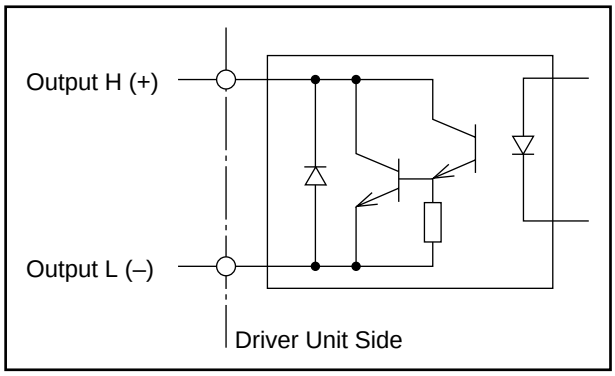
Table 6-7

General Output Specification

Item	Specification
Maximum Switching Ability	24VDC
Maximum Load Current	100mA
Maximum Saturated Voltage	1V

Figure 6-5

General Output Circuit



6.2.3.4. Position Feedback Output Signal

Applied outputs: CHA, CHB, CHZ, *CHA, *CHB, *CHZ

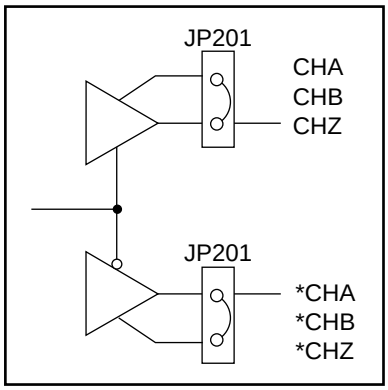
Table 6-8

Position Feedback Output Specification

Item	Specification
Output Format	Line driver or open collector
Output Device (Line Driver)	TI SN75113
Recommended Receiving Device (Line Receiver)	TI SN75115 or equivalent
Maximum Output Current	±40mA
Pull-Up Voltage	5VDC
Pull-Up Resistance	200~510Ω

Figure 6-6

Position Feedback Output Circuit



6.2.3.5. Analog Input Signal

Applied inputs: AIN+, AIN–

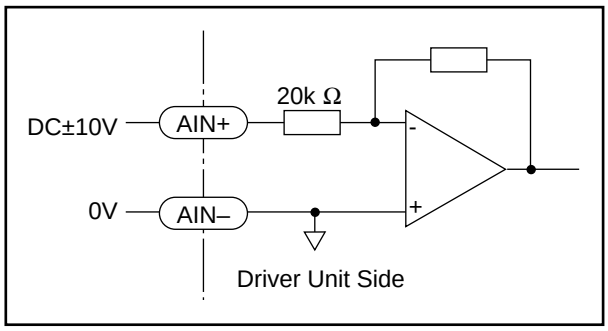
Table 6-9

Analog Input Specification

Item	Specification
Maximum Input Voltage	±10VDC
Input Impedance	20kΩ
Maximum Current	0.5mA

Figure 6-7

Analog Input Circuit

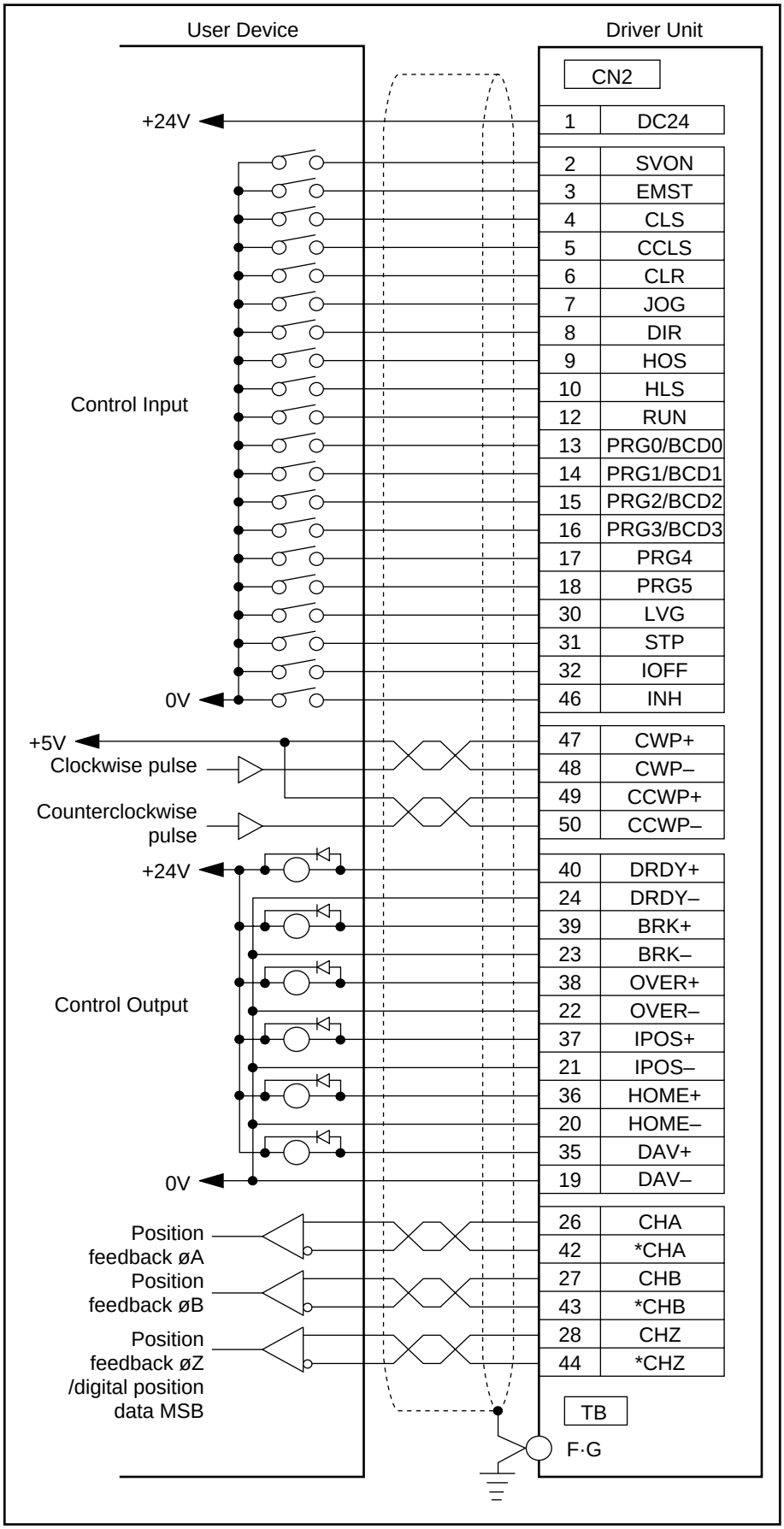


6.2.4. CN2 Sample Wiring Diagram

6.2.4.1. Position Control Mode Sample

Figure 6-8

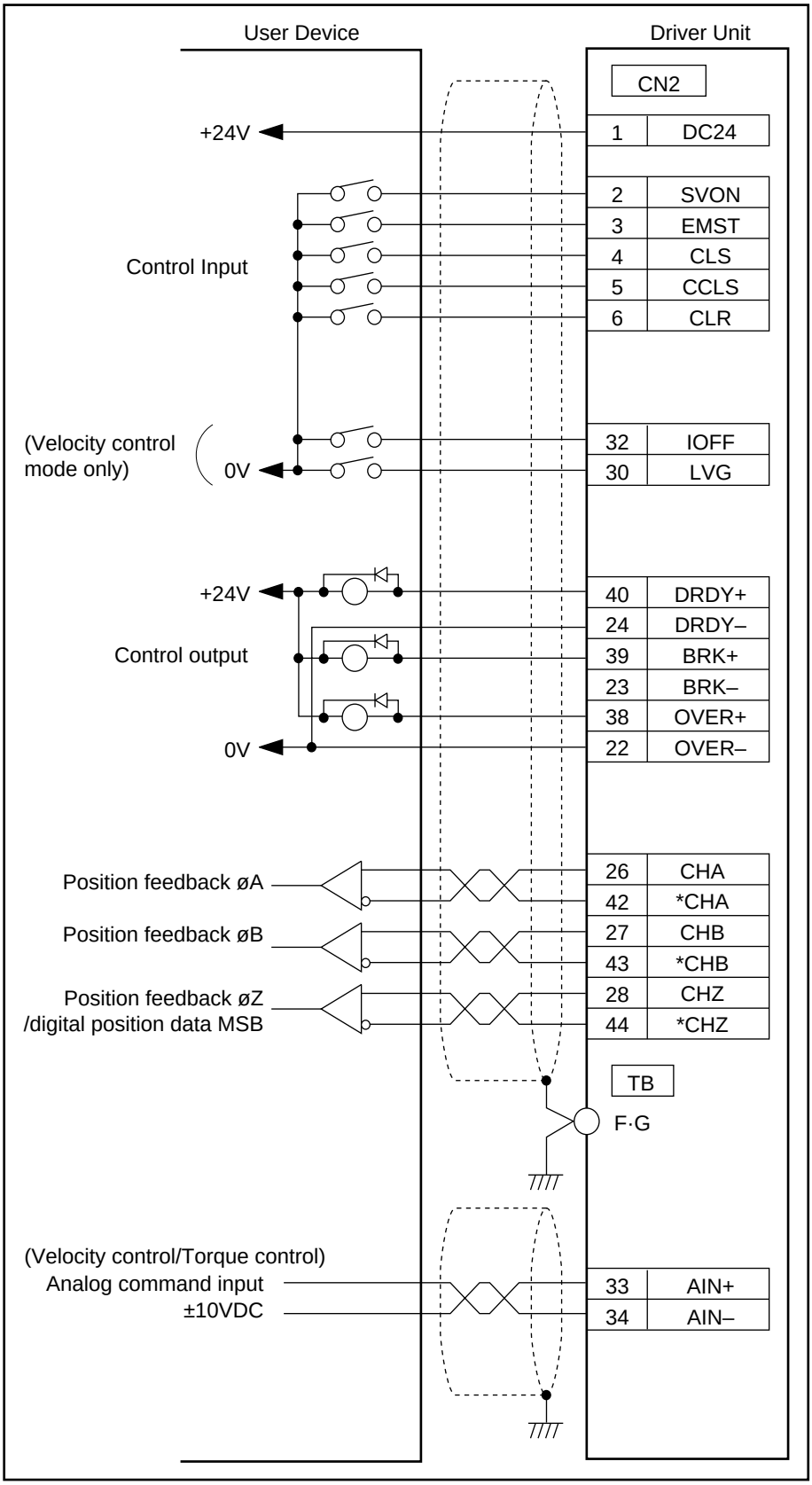
Position Control Mode Sample Wiring Diagram



6.2.4.2. Velocity or Torque Control Mode Sample

Figure 6-9

Velocity/Torque Control Mode Sample Wiring Diagram



6.3. CN3: Resolver Cable Connector

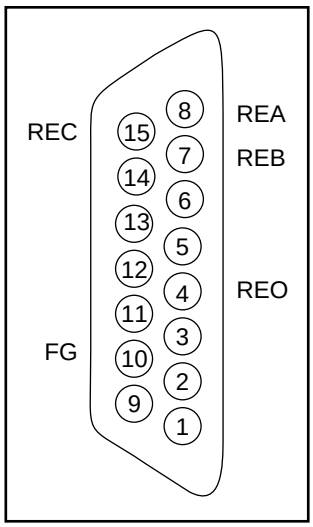
Since the resolver cable supplied with the Megatorque Motor System should always be used, you need only plug the resolver cable connector into CN3. Knowledge of the pin assignment or signal names is not necessary. This section is offered for reference.

Caution *If the length of the resolver cable is changed, resolver's detection accuracy changes. If it is necessary to adjust the cable length, contact NSK.*

6.3.1. CN3 Pin-Out

Figure 6-10

CN3 Pin-Out



6.3.2. CN3 Signal List

Table 6-10

CN3 Signal List

Pin	Signal Name	Function
1	–	(Connected internally)
2	–	(Connected internally)
3	–	(Connected internally)
4	REO	Resolver excitation output
5	–	(Connected internally)
6	–	(Connected internally)
7	REB	Resolver phase B
8	REA	Resolver phase A
9	–	(Connected internally)
10	FG	Frame ground
11	–	(Connected internally)
12	–	(Connected internally)
13	–	(Connected internally)
14	–	(Connected internally)
15	REC	Resolver phase C

7. Operational Function

7.1. Control Mode

The Megatorque Motor System can be used in position, velocity or torque control mode.

The position control mode is selected at factory when shipped.

Table 7-1

Control Mode Overview

Control Mode	Command	Overview
Position Control Mode	• RS-232C communication command • Programmable Indexer (built-in program) • BCD command • Pulse train command	A positioning angle is specified as a command. • A velocity and an acceleration rate are also specified in RS-232C communication, Programmable Indexer or BCD command. • Jogging and Homing (returning to home position using a specified sequence) are available as additional functions.
Velocity Control Mode	• RS-232C communication command • Analog voltage command*	A velocity is specified as a command. • A positioning angle is not controlled. It should be controlled by an external controller if necessary.
Torque Control Mode	• RS-232C communication command • Analog voltage command*	A Motor torque is specified as a command. • A positioning angle and a velocity are not controlled. They should be controlled by an external controller if necessary.

Note * The analog voltage command is only available on the models shown below:

M-RS1410FN001MA15C

This digit must be "5."

Changing Control Mode

The control mode is set in the following ways:

(a) Power-on set

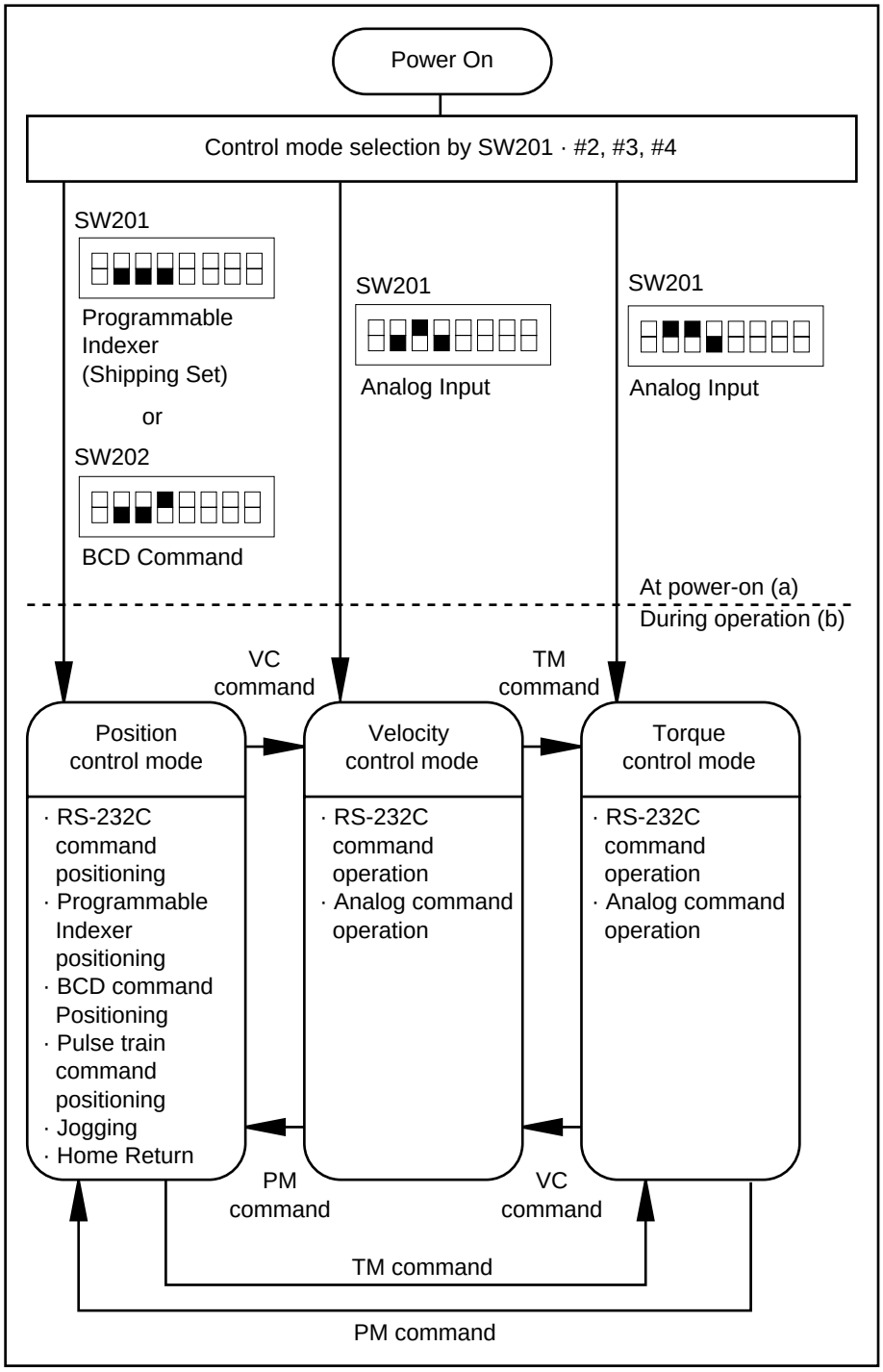
The control mode is set at power-on by an internal switch SW201 #2 ~ #4.

(b) During operation

The control mode can be changed using RS-232C commands (PM, VC and TM) during operation.

Figure 7-1

Control Mode Setting



7.2. Preparation for Operation

(1) Turn on the power.

(2) After a short delay, check for the OVER and DRDY outputs.

* If the OVER and/or DRDY output signal is abnormal, refer to chapter 9. Warning And Alarm and take proper measures.

(3) If there is no problem, turn on the SVON input. The servo turns on.

(4) Issue a necessary operation command.

Figure 7-2

Power-On Sequence

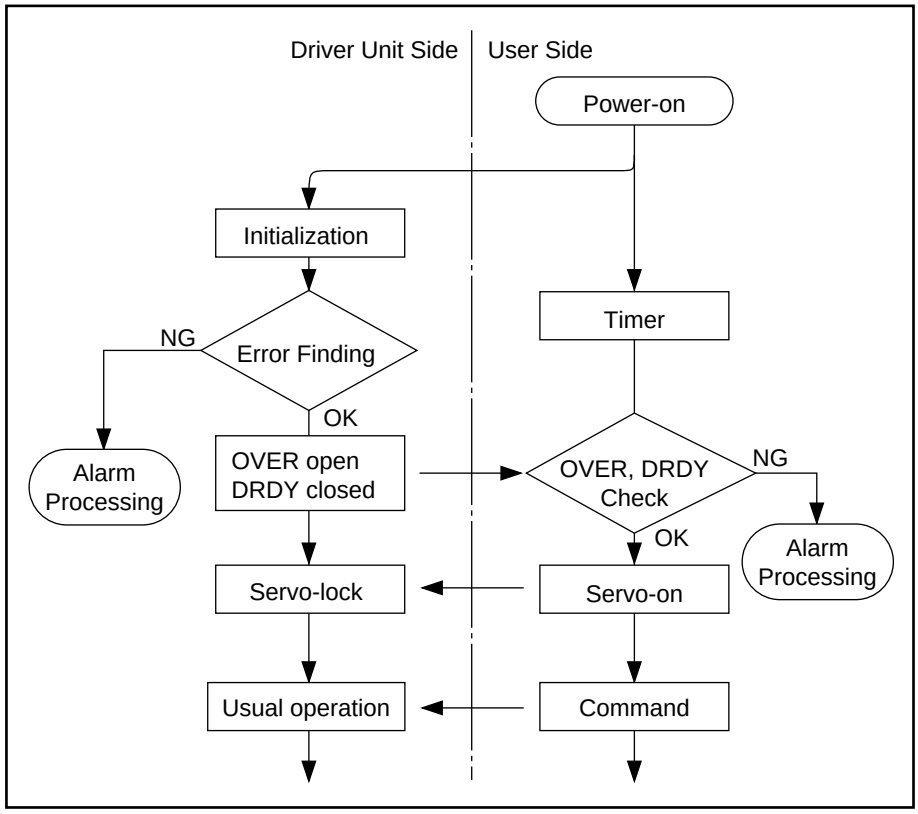
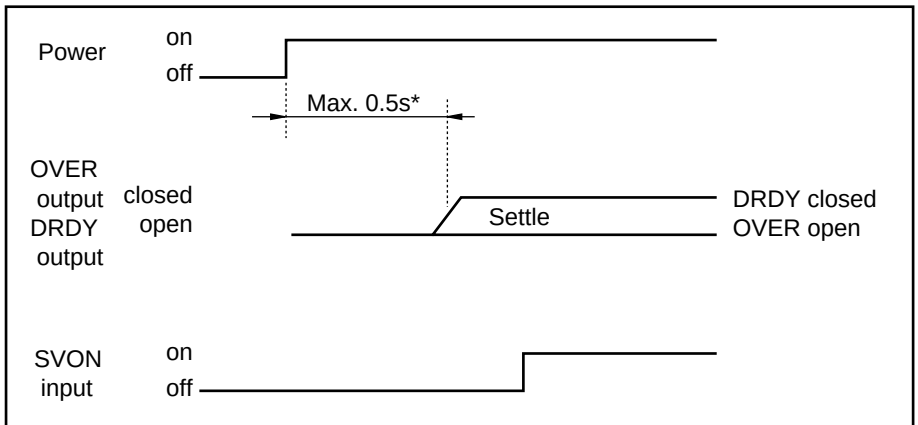


Figure 7-3

Power-On Timing



* If the system is initialized when the power is turned on, the OVER and DRDY output signals become stable within 8 seconds. The system need not be initialized normally. If it is initialized, stored servo parameters are reset to the shipping-set values. Thus, they must be specified again.

7.3. General Operation And Function

Table 7-2

General Operation And Function

Item	I/O Signal (CN2)	Parameter/ Command (RS-232C)	Function
Servo On	SVON input	SV command MO command	SVON input: servo on input SV command: servo on MO command: servo off
Emergency Stop	EMST input	MS command	EMST input: normally open emergency stop input MS command: motor stop
Brake	BRK output	–	BRK output: normally closed brake output
Rotation Limit	CLS input CCLS input	LS	CLS input: CW rotation limit switch input CCLS input: CCW rotation limit switch input LS: software rotation limit coordinate setting
Position Feedback Signal	CHA output CHB output CHZ output	–	A digital signal indicating motor rotation
Velocity Monitor	VELOCITY pin (front panel)	–	Analog velocity monitor: 12-bit resolver resolution — ±10 V (CCW/CW) 10-bit resolver resolution — ±7.5 V (CCW/CW)
Output Torque Reduction	–	TL	TL: output torque reduction ratio setting
Velocity Gain Reduction	LVG input	LG	LVG input: velocity gain reduction input LG: velocity gain reduction ratio setting
Position/ Velocity Integrator Off	IOFF input	PM VM	IOFF input: Position/velocity integrator off PM: position control mode selection VM: velocity control mode selection

7.3.1. Servo On

- The Motor servo turns on if the SVON input goes active with DRDY output closed.
- The positional error is cleared in the servo off state.
- The servo turns off if an MO command is executed under the condition where the servo is turned on by activating the SVON input.
- The servo turns on if an SV command is executed under the condition where the servo is turned off by issuing an MO command.

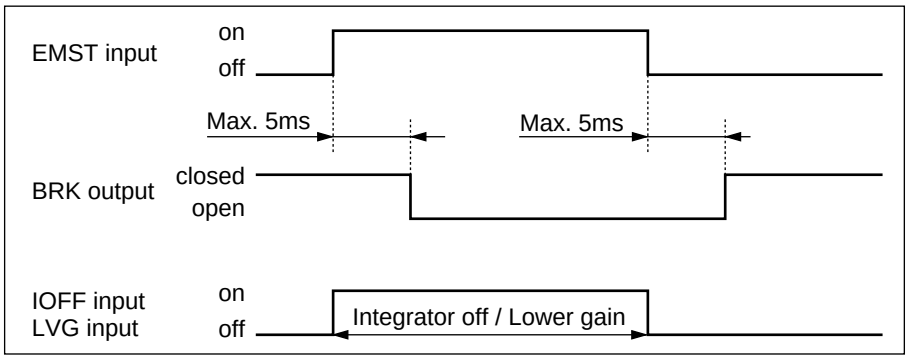
7.3.2. Emergency Stop

- If the EMST input goes active, the BRK output opens within 5ms and the Motor stops in the servo lock state in velocity control mode.
- No operation commands are accepted while the EMST input is active.
- If the brake is applied directly by activating the BRK output, contention may occur between braking and integration control when the EMST input goes active, resulting in excessive current passing through the Motor. In such a case, cut off integration control by using the IOFF input, then reduce the velocity gain using the LVG input as well.
- If an MS command is executed, the Motor stops in the servo lock state. However, the BRK output remains open.

Caution *Do not use EMST input when you want Motor to stop at the correct position with enough rigidity. Since Motor is in a velocity control mode when stopped by EMST input, the rotor rigidity is low and the position may be incorrect. Use EMST input for emergency stop purpose only.*

Warning *The servo lock state produced by activating the EMST input is not an error originating from the Motor or Driver Unit. Therefore, the DRDY output remains closed and no alarms are displayed.*

Figure 7-4
Emergency Stop Timing

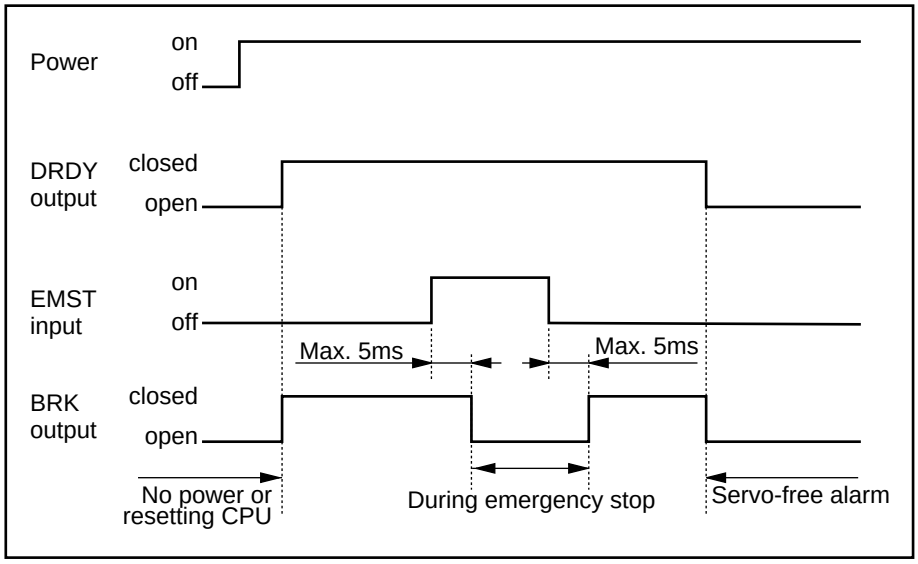


7.3.3. Brake

Stop the Motor by applying external force as necessary in case that an emergency stop occurs or the Motor servo becomes free. The BRK output (normally closed output) may be used as a control signal for an external brake in such a case.

Figure 7-5

Brake Timing



7.3.4. Rotation Limit

7.3.4.1. Rotation Limit By External Sensor

- If an external sensor shall be used in the Motor rotation range to make an inhibited area, use the CLS or CCLS input.
- If the CLS input is turned on, the Motor stops in the servo lock state. In this state, the Motor may be rotated counterclockwise only.
- If the CCLS input is turned on, the Motor stops in the servo lock state. In this state, the Motor may be rotated clockwise only.

7.3.4.2. Software Rotation Limit

- The LS parameter allows the user to specify the over travel limit making use of the internal relative position counter.
- The LS parameter goes valid if both positive data (clockwise limit) and negative data (counterclockwise limit) are specified.
- Since the relative position counter is established by completing the Home Return sequence, it is invalidated before or during the Home Return.

7.3.5. Position Feedback Signal

7.3.5.1. Position Feedback Signal Direction

The direction of position feedback signal may be reversed with the internal switch SW202. For setting of SW202, refer to section 3.2.3.2. SW202.

- Normal — øA (phase A) leads in the clockwise direction.
- Reversed — øB (phase B) leads in the clockwise direction.

7.3.5.2. CHZ Output Type

The CHZ output type, øZ (phase Z) or digital position signal MSB, may be selected with the internal switch SW202. For setting of SW202, refer to section 3.2.3.2. SW202.

7.3.5.3. Resolution of øA/øB

The resolutions of øA and øB may be selected with jumpers JP403 and JP404. For setting, refer to section 3.2.4.3 JP403 and JP404.

Table 7-3

Resolution Of øA/øB

Motor Size	øA/øB Resolution [count/rev]	
	Resolver Resolution = 12-bit	Resolver Resolution = 10-bit, or Resolver Resolution = Automatic Switching
04××	102 400 or 25 600	25 600
06××, 08××, 10××, 14××	153 600 or 38 400	38 400
B×××	122 880 or 30 720	30 720

7.3.5.4. Resolution of øZ

Table 7-4

Resolution Of øZ

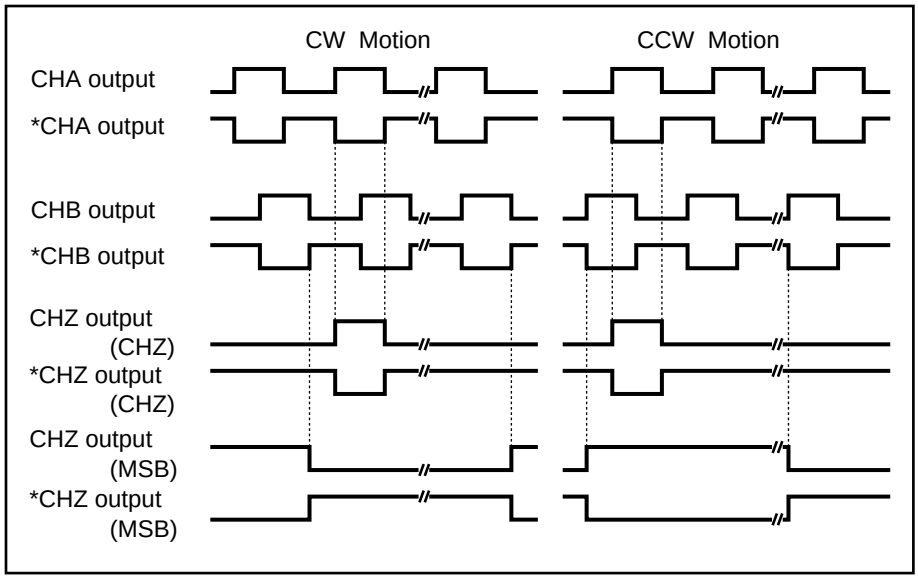
Motor Size	øZ Resolution [count/rev]
04××	100
06××, 08××, 10××, 14××	150
B×××	120

7.3.5.5. Output Timing

(a) Normal output

Figure 7-6

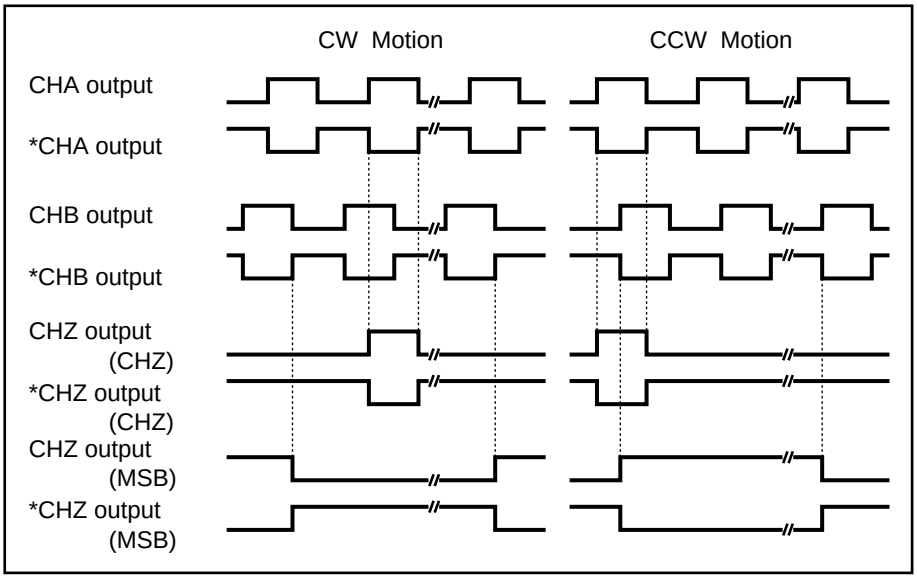
Normal Output Timing



(b) Reversed output

Figure 7-7

Normal Output Timing



7.3.6. Velocity Monitor

The Motor velocity may be monitored by checking the voltage between the VELOCITY and GND check pins on the front panel.

Warning *The voltage of velocity monitor (±10 or ±7.5V) is a "typical" value, which is subject to slight variance. It does not represent accurate velocity.*

(a) Resolver resolution = 12-bit

Figure 7-8

Voltage Vs. Velocity (12-bit Resolver)

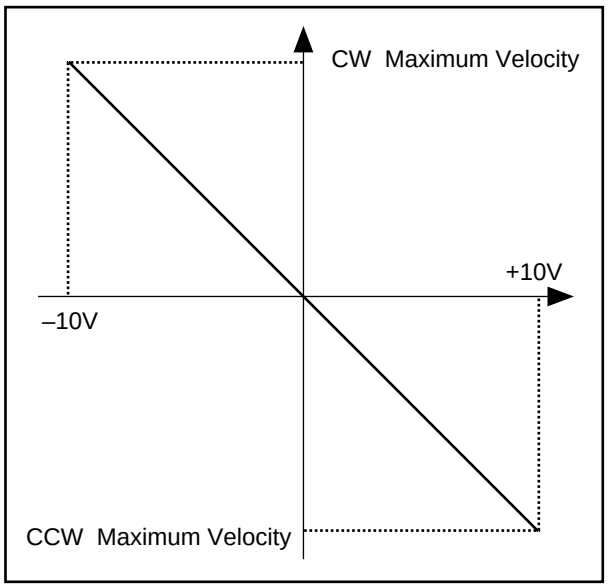


Table 7-5

Maximum Velocity (12-bit Resolver)

Motor Size	Maximum Velocity [rps]
04××	1.5
06××, 08××, 10××, 14××	1.0
B×××	1.25

(b) Resolver resolution = 10-bit or automatic switching

Figure 7-9

Voltage Vs. Velocity (10-bit Or Automatic Switching Resolver)

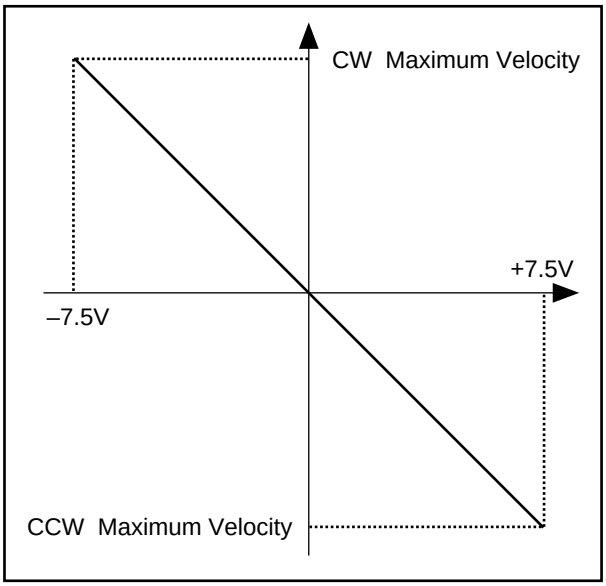


Table 7-6

Maximum Velocity (10-bit Or Automatic Switching Resolver)

Motor Size	Maximum Velocity [rps]
04××	4.5
06××, 08××, 10××, 14××	3.0
B×××	3.75

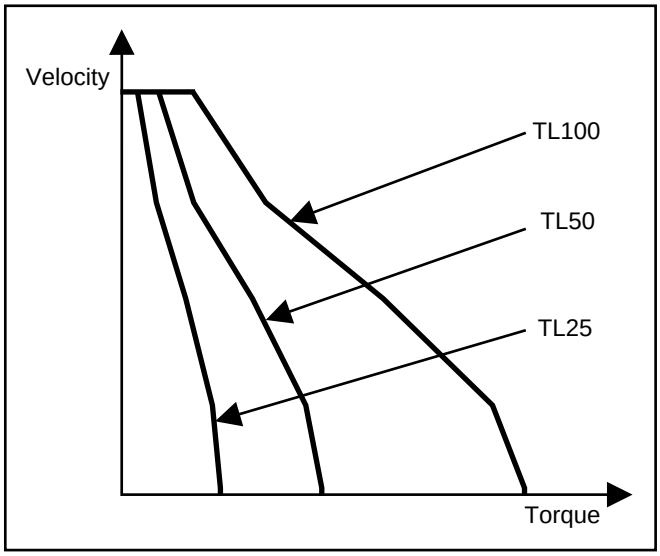
7.3.7. Output Torque Reduction

The Motor output torque may be reduced by using the parameter TL.

Important *The output torque of the Megatorque Motor varies with motor speed. It is reduced as shown in the following graph.*

Figure 7-10

Output Torque Reduction



7.3.8. Velocity Gain Reduction

If the LVG input is activated, the velocity loop proportional gain specified by parameter VG may be reduced at a rate of the LG set value. This function is useful if the load inertia varies remarkably in operation cycles.

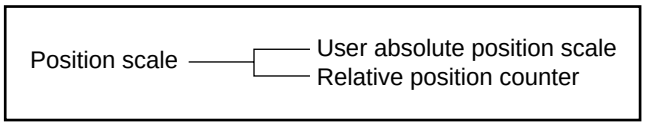
7.4. Position Scale

The Megatorque Motor System controls the rotor position scales internally. Its positioning is based on the position scale.

Important *The position scale is not effected by the resolver resolution.*

Figure 7-11

Position Scales



Both position scales will not be deleted even if the power is turned off. However, if the Motor rotates with power off, the position scales are not updated. Accordingly, a position data may be different from the actual position when the power is turned on. Thus, be sure to execute a Home Return sequence when the power is turned on.

7.4.1. User Absolute Position Scale

A positioning command will be based on this user absolute position scale.

Note *Although some Motor characteristics differ with the Motor sizes, the following description uses only a typical number (the number of Motor sizes 06××, 08××, 10×× and 14××), to make the description simple. Please use the next table for other Motor size.*

Table 7-7

Motor Specification

Motor Size	Number Of Teeth [Marked With (1)]	Maximum Motor Resolution [Marked With (2)]	Maximum Absolute Position [Marked With (3)]
04××	100	409 600	409 599
06××, 08××, 10××, 14××	150	614 400	614 399
B×××	120	491 520	491 519

The resolution over one revolution of the Motor depends on the number of teeth of the Motor. A Motor has 150 (1) teeth on its circumference, and the position sensor divides 1-tooth pitch into 4096 parts. In other words, the resolution is found as follows:

(4096 counts per tooth) × (150 (1) teeth per revolution)

= 614 400 (2) counts per revolution

The system generates data for controlling the circumferential position of the Motor in integers from 0 to 614 399 (3) based on the data of the number-of-teeth counter (øZ counter) and position data of one tooth. (This data is called Motor absolute position data.)

User absolute position scale is based on this Motor absolute position data. The position offset by the value of the parameter AO from point 0 of the Motor absolute position data is regarded as the home position. The position on the Motor perimeter is controlled cyclically in integers from 0 to 614 399 (3). It increases in the clockwise direction. If it exceeds 614 399 (3), it is reset to 0. Or, it decreases in the counterclockwise direction. From 0, it is reset to 614 399 (3).

The home position may be specified by either of the following methods:

(1) Executing a Home Return sequence.

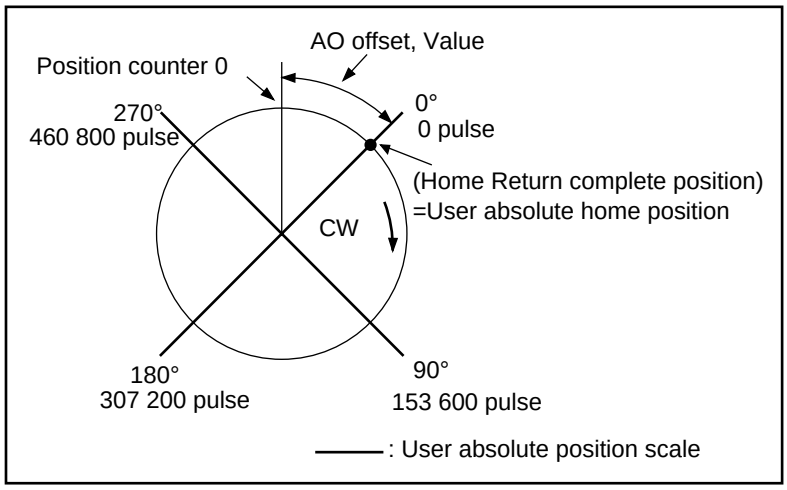
The position at which a Home Return sequence is completed is regarded as the home position. The offset AO from point 0 of the Motor absolute position scale is updated automatically.

(2) Specifying the current position as the home position by issuing an AZ command (direct teaching).

If the Motor rotates in the power off condition and the position data does not correspond to the actual position, it is difficult to adjust the position scale by using an AZ command. Thus, execute a Home Return sequence to adjust the home position.

Figure 7-12

User Absolute Position Scale



7.4.2. Relative Position Counter

The software rotation limit switch is specified in the relative position counter. It becomes valid on completion of Home Return.

The relative position counter expands in the clockwise and counterclockwise directions from the home position. It has the same resolution as the user absolute position scale.

Counter data are between –2 147 483 648 and +2 147 483 647 from the home position. The counter increases in the clockwise direction. If it exceeds +2 147 483 647, it is reset to –2 147 483 648. On the contrary, it decreases in the counterclockwise direction. If it lowers below –2 147 483 648, it is reset to +2 147 483 647.

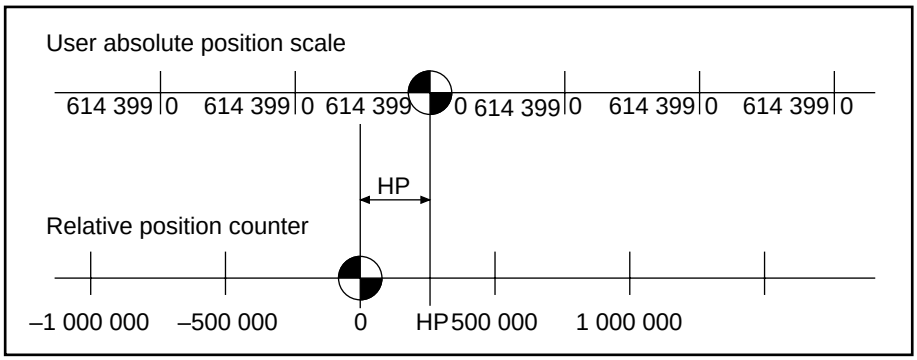
The home position may be specified in either of the following methods:

(1) Executing a Home Return sequence.

The set value of the parameter HP is the relative counter data of the position at which Home Return is completed. By using the parameter HP, the home position in the relative position counter may be specified independently from the home position in user absolute position scale.

Figure 7-13

Relation Between Two Home Positions



The parameter HP is factory-set to 0. With this setting, the relative position counter's home position is the same as the user absolute home position.

(2) Specifying the current position as the home position by issuing an IP command (direct teaching).

If the Motor rotates in the power off condition and the counter data does not correspond to the actual position, it is difficult to adjust the counter by using an IP command. Thus, execute a Home Return sequence to adjust the home position.

7.4.3. Reading Position

Table 7-8

Position-Reading Command

Command	Read Data	Data Unit
TP0	Motor absolute position data	count
TP1	Relative position counter	count
TP2	User absolute position	count
TP3	Angle converted from motor absolute position data	0.01°
TP5	Angle converted from user absolute position	0.01°

7.5. Position Control Mode Operation

7.5.1. Position Control Additional Function

7.5.1.1. In-Position Output

If the position error is reduced to a value within the pulse width specified by using IN when positioning is completed, the IPOS output closes. Or, the IPOS output may be closed after confirming that the position error is within the IN range for preset period of time, which is specified by using IS.

Two output states may be selected, the level output and one-shot output. The format may be selected by using FW, the value of which serves as the one-shot output time.

(a) Level output

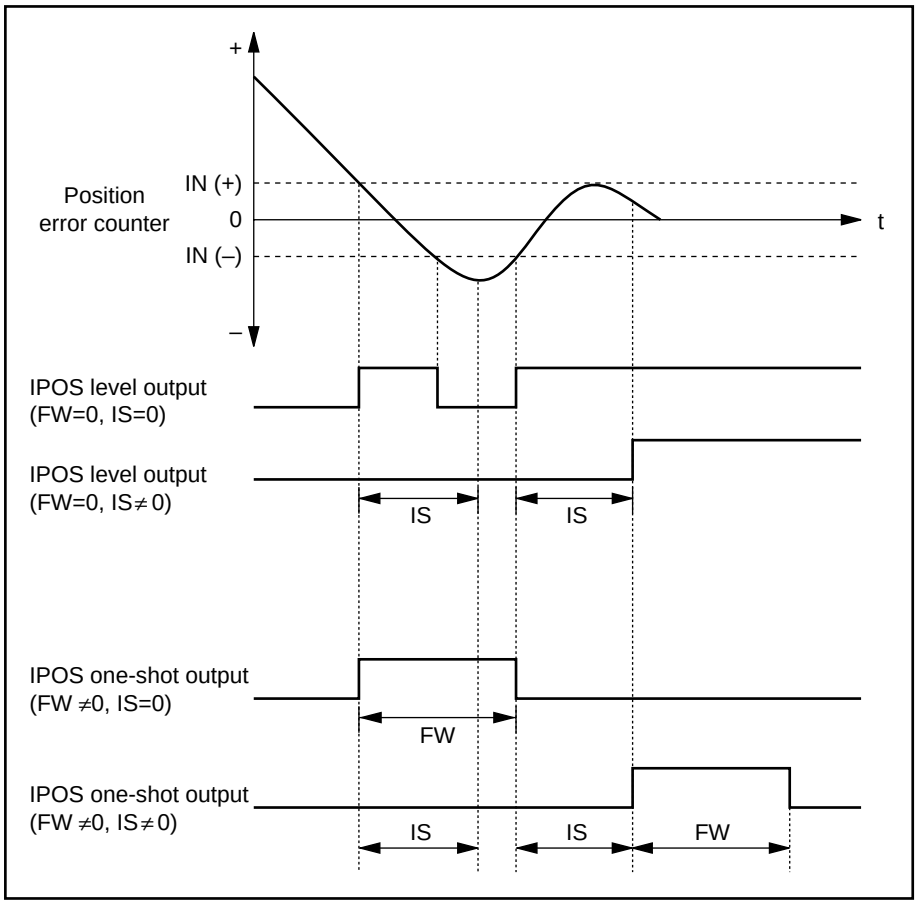
If FW is set to 0, the IPOS output is always closed if the position error is less than the range specified by using IN.

(b) One-shot output

If FW is not set to 0, the IPOS output remains closed only for the period of time specified by using FW. One-shot output is executed when Home Return, RS-232C communication operation or Programmable Indexer operation is performed. It is not executed when pulse train command operation or jogging is performed.

Figure 7-14

In-Position Configuration



7.5.1.2. Excess Position Error

An excess position error warning or alarm is given if the position error exceeds the CO set value.

However, if CO is set to 0, the excess position error warning or alarm is invalidated.

The shipping set is CO2048 (warning enabled, limit: 2048 counts).

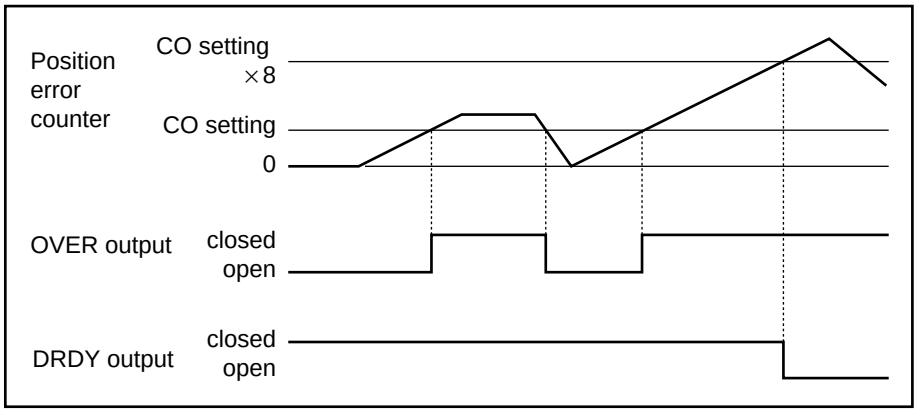
Two OVER and DRDY output formats shown below may be selected according to the CO setting

(1) Output format 1 — warning enabled

- If the position error counter reads a value over the CO set value, the OVER output closes. If the value lowers below the CO set value, OVER opens.
- If the position error counter reads a value over CO × 8, an alarm is given, the DRDY output opens, and the Motor enters the servo lock state. This state is maintained until the CLR input or CL command resets the alarm.

Figure 7-15

Excess Position Error (Warning Enabled) Configuration

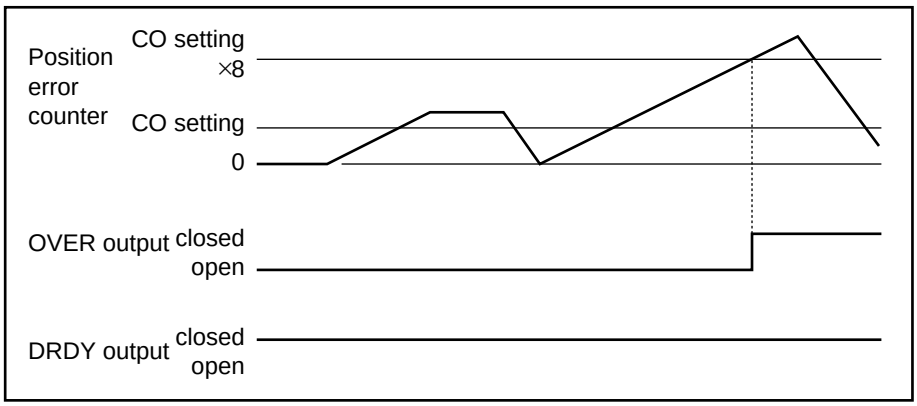


(2) Output format 2 — warning disabled

- If the CO value is specified with the /AL option like CO×××/AL, the OVER output closes and the Motor enters the servo lock state if the value of the position error counter exceeds CO × 8. The DRDY output does not change at that time. This state is maintained until the CLR input or CL command resets the alarm.

Figure 7-16

Excess Position Error (Warning Disabled) Configuration



7.5.2. RS-232C Communication Positioning Operation

Positioning may be executed directly through the RS-232C interface.

7.5.2.1. Operation Command

Two types of commands are available: the absolute type commands which execute positioning to any points in user absolute position scale, and the incremental type commands which execute positioning by moving specified distance from the current position.

The units of the commands are angles (0.01°) or counts.

Positioning is executed by using preset drive waveform according to an input operation command.

Table 7-9

RS-232C Positioning Command

Command Type	Description	Option Code
AD data	This absolute type command executes positioning in units of 0.01°. The Motor rotates up to the position specified in "data" in user absolute position scale in units of 0.01°.	/CW: clockwise rotation /CCW: counterclockwise rotation /SD: shortest distance /EX: in the direction specified by using DIR input (Clockwise rotation is always selected by default.)
AR data	This absolute type command executes positioning in units of pulses. The Motor rotates up to the position specified in "data" in user absolute position scale in units of pulses.	
ID data	This incremental type command executes positioning in units of 0.01°. The Motor rotates by the angle specified in "data" from the current position.	/EX: in the direction specified by using DIR (Direction depends on the sign of "data" by default.)
IR data	This incremental type command executes positioning in units of pulses. The Motor rotates by the pulses specified in "data" from the current position.	
HS data	This command returns the Motor to the home position. Specify the mode and direction of home return sequence "data."	–

Example 1: Type as shown below to rotate the Motor counterclockwise to the 90° position in user absolute position scale.

The Motor begins to rotate as soon as the ENT key is pressed.




```
:AD9000/CCW
:
```

Example 2: Type as shown below to rotate the Motor to the 0 position in user absolute position scale in the shortest route.

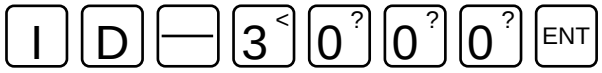
The Motor begins to rotate as soon as the ENT key is pressed.




```
:AR0/SD
:
```

Example 3: Type as shown below to rotate the Motor counterclockwise 30° from the current position.

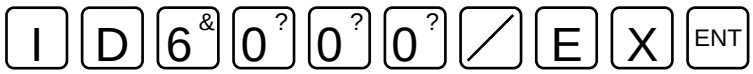
The Motor begins to rotate as soon as the ENT key is pressed.




```
:ID-3000
:
```

Example 4: Type as shown below to rotate the Motor 60° from the current position in the direction specified by using DIR.

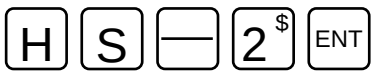
The Motor begins to rotate as soon as the ENT key is pressed.




```
:ID6000/EX
:
```

Example 5: Type as shown below to return the Motor to the home position counterclockwise in mode 2.

The Motor begins to rotate as soon as the ENT key is pressed.




```
:HS-2
:
```

Caution *In process of positioning, no command may be input. ("××× INHIBITED" is displayed if some command is input.)*

7.5.2.2. Drive Waveform

The drive waveform of RS-232C communication positioning operation should be either trapezoidal or simplified sine curve.

Table 7-10

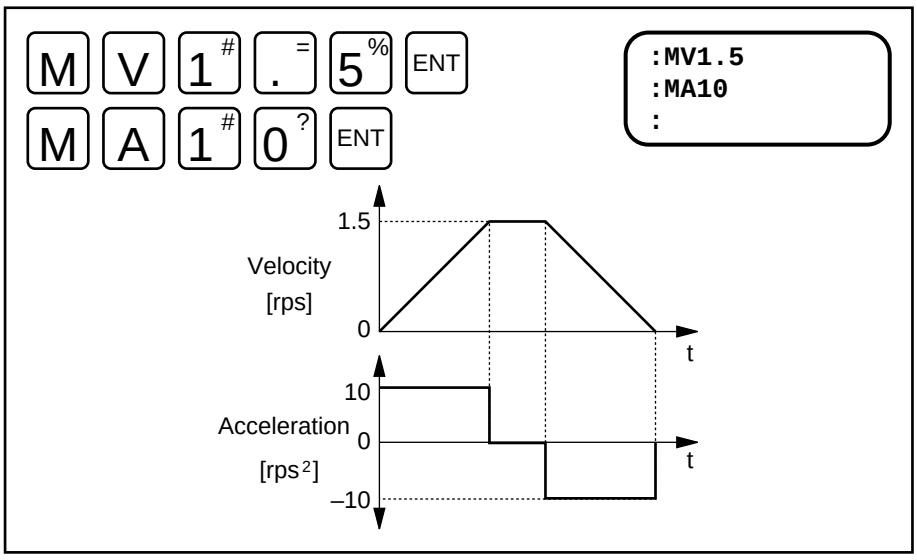
Velocity And Acceleration Parameters

Command Type		Description
Velocity	MV data	Specifies the maximum velocity of the Motor in "data" in units of rps.
	MV data1, data2	This is the velocity command for trapezoidal driving with an offset. Specifies the maximum velocity of the Motor in "data1" and the initial velocity in "data2" in units of rps. If the acceleration is specified in 'MA data1, data2,' data2 of this command is invalidated.
Acceleration	MA data	This is the acceleration command for trapezoidal motion profiles. Specifies the average acceleration of the Motor in "data" in units of rps^2.
	MA data1, data2	This is the acceleration type command for simplified sine wave driving. Specify the average acceleration of the Motor in "data1" and the initial revolution in "data2" in units of rps^2.

Example 1: Type as shown below to set the maximum velocity to 1.5rps and acceleration to $10rps^2$ for trapezoidal motion profiles.

Figure 7-17

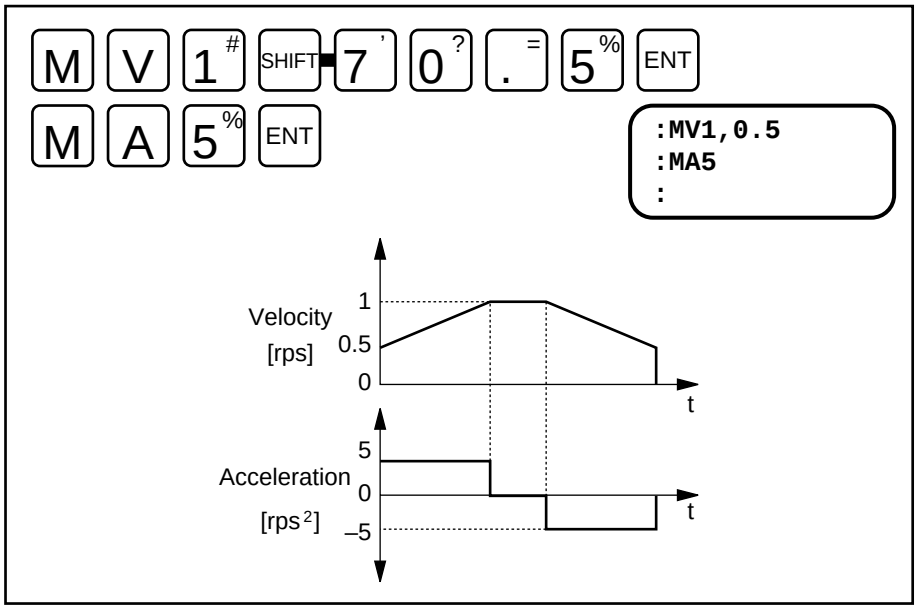
Trapezoidal Motion Profiles, Velosity 1.5rps, Acceleration $10rps^2$



Example 2: Type as shown below to set the maximum velocity to 1.0rps, initial velocity to 0.5rps and acceleration to 5rps^2 for trapezoidal driving with an offset.

Figure 7-18

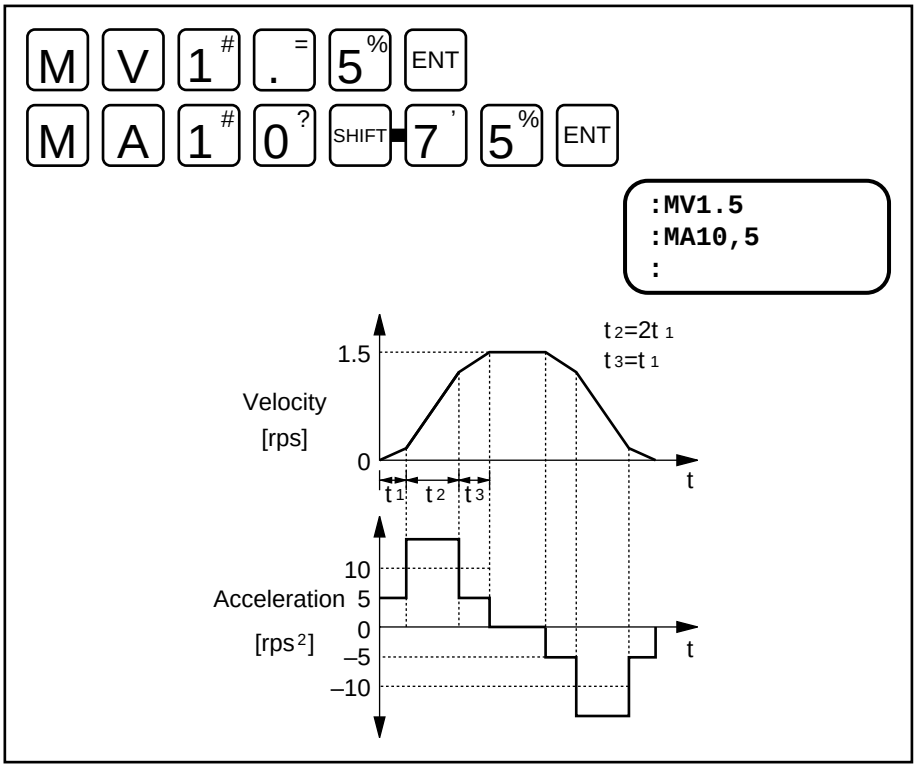
Trapezoidal Driving with an Offset, Maximum Velocity 1.0rps, Initial Velocity 0.5rps, Acceleration 5rps^2



Example 3: Type as shown below to set the maximum velocity to 1.5rps, average acceleration to 10rps^2 and initial acceleration to 5rps^2 for simplified sine curve driving.

Figure 7-19

Simplified Sine Curve Driving , Maximum Velocity 1.5rps, Average Acceleration 10rps^2, Initial Acceleration 5rps^2



7.5.3. Programmable Indexer Positioning Operation

Program operation means executing a positioning command, etc. which has been programmed in the Driver Unit, by issuing an external start command from outside. A channel for execution is selected externally each time program operation is to be executed.

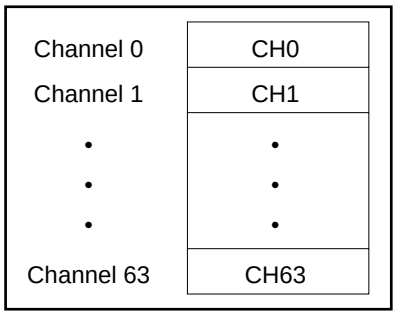
Either Programmable Indexer or BCD command can be used at one time, and the internal switch SW201 selects which to use. The Programmable Indexer is activated at shipping.

7.5.3.1. Programming

- Programming for program operation is executed through the RS-232C interface while program operation is not being executed. The RUN input is invalid during programming.
- The program area is as shown below. Sixty four channels from channel 0 to channel 63 are available.

Figure 7-20

Program Area



7.5.3.2. Program Entry

Table 7-11: Program Entry

Item	Description	Operation Example	Display
Setting	① Select the channel to be programmed. If they are declared, the current setting is displayed. The "?" prompt appears, indicating that the system is ready for setting. ② Enter a command. ③ Specify a condition for the command. ④ To cancel the condition, specify "0." (If an improper condition is specified, correct it.) If the same type of condition is specified, finally-entered condition is valid. ⑤ If only the ENT key is pressed, the ":" prompt appears, indicating that programming is completed.	① C H 1# 0? ENT ② I D 9) 0? 0? 0? / E X ENT ③ C V 0? .= 5% ENT ④ C A 0? ENT ⑤ ENT	:CH10 ① AD18000/SD CV0.9 CA2 ?ID9000/EX ② ?CV0.5 ③ ?CA0 ④ ? ⑤ :
Reading Current Setting	① Select the channel and page to be read out. If they have been programmed, the current setting is displayed.	① T C 1# 0? ENT	:TC10 ① ID9000/EX CV0.5 :
Deletion	① Select the channel and page to be deleted. If the ENT key is pressed, channel data disappears.	① C C 1# 0? ENT	:CC10 ① :

7.5.3.3. Command and Condition Parameter

(1) Home Return

Command: HS

Condition Parameter: CV, CA, CZ (omissible)

- Programming the Home Return sequence.
- Command format: HS data seq
  data — mode and direction of Home Return sequence (0 by default)
  seq — sequence code (*, &, %, $) → See (4) Sequence Code
- The velocity CV, acceleration CA, and speed of searching the home position CZ may be specified for the same channel. If they are not specified, the values HV, HA and HZ are used for operation respectively.

Programming Example

```
:CH0
 HS0
```

(2) Positioning

Command: AD, AR, ID, IR

Condition Parameter: CV, CA (omissible)

- Programming positioning.

Table 7-12

Positioning Command

Command Format*	Description	Option	
AD data1 data2 seq	An absolute command in units of 0.01°. The Motor rotates to position “data1” in user absolute position scale in units of 0.01°.	Option Code “data2” /CW: clockwise /CCW: counterclockwise /SD: shortest route /EX: direction specified with DIR input (Clockwise rotation is always selected by default.)	
AR data1 data2 seq	An absolute command in units of counts. The Motor rotates to position “data1” in user absolute position scale in units of counts.		
ID data1 data2 data3 seq	An incremental command in units of 0.01° The Motor rotates “data1” degrees from the current position in units of 0.01°.	Option Code “data2” /n: (n < 99) The value data1 is divided by n evenly. The quotient serves as the unit of execution. (The value data1 is not divided by default.)	Option Code “data3” /EX: direction specified with DIR input (The direction depends on the sign of data1 by default.)
IR data1 data2 data3 seq	An incremental command in units of counts The Motor rotates “data1” counts from the current position in units of counts.		

Note * “seq” indicates a sequence code, *, &, % or $, which specifies the condition of executing the following channel. → See (4) Sequence Code

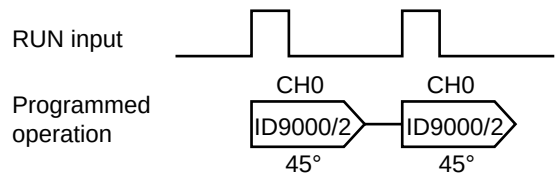
- The velocity CV and acceleration CA may be specified for the same channel. If they are not specified, the values MV and MA are used for operation respectively.

Programming Example

Figure 7-21

Positioning Command Programming Example

```
:CH0
 ID9000/2
 CV1.5
 CA5
```



(3) Jump

Command: JP

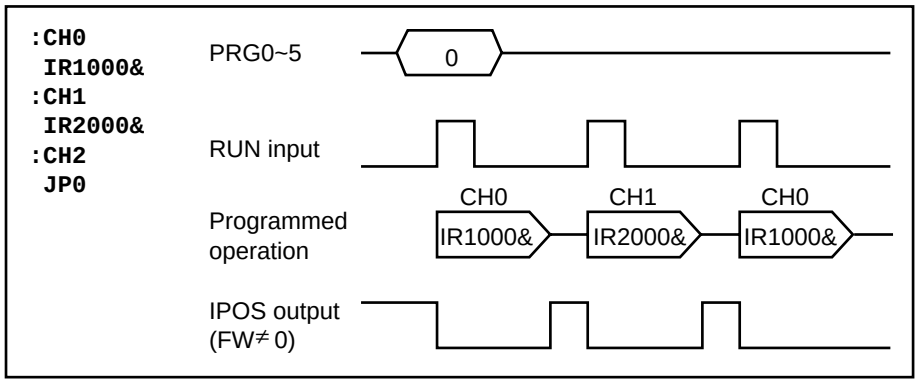
Condition Parameter: none

- An unconditional jump command
- Jumps to a specified channel, then executes operation.
- Command format: JP data
  data — channel number to which to jump (0 by default)

Programming Example

Figure 7-22

Jump Command Programming Example



(4) Sequence Code

Related Command: HS, AD, AR, ID, IR

Code: *, &, %, $

- If a sequence code is added to a command, the following channel may be executed without selecting the channel externally.

Table 7-13

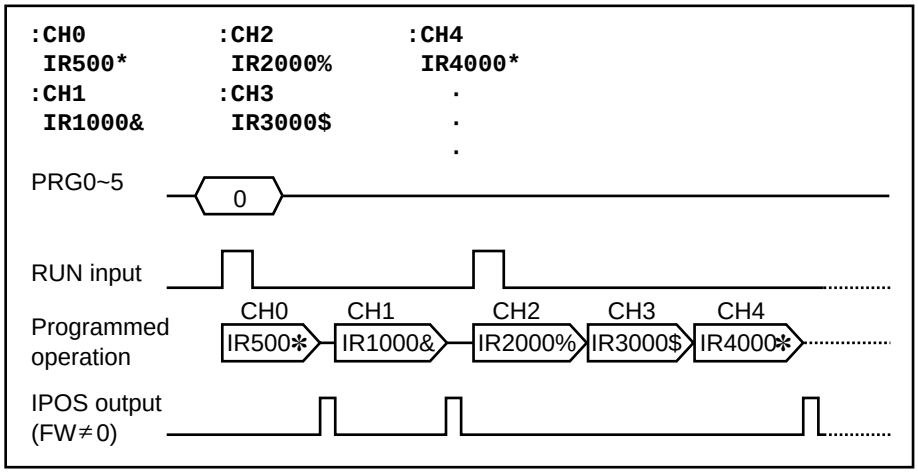
Sequence Code

Sequence Code	IPOS Output	Channel Execution
Asterisk, *	Yes	Execution on completion of positioning
Ampersand, &	Yes	Stopping and then execution on completion of positioning
Percent, %	No	Execution on completion of positioning
Dollar, $	No	Execution after pulse distribution

Programming Example

Figure 7-23

Sequence Code Programming Example



(5) Changing Sequence Code

Command: OE

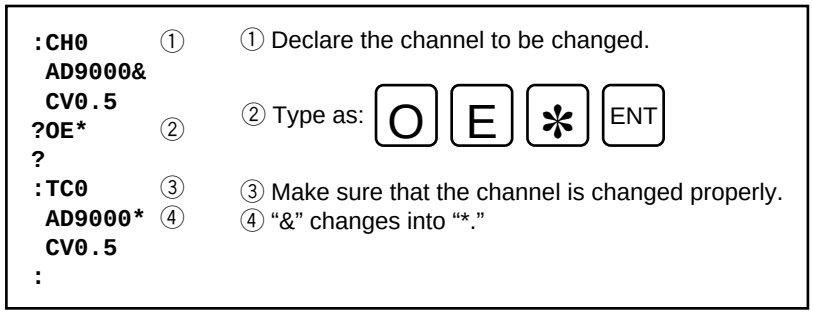
- OE may change a sequence code currently specified.
- Command format: OE seq

  seq — new sequence code (*, &, % or $)

Programming Example

Figure 7-24

Sequence Code Change Example



7.5.3.4. Operation Signal

(1) Channel Selection Input Signal

Input: PRG0, PRG1, PRG2, PRG3, PRG4, PRG5

Location: CN2

- These signals select channels for program operation.
- They select channels 0 to 63 by 6-bit binary as follows.

Table 7-14

Channel Select

('–' means 'off')

Selected Channel	PRG5	PRG4	PRG3	PRG2	PRG1	PRG0
Channel 0	–	–	–	–	–	–
Channel 1	–	–	–	–	–	on
Channel 2	–	–	–	–	on	–
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
Channel 61	on	on	on	on	–	on
Channel 62	on	on	on	on	on	–
Channel 63	on	on	on	on	on	on

(2) Start Input Signal

Input: RUN

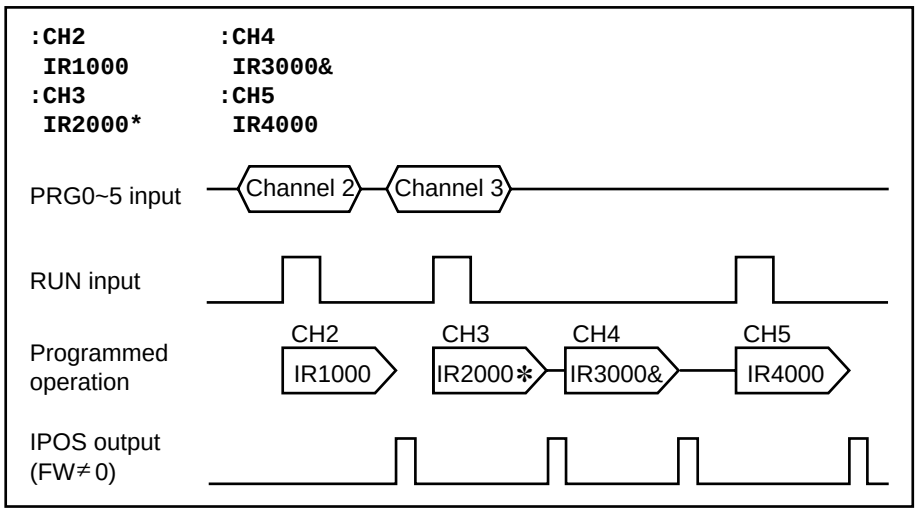
Location: CN2

- Starts up a channel specified by PRG0 to PRG5.
- Starts up the following channel if the sequence code '&' is specified for waiting for the RUN signal.

Operation Example

Figure 7-25

RUN Input Operation Example

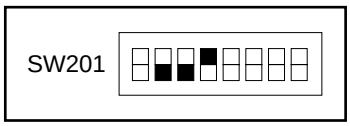


7.5.4. BCD Command Positioning Operation

- The BCD command positioning operation substitutes for the Programmable Indexer positioning operation. Either Programmable Indexer or BCD command can be used at one time, and the internal switch SW201 selects which to use. Since the Programmable Indexer is activated at shipping, set the SW201 #2~#4 as shown in the next figure to activate BCD command.

Figure 7-26

SW201 Setting For BCD Command



- Indexing amount and execution are specified using external signals. Velocity and acceleration are specified through the RS-232C interface.
- A command to be input is made up of characters generated using external input signals. The following input/output signals are used. (ACKIN and BCD× inputs are used as PRG0 ~ PRG5 for the Programmable Indexer.)

Table 7-15

Signals For BCD Command 1

Signal	Description
BCD0 ~ BCD3 Input	ON and OFF combinations of these 4 signals are combined to create commands.
ACKIN Input	Enters created command data into the Driver Unit.
DAV Output	The confirmation output for ACKIN input.

- The following input signals are used to execute commands

Table 7-16

Signals For BCD Command 2

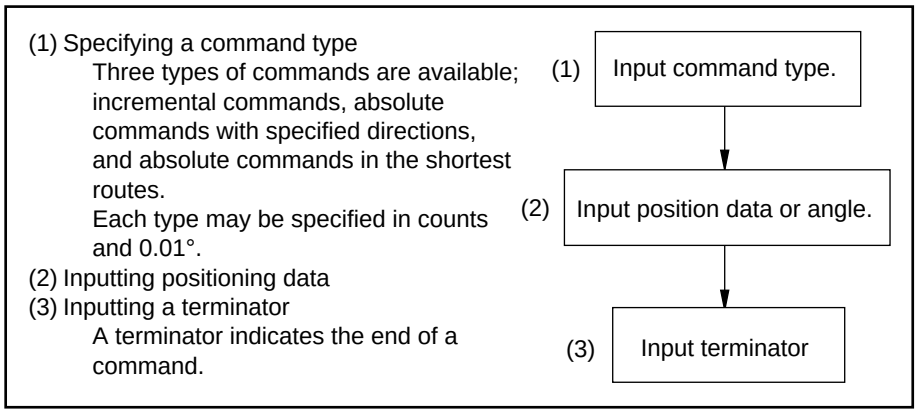
Input	Description
DIR	Specifies the rotational direction.
RUN	If RUN goes active, positioning starts.
STP	If STP goes active, positioning stops. Positioning does not restart if STP goes inactive.

7.5.4.1. Command Setting

- Specify a command in the sequence shown below:

Figure 7-27

BCD Command Flow



- Once a command is entered, it is stored inside until another command is specified or an entry error occurs.
- Use MA and MV to specify the rotational acceleration and velocity, respectively.
- The characters (command characters) shown below are available for specifying commands.

Table 7-17

Command Character

Resolver	Count	Degrees
Incremental Command	E	D
Absolute Command (Rotating Direction = User Defined)	EE	DE
Absolute Command (Rotating Direction = Shorter Move)	ED	DD
Position Or Angle Data	0~9	
Terminator	F	
Cancel	C	

Note Characters A and B are not used. Do not enter them.

- These command characters are created through BCD0 to BCD3. The relationship between input state and created characters is as shown below.

Table 7-18

Making Command Character

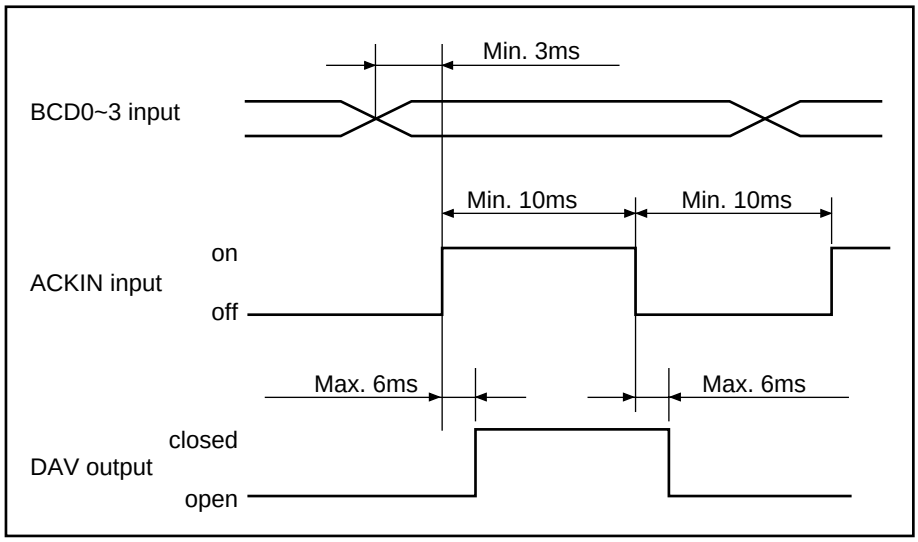
Char.	BCD3	BCD2	BCD1	BCD0
0	–	–	–	–
1	–	–	–	on
2	–	–	on	–
3	–	–	on	on
4	–	on	–	–
5	–	on	–	on
6	–	on	on	–
7	–	on	on	on

Char.	BCD3	BCD2	BCD1	BCD0
8	on	–	–	–
9	on	–	–	on
A	on	–	on	–
B	on	–	on	on
C	on	on	–	–
D	on	on	–	on
E	on	on	on	–
F	on	on	on	on

- Command characters created using the signals shown above are input to the Driver Unit by activating the ACKIN input. In other words, it is necessary to create a character through BCD0 to BCD5 and to enter it by activating ACKIN in order to enter a command character.
- The following shows the timing chart of inputting a command character.

Figure 7-28

BCD Command Input timing



Errors in specifying commands

- The possible errors are as shown below:
  - A command type is specified not at the beginning of a command.
  - A terminator is entered without any positioning data.
  - An unusable character (A or B) is entered.
  - Positioning data is out of the allowable range.
- If these errors take place, the following phenomena occur:
  - No DAV output signal is returned.
  - An already specified positioning command is invalidated. In other words, positioning is not executed though the RUN input signal goes active.
- To clear this erroneous condition, use any of the following methods:
  - Enter a cancel command. A DAV output signal is returned immediately after the cancel command is entered.
  - Enter a terminator. In this case, no DAV output signal is returned for the entered terminator. A DAV signal is returned when new data is entered after terminator entry.

7.5.4.2. Function of Command

(a) Incremental positioning (in units of counts)

Table 7-19

Incremental Positioning (Counts) Function

Format	E××××××××F (×××××××× = index data)
Data Range	0 ~ 99 999 999 [counts]
Rotational Direction	Clockwise if DIR input is inactive, counterclockwise if active.

(b) Incremental positioning command (in units of 0.01°)

Table 7-20

Incremental Positioning (Degrees) Function

Format	D××××××F (×××××× = index data)
Data Range	0 ~ 144 000 [× 0.01°]
Rotational Direction	Clockwise if DIR input is inactive, counterclockwise if active.

(c) Absolute positioning command in specified direction (in units of counts)

Table 7-21

Absolute Positioning In Specified Direction (Counts) Function

Format	EE×××××× (×××××× = index data)
Data Range	Depends on the Motor size. Compliant with user absolute position scale. 06××, 08××, 10××, 14×× — 0 ~ 614 399 [count] 04×× — 0 ~ 409 599 [count] B××× — 0 ~ 491 519 [count]
Rotational Direction	Clockwise if DIR input is inactive, counterclockwise if active.
Reference	If the destination is the same as the current position, the Motor is rotated by 1 turn in the specified direction for positioning.

(d) Absolute positioning command in specified direction (in units of 0.01°)

Table 7-22

Absolute Positioning In Specified Direction (Degrees) Function

Format	DE××××× (××××× = index data)
Data Range	0 ~ 35999 [× 0.01°] (Compliant with user absolute position scale.)
Rotational Direction	Clockwise if DIR input is inactive, counterclockwise if active.
Reference	If the destination is the same as the current position, the Motor is rotated by 1 turn in the specified direction for positioning.

(e) Absolute positioning command in shortest route (in units of counts)

Table 7-23

Absolute Positioning In Shortest Route (Counts) Function

Format	ED×××××× (×××××× = index data)
Data Range	Depends on the Motor size. Compliant with user absolute position scale. 06××, 08××, 10××, 14×× — 0 ~ 614 399 [count] 04×× — 0 ~ 409 599 [count] B××× — 0 ~ 491 519 [count]
Rotational Direction	The Motor rotates in the direction where the rotational angle is smaller. If the destination is the opposite position to the current position, the Motor rotates clockwise if DIR input is inactive, counterclockwise if active.
Reference	The Motor does not rotate if the destination is the same as the current position.

(f) Absolute positioning command in shortest route (in units of 0.01°)

Table 7-24

Absolute Positioning In Shortest Route (Degrees) Function

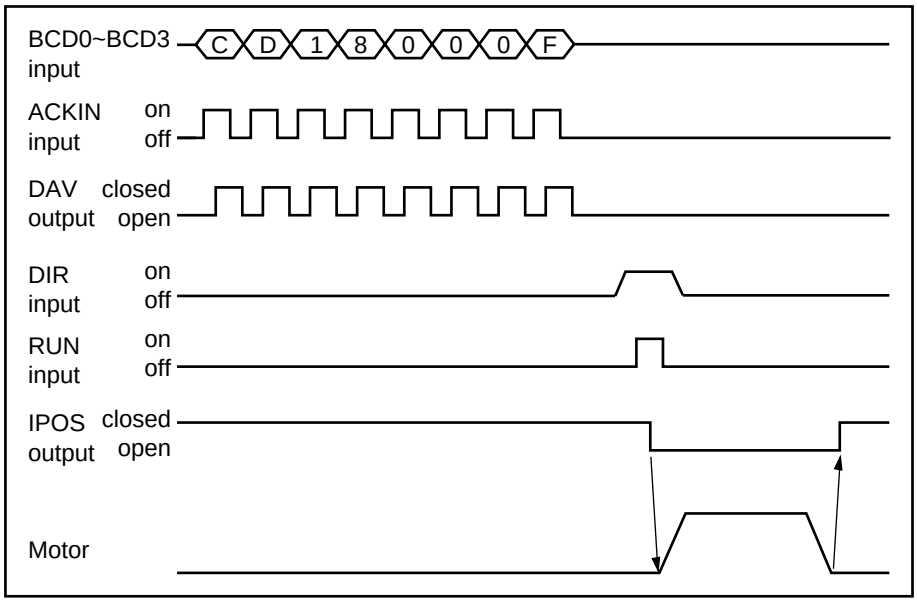
Format	DD××××× (××××× = index data)
Data Range	0 ~ 35999 [× 0.01°] (Compliant with user absolute position scale.)
Rotational Direction	The Motor rotates in the direction where the rotational angle is smaller. If the destination is the opposite position to the current position, the Motor rotates clockwise if DIR input is inactive, counterclockwise if active.
Reference	The Motor does not rotate if the destination is the same as the current position.

7.5.4.3. Execution Timing

Example of incremental positioning (in units of 0.01°)

Figure 7-29

BCD Command Positioning Timing



- Enter a cancel command C into the Driver Unit before entering an intended command. If the previous command caused an error, the cancel command will cancel it.
- Activate the ACKIN input to enter the command type, positioning data, and terminator into the Driver Unit character by character.
- If the RUN input goes active, positioning is executed according to an already- specified positioning command.
- On completion of positioning, the IPOS output is closed when the position error counter reads a value within the in-position limit (specified with parameter IN).
- If the STP input goes active in positioning, the positioning operation is discontinued.

7.5.5. Pulse Train Command Positioning Operation

- The following show the input signals concerned:

Table 7-25

Pulse Train Input

Input	Function		
	CW & CCW	Step & Direction	øA/øB
CWP	Input CW pulse.	Input rotational direction.	Input øB.
CCWP	Input CCW pulse.	Input pulse train.	Input øA.
INH	If INH is active, all pulse trains input through CWP and CCWP are ignored.		

- Select a pulse train type with SW201.
- 5VDC power is used for pulse train input. It is different from the power for other inputs.

7.5.5.1. Pulse Train Resolution

The rotational angle per input pulse may be selected using parameter CR. In addition, angle magnification, ×1, ×2 or ×4, may be selected with the internal switch SW201 for øA/øB input.

Figure 7-30

Pulse Train Resolution Setting

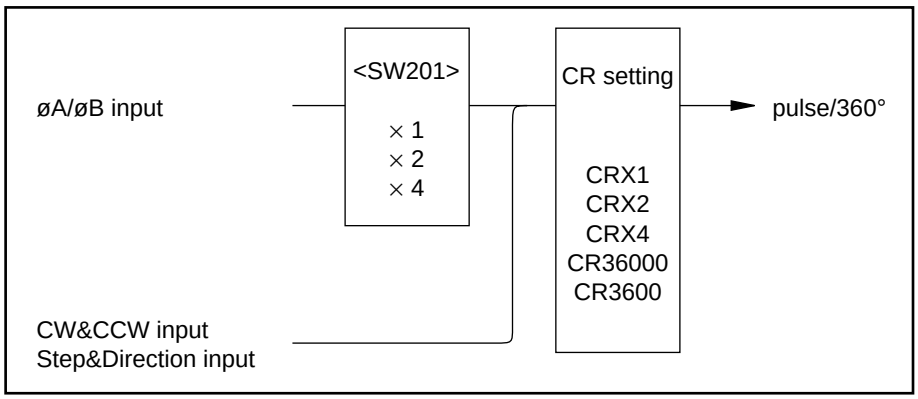
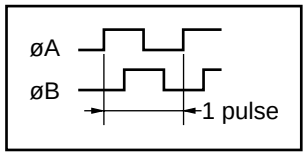


Table 7-26

Pulse Train Resolution Specification

Parameter CR Setting	Motor Size	Resolution [count/rev]			
		CW & CCW or Step & Direction Format	øA/øB Format		
			×1	×2	×4
CR×1	06××, 08××, 10××, 14××	614 400	614 400	307 200	153 600
	04××	409 600	409 600	204 800	102 400
	B×××	491 520	401 520	245 760	122 880
CR×2	06××, 08××, 10××, 14××	307 200	307 200	153 600	76 800
	04××	204 800	204 800	102 400	51 200
	B×××	245 760	245 760	122 880	61 440
CR×4	06××, 08××, 10××, 14××	153 600	153 600	76 800	38 400
	04××	102 400	102 400	51 200	25 600
	B×××	122 880	122 880	61 440	30 720
CR36000	All	36 000	36 000	18 000	9000
CR3600	All	3600	3600	1800	900

Note * Each cycle of phase A or B serves as a count if the øA/øB format is used. (See the figure.)



7.5.5.2. Pulse Train Input Timing

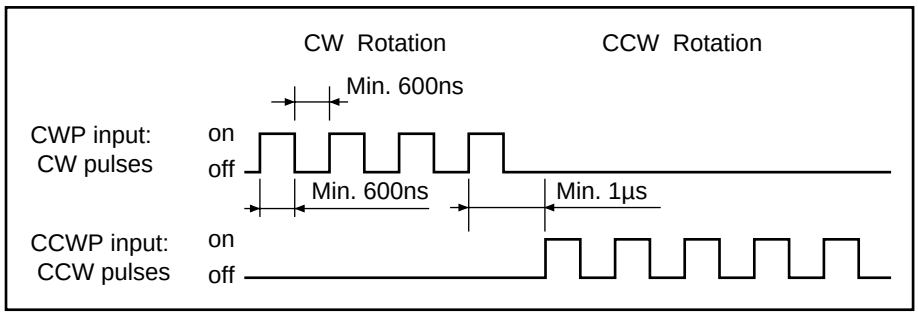
The following shows the timing of accepting pulses.

Important *In addition to the conditions shown below, the maximum velocity places restrictions. The pulse frequency should not exceed the maximum velocity of the Motor.*

(1) CW & CCW format

Figure 7-31

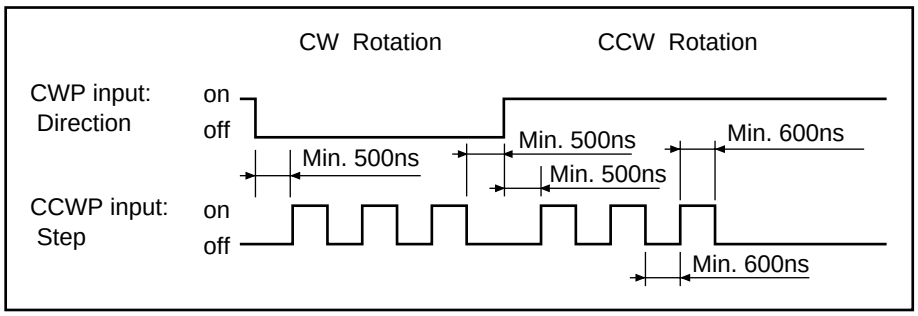
CW & CCW Pulse Timing



(2) Step & direction format

Figure 7-32

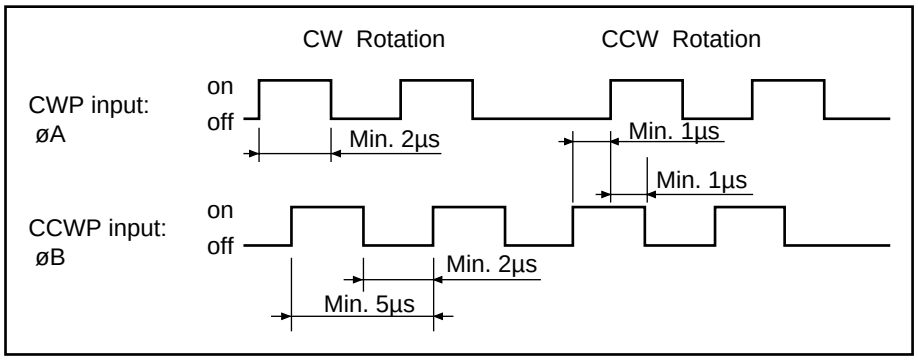
Step & Direction Pulse Timing



(3) øA/øB format

Figure 7-33

øA/øB Pulse Timing



7.5.6. Jogging Operation

If the JOG input goes active, the Motor begins to rotate and is accelerated. While JOG remains active, the Motor keeps rotating. If it goes inactive, the Motor is decelerated and then stops.

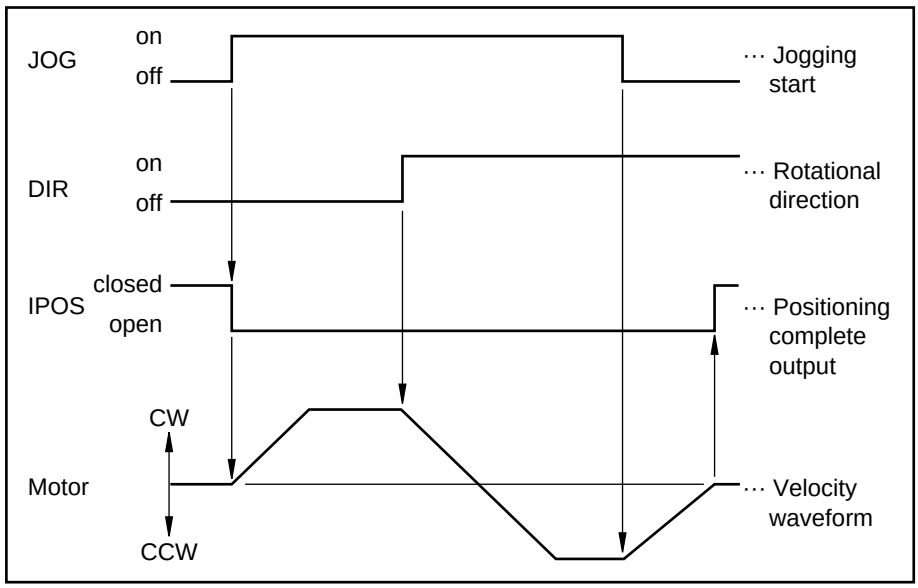
Table 7-27

Jogging Parameter/Signal

Item	Parameter/Signal	Function
Jogging Acceleration Setting	Parameter JA	Specify in units of rps^2.
Jogging Velocity Setting	Parameter JV	Specify in units of rps.
Jogging Start	JOG input (CN2)	Active JOG starts rotation.
Rotational Direction	DIR input (CN2)	Active: CCW, inactive: CW

Figure 7-34

Jogging Timing

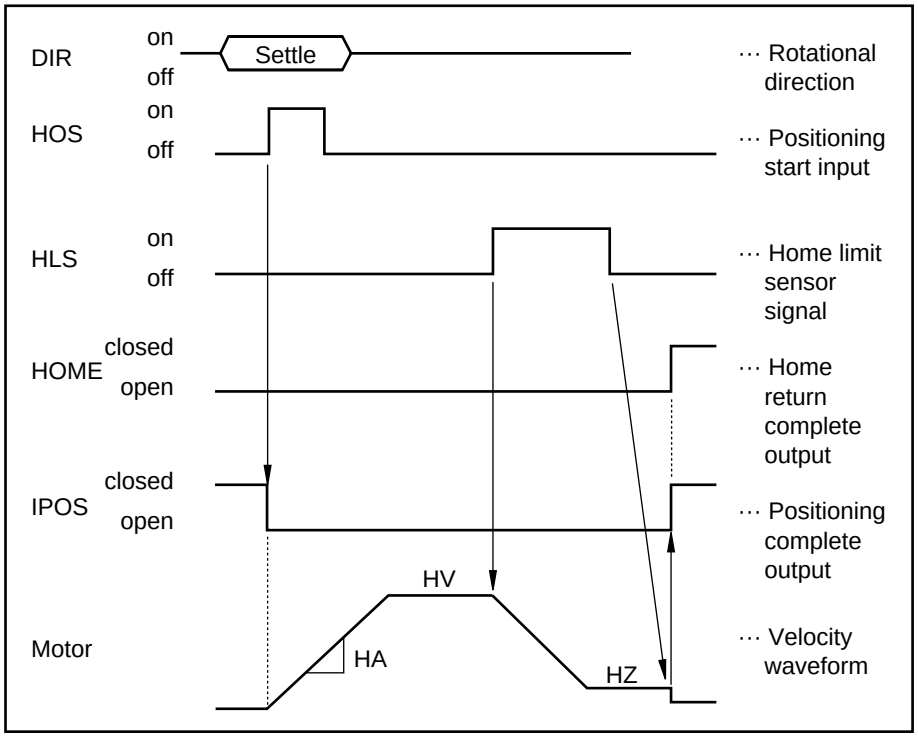


7.5.7. Home Return Operation

The following shows the basic motion of the Home Return sequence.

Figure 7-35

Home Return Basic Motion



- If the HOS input goes active, the Motor begins to rotate.
- If the HLS input goes active, the Motor begins to decelerate. If HLS goes inactive, the Motor stops.
- On completion of the Home Return sequence, the HOME output is closed.
- On completion of the Home Return sequence, the position scale is reset.

Table 7-28

Home Return Parameter/ Command/Signal

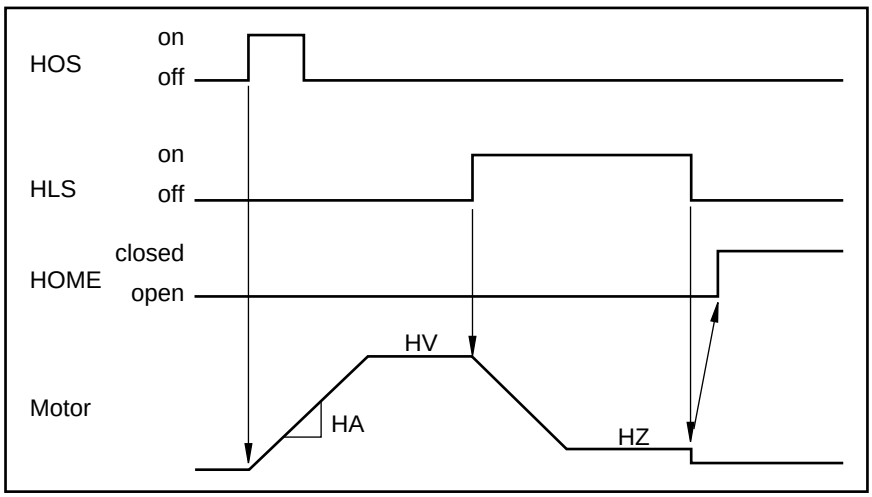
Item	Parameter/ Command/Signal	Function
Home Return Start Input	HOS input (CN2)	Active HOS starts the Home Return sequence.
	HS command	Starts the Home Return sequence.
Home Return Velocity Setting	Parameter HV	Specifies the velocity (rps) until the HLS input goes active.
Home Return Acceleration Setting	Parameter HA	Specifies the acceleration in units of rps^2.
Home Position Searching Velocity Setting	Parameter HZ	Specifies the search speed (rps) after the HLS input signal goes active.
Home Return Direction Input	DIR input	Specifies the direction of the Home Return sequence. Inactive: CW, active: CCW
Home Return Completion Output	HOME output (CN2)	Closed if the Home Return sequence operation is completed. Remains closed until a rotation command is input.
Home Return Mode Selection	Parameter OS	Specifies the mode of the Home Return sequence.
Home Return Area Judgment Selection	Parameter HC	Selects whether or not the Home Return area judgment function is used.
Home Position Offset Setting	Parameter HO	Sets an offset in Home Return mode 3.
Home Return Relative Position Data Setting	Parameter HP	Specifies a Home Return relative position data.

7.5.7.1. Home Return Sequence Mode

(a) Mode 1

Figure 7-36

Home Return Mode 1 Timing

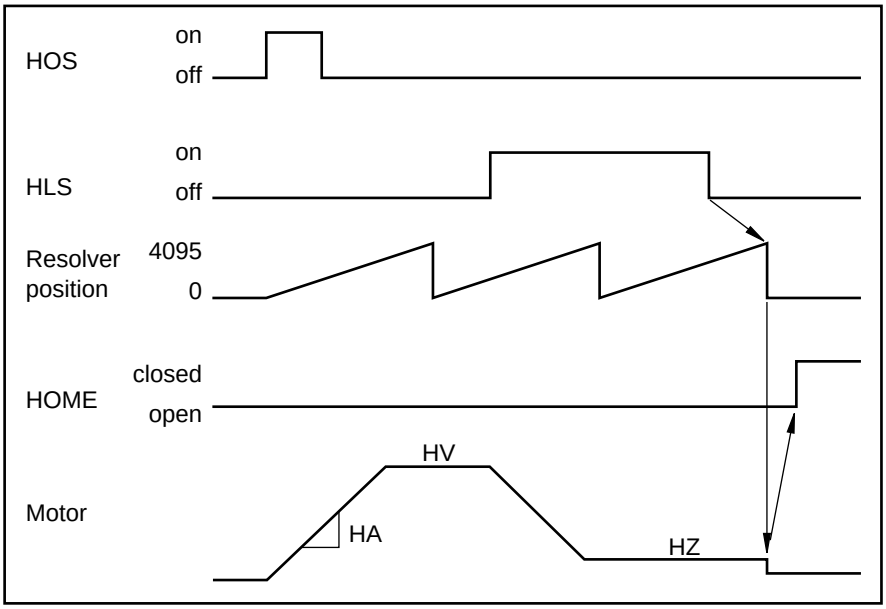


- If the HOS input goes active under the condition where OS1 is specified, Home Return mode 1 is selected.
- At the point where the HLS input goes inactive, Home Return is completed. Or, it is point 0 in user absolute position scale.
- A Home Return sequence may be started by using the HS command, instead of the HOS input. HS1 causes clockwise rotation, and HS-1 causes counterclockwise rotation. (The DIR input is ignored.)

(b) Mode 2

Figure 7-37

Home Return Mode 2 Timing

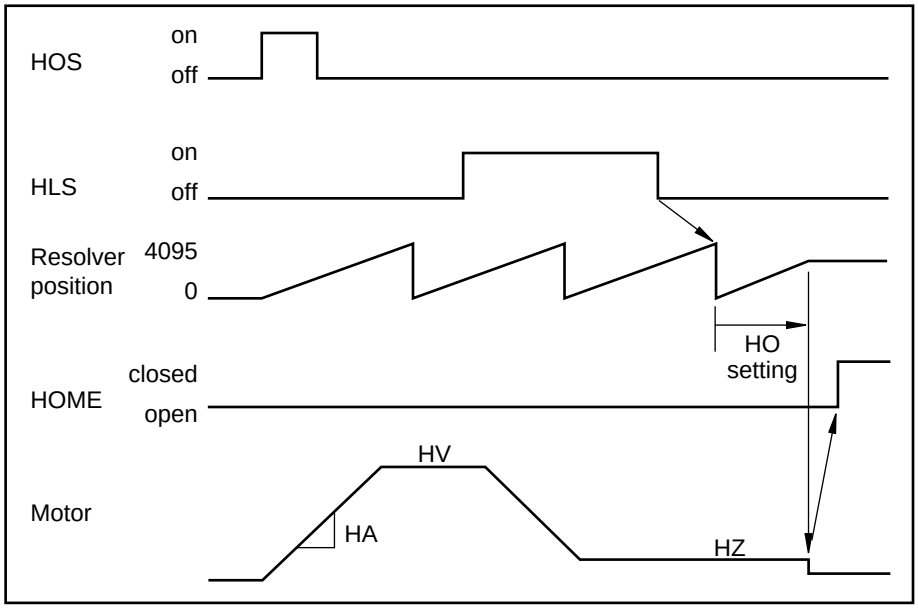


- If the HOS input goes active under the condition where OS2 is specified, Home Return mode 2 is selected.
- At the point where the HLS input signal goes inactive and the position detector detects data 0 for the first time, Home Return is completed. Or, it is point 0 in user absolute position scale. Therefore, the point where the Home Return sequence is completed is free from drift of the HLS switch.
- A Home Return sequence may be started by using the HS command, instead of the HOS input. HS2 causes clockwise rotation, and HS-2 causes counterclockwise rotation. (The DIR input is ignored.)

(c) Mode 3

Figure 7-38

Home Return Mode 3 Timing



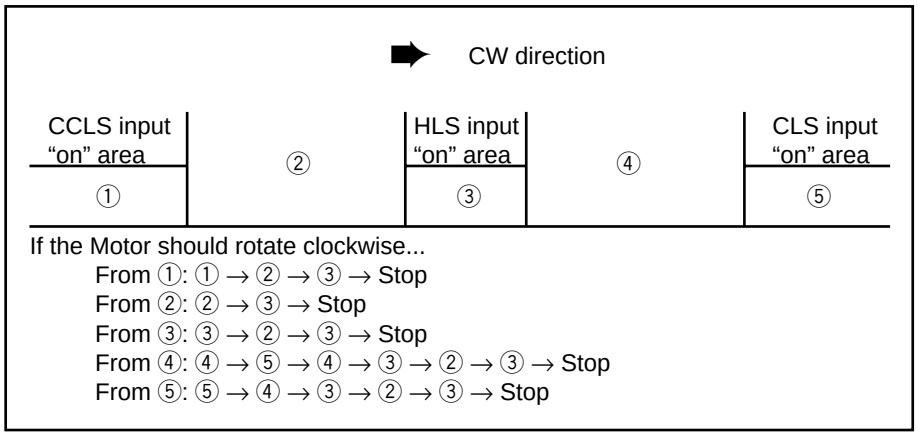
- If the HOS input goes active under the condition where OS3 is specified, Home Return mode 3 is selected.
- At the point where the HLS input goes inactive and the Motor moves by the amount specified with HO from where the position detector detects data 0 for the first time, Home Return is completed. Or, it is point 0 in user absolute position scale. Therefore, any offset may be specified between the HLS switch and home position.
- A Home Return sequence may be started by using the HS command, instead of the HOS input. HS3 causes clockwise rotation, and HS-3 causes counterclockwise rotation. (The DIR input is ignored.)

7.5.7.2. Area Judgment Function

- By using the HC command, the area judgment function may be added to the Home Return sequence.
  - If HC0 is specified, the area judgment function is not added.
  - If HC1 is specified, the area judgment function is added.
- If this function is used with the rotation limit inputs CLS and CCLS, the Motor may return to the home position from any position in a specified direction.

Figure 7-39

Area Judgment Function Example

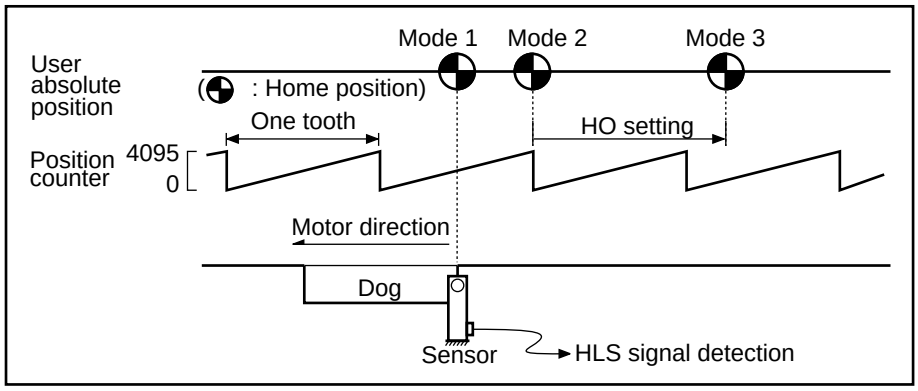


7.5.7.3. Home Limit Switch Adjustment

- The position of the home limit switch (sensor and dog) should be adjusted to set the Home Return completion position. Adjustment differs with the Home Return modes. Follow the instructions shown below.
- The Home Return completion positions (i.e., home position of user absolute position scale) in the modes are as shown below:
  - Mode 1 — The point where the home limit switch turns off
  - Mode 2 — The point where the home limit switch turns off and the position detector detects data 0 for the first time
  - Mode 3 — The point offset from the point at which mode 2 is completed

Figure 7-40

Home Position



What Is The Position Sensor?

The Megatorque Motor incorporates a position sensor (i.e., resolver), which divides the distance between adjacent teeth into 4096 parts from 0 to 4095. The data of the resolver is used for Motor position control in the System. In Home Return mode 2 or 3, the home position is determined based on the point where this data is 0.

Motor Size	Number Of Teeth
04××	100
06××, 08××, 10××, 14××	150
B×××	120

The number of teeth on the Motor perimeter differs with Motor sizes as shown in the table.

(a) Adjustment in Home Return mode 1

In this mode, the position where the HLS input goes inactive is the home position. Adjust the sensor or dog at a position which should serve as the mechanical home position.

(b) Adjustment in Home Return mode 2 or 3

In mode 2, the position where the HLS input goes inactive and then the position detector detects data 0 for the first time is the home position. The position apart by the offset from the home position in mode 2 is the home position in mode 3.

The home limit switch identifies a tooth among the teeth on the Motor perimeter. Adjust it to the approximate center of a tooth for stable operation.

(1) Select Home Return mode 1, then issue a TR command to check for the data of the position detector at the point where Home Return is completed.

To use TR command, type as:




```
:TR
 XXXX
:
```

Adjust the sensor or dog so that the data of the position detector is between 1000 and 3000. If you use Home Return mode 2, the adjustment is completed here.

(2) For Home Return mode 3, specify HO additionally for the home position in mode 2.

To specify HO, follow the instruction below.

① Complete Home Return mode 2.

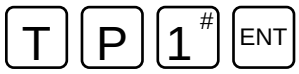
② Issue an MO command to deactivate the Motor servo.
Type as:




```
:MO
:
```

③ Turn the Motor by hand in the same direction as the Home Return sequence direction and adjust the Motor to the target home position.

④ Use TP1 to read out the relative position counter at this position.
Type as:




```
:TP1
 xxxxxx
:
```

⑤ Assign the absolute value of the read value to HO. (If an HP compensation value has been specified, subtract it from the absolute value.)
HO = | (value read with TP1) – (HP set value) |

```
:TP1
 xxxxxx
:
```

⑥ Issue an SV command to turn on the Motor servo.




```
:SV
:
```

⑦ Complete Home Return mode 3.
The adjustment is complete if the Motor returns to the target home position. If not, adjust again.

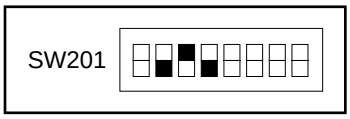
7.6. Velocity Control Mode Operation

To set the Megatorque Motor System to velocity control mode, the following two methods are available:

(a) The power-on set of internal switch SW201 #2 ~ #4*

Figure 7-41

SW201 Setting For Velocity Control Mode



(b) By RS-232C commands

Table 7-29

Velocity Control Mode Command

Command	Function
VC	Selects velocity control mode
DC	Activates RS-232C interface and commands.
AC*	Activate analog interface.*

Note * The analog interface is available only on the models specified below.

M-RS1410FN001MA15C

This digit must be "5."

7.6.1. RS-232C Communication Command Operation

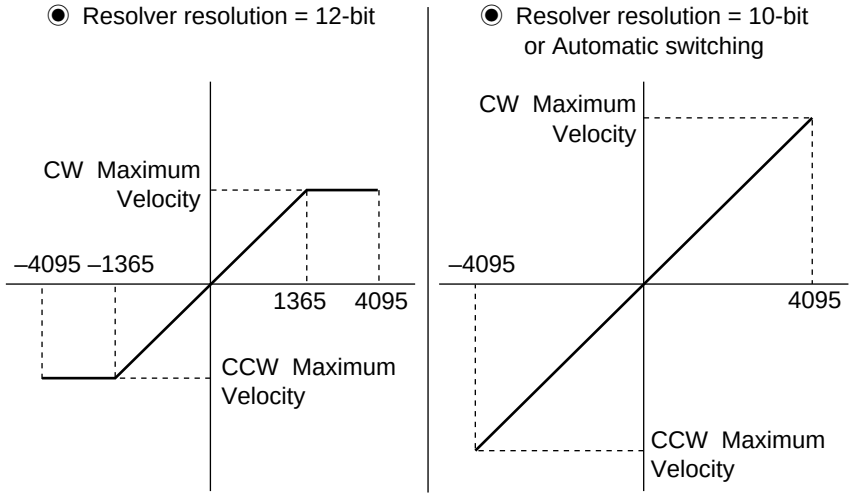
In velocity control mode, you can command the Motor to rotate at a certain velocity via RS-232C communication using DC command.

Format: DC data

The velocity is in proportion to the “data” as shown below.

Figure 7-42

DC Command Data Vs. Velocity



Motor Size	Maximam Velocity [rps]	
	Resolver resolution = 12-bit	Resolver resolution = 10-bit or Automatic switching
04××	1.5	4.5
06××, 08×× 10××, 14××	1.0	3.0
B×××	1.25	3.75

7.6.2. Analog Command Operation

Note *The analog interface is available only on the models specified below.*

M-RS1410FN001MA15C
This digit must be "5."

In velocity control mode, you can command the Motor to rotate at a certain velocity using analog voltage.

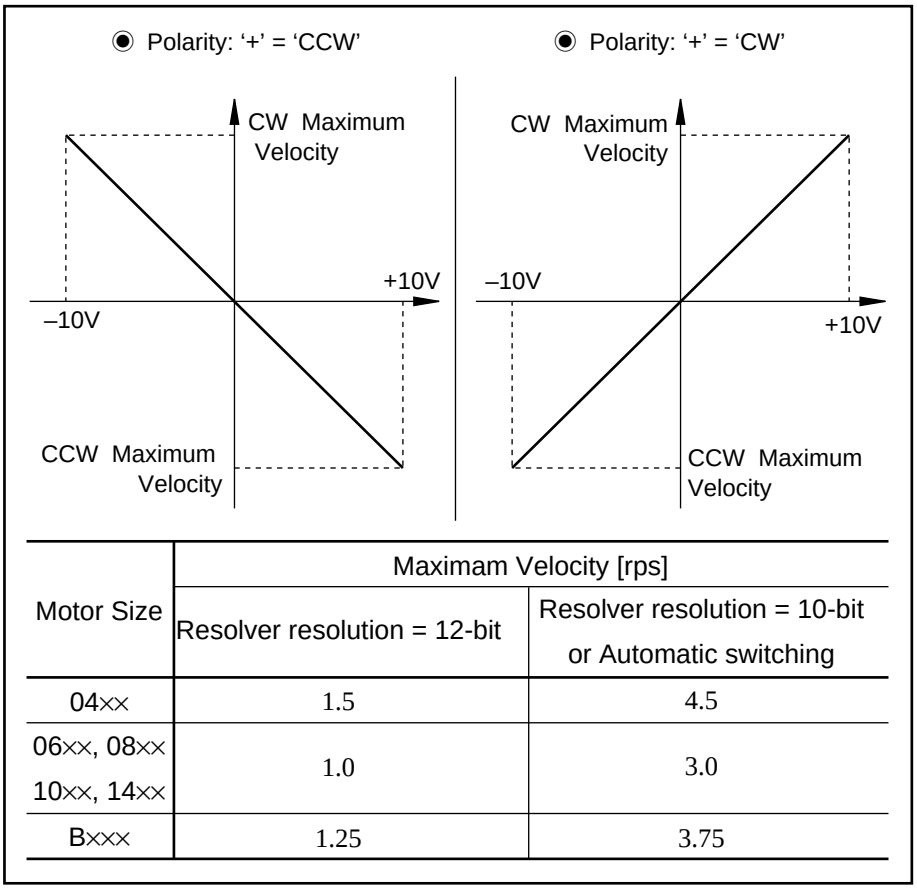
- The analog voltage of ±10VDC is used for the command.
- The analog command offset can be adjusted using front panel volume VR1 or RS-232C command ZA.
- The polarity of the command voltage can be reversed using internal switch SW201 #8.

Table 7-30
Selecting Analog Command Voltage Polarity

SW201 #8	Analog Command Voltage Polarity	Shipping Set
off	'+' = CCW	✔
on	'+' = CW	

The velocity is in proportion to the voltage as shown below.

Figure 7-43
Voltage Vs. Velocity



Motor Size	Maximam Velocity [rps]	
	Resolver resolution = 12-bit	Resolver resolution = 10-bit or Automatic switching
04××	1.5	4.5
06××, 08×× 10××, 14××	1.0	3.0
B×××	1.25	3.75

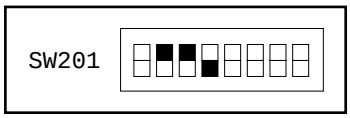
7.7. Torque Control Mode Operation

To set the Megatorque Motor System to torque control mode, the following two methods are available:

(a) The power-on set of internal switch SW201 #2 ~ #4*

Figure 7-44

SW201 Setting For Torque Control Mode



(b) By RS-232C commands

Table 7-31

Torque Control Mode Command

Command	Function
TM	Selects torque control mode
DC	Activates RS-232C interface and commands.
AC*	Activate analog interface.*

Note * The analog interface is available only on the models specified below.

M-RS1410FN001MA15C

This digit must be "5."

7.7.1. RS-232C Communication Command Operation

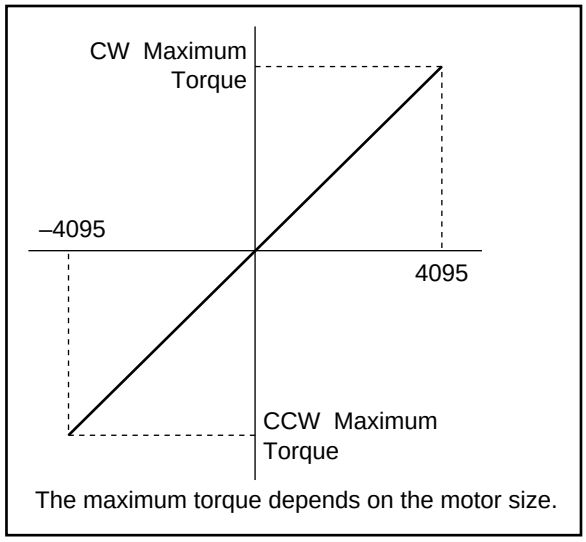
In torque control mode, you can command the Motor to generate torque, via RS-232C communication using DC command.

Format: DC data

The torque is in proportion to the "data" as shown below.

Figure 7-45

DC Command Data Vs. Torque



7.7.2. Analog Command Operation

Note *The analog interface is available only on the models specified below.*

M-RS1410FN001MA15C

This digit must be "5."

In torque control mode, you can command the Motor to generate torque, using analog voltage.

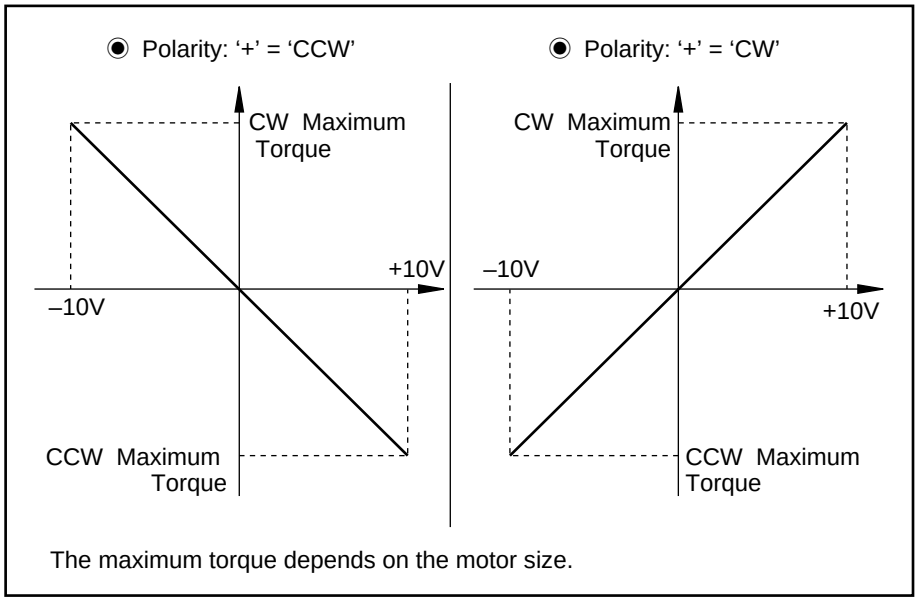
- The analog voltage of ±10VDC is used for the command.
- The analog command offset can be adjusted using front panel volume VR1 or RS-232C command ZA.
- The polarity of the command voltage can be reversed using internal switch SW201 #8.

Table 7-32 Selecting Analog Command Voltage Polarity

SW201 #8	Analog Command Voltage Polarity	Shipping Set
off	'+' = CCW	✔
on	'+' = CW	

The torque is in proportion to the voltage as shown below.

Figure 7-46 Voltage Vs. Torque



7.8. Servo Compensator Circuit

7.8.1. Block Diagram

7.8.1.1. Position Control

Figure 7-47

Position Control Block Diagram

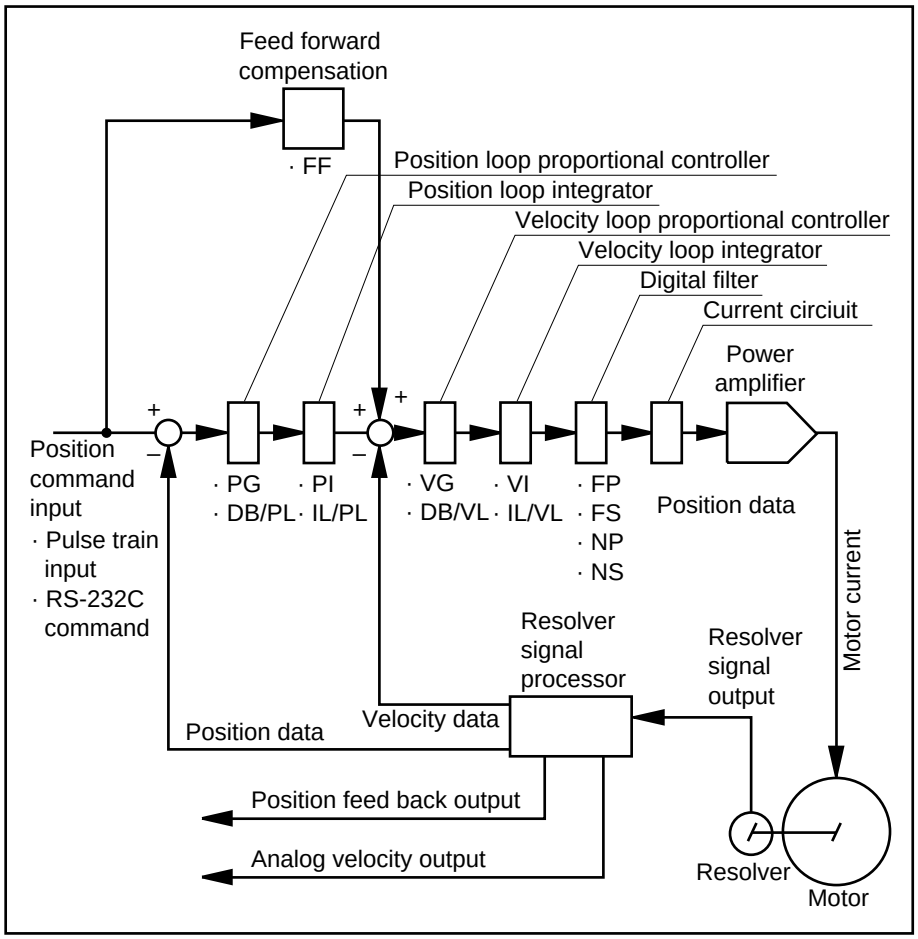


Table 7-33

Position Control Parameter

Item	Parameter	Function
Position Loop	PG	Position gain
	DB/PL	Dead band (position loop)
	PI	Position integrator frequency
	IL/PL	Integration limit (position loop)
Velocity Loop	VG	Velocity gain
	DB/VL	Dead band (velocity loop)
	VI	Velocity integrator frequency
	IL/VL	Integration limit (velocity loop)
Filter	FP	Low-pass filter, primary
	FS	Low-pass filter, secondary
	NP	Notch filter, primary
	NS	Notch filter, secondary
Feed Forward Compensation	FF	Feed forward gain

7.8.1.2. Velocity Control

Figure 7-48

Velocity Control Block Diagram

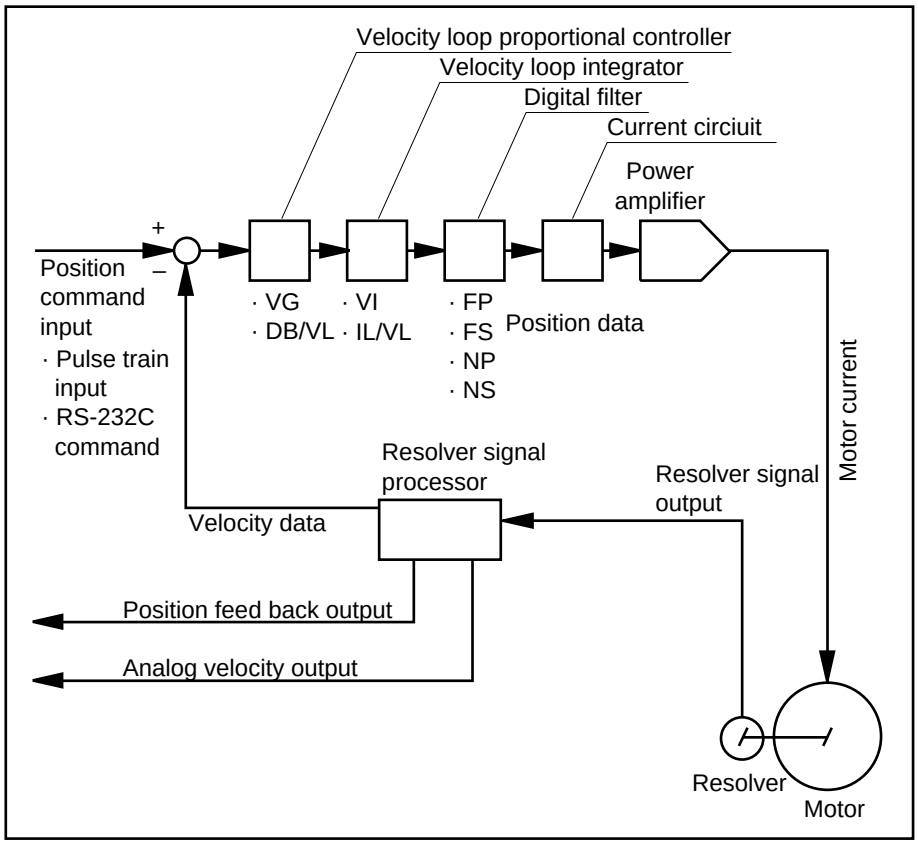


Table 7-34

Velocity Control Parameter

Item	Parameter	Function
Velocity Loop	VG	Velocity gain
	DB/VL	Dead band (velocity loop)
	VI	Velocity integrator frequency
	IL/VL	Integration limit (velocity loop)
Filter	FP	Low-pass filter, primary
	FS	Low-pass filter, secondary
	NP	Notch filter, primary
	NS	Notch filter, secondary

7.8.1.3. Torque Control

Figure 7-49

Torque Control Block Diagram

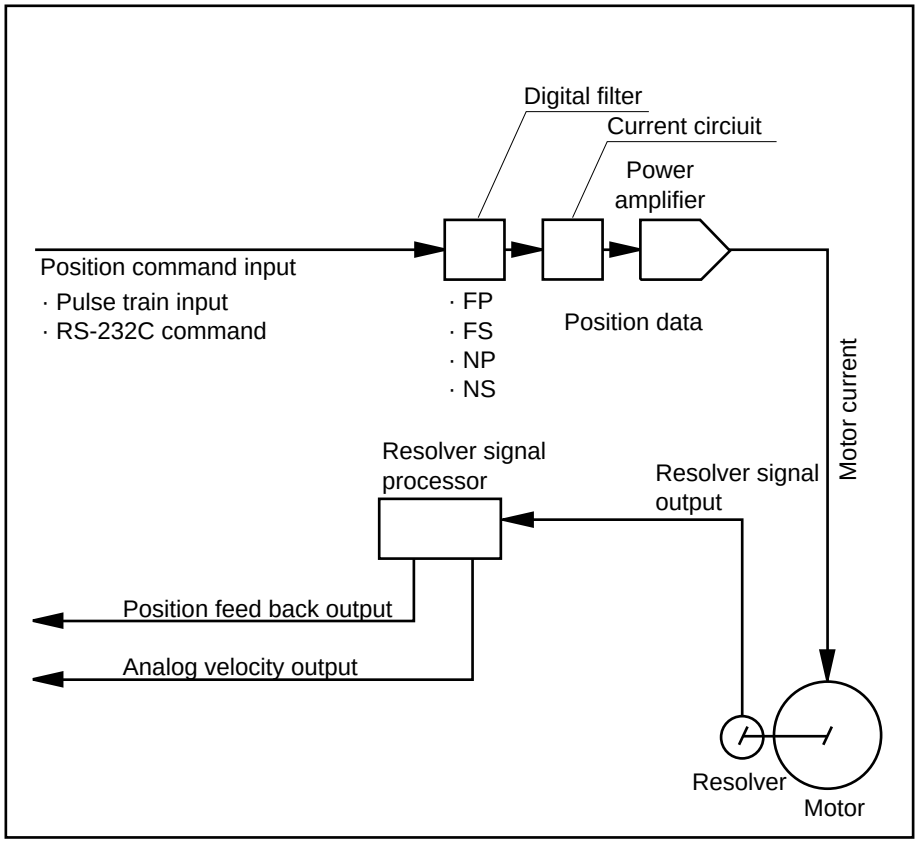


Table 7-35

Torque Control Parameter

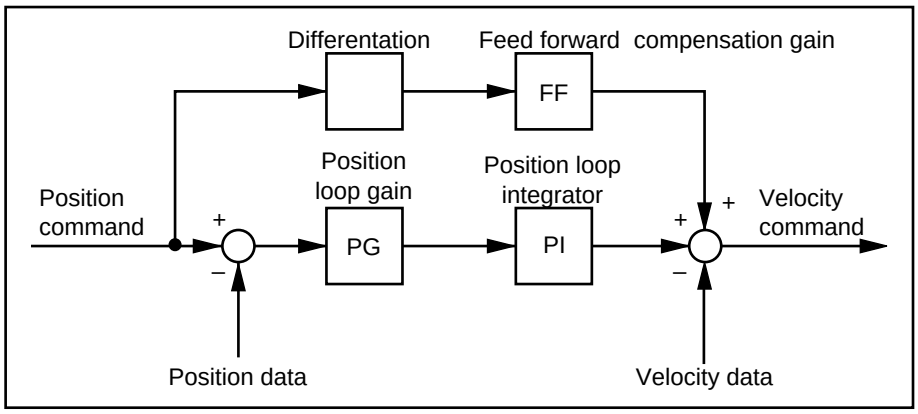
Item	Parameter	Function
Filter	FP	Low-pass filter, primary
	FS	Low-pass filter, secondary
	NP	Notch filter, primary
	NS	Notch filter, secondary

7.8.2. Feed Forward Compensation

- A velocity command created by differentiating a position command may be fed to the velocity loop in the forward direction. The gain of this feed forward may be specified by using the parameter FF.
- The feed forward compensation improves tracing delay in acceleration and deceleration.
- If a large FF parameter is specified, overshoot may occur frequently though the tracing delay is improved. The proper value of the FF parameter is 0.5 approximately.

Figure 7-50

Feed Forward Compensation Block Diagram

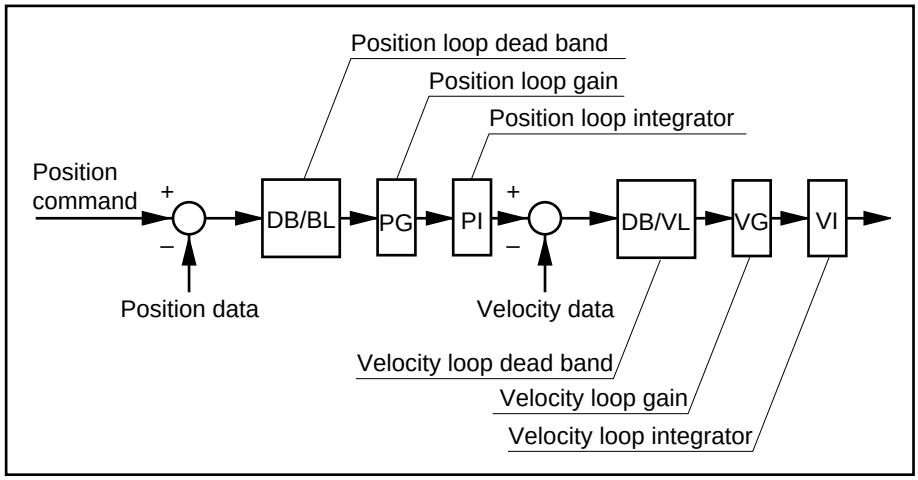


7.8.3. Dead Band

- If dead bands are specified near deviation 0 of the position and velocity loops, commands may be zeroed in the ranges below 0.
- In some service conditions, slight vibration may be caused due to minute deviation. Provision of a dead band eliminates such slight vibration.
- If a dead band is specified, repetitive positioning accuracy is deteriorated by the amount of the dead band though slight vibration may be eliminated.

Figure 7-51

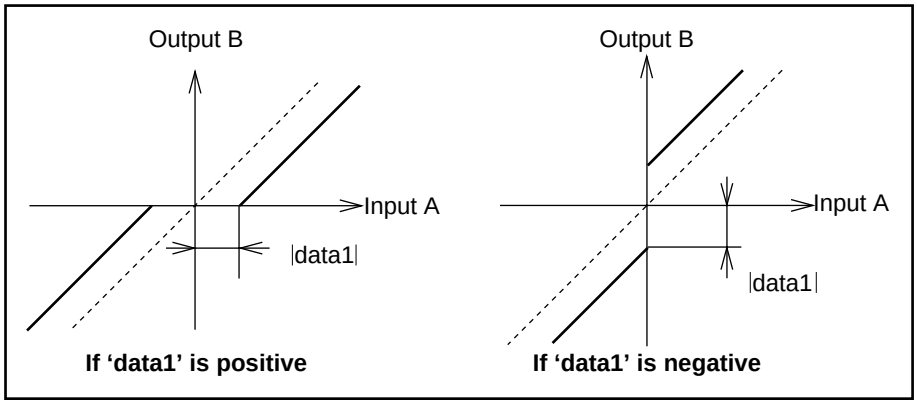
Dead Band Block Diagram



- DB is used to specify a dead band for the position error (output from the position error counter) or velocity error.
  DB data1 /PL — dead band setting for the position error
  DB data1 /VL — dead band setting for the velocity error
- If 0 is specified in ‘data1,’ the dead band circuit is deactivated.
- Values of ‘data1’ shall be specified in units of the following:
  DB data1 /PL — in units of counts
  DB data1 /VL — in units of 1/1365rps (4095 = velocity error of 3rps)
- The function depends on the sign of a ‘data1’ value as shown below:
  If ‘data1’ is positive → dead band setting for error
  If ‘data1’ is negative → offset setting for error

Figure 7-52

Dead Band Function

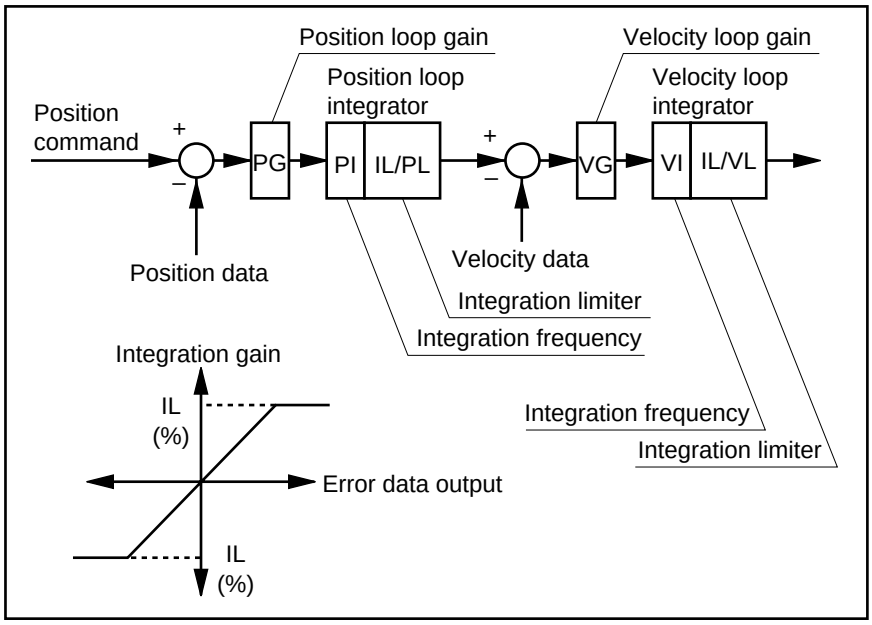


7.8.4. Integration Limiter

- Use the IL parameter to specify the upper limit of the output of the position loop and velocity loop integration circuit.
- Integration control is inevitable for accurate positioning. However, it is subject to deviation and overshoot due to integration if the Motor is accelerated and decelerated at a high rate. To eliminate such troubles, use an integration limiter to suppress excessive integration.
- Use the following control modes if an integration limiter is used:
  · To use an integration limiter in the position loop — PM3
  · To use an integration limiter in the velocity loop — VM3

Figure 7-53

Integration Limiter Block Diagram

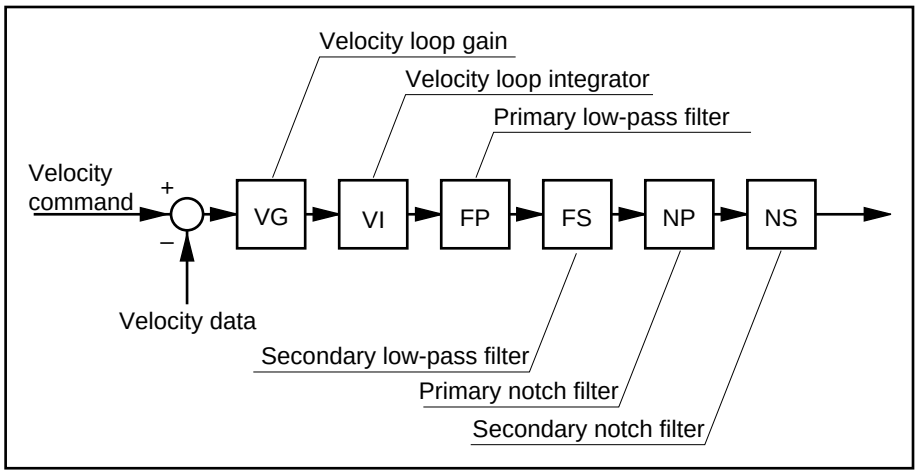


7.8.5. Digital Filter

- Specify the frequency of the filter in the velocity loop.
- The filter may reduce mechanical vibrations.

Figure 7-54

Digital Filter Block Diagram



Caution *Use as few filters as possible (FP only or FP + NP). The use of multi-stage filters may reverse the phases and cause unstable operation in some service conditions.*

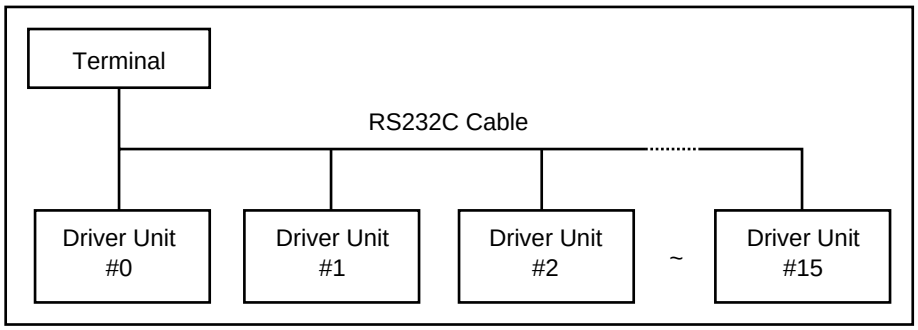
7.9. Daisy Chain Communication

7.9.1. Overview

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

Figure 7-55

Daisy Chain Communication Overview

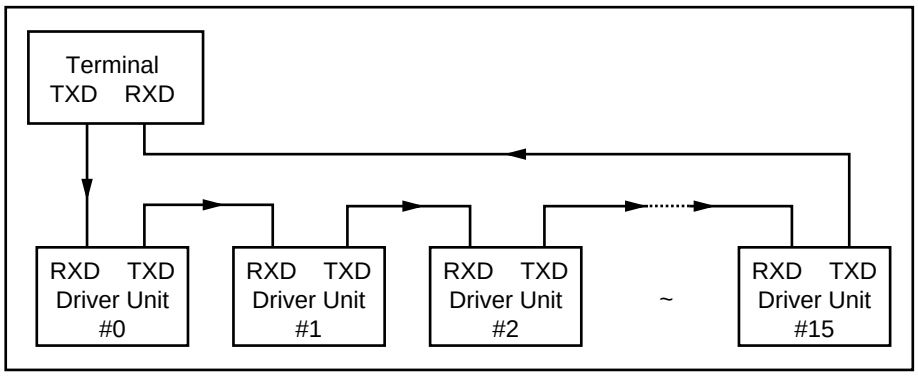


7.9.2. Connection

As for the data communication lines, connect the output of the RS-232C terminal with the input of the axis #0 unit, the output of the axis #0 with the input of the axis #1 unit, and so forth as shown below. Connect the output of the final axis with the input of the RS-232C terminal.

Figure 7-56

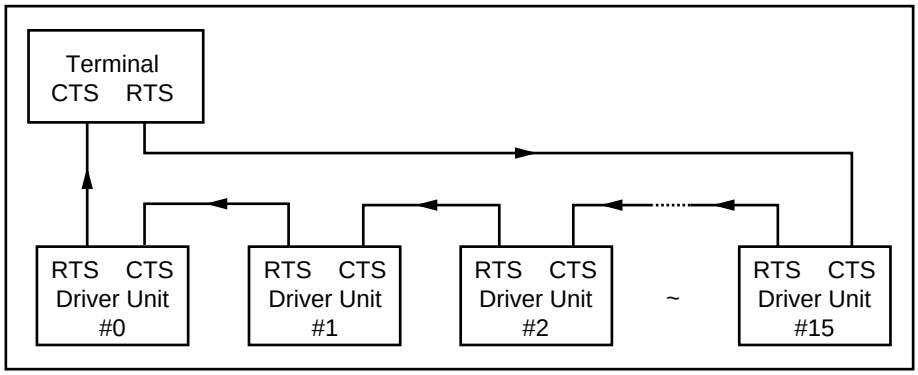
Data Line Connection



As for the lines carrying requests to send data, connect the input of the RS-232C terminal with the output of the axis #0 unit, the input of the axis #0 with the output of the axis #1 unit, and so forth as shown below. Connect the input of the final axis with the output of the RS-232C terminal.

Figure 7-57

Request-to-send Line Connection

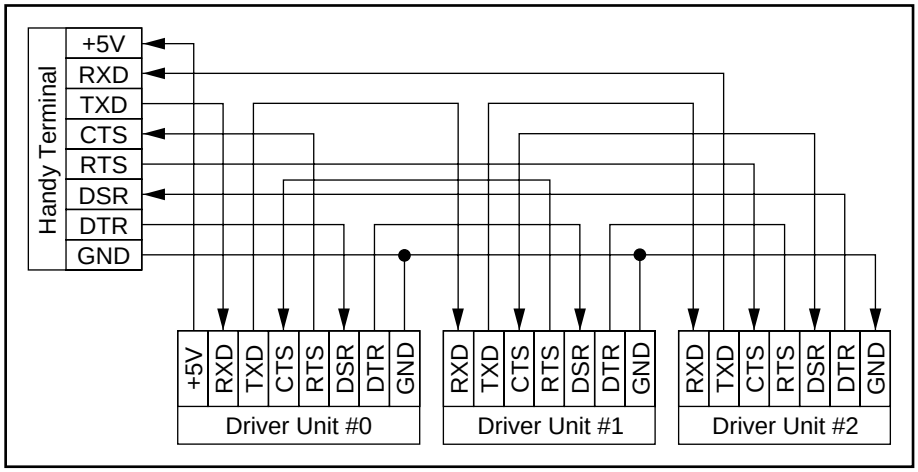


Connection example

If our Handy Terminal is used for communication, connect it as shown below. Also refer to “Appendix 4: RS-232C Serial Communication” which describes the specifications of connector CN1.

Figure 7-58

Handy Terminal Connection Example



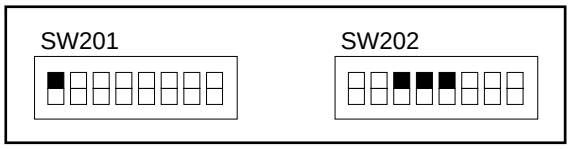
7.9.3. Operation

(1) Switch setting before power-on

Set the internal switches SW201 and SW202 as shown below.

Figure 7-59

SW201 & SW202 Setting



- If the Driver Unit is initialized when power is turned on, the normal operation is not guaranteed in daisy chain communication. Be sure to set switch SW201 #1 'on' in order not to initialize the Driver Unit when power is turned on.
- Set switch SW202 #3 ~ #5 'on' to assign the axis number setting function to the switch on the front panel.
- For daisy chain communication, a unique number is assigned to each Driver Unit. (This number is called an axis number.) SW1 on the front panel is used to set the axis numbers. The Driver Unit which receives a signal through the RS-232C interface first has a axis number 0. Other Driver Units have axis numbers which increase like 2, 3 and so forth in sequence. Since these numbers are hexadecimal, assign A to F to Driver Units No. 10 to No. 15.

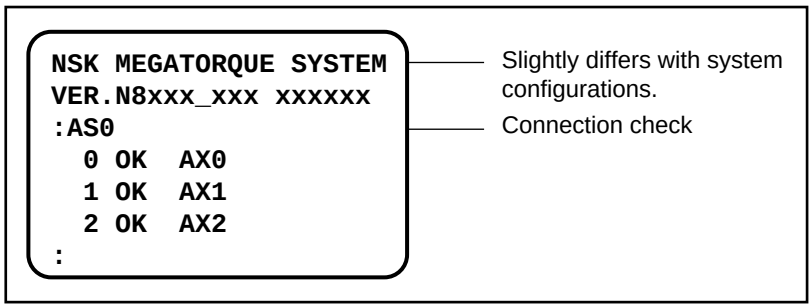
(2) Power on

If the Handy Terminal is not used, turn on power in the order of the RS-232C terminal and Driver Units, which shall be turned on from the largest axis numbers to the smallest axis numbers. (Or, all Driver Units shall be turned on simultaneously.) When the Driver Unit of axis number 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 message example shows a 3-axis configuration.

Figure 7-60

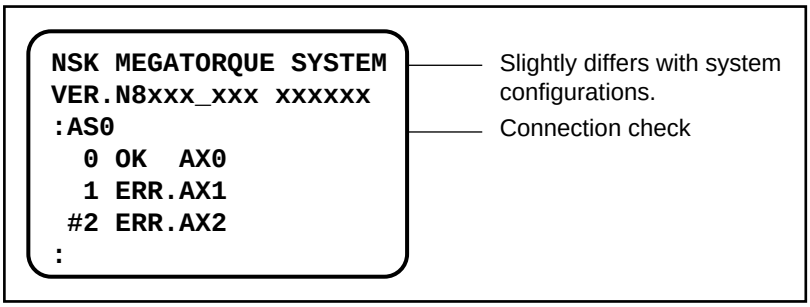
Proper Connection



If connection is improper, the following message may be displayed. The following message example shows a case where axis #1 and axis #2 are connected improperly.

Figure 7-61

Improper Connection



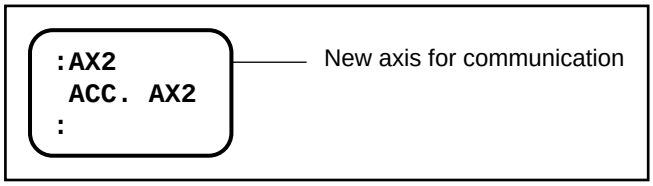
If the proper message is not displayed, check for connection order, setting of the switch on the front panel, and cable connection.

(3) Selection of Driver Unit used for 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.

Figure 7-62

Selecting Driver Unit

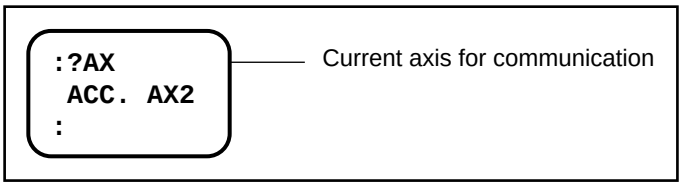


Caution *Do not select any unit that is not connected. Otherwise, operation may hang up. To return to the normal state, press the BS key first, then select the number of a connected Driver Unit.*

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

Figure 7-63

Checking Selected Driver Unit



7.10. Built-In Absolute Position Sensor Function

This section gives auxiliary explanation about a system with built-in absolute position sensor, which is specified on the System number as follows. It does not apply to the standard system.

7.10.1. Features

- This type of system incorporates a position sensor which detects an absolute position on the perimeter. It reads the current position and determines the coordinate automatically when power is turned on. Therefore, it does not require Home Return every time power is turned on.
- The following commands and parameters are modified for the system with built-in absolute position sensor.

Table 7-36 Modified Command/Parameter

Name	Function	Modification
AP	Absolute Position	Deleted
AO	Absolute Position Scale Offset	Password required
AZ	Absolute Zero Position Set	
IP	Incremental Position Set	
LP	Incremental Position Judge	Added
HI	Home In-Position Limit	
HW	Home Width	

7.10.2. How to Set Home Position

7.10.2.1. User Absolute Position Scale Home Position

Important *Set this home position if you plan to use the absolute positioning function.*

The home position may be determined in either of the following manners:

① Issue an AZ command to specify the current position as the home position of user absolute position scale. The system with a built-in absolute position sensor requires entry of the password for the AZ command. Type "/NSK ON", then issue an AZ command.

② Execute a Home Return sequence.

Once the home position of user absolute coordinate system is specified in either way, it is stored in the system. Thus, it need not be re-specified unless the Motor installation is changed.

We recommend that the home position should be specified with an AZ command since no external home position limit is required.

7.10.2.2. Relative Position Counter Home Position

Important *Set this home position if you plan to use software rotation limit function.*

(1) Power-On Set

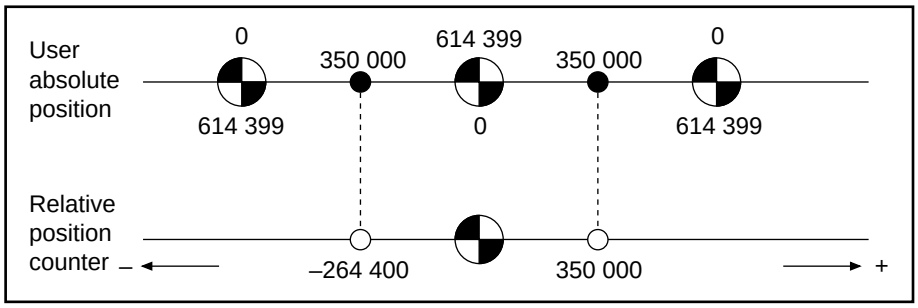
When power is turned on, a value (user absolute position + parameter HP) is set automatically as a relative position. The parameter HP is factory-set to 0, and the relative home position is the same as user absolute home position in the initial state. The value of HP is read only when power is turned on. If it is changed, turn off power once, then turn it on again.

A straight line expanding to the positive and negative directions from the home position represents the relative position counter. Thus, it should be determined whether the power-on point has a positive or negative viewed from the home position.

Provided user absolute position is 350 000 and parameter HP is 0, for example, the relative position may be +350 000 or –264 400, either of which is the true value.

Figure 7-64

Relative Position Judgment Example 1



The LP parameter serves as the criterion for judging the true value. If a absolute position when power is turned on is larger than the value of LP, a negative relative position is regarded as the relative position.

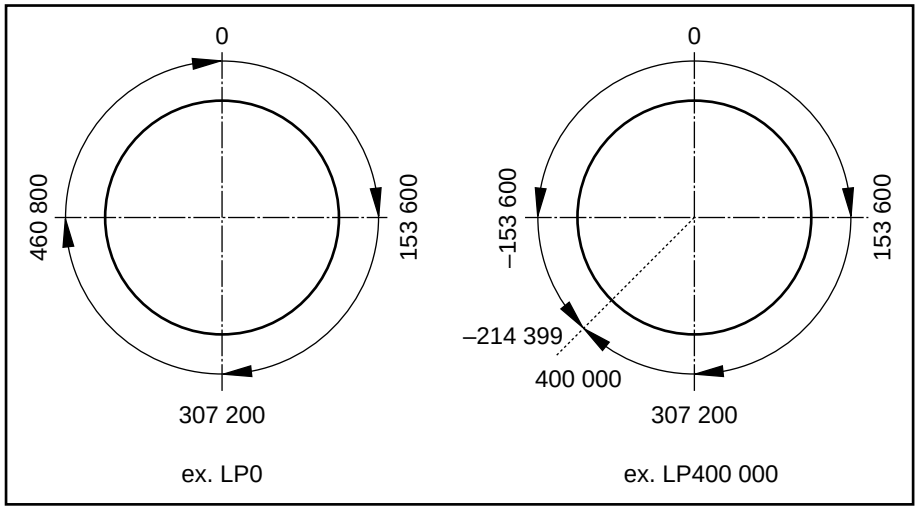
In the above example, the relative position is 350 000 if LP > 350 000, or it is –264 400 if LP < 350 000.

However, if LP = 0, the positive relative position is adopted.

Figure 7-65

Relative Position Judgment

Example 2



(2) To set a relative position temporarily

To set a relative position temporarily without turning off power, use an IP command. The system with a built-in absolute position sensor requires entry of the password of the IP command. Type “/NSK ON” then issue an IP command.

7.10.3. Position Scale Setting Example

(1) Turn on the Driver Unit power.

(2) Specify the home position in user absolute position scale.

① Input an MO command to bring the Motor servo into a free state.
② Turn the Motor to any position.
③ Type the password /NSK ON.
④ Input an AZ command.

```
:MO
:/NSK ON
 NSK ON
:AZ
```

Through the above setting, the Motor moves to the position specified in ④ by issuing AR0 (or AD0).

(3) Specify a software limit (if used).

Assuming that the Motor remains the position stopped at (2) 2.

① Type the password /NSK ON.
② Input an IP0 command.
③ Input an MO command to bring the Motor servo into a free state.
④ Turn the Motor clockwise to the software limit clockwise position.
⑤ Issue a TP1 command to read the position data.
⑥ Input an LS command at the position read in ⑤ above.
⑦ Issue a TP2 command to read the position data.
⑧ Turn the Motor counterclockwise to the software limit counterclockwise position.
⑨ Issue a TP1 command to read the position data.
⑩ Input an LS command at the position read in ⑨ above.
⑪ Issue a TP2 command to read the position data.
⑫ Subtract the position data in ⑦ from the position data in ⑪.
⑬ Divide the data in ⑫ by ②.
⑭ Add the data in ⑦ to the position data in ⑬.
⑮ Input data found in ⑭ by issuing an LP command.

```
:/NSK ON
 NSK ON
:IP0
:MO
:TP1
 xxxxxx
:LSxxxxxx
:TP2
 yyyyyy
:TP1
 -zzzzzz
:LS-ZZZZZZ
:TP2
 wwwwww
:LPvvvvvv
```

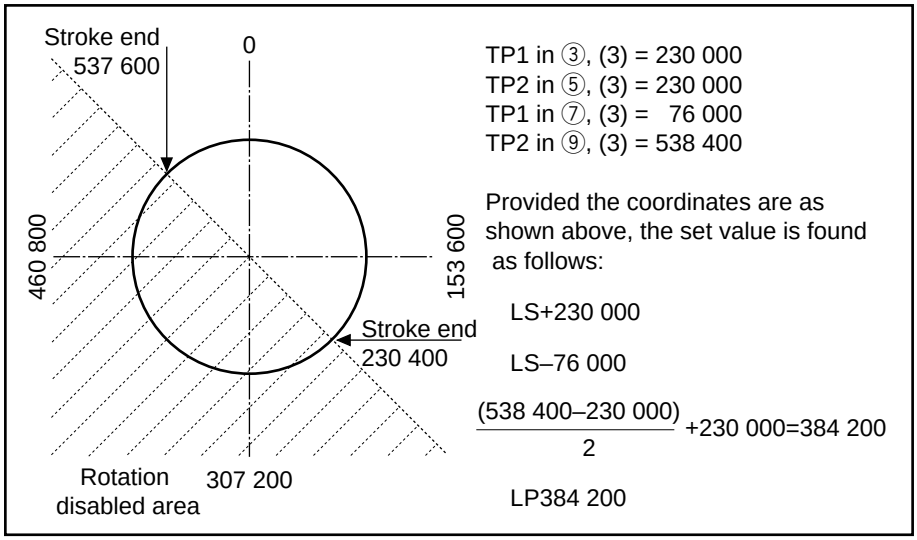
The software limit position shall be inside the stroke end (i.e., the limit of machine motion).

(4) Turn off the Driver Unit power.

Example — Setting for a 6” Motor using an AZ command

Figure 7-66

Setting Example



7.10.4. Setting of Home Position Output

A home position signal HOME may be output while the Motor with a built-in absolute position sensor is at the home position of user absolute position scale.

HOME output condition is set by parameters HW and HI.

HW — Home Width

- When the Motor passes through the home position, HOME output will be closed for the time specified by parameter HW, if HW is specified. The time can be specified between 0.3 ~ 10 seconds.
- The HOME output works same as is in a standard System (which does not have the absolute position sensor built-in), if HW is not specified.
- HW is factory-set to 0.

HI — Home In-Position Limit

- Specifies the in-position limit for the home position. The limit can be specified between 0 ~ ±4095 counts.
- HI is factory-set to 0.

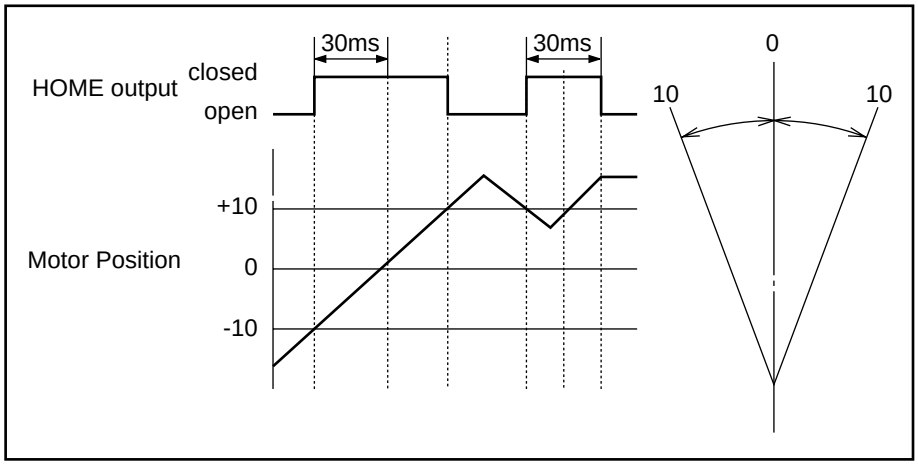
Note *For details of commands, see chapter 8. Command And Parameter List.*

Example: HW0.3, HI10

- A HOME output is closed if the Motor stops within ±10 counts from the home position (always closed).
- If the Motor passes through the home position, a HOME output is closed for 30ms.

Figure 7-67

HOME Output Timing Example



8. Command and Parameter List

8.1. Communication Specification

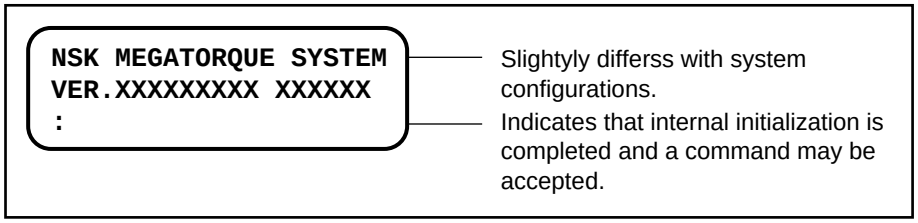
Setting of various parameters, trial running, and adjustment are enabled by issuing commands to the Driver Units through serial communication (i.e., communication through the RS-232C interface).

8.1.1. When Power Is Turned On

If a terminal (such as NSK Handy Terminal FHT01) 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 8-1

Power-On Message



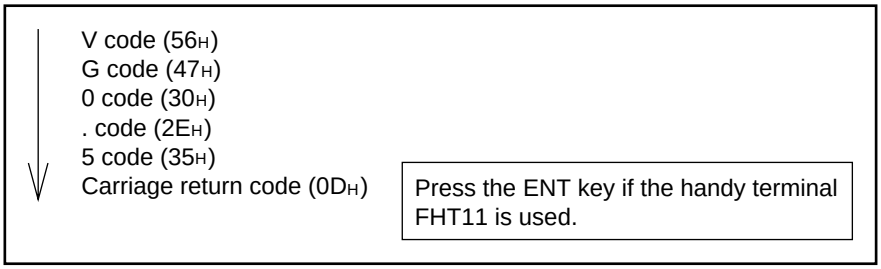
8.1.2. Command Entry

A communication command shall consist of “a command (character string) + data (if necessary) + carriage return code (0D$_H$).”

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 8-2

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.) If a carriage return code is input, the Driver Unit returns the “carriage return code (0D$_H$) + line feed code (0A$_H$).”

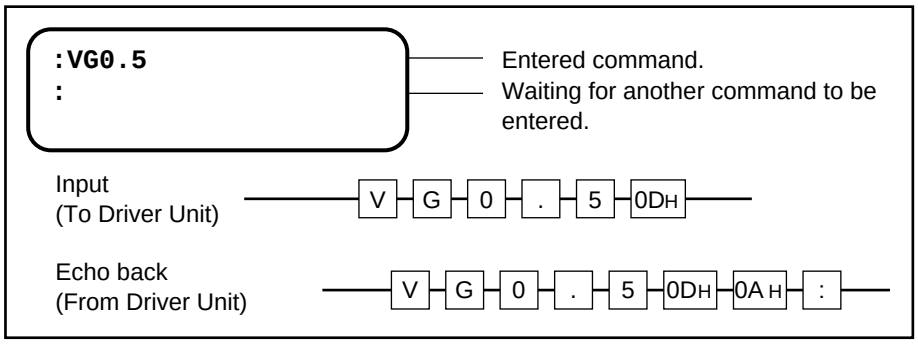
When a carriage return code is input, the Driver Unit decodes a character string which it has received (VG0.5 in the example above) and executes it. Therefore, a

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 a internal data read command, etc., it returns the data before ":". Entered command Waiting for another command to be entered.

Figure 8-3

Successful Input Example



8.1.3. Password

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

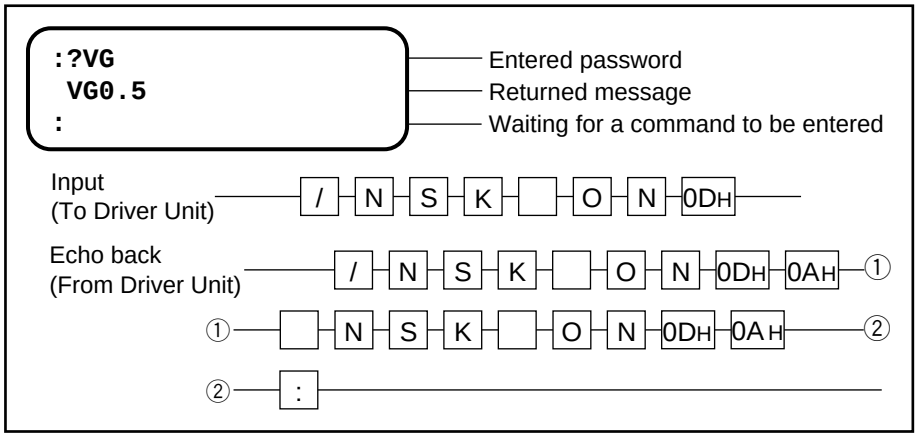
The password is /NSK ON (a space between K and O) as shown below. If the Driver Unit accepts it, it returns an "NSK ON" message.

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 8-4

Password Example

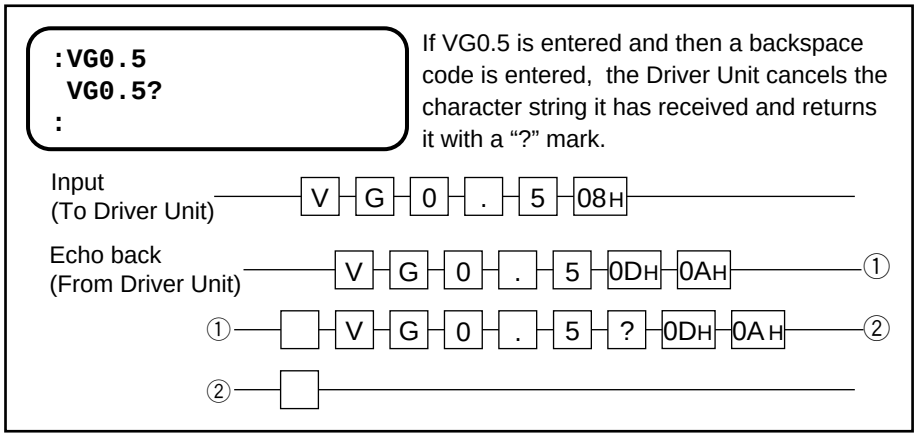


8.1.4. Canceling Command

To cancel a command which has been entered halfway, enter a backspace code (08H). (If the Handy Terminal FHT01 is used, press the BS key.)

Figure 8-5

Canceling Example



8.1.5. 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).

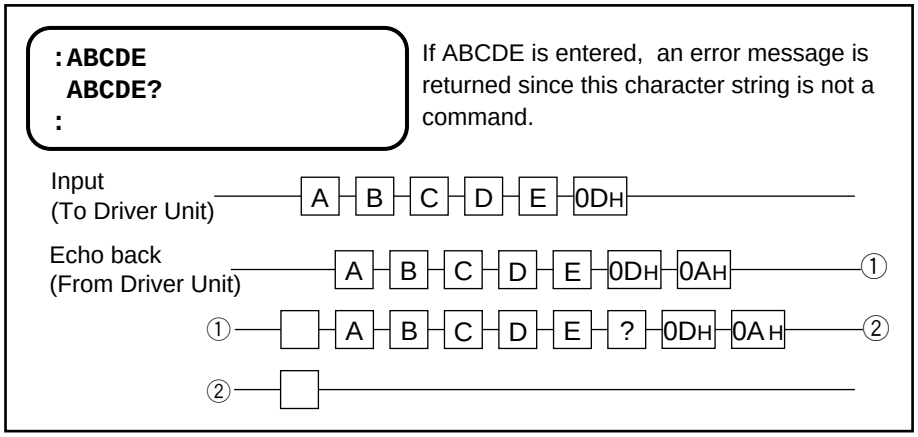
② If data or subscript out of the allowable range is entered.

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.

Figure 8-6

Input Error Example 1

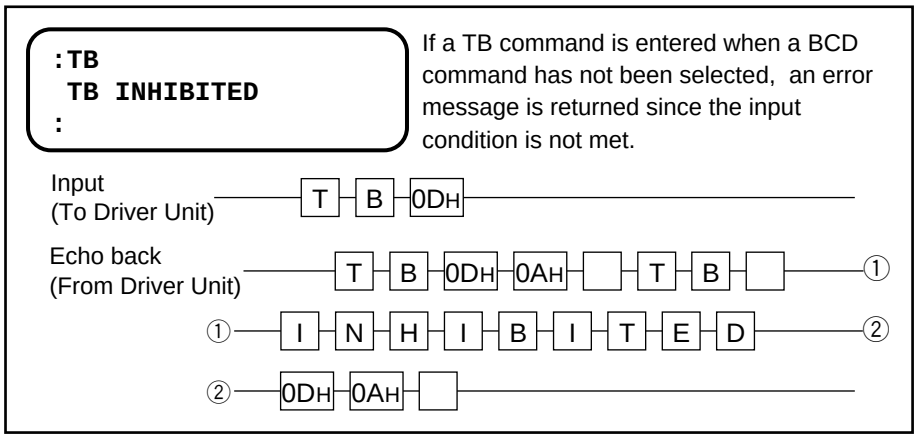


④ If the input condition is not met when entering a command.

In this case, the entered character string with "INHIBITED" is returned.

Figure 8-7

Input Error Example 2



8.1.6. Readout Command

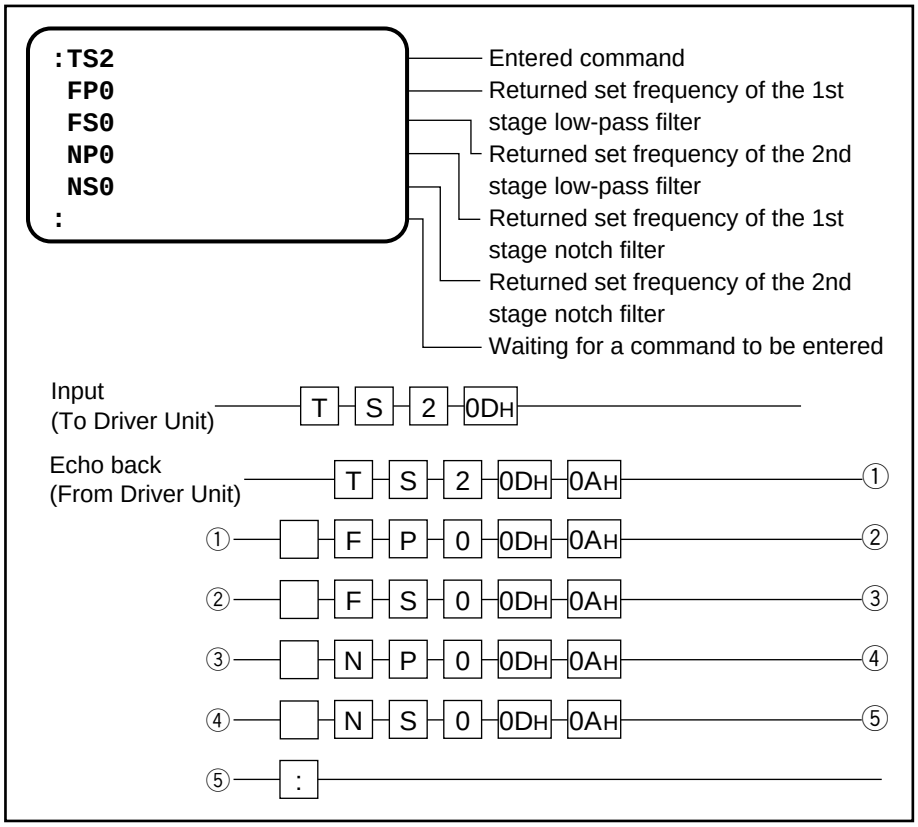
If a command for reading the internal state (i.e., parameter set values, current position, etc.) of the Driver Unit among the communication commands of this system is entered, the Driver Unit returns data, etc.

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

Example 1: TS command for reading set value

Figure 8-8

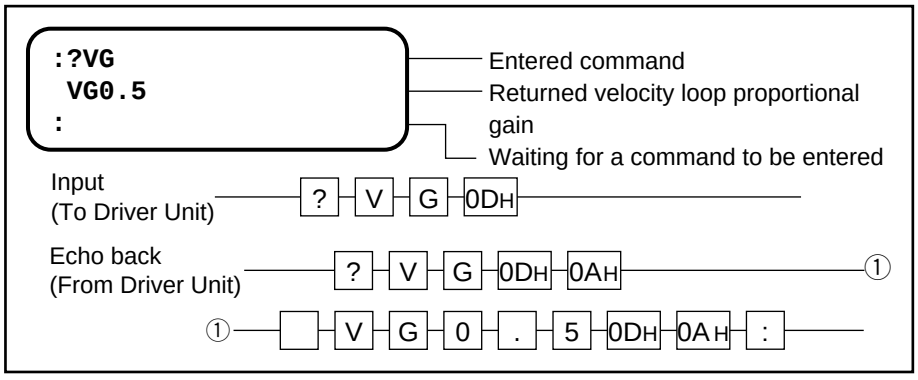
TS Command Example



Example 2: If set value reading function ? is used

Figure 8-9

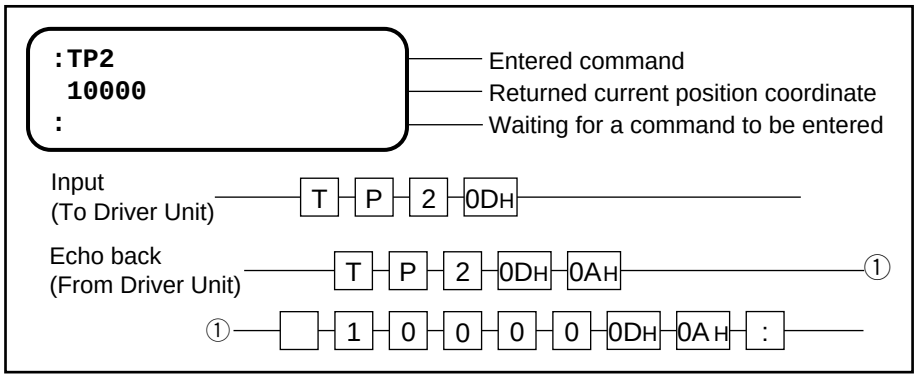
"?" Function Example



Example 3: TP command for reading current position data

Figure 8-10

TP Command Example



8.1.7. Communication Command List

The communication commands of the Driver Units are classified into the following:

Table 8-1

Functional Classification

1. Driver Unit function	7. Jog setting
2. Servo parameter	8. Alarm
3. Move command	9. Communication setting
4. Program editing	10. Velocity control
5. Position scale setting	11. Torque control
6. Home return setting	12. Commands for system with built-in absolute position sensor

They are also classified into the following according to their effect:

Table 8-2

Effect Classification

Classification (Abbreviation*)	Function
Parameter Setting (Parameter)	Data such as I/O conditions, operation parameters, etc. which are specified in advance
Driver Unit Status Adjustment Command (Driver Unit)	Commands for changing the Motor servo conditions
Program Setting (Program)	Used to write positioning programs such as Programmable Indexer, user program patterns.
Operation Command (Operation)	Commands for executing positioning directly
Readout Command (Readout)	Commands for reading the state of the Motor and Driver Units

Note * These abbreviation is used in following command lists.

The lists below shows the commands and their functions.

8.1.7.1. Driver Unit Function Command

Table 8-3

Driver Unit Function Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
CO	Position error counter over limit	✔				
LS	Over travel limit switch position	✔				
NW	Neglect width	✔				
IN	In-position	✔				
IS	In-position stability timer	✔				
FW	FIN width	✔				
CR	Circular resolution	✔				
IO	Input/output monitor					✔
CL	Clear alarm		✔			
MO	Motor off		✔			
SV	Servo on		✔			
MS	Motor stop				✔	
OG	Origin set			✔		
PA	Phase adjust		✔			
SI	Set initial parameters			✔		
MI	Read Motor ID					✔
OL	Overload limit	✔				
RC	Rated current	✔				
RP	RUN pre-input		✔			

8.1.7.2. Servo Parameter Command

Table 8-4

Servo Parameter Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
PG	Position gain	✔				
PI	Position integrator frequency	✔				
PM	Position mode		✔			
VG	Velocity gain	✔				
VI	Velocity integrator frequency	✔				
VM	Velocity integrator mode		✔			
FP	Low-pass filter, primary	✔				
FS	Low-pass filter, secondary	✔				
NP	Notch filter, primary	✔				
NS	Notch filter, secondary	✔				
DB	Dead band	✔				
FC	Friction compensation	✔				
FF	Feed forward gain	✔				
IL	Integration limit	✔				
LG	Lower gain	✔				
LR	Low torque ripple		✔			
TL	Torque limit rate	✔				
TS	Tell settings					✔
MM	Multi-line mode	✔				

8.1.7.3. Move Command

Table 8-5

Move Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
IR	Incremental positioning, resolver				✔	
ID	Incremental positioning, degree				✔	
AR	Absolute positioning, resolver				✔	
AD	Absolute positioning, degree				✔	
MA	Move acceleration	✔				
MV	Move velocity	✔				
HS	Home Return start				✔	
EC	End-of-command message		✔			
SP	Start program				✔	
TB	Tell BCD command					✔

8.1.7.4. Program Editing Command

Table 8-6

Program Editing Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
CH	Channel select			✔		
TC	Tell channel program					✔
CC	Clear Channel			✔		
IR	Incremental positioning, resolver			✔		
ID	Incremental positioning, degree			✔		
AR	Absolute positioning, resolver			✔		
AD	Absolute positioning, degree			✔		
CA	Channel acceleration			✔		
CV	Channel velocity			✔		
CZ	Channel Home searching velocity			✔		
HS	Home Return start			✔		
JP	Jump			✔		
OE	Sequence option edit			✔		

8.1.7.5. Position Scale Setting Command

Table 8-7

Position Scale Setting Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
TP	Tell position					✔
TE	Tell position error counter					✔
AP	Absolute position		✔			
IP	Incremental position set		✔			
AZ	Absolute zero position set		✔			
AO	Absolute position scale offset	✔				
TR	Tell RDC position data					✔

8.1.7.6. Home Return Setting Command

Table 8-8

Home Return Setting Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
OS	Home Return mode	✔				
HS	Home Return start				✔	
HA	Home Return acceleration	✔				
HV	Home Return velocity	✔				
HZ	Home Return near-zero velocity	✔				
HO	Home offset	✔				
HP	Home position	✔				
HC	Home Return cycle	✔				

8.1.7.7. Jog Setting Command

Table 8-9

Jog Setting Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
JA	Jog acceleration	✔				
JV	Jog velocity	✔				

8.1.7.8. Alarm Command

Table 8-10

Alarm Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
TA	Tell alarm status					✔

8.1.7.9. Communication Setting Command

Table 8-11

Communication Setting Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
BM	Backspace mode		✔			
AS	Ask daisy chain status					✔
AX	Axis select		✔			

8.1.7.10. Velocity Control Mode Command

Table 8-12

Velocity Control Mode Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
VC	Velocity control mode select		✔			
VM	Velocity integrator mode select		✔			
AC	Analog command		✔			
VR	Velocity range	✔				
ZA	Analog command zero adjust	✔				
DC	Digital RS-232C command				✔	

8.1.7.11. Torque Control Mode Command

Table 8-13

Torque Control Mode Command

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
TM	Torque control mode select		✔			
AC	Analog command		✔			
ZA	Analog command zero adjust	✔				
DC	Digital RS-232C command				✔	

8.1.7.12. Command for System With Built-In Absolute Position Sensor

Table 8-14

Command For System With Built-In Absolute Position Sensor

Name	Function	Parameter	Driver Unit	Program	Operation	Readout
LP	Incremental position judge	✔				
HI	Home in-position	✔				
HW	Home width	✔				

8.2. Detail of Command and Parameter

- "Shipping set" denotes a value which is set in the factory before shipment.
- "Default" denotes a value which is adopted by entering a command and parameter with no data.

AC Analog Command

Format:
AC

Description:
After executing the AC command, the Motor will be controlled by the analog command, in velocity or torque control mode. After executing the AC command, the analog command will be active until one of the following commands are executed.

(1) PM, VC, TM — If these control mode select commands are executed, then digital RS-232C command port will be automatically selected in the new control mode. The Motor will remain in the 'DC0' status.

(2) DC — The digital RS-232C command will be activated.

AD Absolute Positioning, Degree

Format:
AD data1 / data2

Data1:
0~35 999 [0.01˚]

Data1 Default:
0

Data2:
CW, CCW, EX, SD

Data2 Default:
CW

Description:
'data1' indicates the position of the destination. This position complies with user absolute position scale (which may be read out by issuing TP5).

'data2' indicates the rotational direction.
CW — clockwise direction
CCW — counterclockwise direction
EX — clockwise if DIR input is inactive, counterclockwise if active
SD — direction in which the move distance is shortest

If the current position is the same as the destination position and SD is specified in 'data2,' the Motor does not rotate. Otherwise, the Motor rotates 1 revolution in the direction specified in 'data2.'

This command has two functions, which depend on the usage. 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. If it is entered in the normal standby condition, it serves as a positioning command.

AO Absolute Position Scale Offset

Format:
AO data

Data:
See description.

Default:
0

Shipping Set:
0

Readout Command:
TS, ?AO

Note:
• Backed-up when power off

Description:
The 'data' range depends on the Motor size:
–614 399~+614 399 [count] — 06××, 08××, 10××, 14××
–409 599~+409 599 [count] — 04××
–491 519~+491 519 [count] — B×××

AO is used to specify a position scale (user absolute position scale) for absolute position control. 'data' represents an offset between user absolute position scale and Motor absolute position data in units of counts. Or, user absolute position scale = Motor absolute position data + AO value.

This value is created automatically when Home Return is completed or an AZ command is executed. Thus, it is not normally set using a communication command.

AP Absolute Position

Format:
AP data

Data:
See description.

Default:
0

Shipping Set:
0

Description:
The ‘data’ range depends on the Motor size:

0~149 — 06××, 08××, 10××, 14××

0~99 — 04××

0~119 — B×××

AP is used to specify a value of the Z phase counter. If this command is entered when the Motor is stopped at any position, the Motor absolute position perimeter data at that point is specified as:

(‘data’ × 4096) + (position sensor data)

Since the position scale may be specified with AO optionally, this value is not normally set using a communication command.

AR Absolute Positioning, Resolver

Format:
AR data1 / data2

Data1:
See description.

Data1 Default:
0

Data2:
CW, CCW, EX, SD

Data2 Default:
CW

Description:

The ‘data1’ range depends on the Motor size:

0~614 399 [count] — 06××, 08××, 10××, 14××

0~409 599 [count] — 04××

0~491 519 [count] — B×××

‘data1’ indicates the position of the destination. This position complies with user absolute position scale (which may be read out by issuing TP5).

‘data2’ indicates the rotational direction.

CW — clockwise direction

CCW — counterclockwise direction

EX — clockwise if DIR input is inactive, counterclockwise if active

SD — direction in which the move distance is shortest

If the current position is the same as the destination position and SD is specified in ‘data2,’ the Motor does not rotate. Otherwise, the Motor rotates by 1 revolution in the direction specified in ‘data2.’

This command has two functions, which depend on the usage. 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 internal channel. If it is entered in the normal standby condition, it serves as a positioning command.

AS Ask Daisy Chain Status

Format:
AS data

Data:
0 or 1

Default:
0

Description:
When communicating in daisy-chain style, AS reads out the preset number of connected Driver Units and the status of each axis.

AS0 — Reads the connection status.

AS1 — Reads the number of connected units.

The AS0 command is executed automatically when power is turned on in the multi-axial communication mode. After the AS0 command is executed, the Driver Unit of axis 0 is always selected.

• AS0

```
•AS0
 0 OK   AX0
 1 OK   AX1
 2 ERR. AX3
#3 OK   AX3
•
```

The connection positions of Driver Units 0, 1 and 3 correspond to the axis numbers. Thus, they are acceptable (OK.) Driver Unit 2 has axis number 3 though it is connected to position 2. Thus, it is non-conformable (ERR.) The # mark of "#3" indicates that axis 3 is the final axis.

• AS1

```
•AS1
 3
•
```

Three Driver Units are connected.

AX Axis Select

Format:
AX data

Data:
0~15

Default:
0

Shipping Set:
0

Readout Command:
TS, ?AX

Description:
When communicating in daisy-chain style, AX selects the active axis in daisy chain communication. Selected Driver Unit sends the message "ACC. AX*n* " (where *n* is the selected axis number) to the terminal. The Driver Unit of axis 0 is always selected when power is turned on.

If AX or ?AX is input when daisy-chain communication is not active, an error message will be given back. Also, TS report does not include the AX setting when daisy-chain communication is not active.

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 select the number of a connected Driver Unit.

AZ Absolute Zero Position Set

Format:
AZ

Description:
If the AZ command is executed with the Motor stationary at any position, the position is adopted as user absolute home position. The AZ command may be accepted when the Motor is stationary (i.e., velocity is 0rps). If it is entered when the Motor is not stationary, an “AZ INHIBITED” message is output. If an AZ command is executed, AO data is updated. In other words, this command has the same function as setting user absolute position scale using the AO command.

BM Backspace Mode

Format:
BM data

Data:
0 or 1

Default:
0

Shipping Set:
0

Readout Command:
?BM

Note:
- Backed-up when power off
- Initialized by SI command

Description:
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.

CA Channel Acceleration

Format:
CA data1 , data2

Data1:
See description.

Data1 Default:
0

Data2:
See description.

Data2 Default:
0

Description:
'data1' and 'data2' have the same data range and the range depends on the Motor size:

0.010~40.000 [rps/s] or 0 — 06××, 08××, 10××, 14××
0.015~60.000 [rps/s] or 0 — 04××
0.010~50.000 [rps/s] or 0 — B×××
Note: (data1) ≥ (data2)

This command is used to specify the rotational acceleration of a given channel of the Programmable Indexer.

If 'data2' is omitted, a trapezoidal drive waveform pattern is selected. Specify the average acceleration in 'data1.'

If 'data2' is specified, a simplified sine wave drive pattern is selected. Specify the initial acceleration in 'data2.'

If no setting is made in a channel (or 0 is specified), the rotational acceleration specified with an MA command is valid.

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.

CC Clear Channel

Format:
CC data

Data:
0~63

Default:
0

Description:
CC deletes the program data of a channel specified in 'data.'

CH Channel Select

Format:
CH data

Data:
0~63

Default:
0

Description:
The Megatorque Motor has position control function, which executes positioning commands stored in the channels if external signals are input. A CH command is used to declare a channel when inputting a positioning command. If a CH command is input, a channel specified in 'data' is selected.

CL Clear Alarm

Format:
CL

Description:
CL clears a excess position error alarm. It has the same function as activation of the CLR input of CN2.

CO Position Error Counter Over Limit

Format:
CO data1 / data2

Data1:
1~99 999 999 [count] or 0

Data1 Default:
0

Data1 Shipping Set:
2048

Data2:
AL or none

Data2 Default:
none

Data2 Shipping Set:
none

Readout Command:
TS, ?CO

Note:
- Backed-up when power off
- Initialized by SI command

Description:
CO is used to specify a criterion of excess position error detection and detection method.

If 'data2' is omitted, an alarm is regarded as a serious alarm. If the position error counter reads a value over this value, the OVER output closes. If it reads a value below this value, OVER opens. (This is a warning output.) If the position error counter reads a value 8 times as high as this value, a "serious alarm" occurs, the DRDY output opens, and the Motor servo is locked. This state is maintained until the alarm is reset by CLR input or CL command.

If AL is specified in 'data2,' an alarm is regarded as a non-serious alarm. If the position error counter reads a value 8 times as high as this value, the OVER output opens, and the Motor servo is locked. The status of the DRDY output does not change. (It remains closed.) This state is maintained until the alarm is reset by CLR input or CL command.

If 0 is specified in 'data1,' the position error over detection function is invalidated. (It does not function.)

CR Circular Resolution

Format:
CR data

Data:
X1, X2, X4, 36 000, 3600

Default:
Not omissible

Shipping Set:
X1

Readout Command:
TS, ?CR

Note:
- Backed-up when power off
- Initialized by SI command

Description:
CR is used to specify the pulse train resolution.

The resolution changes immediately after it is specified.

CV Channel Velocity

Format:
CV data1 , data2

Data1:
See description.

Data1 Default:
0

Data2:
See description.

Data2 Default:
0

Description:
'data1' and 'data2' have the same data range and the range depends on the Motor size:

0.0030~3.0000 [rps] or 0 — 06××, 08××, 10××, 14××

0.0045~4.5000 [rps] or 0 — 04××

0.0038~3.7500 [rps] or 0 — B×××

Note: (data1) ≥ (data2)

This command is used to specify the rotational velocity of each channel of the internal program.

If 'data2' is omitted, a trapezoidal drive waveform pattern is selected. Specify the maximum velocity in 'data1.'

If 'data2' is specified, a trapezoidal drive pattern with an offset is selected. Specify the initial velocity in 'data2.'

If no setting is made in a channel (or 0 is specified), the rotational velocity specified with an MV command is valid.

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.

CZ Channel Home Return Near-Zero Velocity

Format:
CZ data

Data:
0.005~1.000 [rps] or 0

Default:
0

Description:
CZ is used to specify the near-zero velocity if a Home Return function (HS) is specified in a channel of the Programmable Indexer.

If no setting is done in a channel (or 0 is specified), the rotational acceleration specified with an HV command is valid.

The CZ 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.

DB Dead Band

Format:
DB data1 / data2

Data1:
–4095~+4095

Data1 Default:
0

Data1 Shipping Set:
0

Data2:
PL, VL

Data2 Default:
Not omissible

Readout Command:
TS

Note:
- Password required
- Backed-up when power off

Description:
DB is used to specify a dead band for the position error (output from the position error counter) or velocity error.

DB data1 /PL — dead band setting for the position error
DB data1 /VL — dead band setting for the velocity error

If 0 is specified in 'data1,' the dead band circuit is deactivated.

Values of 'data1' shall be specified in units of the following:

DB data1 /PL — in units of counts
DB data1 /VL — in units of 1/1365rps (4095 = velocity error of 3rps)

The function depends on the sign of a 'data1' value as shown below:

If 'data1' is positive → dead band setting for error
If 'data1' is negative → offset setting for error

DC Digital RS-232C Command

Format:
DC data

Data:
–4095~+4095

Default:
0

Description:
Selects RS-232C port as the source of the command variable, to be used for command purposes in either velocity or torque modes.

'data' is the command itself, where
Velocity control mode → ±4095 = maximum velocity
Torque control mode → ±4095 = maximum torque

The sign of 'data' specifies the direction of rotation.
data > 0 — clockwise
data < 0 — counterclockwise

The out-of-range data will be accepted and treated as ±4095.

Caution
Take great care when inputting DC command in the position control mode. The Motor will rotate through the amount of counts specified by DC command data immediately using the maximum acceleration and velocity, resulting in an excess position error alarm most of the time.

EC End-Of-Command Message

Format:
EC data

Data:
0 or 1

Default:
0

Shipping Set:
0

Readout Command:
TS, ?EC

Note:
- Backed-up when power off
- Initialized by SI command

Description:
EC is used to specify whether or not to use a message which indicates that the Driver Unit is ready to accept another operation command in process of positioning.
EC0 — Message is not output.
EC1 — Message is output.

If outputting a message is selected, a message "!" is output.

Note the following points if the message is to be output:
(1) In the period from the beginning of positioning to message output, another positioning command cannot be input through communication. If the user tries to input a command, an error message "×× INHIBITED" is displayed.
(2) Do not input any other command or parameter in the period from the beginning of positioning to message output. If a command or parameter is input at the timing when the message is output, the command is executed before outputting the message.

FC Friction Compensation

Format:
FC data

Data:
0~2048

Default:
0

Shipping Set:
0

Readout Command:
TS, ?FC

Note:
- Password required
- Backed-up when power off

Description:
FC is used to specify a compensation value for eliminating rotational friction of the Motor due to Coulomb's friction.

If 0 is specified in 'data,' the compensation circuit is deactivated.

If a value between 1 and 2048 is specified in 'data,' the Motor torque is offset by the set value in the direction specified in a rotational velocity command. If 2048 is specified in data, the maximum torque is generated.

FF Feed Forward Gain

Format:
FF data

Data:
0.01~1.0 or 0

Default:
0

Shipping Set:
0

Readout Command:
TS, ?FF

Note:
- Password required
- Backed-up when power off

Description:
FF is used to specify a feed forward control gain for improving dynamic positioning response.

If 0 is specified in 'data,' the feed forward control circuit is deactivated.

If a value between 0.01 and 1.00 is specified in 'data,' a position command is differentiated, the gain is multiplied by the result of differentiation, and the product is added to the velocity command.

FP Low-Pass Filter, Primary

Format:
FP data

Data:
10~500 [Hz] or 0

Default:
0

Shipping Set:
0

Readout Command:
TS, ?FP

Note:
- Backed-up when power off
- Initialized by SI command

Description:
FP is used to specify the frequency of the 1st stage low-pass filter of the velocity loop.

If 0 is specified, the 1st stage low-pass filter of the velocity loop is deactivated. In such a case, “PRI.LPF OFF” is displayed.

If a value other than 0 (i.e., 10~500) is entered, the value is adopted as the frequency. In this case, the entered filter frequency may be fine-adjusted with the + or – keys immediately after the command is entered.

FS Low-Pass Filter, Secondary

Format:
FS data

Data:
10~500 [Hz] or 0

Default:
0

Shipping Set:
0

Readout Command:
TS, ?FS

Note:
- Backed-up when power off
- Initialized by SI command

Description:
FS is used to specify the frequency of the 2nd stage low-pass filter of the velocity loop.

If 0 is specified, the 2nd stage low-pass filter of the velocity loop is deactivated. In such a case, “SEC.LPF OFF” is displayed.

If a value other than 0 (i.e., 10~500) is entered, the value is adopted as the frequency. In this case, the entered filter frequency may be fine-adjusted with the + or - keys immediately after the command is entered.

FW FIN Width

Format:
FW data

Data:
0.3~100 [0.1s] or 0

Default:
0

Shipping Set:
0

Readout Command:
?FW

Note:
- Backed-up when power off
- Initialized by SI command

Description:
FW is used to specify the format of outputting an IPOS signal.

If 'data' is 0, the IPOS output closes while the value of the deviation counter is within the range specified in an IN command on completion of positioning.

If 'data' is not 0, the IPOS output is always open while stationary. It closes instantaneously (like a one-shot pulse) the moment when the value of the error counter enters the range specified in an IN command on completion of positioning (Programmable Indexer operation, RS-232C communication operation, BCD operation or Home Return.) After a one-shot output, the IPOS output remains open free from change even if pulses collected in the error counter change. Specify the width of one-shot output in 'data' in units of 0.1 seconds. 0.03 to 10 seconds may be specified by specifying 0.3 to 100 in 'data.'

HA Home Return Acceleration

Format:
HA data

Data:
See description.

Default:
Not omissible

Shipping Set:
1

Readout Command:
TS, ?HA

Note:
- Backed-up when power off
- Initialized by SI command

Description:
'data' depends on the Motor size.

0.010 ~ 40.000 [rps/s] — 06××, 08××, 10××, 14××

0.015 ~ 60.000 [rps/s] — 04××

0.010 ~ 50.000 [rps/s] — B×××

Sets the Home Return acceleration.

HC Home Return Cycle

Format:
HC data

Data:
0 or 1

Default:
0

Shipping Set:
0

Readout Command:
?HC

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Sets the use of ‘rotation limit sensor’ function in Home Return.

HC0 — off

HC1 — on

HI Home In-Position Limit

Format:
HI data

Data:
0~4095 [count]

Default:
0

Shipping Set:
0

Readout Command:
?HI

Note:
- Backed-up when power off
- Initialized by SI command

Description:
HI is only valid for systems with a built-in absolute position sensor.

Specify the range of the home position (i.e., the range where the HOME output signal closes) if “home position output” is specified in the HW parameter.

HO Home Offset

Format:
HO data

Data:
See description.

Default:
0

Shipping Set:
0

Readout Command:
TS, ?HO

Note:
- Backed-up when power off
- Initialized by SI command

Description:
The 'data' range depends on the Motor size.

0~610 305 [count] — 06××, 08××, 10××, 14××

0~405 505 [count] — 04××

0~487 425 [count] — B×××

Specify an offset from the point where the position detector data 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 if Home Return is done in mode 3.

HP Home Position

Format:
HP data

Data:
–99 999 999~+99 999 999 [count]

Default:
0

Shipping Set:
0

Readout Command:
TS, ?HP

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Specify a relative position data of the point at which Home Return is completed.

HS Home Return Start

Format:
HS data

Data:
–3~+3

Default:
0

Description:
HS is used to select the Home Return mode and rotational direction and to start Home Return.

HS0 — Same as starting by using the HOS input.
HS0 — The Home Return mode will be specified with the OS parameter.
HS0 — The rotational direction will be specified with DIR input status.
HS1 — clockwise rotation in Home Return mode 1
HS-1 — counterclockwise rotation in Home Return mode 1
HS2 — clockwise rotation in Home Return mode 2
HS-2 — counterclockwise rotation in Home Return mode 2
HS3 — clockwise rotation in Home Return mode 3
HS-3 — counterclockwise rotation in Home Return mode 3

This command may also be used in the Programmable Indexer.

HV Home Return Velocity

Format:
HV data

Data:
See description.

Default:
Not omissible

Shipping Set:
0.2

Readout Command:
TS, ?HV

Note:
- Backed-up when power off
- Initialized by SI command

Description:
The 'data' range depends on the Motor size.

0.0030~3.0000 [rps] — 06××, 08××, 10××, 14××
0.0045~4.5000 [rps] — 04××
0.0038~3.7500 [rps] — B×××

Sets the Home Return velocity.

HW Home Width

Format:
HW data

Data:
0.3~100 [0.1s] or 0

Default:
0

Shipping Set:
0

Readout Command:
?HW

Note:
- Backed-up when power off
- Initialized by SI command

Description:
HW is only valid for a system with a built-in absolute position sensor.

Specify the format of outputting the HOME output.

If 'data' is 0, "Home Return complete output" is selected. HOME closes on completion of Home Return. It opens if the Motor moves away from the home position.

If 'data' is not 0, "home position output" is selected. HOME closes if the Motor is at a position within the range specified in the HI parameter around user absolute home position. It opens if the Motor gets out of that range. If the time when the Motor stays in the range is less than the value specified in data, HOME remains closed for the time specified in data at least. 0.03 to 10 seconds may be specified in 'data.'

HZ Home Return Near-Zero Velocity

Format:
HZ data

Data:
0.005~1.000 [rps]

Default:
Not omissible

Shipping Set:
0.01

Readout Command:
TS, ?HZ

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Sets the Home Return near-zero velocity.

ID Incremental Positioning, Degree

Format:
ID data1 / data2 /EX

Data1:
–144 000~+144 000 [0.01˚]

Data1 Default:
0

Data2:
1~99

Data2 Default:
1

Description:
'data1' specifies the rotational amount from the current position in unit of 0.01˚.

The rotational direction depends on the sign of 'data1' or the setting of the DIR input.

/EX omitted, data1 > 0 — clockwise rotation

/EX omitted, data1 < 0 — counterclockwise rotation

/EX specified, data1 > 0

— clockwise if DIR input is inactive, counterclockwise if active.

(An input error occurs if the /EX is specified and data1 < 0.)

Specify the number of divisions in 'data2.' The value of 'data1' is divided by the value of 'data2,' if 'data2' is specified. For example, if the RUN input is activated to execute a channel programmed as ID10000/5, the Motor rotates 20.00°. It rotates 20° if RUN is activated next time. Like this, if RUN is activated five times, the Motor rotates five times by 20.00°, amounting to 100.00° in all.

This command has two functions, depending on its usage. 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 internal channel. If it is entered in the normal standby condition, it serves as a positioning command.

IL Integration Limit

Format:
IL data1 / data2

Data1:
0~100 [%]

Data1 Default:
0

Data1 Shipping Set:
100

Data2:
PL, VL

Data2 Default:
Not omissible

Readout Command:
TS, ?IL

Note:
- Password required
- Backed-up when power off

Description:

IL provides the position or velocity loop integration output with a limiter.

IL data1 /PL — Provides the position loop integration with a limiter.

IL data1 /VL — Provides the velocity loop integration with a limiter.

A value of 'data1' shall be specified in percent. 100% denotes the following:

Position loop — a velocity command corresponding to 3rps integration output

Velocity loop — a maximum torque command of integration output

To validate the integration limiter, specify as follows:

Position loop — PM3

Velocity loop — VM3

IN In-Position Limit

Format:
IN data

Data:
0~99 999 999 [count]

Default:
0

Shipping Set:
1

Readout Command:
TS, ?IN

Note:
- Backed-up when power off
- Initialized by SI command

Description:

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 output opens.

IO Input/Output Monitor

Format:
IO data /RP

Data:
0~8

Default:
0

Description:
Verifies on/off status of the control input and output signals on CN2. Specify the signal status to be read out in 'data.'

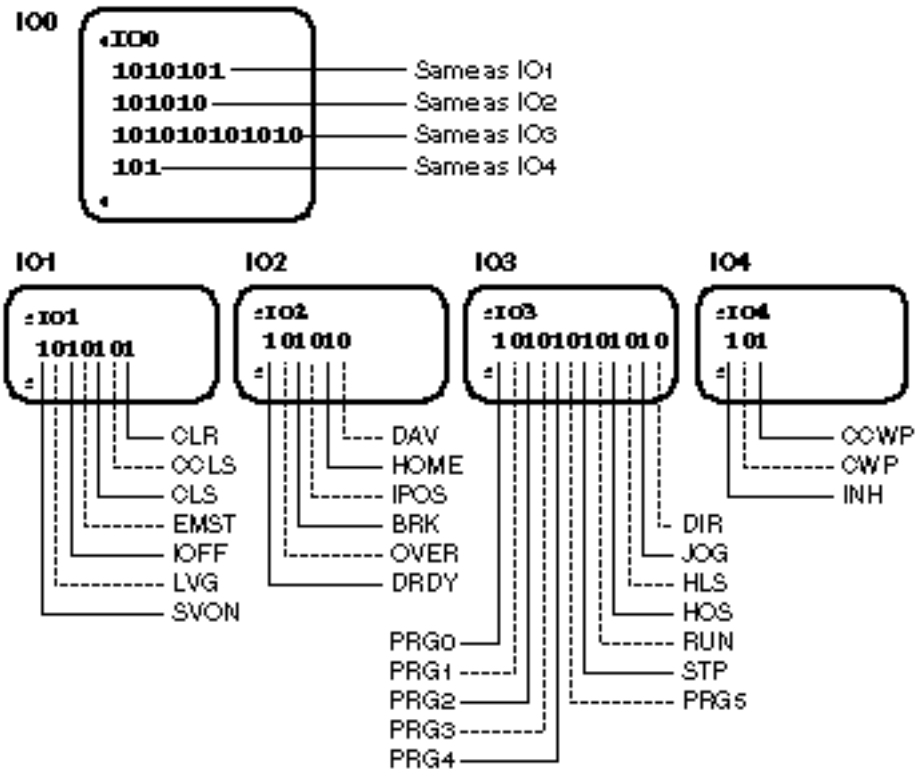
If any of the IO1 to IO4 commands is executed with an /RP option, reading is repeated automatically. Or, the Driver Unit outputs read values repeatedly. To terminate automatic reading, press the BS key. The /RP option may not be used for the IO0 command.

If an IO command is executed, the status of the inputs and outputs is indicated as 1's and 0's. 1 and 0 mean the following:

Input — 0: OFF, 1: ON

Output — 0: close, 1: open

The following shows inputs and outputs for each command.



IP Incremental Position Set

Format:
IP data

Data:
–99 999 999~+99 999 999

Default:
0

Description:
Sets the built-in relative position counter.

IR Incremental Positioning, Resolver

Format:
IR data1 / data2 /EX

Data1:
–99 999 999~+99 999 999 [count]

Data1 Default:
0

Data2:
1~99

Data2 Default:
1

Description:
'data1' specifies the rotational amount from the current position in unit of counts.

The rotational direction depends on the sign of 'data1' or the setting of the DIR input.

/EX omitted, data1 > 0 — clockwise rotation
/EX omitted, data1 < 0 — counterclockwise rotation
/EX specified, data1 > 0
— clockwise if DIR input is inactive, counterclockwise if active.
(An input error occurs if the /EX is specified and data1 < 0.)

Specify the number of divisions in 'data2.' The value of 'data1' is divided by the value of 'data2,' if 'data2' is specified. For example, if the RUN input is activated to execute a channel programmed as ID10000/5, the Motor rotates 2000 counts. It rotates 2000 counts if RUN is activated next time. Like this, if RUN is activated five times, the Motor rotates five times by 2000 counts, amounting to 10000 counts in all.

This command has two functions, depending on its usage. 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 internal channel. If it is entered in the normal standby condition, it serves as a positioning command.

IS In-Position Stability Timer

Format:
IS data

Data:
0.3~100 [0.1s] or 0

Default:
0

Shipping Set:
0

Readout Command:
?IS

Note:
• Backed-up when power off

Description:
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.

JA Jog Acceleration

Format:
JA data

Data:
See description.

Default:
Not omissible

Shipping Set:
1

Readout Command:
TS, ?JA

Note:
• Backed-up when power off
• Initialized by SI command

Description:
The 'data' range depends on the Motor size.

0.010 ~ 40.000 [rps/s] — 06××, 08××, 10××, 14××
0.015 ~ 60.000 [rps/s] — 04××
0.010 ~ 50.000 [rps/s] — B×××

Sets the acceleration for jog operation.

JP Jump

Format:
JP data

Data:
0~63

Default:
0

Description:
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.

JV Jog Velocity

Format:
JV data

Data:
See description.

Default:
Not omissible

Shipping Set:
1

Readout Command:
TS, ?JV

Note:
- Backed-up when power off
- Initialized by SI command

Description:
The 'data' range depends on the Motor size.

0.0030~3.0000 [rps] — 06××, 08××, 10××, 14××

0.0045~4.5000 [rps] — 04××

0.0380~3.7500 [rps] — B×××

Sets the velocity for jog operation.

LG Lower Gain

Format:
LG data

Data:
1~100 [%]

Default:
Not omissible

Shipping Set:
50

Readout Command:
TS, ?LG

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Specify the rate of reducing the velocity gain if the velocity gain reduction input LVG goes active.

LP Incremental Position Judge

Format:
LP data

Data:
See description.

Default:
0

Shipping Set:
0

Readout Command:
?LP

Note:
- Backed-up when power off
- Initialized by SI command

Description:
LP is effective only for a system with a built-in absolute position sensor.

The 'data' range depends on the Motor size.

0~614 399 [count] — 06××, 08××, 10××, 14××

0~409 599 [count] — 04××

0~491 519 [count] — B×××

It serves as a criterion for judging whether to specify the relative position, positive or negative, when power is turned on.

If 'data' = 0, the positive relative position is set.

If 'data' ≠ 0, positive position is set if the position data when power is turned on is greater than or equal to 'data.' Negative position is set if the position data when power is turned on is less than 'data.' (Specifies a value by subtracting the Motor resolution from the position data when power is turned on.)

LR Low Torque Ripple

Format:
LR data

Data:
0 or 1

Default:
0

Shipping Set:
0

Readout Command:
TS, ?LR

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Sets torque specification.

LR0 — standard

LR1 — low torque ripple

LS Over Travel Limit Switch Position

Format:
LS data

Data:
–99 999 999~+99 999 999 [count]

Default:
0

Shipping Set:
0

Readout Command:
?LS

Note:
- Backed-up when power off
- Initialized by SI command

Description:

LS is used to specify a software over travel limit using the internal relative position counter. Data indicates the rotational direction and limit position (in the internal relative position counter).

If the Motor reaches the position specified in a positive limit, all future clockwise rotation commands are ignored. In other words, the Motor may rotate counterclockwise only. If the Motor reaches the position specified in a negative limit, all future counterclockwise rotation commands are ignored. In other words, the Motor may rotate clockwise only.

If data 0 is specified, both the positive and negative over travel limits are canceled.

The LS command is invalid unless both positive data and negative data are specified. It is also invalid if the Motor hasn't returned to the home position. If the Motor is at a position out of the limits specified in LS, a software rotation limit over alarm occurs.

MA Move Acceleration

Format:
MA data1 , data2

Data1:
See description.

Data1 Default:
Not omissible

Data1 Shipping Set:
1

Data2:
See description.

Data2 Default:
0

Data2 Shipping Set:
0

Readout Command:
TS, ?MA

Note:
- Backed-up when power off
- Initialized by SI command

Description:

'data1' and 'data2' have same data range and the range depends on the Motor size:

0.010~40.000 [rps/s] (or 0) — 06××, 08××, 10××, 14××

0.015~60.000 [rps/s] (or 0) — 04××

0.010~50.000 [rps/s] (or 0) — B×××

Note: (data1) ≥ (data2), "0" is available only for 'data2.'

This command is used to specify the rotational acceleration in positioning control operation.

If 'data2' is omitted, a trapezoidal drive waveform pattern is selected. Specify the average acceleration in 'data1.'

If 'data2' is specified, a simplified sine wave drive pattern is selected. Specify the initial acceleration in 'data2.'

The rotational acceleration specified in this command is valid in the following cases:

- A BCD command is used for position control operation.
- Position control operation is executed according to a command in an Programmable Indexer channel in which CA0 is specified for the rotational acceleration.
- Position control operation is executed directly with a communication command.

MI Read Motor ID

Format:
MI

Description:

MI indicates the version of the Driver Unit software.

MM Multi-line Mode

Format:
MM data

Data:
0 or 1

Default:
0

Shipping Set:
0

Readout Command:
TS, ?MM

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Defines the reporting format used by the TC and TS commands.

MM0 — Reports all parameters continuously.

MM1 — Reports all parameters pausing at each parameter.

To step to the next parameter, input a space. To quit from the report, input a backspace.

MO Motor Off

Format:
MO

Description:
As soon as the MO command is input, the Motor servo turns off. To activate the Motor servo, input the SV command.

MS Motor Stop

Format:
MS

Description:
Makes Motor servo-lock. If executed in torque control mode, the control mode will automatically switch to velocity control mode to make Motor servo-lock.

MV Move Velocity

Format:
MV data1 , data2

Data1:
See description.

Data1 Default:
Not omissible

Data1 Shipping Set:
1

Data2:
See description.

Data2 Default:
0

Data2 Shipping Set:
0

Readout Command:
TS, ?MV

Note:
- Backed-up when power off
- Initialized by SI command

Description:
'data1' and 'data2' have same data range and the range depends on the Motor size:

0.0030~3.0000 [rps] (or 0) — 06××, 08××, 10××, 14××
0.0045~4.5000 [rps] (or 0) — 04××
0.0038~3.7500 [rps] (or 0) — B×××
Note: (data1) ≥ (data2), "0" is available only for 'data2.'

This command is used to specify the rotational velocity in positioning control operation.

If 'data2' is omitted, a trapezoidal drive waveform pattern is selected. Specify the maximum velocity in 'data1.'

If 'data2' is specified, a trapezoidal drive pattern with an offset is selected. Specify the initial velocity in 'data2.'

The rotational velocity specified in this command is valid in the following cases:
- A BCD command is used for position control operation.
- Position control operation is executed according to a command in an Programmable Indexer channel in which CV0 is specified for the rotational velocity.
- Position control operation is executed directly with a communication command.

NP Notch Filter, Primary

Format:
NP data

Data:
10~500 [Hz] or 0

Default:
0

Shipping Set:
0

Readout Command:
TS, ?NP

Note:
- Backed-up when power off
- Initialized by SI command

Description:
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. In this case, the entered filter frequency may be fine-adjusted with the + or – keys immediately after the command is entered.

NS Notch Filter, Secondary

Format:
NS data

Data:
10~500 [Hz] or 0

Default:
0

Shipping Set:
0

Readout Command:
TS, ?NS

Note:
- Backed-up when power off
- Initialized by SI command

Description:
NS is used to specify the frequency of the 2nd stage notch filter of the velocity loop.

If 0 is specified, the 2nd stage notch filter of the velocity loop is deactivated. In such a case, "SEC.NF OFF" is displayed.

If a value other than 0 (i.e., 10~500) is entered, the value is adopted as the frequency. In this case, the entered filter frequency may be fine-adjusted with the + or – keys immediately after the command is entered.

NW Neglect Width

Format:
NW data

Data:
0~4

Default:
0

Shipping Set:
0

Readout Command:
?NW

Note:
- Backed-up when power off
- Initialized by SI command

Description:
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.

Timer = 'data' × 2.8 [ms]

OE Sequence Option Edit

Format:
OE data

Data:
*, &, %, $

Default:
Not omissible

Description:
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.

OG Origin

Format:
OG

Note:
• Password required

Description:

Caution

Do not input the OG command. System calibration may be degraded if the OG command is used. The OG command is for NSK factory use only.

OL Overload Limit

Format:
OL data

Data:
0~100 [%]

Default:
0

Shipping Set:
Unique value for each System

Readout Command:
?OL

Note:
• Password required
• Backed-up when power off
• Initialized by SI command

Description:

Caution

Do not change the OL setting. OL is set properly for each System. If it needs to be set again, contact NSK.

If 0 is specified, “THERMAL OFF” is displayed and this function is deactivated.

OS Origin Setting Mode

Format:
OS data

Data:
1~3

Default:
Not omissible

Shipping Set:
1

Readout Command:
TS

Note:
• Backed-up when power off
• Initialized by SI command

Description:

Specify the mode of Home Return. A mode is selected according to the value of OS when Home Return is activated by a HOS input signal or HS0 command as shown below:

OS1 — mode 1
OS2 — mode 2
OS3 — mode 3

PA Phase Adjust

Format:
PA data

Data:
24~1048

Default:
Not omissible

Shipping Set:
Unique value for each System

Readout Command:
TS, ?PA

Note:
- Password required
- Backed-up when power off

Description:

Caution

Do not set PA before consulting NSK first. System calibration may be degraded if PA is set.

Important

Read the PA parameter value and record the value in a safe place. If the PA data is inadvertently altered, the original value can be re-inputted. Every system has its own unique PA parameter.

PG Position Gain

Format:
PG data

Data:
0.001~31.000

Default:
Not omissible

Shipping Set:
0.1

Readout Command:
TS, ?PG

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Specifies a position gain.

Immediately after PG is entered, the position gain may be fine-tuned with the + or – key.

PI Position Integrator Frequency

Format:
PI data

Data:
0.1~127.0

Default:
Not omissible

Shipping Set:
1

Readout Command:
TS, ?PG

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Specifies position integrator frequency.

Immediately after PI is entered, the position integrator frequency may be fine-tuned with the + or – key.

PM Position Mode

Format:
PM data

Data:
0~3

Default:
0

Shipping Set:
0

Note:
- Backed-up when power off
- Initialized by SI command

Description:
PM changes the position loop control mode (P or PI control) as shown below:

PM0 — position control mode, position loop P control

PM1
— position control mode, position loop PI control, integration limiter inactive

PM3
— position control mode, position loop PI control, integration limiter active

(Use VM command to change the velocity loop control mode, P or PI control.)

If PM command is input in velocity or torque control mode, the System will be in the position control mode.

RC Rated Current

Format:
RC data

Data:
0~100 [%]

Default:
0

Shipping Set:
Unique value for each System

Readout Command:
?RC

Note:
- Password required
- Backed-up when power off
- Initialized by SI command

Description:

Caution

Do not change the RC setting. RC is set properly for each System. If it needs to be set again, contact NSK.

RP RUN Pre-input

Format:
RP data

Data:
0 or 1

Default:
0

Shipping Set:
0

Readout Command:
TS, ?RP

Note:
- Backed-up when power off
- Initialized by SI command

Description:

Selects whether the RUN input can be used while a move is being executed.

RP0 — ignored

RP1 — accepted

SI Set Initial Parameters

Format:
SI

Description:
Sets parameters to the shipping set value, and clears all Programmable Indexer's channel programs.

Note:
• Password required

The following parameters will be initialized by SI:
BM, CR, EC, FP, FS, FW, HA, HC, HI, HO, HP, HV, HW, HZ, IN, JA, JV, LG, LP, LR, LS, MA, MM, MV, NP, NS, NW, OL, OS, PG, PI, PM, RC, RP, TL, VG, VI, VM, VR, ZA

SP Start Program

Format:
SP data

Description:
SP executes the Programmable Indexer of a channel number specified in 'data.'

Data:
0~63

Default:
0

SV Servo On

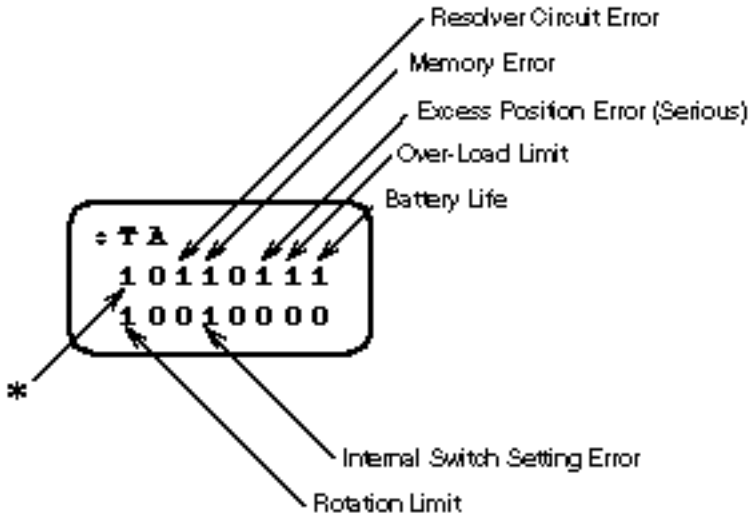
Format:
SV

Description:
When the Motor servo is turned off by MO command, executing the SV command will make Motor servo-on.

TA Tell Alarm Status

Format:
TA

Description:
TA reads out alarm status in 16 digits on 2 lines. 0 indicates the normal state. 1 indicates an alarm.



* Indicates '1' when one or more of following errors occur; Heat sink Over-Temperature, TB Connection Error, Regeneration Resister Over-Temperature, Control AC Line Under-Voltage, Over-Voltage, Over-Current, Main AC Line Under-Voltage/Fuse Blown, Internal Fuse Blown.

TB Tell BCD Command

Format:
TB

Description:
Reports the BCD position command memorized in the Driver Unit memory using external signals.

The reporting format corresponds to the inputting format, except for terminator code 'F,' which will not be displayed though it is needed at input.

If input when BCD command is not selected as position command, the command will be refused with the message 'TB INHIBITED.'

No message will return when no BCD command is memorized.

TC Tell Channel Program

Format:
TC data

Data:
0~63

Default:
0

Description:
TC displays the contents of the program of a channel specified in ‘data.’

No data is displayed if programming is not performed.

The display mode can be set using parameter MM.

TE Tell Position Error Counter

Format:
TE /RP

Description:
TE reads a value of the positional 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.

TL Torque Limit Rate

Format:
TL data

Data:
0~100 [%]

Default:
0

Shipping Set:
100

Readout Command:
TS, ?TL

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Sets the torque limit rate. The Motor torque will be reduced to a percentage specified by the TL command.

TM Torque Control Mode

Format:
TM

Description:
Sets the Driver Unit to torque control mode.

TP Tell Position

Format:
TP data /RP

Data:
0~5

Default:
0

Description:
TP reads the current position of the Motor. It reads the following:

TP1 — Relative position counter in units of counts

TP2 — User absolute position in units of counts

TP5 — User absolute position in units of angle

If TP command is executed with an /RP option, reading is repeated automatically. Or, the Driver Unit outputs read values repeatedly. To terminate automatic reading, press the BS key.

TR Tell RDC Position Data

Format:
TR /RP

Description:
TR reads data of the position sensor. Data is between 0 and 4095.

If TR command is executed with an /RP option, reading is repeated automatically. Or, the Driver Unit outputs read values repeatedly. To terminate automatic reading, press the BS key.

The following shows the relationship between the position sensor data and Motor position:

- Motor position perimeter data
  = (Z phase counter × 4096) + (position sensor data)
- User absolute position = (Motor position perimeter data) + (parameter AO)

A count of the Z phase counter corresponds to 4096 of the position sensor data. Or, if position sensor data changes from 4095 into 0, the position counter is incremented by one. If position sensor data changes from 0 into 4095, the position counter is decremented by one.

TS Tell Settings

Format:
TS data

Data:
0~6

Default:
0

Description:
Reports the values of parameters.

TS0 — PG, PI, VG, VI, LG, FP, FS, NP, NS, IN, CO, TL, LR, VR, PA

TS1 — PG, PI, VG, VI, LG

TS2 — FP, FS, NP, NS

TS3 — IN, CO, TL, DB, FC, ZA, IL, FF, AO

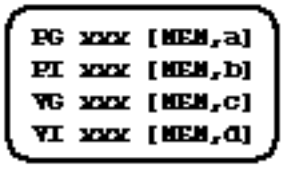
TS4 — AX, RP, MM, EC, CR, LR, VR, PA

TS5 — MA, MV, CD

TS6 — HP, HO, HA, HV, HZ, OS, JA, JV

About TS1...

TS1 command will show not only the parameter setting but also the control mode as shown below.



(xxx = current setting)

You can read the current control mode by a~d.

a	b	c	d	Control Mode
ON	ON	ON	ON	Position control mode, position loop PI control, velocity loop PI control
ON	ON	ON	OFF	Position control mode, position loop PI control, velocity loop P control
ON	OFF	ON	ON	Position control mode, position loop P control, velocity loop PI control
ON	OFF	ON	OFF	Position control mode, position loop P control, velocity loop P control
OFF	OFF	ON	ON	Velocity control mode, velocity loop PI control
OFF	OFF	ON	OFF	Velocity control mode, velocity loop P control
OFF	OFF	OFF	ON	Torque control mode

If the Motor servo is deactivated, b and d are indicated as “OFF.” If an integration limiter is specified with a PM3 or VM3 command, b and d change from “ON” into “LIM.”

VC Velocity Control Mode

Format:
VC

Description:
Sets the Driver Unit to velocity control mode.

To select velocity loop control mode, use the VM command.

VG Velocity Gain

Format:
VG data

Data:
0.10~255.00

Default:
Not omissible

Shipping Set:
1

Readout Command:
TS, ?VG

Note:
- Backed-up when power off
- Initialized by SI command

Description:
VG specifies velocity gain.

Immediately after VG is entered, velocity gain may be fine-tuned with the + or – key.

VI Velocity Integrator Frequency

Format:
VI data

Data:
0.10~127.00 [Hz]

Default:
Not omissible

Shipping Set:
1

Readout Command:
TS, ?VI

Note:
- Backed-up when power off
- Initialized by SI command

Description:
VI specifies velocity integrator frequency.

Immediately after VI is entered, velocity integrator frequency may be fine-tuned with the + or – key.

VM Velocity Integrator Mode

Format:
VM data

Data:
0~3

Default:
0

Shipping Set:
1

Note:
- Backed-up when power off
- Initialized by SI command

Description:
VM changes the velocity loop integrator control as shown below:

VM0 — velocity loop P control

VM1 — velocity loop PI control, integration limiter inactive

VM3 — velocity loop PI control, integration limiter active

VR Analog Command Velocity Range

Format:
VR data

Data:
See description.

Default:
Not omissible

Shipping Set:
See description.

Readout Command:
TS, ?VR

Note:
- Initialized by SI command

Description:
Sets the velocity analog command scale.

The 'data' range and shipping set depends on the resolver resolution and Motor size. See below.

This parameter is not backed-up. The velocity analog command scale will be always re-defined at power-on as shown below.

Item	Motor Size	Resolver Resolution	
		Automatic Switching or 10-bit	12-bit
Data Range	06××~14××	1.0 or 3.0	1.0
	0408	1.5 or 4.5	1.5
	B×××	1.25 or 3.75	1.25
Power-On Set	06××~14××	3.0	1.0
	0408	4.5	1.5
	B×××	3.75	1.25
Shipping Set	06××~14××	3.0	—
	0408	4.5	—
	B×××	3.75	—

ZA Analog Command Zero-Speed Offset

Format:
ZA data

Data:
–127~+127

Default:
0

Shipping Set:
0

Readout Command:
TS, ?ZA

Note:
- Backed-up when power off
- Initialized by SI command

Description:
Specifies offset to the analog command voltage if the Motor does not stop at ± 0V command.

The offset voltage is in proportion to the ‘data’ as:
‘data’ ±127 = ±0.31VDC

To set this offset, the front panel volume VR1 can also be used.

8.3. Set Value Reading Function

The set value of a parameter may be read out by typing as follows:

? key + parameter code + ENT key

This parameter reading function applies to the following parameters. An error occurs if it is executed for other parameters.

Caution *As for the checked commands, shown below, if you fail to press the ? key, data will change into 0. For example, if you intend to read out the set value of the IN command and types IN, instead of ?IN, by mistake, the System will regard its data as 0 and the in-position limit will be zeroed. Use great care in key entry.*

Table 8-15 Command With Parameter-Reading Function

Caution	Name	Function	Caution	Name	Function
✔	AX	Axis select	✔	LP	Incremental position judge
✔	BM	Backspace mode	✔	LS	Over travel limit switch position
✔	CO	Position error counter over limit		MA	Move acceleration
	CR	Circular resolution	✔	MM	Multi-line mode
✔	EC	End-of-command message		MV	Move velocity
✔	FP	Low-pass filter, primary	✔	NP	Notch filter, primary
✔	FS	Low-pass filter, secondary	✔	NS	Notch filter, secondary
✔	FW	FIN width	✔	NW	Neglect width
	HA	Home Return acceleration		OL	Overload limit
✔	HC	Home Return cycle		PA	Phase adjust
✔	HI	Home in-position		PG	Position gain
✔	HO	Home offset		PI	Position integrator frequency
✔	HP	Home position		RC	Rated current
	HV	Home Return velocity	✔	RP	RUN pre-input activity
✔	HW	Home width	✔	TL	Torque limit rate
	HZ	Home Return near-zero velocity		VG	Velocity gain
✔	IN	In-position		VI	Velocity integrator frequency
	JA	Jog acceleration		VR	Analog command velocity range
	JV	Jog velocity		ZA	Analog command zero adjust

8.4. Fine Adjustment

Filter frequency, proportional gain, or integration frequency may be fine-tuned with the + or – key immediately after entry (before the next communication is executed after entry). The user need not press the ENT key after typing the + or – key. If the + or – key is pressed, the adjusted value is displayed together with the command parameter.

The fine adjustment function applies to the following parameters:

Table 8-16

Command With Fine Adjust Function

Name	Function	Increment By "+"	Decrement By "–"
FP	Low-pass filter, primary	+1Hz	–1Hz
FS	Low-pass filter, secondary	+1Hz	–1Hz
NP	Notch filter, primary	+1Hz	–1Hz
NS	Notch filter, secondary	+1Hz	–1Hz
PG	Position gain	+0.01	–0.01
PI	Position integrator frequency	+0.1Hz	–0.1Hz
VG	Velocity gain	+0.1	–0.1
VI	Velocity integrator frequency	+0.1Hz	–0.1Hz

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9. Warning and Alarm

If an error occurs in the Megatorque Motor System, the Driver Unit gives a warning or an alarm. If a warning or alarm is given, take proper measures and eliminate the cause.

The DRDY and OVER output signals are used to inform the host controller of errors in the Megatorque Motor System.

Table 9-1 Warning/Alarm Output

Condition	DRDY Output	OVER Output
Normal Status	Closed	Open
Warning	Closed	Closed
Alarm	Open	Open (closed on some alarms)

If the Motor servo is deactivated when a warning or alarm is given, the BRK output opens. If the weight of the load or inertia may cause a dangerous accident when the Motor servo is deactivated due to a warning or alarm, use the BRK output to trigger a brake to externally stop the Motor.

9.1. Identifying Warning/Alarm

A warning or alarm should be identified in order to eliminate its cause. To identify it, use the LEDs on the front panel and the TA communication command.

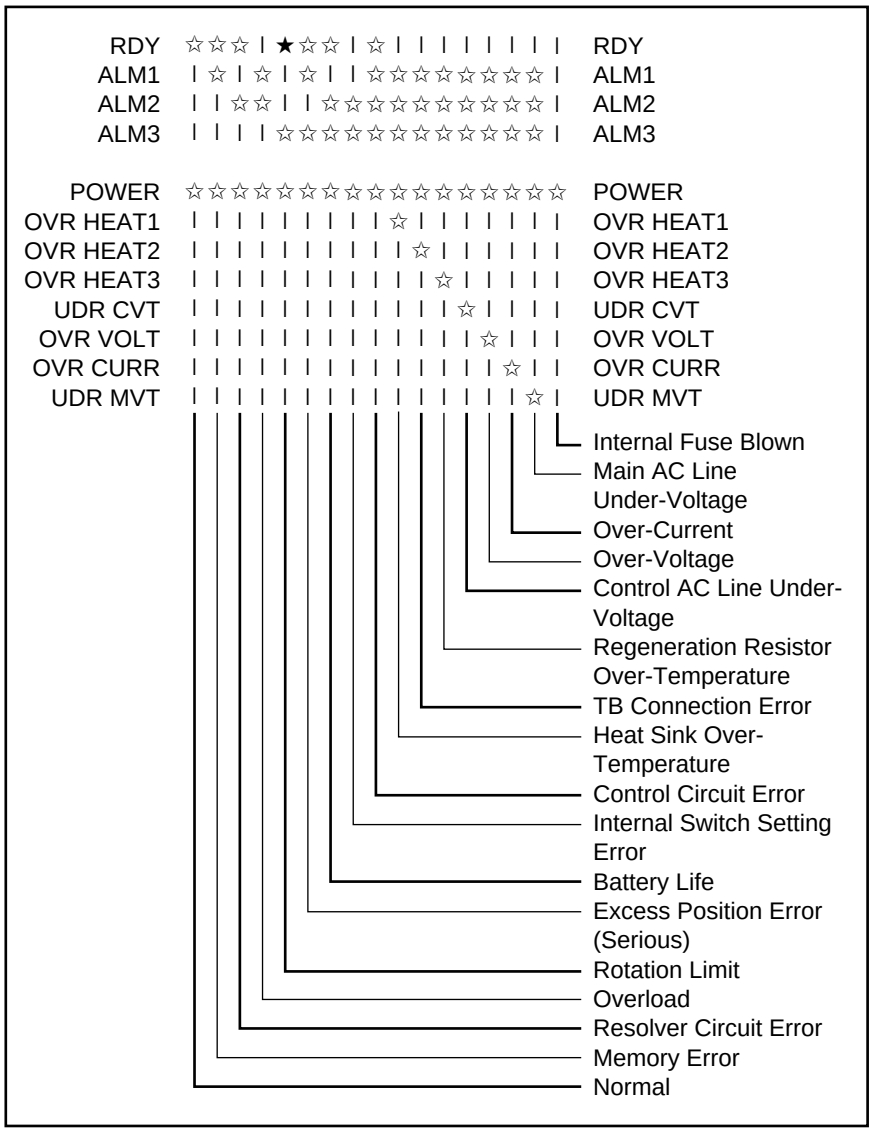
9.1.1. Using LED

Caution *If the LEDs indicate a pattern not shown below, contact NSK immediately.*

Important *"Excess position error (warning)" cannot be monitored by LEDs. The LED indication is as same as the normal state when that warning is given.*

- If the Driver Unit front panel is visible in your system, then you can identify the warning/alarm by eleven LEDs. All the LEDs should be monitored.
- If there are two or more warnings/alarms at the same time, the LED alarm patterns alternate. Each pattern lights for about 1.4 seconds.
- The following LED symbols are used.
  ☆ — illuminated
  ★ — blinking
  ı — off

Figure 9-1
LED Indication



9.1.2. Using TA Command

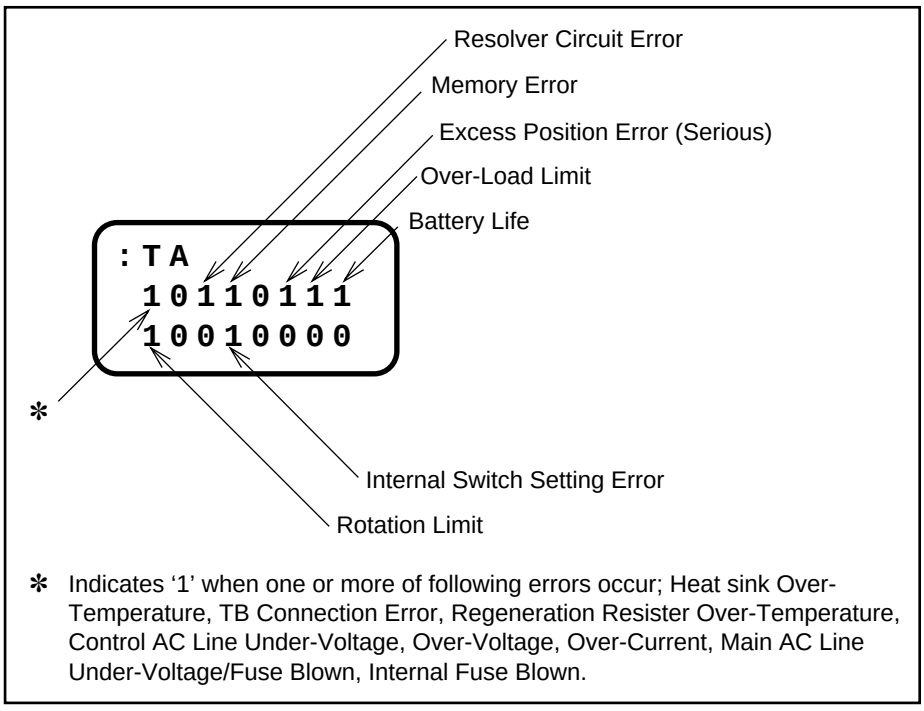
Important *"Control circuit error" and "internal fuse blown" cannot be monitored by the TA command because RS-232C communication will be disabled when these errors occur.*

Important *"Excess position error (warning)" cannot be monitored by the TA command. The TA report is as same as the normal state when that warning is given.*

- If you use RS-232C communications, you can access 14 warnings/alarms in 7 groups using the TA command. The TA command generates a 16- digit report using '1' and '0' as shown below.
- If there are two or more alarms at the same time, the TA command will reveal all of them simultaneously

Figure 9-2

TA Report



* Indicates '1' when one or more of following errors occur; Heat sink Over-Temperature, TB Connection Error, Regeneration Resister Over-Temperature, Control AC Line Under-Voltage, Over-Voltage, Over-Current, Main AC Line Under-Voltage/Fuse Blown, Internal Fuse Blown.

9.2. Warning/Alarm Table

9.2.1. Normal Status

Table 9-2: Normal Status

Status	Motor Condition	DRDY	OVER	BRK	Cause	Remedy
Power-off	servo-off	open	open	open	Power is not supplied.	Turn on power.
CPU Initializing	servo-off	open	open	open	Initializing the CPU.	Wait for the CPU to initialize.
SVON Input OFF	servo-off	closed	open	closed	SVON input is not active.	Activate the SVON input.
EMST Input ON	servo-lock	closed	open	open	EMST input is active.	Eliminate the cause of emergency stop, then deactivate the EMST input.

9.2.2. Warning/Alarm Status

Table 9-3

Warning/Alarm Status

Warning/Alarm		Motor Condition	DRDY	OVER	BRK	Illuminated LED	TA Report
Warning	Excess Position Error (Slight)	Runs normally.	closed	closed	closed	same as normal	same as normal
	Software Rotation Limit	one-way servo-lock	closed	closed	closed	RDY (blinking), ALM3, POWER	00000000 10000000
	Battery Life	Runs normally.	closed	closed	closed	RDY, ALM2, ALM3, POWER	00000001 00000000
Alarm	Memory Error	servo-off	open	open	open	RDY, ALM1, POWER	00010000 00000000
	Resolver Circuit Error	servo-off	open	open	open	RDY, ALM2, POWER	00100000 00000000
	Overload	servo-off	open	open	open	RDY, ALM1, ALM2, POWER	00000010 00000000
	Excess Position Error (Serious)	servo-lock (velocity loop)	open (closed)	closed	closed	RDY, ALM1, ALM3, POWER	00000100 00000000
	Internal Switch Setting Error	servo-off	open	open	open	ALM2, ALM3, POWER	00000000 00010000
	Control Circuit Error	servo-off	open	open	open	RDY, ALM1, ALM2, ALM3, POWER	not available
	Heat Sink Over-Temperature	servo-off	open	open	open	ALM1, ALM2, ALM3, POWER, OVR HEAT1	10000000 00000000
	TB Connection Error	servo-off	open	open	open	ALM1, ALM2, ALM3, POWER, OVR HEAT2	10000000 00000000
	Regeneration Resistor Over-Temperature	servo-off	open	open	open	ALM1, ALM2, ALM3, POWER, OVR HEAT3	10000000 00000000
	Control AC Line Under-Voltage	servo-off	open	open	open	ALM1, ALM2, ALM3, POWER, UDR CVT	10000000 00000000
	Over-Voltage	servo-off	open	open	open	ALM1, ALM2, ALM3, POWER, OVR VOLT	10000000 00000000
	Over-Current	servo-off	open	open	open	ALM1, ALM2, ALM3, POWER, OVR CURR	10000000 00000000
	Main AC Line Under-Voltage	servo-off	open	open	open	ALM1, ALM2, ALM3, POWER, UDR MVT	10000000 00000000
	Internal Fuse Blown	servo-off	open	open	open	none	not available

9.3. Detail Of Warning/Alarm

- The following LED symbols are used in this section.
  - ☆ — illuminated
  - ★ — blinking
  - ǀ — off
- If a warning or alarm cannot be canceled through measures described below, contact NSK immediately.
- If the LEDs indicate a pattern not shown below, contact NSK immediately.

9.3.1. Warning

9.3.1.1. Excess Position Error (Slight)

Output

DRDY: closed
OVER: closed
BRK: closed

TA Report

00000000
00000000

LED

☆ RDY
ǀ ALM1
ǀ ALM2
ǀ ALM3
☆ POWER
ǀ OVR HEAT1
ǀ OVR HEAT2
ǀ OVR HEAT3
ǀ UDR CVT
ǀ OVR VOLT
ǀ OVR CURR
ǀ UDR MVT

Motor Condition:

The Motor keeps rotating normally.

Cause:

The position error counter reads a value over the criterion specified in CO during a positioning operation (including Home Return and jogging). If the value exceeds a value 8 times the CO value, a excess position error error (serious) occurs.

Remedy:

If the error is left as is, the Motor operates so that the error counter reaches 0. Thus, no special remedy is required normally. If the error occurs frequently, tuning may be incorrect. Carry out the following adjustment:

- Adjust the gains (VG and PG).
- Decrease the acceleration (MA, CA, HA, JA, etc.).
- Increase the CO value (judgment criterion).

Note:

This warning is not given if /AL option is specified when setting CO value.

9.3.1.2. Rotation Limit (Software Control)

Output

DRDY: closed
OVER: closed
BRK: closed

TA Report

00000000
10000000

LED

★ RDY
| ALM1
| ALM2
☆ ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

The Motor will only rotate in a direction opposite to that of the rotation limit. For the rotation limit direction, the Motor servo locks.

Cause:

The Motor enters an inhibited area specified by LS.

Remedy:

Get out of the inhibited area. The OVER output opens. The OVER output may also be reset by inputting CLR. However, a warning is given again if the Motor is in the inhibited area.

9.3.1.3. Battery Life

Output

DRDY: closed
OVER: closed
BRK: closed

TA Report

00000001
00000000

LED

☆ RDY
| ALM1
☆ ALM2
☆ ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

The Motor keeps operating.

Cause:

The voltage of the RAM backup battery lowers below 2.2VDC.

Remedy:

Replace the battery. For the replacement method, refer to “Appendix 6. Replacing Battery.”

9.3.2. Alarm

9.3.2.1. Memory Error

Output

DRDY: open
OVER: open
BRK: open

TA Report

00010000
00000000

LED

☆ RDY
☆ ALM1
| ALM2
| ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

The parameters stored in the RAM in the Driver Unit contain some error.

Remedy:

Turn off power, then turn it on again under the condition where the parameters are initialized (with SW201 #1 off). Note that all the parameters and channel data are reset to the shipping-set values. Thus, it is necessary to record them and input them afterwards. (Among the parameters, PA should be set the different way than other parameters. For PA setting, refer to “Appendix 7. Checking PA Value.”)

9.3.2.2. Resolver Circuit Error

Output

DRDY: open
OVER: open
BRK: open

TA Report

00100000
00000000

LED

☆ RDY
| ALM1
☆ ALM2
| ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

Position detection is disabled due to breakage of the resolver cable, etc.

Remedy:

Turn off power, check the resolver wiring, then turn on the power again. The alarm will be canceled.

If this alarm occurs frequently, contact NSK.

9.3.2.3. Overload

Output

DRDY: open
OVER: open
BRK: open

TA Report

00000010
00000000

LED

| RDY
☆ ALM1
☆ ALM2
| ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

The Motor is restrained mechanically in operation, and an internal coil current command value accumulated in the software exceeds the set value. The value specified by OL serves as the detection criterion.

Remedy:

Activate the CLR input or issue a CL command to cancel the alarm. If the Motor is hot, wait until it becomes cool, then return to normal use.

Note:

The OL parameter is factory-set according to the Motor size. Do not change it.

If it should be changed, a higher OL causes an overload alarm to occur less frequently. If OL is zeroed, no alarm occurs.

9.3.2.4. Excess Position Error (Serious)

Output

DRDY: open*
OVER: closed
BRK: closed

TA Report

00000100
00000000

LED

☆ RDY
☆ ALM1
ǀ ALM2
☆ ALM3
☆ POWER
ǀ OVR HEAT1
ǀ OVR HEAT2
ǀ OVR HEAT3
ǀ UDR CVT
ǀ OVR VOLT
ǀ OVR CURR
ǀ UDR MVT

Motor Condition:

The Motor servo locks in velocity control mode.

Cause:

The value of the position error counter exceeds a value 8 times the detection criterion (specified with CO).

- Breakage of the Motor wiring
- The servo parameters (VG, VI and PG) are not set properly.
- The velocity and/or acceleration (MV, MA, etc.) is too high.

Remedy:

This alarm is canceled if the CLR input is activated or the CL command is input. The position error counter is cleared to zero. Adjustment procedures are the same as described in the section 9.3.1.1. Excess Position Error (Slight).

Note:

* The DRDY output will be closed if /AL option is specified when setting CO.

9.3.2.5. Internal Switch Setting Error

Output

DRDY: open
OVER: open
BRK: open

TA Report

00000000
00010000

LED

ǀ RDY
ǀ ALM1
☆ ALM2
☆ ALM3
☆ POWER
ǀ OVR HEAT1
ǀ OVR HEAT2
ǀ OVR HEAT3
ǀ UDR CVT
ǀ OVR VOLT
ǀ OVR CURR
ǀ UDR MVT

Motor Condition:

Servo-off

Cause:

Power is turned on under the condition where the internal switch SW201 #2 ~ #4 are set improperly.

Remedy:

Turn off power, set SW201 #2 ~ #4 properly, then turn on power.

9.3.2.6. Control Circuit Error

Output

DRDY: open
OVER: open
BRK: open

TA Report

Not available

LED

☆ RDY
☆ ALM1
☆ ALM2
☆ ALM3
☆ POWER
ǀ OVR HEAT1
ǀ OVR HEAT2
ǀ OVR HEAT3
ǀ UDR CVT
ǀ OVR VOLT
ǀ OVR CURR
ǀ UDR MVT

Motor Condition:

Servo-off

Cause:

An error occurs in the control circuit in the Driver Unit.

Remedy:

This alarm is canceled by turning off power, then turning it on again. If this alarm occurs frequently, contact NSK.

9.3.2.7. Heat Sink Over-Temperature

Output

DRDY: open
OVER: open
BRK: open

TA Report

10000000
00000000

LED

| RDY
☆ ALM1
☆ ALM2
☆ ALM3
☆ POWER
☆ OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

The temperature of the heat sink in the power amplifier exceeds 90˚C due to continued heavy torque demand.

Remedy:

Stop operation, check for the points show below, then cool the Motor and Driver Unit by air:

- Check to see whether the duty cycle of the Motor is too high.
- Check to see whether excessive load is applied to the Motor.
- Check to see whether the ambient temperature of the Driver Unit is higher than the normal condition.

If no troubles are found in the above check and this alarm occurs frequently, contact NSK.

9.3.2.8. TB Connection Error

Output

DRDY: open
OVER: open
BRK: open

TA Report

10000000
00000000

LED

| RDY
☆ ALM1
☆ ALM2
☆ ALM3
☆ POWER
| OVR HEAT1
☆ OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

Power is turned on under the condition where the shorting bracket which is attached to the NC terminal of the front panel TB in the factory, is removed.

Remedy:

Turn off power, connect the shorting bracket to the NC terminal, then turn on power again.

Note:

The user may use this alarm as “Motor over-temperature” alarm if the user equips the Motor with a thermostat and connect it to the NC terminal of TB.

9.3.2.9. Regeneration Resistor Over-Temperature

Output

DRDY: open
OVER: open
BRK: open

TA Report

10000000
00000000

LED

| RDY
☆ ALM1
☆ ALM2
☆ ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
☆ OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

The temperature of the regenerative resistor in the power amplifier exceeds 80˚C due to continued heavy torque demand. Or, regenerative current cannot be processed when the Motor is decelerated rapidly.

Remedy:

Stop operation, then cool the Driver Unit sufficiently. The rotational energy is compensated with regenerative resistance when the Motor is decelerated. Reduce the duty cycle of the Motor, etc.

9.3.2.10. Control AC Line Under-Voltage

Output

DRDY: open
OVER: open
BRK: open

TA Report

10000000
00000000

LED

| RDY
☆ ALM1
☆ ALM2
☆ ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
☆ UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

The voltage of the input power (control power) for the power amplifier control circuit falls below 70VAC due to an error in the power supply.

Remedy:

Turn off power, check the power supply and power cable, then turn on power again.

9.3.2.11. Over-Voltage

Output

DRDY: open
OVER: open
BRK: open

TA Report

10000000
00000000

LED

| RDY
☆ ALM1
☆ ALM2
☆ ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
☆ OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

Excessive DC voltage is applied to the main circuit when a load having a large moment of inertia is decelerated rapidly, etc. Or, the voltage of the input power (main power) of the power amplifier main circuit exceeds 290VAC due to an error in the power supply.

Remedy:

Turn off power, check the supply voltage, then turn on power again. If the power supply is not defective, carry out the same measures as described in the section 9.3.2.7. Heat Sink Over-Temperature.

9.3.2.12. Over-Current

Output

DRDY: open
OVER: open
BRK: open

TA Report

10000000
00000000

LED

| RDY
☆ ALM1
☆ ALM2
☆ ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
☆ OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

Over-current flows through the Motor due to poor insulation of the Motor cable, etc.

Remedy:

Turn off power, check the Motor wiring, then turn on power again.

9.3.2.13. Main AC Line Under-Voltage

Output

DRDY: open
OVER: open
BRK: open

TA Report

10000000
00000000

LED

| RDY
☆ ALM1
☆ ALM2
☆ ALM3
☆ POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
☆ UDR MVT

Motor Condition:

Servo-off

Cause:

The fuse has blown. The voltage of the power amplifier main circuit power lowers below 40VAC due to an error in the power supply.

Remedy:

Check the fuse, supply voltage, and power supply wiring, then turn on power again.

If the fuse blows out frequently, contact NSK.

Note:

2 fuses are supplied with the System.

Fuse Specification:
Manufacturer — BUSSMDA
Model — MDA20A
Capacity — 20A

9.3.2.14. Internal Fuse Blown

Output

DRDY: open
OVER: open
BRK: open

TA Report

Not available

LED

| RDY
| ALM1
| ALM2
| ALM3
| POWER
| OVR HEAT1
| OVR HEAT2
| OVR HEAT3
| UDR CVT
| OVR VOLT
| OVR CURR
| UDR MVT

Motor Condition:

Servo-off

Cause:

The Driver Unit uses a power fuse in order to prevent affects upon the primary side (control power) in case an error (such as burn-out) in the Driver Unit. If this fuse blows, no LEDs turn on and the Driver Unit ceases to function.

Remedy:

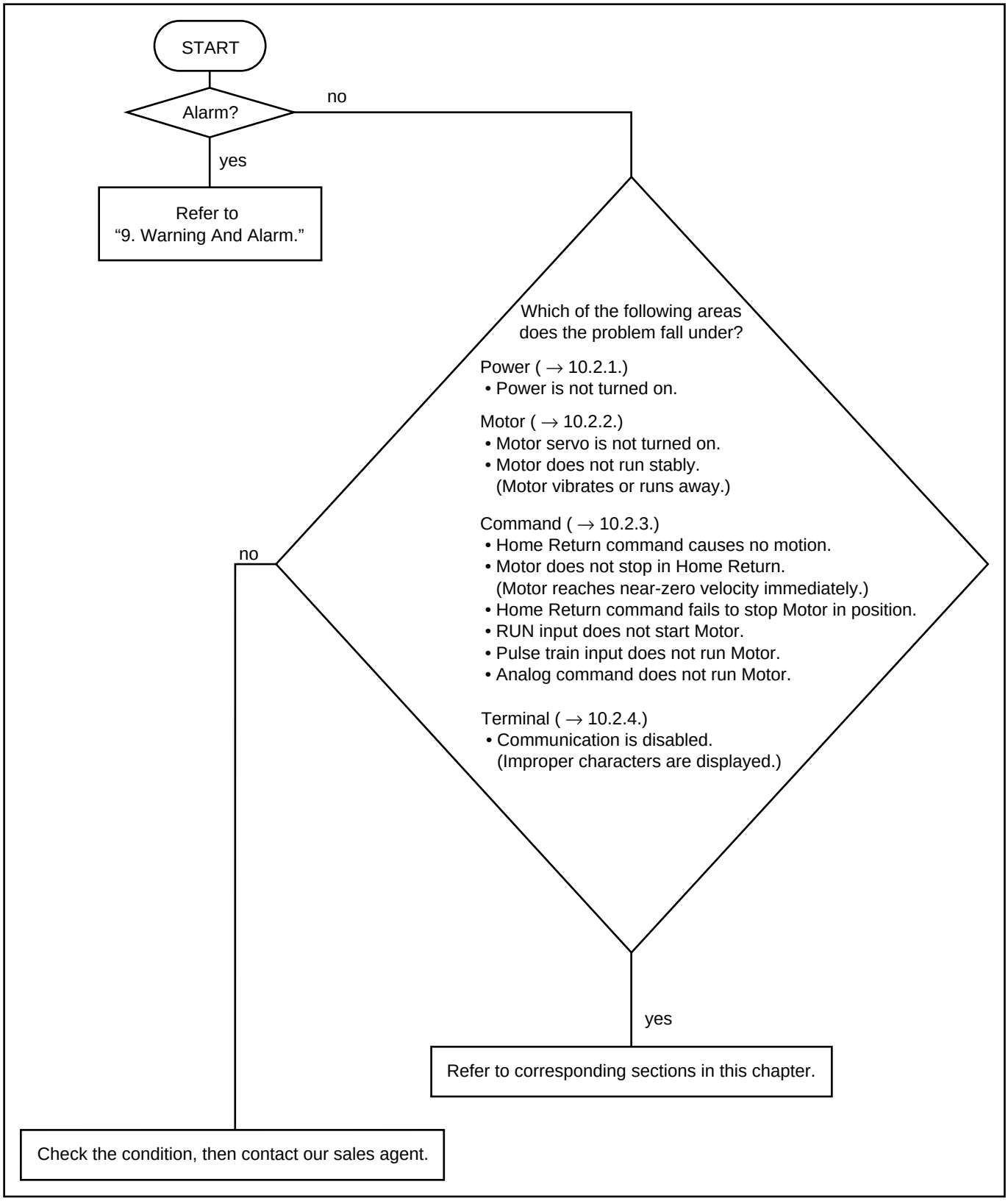
Contact NSK.

10. Troubleshooting

If problems do occur, troubleshoot using the flow chart shown below.

Figure 10-1

Troubleshooting Flow



10.1. How to Monitor I/O Signal

The status of the input and output signals may be checked by inputting IO commands from the terminal.

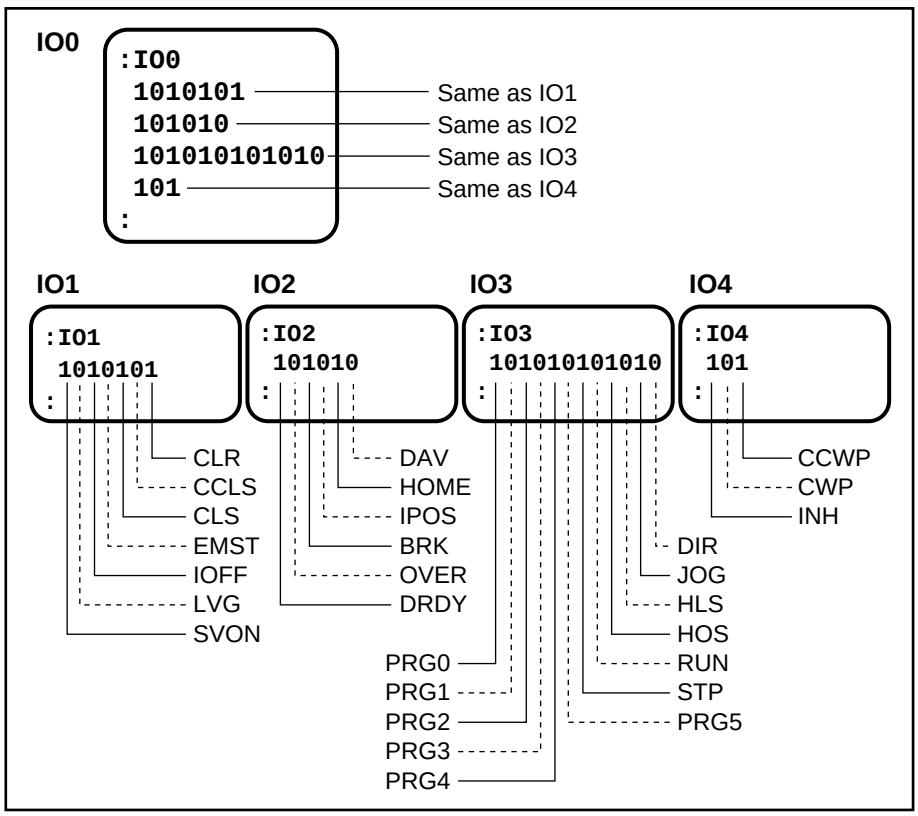
If an IO command is executed, the status of the inputs and outputs is indicated as 1's and 0's. 1 and 0 mean the following:

Input — 0: OFF, 1: ON

Output — 0: close, 1: open

Figure 10-2

IO Command Display



Example 1 — Monitoring SVON input status

Type as: I O 1# / R P ENT

```
:IO1/RP
 1000000
```

Since the leftmost digit is 1, the SVON input is ON.

(Push BS key to return to the normal state.)

Example 2 — Monitoring CN2 outputs

Type as: I O 2$ / R P ENT

```
:IO2/RP
 010011
```

DRDY, BRK and IPOS are closed.

(Push BS key to return to the normal state.)

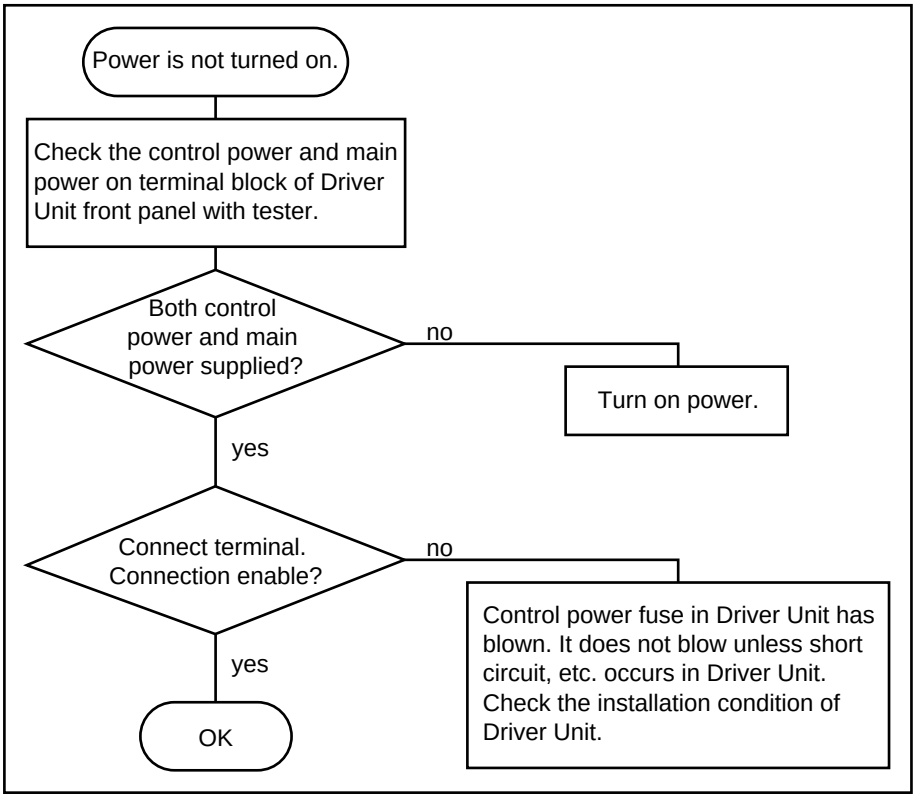
10.2. Troubleshooting

10.2.1. Power Trouble

Power is not turned on.

Figure 10-3

Power Trouble

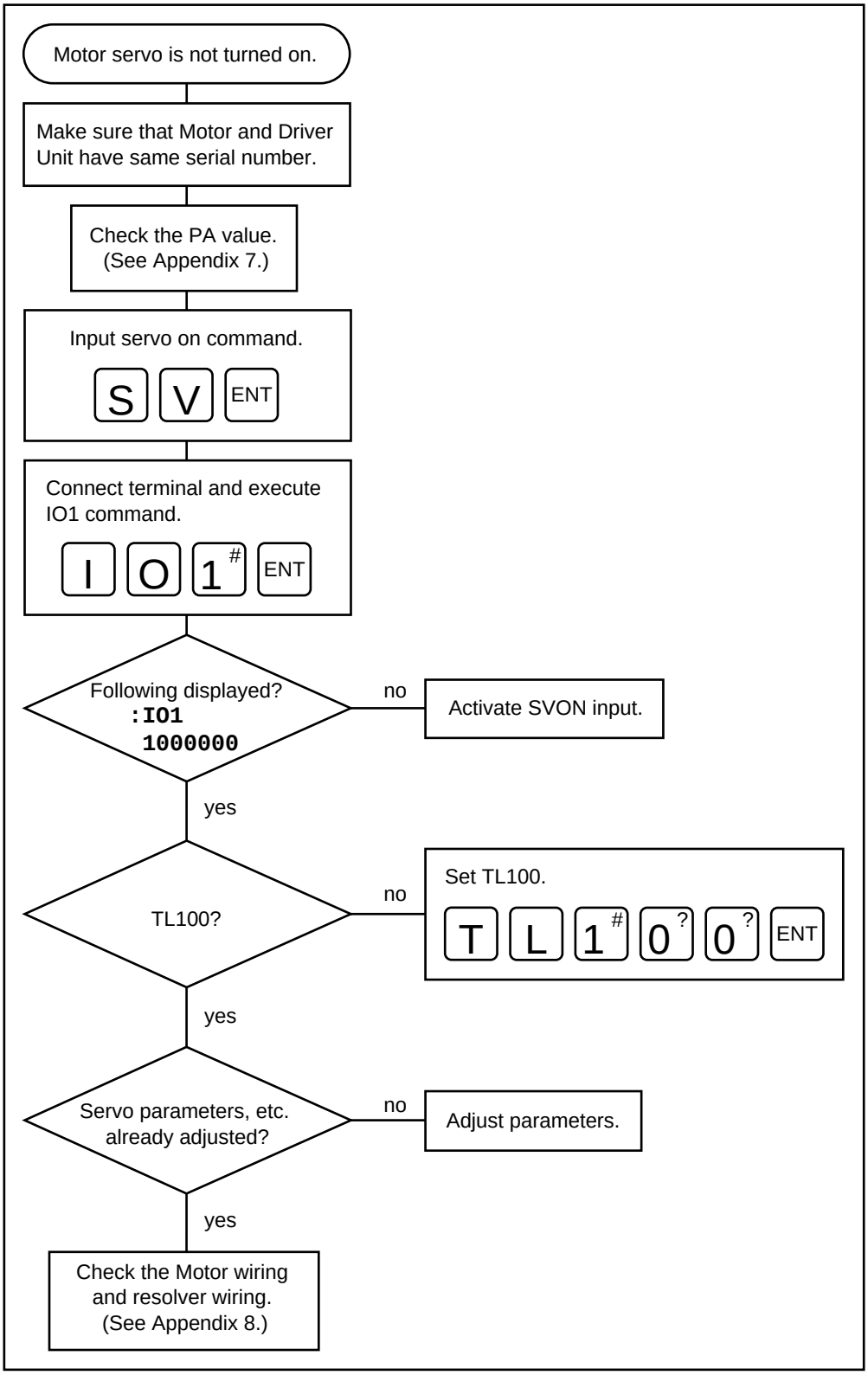


10.2.2. Motor Trouble

(1) Motor servo is not turned on.

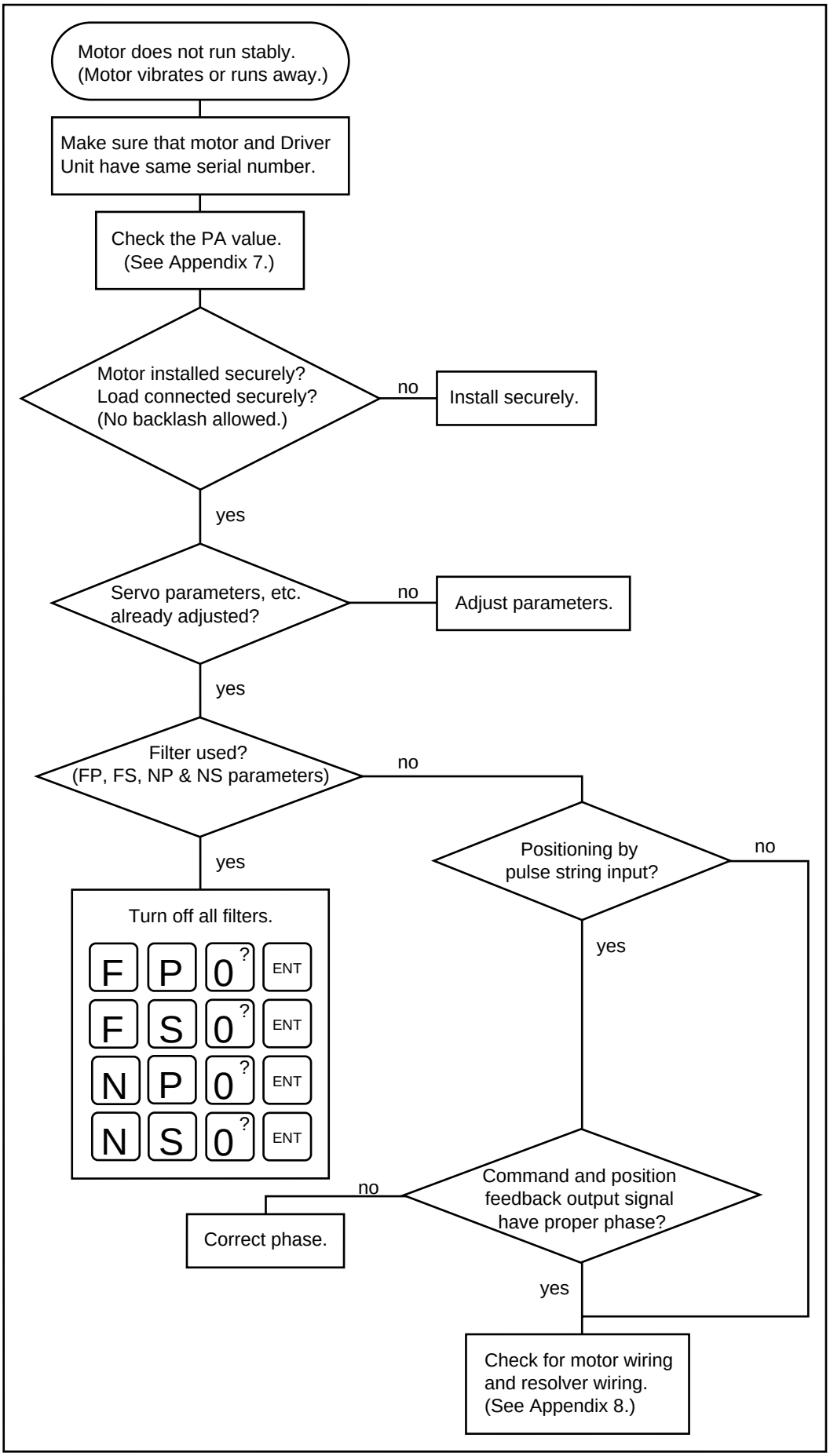
Figure 10-4

Motor Trouble (1)



(2) Motor does not run stably. (Motor vibrates or runs away.)

Figure 10-5: Motor Trouble (2)

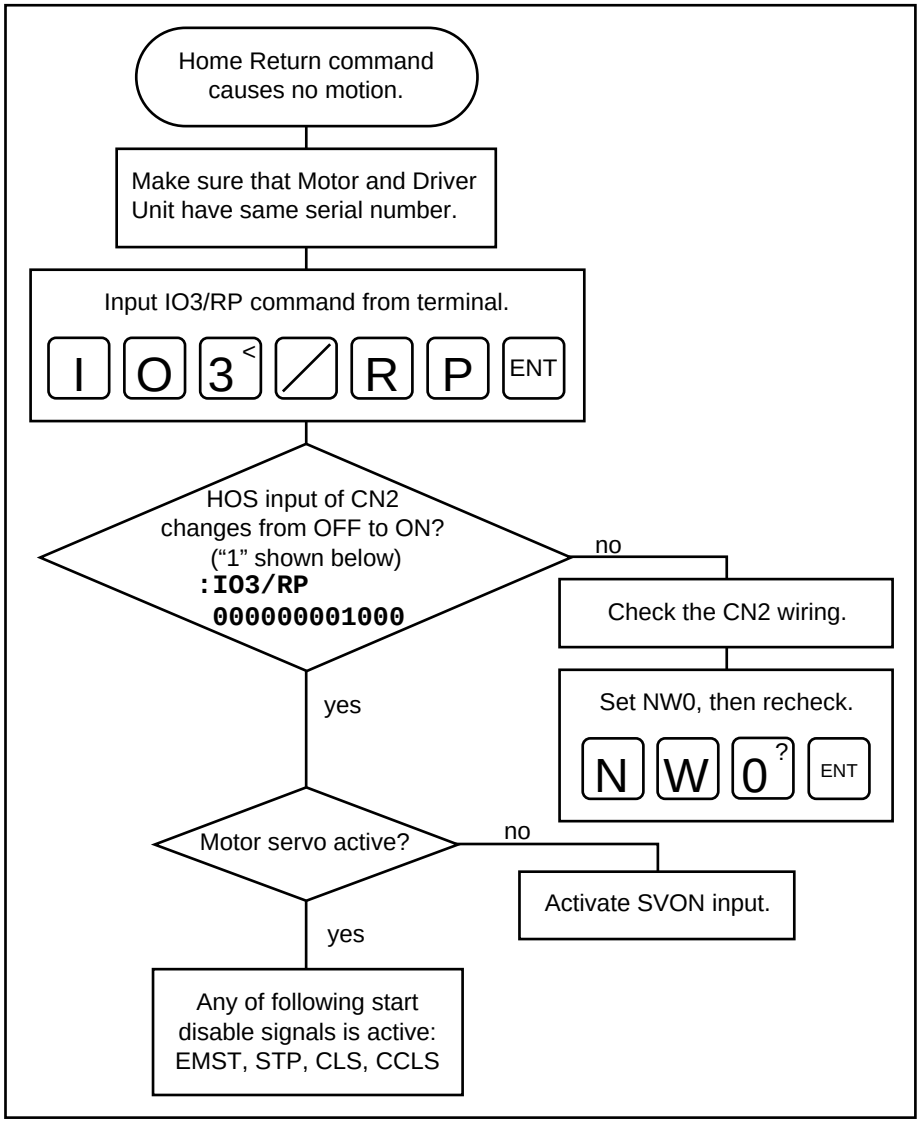


10.2.3. Command Trouble

(1) Home Return command causes no motion.

Figure 10-6

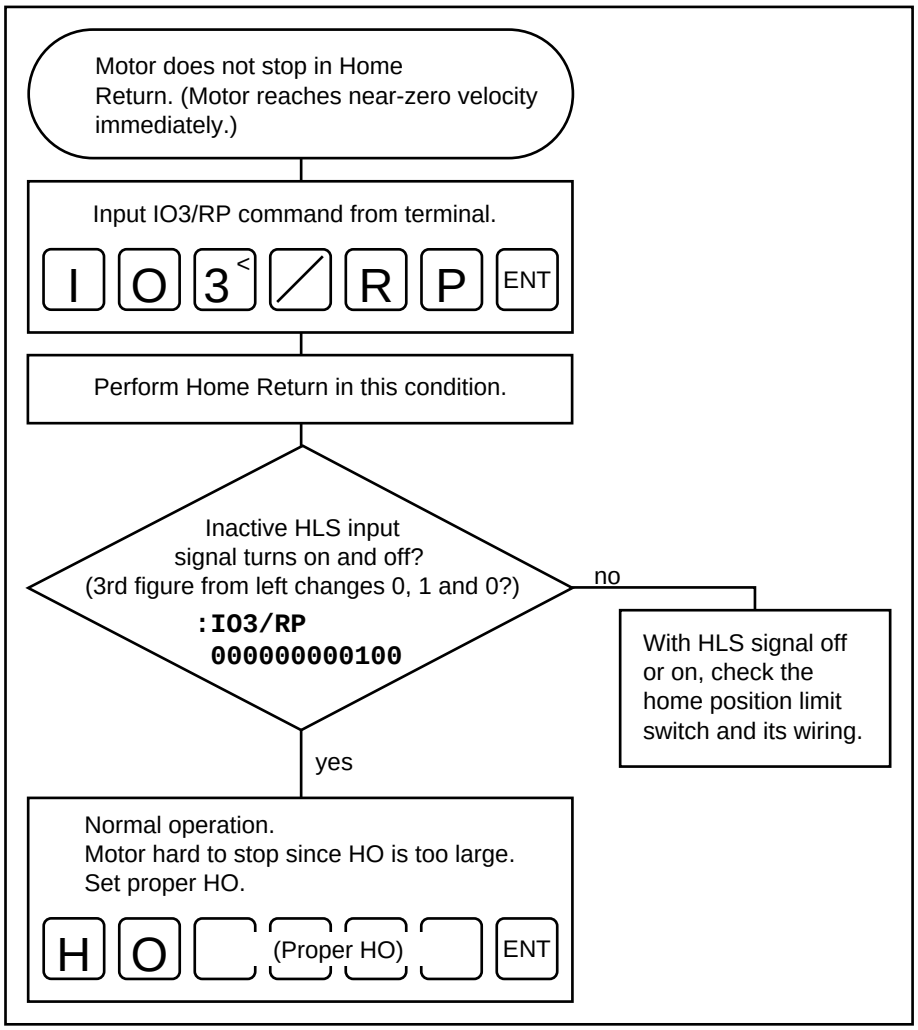
Command Trouble (1)



(2) Motor does not stop in Home Return. (Motor reaches near-zero velocity immediately.)

Figure 10-7

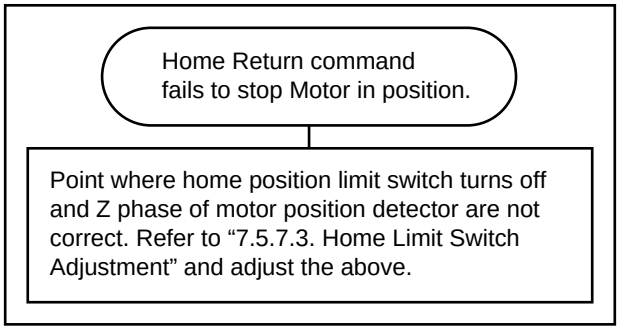
Command Trouble (2)



(3) Home Return command fails to stop Motor in position.

Figure 10-8

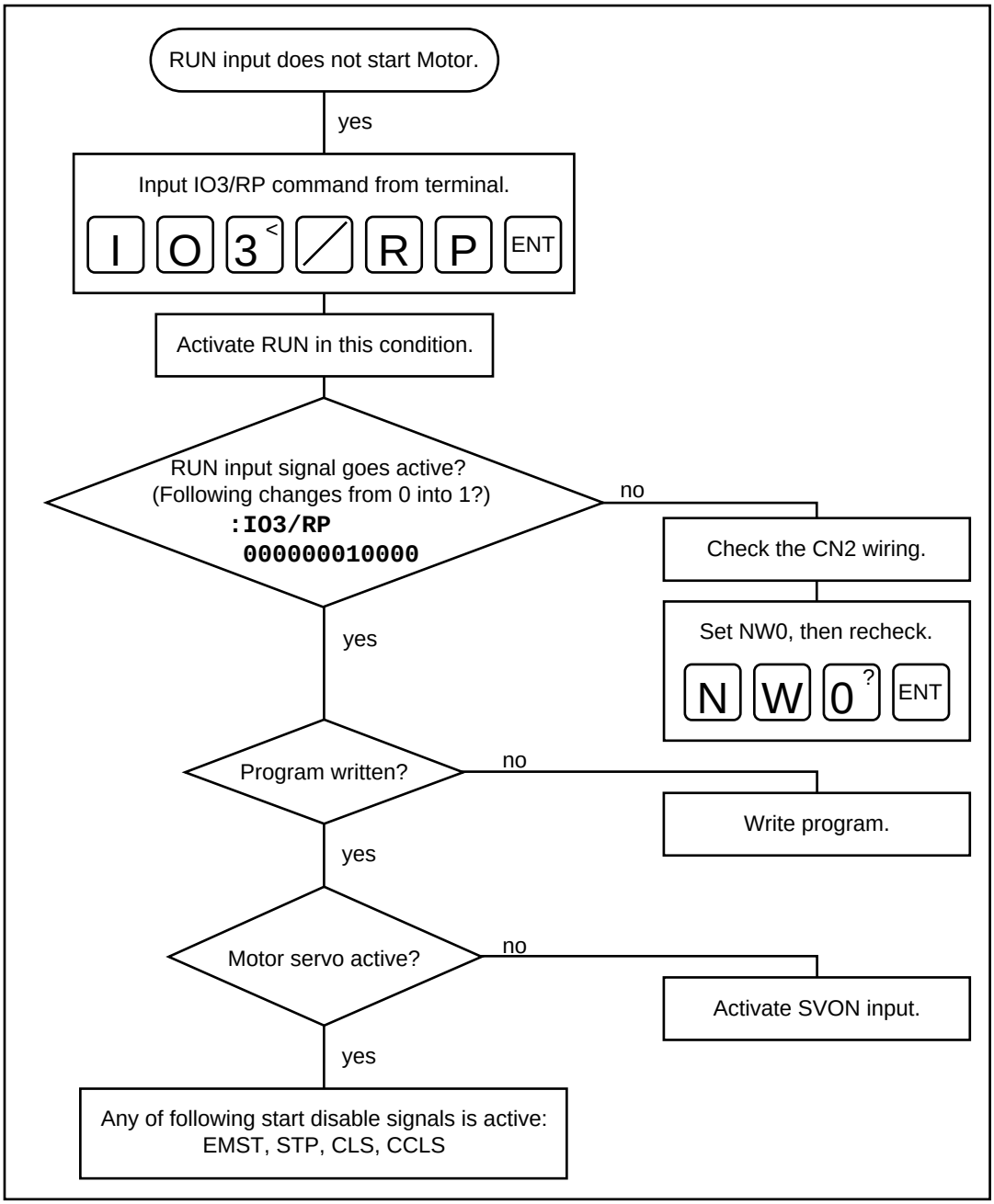
Command Trouble (3)



(4) RUN input does not start Motor.

Figure 10-9

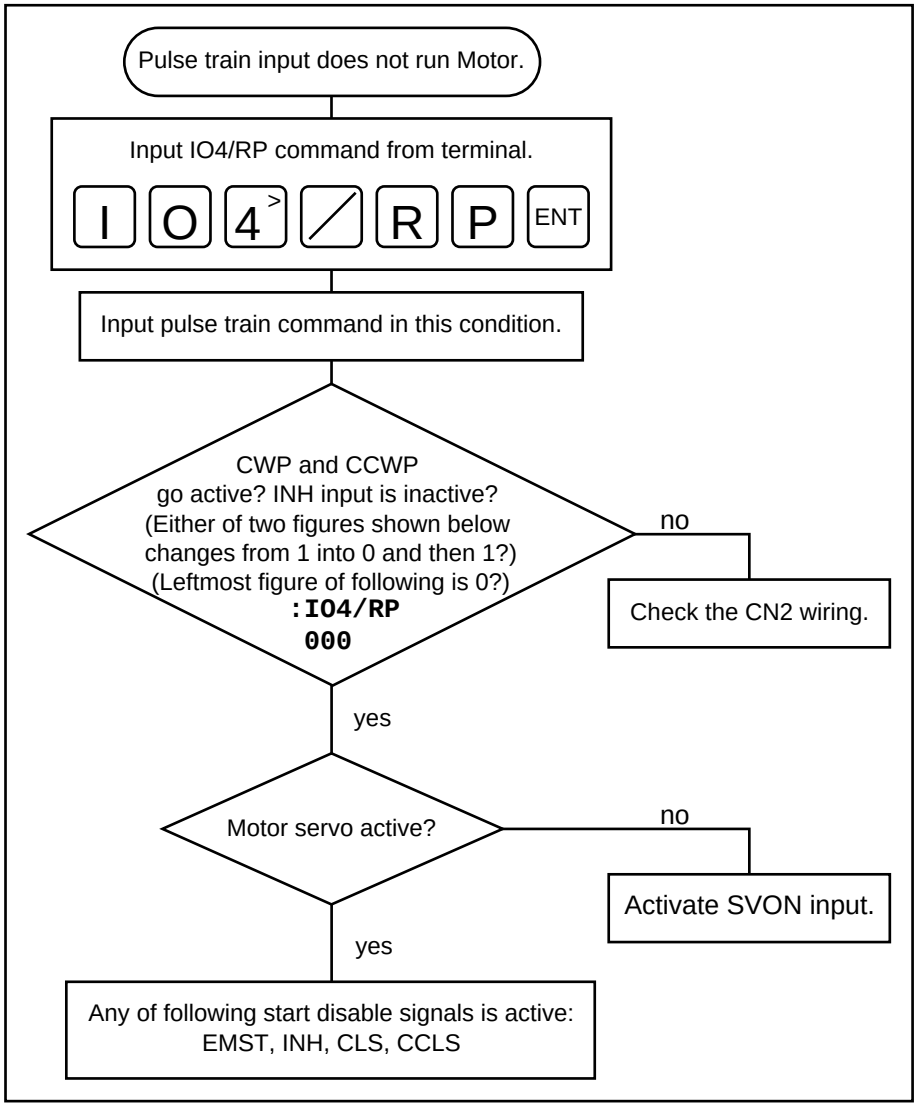
Command Trouble (4)



(5) Pulse train input does not run Motor.

Figure 10-10

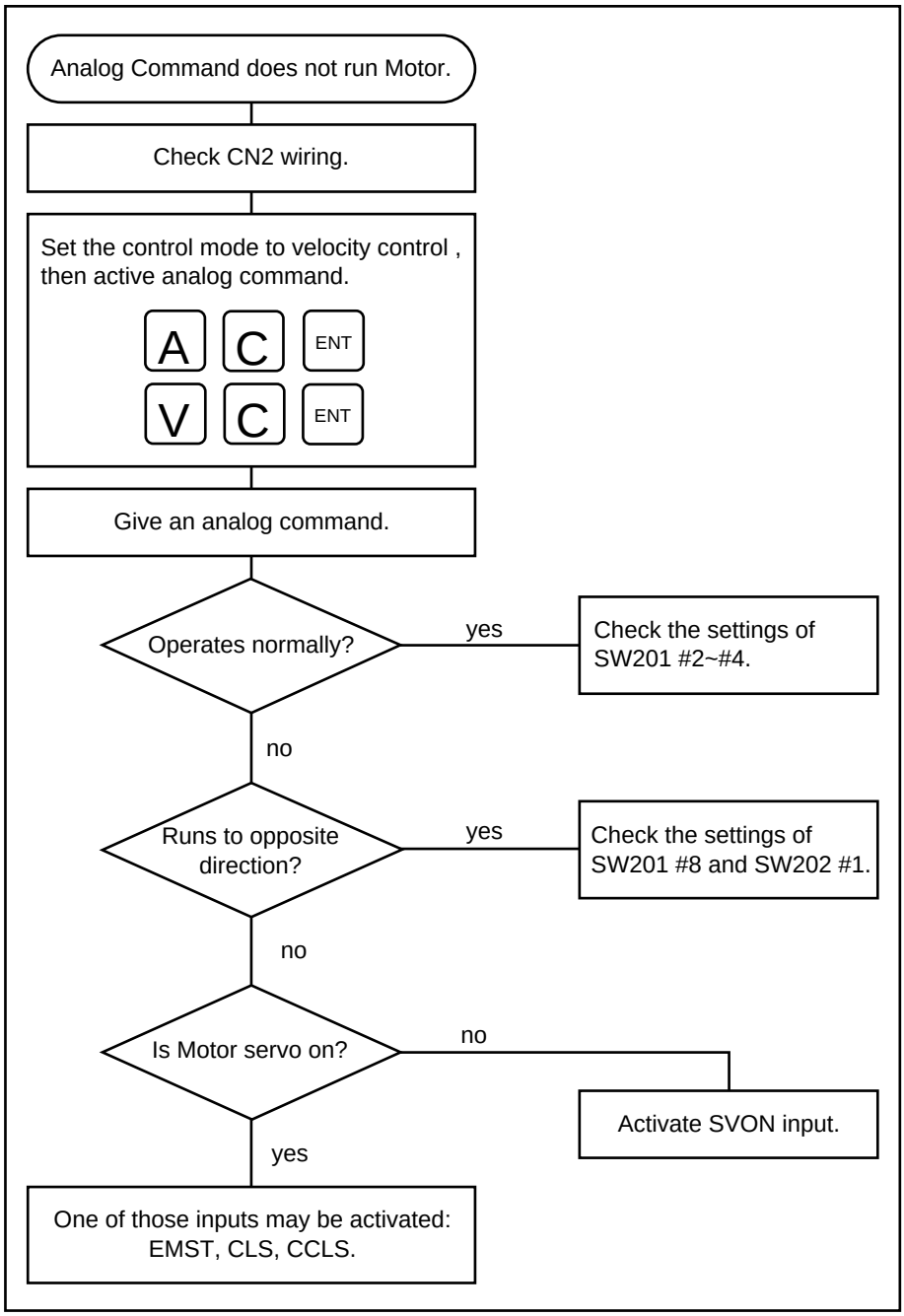
Command Trouble (5)



(6) Analog command does not run Motor.

Figure 10-11

Command Trouble (6)

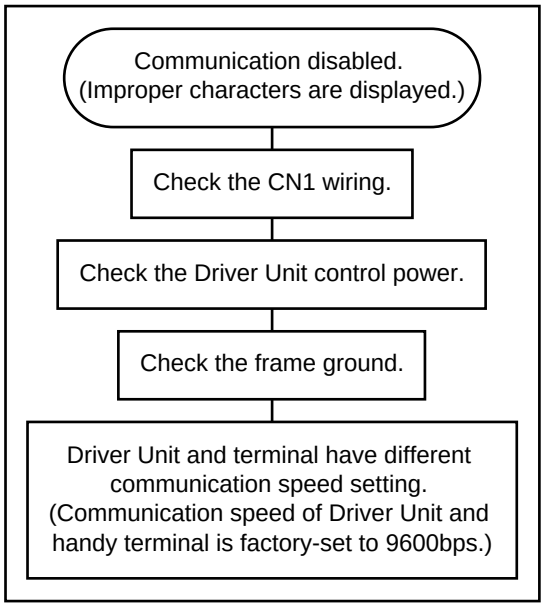


10.2.4. Terminal Trouble

Communication is disabled (Improper characters are displayed.)

Figure 10-12

Terminal Trouble



(Blank Page)

Appendix

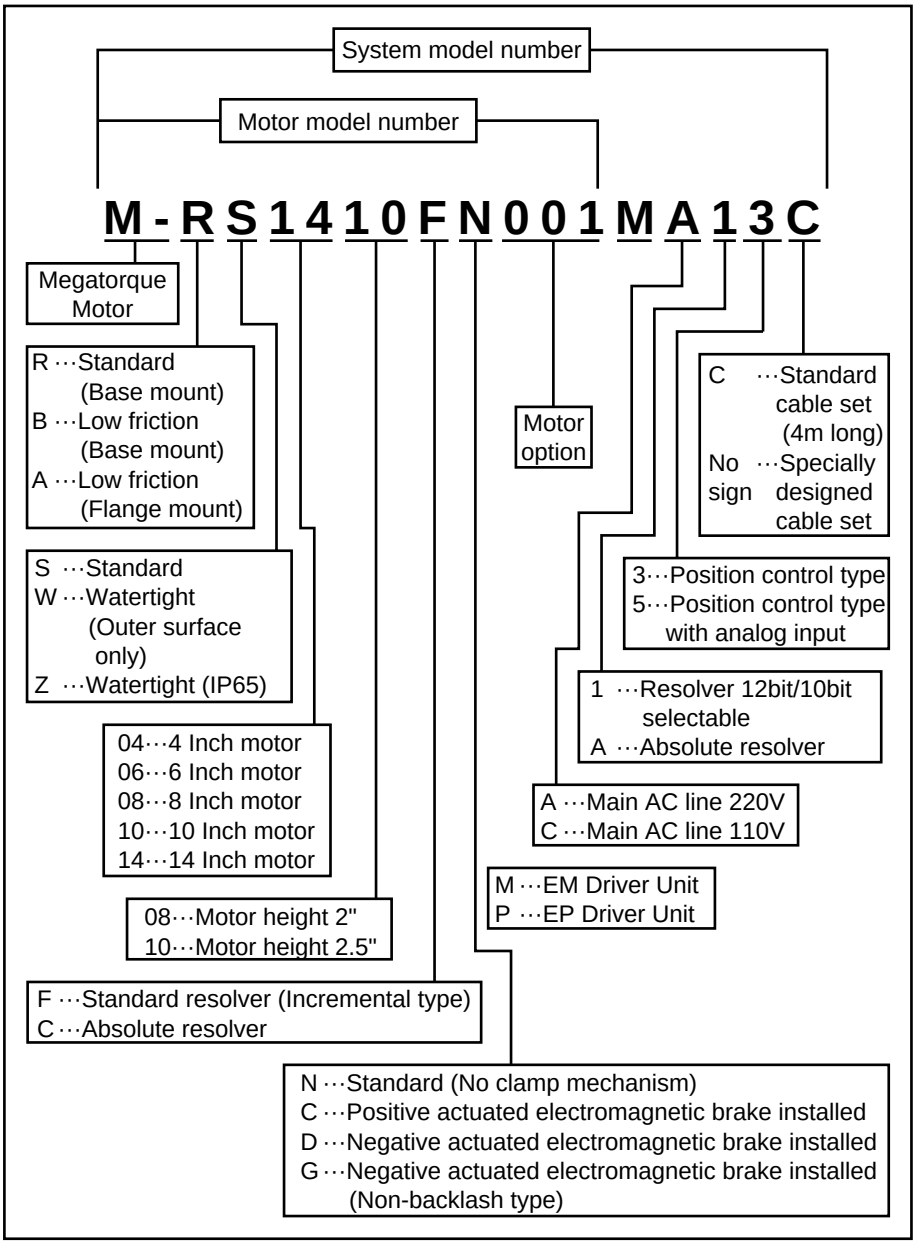
Appendix 1. System and Motor Specification

A.1.1. System/Motor Number

Motor size: 0408, 0608, 0810, 1010, 1410

Figure A-1

System/Motor Model Number

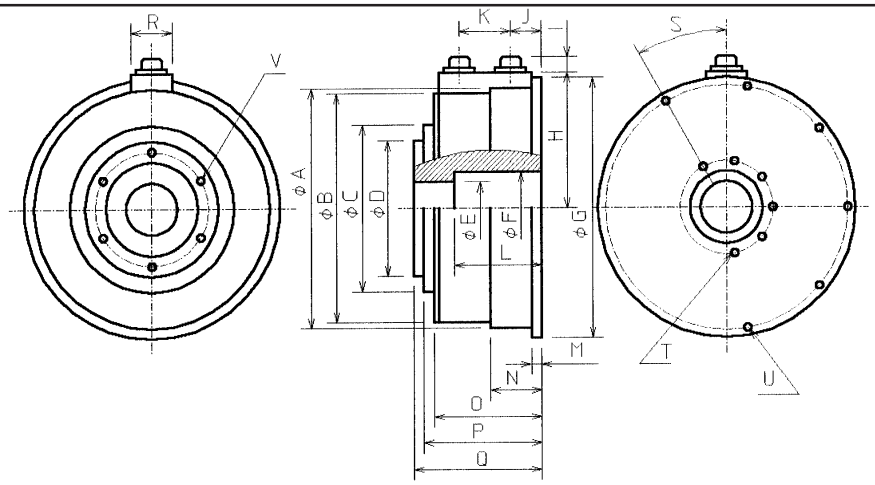


A.1.2. Motor Dimension

A.1.2.1. Connector Type

Figure A-2

Connector Type Motor Dimension



Unit:mm

	A	B	C	D	E	F	G	H	I	J
0608	176	176	146	110h7	40	40	215h8	111.2	16.6 (23)	28.3 (33.3)
0810	220	220	156	135h7	50	50	250h8	133	16.6 (23)	34 (39)
1010	286	282	208	170h7	64	90	320h8	164.5	16.6 (23)	37 (42)
1410	378	377	288	245h7	118	154	420h8	210	16.6 (23)	42 (43)

	K	L	M	N	O	P
0608	62.6 (79.2)	-	12 (17)	-	109.5 (133.5)	116 (142)
0810	67.3 (83.8)	-	13 (18)	-	125.5 (151.5)	134 (160)
1010	74 (89.8)	109 (114)	15 (20)	66 (71)	138 (163)	150 (175)
1410	82 (101.8)	115 (120)	16 (21)	71 (76)	148 (173)	155 (180)

	Q	R	S	T
0608	121.5 (146.5)	35 (40)	30˚	6-M8×1.25 Deep 8, PCD75, 60˚ Spacing
0810	139 (164)	42	30˚	6-M8×1.25 Deep 12, PCD80, 60˚ Spacing
1010	160 (185)	42	30˚	9-M8×1.25 Deep 13, PCD110, 40˚ Spacing
1410	170 (195)	42	30˚	9-M8×1.25 Deep 15, PCD188, 40˚ Spacing

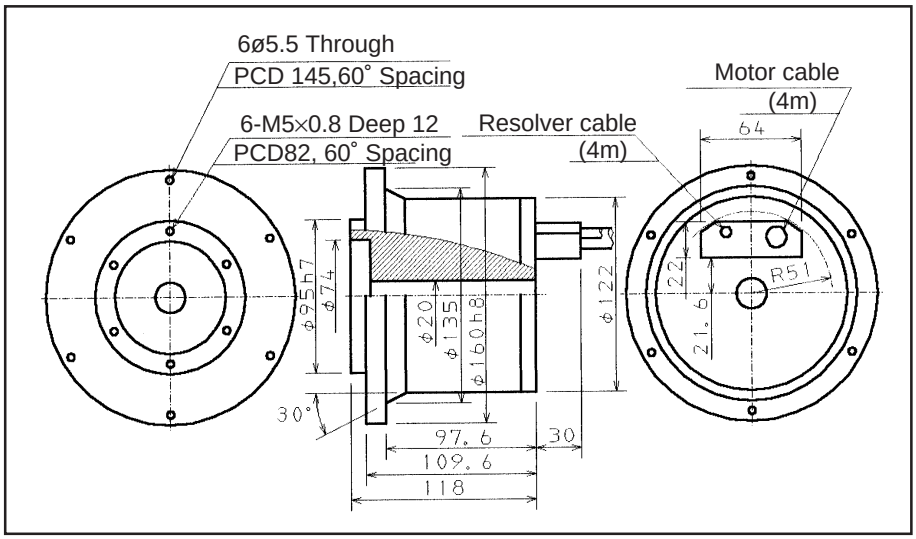
	U	V
0608	6-ø7 Through, PCD200, 60˚ Spacing	6-M5×0.8 Deep 12, PCD97, 60˚ Spacing
0810	6-ø7 Through, PCD234, 60˚ Spacing	6-M6×1.0 Deep 15, PCD120, 60˚ Spacing
1010	6-ø9 Through, PCD300, 60˚ Spacing	6-M8×1.25 Deep 20, PCD152, 60˚ Spacing
1410	6-ø11 Through, PCD400, 60˚ Spacing	6-M8×1.25 Deep 20, PCD230, 60˚ Spacing

Note Values enclosed in parentheses indicate the dimensions of motors with a built-in absolute position detector.

A 1.2.2. Direct-Cable (Rotor On Top) Type

Figure A-3

Direct-Cable (Rotor On Top) Type Motor Dimension



A.1.3. Motor Specification

Table A-1

Motor Specification

Item	Unit	Specification				
		AS0408	RS0608	RS0810	RS1010	RS1410
Maximum Torque	kgf·m	1	4	9	15	25
Maximum Current	A	3 (6) (1)	6	7.5	7.5	7.5
Rated Voltage (1)	VDC	300 (150)	300 (150)	300 (150)	300 (150)	300 (150)
Motor Winding Temperature Range (2)	˚C	90	90	90	90	90
Maximum Velocity (3)	rps	4.5 (1.5)	3.0 (1.0)	3.0 (1.0)	3.0 (1.0)	3.0 (1.0)
Maximum Friction Torque	kgf·cm	10	30	45	55	80
Axial Load Capacity	kgf	180	380	460	970	2000
Moment Load Capacity	kgf·m	2	6	8	16	40
Axial Stiffness	mm/kgf	2.5×10^{-5}	4.0×10^{-5}	3.0×10^{-5}	1.4×10^{-5}	1.0×10^{-5}
Moment Stiffness (4)	rad/kgf·m	3.0×10^{-5}	3.5×10^{-5}	2.5×10^{-5}	1.5×10^{-5}	3.0×10^{-6}
Rotor Inertia GD^2	kgf·m^2	0.009	0.031	0.084	0.3	1.07
Weight (5)	kgf	6.5 (7.5)	14 (20)	24 (35.5)	40 (61)	73 (98)
Environment		Operation temperature 0 ~ 40˚C, humidity 20 ~ 80%, indoor use only				

Note (1) Those not enclosed in parentheses indicate specifications for main power 200VAC type System and those enclosed in parentheses indicate specifications for 100VAC type.

(2) Specifications at the ambient temperature of 40˚C

(3) Those not enclosed in parentheses indicate specifications for resolver resolution 10-bit setting and those enclosed in parentheses indicate specifications for 12-bit.

(4) Specifications if Motors are mounted on rigid bases.

(5) Those not enclosed in parentheses indicate specifications for standard System and those enclosed in parentheses indicate specifications for System with built-in absolute position sensor.

A.1.4. Output Torque Specification

Table A-2

Output Torque Specification

Unit: N·m

Motor Size	Driver Unit AC Line	Torque Option	Maximum Torque (1)	Rated Torque (2)	Maximum Stall Torque (3)	Rated Stall Torque (4)
0408	200V or 100V	Normal	9.8	6.8	7.8	4.9
		Low Ripple	6.8	4.9	6.8	3.9
0608	100V	Normal	36.2	17.6	33.3	16.6
		Low Ripple	30.3	15.6	29.4	15.6
	200V	Normal	39.2	18.6	33.3	16.6
		Low Ripple	34.3	16.6	31.3	15.6
0810	100V	Normal	88.2	46.0	78.4	31.3
		Low Ripple	78.4	38.2	73.5	27.4
	200V	Normal	88.2	49.0	78.4	31.3
		Low Ripple	78.4	44.1	73.5	27.4
1010	100V	Normal	147.0	88.2	113.6	73.5
		Low Ripple	126.4	77.4	108.7	73.5
	200V	Normal	147.0	112.7	137.2	76.4
		Low Ripple	112.7	78.4	107.8	76.4
1410	100V	Normal	225.4	208.7	196.0	179.3
		Low Ripple	186.2	173.4	174.4	156.8
	200V	Normal	245.0	235.2	196.0	176.4
		Low Ripple	196.0	190.1	186.2	156.8

Note (1) Maximum torque — the maximum torque which a Motor can output

(2) Rated torque — the maximum torque which a motor can output continuously without exceeding the rated temperature, while rated temperature = 130˚C (at ambient temperature of 40˚C, 90˚C rise of coil temperature)

(3) Maximum stall torque — maximum output torque of a motor at zero velocity

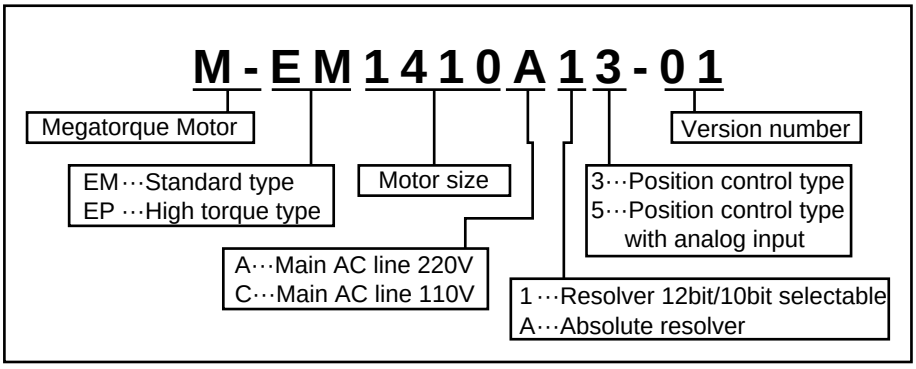
(4) Rated stall torque — maximum torque which a motor can output without exceeding the rated temperature continuously when the Motor is stationary, while rated temperature = 130˚C (at ambient temperature of 40˚C, 90˚C rise of coil temperature)

Appendix 2. Driver Unit Specification

A.2.1. Driver Unit Number

Figure A-4

Driver Unit Number

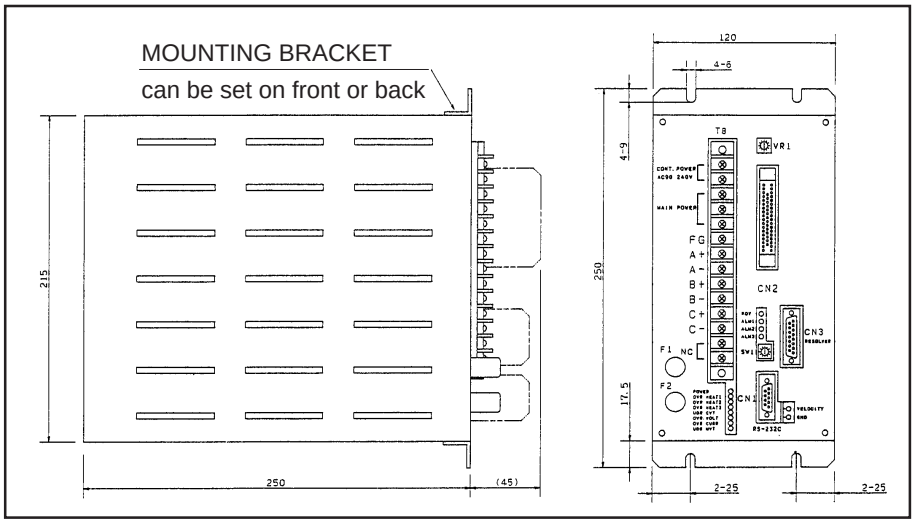


A.2.2. Driver Unit Dimension

A.2.2.1. EM Type Driver Unit

Figure A-5

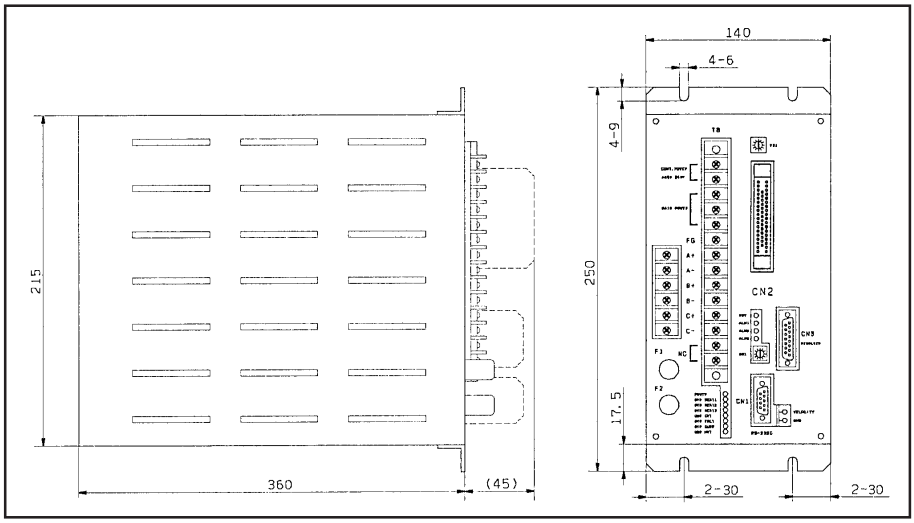
EM Type Driver Unit Dimension



A.2.2.2. EP Type Driver Unit

Figure A-6

EP Type Driver Unit Dimension

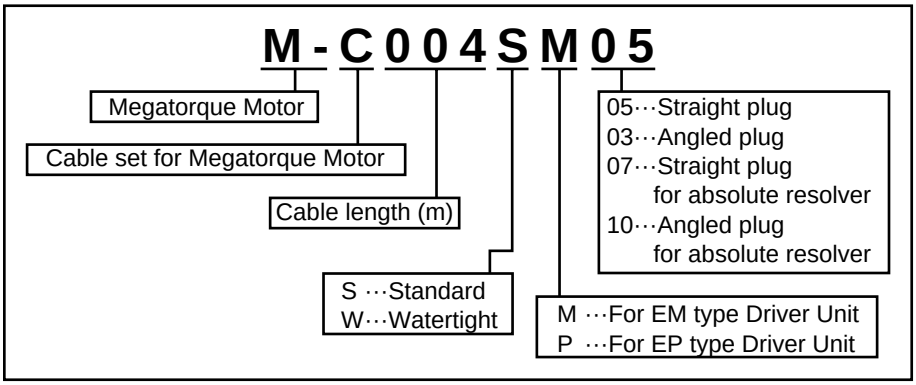


Appendix 3. Cable Set Specification

A.3.1. Cable Set Model Number

Figure A-7

Cable Set Model Number

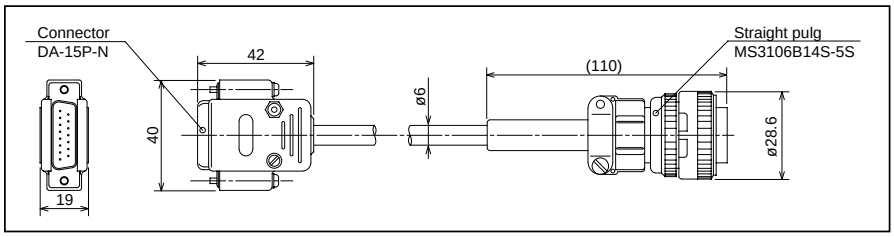


A.3.2. Cable Set Dimension

A.3.2.1. Resolver Cable (For EM/EP Type Driver Unit)

Figure A-8

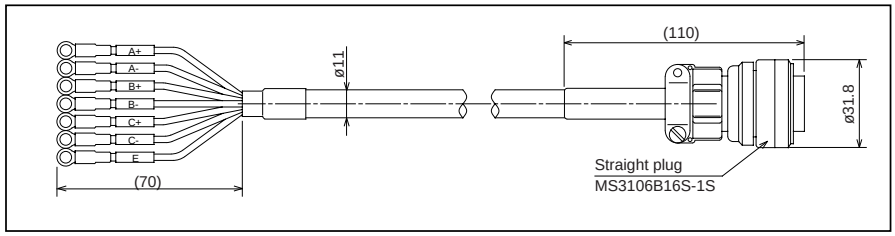
Resolver Cable Dimension



A.3.2.2. Motor Cable (For EM Type Driver Unit)

Figure A-9

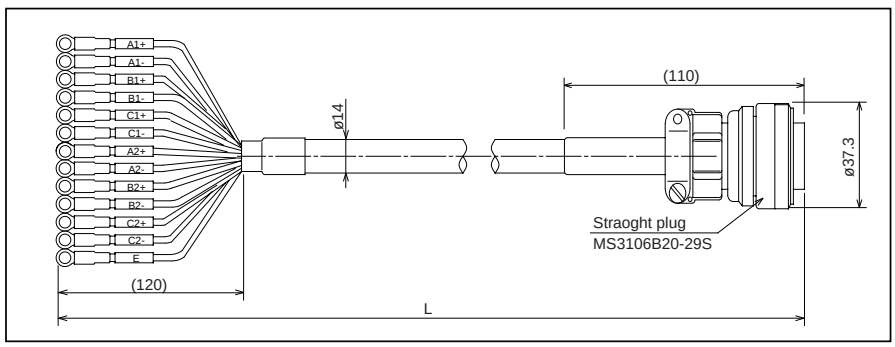
Motor Cable Dimension
(For EM Type)



A.3.2.3. Motor Cable (For EP Type Driver Unit)

Figure A-10

Motor Cable Dimension
(For EP Type)



Appendix 4. RS-232C Serial Communication

If any terminal other than NSK Handy Terminal FHT01 is used as an RS-232C terminal, read the description below for specifications.

Connector CN1 is the RS-232C port of the Driver Unit.

A.4.1. CN1 Pin-Out

Figure A-11

CN1 Pin-Out

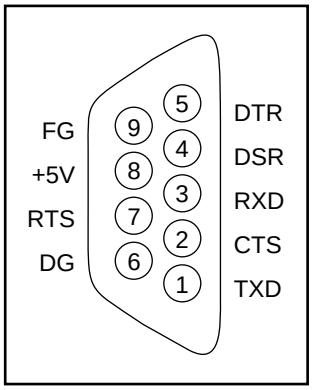


Table A-3

CN1 Connector Type

Connector Type (Driver Unit Side)	JAE DE-9S-N
Mating Connector Type (User Device Side)	JAE DE-9P-N
Mating Connector Shell Type (User Device Side)	JAE DE-C1-J6

A.4.2. CN1 Signal List

Table A-4

CN1 Signal List

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

A.4.3. Interface Specification

Table A-5

Interface Specification

Item	Specification
Transmission	Full duplex
Communication Speed [bps] *	9600 (standard), 4800, 1200, 300 *
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

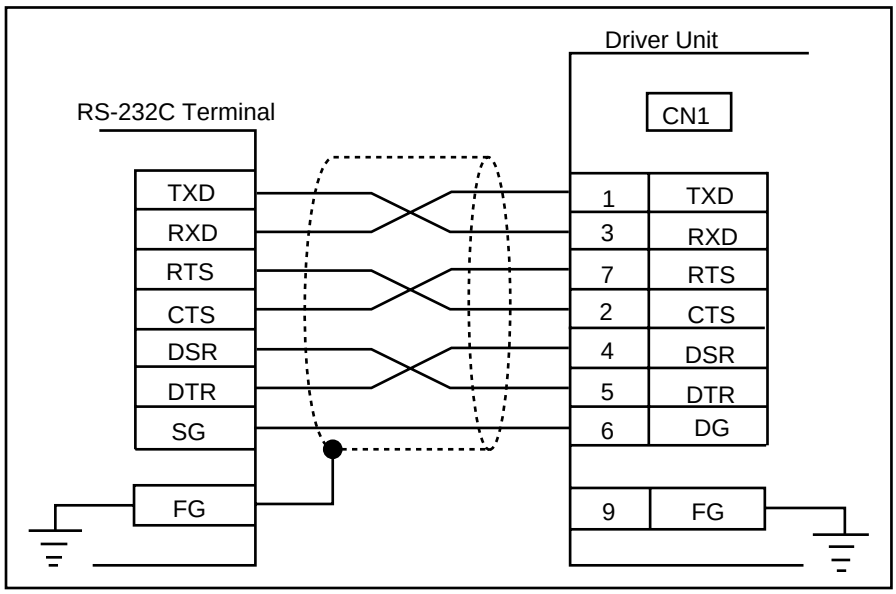
Note * Selectable — can be set by SW202.

A.4.4. CN1 Sample Wiring Diagram

A.4.4.1. RTS Control/CTS Monitoring Active (Standard)

Figure A-12

CN1 Wiring With RTS Control/CTS Monitoring

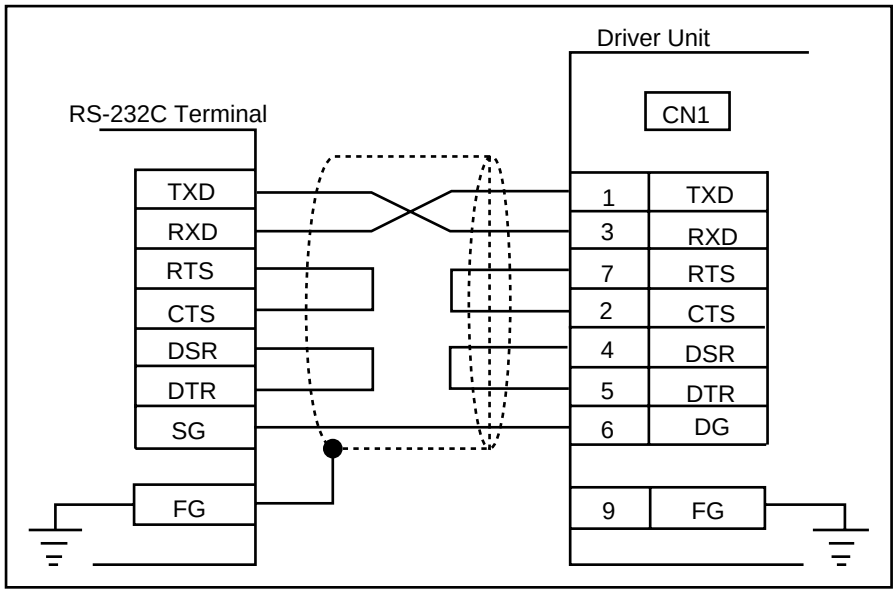


A.4.4.2. RTS Control/CTS Monitoring Inactive

Caution *Since this connection applies to non-procedure communication, the Driver Unit may fail to read data if a large amount of data is transmitted too quickly. Make sure that the Driver Unit echoes back, or leave spaces between data transmission.*

Figure A-13

CN1 Wiring Without RTS Control/ CTS Monitoring



Appendix 5. Parameter/Program Setting List

Write down your programs in Programmable Indexer channel or parameter settings against the trouble. You can read out the programs using TC command. Most parameter settings can be read using TS or ?×× (×× = parameter) command.

Parameter Setting List

Name	Shipping Set	Setting	Name	Shipping Set	Setting	Name	Shipping Set	Setting
AO	0		IN	1		PG	0.1	
CO	2048		JA	1		PI	1	
CR	X1		JV	1		TL	100	
FP	0		LR	0		VG	1	
FS	0		LS	0	+	VI	1	
HA	1				–			
HO	0		MA	1				
HP	0		MV	1				
HV	0.2		NP	0				
HZ	0.01		NS	0				

Program List

CH	Program	CH	Program	CH	Program	CH	Program
0		16		32		48	
1		17		33		49	
2		18		34		50	
3		19		35		51	
4		20		36		52	
5		21		37		53	
6		22		38		54	
7		23		39		55	
8		24		40		56	
9		25		41		57	
10		26		42		58	
11		27		43		59	
12		28		44		60	
13		29		45		61	
14		30		46		62	
15		31		47		63	

Appendix 6. Replacing Battery

The Driver Unit uses a lithium battery to back up the control parameters written in the RAM after power is turned off. In normal service condition, it backs up data in the RAM for approximately 10 years after delivery without replacing the battery. Thus, battery replacement is not usually required. If it needs replacing for some reason, follow the steps shown below.

(1) Turn on power of the Driver Unit, then leave the Driver Unit for 30 minutes or more.
- This wait period is used to charge the super capacitor, which backs up the RAM while replacing the battery.
- During this period, the Driver Unit may drive the Motor.
- If power has been supplied to the Driver Unit for 30 minutes or more (including motor operation time) when the battery is to be replaced, the capacitor charging period is not required.

(2) Turn off power of the Driver Unit, then detach the front and side panels from the Driver Unit.

Front panel: M3 × 6 countersunk screws × 2 and blind screws × 2
Side panel: M3 × 6 countersunk screws × 4

(3) Detach the RDC board.

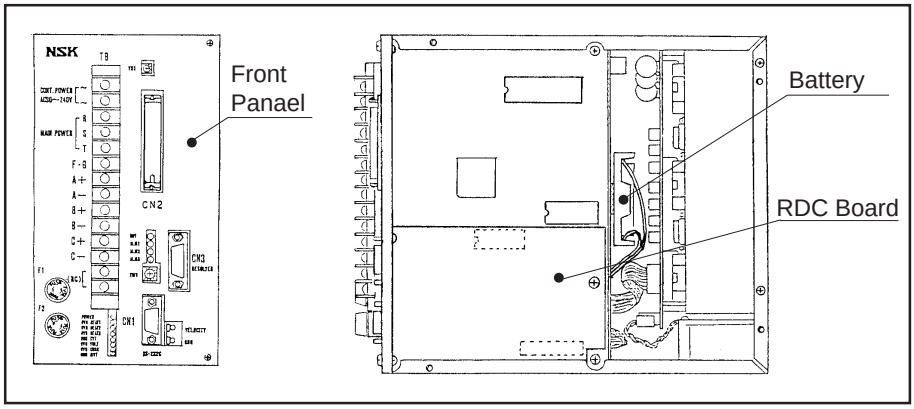
The RDC board is attached to the CB board with screws (M3 × 6 Semus screws × 3) and connector. Remove the screws, then lift the RDC board with care not to damage its connector.

(4) Replace the battery.
- The battery is connected with a connector. Soldering is not required.
- The super capacitor will last for approximately 30 minutes. Complete operation to this point within 30 minutes since power is turned off.
- The battery socket is fixed to the middle chassis with velcro. Replace the battery with the socket.

NSK will provide the battery (part number: M-E5118-0003). Contact NSK to order a battery. A battery has a holder and connector. It may be replaced without any tools.

Figure A-14

Location Of Each Part

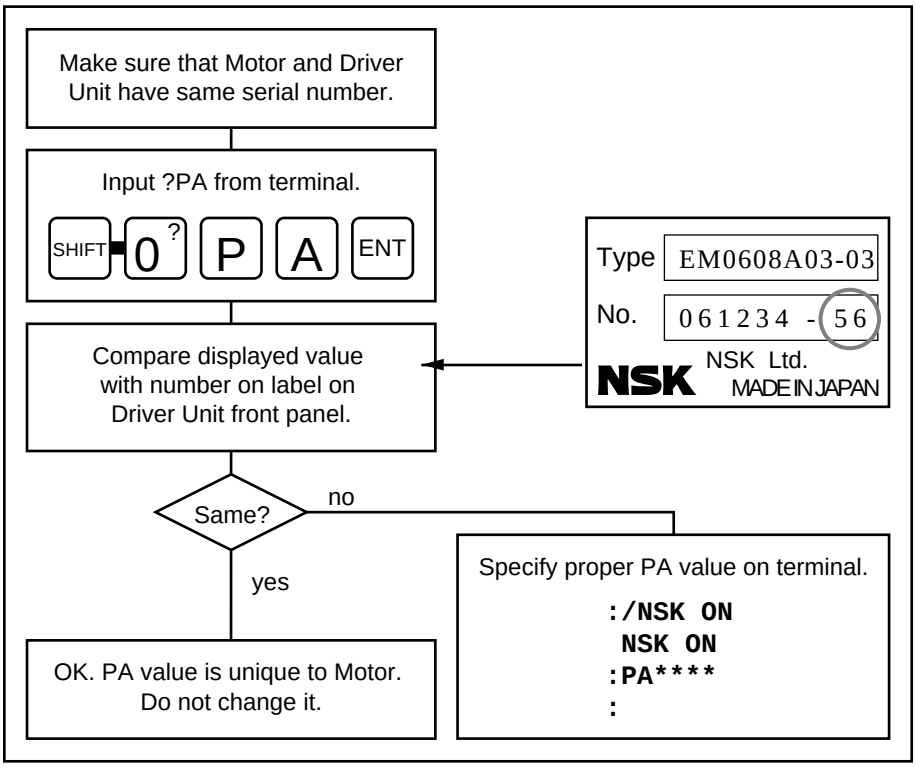


Appendix 7. Checking PA Value

When checking PA value, follow the flowchart below.

Figure A-15

PA Value Check



Appendix 8. Checking Motor and Resolver Wiring

Order of checking

1. Check cable appearance.
2. Check connector engagement.
3. Check conductivity and insulation of wiring.

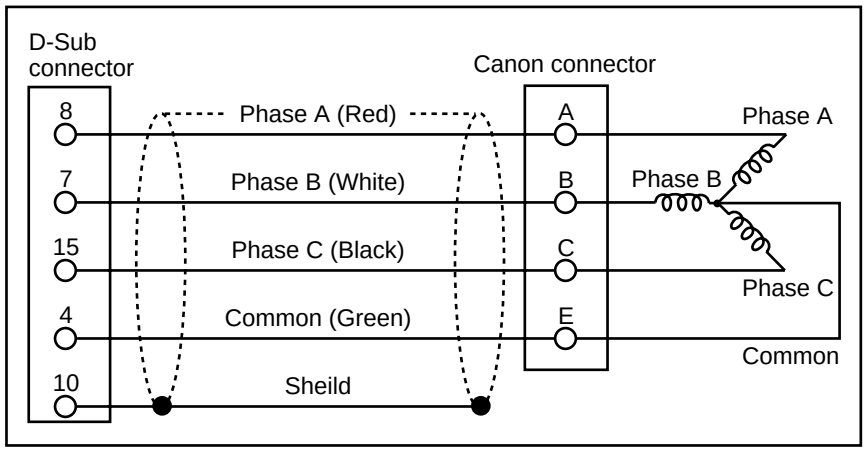
Caution *Disconnect the wiring from the Driver Unit to perform megger test. Otherwise, the internal circuits of the Driver Unit may be damaged.*

Caution *Use voltage of 500VDC or less for megger test.*

Resolver

Figure A-16

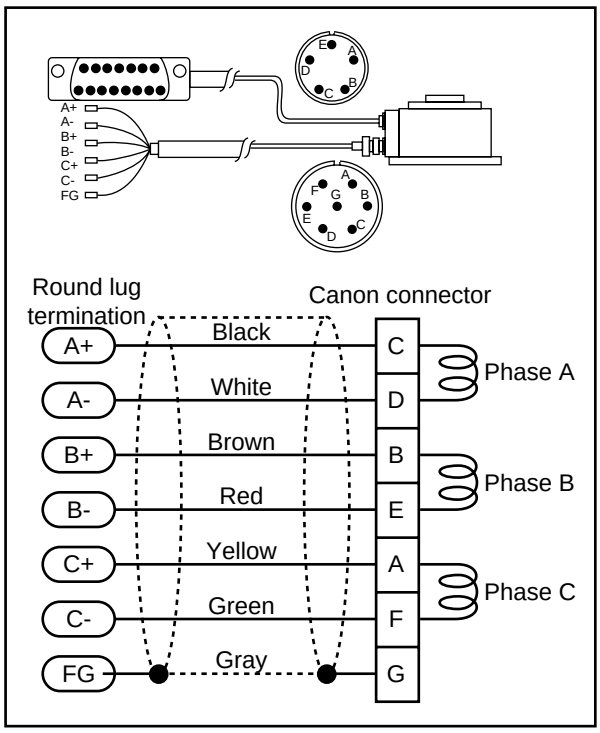
Checking Resolver Wiring



Motor for type EM Driver Unit

Figure A-17

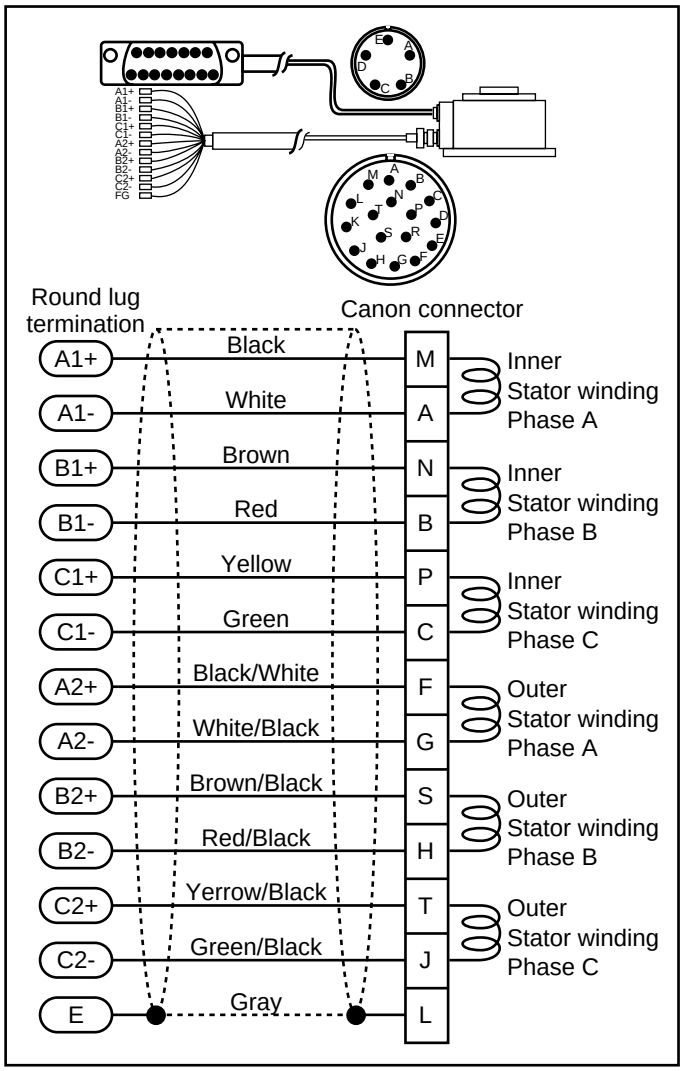
Checking Motor Wiring (EM)



Motor for type EP Driver Unit

Figure A-18

Checking Motor Wiring (EP)



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