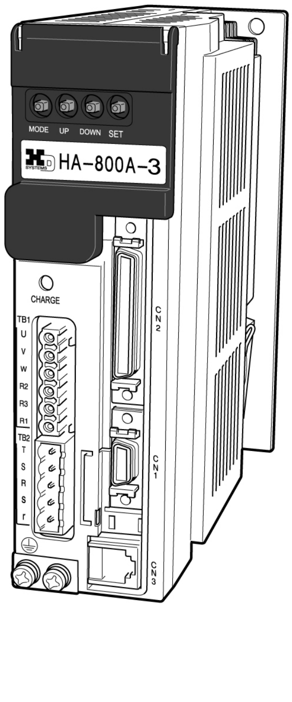
100V/200V power supply
AC Servo Driver

HA-800A series manual

(for SHA, FHA-Cmini, FHA-C, RSF/RKF series)



This operation manual covers the following software versions: ●**Ver 3.x**

ISO14001
(Hotaka plant)
ISO9001

Introduction

Thank you very much for your purchasing our HA-800A series servo driver.
Wrong handling or use of this product may result in unexpected accidents or shorter life of the product. Read this document carefully and use the product correctly so that the product can be used safely for many years.
Product specifications are subject to change without notice for improvement purposes.
Keep this manual in a convenient location and refer to it whenever necessary in operating or maintaining the units.
The end user of the driver should have a copy of this manual.

SAFETY GUIDE

To use this driver safely and correctly, be sure to read SAFETY GUIDE and other parts of this document carefully and fully understand the information provided herein before using the driver.

NOTATION

Important safety information you must note is provided herein. Be sure to observe these instructions.

WARNING	Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious personal injury.
CAUTION	Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate personal injury and/or damage to the equipment.
Caution	Indicates what should be performed or avoided to prevent non-operation or malfunction of the product or negative effects on its performance or function.

LIMITATION OF APPLICATIONS

The equipment listed in this document may not be used for the applications listed below:

- Space equipment
- Aircraft, aeronautic equipment
- Nuclear equipment
- Household apparatus
- Vacuum equipment
- Automobile, automotive parts
- Amusement equipment, sport equipment, game machines
- Machine or devices acting directly on the human body
- Instruments or devices to transport or carry people
- Apparatus or devices used in special environments

If the above list includes your intending application for our products, please consult us.

CAUTION

Safety measures are essential to prevent accidents resulting in death, injury or damage of the equipment due to malfunction or faulty operation.

SAFETY NOTE

- **CAUTIONS FOR ACTUATORS AT APPLICATION DESIGNING**

CAUTION

Always use under followings conditions:

The actuator is designed to be used indoors. Observe the following conditions:

- **Ambient temperature: 0℃ to 40℃**
- **Ambient humidity: 20% to 80%RH (Non-condensation)**
- **Vibration: Max 24.5 m/S2**
- **No contamination by water, oil**
- **No corrosive or explosive gas**

Follow exactly the instructions in the relating manuals to install the actuator in the equipment.

- **Ensure exact alignment of motor shaft center and corresponding center in the application.**
- **Failure to observe this caution may lead to vibration, resulting in damage of output elements.**

- **CAUTION FOR ACTUATORS IN OPERATIONS**

WARNING

Never connect cables directly to a power supply socket.

- **Each actuator must be operated with a proper driver.**
- **Failure to observe this caution may lead to injury, fire or damage of the actuator.**

Do not apply impacts and shocks.

- **Do not use a hammer during installation.**
- **Failure to observe this caution could damage the encoder and may cause uncontrollable operation.**

Avoid handling of actuators by cables.

- **Failure to observe this caution may damage the wiring, causing uncontrollable or faulty operation.**

CAUTION

Keep limited torques of the actuator.

- **Keep limited torques of the actuator.**
- **Be aware, that if arms attached to output element hits by accident an solid, the output element may be uncontrollable.**

● CAUTIONS FOR DRIVERS AT APPLICATION DESIGNING

CAUTION

Always use drivers under followings conditions:

- **Mount in a vertical position keeping sufficient distance to other devices to let heat generated by the driver radiate freely.**
- **0℃ to 50℃, 95% RH or below (Non condensation)**
- **No vibration or physical shock**
- **No corrosive, inflammable or explosive gas**

Use sufficient noise suppressing means and safe grounding.

- **Keep signal and power leads separated.**
- **Keep leads as short as possible.**
- **Ground actuator and driver at one single point, minimum ground resistance class: D (less than 100 ohms)**
- **Do not use a power line filter in the motor circuit.**

Pay attention to negative torque by inverse load.

- **Inverse load may cause damages of drivers.**
- **Please consult our sales office, if you intent to apply products for inverse load.**

Use a fast-response type ground-fault detector designed for PWM inverters.

- **Do not use a time-delay-type ground-fault detector.**

Safety measures are essential to prevent accidents resulting in death, injury or damage of the equipment due to malfunction or faulty operation.

● CAUTION FOR DRIVERS IN OPERATIONS

WARNING

Never change wiring while power is active.

Make sure of power non-active before servicing the products. Failure to observe this caution may result in electric shock or personal injury.

Do not touch terminals or inspect products at least 15 minutes after turning OFF power.

- **Otherwise residual electric charges may result in electric shock. In order to prevent electric shock, perform inspections 15 minutes after the power supply is turned OFF and confirming the CHARGE lamp is turned OFF.**
- **Make installation of products not easy to touch their inner electric components.**

CAUTION

Do not make a voltage resistance test.

- **Failure to observe this caution may result in damage of the control unit.**
- **Please consult our sales office, if you intent to make a voltage resistance test.**

Do not operate control units by means of power ON/OFF switching.

- **Start/stop operation should be performed via input signals.**
- **Failure to observe this caution may result in deterioration of electronic parts.**

DISPOSAL OF AN ACTUATOR, A MOTOR, A CONTROL UNIT AND/OR THEIR PARTS

CAUTION

All products or parts have to be disposed of as industrial waste.

Since the case or the box of drivers have a material indication, classify parts and dispose them separately.

Structure of this document

Chapter 1	**Functions and configuration**	Overviews of driver models, specifications, external dimensions, etc., are explained.
Chapter 2	**Installation/wiring**	Receiving inspection, environment, power wiring, noise suppression and connector wiring are explained.
Chapter 3	**Startup**	Startup procedures to be followed when the driver is used for the first time, from receiving inspection to operation of the actual system, are explained.
Chapter 4	**Encoder system**	The encoder configuration is different depending on the actuator model. Details of each actuator are explained.
Chapter 5	**I/O signals**	Details of I/O signal conditions and signal functions are explained.
Chapter 6	**Panel display and operation**	How to operate the display, operation buttons on the driver's front panel and overview of operation in each mode is explained.
Chapter 7	**Status display mode/ Alarm mode/ Tune mode**	Explanation of information displayed in the status display mode and alarm mode. Operations and details of servo loop gains, various judgment criteria and acceleration/deceleration time setting during speed control performed in the tune mode are explained.
Chapter 8	**System parameter mode**	Details of how to assign I/O signals and set their logics, as well as extended functions such as control mode selection, pulse input system selection and electronic gear setting, etc., are explained.
Chapter 9	**Test mode**	Details of how to check the system operation by auto-tuning via jogging, monitoring of I/O signals and simulated operation of output signals are explained.
Chapter 10	**Communication software (PSF-800)**	How you can use the dedicated personal computer software to check I/O signal statuses, rotation speeds and other servo statuses, perform auto-tuning, set parameters, assign I/O signals and monitor servo operation waveforms are explained.
Chapter 11	**Troubleshooting**	Details of how driver alarms and warnings generate are explained.
Chapter 12	**Option**	Options you can purchase as necessary are explained.
Appendix		The list of default parameters and regenerative resistors are explained.

Table of contents

Chapter 7 Status display mode/alarm mode/tune mode

Chapter 8 System parameter mode

Chapter 9 Test mode

Chapter 10 Communication software

Chapter 11 Troubleshooting

Chapter 12 Option

Appendix

Related manual

The table below lists related manual. Check each item as necessary.

Title	Description
AC Servo Actuator SHA series manual	The specifications and characteristics of SHA-20A to SHA-65A actuators are explained.
AC Servo Actuator FHA-C series manual	The specifications and characteristics of FHA-17C to FHA-40C actuators are explained.
AC Servo Actuator FHA-Cmini series manual	The specifications and characteristics of FHA-8Cmini to FHA-14Cmini actuators are explained.
AC Servo Actuator RSF/RKF series manual	The specifications and characteristics of RSF-17 to RSF-32 and RKF-20 to RKF-32 actuators are explained.

Related actuator/driver standards

				Function	HA-800*-1	HA-800*-3	HA-800*-6	HA-800*-24
				Rated current (A)	1.5	3	6	24
				Maximum current (A)	4.0	9.5	19	55
				General-purpose I/O	HA-800A			
				MECHATROLINK	HA-800B			
				CC-Link	HA-800C			
		Overseas standard		UL/cUL	○			
				CE	○			
				TUV	○			
Applicable actuator	**Voltage**	**UL/c UL**	**CE**	**Encoder type**				
FHA-8C-xx-E200	200		○	Wire-saving incremental	-1C-200			
FHA-11C-xx-E200	200		○		-1C-200			
FHA-14C-xx-E200	200		○		-1C-200			
FHA-17C-xx-E250	200	○	○			-3C-200		
FHA-25C-xx-E250	200	○	○			-3C-200		
FHA-32C-xx-E250	200	○	○				-6C-200	
FHA-40C-xx-E250	200	○	○				-6C-200	
FHA-8C-xx-12S17b	200			17-bit absolute	-1D/E-200			
FHA-11C-xx-12S17b	200				-1D/E-200			
FHA-14C-xx-12S17b	200				-1D/E-200			
FHA-17C-xx-S248	200	○	○	13-bit absolute		-3A-200		
FHA-25C-xx-S248	200	○	○			-3A-200		
FHA-32C-xx-S248	200	○	○				-6A-200	
FHA-40C-xx-S248	200	○	○				-6A-200	
FHA-8C-xx-E200	100		○	Wire-saving incremental	-1C-100			
FHA-11C-xx-E200	100		○		-1C-100			
FHA-14C-xx-E200	100		○		-1C-100			
FHA-17C-xx-E250	100	○	○			-3C-100		
FHA-25C-xx-E250	100	○	○				-6C-100	
FHA-32C-xx-E250	100	○	○				-6C-100	
FHA-8C-xx-12S17b	100			17-bit absolute	-1D/E-100			
FHA-11C-xx-12S17b	100				-1D/E-100			
FHA-14C-xx-12S17b	100				-1D/E-100			
FHA-17C-xx-S248	100	○	○	13-bit absolute		-3A-100		
FHA-25C-xx-S248	100	○	○				-6A-100	
FHA-32C-xx-S248	100	○	○				-6A-100	

				Function	HA-800*-1	HA-800*-3	HA-800*-6	HA-800*-24
				Rated current (A)	1.5	3	6	24
				Maximum current (A)	4.0	9.5	19	55
				General-purpose I/O	HA-800A			
				MECHATROLINK	HA-800B			
				CC-Link	HA-800C			
		Overseas standard		UL/cUL	O			
				CE	O			
				TUV	O			
Applicable actuator	**Voltage**	**UL/c UL**	**CE**	**Encoder type**				
SHA20Axxxx-C08x200-xxS17bA	200	O	O	17-bit absolute		-3D/E -200		
SHA25Axxxx-B09x200-xxS17bA	200	O	O			-3D/E -200		
SHA32Axxxx-B12x200-xxS17bA	200	O	O				-6D/E -200	
SHA40Axxxx-B15x200-xxS17bA	200	O	O				-6D/E -200	-24D/E -200
SHA58Axxxx-A21x200-xxS17bA	200	O	O					-24D/E -200
SHA65Axxxx-A21x200-xxS17bA	200	O	O					-24D/E -200
SHA25Axxxx-B09x100-xxS17bA	100	O	O				-6D/E -100	

Compatible standards

Motor & Actuator

UL 1004-1 (Rotating Electrical Machines - General Requirements)
UL 840 (Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment)
CSA-C22.2 No. 100 (Motors and Generators), CSA-C22.2 No. 0.2 (Insulation Coordination)
(UL File No. E243316)
EN60034-1 (Low Voltage Directive)
* The compatible Motor and Actuator standards vary depending on the model.
For details, refer to the individual catalogue.

Driver

<HA-800A-1*, HA-800A-3*, HA-800A-6*, HA-800A-24*>

UL 508C (Power Conversion Equipment)
CSA-C22.2 No.14 (Industrial Control Equipment)
(UL File No. E229163)

EN61800-5-1 (Low Voltage Directive)
EN61800-3 (EMC Directive)

Conformance to European EC Directives

We conduct the Low Voltage Directive and EMC Directive conformance check test related to CE marking for the HA-800 series drivers at the third party authentication agency in order to ease CE marking by customer's device.

Precautions on conformance to EMC Directives

We fabricated a model that embeds AC Servo Driver and AC Servo Actuator or Motor in a control board for our AC servo system and use the model to comply with standards related to EMC Directives.
In your actual use, using conditions, cable length and other conditions related to wiring may be different from the model.
For these reasons, it is necessary that the final equipment or devices incorporating AC Servo Driver and AC Servo Actuator comply with EMC Directives.
We introduce peripheral devices used in our model such as noise filter to make it easy for you to comply with EMC Directives when incorporating and using this product.

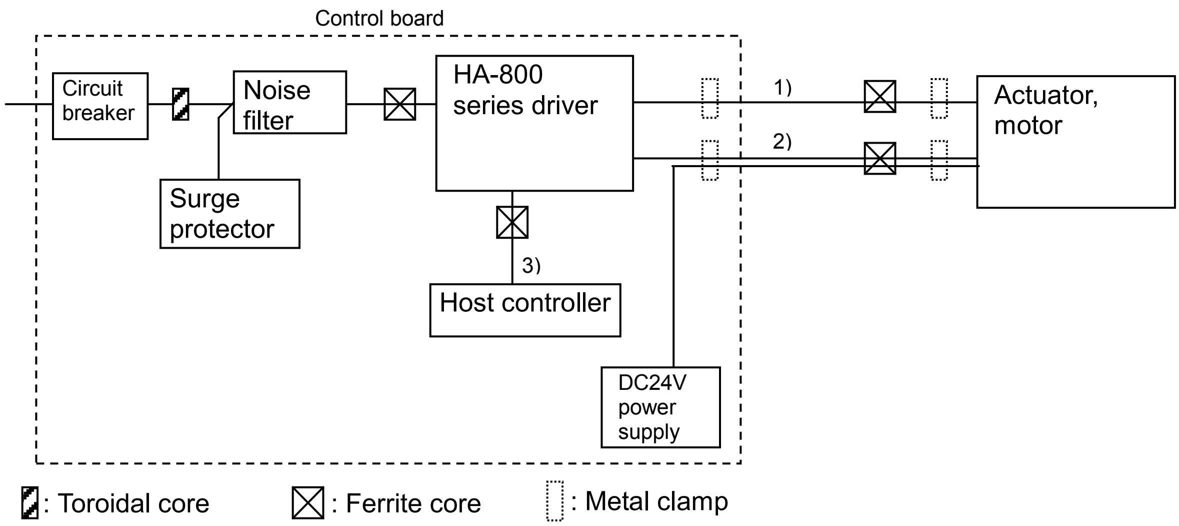
Standard related to EMC Directives

Motor/driver
EN55011/ Group 1 Class A/ A2: 2007
EN61800-3: 2004
IEC61000-4-2: Electrostatic discharge immunity
IEC61000-4-3: Radio frequency field immunity
IEC61000-4-4: Electrical fast transient/burst immunity
IEC61000-4-5: Surge immunity
IEC61000-4-6: Immunity to conducted disturbances, induced by radio-frequency
IEC61000-2-1: Voltage dip and voltage variations immunity
IEC61000-2-4: Low frequency conducted disturbance
IEC60146-1-1 Class B

Configuration of peripheral devices

Installation environment (conditions): Please observe the following installation environment in order to use this product safely.
1) Overvoltage category: III
2) Pollution degree: 2

Model configuration diagram



1) Encoder cable 2) Motor cable (motor power and holding brake)
3) Interface cable

(1) Input power supply
- 200V input type
  - Main circuit power: 3 phase/single phase, 200 to 230V (+10%, -15%), 50/60Hz
  - Control power supply: Single phase, 200 to 230V (+10%, -15%), 50/60Hz
- 100V input type
  - Main circuit power: Single phase, 100 to 115V (+10%, -15%), 50/60Hz
  - Control power supply: Single phase, 100 to 115V (+10%, -15%), 50/60Hz

(2) Circuit breaker

Use a circuit breaker complying with IEC standard and UL standard (UL Listed) for the power input area.

(3) Noise filter

Use a noise filter complying with EN55011 Group 1 Class A.
(For details, refer to the next page.)

(4) Toroidal core

Install toroidal core in the power input area.
Depending on the noise filter, 4-turn input to L1, L2, L3, and ground or 1-turn input to L1, L2, and L3, not including ground, may be valid.
(For details, refer to the next page.)

(5) Motor cable, encoder cable

Use shield cables for the motor cable and encoder cable.
Clamp ground the shield of the motor cable and encoder cable near the driver and motor.
If you use FHA-8C/11C/14C or RSF-8B/11B/14B, insert the ferrite core into the motor cable and encoder cable (near the motor).

(6) Interface cable

If you use the HA-800A driver, use ferrite core for the interface cable.

(7) Surge protector

Install the surge absorber in the AC power input area. Remove the surge absorber when you perform voltage resistance test of AC/DC machine/system with built-in surge absorber.
(The surge absorber may be damaged.)

(8) Ground

In order to prevent electric shock, make sure to connect the ground wire of the control board (control cabinet) to the ground terminal ⏚ of the AC Servo Driver.

Moreover, do not tighten the connection to the ground terminal ⏚ of the AC Servo Driver together.

Recommended parts for compliance with EMC

(1) Noise filter

Model	Specifications	Manufacturer	Remarks
RF3020-DLC	Rated voltage: Line-Line 440 to 550V Rated current: 20 A	RASMI ELECTRONICS LTD.	Enable the 4-turn input to L1, L2, L3, and ground for toroidal core.
RF3030-DLC	Rated voltage: Line-Line 440 to 550V Rated current: 30 A	RASMI ELECTRONICS LTD.	
RF3040-DLC	Rated voltage: Line-Line 440 to 550V Rated current: 40 A	RASMI ELECTRONICS LTD.	
HF3010A-UN	Rated voltage: AC250V Rated current: 10A	Soshin Electric Co., Ltd.	Enable 1-turn input to L1, L2, and L3, not including ground for toroidal core.
HF3030A-UN	Rated voltage: AC250V Rated current: 30A	Soshin Electric Co., Ltd.	
HF3040A-UN	Rated voltage: AC250V Rated current: 40A	Soshin Electric Co., Ltd.	
SUP-P5H-EPR	Rated voltage: AC250V Rated current: 5A	Okaya Electric Industries Co., Ltd.	Enable the 4-turn input to L1, L2, L3, and ground for toroidal core. Moreover, install insulation transformer and ferrite core at the power input area. Refer to (3) and (5).
SUP-P10H-EPR	Rated voltage: AC250V Rated current: 10A	Okaya Electric Industries Co., Ltd.	
3SUP-H5H-ER-4	Rated voltage: AC250V Rated current: 5A	Okaya Electric Industries Co., Ltd.	
3SUP-H10-ER-4	Rated voltage: AC250V Rated current: 10A	Okaya Electric Industries Co., Ltd.	

(2) Toroidal core

Model	Outer diameter	Inner diameter	Manufacturer
MA070R-63/38/25A	65 mm	36 mm	JFE Ferrite Corporation
LRF624520MK	66 mm	41 mm	Nippon Chemi-Con Corporation

(3) Ferrite core

Model	Manufacturer
ZCAT3035-1330	TDK Corporation
ZCAT2032-0930	TDK Corporation
ZCAT2132-1130	TDK Corporation

(4) Surge protector

Model	Manufacturer
RAV-781BXZ-4	Okaya Electric Industries Co., Ltd.
RAV-781BWZ-4	Okaya Electric Industries Co., Ltd.

(5) Insulation transformer

Model	Specifications	Manufacturer
PT1-20002	Number of phase: Single phase Rated current: 2 A Power capacity: 400VA	Harmonic Drive Systems Inc.
PT1-20004	Number of phase: Single phase Rated current: 4 A Power capacity: 800VA	Harmonic Drive Systems Inc.
PT1-20008	Number of phase: Single phase Rated current: 8 A Power capacity: 1600VA	Harmonic Drive Systems Inc.

(5) Insulation transformer

The use of the insulation transformer is recommended in the place thought that the noise environment is severe though HA-800 series have an enough noise tolerance though it doesn't use the insulation transformer.

Driver Model	No. of phase	Power capacity (kVA)	
HA-800A-1*	3	FHA-8,11C	0.15
		FHA-14C	0.25
HA-800A-3*	3	FHA-17C RSF-17	0.4
		SHA-20 SHA-25 FHA-25C RSF-20,25 RKF20,25 MAC08 MAB09	0.8
HA-800A-6*	3	SHA-25	0.8
		SHA-32 FHA-32C RSF-32 RKF-32 MAB-12	1.5
		SHA-40 FHA-40C MAB-15	1.8
HA-800A-24*	3	SHA-40 MAB-15	2.5
		SHA-58 SHA-65	3.5
		MAA-21	5.5

Chapter 1

Functions and configuration

Outlines of driver models, specifications, external dimensions, etc., are explained in this chapter.

1-1 Overview of drivers

The HA-800 driver series are dedicated servo drivers for SHA series, FHA-C series, RSF series and other actuators which are ultra-thin and feature a hollow shaft structure. These actuators utilize speed reducer harmonic drive® for precision control and AC servo motors.
The HA-800 drivers provide many superior functions to allow various actuators to excel in performance.

Overview of functions

Shorter positioning stabilization time using original control logic (compared to HA-655)

By utilizing the characteristics of HarmonicDrive® in the control logic, positioning overshoot and undershoot are suppressed and the positioning stabilization time is reduced significantly.

Adopting an I/O signal function assignment method

Desired functions can be selected from a wide range of functions and assigned to I/O signals according to specific applications.
Also, multiple functions can be assigned to a single input terminal for an input signal, which adds to usability.

Auto-tuning function

The auto-tuning function allows the driver to estimate the load and automatically set an appropriate servo gain in the test mode.

Control mode switching

You can use an input signal to switch the control mode applied to the current operation.
The following switching patterns are supported:
Position control mode ↔ Speed control mode
Position control mode ↔ Torque control mode
Speed control mode ↔ Torque control mode

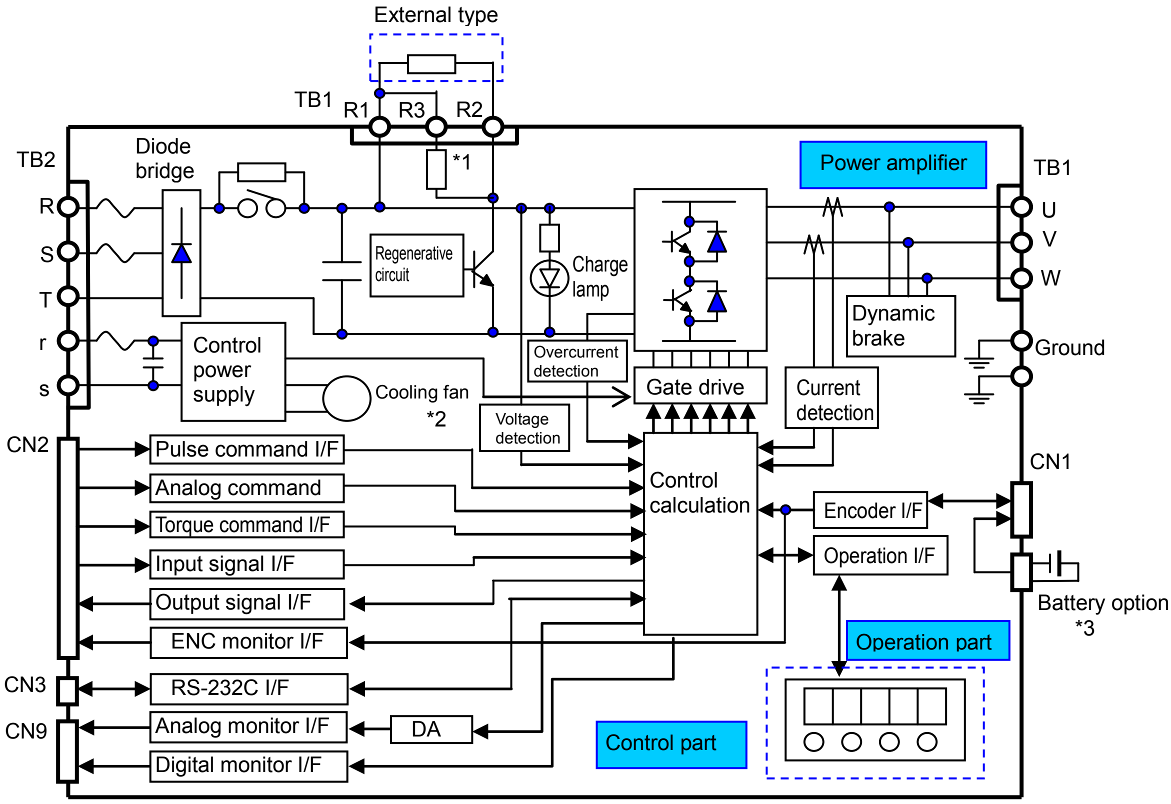
- **Position control mode**
  The pulse speed and pulse count specified by an external pulse train are used to implement smooth speed control and high-accuracy positioning control.

- **Speed control mode**
  An external analog speed command (DC±10V) or internal speed command via parameter is used to smoothly control the rotation speed and direction of the actuator at high accuracy.

- **Torque control mode**
  An external analog torque command (DC±10V) is used for the torque control of the motor.

1-2 Function block diagram

An internal function block diagram of this driver is shown.

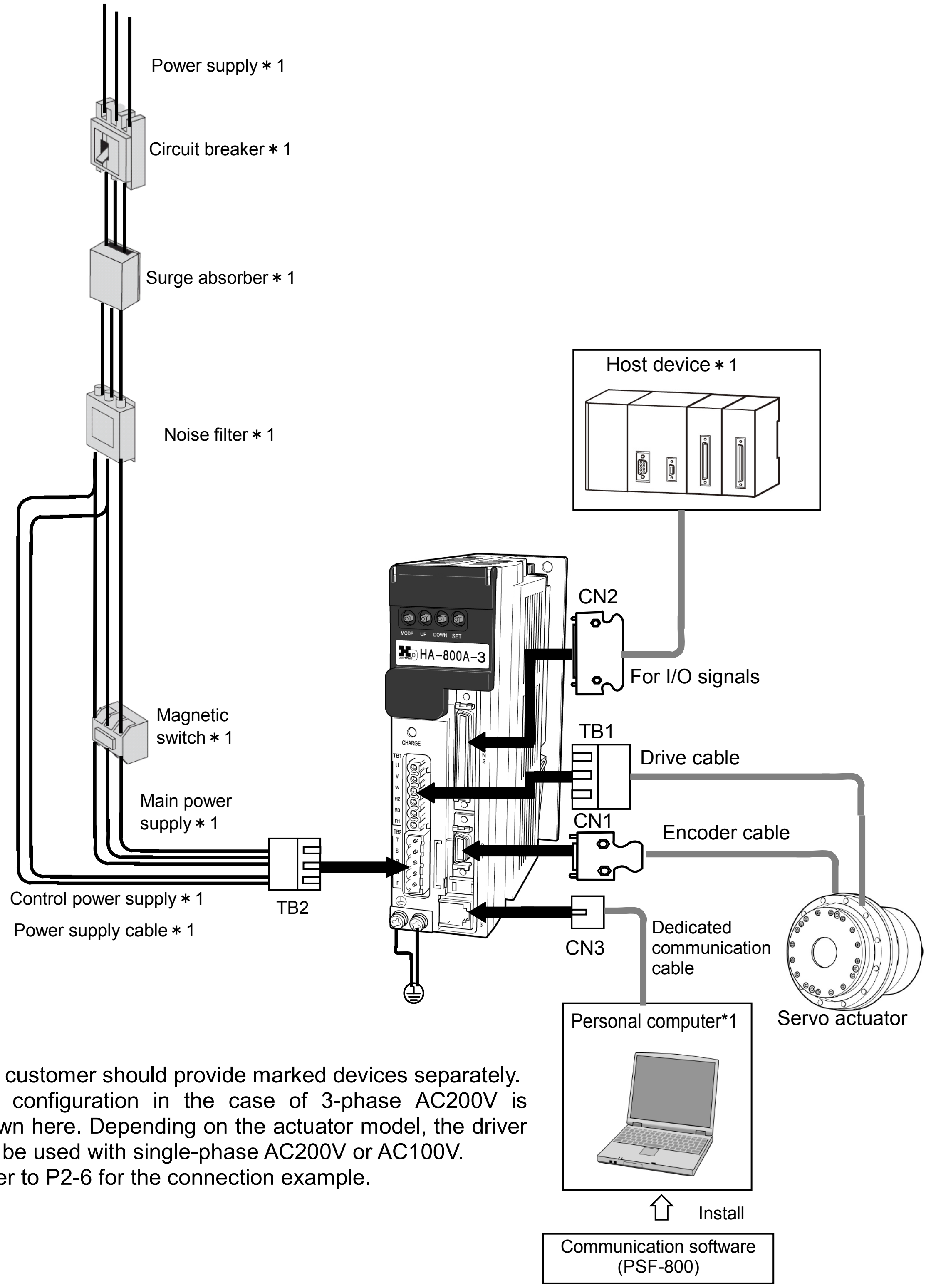


*1: The HA-800-1 has no built-in regenerative resistor.
*2: The HA-800-6 and higher models come with a cooling fan.
*3: A battery is required if an absolute encoder is used.

1-3 Device configuration diagram

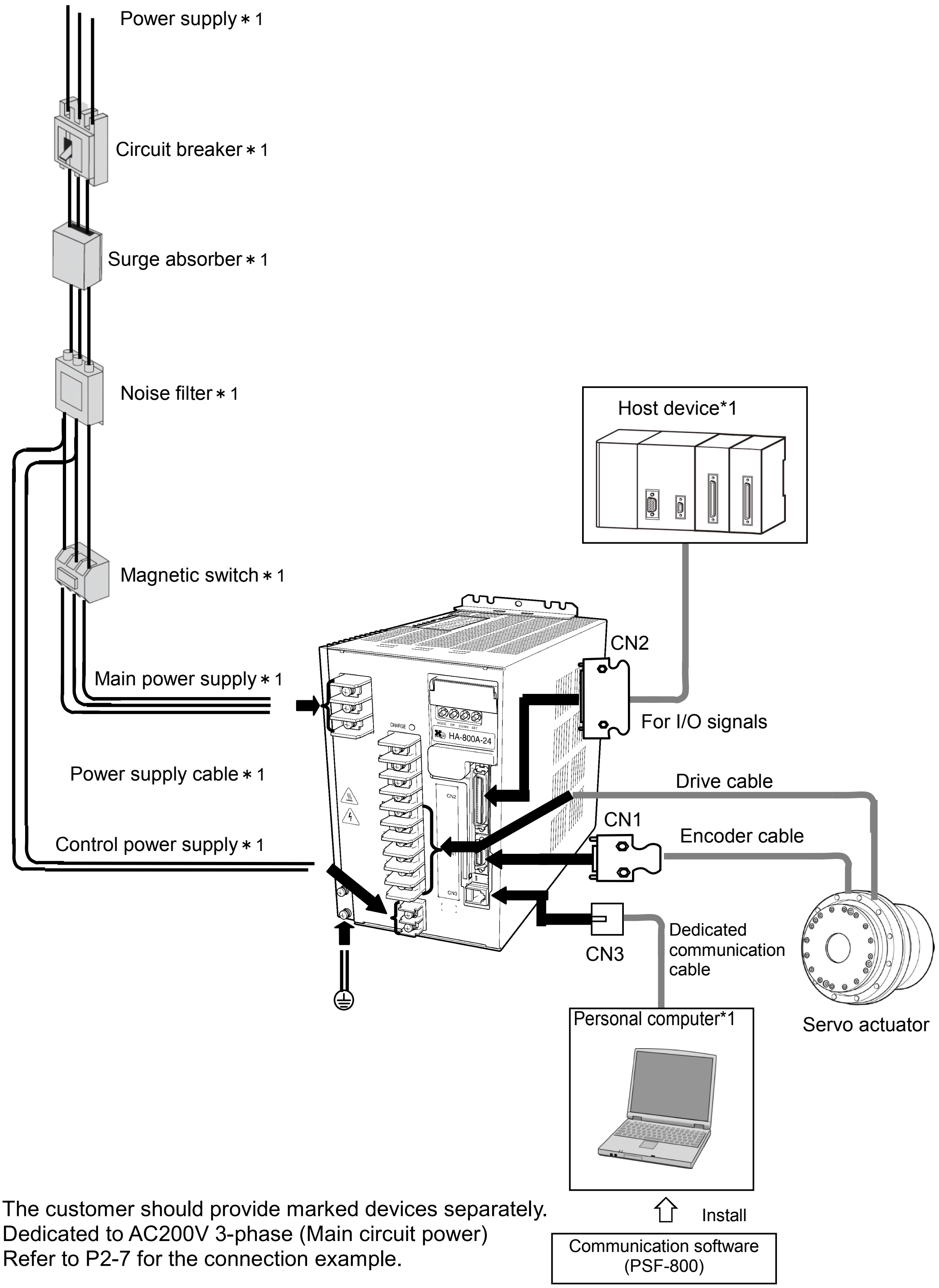
A basic configuration diagram of this driver is shown.

HA-800A-1,3,6-200



*1: The customer should provide marked devices separately.
*2: The configuration in the case of 3-phase AC200V is shown here. Depending on the actuator model, the driver can be used with single-phase AC200V or AC100V.
Refer to P2-6 for the connection example.

HA-800A-24-200



*1: The customer should provide marked devices separately.
*2: Dedicated to AC200V 3-phase (Main circuit power)
Refer to P2-7 for the connection example.

1-4 Driver model

The following explains how to read the driver model name and symbol, as well as options.

Driver model

HA-800A-3A-200-SP

Model: AC Servo Driver HA series

Series: 800 series

800A	I/O command type
800B	MECHATROLINK type
800C	CC-Link type

Rated output current:

1	1.5 A
3	3 A
6	6 A
24	24 A

Available encoder*:

A	13-bit absolute encoder
B	14-wire incremental encoder
C	4-wire wire-saving incremental encoder
D	17-bit absolute encoder
E	17-bit encoding incremental model

Input voltage:

200	AC200V
100	AC100V

Custom specification code:

Blank	Standard product
SP	Special product

*: For details on the available encoders, see Chapter 4.

Option

Extension cables (optional)

Refer to [1-5 Actuator and extension cable combinations].

Dedicated communication cables (optional)

Model EWA-RS03

Connectors (optional)

Model CNK-HA80A-S1/CNK-HA80A-S2/CNK-HA80A-S1-A/CNK-HA80A-S2-A

Servo parameter setting software

PSF-800 (Downloadable from our website http://www.hds.co.jp/)

Backup battery for absolute encoder

HAB-ER17/33 (attached to the shipped driver)

1-5 Actuator and extension cable combinations

The following explains the combinations of drivers, actuators and extension cables (option).

Actuator series	Model No.	Input voltage (V)	Encoder type	Combined driver	Extension cables (option)
				HA-800A	
SHA series	20	200	17-bit Absolute	HA-800A-3D/E-200	Motor wire EWD-MB**-A06-TN3 Encoder wire EWD-S**-A08-3M14
	25	100		HA-800A-6D/E-100	
		200		HA-800A-3D/E-200	
	32	200		HA-800A-6D/E-200	
	40	200		HA-800A-6D/E-200	
	40	200		HA-800A-24D/E-200	Motor wire Model No.40:EWD-MB**-A06-TMC Model No.58,65:EWD-MB**-D09-TMC Encoder wire Model No.40:EWD-S**-A08-3M14 Model No.58,65:EWD-S**-D10-3M14
	58	200		HA-800A-24D/E-200	
	65	200		HA-800A-24D/E-200	
FHA-Cmini series	8	200	4 wires, wire-saving type Incremental	HA-800A-1C-200	Motor wire EWC-M**-A06-TN3 Encoder wire EWC-E**-M06-3M14
	11	200		HA-800A-1C-200	
	14	200		HA-800A-1C-200	
	8	100		HA-800A-1C-100	
	11	100		HA-800A-1C-100	
	14	100		HA-800A-1C-100	
	8	200	17-bit Absolute	HA-800A-1D/E-200	Motor wire EWC-M**-A06-TN3 Encoder wire EWD-S**-A08-3M14
	11	200		HA-800A-1D/E-200	
	14	200		HA-800A-1D/E-200	
	8	100		HA-800A-1D/E-100	
	11	100		HA-800A-1D/E-100	
	14	100		HA-800A-1D/E-100	
FHA-C series	17	200	4 wires, wire-saving type Incremental	HA-800A-3C-200	Motor wire EWC-MB**-M08-TN3 Encoder wire EWC-E**-B04-3M14
	25	200		HA-800A-3C-200	
	32	200		HA-800A-6C-200	
	40	200		HA-800A-6C-200	
	17	200	13-bit Absolute	HA-800A-3A-200	Motor wire EWC-MB**-M08-TN3 Encoder wire EWC-S**-B08-3M14
	25	200		HA-800A-3A-200	
	32	200		HA-800A-6A-200	
	40	200		HA-800A-6A-200	
	17	100	4 wires, wire-saving type Incremental	HA-800A-3C-100	Motor wire EWC-MB**-M08-TN3 Encoder wire EWC-E**-B04-3M14
	25	100		HA-800A-6C-100	
	32	100		HA-800A-6C-100	
	17	100	13-bit Absolute	HA-800A-3A-100	Motor wire EWC-MB**-M08-TN3 Encoder wire EWC-S**-B08-3M14
	25	100		HA-800A-6A-100	
	32	100		HA-800A-6A-100	
RSF series	17	200	14 wires Incremental	HA-800A-3B-200	Motor wire EWA-M**-A04-TN3 Encoder wire EWA-E**-A15-3M14
RSF/RKF series	20	200		HA-800A-3B-200	
	25	200		HA-800A-3B-200	
	32	200		HA-800A-6B-200	

*1: The maximum torque, allowable continuous torque, and operable range depend on the driver combined with the SHA40A actuator. Select the option according to your intended application. Refer to "Operable Range" in the SHA Series Manual.

*2: ** in the extension cable model indicates the cable length. Select a desired length from the following 3 types: 03:3m、05:5m、10:10m

1-6 Driver ratings and specifications

The following explains the ratings and specifications of this driver.

Input voltage		Power supply: 200V			Power supply: 100V		
Model		HA-800A-1*-200	HA-800A-3*-200	HA-800A-6*-200	HA-800A-1*-100	HA-800A-3*-100	HA-800A-6*-100
Driver's rated current*1		1.5 A	3.0 A	6 A	1.5 A	3.0 A	6 A
Driver's maximum current*1		4.0 A	9.5 A	19.0 A	4.0 A	9.5 A	19.0 A
Input voltage	Main circuit	AC200 to 230V (single phase*2*3/3 phase), +10 to -15%			AC100 to 115V (single phase), +10 to -15%		
	Control circuit	AC200 to 230V (single phase), +10 to -15% 30VA			AC100 to 115V (single phase), +10 to -15% 30VA		
Power frequency		50/60Hz					
Allowed revolution (motor shaft)	13-bit Absolute	—	-4,096 to 4,095		—	-4,096 to 4,095	
	17-bit Absolute	-32,768 to 32,767			-32,768 to 32,767		
Allowed environment		Operating temperature: 0 to 50℃ Storage temperature: -20 to 65℃ Operating/storage humidity: below 95%RH (No condensation) Vibration resistance: 4.9 m/s^2 (10 to 55Hz, Tested for 2 hours each in the X, Y, and Z directions) Shock resistance: 98m/s^2 (Tested once each in the X, Y, and Z directions) Ambience: Free from metal powder, powder dust, oil mist and corrosive gases					
Structure		Natural air cooling		Forced air-cooling	Natural air cooling		Forced air-cooling
Installation method		Base mount (wall installation)					
Control modes		Position control, speed control, torque control (Switchable using I/Os)					
Position command pulse		Line collector type: Maximum response frequency 2-pulse train, 1-pulse train: 1MHz, 2-phase pulse train: 200kHz Open collector type: Maximum response frequency 200kHz					
Speed command voltage		DC ± 10V/max. rotation speed, input impedance approx. 68kΩ					
Torque command voltage		DC ± 10V/maximum torque, input impedance approx. 68kΩ					
Speed control range		1: 1,000					
Input signals		Emergency stop, reset, clear, FWD inhibit, REV inhibit, FWD enable, REV enable, FWD selection, REV selection, internal speed command 1, internal speed command 2, internal speed limit 1, internal speed limit 2, torque limit, electronic gear selection, control mode, INHIBIT					
Output signals		Operation preparation complete, alarm, in-position complete, attained speed, attained torque, speed limiting, torque limiting, zero speed, control mode, DB status, battery voltage low, overload status, cooling fan stopped, FWD inhibit input effective, REV inhibit input effective, warning					
Motor terminals		3 channels, motor rotation speed, current command, general-purpose output (parameter selection)					
Digital I/O port		RS-232C/RS-485: Status monitor, various parameters settings (PSF-800) Digital output: Absolute encoder data output					
Operation panel	Configuration	Display (7-segment LED), 5 digits (red), 4 push-button switches					
	Status display function	Rotation speed (r/min), torque command (%), over load rate (%), input signal monitor, output signal monitor, alarm history (8 alarms), etc.					
	Parameter adjustment function	System parameters 1, 2, 3, 4, adjustment parameters 1, 2					

<table>
<tr><td rowspan="2">Protective functions</td><td>Alarms</td><td colspan="6">Emergency stop, overspeed, overload, IPM error (overcurrent),
regenerative resistor overheat, encoder disconnection, encoder receiving error,
UVW error, system failure, multi revolution overflow, multi revolution data error,
error counter overflow, memory failure, FPGA configuration error, FPGA setting error,
MEMORY error, Single revolution data error, BUSY error, overheat error,
communication error</td></tr>
<tr><td>Warnings</td><td colspan="6">Battery voltage low, Overload status, cooling fan stopped, main circuit power voltage low, FWD inhibit input effective,
REV inhibit input effective</td></tr>
<tr><td colspan="2">Regenerative processing</td><td>Comes with an external regenerative resistor mounting terminal</td><td colspan="2">Regenerative resistor contained
Comes with an external regenerative resistor mounting terminal</td><td>Comes with an external regenerative resistor mounting terminal</td><td colspan="2">Regenerative resistor contained
Comes with an external regenerative resistor mounting terminal</td></tr>
<tr><td colspan="2">Regenerative resistor absorption power</td><td>—</td><td>3W max.</td><td>8W max.</td><td>—</td><td>3W max.</td><td>8W max.</td></tr>
<tr><td colspan="2">Embedded functions</td><td colspan="6">Status display function, self diagnosis, electronic gear, JOG and other operations, dynamic brake,
multi revolution data backup battery</td></tr>
<tr><td colspan="2">Surge-current prevention function</td><td colspan="6">Incorporated (CPU control based on monitoring of main circuit voltage)</td></tr>
<tr><td colspan="2">Operation mode</td><td colspan="6">Status display mode (for usual operations), test mode, tune mode, system parameter configuration mode</td></tr>
<tr><td colspan="2">Mass</td><td colspan="2">1kg</td><td>1.2kg</td><td colspan="2">1kg</td><td>1.2kg</td></tr>
</table>

*1: Set according to the specification of the combined actuator.

*2: If the FHA-Cmini (FHA-8C/11C/14C) or FHA-17C is combined, 3-phase 200V or single-phase 200V input can be used.

*3: If the SHA series or any of FHA-25C/32C/40C is combined, use of 3-phase 200V input is recommended. Single-phase AC200V input can also be used by derating the output.Derate the rotation speed or output torque based on the continuous motion range of the actuator being 100%

Actuator reduction ratio	SHA20A 51/81/ 101/121/161	SHA25A 51/81/ 101/121	SHA25A 11/161	SHA32A 51/81/ 101/121	SHA32A 11/161	SHA40A 51/81/101/121/161 (Combined with HA-800A-6)	FHA-25C 50/100/ 160	FHA-32C 50/100/ 160	FHA-40C 50/100/ 160
Derating	100%	40%	70%	60%	80%	30%	60%	80%	40%

Actuator reduction ratio	SHA25A 50/80/ 100/120	SHA25A 160	SHA32A 50/80/ 100/120	SHA32A 160	SHA40A 50/80/100/120/160 (Combined with HA-800A-6)
Derating	40%	70%	60%	100%	30%

1

Functions and configuration

Input voltage		Power supply: 200V
Model		HA-800A-24
Driver's rated current*1		24 A
Driver's maximum current*1		55 A
Input voltage	Main circuit	AC200 to 230V (3 phase), +10 to -15%
	Control circuit	AC200 to 230V (single phase), +10 to -15% 30VA
Power frequency		50/60Hz
Allowed revolution (motor shaft)		-4,096 to 4,095 (13 bits, absolute) -32,768 to 32,767 (17 bits, absolute)
Allowed environment		Operating temperature: 0 to 50℃ Storage temperature: -20 to 65℃ Operating/storage humidity: below 95%RH (No condensation) Vibration resistance: 4.9 m/s^2(10 to 55Hz, Tested for 2 hours each in the X, Y, and Z directions) Shock resistance: 98m/s^2 (Tested once each in the X, Y, and Z directions) Ambience: Free from metal powder, powder dust, oil mist and corrosive gases
Structure		Forced air-cooling type
Installation method		Base mount (wall installation)
Control modes		Position control, speed control, torque control (Switchable using I/Os)
Position command pulse		Line collector type: Maximum response frequency 2-pulse train, 1-pulse train: 1MHz, 2-phase pulse train: 200kHz Open collector type: Maximum response frequency 200kHz
Speed command voltage		DC ± 10V/max. rotation speed, input impedance approx. 68kΩ
Torque command voltage		DC ± 10V/maximum torque, input impedance approx. 68kΩ
Speed control range		1: 1,000
Input signals		Emergency stop, reset, clear, FWD inhibit, REV inhibit, FWD enable, REV enable, FWD selection, REV selection, internal speed command 1, internal speed command 2, internal speed limit 1, internal speed limit 2, torque limit, electronic gear selection, control mode, INHIBIT
Output signals		Operation preparation complete, alarm, in-position complete, attained speed, attained torque, speed limiting, torque limiting, zero speed, control mode, DB status, battery voltage low, overload status, cooling fan stopped, FWD inhibit input effective, REV inhibit input effective, warning,
Motor terminals		3 channels, motor rotation speed, current command, general-purpose output (parameter selection)
Digital I/O port		RS-232C/RS-485: For monitoring output current, setting various parameters (PSF-800) Digital output: Absolute encoder data output
Operation panel	Configuration	Display (7-segment LED), 5 digits (red), 4 push-button switches
	Status display function	Rotation speed (r/min), torque command (%), over load rate (%), input signal monitor, output signal monitor, alarm history (8 alarms), etc.
	Parameter adjustment function	System parameters 1, 2, 3, 4, adjustment parameters 1, 2
Protective functions	Alarms	Emergency stop, overspeed, overload, IPM error (overcurrent), regenerative resistor overheat, encoder disconnection, encoder receiving error, UVW error, system failure, multi revolution overflow, multi revolution data error, error counter overflow, memory failure, FPGA configuration error, FPGA setting error, MEMORY error, MT error, ST error, PS error, BUSY error, overheat error, communication error, 1-phase missing error, main circuit voltage low error, overregeneration error, excessive regenerative power error
	Warnings	Battery voltage low, Overload status, main circuit power voltage low, FWD inhibit input effective, REV inhibit input effective
Regenerative processing		Regenerative resistor contained Comes with an external regenerative resistor mounting terminal

Regenerative resistor absorption power	90W max.
Embedded functions	Status display function, self diagnosis, electronic gear, JOG and other operations, dynamic brake, multi revolution data backup battery
Surge-current prevention function	Incorporated (CPU control based on monitoring of main circuit voltage)
Operation mode	Status display mode (for usual operations), test mode, tune mode, system parameter configuration mode
Mass	5.5kg

*1: Set according to the specifications of the combined actuator.

1-7 Function list

The following explains a list of functions provided by this driver.

P:Position control S:Speed control T:Torque control

Function	Description	Applicable control mode	Reference
Position control mode	The driver functions as a position control servo.	P	P5-16
Speed control mode	The driver functions as a speed control servo.	S	
Torque control mode	The driver functions as a torque control servo.	T	
Position/speed switching mode	A signal input is used to switch between position control and speed control.	P/S	P8-4
Position/torque switching mode	A signal input is used to switch between position control and torque control.	P/T	
Speed/torque switching mode	A signal input is used to switch between speed control and torque control.	S/T	
Input signal selection	You can assign the necessary input signal pins and select changes in their logic.	All	Chapter 5
Output signal selection	You can assign the necessary output signal pins and change their logics.	All	
Absolute position sensor	Once the absolute position is set, an actuator equipped with an absolute position encoder will recognize the current position after each subsequent reconnection of power.	All	P4-13 P4-23
Shorter positioning time	The HarmonicDrive® characteristics of the actuator are utilized in the control logic to shorten the positioning time.	All	P3-15
Auto-tuning	The driver can estimate the load in the JOG mode and automatically set an appropriate servo gain.	All	P9-11
Regenerative processing	If the regenerated power exceeds the value permitted by the driver, the excess power is used for the external regenerative resistor.	All	P2-17
Alarm history	The descriptions and occurrence times of up to 8 most recent alarms are displayed.	All	P7-9
Alarm history clear	The alarm history is cleared.	All	P7-11
Alarm code output	When an alarm occurs, its description is displayed and an alarm is output.	All	P7-10
Warning output	When a warning occurs, its description is displayed and an alarm is output.	All	
Electronic gear	You can change the weight (multiplier) of pulse input by setting desired values for the numerator and denominator of electronic gear.	All	P8-6
JOG operation	Operation check can be performed to see if the power supply, motor wire and encoder wiring are normal, regardless of the I/O signals received from the host.	All	P9-6
Status display mode	The servo driver status can be displayed, and monitored if requested.	All	P7-1
Test mode	Functions such as I/O signal monitor, output signal operation, JOG operation and auto-tuning are available.	All	Chapter 9
Tune mode	Set the servo gain, in-position range and various other items relating to the servo system.	All	Chapter 7
System parameter mode	Assign I/O signals, electronic gear and other extended functions.	All	Chapter 8
Analog monitor output	The motor speed and motor current can be monitored as voltage levels.	All	P5-28
Status monitor output	The selected servo status can be monitored.	All	P8-4

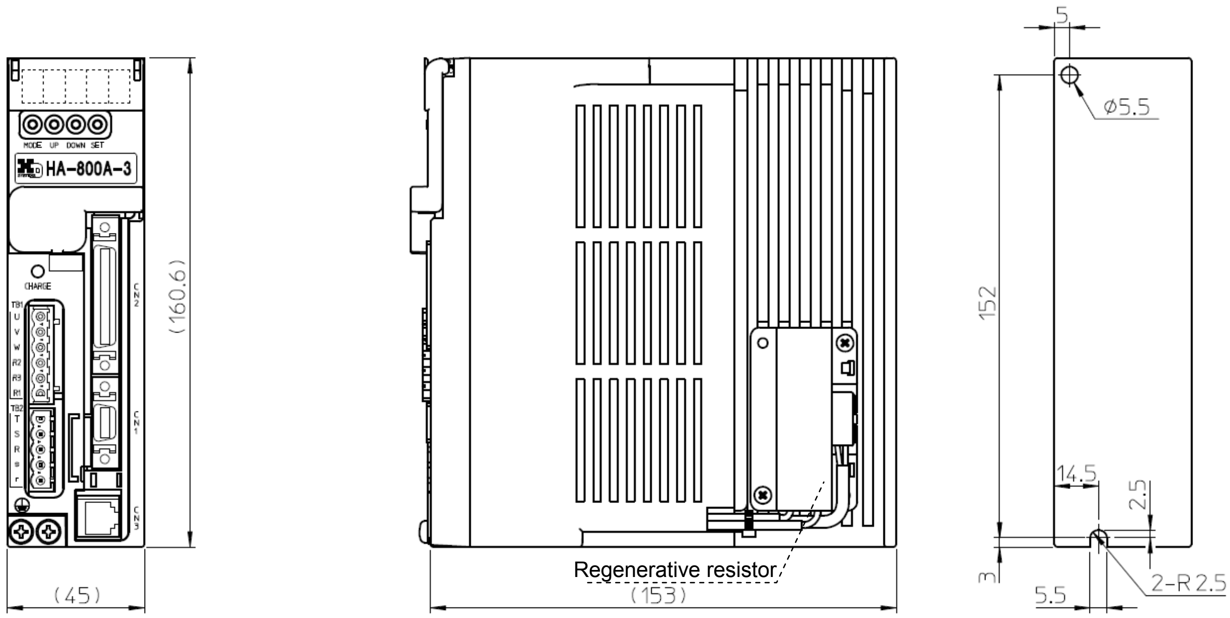
Output shaft single revolution absolute function * (SHA-CG-S only)	You can control the absolute position information accurately even when rotation continues in just one direction, for example indexing.	All	P8-13 A-5
Output shaft divide function *	You can select a setting of 36,000, 360,000, or 3,600,000 divisions for the output shaft and can set operation commands in angle units.	P	P8-13 A-5
Absolute encoder function setting *	A 17-bit absolute encoder can be used as an incremental encoder.	All	P8-12

*: This is available for HA-800 software version 3.x or later.

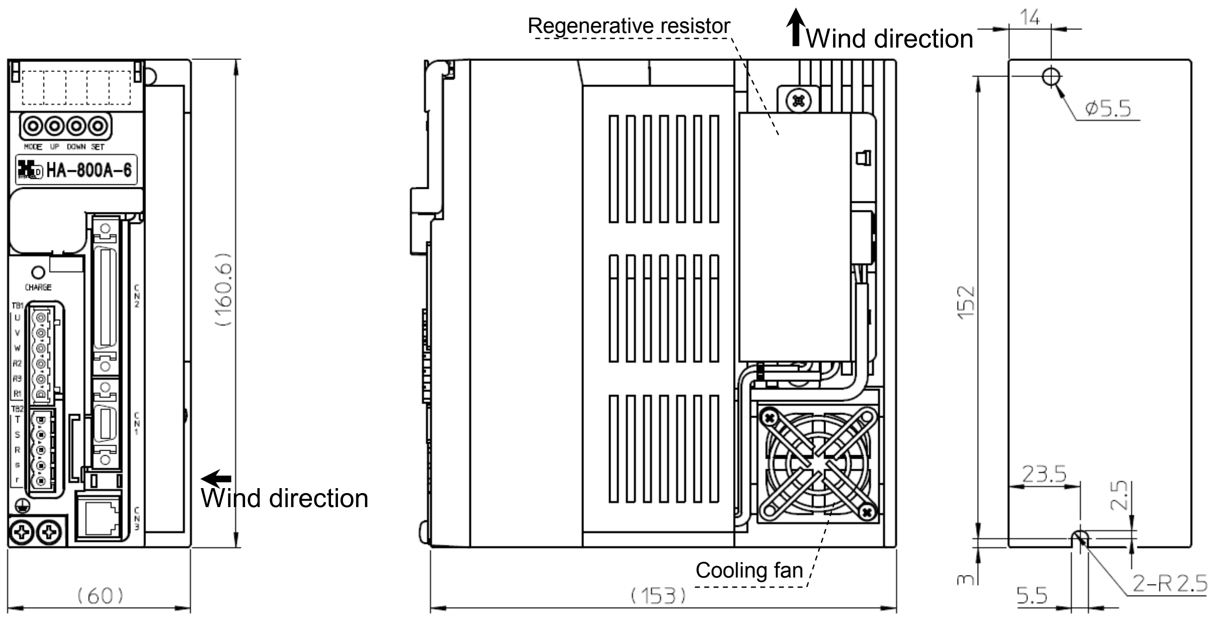
1-8 External drawing

The following shows the external drawing of this driver.

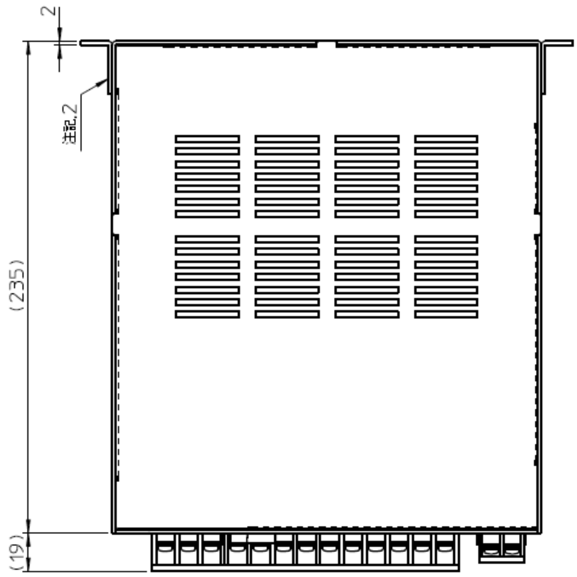
HA-800A-1/3 (Mass: 1 kg)



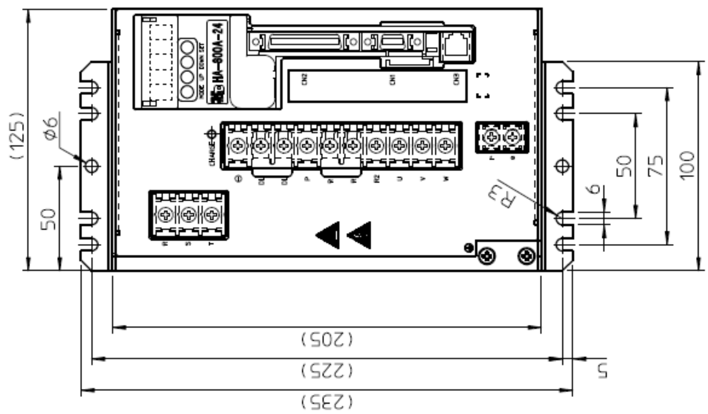
HA-800A-6 (Mass: 1.2kg)

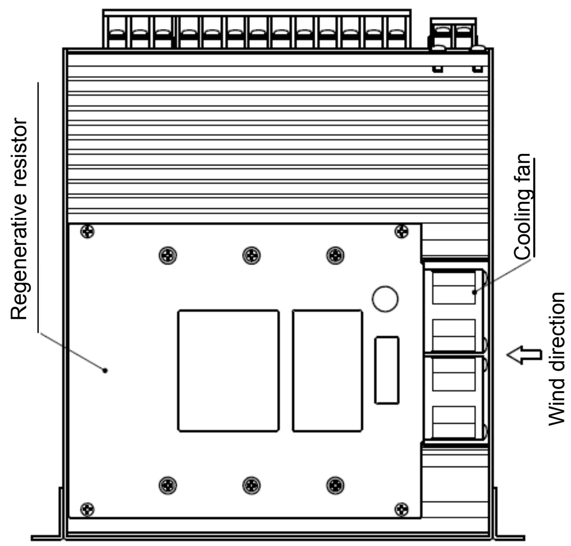


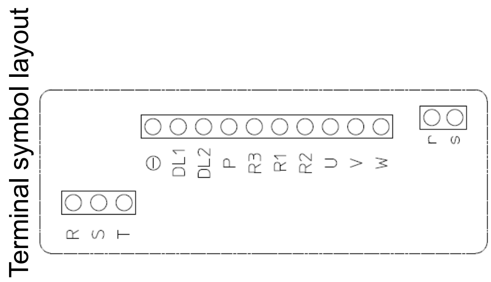
HA-800A-24 (Mass: 5.5 kg)



Installation direction Top ⇦



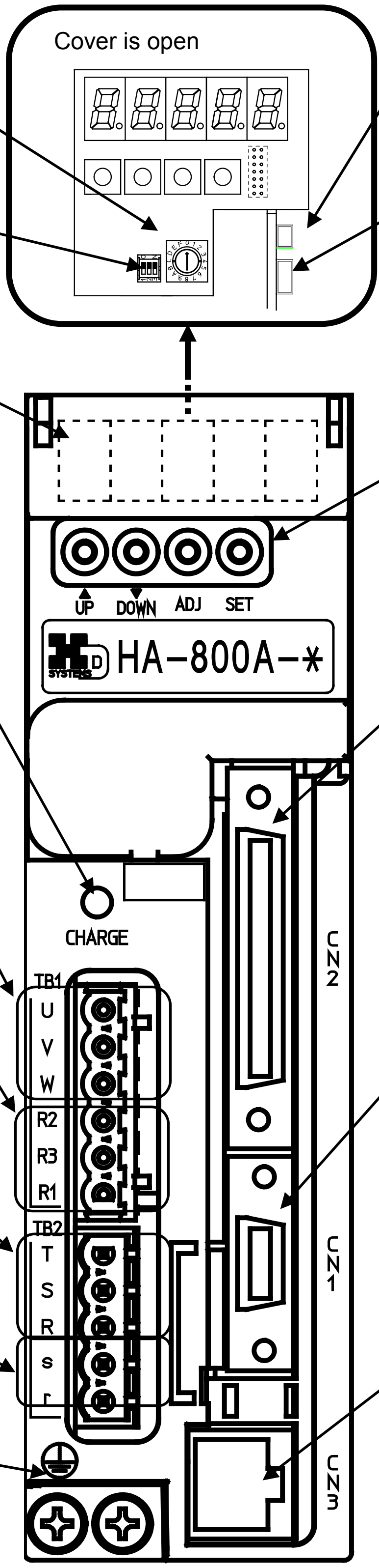




1-9 Name and function of each part of a display panel

The following explains the operation part on the front side of this driver as well as each function provided on the operation part.

HA-800A-1/HA-800A-3/HA-800A-6



Device number setting switch (SW5)

Set the device number of each driver when multiple drivers are connected for communication.

Communication setting switch (SW6)

Set the terminating resistance when multiple drivers are connected for communication.

LED display

The driver status display, alarm display, data values, etc., can be checked.

CHARGE lamp

This lamp turns ON when the main circuit power is input.
If this lamp remains ON after the power has been turned OFF, the system is still charged with high voltage. Do not touch the power connector.

Servo motor connection terminal (U, V, W)

Connect the servo motor drive wire.[Wiring the driver and motor] P2-17

Regenerative resistor connection terminal (R1, R2, R3)

A terminal for connecting an external regenerative resistor.
Connect an external regenerative resistor if the regeneration capacity is not enough.
[Regenerative resistor] PA-7

Main circuit power connection terminal (T, S, R)

A terminal for connecting the main circuit power supply.
[Connecting power cables] P2-6

Control circuit power connection terminal (s, r)

A terminal for connecting the control circuit power supply.
[Connecting power cables] P2-6

Ground terminal

A ground terminal for protection against electric shock. Be sure to connect this terminal.
[Connecting a ground wire] P2-8

Maintenance connector

Do not connect.

Waveform monitoring connector (CN9)

The speed, current waveform and status signal can be monitored.
[Monitor output] (P5-28)

Push-button switches

4 switches are used to change the display, set various functions and perform JOG operation.
[Chapter 6 Panel display and operation]

I/O signal connector (CN2)

A connector for command signals and I/O signals.
[Chapter 5 I /O signals]

Encoder connector (CN1)

A connector between the servo actuator and encoder. Take note that the connection method varies depending on the model.
[Connecting the encoder] P2-18

PSF-800 communication connector (CN3)

A communication connector for dedicated driver communication software PSF-800. [Chapter 10 Communication software]

HA-800A-24

Device number setting switch (SW5)
Set the device number of each driver when multiple drivers are connected for communication.

Communication setting switch (SW6)
Set the terminating resistance when multiple drivers are connected for communication.

LED display
The driver status display, alarm display, data values, etc., can be checked.

Main circuit power connection terminal (R, S, T)
A terminal for connecting the main circuit power supply.
[Connecting power cables] P2-6

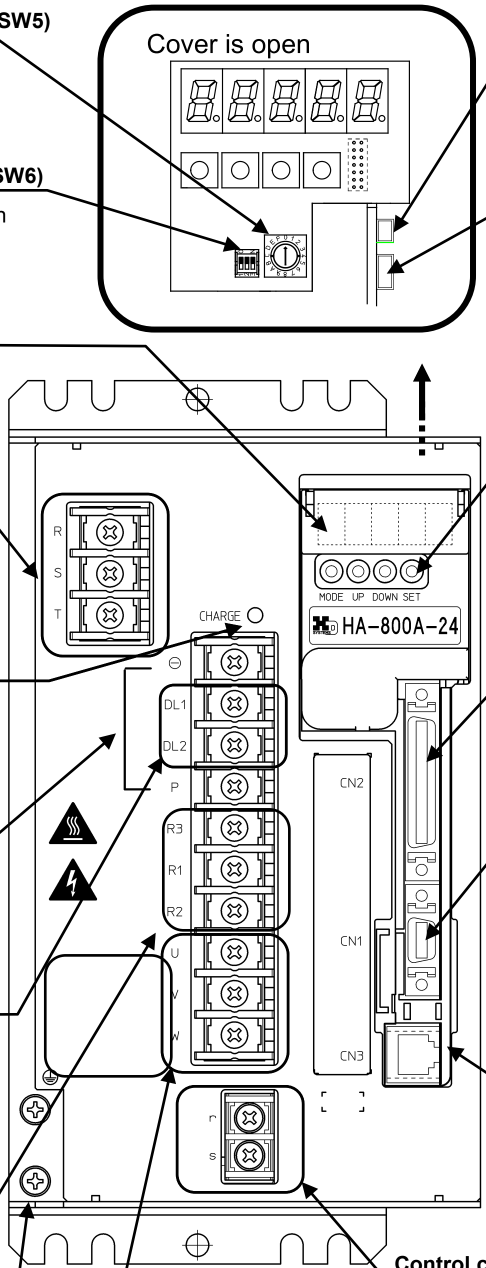
CHARGE lamp
This lamp turns ON when the main circuit power is input.
If this lamp remains ON after the power has been turned OFF, the system is still charged with high voltage. Do not touch the power connector.

Maintenance terminal
Do not wire the - and P terminals.

DC reactor connection terminal (DL1,DL2)
Terminals between DL1 and DL2 have been short-circuited with a short bar as default. Normally this short bar need not be removed before use

Regenerative resistor connection terminal (R1,R2,R3)
A terminal for connecting an external regenerative resistor.
Connect an external regenerative resistor if the regeneration capacity is not enough.
[Regenerative resistor] PA-7

Ground terminal
A ground terminal for protection against electric shock. Be sure to connect this terminal.
[Connecting a ground wire] P2-8



Maintenance connector
Do not connect.

Waveform monitoring connector (CN9)
The speed, current waveform and status signal can be monitored.
[Monitor output] (P5-28)

Push-button switches
4 switches are used to change the display, set various functions and perform JOG operation.
[Chapter 6 Panel display and operation]

I/O signal connector (CN2)
A connector for command signals and I/O signals.
[Chapter 5I /O signals]

Encoder connector (CN1)
A connector between the servo actuator and encoder. Take note that the connection method varies depending on the model.
[Connecting the encoder] P2-18

PSF-800 communication connector (CN3)
A communication connector for dedicated driver communication software PSF-800. [Chapter 10 Communication software]

Control circuit power connection terminal (r, s)
A terminal for connecting the control circuit power supply.
[Connecting power cables] P2-6

Servo motor connection terminal (U, V, W)
Connect the servo motor drive wire.
[Wiring the driver and motor] P2-17

Chapter 2

Installation/wiring

Receiving inspection, environment, power wiring, noise suppression and connector wiring are explained in this chapter.

2-1 Receiving inspection

After unpacking, check the items described below.

Check procedure

1 Check for damage.

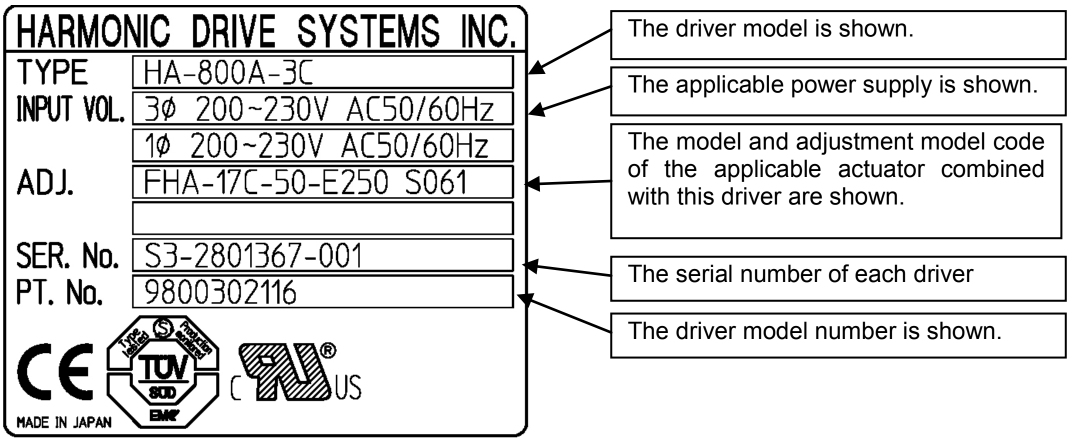
If any damage is found, immediately contact the supplier or store where you purchased your driver.

2 Check if the driver is what you ordered.

Check the model code shown below the display panel on the front face of this driver.
For information on how to check the model, refer to [Driver model] (P1-5).

Check the model, input voltage and combined actuator on the nameplate attached on the right side face of the driver.
If the model is wrong, immediately contact the supplier or store where you purchased your driver.

Nameplate



WARNING

Do not combine the actuator other than the one specified on the nameplate.
The characteristics of this driver have been adjusted according to the actuator. Wrong combinations of HA-800A drivers and actuators may cause insufficient torque or overcurrent that may lead to actuator burnout, injury or fire.

Do not connect the power supply other than the voltage specified on the nameplate.
Connecting a power supply not matching the input voltage specified on the nameplate may result in damage to the HA-800A driver, injury or fire.

2-2 Installation location and installation

Install this driver in a manner meeting the conditions specified below.

Installation environment

Operating temperature	● 0 to 50℃ Store the driver in a cabinet. The temperature in the cabinet may be higher than the outside air temperature due to power losses of the housed devices, size of the cabinet, etc. Consider an appropriate cabinet size, cooling and layout to make sure the temperature around the driver does not exceed 50℃.
Operating humidity	● Relative humidity of 95% or less, non-condensing Exercise caution if the driver is used in a place subject to significant temperature differences between day and night or in patterns where the driver is started/stopped frequently, because these conditions increase the chances of condensation.
Vibration	● 4.9 m/s^2 (0.5G) (10 to 55Hz) or less (Tested at 10-55 MHz for 2 hours each in the X, Y, and Z directions) If there is a source of vibration nearby, install the driver on a base via a shock absorber to prevent the vibration from transmitting directly to the driver.
Impact	● 98 m/s^2 (10G) or less (Tested once each in the X, Y, and Z directions)
Others	● Free from dust, dirt, condensation, metal powder, corrosive gases, water, water droplets, oil mist, etc. Avoid using the driver in an environment subject to corrosive gases because accidents may occur due to poor contact of contact parts (connectors, etc.). ● Avoid exposure to direct sunlight.

Notices on installation

Install this driver vertically by providing sufficient clearances around it to ensure good ventilation. When installing the driver, provide a clearance of at least 30mm from a wall or adjacent machine, at least 50mm from the floor, and at least 50mm from the ceiling.

The table below shows the power losses of HA-800A drivers for reference when planning the cooling system.

FHA-C series

Driver	HA-800A-1			HA-800A-3		HA-800A-6	
Actuator	FHA-8C	FHA-11C	FHA-14C	FHA-17C	FHA-25C	FHA-32C	FHA-40C
Power loss	25W	30W	40W	30W	40W	50W	60W

RSF/RKF series

Driver	HA-800A-1	HA-800A-3		HA-800A-6
Actuator	RSF-17	RSF/RKF -20	RSF/RKF -25	RSF/RKF -32
Power loss	35W	40W	55W	60W

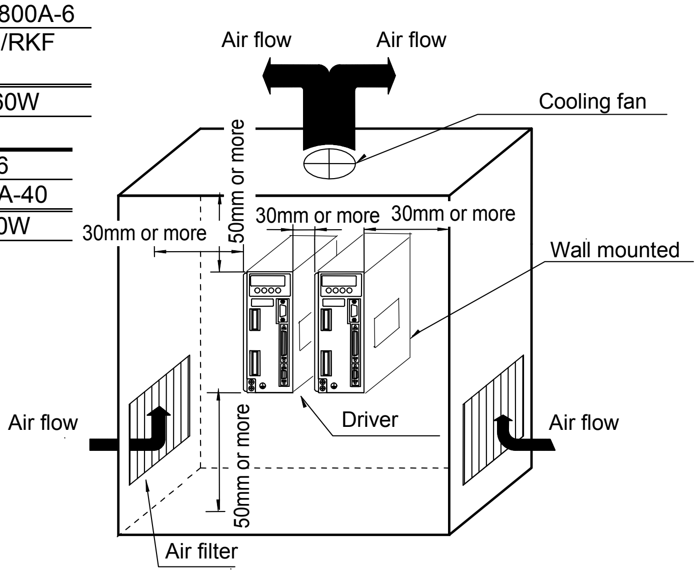
SHA series (200V)

Driver	HA-800A-3	HA-800A-3	HA-800A-6	
Actuator	SHA-20	SHA-25	SHA-32	SHA-40
Power loss	35W	35W	60W	60W

Driver	HA-800A-24		
Actuator	SHA-40	SHA-58	SHA-65
Power loss	130W	130W	130W

SHA series (100V)

Driver	HA-800A-6
Actuator	SHA-25
Power loss	40W



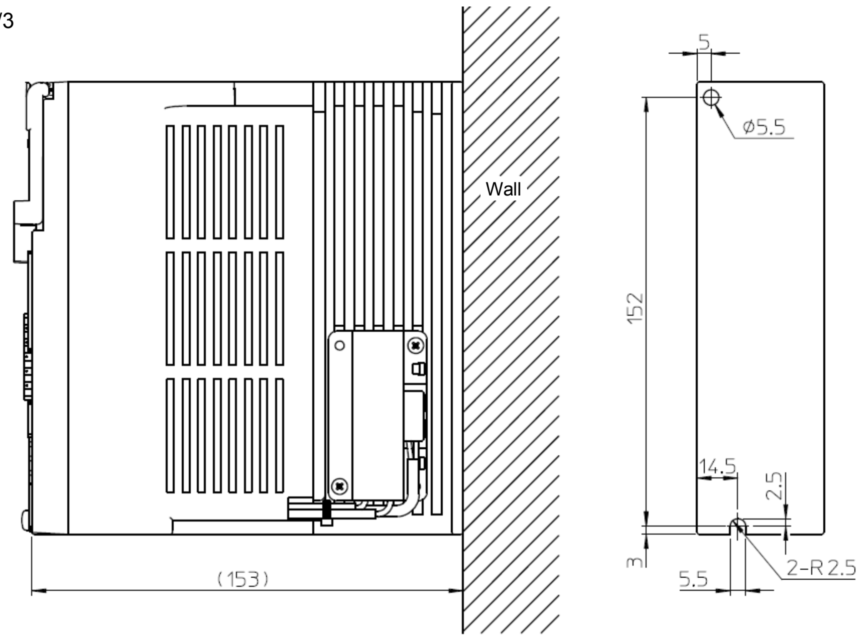
Installation procedure

[HA-800A-1, HA-800A-3, HA-800A-6]

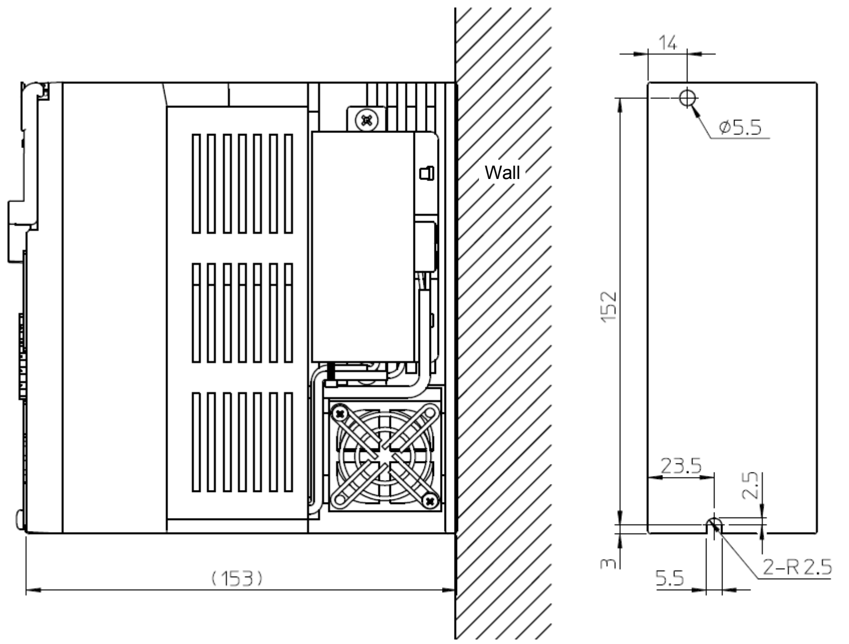
Install the driver using 2 mounting holes provided at the back. The wall on which to install the driver should be made of an iron sheet of 2mm or more in thickness.

1. **Screw a M4 screw into the middle of the tapped hole provided at the bottom of the mounting surface.**
2. **Hook the mounting hole (cut hole) provided at the bottom of the driver onto the M4 screw installed in 1.**
3. **Securely tighten a M4 screw through the mounting hole at the top of the driver and hole in the mounting surface.**
4. **Securely tighten the M4 screw at the bottom.**

HA-800A-1/3



HA-800A-6



[HA-800A-24]

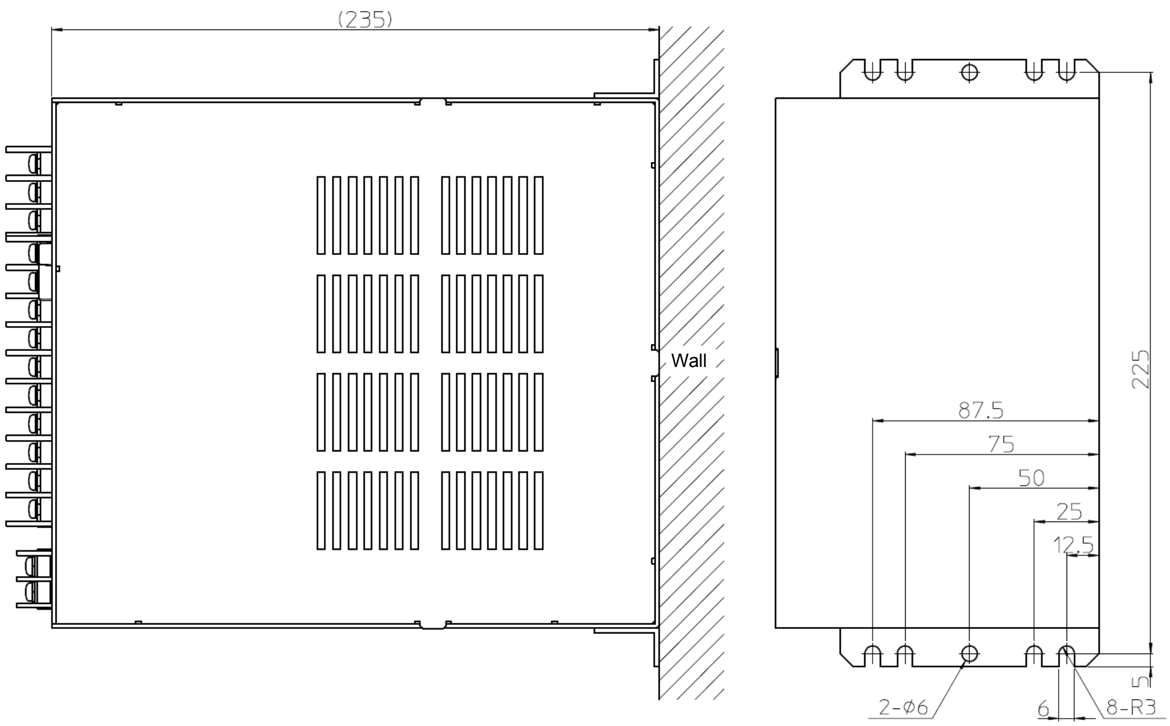
An iron sheet of 5 mm or more in thickness is recommended for the wall on which to install the driver.

1 **Screw an M5 screw into the middle of the mounting hole (U-shaped) provided at the bottom of the driver.**

2 **Securely tighten an M5 screw through the mounting hole (U-shaped) at the top of the driver.**

3 **Securely tighten the screw at the bottom of the driver as well.**
Confirm that all the 8 screws are securely tightened.

HA-800A-24



2

Installation/wiring

2-3 Connecting power cables

The following explains how to connect the power supply to this driver.

WARNING

Before connecting the power cable to the HA-800A driver, completely unplug the power cable from the main power supply. Failure to do so may result in electric shock during the connection work.

CAUTION

(1) Connect the power cable to the HA-800A driver after installing the driver on the specified wall.
(2) Ground the HA-800A driver to avoid electric shock, malfunctions caused by external noise, and for the suppression of radio noise emissions.

Allowable cable sizes

The table below lists the minimum allowable wire sizes of power cables, ground cables and other cables. We recommend the thickest wires possible.
When bundling wires or placing them into ducts, rigid plastic conduits or metal pipes, use wires of the next larger size.
It is recommended to use HIV (special heat-resistant vinyl wires).

[3-phase 200V input]

<table>
<tr><th colspan="2"></th><th colspan="9">Min. allowable wire size (mm²)</th></tr>
<tr><th colspan="2">Driver</th><th colspan="2">HA-800A-1</th><th colspan="2">HA-800A-3</th><th colspan="2">HA-800A-6</th><th colspan="3">HA-800A-24</th></tr>
<tr><th colspan="2">Combined actuator
Combined motor</th><td colspan="2">FHA-8C
FHA-11C
FHA-14C</td><td>FHA-17C
FHA-25C</td><td>SHA20
SHA25
MAC08
MAB09</td><td>FHA-32C
FHA-40C</td><td>SHA32
SHA40
MAB12
MAB15</td><td>SHA40
MAB15</td><td>SHA58
SHA65</td><td>MAA21</td></tr>
<tr><th>Main circuit power</th><th>R,S,T</th><td colspan="2">0.75</td><td colspan="2">1.25</td><td>2.0</td><td>2.0</td><td>3.5</td><td>3.5</td><td>5.5</td></tr>
<tr><th>Control circuit power</th><th>r, s</th><td colspan="2">0.75</td><td colspan="2">1.25</td><td colspan="2">1.25</td><td colspan="3">1.25</td></tr>
<tr><th>Motor cables *1</th><th>U,V,W,E</th><td>0.5</td><td>0.725</td><td>0.75</td><td>1.25</td><td colspan="2">2.0
(1.25) *2</td><td>2.0
(1.25) *2</td><td colspan="2">5.5
(3.5) *3</td></tr>
<tr><th>Ground (FG) wire</th><th>Ground mark</th><td colspan="2">3.5</td><td colspan="2">3.5</td><td colspan="2">3.5</td><td>3.5</td><td>3.5</td><td>5.5</td></tr>
<tr><th>Regenerative resistor</th><th>R1,R2</th><td colspan="2">1.25</td><td colspan="2">1.25</td><td colspan="2">1.25</td><td colspan="3">3.5</td></tr>
<tr><th>Encoder cable</th><th>CN1</th><td colspan="9">Twisted pair shield cable of 0.3mm² or larger *1</td></tr>
<tr><th>Control signal wire</th><th>CN2</th><td colspan="9">Twisted pair wire or twisted pair whole-shield cable (AWG24, 0.2 mm²)</td></tr>
</table>

*1: We provide extension cables (3m/5m/10m) for motor cables (including brake cables) and encoder cables. For the combinations of HA-800A drivers, actuators and extension cables, refer to [Actuator and extension cable combinations] (P1-6).
*2: 1.25 mm² is used in case of 105℃ heat-resistant wires. If you use HIV cables, 2 mm² or thicker cables are recommended.
*3: 3.5 mm² is used in case of 105℃ heat-resistant wires. If you use HIV cables, 5.5 mm² or thicker cables are recommended.

[single-phase100V input]

		Min. allowable wire size (mm²)				
Driver		**HA-800A-1**		**HA-800A-3**	**HA-800A-6**	
Combined actuator **Combined motor**		**FHA-8C FHA-11C FHA-14C**		**FHA-17C**	**FHA-25C FHA-32C**	**SHA25 MAB09**
Main circuit power	R,S,T	0.75		1.25	2.0	2.0
Control circuit power	r, s	0.75		1.25	1.25	
Motor cables *1	U,V,W, E	0.5	0.725	0.75	2.0 (1.25) *2	
Ground (FG) wire	Ground mark	3.5		3.5	3.5	
Regenerative resistor	R1,R2	1.25		1.25	1.25	
Encoder cable	CN1	Twisted pair shield cable of 0.3mm² or larger *1				
Control signal wire	CN2	Twisted pair wire or twisted pair whole-shield cable (AWG24, 0.2 mm²)				

*1: We provide extension cables (3m/5m/10m) for motor cables (including brake cables) and encoder cables. For the combinations of HA-800A drivers, actuators and extension cables, refer to [Actuator and extension cable combinations] (P1-6).

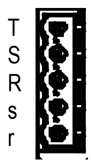
*2: 1.25 mm² is used in case of 105℃ heat-resistant wires. If you use HIV cables, 2 mm² or thicker cables are recommended.

Connecting power cables

The following terminal block for power connection is provided on the display panel on the front face of this driver. Connect the power source cables to the respective terminals as shown below. If a 3-phase power supply is used, its phases can be arranged in any order.

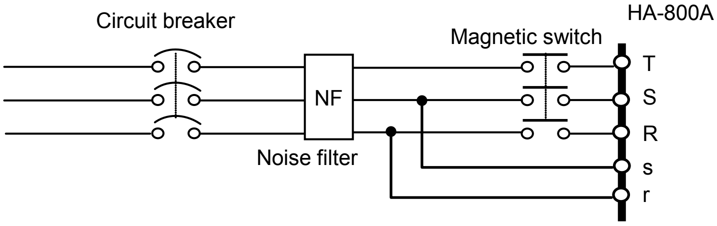
Terminal block for power connection (for TB2)

Manufacturer	Phoenix Contact
Model	FKC2,5/5-ST-5.08

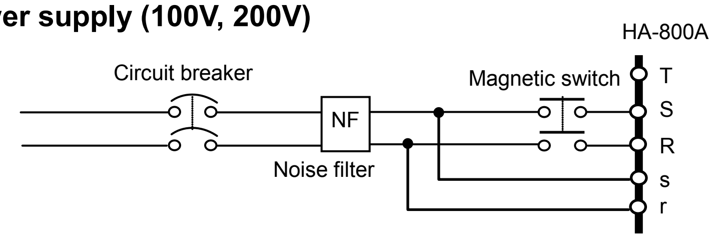


HA-800-1/3/6

- **3-phase power supply (200V)**

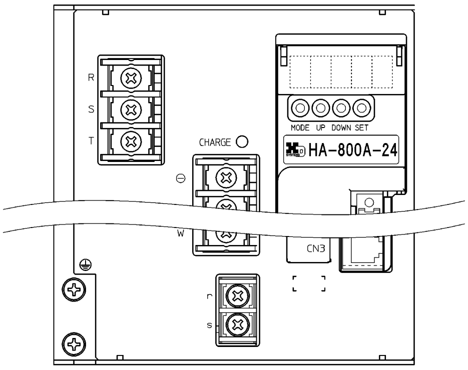


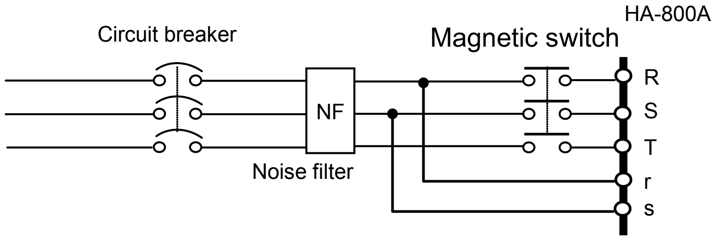
- **Single-phase power supply (100V, 200V)**



HA-800-24

- **3-phase power supply (200V)**



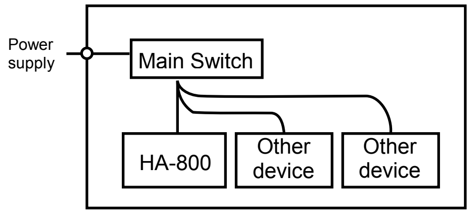


Terminal block for power connection

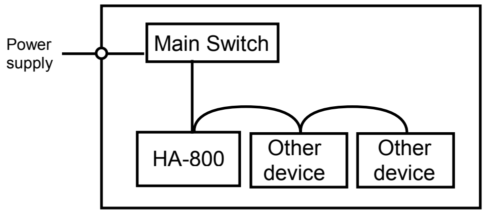
Terminal name	Screw size	Crimp terminal external diameter	Reference
R,S,T, ⏚	M4	ϕ8mm	Round crimp terminal (R-type) 3.5-R4 (J.S.T. Mfg. Co., Ltd) 5.5-4NS (J.S.T. Mfg. Co., Ltd)
r,s	M4	ϕ8mm	Round crimp terminal (R-type) R1.25-4 (J.S.T. Mfg. Co., Ltd)

Caution

- The power-receiving part of the driver adopts a surge-current-suppress-circuit. Although this circuit prevents extreme voltage drops when the power is input, avoid daisy-chain wiring between the power supply and devices and wire each device separately from the main power supply switch.



Good wiring example



Bad wiring example

Protecting power lines

Be sure to use a circuit breaker (MCB) in the power line to protect the power line.
Select an appropriate circuit breaker from the table below.

Input voltage	200V	200V	200V	200V	100V	200V	200V	200V		
Driver model	HA-800A -1-200	HA-800A -1-200	HA-800A -3-200	HA-800A -3-200	HA-800A -6-100	HA-800A -6-200	HA-800A -6-200	HA-800A-24-200		
Actuator motor	FHA-8C FHA-11C	FHA-14C	FHA-17C RSF-17	SHA20 SHA25 FHA-25C RSF-20 RSF-25 RKF-20 RKF-25 MAC08 MAB09	SHA25	SHA32 FHA-32C RSF-32 RKF-32 MAB12	SHA40 FHA-40C MAB15	SHA40 MAB15	SHA58 SHA65	MAA 21
Interrupting current (A) capacity of circuit breaker (MCB)	3	5		10	15		20	30		
Required power capacity per driver (kVA) *1	0.15	0.25	0.4	0.8	0.8	1.5	1.8	2.5	3.5	5.5
Surge-current upon main circuit power ON (A) *2	15	15	15	15	8	15	15	15	15	15

*1: The values are for allowable continuous output of the actuator.

*2: The values are quoted at ambient temperature of 25℃.

The above values are based on the standard input voltage (AC200V, AC100V).

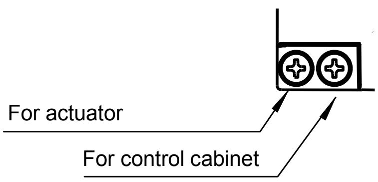
The circuit breaker cutoff capacity is a recommended value for 3-phase AC200V input or single-phase AC100V input.

Connecting a ground wire

Use a ground wire of an appropriate size selected from the table below, or larger.

Cable	Symbol	Min. allowable wire size (mm^2)			
		HA-800A-1	HA-800A-3	HA-800A-6	HA-800A-24
Ground (FG) wire	Ground mark	3.5	3.5	3.5	3.5, 5.5

The HA-800A driver has 2 types of ground terminals, as shown below.
Make sure to use wire sizes in the table above or larger for the ground terminals and connect it using a round crimp terminal.
Make sure to connect a single wire to a single ground terminal.



Power ON and OFF sequences

Provide a sequence circuit that cuts off the main circuit power ON/OFF switch in response to an emergency stop signal, etc. If an alarm signal has been assigned to an output signal, also provide a sequence circuit that cuts off the main circuit power ON/OFF switch in response to the alarm output.

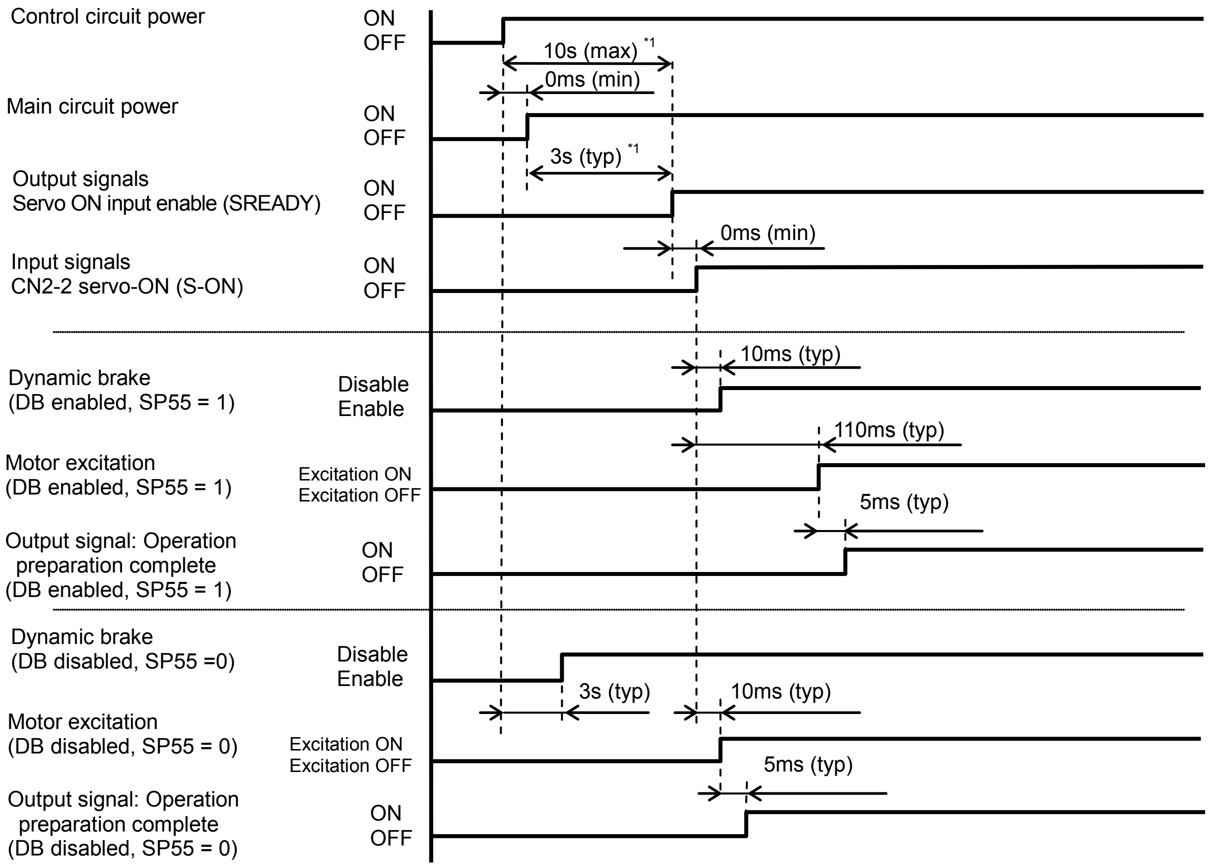
Caution

- Turn ON/OFF the power after switching the [CN2-2 servo-ON: S-ON] signal of the HA-800A driver to OFF.
- If the power is turned ON/OFF too frequently, the surge-current limiting resistor in the internal circuit may deteriorate.
  The power ON/OFF frequency should not exceed 5 times in an hour and 30 times in a day. Furthermore, the interval between turning OFF and ON the power should keep more than 30 seconds.

Power ON sequence, servo-ON sequence (HA-800A-1, -3, -6)

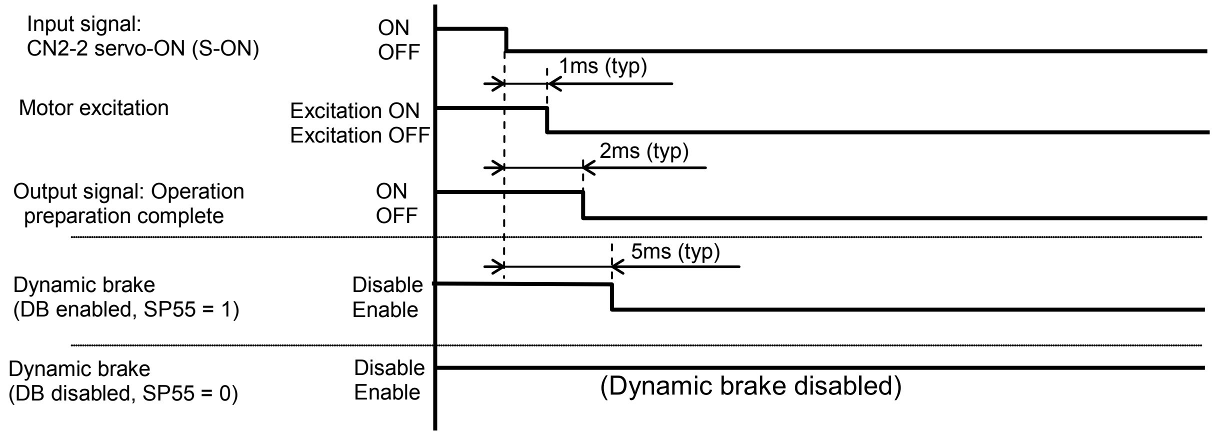
Create a sequence program for the host device so that the power to this driver will be turned ON at the timings shown below. The chart below shows a power ON sequence based on a 17-bit absolute encoder system.

I/O outputs and monitor output remain indeterminable for approximately 10 seconds after turning the control power supply ON.

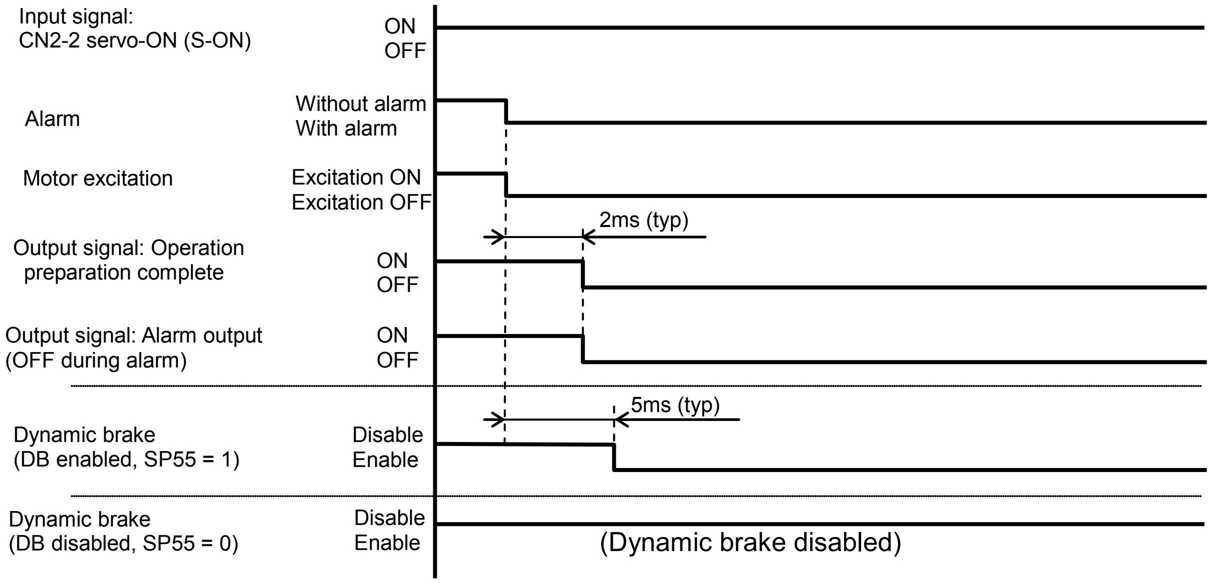


*1: This value is for when the control circuit power and main circuit power are turned ON simultaneously.
If the main circuit power is turned ON 7 seconds or more after the control circuit power, the servo ON enable signal will be output after approximately 3 seconds, provided that the capacitor in the main circuit power has been discharged fully.

Servo-OFF sequence (HA-800A-1, -3, -6)



Sequence when an alarm generates (HA-800A-1, -3, -6)

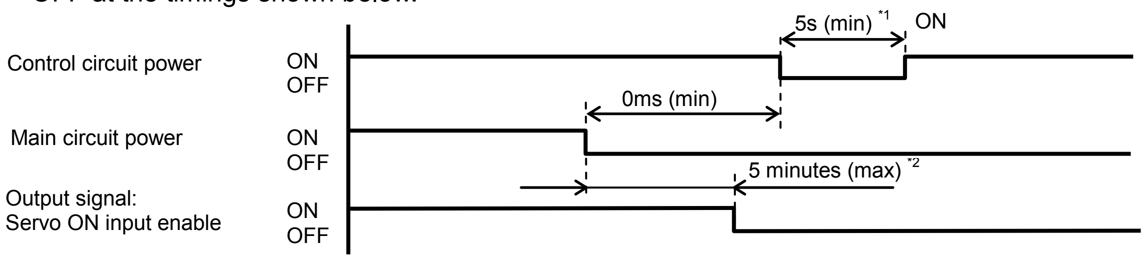


2

Installation/wiring

Power OFF sequence (HA-800A-1, -3, -6)

Create a sequence program for the host device so that the power to this driver will be turned OFF at the timings shown below.

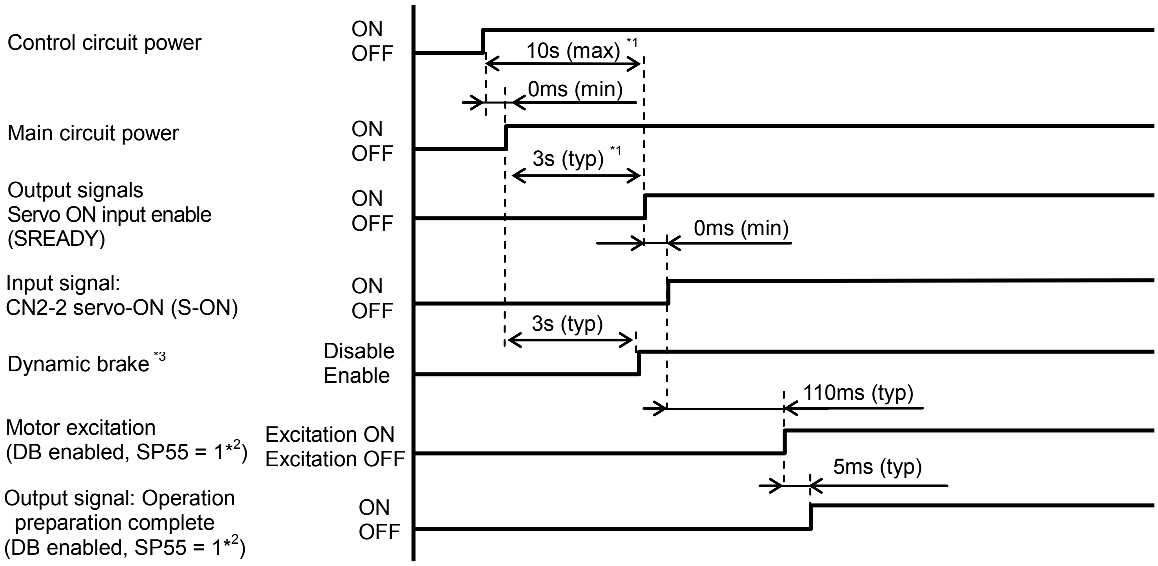


*1: After turning OFF the control circuit power, wait for at least 5 seconds before turning it ON.

*2: If the main circuit power is turned OFF while [CN2-2 servo-ON (S-ON)] is OFF (servo OFF), it may take up to 5 minutes or so before the servo ON input enable signal (SREADY) turns OFF (main circuit DC voltage drop).
If the main circuit power is turned OFF while servo-ON (during motor excitation), the motor excitation is continued until the servo ON input enable signal (SREADY) turns OFF (main circuit DC voltage drop).
If the main circuit DC voltage does not drop due to regeneration operation, etc., it takes long until the motor excitation turns OFF.
Turn the servo OFF first and then cut the main circuit power OFF, except when alarms are being generated.
If the main circuit power and control circuit power are turned OFF simultaneously, the motor excitation turns OFF in several 10 to 100ms (the time varies depending on the input voltage).
At this point, the servo ON input enable signal (SREADY) also turns OFF, but the capacitor for the main circuit power is still charged and therefore do not touch the power terminals until the main circuit charge monitor LED on the front panel turns OFF (approximately 15 minutes).

Power ON, servo-ON sequence (HA-800A-24)

Create a sequence program for the host device so that the power to this driver will be turned ON at the timings shown below.
The chart below shows a power ON sequence based on a 17-bit absolute encoder system.
I/O outputs and monitor output remain indeterminable for approximately 10 seconds after turning the control power supply ON.

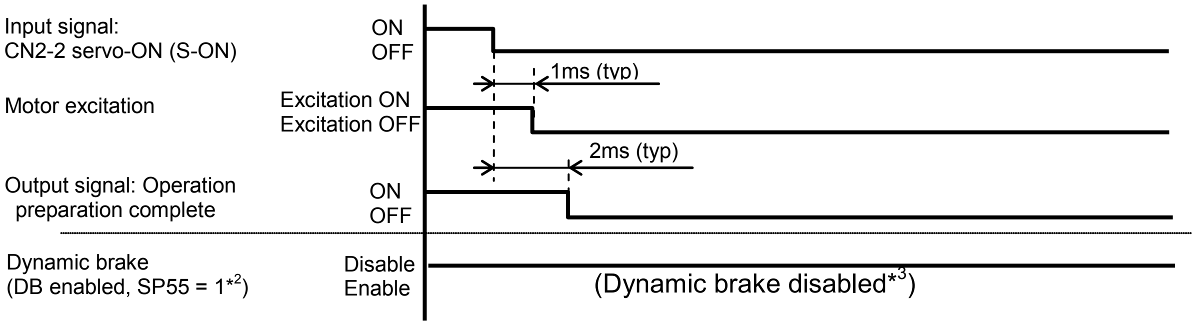


*1: This value is for when the control circuit power and main circuit power are turned ON simultaneously.
If the main circuit power is turned ON 7 seconds or more after the control circuit power, the servo ON enable signal will be output after approximately 3 seconds, provided that the capacitor in the main circuit power has been discharged fully.

*2: Make sure to use HA-800A-24 by setting [SP55: DB enable/disable setting] to 1 (default setting).

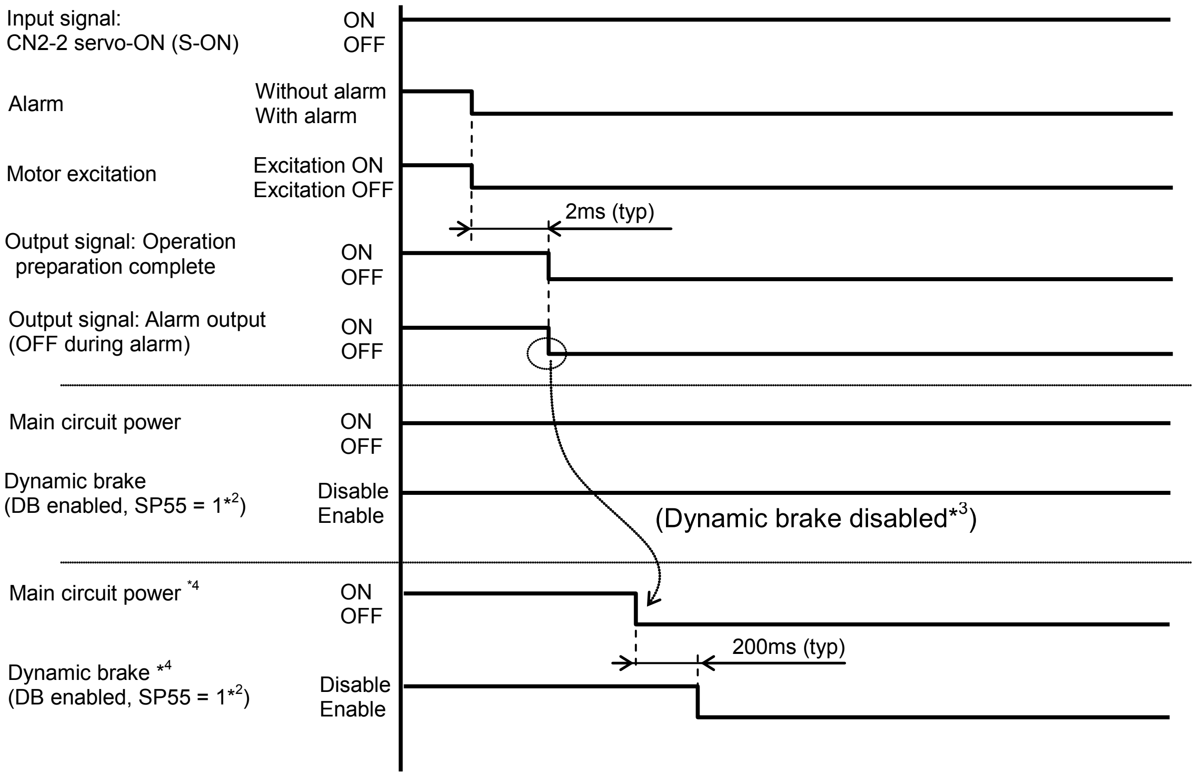
*3: The dynamic brake operates interlinked to the main circuit power.

Servo-OFF sequence (HA-800A-24)



*2: Make sure to use HA-800A-24 by setting [SP55: DB enable/disable setting] to 1 (default setting).
*3: The dynamic brake operates interlinked to the main circuit power.

Sequence when an alarm generates (HA-800A-24)



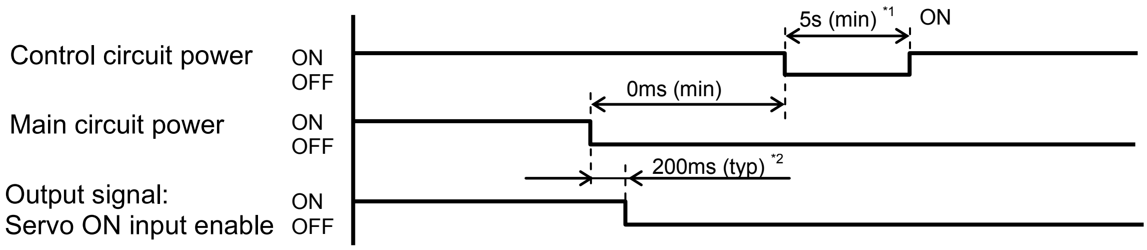
*2: Make sure to use HA-800A-24 by setting [SP55: DB enable/disable setting] to 1 (default setting).
*3: The dynamic brake operates interlinked to the main circuit power.
*4: It is possible to use the dynamic brake by using output signal alarm output to cut off the main circuit power of the driver.
By cutting off the driver's main circuit power, the main circuit discharge function is enabled, which lowers the main circuit DC voltage and activates the dynamic brake.
However, if regenerative resistances such as regenerative overheat alarm (AL41) and overregeneration alarm (AL42) are under high load, the discharge function may not operate and the dynamic brake thus may not be activated.

2

Installation/wiring

Power OFF sequence (HA-800A-24)

Create a sequence program for the host device so that the power to this driver will be turned OFF at the timings shown below.



*1: After turning OFF the control circuit power, wait for at least 5 seconds before turning it ON.

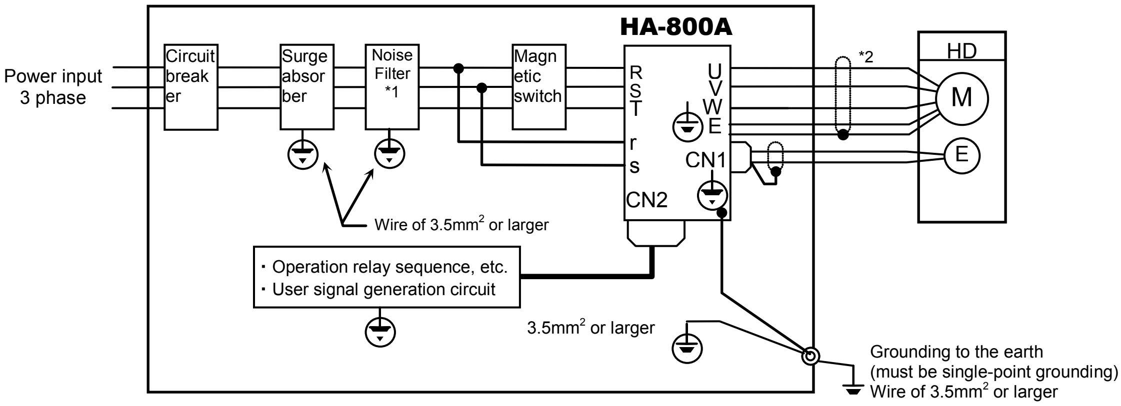
*2: If you turn the main circuit power OFF, the servo ON input enable signal (SREADY) turns OFF in approximately 0.2 seconds due to the main circuit discharge function.
However, if regenerative resistance such as regenerative resistor overheat alarm (AL41) and overregeneration alarm (AL42) are under high load, the discharge function may not operate and it takes approximately 10 minutes to discharge.
If the main circuit power is turned OFF while servo-ON (during motor excitation), the motor excitation is continued until the servo ON input enable signal (SREADY) turns OFF (main circuit DC voltage drop).
If the main circuit DC voltage does not drop due to regeneration operation, etc., it takes long until the motor excitation turns OFF.
Turn the servo OFF first and then cut the main circuit power OFF, except when alarms are being generated.
If the main circuit power and control circuit power are turned OFF simultaneously, the motor excitation turns OFF in several 10 to 100ms (the time varies depending on the input voltage).
At this point, the servo ON input enable signal (SREADY) also turns OFF, but the capacitor for the main circuit power is still charged and therefore do not touch the power terminals until the main circuit charge monitor LED on the front panel turns OFF (approximately 15 minutes).

2-4 Suppressing noise

The main circuit of this driver uses a power element (IPM) based on PWM control. Switching noise generates due to sudden changes in current/voltage that occur when this element is switched. If wiring and grounding are inappropriate, other external devices may malfunction or radio noise may generate. This driver also has a CPU and other built-in electronic circuits. Accordingly, provide appropriate wiring and other measures to minimize malfunctions caused by external noise.
To prevent troubles caused by external noise, be sure to provide wiring and grounding as follows.

Grounding

Refer to the figure below when grounding all devices comprising the system.



*1: For information on grounding line filters, refer to [Installing noise filters] P2-15.
*2: FHA-17C to 40C actuators come with a shield connected to the body.

Grounding motor frame

When the actuator is grounded on the driven machine side through the frame, current flows through the floating capacity (Cf) of the motor from the power circuit of the driver. To avoid negative influence of the current, always connect the ground terminal (motor frame) of the actuator to the ground terminal of the driver, and connect the ground terminal of the driver directly to ground.

Grounding ducts

When the motor cables are housed in a metal conduit or a metal box, be sure to ground their metal parts.
Always connect the ground at a single point.

Installing noise filters

Use of noise filters is recommended to prevent malfunctions caused by impulse noise that may enter from the power line and also to prevent noise generating inside the driver from emitting to the power line.
When multiple drivers are used, install noise filters for each driver.
Select bi-directional noise filters that can suppress both external noise and internal noise.
Recommended noise filters are shown below.

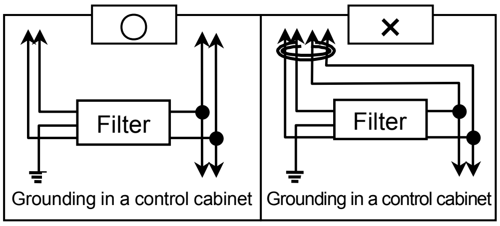
Model	Specifications	Manufacturer
RF3020-DLC	Rated voltage: Line-Line 440 to 550V, rated current: 20A	RASMI ELECTONICS LTD
RF3030-DLC	Rated voltage: Line-Line 440 to 550V, rated current: 30A	
RF3040-DLC	Rated voltage: Line-Line 440 to 550V, rated current: 40A	
HF3010A-UN	Rated voltage: 250VAC, rated current: 10A	Soshin Electric Co., Ltd.
HF3030A-UN	Rated voltage: 250VAC, rated current: 30A	
HF3040A-UN	Rated voltage: 250VAC, rated current: 40A	
SUP-P5H-EPR	Rated voltage: 250VAC, rated current: 5A	Okaya Electric Industries Co., Ltd.
SUP-P10H-EPR	Rated voltage: 250VAC, rated current: 10A	
3SUP-H5H-ER-4	Rated voltage: 250VAC, rated current: 5A	
3SUP-H10H-ER-4	Rated voltage: 250VAC, rated current: 10A	

EMC Directive conformance check tests are conducted by connecting the noise filter and toroidal core in the table above to the driver power input area.
For the measure to comply with EMC Directives, refer to "Conformance to European EC Directives" on P15.

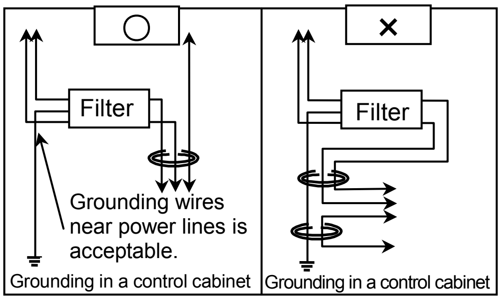
Caution

- Install the noise filters and this driver as close as possible with one another.
- Also install noise filters to the power source cables of electric devices other than this driver in the same manner.
  In particular, always install noise filters to sources of high-frequency, such as electric welders and electrical-discharge processing machines.
- Incorrect use of noise filters can seriously reduce its effectiveness. Install noise filters by referring to the cautionary information provided below.

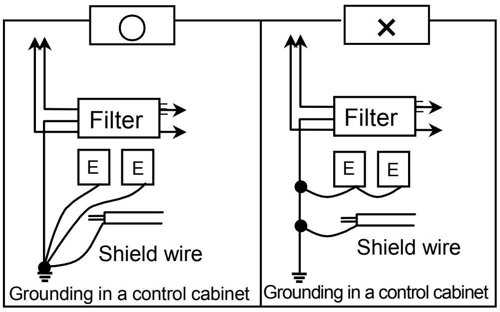
- Separate the filtered wires and unfiltered wires from each other. Do not place them in the same pipe or duct, or bundle them together.



- Do not place the ground wire and filtered wires in the same pipe or duct, or bundle them together.



- Do not daisy-chain ground wires, but connect one ground wire separately to each device or to a single point on the control cabinet or ground plate.



- Be sure to install surge protector devices to coils of magnetic relays, magnetic switches (contactors), solenoids, etc.
- Do not open the end of analog input signal cables such as speed signal cables.
- Since this driver is designed for industrial use, it incorporates no measures to prevent radio interference.
  If the driver is used in the following environments, connect line filters to the input side of the power source cable:
- Used near houses
- Where radio interference may present problems

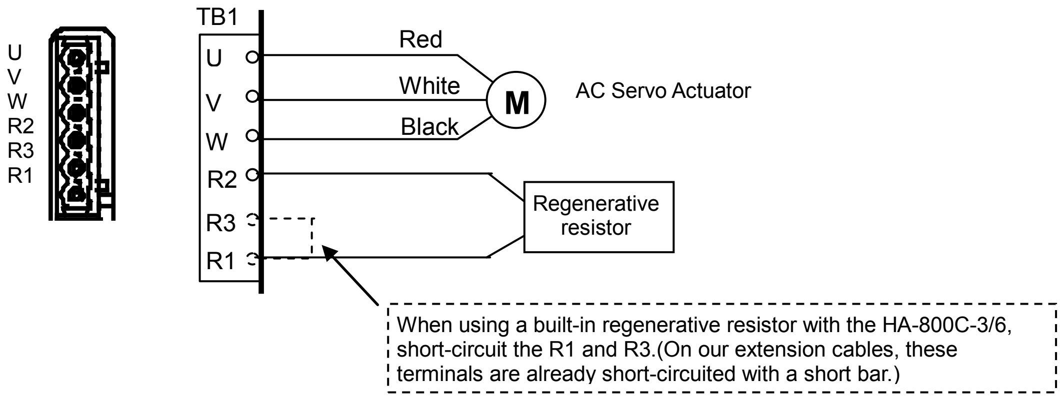
2-5 Wiring the driver and motor

The following explains how to wire this driver and motor.

Connecting the motor

Connect the motor by connecting the U, V and W terminals of the TB1 connector, as shown below. Refer to the actuator manual to check the phase order of motor cable wires beforehand, and connect each pair of terminals that have the same symbol. Take note that if the phase order is wrong or any of the phases is missing, alarms, etc., will not generate.

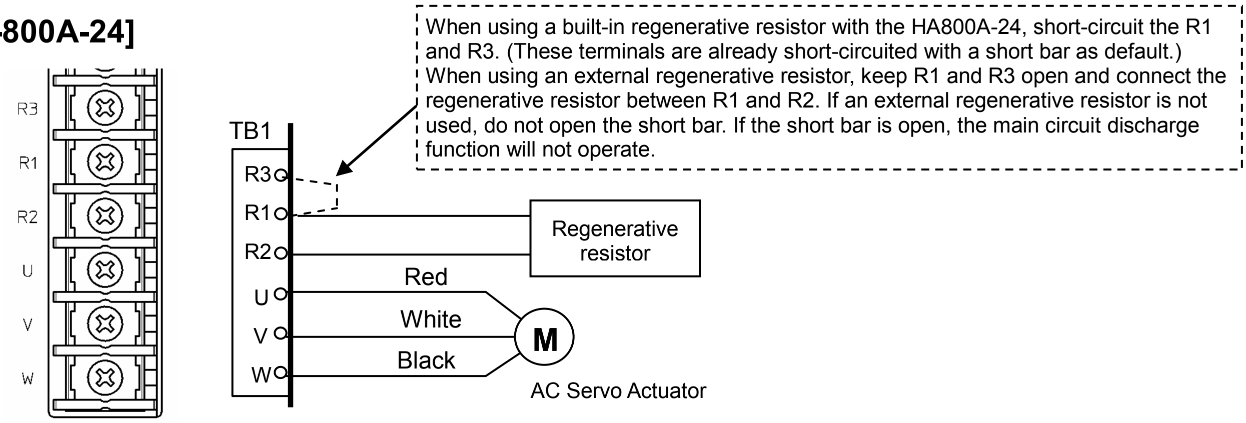
[HA-800A-1/-3/-6]



Terminal block for motor connection (for TB1)

Manufacturer	Phoenix Contact
Model	FKIC2.5/6-ST-5.08

[HA-800A-24]



Terminal block for motor connection

Screw size	Crimp terminal outer diameter	Reference
M4	ϕ8mm	Round crimp terminal (R-type) 3.5-R4 (J.S.T. Mfg. Co., Ltd) 5.5-4NS (J.S.T. Mfg. Co., Ltd)

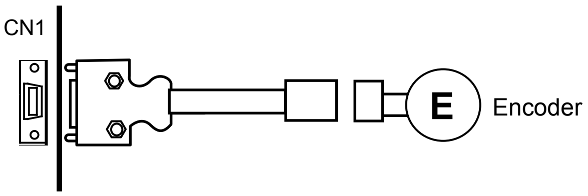
WARNING

If the phase order of the motor cable is wrong or any wire is disconnected or connected during operation, an uncontrollable operation may result.

Connecting the encoder

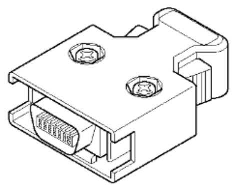
To connect the encoder, connect the CN1 connector, as shown below.
For the encoder signal wire, use a twisted pair shield cable with a wire size of $0.3mm^2$ or larger and having the necessary number of cores.
Shorten the wiring length as much as possible.

- If provided by the customer
  Wiring length: 10m or less Wire conductivity: 0.04Ω/m or less
- We have optional cables of 3m/5m/10m long.



Encoder connector (CN1)

	Connector	Cover
Manufacturer	3M	3M
Model	10114-3000PE	10314-52F0-008



Pin layout of encoder connector (CN1)

The pin layout shown below is viewed from the soldered side.

4-wire wire-saving incremental encoder

6	4	2	
NC	NC	NC	
7	5	3	1
$\overline{SD}$	SD	NC	+5V
13	11	9	
NC	NC	NC	
14	12	10	8
NC	NC	NC	0V

13-bit absolute encoder

6	4	2	
CLR	BAT−	BAT+	
7	5	3	1
$\overline{SD}$	SD	NC	+5V
13	11	9	
NC	NC	NC	
14	12	10	8
NC	NC	NC	0V

17-bit absolute encoder

6	4	2	
NC	BAT−	BAT+	
7	5	3	1
$\overline{SD}$	SD	NC	+5V
13	11	9	
NC	NC	NC	
14	12	10	8
NC	NC	NC	0V

14-wire incremental encoder

6	4	2	
$\overline{Z}$	$\overline{B}$	B	
7	5	3	1
$\overline{A}$	A	Z	+5V
13	11	9	
W	V	U	
14	12	10	8
$\overline{W}$	$\overline{V}$	$\overline{U}$	0V

(*: In the 17-bit encoder incremental model, there is no need to connect BAT+/BAT-.)

Caution

- Do not connect NC terminals. If NC terminals are connected by mistake, malfunctions may result.

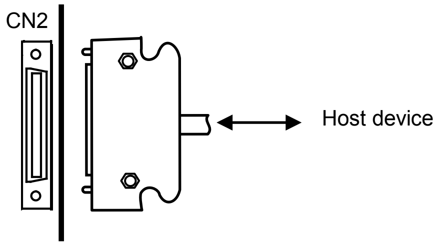
2 Installation/wiring

2-6 Wiring the host device

The following explains wiring of this driver and host device.

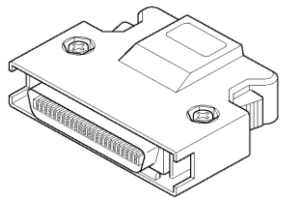
Connecting the host device

To connect the host device, connect the CN2 connector, as shown below.
For the I/O signal cable, use a twisted pair shield cable or twisted pair whole-shield cable with a wire size of 0.2mm^2 (AWG24) and having the necessary number of cores.



I/O signal connector (CN2)

	Connector	Cover
Manufacturer	3M	3M
Model	10150-3000PE	10350-52F0-008



Pin layout of I/O signal connector (CN2)

The pin layout shown below is viewed from the soldered side.

	24 OUT-COM	22 OUT7	20 OUT5	18 OUT3	16 OUT1	14	12	10 IN8	8 IN-COM	6 IN5	4 IN3	2 IN1 (S-ON)
25 OUT-COM	23 Z (OC)	21 OUT6	19 OUT4	17 OUT2	15	13	11	9 IN7	7 IN6	5 IN4	3 IN2	1 IN-COM
	49 FG	47 Z−	45 B−	43 A−	41 POS-DAT-	39	37	35	33 TRQ-CMD	31 SPD-CMD	29 REV+	27 FWD+
50 FG	48 MON-COM	46 Z+	44 B+	42 A+	40 POS-DAT+	38	36	34 TRQ-COM	32 SPD-COM	30 REV-	28 FWD-	26 +24V

Assign functions to input signals (IN1 to IN8) and output signals (OUT1 to OUT7) using system parameters for input/output signals. Refer to [Chapter 5 I/O signals] for the functions that are assigned by default.

Caution

- Keep the I/O signal cable to 3m or shorter.
- Separate power cables (power source cables and motor wires and other circuits subject to strong electric power) and I/O signal cables by more than 30cm. Do not encase them in the same pipe or duct, nor bundle them together.
- Do not open the end of cables for analog input signals, such as speed signals.

Connecting the personal computer (PSF-800)

To connect to the personal computer, use dedicated communication cable or refer to the following pin layout.
Dedicated communication cable: EWA-RS03 (option)
Cable length: 1.6m

PSF-800 communication connector (CN3)

	Connector
Manufacturer	Hirose Electric Co., Ltd.
Model	TM11P-66P(53)

Connector on the personal computer side (D-sub 9-pin female)

	Socket	Hood	Jack screw
Manufacturer	OMRON Corporation	OMRON Corporation	OMRON Corporation
Model	XM2D-0901	XM2S-0913	XM2Z-0073

Pin layout of PSF-800 communication connector (CN3)

Driver side

Symbol	Pin No.
TxD	1
GND	2
485+	3
485-	4
GND	5
RxD	6

Personal computer side

Pin No.	Symbol
1	-
2	TxD
3	RxD
4	-
5	GND
6	-
7	-
8	-
9	-

The host and the first axis communicate via RS-232C.
The second and subsequent axes perform RS-485 communication.
Prepare commercially available Sanwa Supply TEL-FC-5, etc. for RS-485 communication cables.
Prepare RS Online model No. 186-3082, etc. for RS-485 communication branch connectors.

Chapter 3

Startup

Startup procedures to be followed when the driver is used for the first time, from receiving inspection to operation of the actual system, are explained in this chapter.

3-1 Startup procedures

The following explains the procedures to start up this driver.

WARNING

Shut off the electric power source on the plant side before any wiring works are carried out. Once the electric power on the plant side is supplied to the system, do not perform any wiring works. Electric shock may result.

CAUTION

(1) Check the wirings again and correct the problems, if any, before turning ON the power.
- **Are all wirings correct?**
- **Are there temporarily wired lines?**
- **Are there any loose terminal connections?**
- **Are the wires grounded properly?**

(2) Clean around the devices. In particular, thoroughly inspect the interior of the system for wire chips, tools and other objects remaining inside the system.

(3) When 2 or more persons are working together, they should discuss the details of work before turning ON the power and each person should pay attention to the safety of others.

(4) Do not operate the driver by turning ON/OFF the power.
- **Frequent power ON/OFF operations may cause deterioration of circuit elements inside the driver.**
- **Start/stop the actuator using command signals.**

Startup procedures

Key startup procedures are as follows:

Check before turning ON the power for the first time	Refer to: [Turning ON the power for the first time] (P3-3)
↓	
Operation check with the actuator alone in the actual control mode	Refer to: [Operation check with the actuator alone] (P3-9)
↓	
Operation check with the actual system	Refer to: [Operation check with the actual system] (P3-13)
↓	
Normal operation	Refer to: [Normal operation] (P3-22)

3-2 Turning ON the power for the first time

The following explains the startup procedure when turning ON the power for the first time.

CAUTION

(1) Be sure to perform a trial run before commencing the normal operation.
(2) In a trial run, separate the actuator from the machine/system and operate the actuator alone (under no load).

Receiving inspection	Check the nameplate attached on the right side face of the driver to see if the driver and actuator combination is correct. Refer to: [Receiving inspection] (P2-1)
↓ Check the installation location	Check the installation environment of the driver. Refer to: [Installation location and installation] (P2-2)
↓ Check the wirings	Check the wirings of power source cable, motor wire, encoder wire and I/O signal cables. Refer to: [Connecting power cables] (P2-5)
↓ Turn ON the control power supply	Turn ON the control power supply. The sequence of the driver's LED display varies depending on the encoder equipped in the actuator. For the absolute encoder, AL53 and AL81 are generated. Execute [T08: multi revolution clear] and turn the control power OFF then ON to reconnect the power. Refer to: [Details on control power supply ON] (P3-4, P3-5)
↓ Turn ON the main power supply	Turn ON the main power supply.
↓ JOG operation with the actuator alone in the test mode	Perform rotary operations via JOG operation to confirm that the power supply, motor, and encoder are wired correctly. Refer to: [Chapter 9 Test mode]

CAUTION

Take note that in rotary operations via JOG, for input signals other than emergency stop, operations ignore the signal status.

Details on control power supply ON

The driver's internal process sequence to be implemented upon power ON varies depending on the connected actuator.

(1) 17-bit absolute encoder (17-bit encoder incremental model) (SHA series, FHA-Cmini series) combination (P3-4)
(2) When a 13-bit absolute encoder (FHA-C series) is combined (P3-5)
(3) When a 4-wire incremental encoder (FHA-Cmini series) is combined (P3-6)
(4) When a 4-wire incremental encoder (FHA-C series) or 14-wire incremental encoder is combined (P3-7)

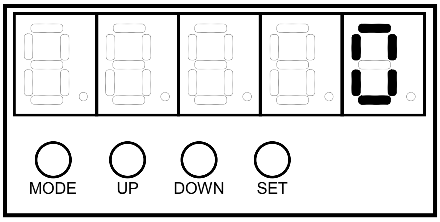
(1) When a 17-bit absolute encoder (SHA series, FHA-Cmini series) is combined

1 Turn ON the control circuit power.

Check the driver and actuator combination as well as the input voltage and multi revolution data of the absolute encoder.

Normal

Abnormal



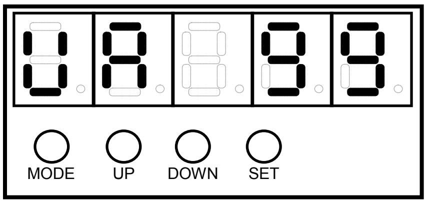
2 The system switches to the status display mode.

The default setting is to display the motor rotation speed.

If multiple alarms or warnings have occurred, the applicable alarms/warnings are displayed one by one.

● **If the actuator combination is wrong**

As shown on the right, [UA99: Wrong actuator connected] is displayed.



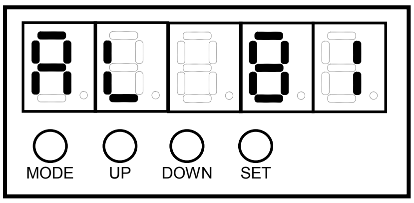
Action to be taken

The combined actuator is specified on the nameplate attached on the right side face of the driver.

Shut off the control circuit power, and exchange the actuator to the correct one. After connecting the correct actuator, turn ON the power again to confirm that the system starts correctly.

● **Absolute multi revolution data error**

his error occurs when the power is turned ON for the first time or the actuator has been disconnected from the driver for an extended period of time (approximately 30 minutes or more). As shown to the left, [AL 81: System down] is generated.



Action to be taken

Issue a multi revolution clear command. After the multi revolution clear command, reconnect the driver power.

For the method to clear the multi revolution counter, refer to [T08: Multi revolution clear](P9-10).

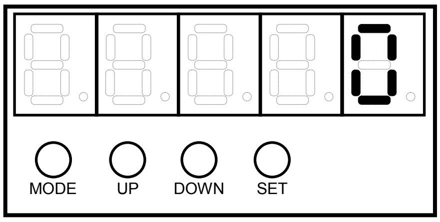
(2) When a 13-bit absolute encoder (FHA-C series) is combined

1 Turn ON the control circuit power.

Check the input voltage and multi revolution data of the absolute encoder.

Normal

Abnormal



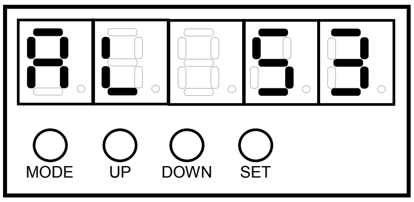
2 The system switches to the status display mode.

The default setting is to display the motor rotation speed.

If multiple alarms or warnings have occurred, the applicable alarms/warnings are displayed one by one.

- **Absolute multi revolution data error**

This error occurs when the power is turned ON for the first time or the actuator has been disconnected from the driver for an extended period of time (approximately 30 minutes or more).
As shown to the left, [AL 53: System down] is generated.



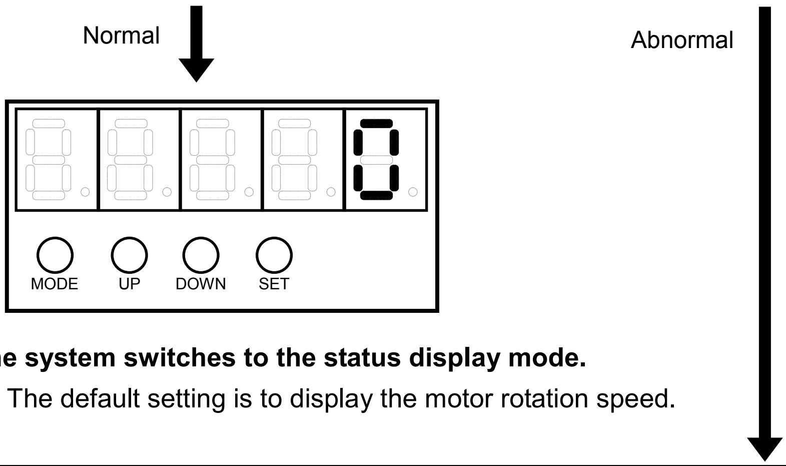
Action to be taken

Issue a multi revolution clear command. After the multi revolution clear command, reconnect the driver power.
For the method to clear the multi revolution counter, refer to [T08: Multi revolution clear](P9-10).

(3) When a 4-wire incremental encoder (FHA-Cmini series) is combined

1 Turn ON the control circuit power.

Check the driver and actuator combination.



2 The system switches to the status display mode.

The default setting is to display the motor rotation speed.

If multiple alarms or warnings have occurred, the applicable alarms/warnings are displayed one by one.

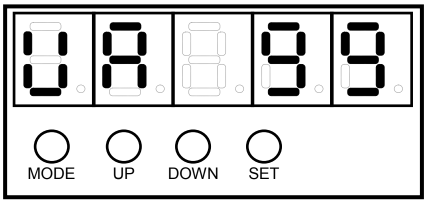
● **If the actuator combination is wrong**

[UA99: Wrong actuator connected] is displayed.

Action to be taken

The combined actuator is specified on the nameplate attached on the right side face of the driver.

Shut off the control circuit power, and exchange the actuator to the correct one. After connecting the correct actuator, turn ON the power again to confirm that the system starts correctly.

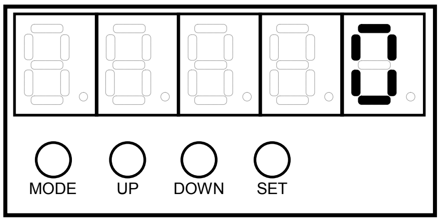


(4) When a 4-wire incremental encoder (FHA-C series) or 14-wire incremental encoder is combined

1 **Turn ON the control circuit power.**

Normal

Abnormal



2 **The system switches to the status display mode.**

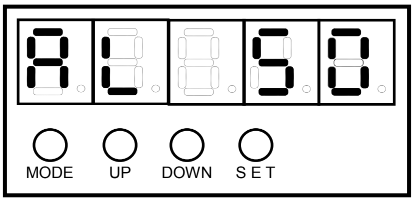
The default setting is to display the motor rotation speed.

If multiple alarms or warnings have occurred, the applicable alarms/warnings are displayed one by one.

□

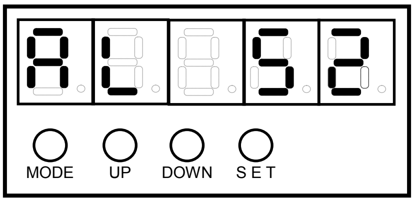
● **Wrong wiring/faulty wiring□**

If there are any problems in wiring the phase A, B, and Z signals, phase U, V, and W and/or power supply, [AL 50: Encoder disconnection] is generated.



● **Wrong wiring/faulty wiring□**

If there are any problems in wiring of phase U, V, and W signals and/or power supply of the encoder, [AL 52: UVW error] is generated.



Troubleshooting upon power ON

Description of operation	Description of problem	Check item	Estimated cause	Reference
Power ON	The LEDs do not turn ON.	The situation improves when the CN1 connector is unplugged.	● Insufficient input voltage or poor power connection ● Defective driver	P2-5 P2-6
		The situation improves when the CN2 connector is unplugged.	● Insufficient input voltage or poor power connection ● Defective driver	
		The situation does not improve even after unplugging the CN1 and CN2 connectors and wires.	● Insufficient input voltage or poor power connection ● Defective driver	
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11
	AL53 and AL81 are generated.	Execute the multi revolution clear, then reconnect the power.		P9-10
JOG operation	Does not rotate.	Is the motor wire connected correctly?	● Poor motor wire connection ● Defective driver ● Defective actuator	P2-17
	The rotation direction is reversed.			
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11

3-3 Operation check with the actuator alone

The following explains the operation check procedure on the motor alone before the motor is assembled into the system.

CAUTION

(1) Be sure to perform a trial run before commencing the normal operation.
(2) In a trial run, separate the actuator from the machine/system and operate the actuator alone (under no load).

Set the control mode

The position control mode is selected as the default setting. To use the driver in the speed control mode or torque control mode, the setting must be changed.
Refer to: [SP-41: Control mode switching setting] (P8-4)

↓

Assign input signals

The factory default values of input signals are shown in Chapter 5. To change other signals and logics, the signal assignments and logics must be changed.
Refer to: [Input signals: System parameter SP00 to SP16] (P5-3)

↓

Assign output signals

The factory default values of output signals are shown in Chapter 5. To change other signals and logics, the signal assignments must be changed.
Refer to: [Output signals: System parameter SP20 to SP26] (P5-23)

↓

Set the function extension mode

As necessary, change the function settings of the driver.
Check the settings for parameters that strongly affect operation.
Refer to: [Function expansion signals] (P8-3)

↓

Check the I/O wirings and logics in the test mode

Check the wirings of driver signals input from the host, as well as driver outputs and host signal wirings/logics, in the test mode.
Refer to: [Chapter 9 Test mode]

↓

Operate from the host controller

Perform actual operations according to the actual operation commands from the host controller.

Troubleshooting at operation check

Position control mode

Operation	Description of problem	Check item	Estimated cause	Reference
Servo-ON input	The servo does not lock.	Is the motor wire connected correctly?	Poor motor wire connection	P2-17
		Is the operation preparation completed?	1. The servo-ON signal has not been input. 2. Is the DC24V power supplied correctly to the IN-COM?	P5-9 P5-4
		Is warning 93 generated?	The main circuit voltage is not input or lower than the warning 93 threshold.	P2-5
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11
Command pulse input	The actuator does not rotate.	Is the motor wire connected correctly?	Wrong motor wire UVW connection	P2-17
		Check the command pulse in the status display mode explained in Chapter 6.	1. Pulse pattern setting error 2. 2-pulse train signal logic error	P8-5
		Is the FWD or REV inhibit inputs enabled?	The FWD/REV inhibit is enabled.	P5-11
		Check the CN2 wirings.	Wiring error	
	Rotates only in 1 direction.	Pulse input pattern setting	Pulse input pattern setting and pulse input system do not match.	P5-18 P8-5
		Is the FWD or REV inhibit input enabled?	The inhibit input in non-rotatable direction is enabled.	P5-11
		Check the CN2 wirings.	Wiring error	
	The rotation direction*1 is reversed.	Check the CN2 wirings.	Pulse signal wiring error	P5-11
		Check the command polarity.	Parameter setting error	P8-7
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11

*1: The rotation polarity varies depending on the actuator model. Refer to the manual of your actuator.

3

Startup

Speed control mode

Operation	Description of problem	Check item	Estimated cause	Reference
Servo-ON input	The servo does not lock.	Is the motor wire connected correctly?	Poor motor wire connection	P2-17
		Is the operation preparation completed?	1. The servo-ON signal has not been input. 2. Is the DC24V power supplied correctly to the IN-COM?	P5-9 P5-4
		Is warning 93 generated?	The main circuit voltage is not input or lower than the warning 93 threshold.	P2-5
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11
FWD enable or REV enable ON	The actuator does not rotate.	Is the motor wire connected correctly?	Wrong motor wire UVW connection	P2-17
		Check the d11 speed command voltage in the status display mode.	The speed command voltage is 0V.	P5-20
		Monitor the I/O statuses using PSF-800 software.	Input signal is incorrect.	P5-9
		Are the internal speed command value and related items correctly set and selected?	Internal speed command setting error or internal speed command selection (CN2) error	P5-10
		Is the FWD or REV inhibit input enabled?	The FWD/REV inhibit inputs are enabled.	P5-9
		Check FWD/REV enable status.	Both the FWD and REV enable inputs are turned ON or OFF.	
	The rotation direction*1 is reversed.	Is the command voltage input correctly?	The opposite polarity is set.	P5-16
		Check FWD/REV enable status.	At + (-) command voltage input, the FWD (REV) enable inputs are turned OFF and the REV (FWD) enable inputs are turned ON.	
		Check the command polarity.	Parameter setting error	P8-7
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11

*1: The rotation polarity varies depending on the actuator model. Refer to the manual of your actuator.

Torque control mode

Operation	Description of problem	Check item	Estimated cause	Reference
Servo-ON input	The servo does not lock.	Is the motor wire connected correctly?	Poor motor wire connection	P2-17
		Is the operation preparation completed?	1. The servo-ON signal has not been input. 2. Is the DC24V power supplied correctly to the IN-COM?	P5-9 P5-4
		Is warning 93 generated?	The main circuit voltage is not input or lower than the warning 93 threshold.	P2-5
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11
FWD selection or REV selection ON	The actuator does not rotate.	Is the motor wire connected correctly?	Wrong motor wire UVW connection	P2-17
		Check the d12 torque command voltage in the status display mode.	The torque command voltage is 0V.	P5-20
		Monitor the I/O statuses using PSF-800 software.	Input signal is incorrect.	P5-9
		Is the FWD or REV inhibit input enabled?	The FWD/REV inhibit inputs are enabled.	P5-10
		Check the FWD/REV selection status.	Both the FWD and REV selections are turned ON or OFF.	
	The rotation direction*1 is reversed.	Is the command voltage input correctly?	The opposite polarity is set.	P5-16
		Check the FWD/REV selection status.	At + (-) command voltage input, the FWD (REV) selection inputs are turned OFF and the REV (FWD) selection inputs are turned ON.	
		Check the command polarity.	Parameter setting error	P8-7
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11

*1: The rotation polarity varies depending on the actuator model. Refer to the manual of your actuator.

3-4 Operation check with the actual system

The following explains the operation checking procedure to be performed using the applicable system assembled with the motor.

> **WARNING**
>
> **If this product is applied to any facility that affects life or may trigger material losses, install safety devices so that accidents will not occur even when the output control is disabled due to damage.**

Assemble into the actual system	Assemble the system into the ultimate condition to be used.
↓ Perform auto-tuning in the test mode	Perform auto-tuning in the offline test mode to set an appropriate gain. Refer to: [Chapter 9 Test mode]
↓ Manually adjust the gain	Issue operation commands from the host controller and check how the machine moves. If the machine movements must be calibrated further, manually adjust the gain. Refer to: [Manual gain adjustment method] (P3-15)
↓ Set the origin using the absolute encoder	This is necessary only on models equipped with an absolute encoder. Refer to: [Origin setting] (P4-8, P4-18)
↓ Operate from the host controller	Perform actual operations according to the actual operation commands from the host controller. Refer to: [Chapter 5 I/O signals]
↓ Stop	

Troubleshooting at actual operation check

Operation	Description of problem	Check item	Estimated cause	Refere-nce
Auto-tuning	Significant vibration does not decrease even after tuning.	Is the startup or shutdown time too short?	Host controller setting error	P9-11
		Is the load inertia too big?	Actuator selection error	
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11
Manual gain adjustment	Vibration does not decrease even after adjusting the gain.	Check the servo gain set value.	Servo gain setting error	P3-15
		Is the startup or shutdown time too short?	Host controller setting error	
		Is the load inertia too big?	Actuator selection error	
	An alarm generates.	Refer to [Chapter 11 Troubleshooting].		Chapter 11

3

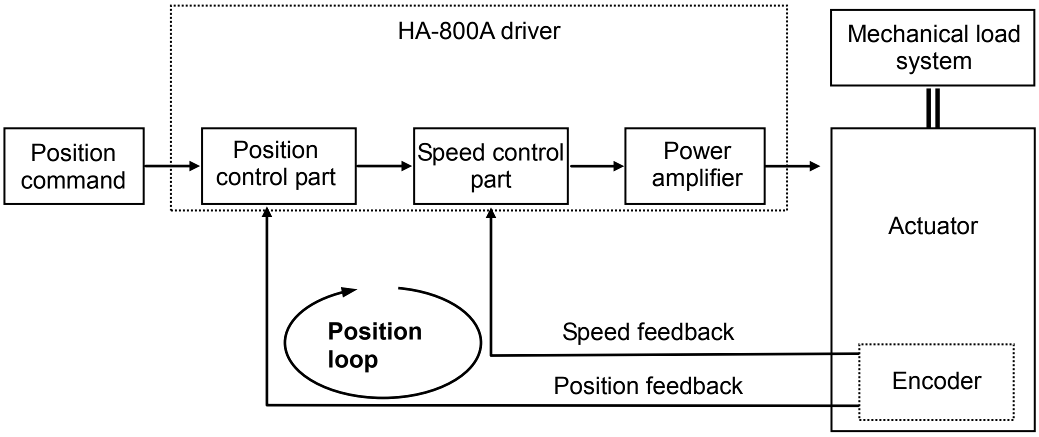
Startup

3-5 Manual gain adjustment method

If sufficient adjustment could not be achieved by auto-tuning, manual adjustment can be performed using various parameters.
When manually adjusting the servo gain, adjust the gains of individual servos one by one. Check the response characteristics using the HA-800 driver monitor software PSF-800 waveform monitoring. Prepare a measuring instrument to observe monitored output waveforms to CN9.

Position control

A block diagram of position control is shown below.



Parameters

The following parameters are used to adjust the position control gain.

Parameter No.	Description	Default
AJ00	Position loop gain	*1
AJ01	Speed loop gain	*1
AJ02	Speed loop integral compensation	*1

*1: The default varies depending on the applicable actuator. Refer to the values of applicable actuator that are the targets of [Appendix: Default setting] (A-1).

Adjustment procedure

1 **Perform rough adjustment via auto-tuning. Refer to [T09: Auto-tuning] (P9-11).**

2 **Set a smaller position loop gain (AJ00) and larger speed loop integral compensation (AJ02).**

3 **Gradually increase the speed loop gain (AJ01) to the extent that the machine does not vibrate or produce abnormal sound, and once vibration or abnormal sound is detected decrease the gain slightly.**

4 **Gradually decrease the speed loop integral compensation (AJ02) to the extent that the machine does not vibrate or produce abnormal sound, and once vibration or abnormal sound is detected increase the compensation slightly.**

5 **Gradually increase the position loop gain (AJ00), and once vibration is detected decrease the gain slightly.**

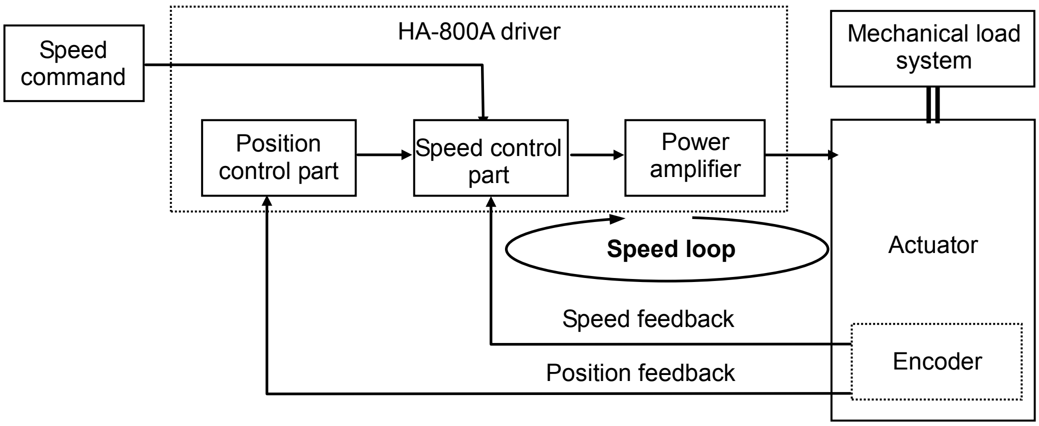
6 **Fine-tune the above gains by observing the settling after positioning and condition of machine operation.**

Adjustment details

- **Speed loop gain (AJ01)**
  This parameter is used to determine the response of the speed loop.
  Increasing the set value of this parameter improves the response, but increasing the value excessively causes the mechanical system to vibrate easily. On the other hand, a lower response of the speed loop eliminates vibration but it may cause the response to drop. In addition, setting the response of the speed loop too low can cause a delay in the external position loop, thereby resulting in overshooting or the machine may vibrate as it executes a speed command.
- **Speed loop integral compensation (AJ02)**
  The speed loop can be integrally compensated to reduce the negative effect of speed fluctuation as the load fluctuates. The greater this integral compensation, the slower the response becomes upon load fluctuation. On the other hand, a smaller compensation improves the speed response upon load fluctuation, but too small a setting induces vibration. Accordingly, adjust the integral vibration to an appropriate level.
- **Position loop gain (AJ00)**
  By increasing the position loop gain, you can improve the control response and shorten the positioning time.
  However, an excessively high gain causes overshooting and the machine will reverse at high speed to compensate for the overshoot. These operations will be repeated and vibration will occur.
  If the position loop gain is too low, on the other hand, the control response drops.

Speed control

A block diagram of speed control is shown below.



Parameters

The following parameters are used to adjust the speed control gain.

Parameter No.	Description	Default
AJ01	Speed loop gain	*1
AJ02	Speed loop integral compensation	*1

*1: The default varies depending on the applicable actuator. Refer to the values of applicable actuator that are the targets of [Appendix: Default setting] (A-1).

Adjustment procedure

1 **Perform rough adjustment via auto-tuning. Refer to [T09: Auto-tuning] (P9-11).**

2 **Set a larger speed loop integral compensation (AJ02).**

3 **Gradually increase the speed loop gain (AJ01) to the extent that the machine does not vibrate or produce abnormal sound, and once vibration or abnormal sound is detected decrease the gain slightly.**

4 **Gradually decrease the speed loop integral compensation (AJ02) to the extent that the machine does not vibrate or produce abnormal sound, and once vibration or abnormal sound is detected increase the compensation slightly.**

5 **Fine-tune the above gains by observing the condition of machine operation under speed control.**

Adjustment details

- **Speed loop gain (AJ01)**

  This parameter is used to determine the response of the speed loop.
  Increasing the set value of this parameter improves the response, but increasing the value excessively causes the mechanical system to vibrate easily. On the other hand, a lower response of the speed loop eliminates vibration but it may cause the response to drop. In addition, setting the response of the speed loop too low can cause a delay in the external position loop, thereby resulting in overshooting or the machine may vibrate as it executes a speed command.

- **Speed loop integral compensation (AJ02)**

  The speed loop can be integrally compensated to reduce the negative effect of speed fluctuation as the load fluctuates. The greater this integral compensation, the slower the response becomes upon load fluctuation. On the other hand, a smaller compensation improves the speed response upon load fluctuation, but too small a setting induces vibration. Accordingly, adjust the integral vibration to an appropriate level.

Applied servo gain adjustment function

The feed-forward control function can be adjusted with the applied adjustment function. Normally, you should first use the above manual gain adjustment methods in [Position control] (P3-15).Only when these adjustments do not provide satisfactory results you should use the applied adjustment function.
The feed-forward control function calculates the speed command/torque command required for operation from the position command. Compared to feedback control alone, the error pulses can be made smaller to improve the responsiveness.
The feed-forward control function is only effective during position control. It does not operate for speed control or torque control.
[SP69: Feed-forward control function setting] allows you to select feed-forward control and the feed-forward control simple adjustment edition. The feed-forward control simple adjustment edition is a function that can achieve the same degree of control performance with fewer setting parameters (2 relevant parameters) than the previous feed-forward control (5 relevant parameters).

SP69: Feed-forward control function setting

○: Affected by AJxx setting ×: Not affected by AJxx setting

Set value	Function	Relevant parameters				
		AJ03	AJ20	AJ21	AJ22	AJ23
0	Feed-forward control (previous compatible function)	○	○	○	○	○
1	Feed-forward control	○	○	○	○	○
2	Feed-forward control simple adjustment version (stable operation mode)	○	×	○	×	×
3	Feed-forward control simple adjustment version (normal operation mode)	○	×	○	×	×
4	Feed-forward control simple adjustment version (high-speed operation mode)	○	×	○	×	×
5	Feed-forward control simple adjustment version (manual tune mode)	○	○	○	×	×

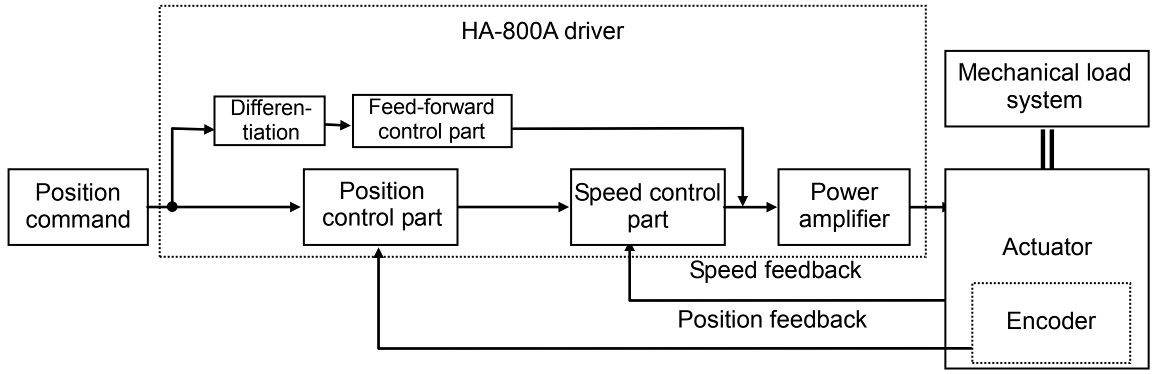
* [SP69: Feed-forward control function setting] is available for HA-800 software version 3.x or later.

*: Changes to system parameter settings (SP00 to 79) are put into effect by changing the setting, then turning control power supply OFF, then ON again.

Caution

- Do not set [SP69: Feed-forward control function setting] to 0 unless you have been using feed-forward control function with software version 2.08 or earlier, and will use the HA-800A with the same device with software version 3.x or later.
  - The feed-forward control function does not operate after switching from speed control or torque control to position control.
- When using the feed-forward control function, it is necessary to set [AJ21: Load inertia moment ratio] correctly. Set this value correctly using the machine specifications value or the auto-tuning function.
- Changes to [AJ03: Feed-forward gain] take effect when the motor shaft rotation speed drops to [AJ07: Zero speed judgment value] or lower.
- Changes to feed-forward function related parameters (AJ20-23) take effect when the motor stops. Setting values can be changed while the motor is operating.

Block diagram of feed-forward control function



Parameters

The following parameters are used for feed-forward control.

Parameter No.	Description	Default
SP69[*1]	Feed-forward control function setting	*2
AJ03	Feed-forward gain	0
AJ20	Feed-forward filter	1
AJ21	Load inertia moment ratio	100
AJ22	Torque constant compensation factor	100
AJ23	Spring constant compensation factor	100

*1: Changes to system parameter settings (SP00 to 79) are put into effect by changing the setting, then turning control power supply OFF, then ON again.
*2: The default varies depending on the applicable actuator. Refer to [Default settings] (Apx-1) in the appendix.

調整内容

- **Feed-forward control function setting (SP69)**

・Setting details

This sets the responsiveness when [SP69: Feed-forward control function setting] is [2, 3, or 4].The appropriate feed-forward filter frequency is set automatically based on the machine's resonance frequency due to the rigidity of the speed reducer in the actuator and the load inertia moment ([AJ21: Load inertia moment ratio]).
When [SP69: Feed-forward control function setting] is [0, 1, or 5], [AJ20: Feed-forward filter] can be set to any desired value.

・Adjustment method

Normally, set [SP69=3: Normal operation mode].From the vibration and responsiveness, set the appropriate operation mode, referencing the table below. The vibration and responsiveness are greatly affected by [AJ03: Feed-forward gain].Also, for a low inertia ratio (when [AJ21: Load inertia moment ratio] is 20 or less), vibration occurs particularly easily.
When the responsiveness is not satisfactory with [SP69=4: High-speed operation mode], you can also adjust the feed-forward filter manually with [SP69=5: Manual tune mode].Only use [SP69=1: Feed-forward control] when [SP69=5: Manual tune mode] cannot produce satisfactory results.

	Vibration	Responsiveness
SP69=2: Stable operation mode	Small	Low speed
SP69=3: Normal operation mode	Medium	Medium speed
SP69=4: High-speed operation mode	Large	High speed

- **Feed-forward gain (AJ03)**

・Adjustment method

If the feed-forward gain is set too high, the command is achieved more quickly. However, an excessively high gain leads to mechanical shock or vibration (hunting).
Set [AJ03L Feed-forward gain] in the range [0 to 100].Set the feed-forward gain to around 50 and check the response. Raise and lower the gain about 5 degrees at a time until you have adjusted to a satisfactory response.
When [AJ03: Feed-forward gain] is 0, the feed-forward control function is disabled.

・Effect of electronic gear setting

Note that when the electronic gear ratio is high, adequate effects may not be obtained from feed-forward control and vibration may occur.
For example, setting the numerator larger and denominator smaller for the electronic gear has the same effect as inputting (numerator)/(denominator) pulses per positioning command pulse. In this case, input change increases in discontinuous steps. Since an input change is differentiated under feed-forward control, if this discontinuous input change increases, the derivative value becomes discontinuous, and vibration may occur.
Also, for a low inertia ratio (when [AJ21: load inertia moment ratio] is 20 or less) and low-speed operation, vibration occurs particularly easily.

- **Feed-forward filter (AJ20)**

・Setting details

Set the filter frequency to be used in feed-forward control. When [SP69: Feed-forward control function setting] is 0, 1, or 5, the setting has an effect.

・Adjustment method

A higher set value has faster response but vibration is more likely to occur. In order to make feed-forward control function effectively, it is necessary to set a value larger than the value of [AJ00: Position loop gain].While checking the response, gradually raise the setting value.

- **Load inertia moment ratio (AJ21)**

・Setting details

Set the ratio of the moment of inertia of load relative to the self-inertia moment.100% means that the load factor is the same as the self-inertia moment. Set the actual load inertia value of the machine. This value can also be set automatically using the auto-tuning function. For details on the auto-tuning function, refer to [Auto-tuning] (P9-11, P10-8).

・Effect of setting

Increasing the load inertia moment ratio has the effect of increasing the feed-forward amount just like when the feed-forward gain is raised. Lowering the load inertia moment ratio has the same effect as lowering the feed forward gain. Set the actual load inertia value of the machine correctly.

- **Torque constant compensation factor (AJ22)**

・Normal use

Variation in the actuator torque constant is compensated for.Feed-forward control is performed based on the value set here.Set this factor to 100% in normal use.When [SP69: Feed-forward control function setting] is 0 or 1, the setting has an effect.

・Effect of factor

The reference value of the torque constant compensation factor is 100%. Setting a higher value increases the actuator torque constant, meaning that the feed-forward control part decreases the feed-forward amount and thereby lowers the feed-forward gain.
On the other hand, setting a low torque constant compensation factor has the same effect as increasing the feed-forward gain. Torque constants of actuators are subject to slight variation, and this parameter is used to compensate for this variation. Accordingly, set this parameter to 100% in normal use.

- **Spring constant compensation factor (AJ23)**

  ・Normal use

  Variation in the actuator spring constant is compensated for. Feed-forward control is performed based on the value set here. Set this factor to 100% in normal use. When [SP69: Feed-forward control function setting] is 0 or 1, the setting has an effect.

  ・**Effect of factor**

  Although the reference value of the spring constant compensation factor is 100%, set an appropriate compensation factor depending on the variation in the actuator's spring constant.
  Resonance frequencies that cause mechanical resonance may occur depending on the actuator's spring constant compensated for by the spring constant compensation factor and the setting of load inertia moment ratio (AJ21).The feed-forward control part implements controls to lower the feed-forward gain at these resonance frequencies.

3-6 Normal operation

This driver operates according to commands received from the host device. No special procedures are required in normal operations.
The following explains the notices when performing normal operations as well as daily maintenance/inspection.

Notices for normal operations

WARNING

(1) Do not change wirings while the power is supplied.
Disconnecting wires or connectors while the power is supplied may cause electric shock or an uncontrollable operation.

(2) Do not touch the terminals for 15 minutes after the power is turned OFF.
Even after the power is turned OFF, electric charge remains in the driver. Do not touch the terminals for 15 minutes after the power-OFF to avoid electric shock.

(3) Do not operate the driver by turning ON/OFF the power.
Frequent power ON/OFF operation may cause deterioration of circuit elements inside the driver.

Daily maintenance/inspection

Perform maintenance/inspection according to the maintenance/inspection standards for electronic devices specified by the department introducing the driver.

WARNING

(1) Be sure to shut down the power before carrying out maintenance/inspection.
Carrying out maintenance/inspection while the power is supplied may cause electric shock.

(2) Do not touch the terminals for 15 minutes after the power is turned OFF.
Even after the power is turned OFF, electric charge remains in the driver. Do not touch the terminals for 15 minutes after the power-OFF to avoid electric shock.

(3) Do not perform megger test or voltage resistance test.
The control circuits in the driver may be damaged and an uncontrollable operation may occur.

Inspection point	Interval	Inspection standard	Treatment
Terminal screws	1-year inspection	No loosen screws	Tightening screws
Unit exterior	1-year inspection	No dust or metal chips on the case	Cleaning
Unit interior	1-year inspection	No discoloration, damage or other abnormalities	Consult Harmonic Drive Systems

3

Startup

Periodically replaced parts

A detection circuit is provided for the following replacement parts of this driver so that any part that can no longer operate correctly can be identified. However, it is recommended that each part be replaced at the specified timing listed below. For details, contact our sales office.

Replacement part	Replacement timing	Replacement method
Cooling fan	5 year	Replaced by our office. Ship your HA-800A driver to our sales office. The driver will be returned once the part has been replaced.
Battery	1 year	Purchase a new battery from our sales office. Replace the old battery with the new one after purchase by referring to [How to replace the backup battery].
Electrode capacitor	5 years	When the capacitor is operated in an environment of 40℃ in average temperature throughout the year. It varies depending on the use environment.
Relay	100,000 times (Number of power ON times)	Use the relay at the frequency of turning power ON/OFF of 30 times/day or less.

The life of the cooling fan assumes that this driver is operated 24 hours a day in an environment of 40℃ in average temperature throughout the year.
The life of the battery assumes that the driver remains unpowered in a condition connected to the actuator.

Backup battery

The backup battery is used to hold the multi revolution data in the absolute encoder when the power supply is cut off.
The absolute encoder has a built-in capacitor to hold the data even after the backup battery is replaced.
All drivers of absolute encoder model come with this battery pre-assembled.

Backup battery

Model code: HAB-ER17/33-2

Battery type	Lithium battery
Manufacturer	Hitachi Maxell, Ltd.
Manufacturer model	ER17/33 (3.6V 1,600 mAh)

Data retention time

Data retention time	Approx. 1 year after the power is cut off
Conditions	Unused power is turned OFF, ambient temperature: 25℃, axis stopped (The actual life varies depending on the condition of use.)

Caution

- With a 13-bit absolute encoder or a 17-bit absolute encoder (FHA-Cmini series), warning 91 will be automatically reset after the battery is replaced.
- With a 17-bit absolute encoder (SHA series), warning 91 will be reset by resetting the alarm and reconnecting the power after the battery is replaced.

Built-in capacitor of actuator

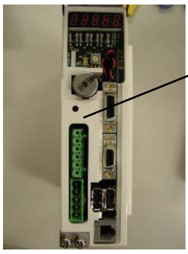
Data retention time

Data retention time	Approx. 30 min. after the power is cut off
Conditions	After 3 h of charging, ambient temperature 25℃, axis stopped

How to replace the backup battery

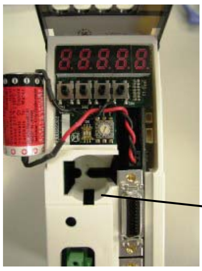
If [UA 91: Low battery power] displays, replace the battery by following the procedure below:

1 Open the operation panel cover.



Panel cover

2 Remove the battery.



Battery holder

3 Set the new battery by placing it in the battery holder with the positive side facing down.

4 Push the battery all the way in and close the panel cover.

- With a 13-bit absolute encoder or a 17-bit absolute encoder (SHA20 and FHA-Cmini series)*, UA91 will be automatically reset after the battery is replaced.
- With a 17-bit absolute encoder (SHA series (excluding SHA20)), UA91 will be reset by resetting the alarm and reconnecting the power after the battery is replaced.

* In Version 2.x and earlier, after the battery is replaced, turning the power back ON releases UA91.

Caution

- Exercise caution to prevent the battery cable from getting caught when closing the panel cover.

Chapter 4

Encoder system

The encoder configuration is different depending on the actuator model. Details of each actuator are explained in this chapter.

4-1 Overview of encoders

A different type of encoder is embedded in the actuator according to the actuator model.
Accordingly, wirings, signal exchange with the driver, etc., vary depending on the applicable model.
Details are explained below for each encoder type. Check the section corresponding to your actuator.

Encoder type	Actuator model	Driver model	Details
17-bit absolute encoder 17-bit encoder incremental model	SHA series FHA-Cmini series	HA-800A-∗D-100/200	P4-4
13-bit absolute encoder	FHA-C series	HA-800A-∗A-100/200	P4-15
4-wire wire-saving incremental encoder	FHA-C series	HA-800A-∗C-100/200	P4-25
4-wire wire-saving incremental encoder	FHA-Cmini series	HA-800A-∗C-100/200	
14-wire incremental encoder	RSF/RKF series	HA-800A-∗B-100/200	

The specifications of encoders that can be connected to the HA-800A driver are shown below. Select an applicable driver model according to the actuator used and the applicable encoder specification.

Item	17-bit absolute encoder *1		13-bit absolute encoder	4-wire wire-saving incremental encoder		14-wire incremental encoder
Actuator model	**SHA series (excluding SHA20)**	**SHA20 and FHA-Cmini series**	**FHA-C series**	**FHA-Cmini series**	**FHA-C series**	**RSF/RKF series**
Details	P4-4	P4-4	P4-15	P4-25	P4-25	P4-25
Applicable driver model	HA-800A-3D/ E-100/200 HA-800A-6D/ E-100/200 HA-800A-24D/ E-200	HA-800A-3D/ E-200 HA-800A-1D/ E-100/200	HA-800A-3A -100/200 HA-800A-6A -100/200	HA-800A-1C-100/200	HA-800A-3C -100/200 HA-800A-6C -100/200	HA-800A-3B -100/200 HA-800A-6B -100/200
Sensor type	Magnetic sensor	Single revolution: Optical sensor multi revolution: Magnetic sensor	Optical sensor	Optical sensor	Optical sensor	Optical sensor
Data storage upon power OFF	Battery backup method	Battery backup method	Battery backup method	None	None	None
Resolution per motor shaft rotation	17 bits (131,072 pulses)	17 bits (131,072 pulses)	13 bits (8,192 pulses)	8,000 pulses *2	10,000 pulses *2	8,000 pulses *2
Maximum motor shaft rotation range	16 bits (-32768 to 32767)	16 bits (-32768 to 32767)	13 bits (-4096 to 4095)	Not limited	Not limited	Not limited
Encoder monitor output pulses	Parameter setting can be changed. Up to 8,192 pulses are output per motor shaft rotation.	Parameter setting can be changed. Up to 8,192 pulses are output per motor shaft rotation.	Fixed	Fixed	Fixed	Fixed
Max. permissible rotational speed upon power failure	6,000 r/min However, 300 r/min when the power is input/encoder is started.	6,000 r/min However, 250 r/min when the power is input/encoder is started.	5,000 r/min (constant speed) 1,400 r/min (accelerating)	—	—	—
Retention time by driver's built-in backup battery	Approx. 1 year (Power not supplied)	Approx. 1 year (Power not supplied)	Approx. 1 year (Power not supplied)	—	—	—
Retention time by actuator's built-in capacitor	Approx. 0.5 h (Fully charged)	Approx. 0.5 h (Fully charged)	Approx. 0.5 h (Fully charged)	—	—	—
Encoder/driver communication method	Line driver receiver method/2.5 Mbps	Line driver receiver method	Line driver receiver method	Line driver receiver method	Line driver receiver method	A, B, Z, U, V and W parallel signals
Encoder/driver connection cable	EWD-S**-A08 -3M14 (model No. 25, 32, 40) EWD-S**-D10 -3M14 (model No. 58, 65) 2-core twisted wire x 3-pair shield cable	EWD-S**-A08 -3M14 2-core twisted wire x 3-pair shield cable	EWC-S**-B08-3M14 2-core twisted wire x 4-pair shield cable	EWC-E**-M06 -3M14 2-core twisted wire x 2-pair shield cable	EWC-E**-B04 -3M14 2-core twisted wire x 2-pair shield cable	EWA-E**-A15 -3M14 2-core twisted wire x 7-pair shield cable

Item		17-bit absolute encoder *1		13-bit absolute encoder	4-wire wire-saving incremental encoder		14-wire incremental encoder
Actuator model		SHA series (excluding SHA20)	SHA20 and FHA-Cmini series	FHA-C series	FHA-Cmini series	FHA-C series	RSF/RKF series
HA-800A current value data output (for reading initial position)		33-bit data transmission output of signed current value (9,600 bps, data refresh cycle 100 ms)	33-bit data transmission output of signed current value (9,600 bps, data refresh cycle 100 ms)	33-bit data transmission output of signed current value (9,600 bps, data refresh cycle 100 ms)	—	—	—
Alarm	Encoder disconnection	○	○	○	○	○	○
	MEMORY error	○	○	×	×	×	×
	System failure	○	○	○	×	×	×
	Single rotation data error	○	○	×	×	×	×
	Multi revolution data error	○	○	×	×	×	×
	BUSY error	○	○	×	×	×	×
	Overheat error	○	○	×	×	×	×
	Communication error	○	○	×	×	×	×
	Encoder counter receiving error	×	×	○	○	○	○
	Multi revolution counter overflow	×	×	○	×	×	×
	Multi revolution data error	×	×	○	×	×	×
Safety/ redundancy		Absolute data dual-redundancy matching method	Absolute data dual-redundancy matching metho	None	None	None	None

*1: The 17-bit encoder incremental model does not perform multi revolution detection and do not require a backup battery. Otherwise it is the same as a 17-bit absolute encoder.

*2: Quadruplicated pulses

4-2 17-bit absolute encoder

CAUTION

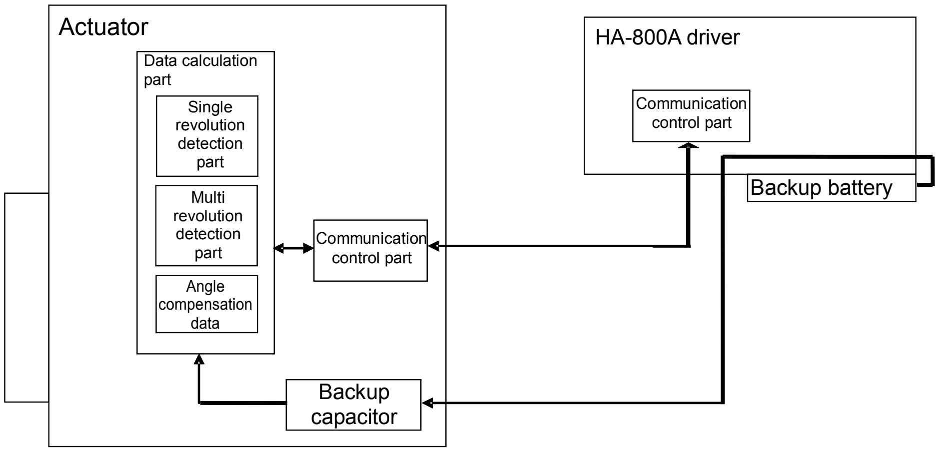
If AL81 (system failure), AL82 (single rotation data error) or AL83 (multi revolution data error) occurs due to a loss of absolute position or error, be sure to reset the origin. Failure to do so may result in unexpected operations.

Features

The SHA series (excluding SHA20) is equipped with a multi revolution-type 17-bit magnetic absolute encoder.
The SHA20 and FHA-Cmini series is equipped with a multi revolution-type 17-bit optical absolute encoder. (Multi revolution detection is magnetic.)
It consists of a detector (17 bits/revolution) for detecting the position after one motor shaft revolution and a cumulative counter (16 bits) for detecting the number of motor revolutions.
This encoder constantly detects the absolute machine position and stores it by means of the backup battery, regardless of whether the power supply for driver or external controller is turned ON/OFF.
Accordingly, once the origin is detected when the machine is installed, originating is not required after subsequent power ON operations. This facilitates the recovery operation after a power failure or breakdown.
The SHA-CG output shaft single revolution absolute model (SHA-CG-S) assumes a machine that only moves the index table in one direction. When the machine continues to rotate in just one direction, the absolute encoder eventually exceeds the number of revolutions that can be detected with multi-revolution detection and it becomes impossible to manage position information accurately.
Therefore, each time the output shaft turns through single revolution, the cumulative multi revolution counter is cleared to 0 to achieve the output shaft single revolution absolute function. This is how position information is accurately managed when the shaft continuously turns in just one direction.
With the 17-bit absolute encoder, the single revolution absolute position detector and the revolution detection/cumulative counter are both made dual-redundant. Two identical data items are constantly compared to ensure highly reliable design permitting self-detection of encoder errors should they occur.
A backup capacitor is also provided in the encoder. (Internal backup. Take note that the retention time is short.)
The 17-bit encoder incremental model does not perform multi revolution detection and do not require a backup battery. Otherwise it is the same as a 17-bit absolute encoder.

Caution

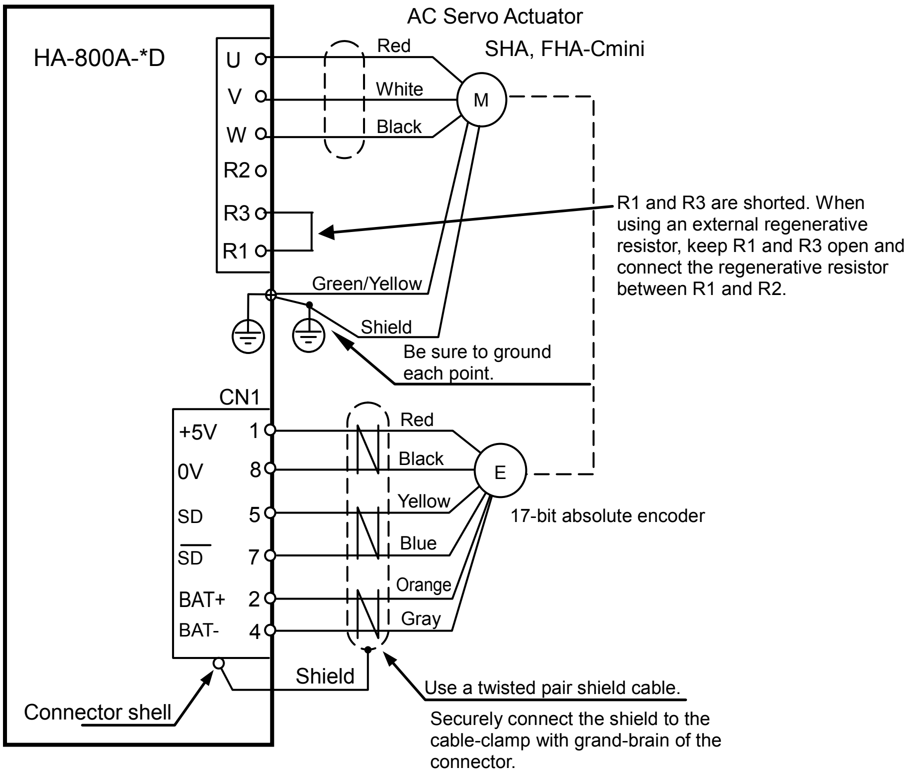
- The backup time is 30 minutes when a new capacitor has been charged for at least 3 hours by supplying power to the actuator. This backup time becomes shorter if the power is supplied for a shorter period or the capacitor deteriorates over time.



Block diagram of actuator/encoder and driver

Standard connection

A connection example of an actuator of 17-bit absolute encoder model with a HA-800A driver is shown.



Startup

Parameters that must be set

Parameter No.	Name	Function
SP61	Encoder monitor output pulses	Set the phase A and B pulses to be output to the encoder monitor output terminals (CN2-42 to 48) when the motor shaft of the 17-bit absolute encoder turns one revolution. Setting range: 1 to 8,192 (Default: 8192) If this parameter is set to the maximum value of 8,192, the resolution becomes 32,768 pulses (8,192 x 4). This corresponds to one-fourth the resolution 131,072 of the 17-bit encoder.
SP66	Absolute encoder function setting	A 17-bit absolute encoder can be set to be used as an incremental encoder. Setting range: 0, 1 0: Use as an absolute encoder. (Default value on HA-800A-*D) 1: Use as an incremental encoder. (Default value on HA-800A-*E)
SP67	Output shaft divide function setting*	When using for position control combined with an SHA-CG series unit, you can set the actuator resolution. Setting range: 0 to 3 (Default value: 0) 0: According to electronic gear settings (SP14, SP44/SP45, SP46/SP47) 1: Division of single output shaft rotation into 36,000 parts (equivalent to 0.01 degree resolution) 2: Division of single output shaft rotation into 360,000 parts (equivalent to 0.001 degree resolution) 3: Division of single output shaft rotation into 3,600,000 parts (equivalent to 0.0001 degree resolution)

*: If you change the setting, the origin needs to be set again. Be sure to change the value before setting the origin.

Startup procedures

1 Absolute encoder function setting (checking the backup battery

Set [SP66: Absolute encoder function setting] according to the method used, then turn the power OFF, then ON again. For details, refer to [SP66: Absolute encoder function setting] (P8-12).
When setting [SP66: Absolute encoder function setting] to 0 (default value on HA-800A-*D) and using as an absolute encoder, open the operation panel cover and confirm that the backup battery is installed.
If not, set one by referring to [How to replace the backup battery] (P3-24).
When setting [SP66: Absolute encoder function setting] to 1 (default value on HA-800A-*E) and using as an incremental encoder, the backup battery is not required.

2 Initializing the absolute encoder system

When the power supply is turned ON for the first time, [AL81: System failure], [AL82: Single revolution data error], [AL83: Multi revolution data error] and [UA91: Battery voltage low warning] generate. It is necessary to initialize (multi revolution data clear) the errors. For details, refer to [T08: Multi revolution clear] (P9-10).
When setting [SP66: Absolute encoder function setting] to 1 and using as an incremental encoder, the backup battery is not required.

* UA91 will not occur on the SHA20 and FHA-Cmini series absolute type if the battery is normal. If UA91 occurs, replace the battery.

3 Setting the parameters

Set [SP61: Encoder monitor output pulses] and [SP67: Output shaft divide function setting*] according to the method used, then turn the power OFF, then ON again to put the parameter into effect. For details, refer to [SP61: Encoder monitor output pulses] (P8-11), [SP67: Output shaft divide function setting] (P8-13), and [Output signal pulses] (P4-11).

*: If you change the setting, the origin needs to be set again. Be sure to change the value before setting the origin.

4 Origin setting

Set the origin in order to link the actuator driver and the mechanical origin.

1. Using as an absolute encoder (SP66=0)
For the origin setting method, refer to [Origin setting] (P4-8).

2. Using as an incremental encoder (SP66=1)
In order to establish the relationship between the actuator driver and the machine origin, use the return-to-origin function on the host controller to execute a return to origin and manage the coordinates with the host controller.

- When the control power supply is turned ON
- When the driver has been replaced
- When the actuator has been replaced

Origin setting

Perform the following to set the origin (read the current value data at the mechanical origin position) in order to link the actuator driver and the mechanical origin.

(1) Move the actuator to the target mechanical origin position via a JOG operation, manually, or using the various host controller functions.
(2) Execute T08 (multi revolution clear) by operating the HA-800A panel, and reconnect the HA-800A power supply.
(3) Perform any of the following to read the current absolute encoder value.
    (a) Use the current value data output at the pins CN2-40, 41.From the pins CN2-40 and 41, receive the absolute encoder’s current value with the host controller and check the data.For details, refer to [Data output] (P4-9).
    (b) (b) Use the HA-800 driver monitor software PSF-800.Check the PSF-800 status display value monitor feedback pulses. For details, refer to [Chapter 10 Communication software].
    (c) (c) Use the status display panel for the HA-800A driver. You can check the current encoder value from the d05 feedback pulse (Low) and d06 feedback pulse (High) shown on the display panel in the status display mode. For details, refer to [d05, 06: Feedback pulses display] (P7-5).
(4) Manage the coordinates (set the origin) with the host controller with the read out current value of the absolute encoder as the origin data.
(5) In operations after setting the origin, use the CN2-40, 41 current value data output to acquire the current value data and manage the coordinates with the host controller. For details, refer to [Data output] (P4-9).

*: The current HA-800A position display will not usually indicate zero at the mechanical origin.

Caution

- Do not turn the actuator until the Step (2) Multi revolution clear is executed and Step (3) Receiving/reading of the current value is completed. If the actuator moves, the origin may become offset.
- Take note that the current value of the 17-bit absolute encoder (10 digits) cannot be fully displayed (only the last 8 digits are displayed) because only a total of 8 digits are allocated for d05 feedback pulse (Low) and d06 feedback pulse (High) on the display panel of the HA-800A driver.

Set the origin in the following situations even if it's not during a start-up.

- The driver has been replaced
- The actuator has been replaced
- [AL81: System failure], [AL82: Single revolution data error] or [AL83: Multi revolution data error] generated due to a loss of absolute position or error.
- When the electronic gear (SP44/SP45, SP46/SP47) or output shaft divide function (SP67) has been changed

Data output

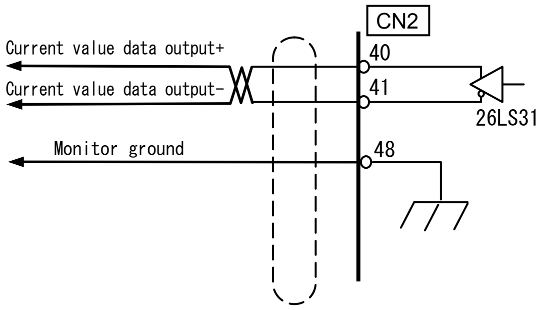
Outputting the current value data from the pins CN2-40 and 41

This is used to acquire the current value data in order to manage the absolute position with the absolute encoder. The current value of the 17-bit absolute encoder is constantly output cyclically. Data of bits 0 to 32 (including the sign) is divided into 9 parts and sent. Data of bits 0 to 32 is sent in 9 transmissions taking 100 ms each, or over a total period of 900 ms.
It is output with a line driver (26LS31), so receive using a line receiver (AM26LS32 or equivalent).
This data is transmitted cyclically and repeatedly after the driver power supply is turned ON and CPU is started, regardless of the timings of phase A, B and Z output signals.

With the SHA-CG series, operation commands can be set in the actuator in angle units with [SP67: Output shaft divide function setting].In this case, the absolute encoder current value data is also output equivalent to degree units.
Also, with the SHA-CG output shaft single revolution absolute model, the output range for the current value is the values for single revolution of the output shaft. For details on the current value data output range, refer to the table below.

* For the current value data reception sequence, sample ladder is available for the Mitsubishi Electric Q Series and the Keyence KV Series. For details, contact our sales office.
* The current value data is unstable immediately after turning the control power supply ON. Read the current value data after 10 seconds or longer elapsed after turning the control power supply ON.

Output format	Start-stop
Communication speed	9600 bps
Stop bit	1 bit
Data length	8 bit
Parity bit	Even parity
Format	LSB first
Refresh cycle (refresh cycle of each number of divisions data)	100 ms



Output format*

Number of divisions	Current value data				Number of divisions data			
	Bit0	Bit1	Bit2	Bit3	Bit4	Bit5	Bit6	Bit7
1	Current value data bits 0 to 3				1	0	0	0
2	Current value data bits 4 to 7				0	1	0	0
3	Current value data bits 8 to 11				1	1	0	0
4	Current value data bits 12 to 15				0	0	1	0
5	Current value data bits 16 to 19				1	0	1	0
6	Current value data bits 20 to 23				0	1	1	0
7	Current value data bits 24 to 27				1	1	1	0
8	Current value data bits 28 to 31				0	0	0	1
9	Code data (If positive, all 0. If negative, all 1)				1	0	0	1

*: If the current value data is negative, each bit of the data is output as its 2's complement

Model	Setting	Output range	Unit
FHA-C series	-	-33554432 to 33554431	pls
SHA-SG/HP series FHA-Cmini series	-	-4294967296 to 4294967295	pls
SHA-CG	SP67=0	-4294967296 to 4294967295	pls
	SP67=1	-23592960 to 23592960*1	pls (×0.01deg equivalent)
	SP67=2	-235929600 to 235929600*1	pls (×0.001deg equivalent)
	SP67=3	-2359296000 to 2359296000*1	pls (×0.0001deg equivalent)
SHA-CG-S	SP67=0	0 to 20971519*2	pls
	SP67=1	0 to 35999	pls (×0.01deg equivalent)
	SP67=2	0 to 359999	pls (×0.001deg equivalent)
	SP67=3	0 to 3599999	pls (×0.0001deg equivalent)

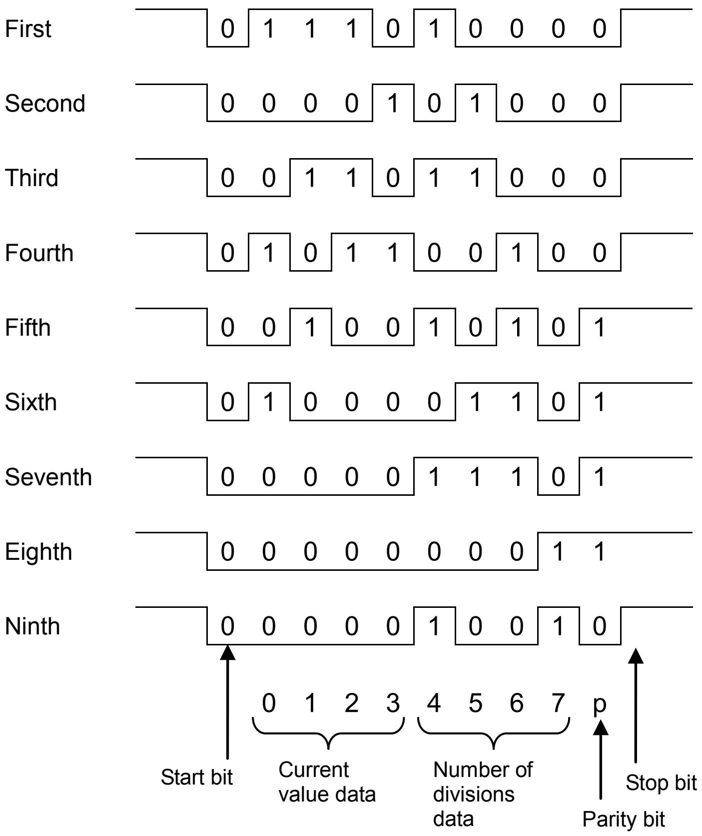
*1: On the SHA=CG, when SP67=1, 2, or 3, the output range depends on the speed reduction range of the actuator and is the range of the calculated angle values of the multi revolution detection range. The output range is from [$-2^{32}/(2^{17}$ x speed reduction ratio) x number of output divisions to $(2^{32}-1)/(2^{17}$ x speed reduction ratio) x number of output divisions].

*2: On the SHA=CG, when SP67=0, the output range depends on the speed reduction ratio of the actuator.
The output range is [0～2^{17} x speed reduction ratio - 1].

Caution

- With the SHA-CG series, the current value data output range depends on the value of [SP67: Output shaft divide function setting].
- With the SHA-CG series, when the power is turned ON, the current value data becomes a value that occurs in single revolution of the output shaft.
- Note that the directions of increase and decrease for the current value output depend on [SP50: command polarity] setting.*: With the SHA-SG/HP series, rotation is in the opposite directions from those below.
  For 0, 1: Increase with clockwise rotation
  For 2: Increase with counter-clockwise rotation

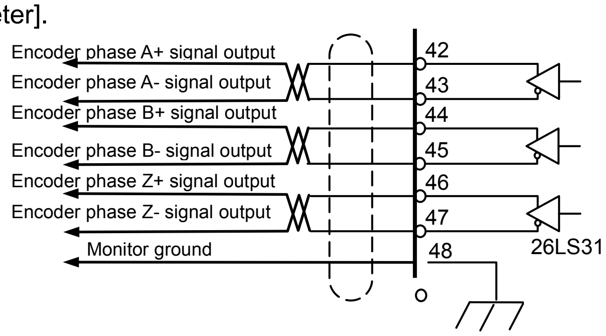
Example: The current value is 1234567 (0012D687h)



Encoder phase A, B and Z signal outputs

When the motor shaft equipped with a 17-bit absolute encoder turns, incremental phase A, B and Z signals are output to the pins CN2-42 to 48. The number of pulses per motor shaft revolution is set by [SP61: System parameter].

CN2-42 Phase output-A+ (LD)
CN2-43 Phase output-A- (LD)
CN2-44 Phase output-B+ (LD)
CN2-45 Phase output-B- (LD)
CN2-46 Phase output-Z+ (LD)
CN2-47 Phase output-Z- (LD)
CN2-48 Monitor ground



- **Output signal pulses**

The output pulses per motor shaft revolution are set by the parameter [SP61: Encoder monitor output pulses].

	Output pulses per motor shaft revolution
Phase A signal output	Set value of SP61 ([1] to [8,192])
Phase B signal output	Set value of SP61 ([1] to [8,192])
Phase Z signal output	1

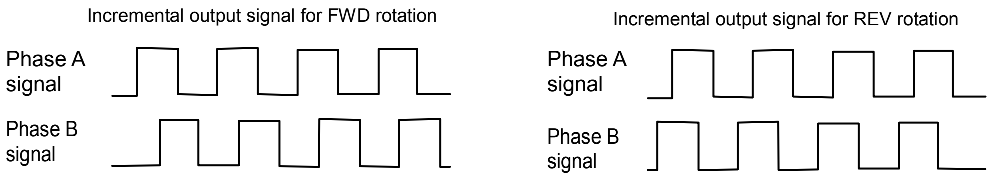
For phase Z, 1 pulse is output per motor shaft revolution.
For example, setting the maximum value 8,192 in SP61 causes 8,192 pulses to be output per motor shaft revolution. Although this corresponds to a resolution of 32,768 pulses, or 4 times 8,192, it is one-fourth the resolution 131,072 of the 17-bit absolute encoder per motor shaft revolution.

8,192 × 4 = 32,768 (Quadruplicate)

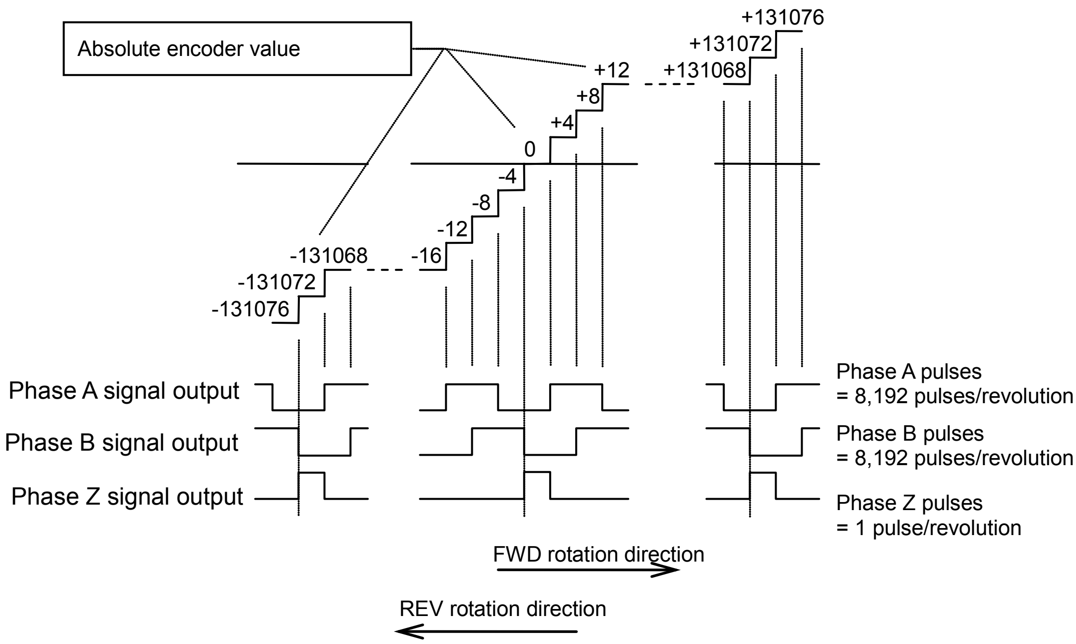
131,072 ÷ 4 ＝ 32,768

- **Phase A, B and Z incremental output waveforms**

For FWD rotation, the phase A signal is output with an advance of 90° relative to the phase B signal. For REV rotation, the phase A signal is output with a delay of 90° relative to the phase B signal.
To obtain the resolution in the quadrupled mode, utilize the leading edges and trailing edges of both phase A and B signals.



When 8,192 is set in SP61, the values of the 17-bit absolute encoder and phase A, B and Z waveforms are as follows. However, the phases of phase-A, B, and Z waveforms delay with respect to the value of the absolute encoder for the signal processing time within the driver, due to the rotation speed of the actuator.



- **Signal input method**

Each phase signal is output by a line driver (26LS31). Receive the signals using a line receiver (AM26LS32 or equivalent).

Caution

- Use an EIA-422A compliant line receiver to receive the signals.

4

Encoder system

Remedial actions for errors/warnings

Remedial action for error

Name	Description	Cause	Action
AL50 Encoder disconnection	Encoder signals have been cut off.	(1) Disconnected encoder signal wire (2) Poor contact/connection of encoder signal connector (3) Encoder error (4) HA-800A driver control circuit error	(1) Repair the wire. (2) Connect the connector properly. (3) Replace the actuator. (4) Replace the HA-800A driver.
AL80 MEMORY error	EEPROM memory error in encoder	(1) Encoder error (2) HA-800A driver control circuit error	(1) Replace the actuator. (2) Replace the HA-800A driver.
AL81 System failure	Encoder system shutdown	(1) Turned the power ON for the first time after the purchase. (2) SHA series (excluding SHA20): Either the voltage of the backup capacitor in the encoder or HA-800 driver battery, whichever is higher, has become 2.85V or below. SHA20 and FHA-Cmini series: The battery voltage has dropped to 2.85V or below. (3) FHA-Cmini series absolute type: The battery voltage has dropped to 2.85V or below. (4) Encoder failure	(1) Perform [T08: Multi revolution clear] to reconnect the power. (2) Replace the HA-800 driver battery with a new one. After the battery has been replaced, set the origin. (3) Replace the actuator.
AL82 Single rotation data error	Encoder single revolution data error	(1) Turned the power ON for the first time (2) Malfunction due to external noise (3) Encoder failure	(1) Perform [T08: Multi revolution clear] to reconnect the power. (2) Provide noise suppression measures to eliminate negative effects of external noise. (3) Replace the actuator.
AL83 Multi revolution data error	Encoder multi revolution data error	(1) Turned the power ON for the first time (2) Malfunction due to external noise (3) Encoder failure	(1) Perform [T08: Multi revolution clear] to reconnect the power. (2) Provide noise suppression measures to eliminate negative effects of external noise. (3) Replace the actuator.
AL84 BUSY error	When the encoder was started, the motor shaft rotated at a constant speed or above and a position specification problem occurred.	(1) When the power supply was turned ON and encoder was started, the motor shaft rotated at a constant speed or above. SHA series (excluding SHA20): 300 r/min or more SHA20 and FHA-Cmini series: 250 r/min or more (2) Encoder failure	(1) When the power supply is turned ON and encoder is started, ensure that the motor shaft rotates at a constant speed or below. (2) Replace the actuator.
AL85 Overheat error	Heated actuator/encoder	(1) The board temperature in the encoder has reached 95℃ or above. (2) The heat sink temperature of the driver has reached 106℃ or above. (3) Encoder failure	(1) Remove the cause of actuator overheat, such as relaxing the actuator drive conditions or improving the heat radiation conditions for the heat sink. (2) Same as above (3) Replace the actuator.

Name	Description	Cause	Action
AL86 Communication error	Data could not be received in at least 4 consecutive communications between the actuator and this driver.	(1) Disconnected encoder signal wire (2) Poor contact/connection of encoder signal connector (3) Malfunction due to external noise	(1) Repair the wire. (2) Connect the connector properly. (3) Provide noise suppression measures to eliminate negative effects of external noise. (4) Check the ground line or other ground.

Remedial action for warning

Name	Description	Cause	Action
UA91 Battery voltage low	The backup battery voltage has dropped to DC3.1V or below.	(1) Voltage drop due to consumption of backup battery (2) Short-circuit the encoder battery wire (3) HA-800A driver control circuit error (4) Encoder failure	(1) SHA series (excluding SHA20): Replace the battery with a new one, input alarm reset and then reconnect the power supply. SHA20 and FHA-Cmini series*: Replace the battery with a new one. * In Version 2.x and earlier, after the battery is replaced, turning the power back ON releases UA91. (2) Repair the wire. (3) Replace the HA-800A driver. (4) Replace the actuator.

4

Encoder system

4-3 13-bit absolute encoder

CAUTION

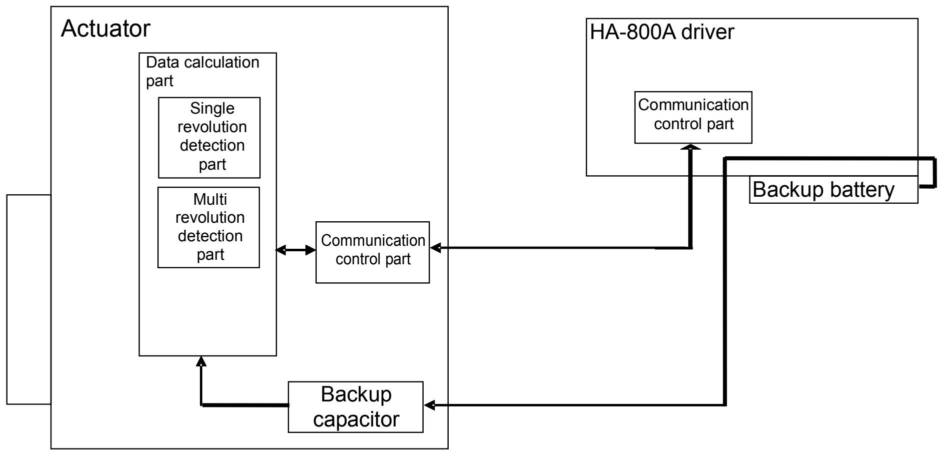
If AL53 (system failure), AL54 (multi revolution counter overflow) or AL55 (multi revolution data error) generates due to a loss of absolute position or error, be sure to reset the origin. Failure to do so may result in unexpected operations.

Features

The FHA-C series is equipped with a multi revolution-type 13-bit optical absolute encoder. It consists of a detector (13 bits/revolution) for detecting the position after one motor shaft revolution and a cumulative counter (13 bits) for detecting the number of motor revolutions.
This encoder constantly detects the absolute machine position and stores it by means of the backup battery, regardless of whether the power supply for driver or external controller is turned ON/OFF. Accordingly, once the origin is detected when the machine is installed, originating is not required after subsequent power ON operations. This facilitates the recovery operation after a power failure or breakdown.
A backup capacitor is also provided in the encoder. (Internal backup. Take note that the retention time is short.)

Caution

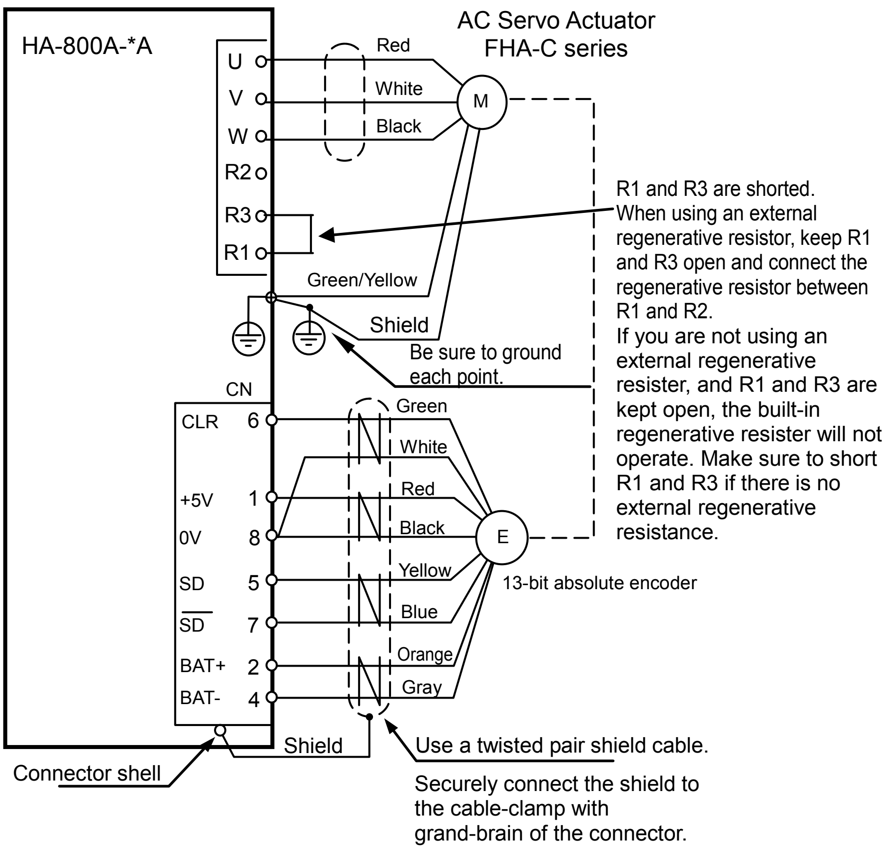
- The backup time is 30 minutes when a new capacitor has been charged for at least 3 hours by supplying power to the actuator. This backup time becomes shorter if the power is supplied for a shorter period or the capacitor deteriorates over time.



Block diagram of actuator/encoder and driver

Standard connection

A connection example of an actuator of 13-bit absolute encoder model with a HA-800A driver is shown.



Startup

Startup procedures

1 Setting the backup battery

Open the operation panel cover, and confirm that the backup battery is set.
If not, set one by referring to [How to replace the backup battery] (P3-24).

2 Initializing the absolute encoder system

When the power supply is turned ON for the first time, [AL53: System failure] generates. It is necessary to initialize (multi revolution data clear) the errors. For details, refer to [T08: Multi revolution clear] (P9-10).

3 Origin setting

Set the origin in order to link the actuator driver and the mechanical origin.
For the origin setting method, refer to [Origin setting] (P4-18).

Origin setting

Perform the following to set the origin (read the current value data at the mechanical origin position) in order to link the actuator driver and the mechanical origin.

(1) Move the actuator to the target mechanical origin position via a JOG operation, manually, or using the various host controller functions.
(2) Execute T08 (multi revolution clear) by operating the HA-800A panel, and reconnect the HA-800A power supply.
(3) Perform any of the following to read the current absolute encoder value.
   (a) Use the current value data output at the pins CN2-40, 41.From the pins CN2-40 and 41, receive the absolute encoder's current value with the host controller and check the data. For details, refer to [Data output] (P4-19).
   (b) Use the HA-800 driver monitor software PSF-800.Check the PSF-800 status display value monitor feedback pulses. For details, refer to [Chapter 10 Communication software].
   (c) Use the status display panel for the HA-800A driver. You can check the current encoder value from the d05 feedback pulse (Low) and d06 feedback pulse (High) shown on the display panel in the status display mode. For details, refer to [d05, 06: Feedback pulses display] (P7-5).
   (d) The current value output data from the pins CN2-42 to 47 (HA-655 driver mode) is used. For customers who have been using the HA-655 driver, position data is output from the phase A, B and Z output ports similar to those of the HA-655 driver. Receive the data with the host controller and check it. For details, refer to [Outputting the current value data from pins CN2-42 to 47 (HA-655 driver mode] (P4-19).
(4) Manage the coordinates (set the origin) with the host controller with the read out current value of the absolute encoder as the origin data.
(5) In operations after setting the origin, use the CN2-40, 41 current value data output to acquire the current value data and manage the coordinates with the host controller. For details, refer to [Data output] (P4-9).

*: The current HA-800A position display will not usually indicate zero at the mechanical origin.

Caution

- Do not turn the actuator until the Step (2) Multi revolution clear is executed and Step (3) Receiving/reading of the current value is completed. If the actuator moves, the origin may become offset.

Set the origin in the following situations even if it's not during a start-up.

- The driver has been replaced
- The actuator has been replaced
- [AL53: System failure], [AL54: Multi revolution counter overflow] or [AL55: Multi revolution data error] generated due to a loss of absolute position or error.
- When the electronic gear (SP44/SP45, SP46/SP47) has been changed

Data output

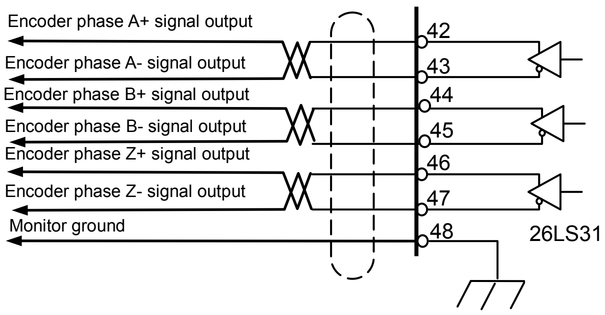
Outputting the current value data from pins CN2-40 and 41

The current value data is output with the same technique as for a 17-bit absolute encoder. For details, refer to [Data output] (P4-9).

Outputting the current value data from the pins CN2-42 to 47 (HA-655 driver mode)

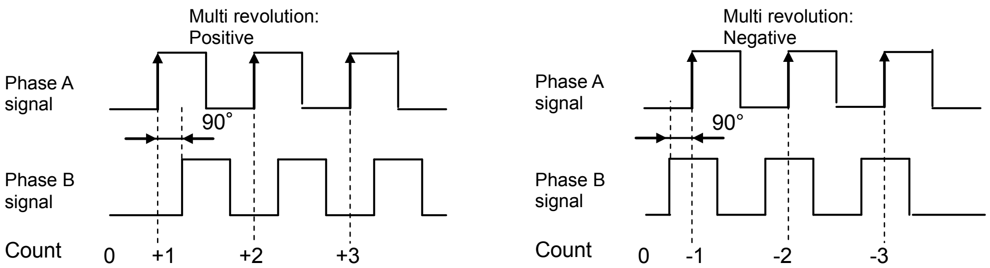
Position data is output from the encoder phase A, B and Z signal output ports as with any HA-655 series driver.
Following the powering sequence, the output ports of the [CN2-42 phase-A: A+] through [CN2-47 phase-Z: Z-] automatically output multi revolution data and absolute data as the current value data just for once.
In normal operation, pulse train signals are output following the transmission of position data and implement similar operations to an incremental encoder.

CN2-42 Phase output-A+ (LD)
CN2-43 Phase output-A- (LD)
CN2-44 Phase output-B+ (LD)
CN2-45 Phase output-B- (LD)
CN2-46 Phase output-Z+ (LD)
CN2-47 Phase output-Z- (LD)
CN2-48 Monitor ground



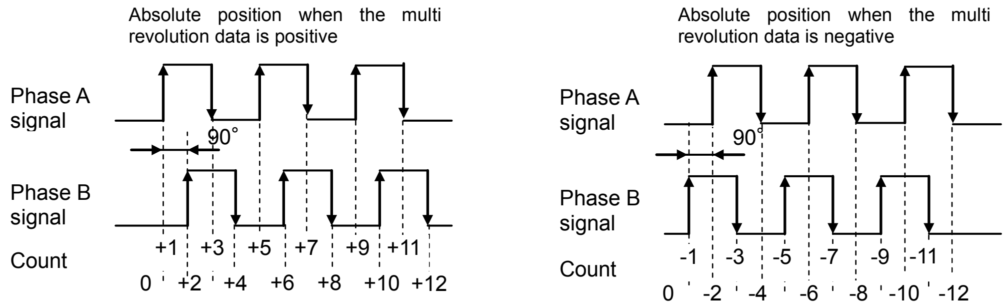
- **Multi revolution data**

"Multi revolution data" is output by 2 phase signals having a phase difference of 90°. If the multi revolution data of the encoder counter installed on the motor shaft is positive, the multi revolution data has a positive value and the phase A signal is output with an advance of 90° relative to the phase B signal. If the multi revolution data is negative, on the other hand, the multi revolution data has a negative value and the phase A signal is output with a delay of 90° relative to the phase B signal. The pulse frequency is 100kHz. Have the host device discriminate the positive/negative polarities of multi revolution data based on the advance/delay relationships of these 2 phase signals.
For the count, use the leading edge of phase A.



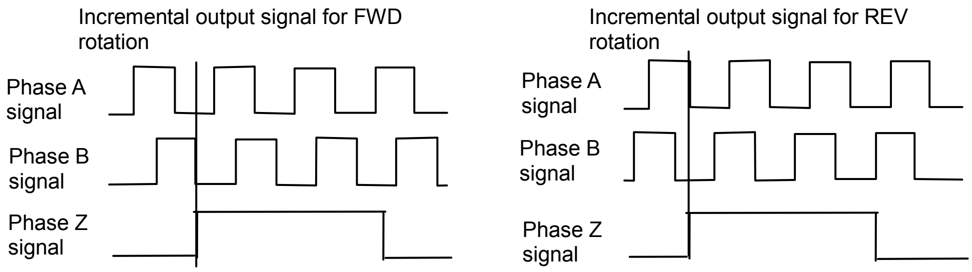
- **Absolute position**

The absolute position is output using 2 phase signals having a phase difference of 90°. If the multi revolution data is positive, the phase A signal is output with an advance of 90° relative to the phase B signal. If the multi revolution data is negative, on the other hand, the phase A signal is output with a delay of 90° relative to the phase B signal. The pulse frequency is 100kHz.
Since pulses are output in the quadrupled form, count the leading edges and trailing edges of both phase A and B signals. In the example shown below, the absolute position is 12.



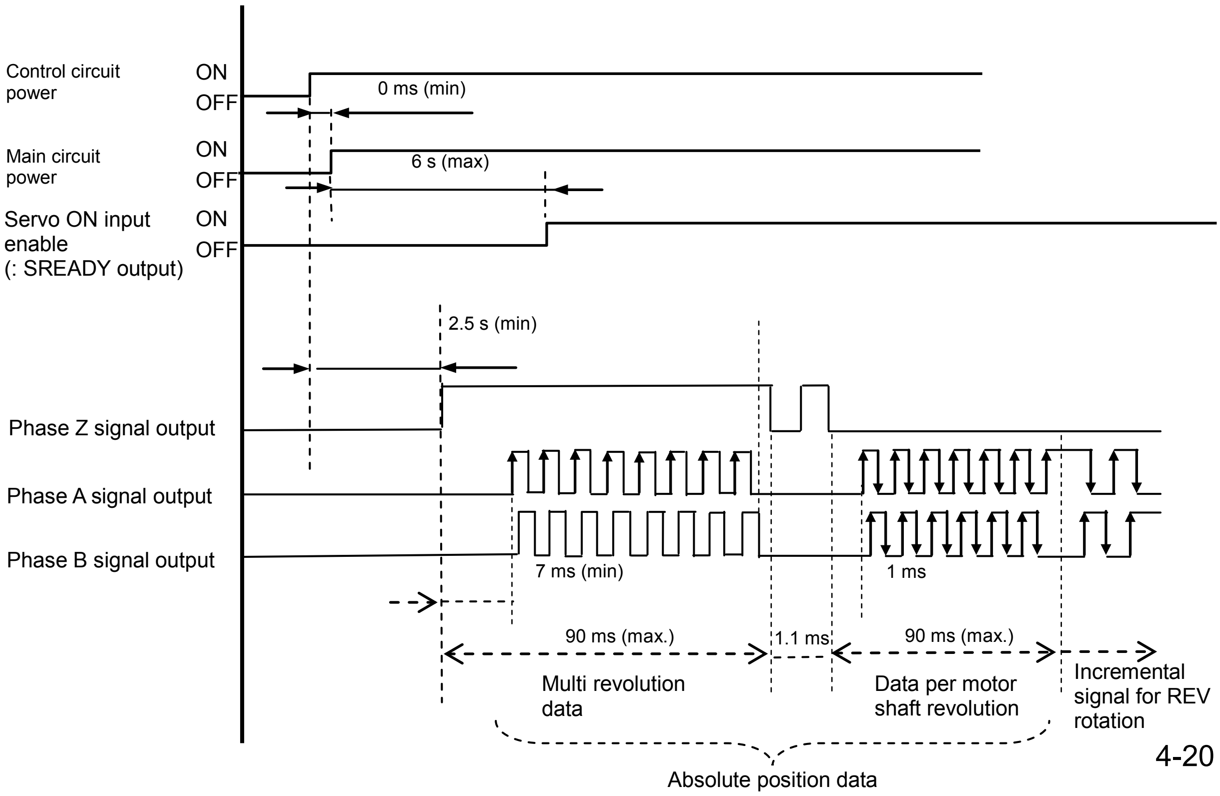
- **Encoder phase A, B and Z incremental signals**

Once multi revolution data and absolute position have been output, 2-phase pulse signals are output in the incremental method. For FWD rotation, the phase A signal is output with an advance of 90° relative to the phase B signal. For REV rotation, the phase A signal is output with a delay of 90° relative to the phase B signal.



- **Output signal sequence**

An example of signal output where the multi revolution data is +8, absolute value is +25, and when REV rotation is started after output of position data, is shown below.



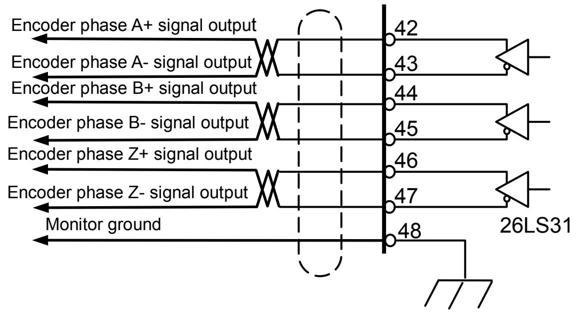
Encoder phase A, B and Z signal outputs

When the motor shaft equipped with a 13-bit absolute encoder turns, incremental phase A, B and Z signals are output to the pins CN2-42 to 48.

- **Number of output pulses**

When the motor shaft turns one revolution, 2,048 pulses are output.
For phase Z, 1 pulse is output per motor shaft revolution. Note that, for phase Z signal, 1 pulse is output per motor shaft rotation, but the width is indeterminable.

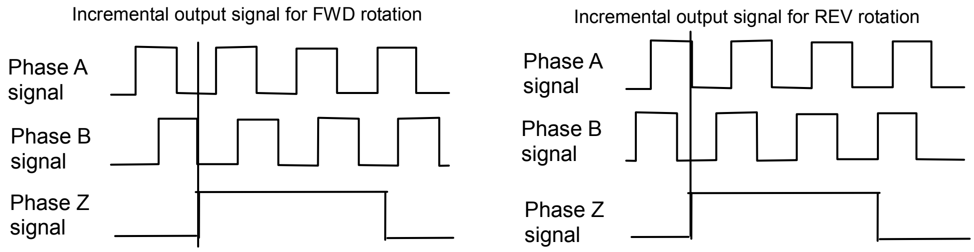
CN2-42 Phase output-A+ (LD)
CN2-43 Phase output-A- (LD)
CN2-44 Phase output-B+ (LD)
CN2-45 Phase output-B- (LD)
CN2-46 Phase output-Z+ (LD)
CN2-47 Phase output-Z- (LD)
CN2-48 Monitor ground



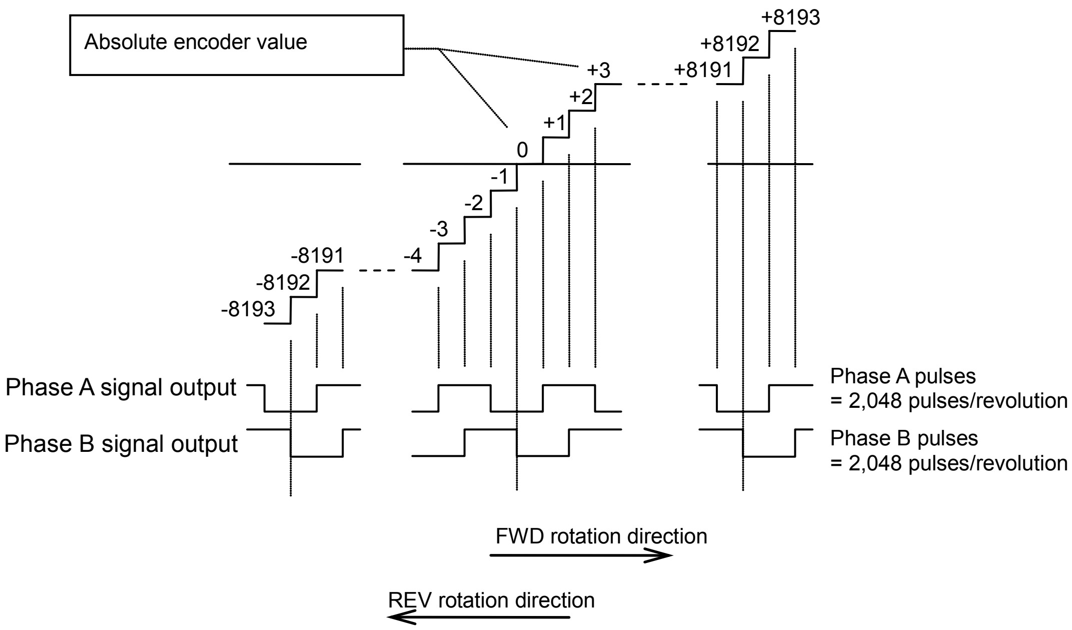
	Output pulses per motor shaft revolution
Phase A	2,048
Phase B	2,048
Phase Z	1

● Phase A, B and Z output signal waveforms

For FWD rotation, the phase A signal is output with an advance of 90° relative to the phase B signal. For REV rotation, the phase A signal is output with a delay of 90° relative to the phase B signal. To obtain the resolution in the quadrupled mode, utilize the leading edges and trailing edges of both phase A and B signals.



The values of the 13-bit absolute encoder and phase A and B waveforms are shown below.



● Signal input method

Each phase signal is output by a line driver (26LS31). Receive the signals using a line receiver (AM26LS32 or equivalent).

Caution

- Use an EIA-422A compliant line receiver to receive the signals.

4

Encoder system

Remedial actions for errors/warnings

Remedial action for error

Name	Description	Cause	Action
AL50 Encoder disconnection	Encoder signals have been cut off.	(1) Disconnected encoder signal wire (2) Poor contact/connection of encoder signal connector (3) Encoder malfunction due to rise in actuator temperature (4) Defective encoder (5) HA-800A driver control circuit error	(1) Repair the wire. (2) Connect the connector properly. (3) Review the actuator installation location and cooling system. (4) Replace the actuator. (5) Replace the HA-800A driver.
AL51 Encoder counter receiving error	Encoder serial data could not be received accurately.	(1) Electrical discontinuity of encoder signal wire (2) Non-connection or poor connection of encoder connector CN1 (3) Defective encoder (4) HA-800A driver control circuit error (5) Communication problem due to noise, etc.	(1) Repair the wire. (2) Connect the connector properly. (3) Replace the actuator. (4) Replace the HA-800A driver. (5) Check the ground line or other ground.
AL53 System failure	Encoder multi revolution data has been lost.	(1) The purchased driver was connected and power supply was turned ON for the first time. (2) The HA-800A driver and actuator have been disconnected for many hours. (3) Either the voltage of the backup capacitor in the encoder or HA-800 driver battery, whichever is higher, has become 2.3V or below. (4) Encoder error	(1) Execute test mode T08 to perform multi revolution clear and then reconnect the power. (2) Execute test mode T08 to perform multi revolution clear and then reconnect the power. (3) Replace the HA-800 driver battery with a new one. After the battery has been replaced, set the origin. (4) Replace the actuator.
AL54 Multi revolution counter overflow	The value in the encoder multi revolution counter has exceeded the range of -4,096 to +4,095 revolutions (motor shaft).	(1) The actuator has turned in one direction in excess of the multi revolution counter range of -4,096 to +4,095 revolutions (motor shaft). (2) Defective encoder (3) HA-800A driver control circuit error	(1) Execute T08 in the test mode to clear the multi revolution data. (2) Replace the actuator. (3) Replace the HA-800A driver.
AL55 Multi revolution data error	The angular acceleration and rotation speed of the motor have exceeded the allowable response range when the encoder power supply was cut off and data was backed up by the battery.	(1) The actuator operated at an acceleration of 5,000 rad/s^2 or more or speed of 1,300 rpm or more, as an equivalent value on the motor shaft, when the driver power supply was cut off. (2) Defective encoder (3) HA-800A driver control circuit error	(1) Execute T08 in the test mode to clear the multi revolution data. (2) Replace the actuator. (3) Replace the HA-800A driver.

Remedial action for warning

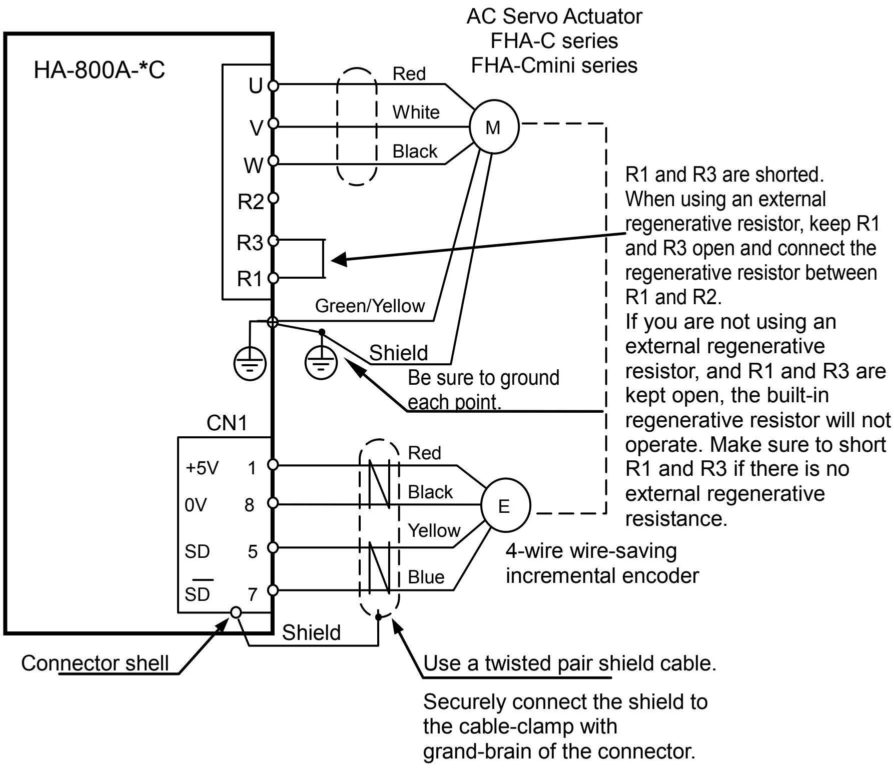
Name	Description	Cause	Action
UA91 Battery voltage low	The backup battery voltage has dropped to DC2.8V or below.	(1) Voltage drop due to consumption of backup battery (2) Short-circuit the encoder battery wire (3) HA-800A driver control circuit error (4) Encoder failure	(1) Replace with a new battery. (2) Repair the wire. (3) Replace the HA-800A driver. (4) Replace the actuator.

4-4 Incremental encoder

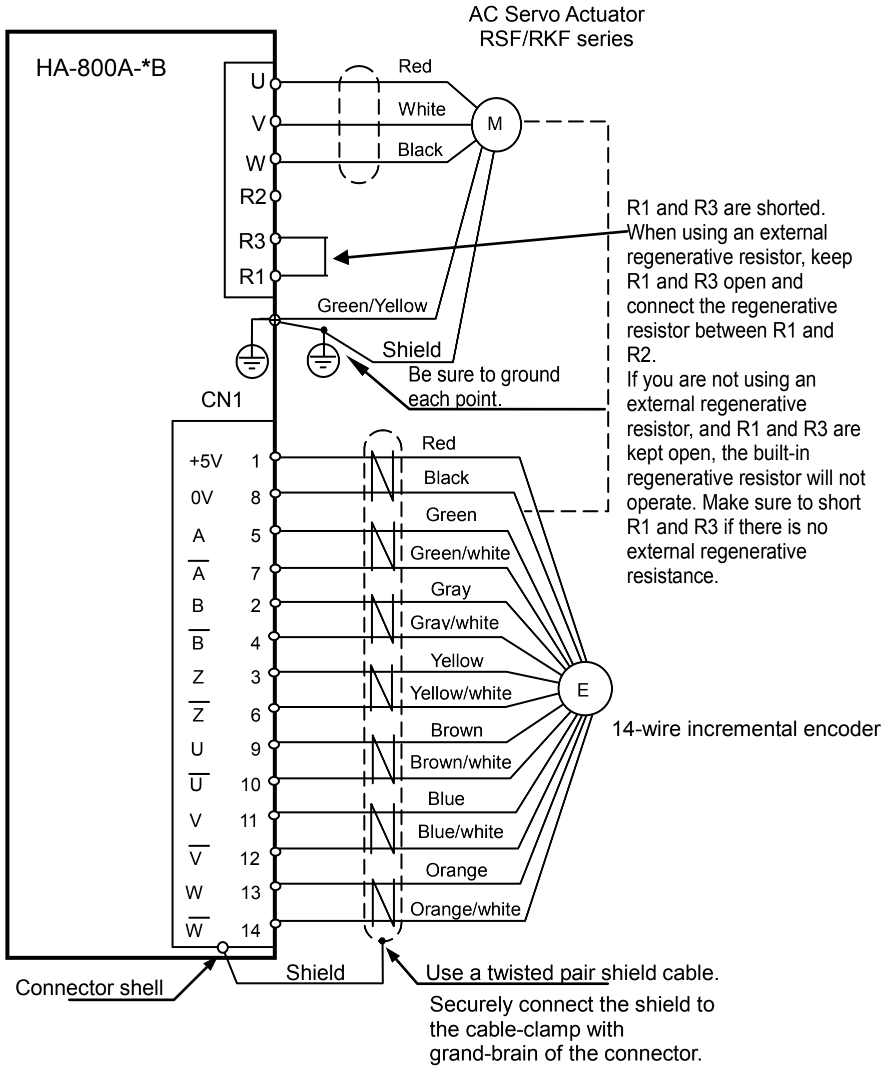
The incremental encoder has a relatively simple structure where pulses are output according to changes in rotation angle. However, it has one drawback of causing loss of current position data when the power supply is cut off, and therefore position control requires originating operation using a separately provided origin sensor.

Standard connection

- **4-wire wire-saving incremental encoder model**



14-wire wire-saving incremental encoder model



Startup

Parameters that must be set

Nothing in particular.

Startup procedures

1 Initializing the incremental encoder system

With incremental encoder systems using FHA-Cmini, FHA-C or RSF/RKF series actuators, driver feedback pulses are reset to 0 (initialized) when the driver power supply is turned ON.

2 Checking originating operation

In order to link the actuator driver and the mechanical origin to each other, either perform originating using the originating function of the host controller, or manage the coordinate data at the host controller.

Set the origin in the following situations even if it's not during a start-up.

- The control power supply has been turned ON
- The driver has been replaced
- The actuator has been replaced

Data output

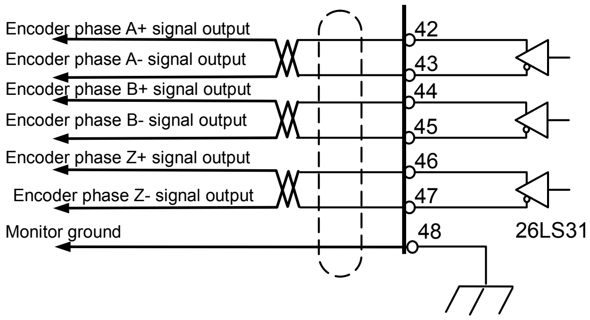
Encoder phase A, B and Z signal outputs

When the motor shaft equipped with an encoder turns, incremental phase A, B and Z signals are output to the pins CN2-42 to 48.

- **Number of output pulses**

The numbers of phase A and B signal output pulses per motor shaft revolution vary depending on the encoder resolution.
For phase Z, 1 pulse is output per motor shaft revolution.

CN2-42 Phase output-A+ (LD)
CN2-43 Phase output-A- (LD)
CN2-44 Phase output-B+ (LD)
CN2-45 Phase output-B- (LD)
CN2-46 Phase output-Z+ (LD)
CN2-47 Phase output-Z- (LD)
CN2-48 Monitor ground

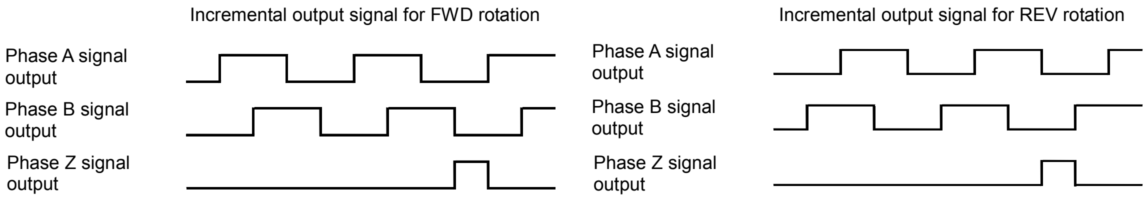


	Output pulses per motor shaft revolution
Phase A	(Encoder resolution) / 4 *1
Phase B	(Encoder resolution) / 4 *1
Phase Z	1

*1: For example, assume that the encoder resolution is 10,000 pulses.
In this case, 2,500 pulses (10,000 / 4) are output.

- **Phase A, B and Z output signal waveforms**

For FWD rotation, the phase A signal is output with an advance of 90° relative to the phase B signal. For REV rotation, the phase A signal is output with a delay of 90° relative to the phase B signal.
To obtain the resolution in the quadrupled mode, utilize the leading edges and trailing edges of both phase A and B signals.



- **Signal input method**

Each phase signal is output by a line driver (26LS31). Receive the signals using a line receiver (AM26LS32 or equivalent).

Caution

- Use an EIA-422A compliant line receiver to receive the signals.

Remedial action for error

Name	Description	Cause	Action
AL50 Encoder disconnection	Encoder signals have been cut off.	(1) Disconnected encoder signal wire (2) Poor contact/connection of encoder signal connector CN1 (3) Encoder malfunction due to rise in actuator temperature (4) Defective encoder (5) HA-800A driver control circuit error	(1) Repair the wire. (2) Connect the connector properly. (3) Review the actuator installation location and cooling system. (4) Replace the actuator. (5) Replace the HA-800A driver.
AL51 Encoder counter receiving error	Encoder serial data could not be received accurately.	(1) Electrical discontinuity of encoder signal wire (2) Poor contact/connection of encoder signal connector CN1 (3) Defective encoder (4) HA-800A driver control circuit error (5) Communication problem due to noise, etc.	(1) Repair the wire. (2) Connect the connector properly. (3) Replace the actuator. (4) Replace the HA-800A driver. (5) Check the ground line or other ground.
AL52 UVW error	Encoder phase U/V/W signal error	(1) Electrical discontinuity of encoder signal wire (2) Poor contact/connection of encoder signal connector CN1 (3) Defective encoder (4) HA-800A driver control circuit error	(1) Repair the wire. (2) Connect the connector properly. (3) Replace the actuator. (4) Replace the HA-800A driver.

Chapter 5

I/O signals

Details of I/O signal conditions and signal functions are explained in this chapter.

5

I/O signals

5-1 I/O signal list

This unit communicates with the host device via the CN2 connector. The following explains the I/O signals used in this communication.

Pin numbers and names of I/O signals

The CN2 pin numbers and corresponding signal names are shown in the table below. Functions can be set and assigned to input signals (pins 3 to 7, 9 and 10) and output signals (pins 16 to 22) using system mode parameters 1 and 2.
The parentheses after each signal name indicate the function assigned by default setting.

Pin No.	Signal	Symbol	Input Output	Pin No.	Signal	Symbol	Input Output
1	Input signal common	IN-COM	Input	26	+24V	+24V	Input
2	Servo-ON	S-ON	Input	27	FWD pulse+	FWD+	Input
3	Input 2 (alarm reset)	IN2	Input	28	FWD pulse-	FWD-	Input
4	Input 3 (deviation counter clear)	IN3	Input	29	REV pulse+	REV+	Input
5	Input 4 (FWD inhibit)	IN4	Input	30	REV pulse-	REV-	Input
6	Input 5 (REV inhibit)	IN5	Input	31	Speed command input	SPD-CMD	Input
7	Input 6 (FWD enable/selection)	IN6	Input	32	Speed command ground	SPD-GND	Input
8	Input signal common	IN-COM	Input	33	Torque command input	TRQ-CMD	Input
9	Input 7 (REV enable/selection)	IN7	Input	34	Torque command ground	TRQ-GND	Input
10	Input 8 (control mode selection)	IN8	Input	35	—	—	—
11	—	—	—	36	—	—	—
12	—	—	—	37	—	—	—
13	—	—	—	38	—	—	—
14	—	—	—	39	—	—	—
15	—	—	—	40	Current value data output+ (LD)	POS-DAT+	Output
16	Output 1(operation preparation complete)	OUT1	Output	41	Current value data output- (LD)	POS-DAT-	Output
17	Output 2(servo-ON input enable)	OUT2	Output	42	Phase output-A+ (LD)	A+	Output
18	Output 3 (alarm)	OUT3	Output	43	Phase output-A- (LD)	A-	Output
19	Output 4 (in-position complete)	OUT4	Output	44	Phase output-B+ (LD)	B+	Output
20	Output 5 (torque limiting)	OUT5	Output	45	Phase output-B- (LD)	B-	Output
21	Output 6 (zero speed output)	OUT6	Output	46	Phase output-Z+ (LD)	Z+	Output
22	Output 7 (warnings)	OUT7	Output	47	phase output-Z- (LD)	Z-	Output
23	Phase Z open collector output	Z (OC)	Output	48	Monitor COM	MON-COM	Output
24	Output signal common	OUT-COM	Output	49	Ground	FG	Output
25	Output signal common	OUT-COM	Output	50	Ground	FG	Output

OC indicates open collector, while LD indicates line driver.
Do not connect the pins marked "-". These pins are connected to internal circuits, so connecting them may result in failure.

Models of I/O signal connector CN2

The models of CN2 connector are shown below:

	Connector	Cover
Manufacturer	3M	3M
Model	10150-3000PE	10350-52F0-008

5-2 Input signals: System parameter SP00 to SP16

The following explains the input signals.

The input signals are explained in the order of pin numbers of CN2. Signals corresponding to system parameters SP00 to SP16 can be assigned to pin numbers 3 to 7, 9 and 10.

- **CN2 connector (input)**

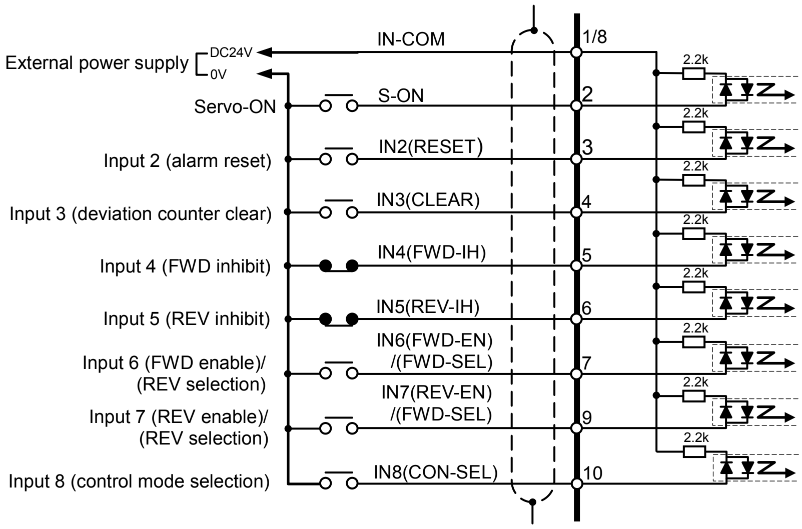
Pin No.	Signal	
1	Input signal common	
2	Servo-ON	
3	Input 2 (alarm reset)	SP00 to 16 can be assigned.
4	Input 3 (deviation counter clear)	
5	Input 4 (FWD inhibit)	
6	Input 5 (REV inhibit)	
7	Input 6 (FWD enable/selection)	
8	Input signal common	
9	Input 7 (REV enable/selection)	SP00 to 16 can be assigned.
10	Input 8 (control mode selection)	
26	+24V	
27	FWD pulse+	
28	FWD pulse-	
29	REV pulse+	
30	REV pulse-	
31	Speed command input	
32	Speed command common	
33	Torque command input	
34	Torque command common	
35	—	

Input signal connection circuit

The following explains how to connect the input signal port to the host device.
This driver has 8 input signal ports as shown below.

Specifications of input ports

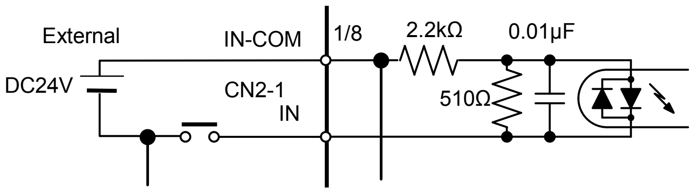
Voltage: DC24V ± 10%
Current: 20 mA or less (per port)



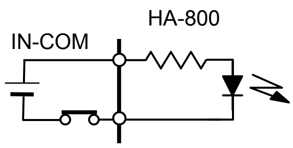
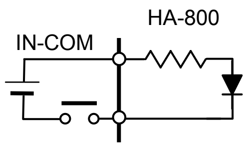
The default setting is shown in parentheses.

Caution

- The driver has no built-in input signal power supply. Connect the +24V side of the external power supply for input signals, to [CN2-1: Input signal common]. The required current capacity is calculated by multiplying the minimum number of ports used by 20 mA.



Input signal function (logic)

		Input signal status from host	
		Opt-isolator ON	Opt-isolator OFF
Circuit status			
Logic setting	0:Normally open (contact A) Logic NO	Enable	Disable
	1:Normally closed (contact B) Logic NC	Disable	Enable

Enable: The function of the selected signal is enabled.
Disable: The function of the selected signal is disabled.

Input signal list

The input signals to which 3 to 7, 9 and 10 pins of CN2 can be assigned are as shown below.
Set the values on the following page to the input signals to be used (Parameter Nos. SP00 to 16) and specify the input pins to be assigned and the corresponding signal logic.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Display parameter No.	Input signal name	Abbreviation	Applicable control mode	Default set value			Detail page
				Assigned pin	Logic*1	Parameter set value (PSF-800)	
–	Servo-ON	S-ON	P.S.T	CN2-2 (fixed)	NO (fixed)	---	P5-9
SP00	Emergency stop	ESTOP	P.S.T	—	NO	0000(0)	P5-9
SP01	Alarm reset	RESET (AL-RES)	P.S.T	CN2-3	NO	0002(2)	P5-9
SP02	Deviation counter clear	CLEAR (ERR-CLR)	P	CN2-4	NO	0003(3)	P5-9
SP03	FWD inhibit	FWD-IH	P.S.T	CN2-5	NC	0104(260)	P5-10
SP04	REV inhibit	REV-IH	P.S.T	CN2-6	NC	0105(261)	P5-10
SP05	FWD enable	FWD-EN	S	CN2-7	NO	0006(6)	P5-11
SP06	REV enable	REV-EN	S	CN2-9	NO	0007(7)	P5-11
SP07	FWD selection	FWD-SEL	T	CN2-7	NO	0006(6)	P5-12
SP08	REV selection	REV-SEL	T	CN2-9	NO	0007(7)	P5-12
SP09	Internal speed command selection 1	SPD-SEL1	S	—	NO	0000(0)	P5-12
SP10	Internal speed command selection 2	SPD-SEL2	S	—	NO	0000(0)	P5-12
SP11	Internal speed limit selection 1	SPD-LMT1	P	—	NO	0000(0)	P5-13
SP12	Internal speed limit selection 2	SPD-LMT2	P	—	NO	0000(0)	P5-13
SP13	Torque limit	TRQ-LMT	P.S	—	NO	0000(0)	P5-14
SP14	Electronic gear selection	G-SEL	P	—	NO	0000(0)	P5-14
SP15	Control mode selection	CON-SEL (MOD-SEL)	P.S.T	CN2-10	NO	0008(8)	P5-15
SP16	Position command disable	INHIBIT	P	—	NO	0000(0)	P5-15

*1: Logic NO: Logical setting 00 (normally open), Logic NC: Logical setting 01 (normally closed)

Setting example）
Setting details: Use the torque limit
(Limit the output torque using the torque limit AJ-11 when the opt-isolator of the CN2-10 pin turns ON.)
Parameter setting method: Torque limit SP13 = 0008 (8)
Control mode selection SP15 = 0000 (0)

* If the control mode selection SP15 = 0008 (8) remains unchanged from the default setting, the torque will be limited and control mode switched when the opt-isolator of the CN2-10 pin turns ON.

Caution

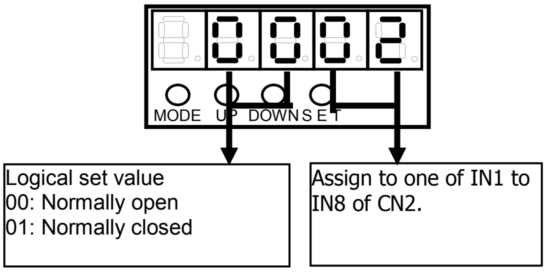
- Multiple input signals can be assigned to one pin. Unnecessary signals should be deleted from the pin assignments. If unnecessary signals are assigned, the system will not operate as expected.
- For the input signal servo-ON, the assigned pin or the logic cannot be changed.
- With signals that are not assigned to pins, their functions are enabled. For example, setting the normally closed (contact B) logic without assigning the emergency stop signal to a pin will cause the system to remain in an emergency stop state. The functions of all other input signals are also enabled. So, exercise caution that setting the normally closed (contact B) logic will enable the functions of these other signals at all times.

List of parameter set values

Set value*[1,2]		Setting details	Operation example	
Front panel	PSF-800		Set to the signal [FWD inhibit (SP03)]	Set to the signal [Electronic gear selection (SP14)]
0000	0	Input signal is always disabled.	FWD inhibit is always disabled (FWD inhibit is cancelled).	Electronic gear selection is always disabled (Select electronic gear 1).
0100	256	Input signal is always enabled.	FWD inhibit is always ON	Electronic gear selection is always enabled (Select electronic gear 2).
0001	1	If IN1 (CN2-2) = ON, input signal is enabled.	FWD rotation is inhibited when IN1 = ON (opt-isolator ON).	Electronic gear selection is enabled when IN1 = ON.
0101	257	If IN1 (CN2-2) = OFF, input signal is enabled.	FWD rotation is inhibited when IN1 = OFF (opt-isolator OFF).	Electronic gear selection is enabled when IN1 = OFF.
0002	2	If IN2 (CN2-3) = ON, input signal is enabled.	FWD rotation is inhibited when IN2 = ON (opt-isolator ON).	Electronic gear selection is enabled when IN2 = ON.
0102	258	If IN2 (CN2-3) = OFF, input signal is enabled.	FWD rotation is inhibited when IN2 = OFF (opt-isolator OFF).	Electronic gear selection is enabled when IN2 = OFF.
0003	3	If IN3 (CN2-4) = ON, input signal is enabled.	FWD rotation is inhibited when IN3 = ON (opt-isolator ON).	Electronic gear selection is enabled when IN3 = ON.
0103	259	If IN3 (CN2-4) = OFF, input signal is enabled.	FWD rotation is inhibited when IN3 = OFF (opt-isolator OFF).	Electronic gear selection is enabled when IN3 = OFF.
0004	4	If IN4 (CN2-5) = ON, input signal is enabled.	FWD rotation is inhibited when IN4 = ON (opt-isolator ON).	Electronic gear selection is enabled when IN4 = ON.
0104	260	If IN4 (CN2-5) = OFF, input signal is enabled.	FWD rotation is inhibited when IN4 = OFF (opt-isolator OFF).	Electronic gear selection is enabled when IN4 = OFF.
0005	5	If IN5 (CN2-6) = ON, input signal is enabled.	FWD rotation is inhibited when IN5 = ON (opt-isolator ON).	Electronic gear selection is enabled when IN5 = ON.
0105	261	If IN5 (CN2-6) = OFF, input signal is enabled.	FWD rotation is inhibited when IN5 = OFF (opt-isolator OFF).	Electronic gear selection is enabled when IN5 = OFF.
0006	6	If IN6 (CN2-7) = ON, input signal is enabled.	FWD rotation is inhibited when IN6 = ON (opt-isolator ON).	Electronic gear selection is enabled when IN6 = ON.
0106	262	If IN6 (CN2-7) = OFF, input signal is enabled.	FWD rotation is inhibited when IN6 = OFF (opt-isolator OFF).	Electronic gear selection is enabled when IN6 = OFF.
0007	7	If IN7 (CN2-9) = ON, input signal is enabled.	FWD rotation is inhibited when IN7 = ON (opt-isolator ON).	Electronic gear selection is enabled when IN7 = ON.
0107	263	If IN7 (CN2-9) = OFF, input signal is enabled.	FWD rotation is inhibited when IN7 = OFF (opt-isolator OFF).	Electronic gear selection is enabled when IN7 = OFF.
0008	8	If IN8 (CN2-10) = ON, input signal is enabled.	FWD rotation is inhibited when IN8 = ON (opt-isolator ON).	Electronic gear selection is enabled when IN8 = ON.
0108	264	If IN8 (CN2-10) = OFF, input signal is enabled.	FWD rotation is inhibited when IN8 = OFF (opt-isolator OFF).	Electronic gear selection is enabled when IN8 = OFF.

*1: The values of the front panel items shows the values displayed on the driver's front display panel (refer to the figure below).For details on operation of the driver's front display panel, refer to [Operation outline of system parameter mode] (P6-8).

*2: The values of PSF-800 items show the values displayed in the PSF-800 communication software parameter window. For details on the method for setting input signals using the PSF-800, refer to [Assigning I/O signals] (P10-13).



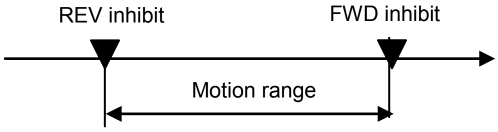
5-3 Details of input signals

The following explains the details of input signals.
For the signal logic, refer to P5-5.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

P: Position control S: Speed control T: Torque control

Parameter No.	Signal name (Abbreviation)	Function	Default setting	Applicable control mode
—	Servo-ON (S-ON)	When the servo ON signal is enabled while the following conditions are satisfied, the driver's servo circuit turns ON and the driver becomes ready: 1. No servo alarm is present. 2. [UA93: Main circuit voltage low] is not present. Disabling the servo-ON signal turns OFF the servo circuit. If the system parameter mode [SP55: DB enable/disable setting] is set to 1, the built-in dynamic brake turns ON. **Caution** The pin assignment of this signal is fixed. It is assigned to pin 2 and the logic is set to normally open.	—	P.S.T
SP00	Emergency stop (ESTOP)	When this input signal is enabled, the servo is turned OFF and [AL01: Emergency stop] is generated. If this signal is assigned to an input pin of CN2, the system operates according to the operation set by the ON/OFF state of the signal. If [SP55: DB enable/disable setting] is set to 1 when the emergency stop signal is enabled, the built-in dynamic brake turns ON. **Caution** The emergency stop function is enabled even when the signal is not assigned to an input pin. If the signal logic is set for the normally closed without assigning emergency stop to an input pin, an emergency stop alarm generates when the driver power is turned ON and the alarm will remain active.	0000	P.S.T
SP01	Alarm reset (RESET)	If a driver alarm generates, the alarm can be reset by the edge of this input signal. The alarm reset signal is effective only when the applicable alarm is resettable and the corresponding alarm condition has already been reset. For the resettable alarms, refer to [Alarms and remedial actions] (P11-1). The servo-ON signal must be input again before the system becomes ready.	0002	P.S.T
SP02	Deviation counter clear (CLEAR)	If the driver is operating in the position control mode, the value of the deviation counter is added to the command counter at the edge of this input signal to clear the deviation counter to 0.	0003	P

P: Position control S: Speed control T: Torque control

<table>
<tr><th>Parameter No.</th><th>Signal name (Abbreviation)</th><th>Function</th><th>Default setting</th><th>Applicable control mode</th></tr>
<tr><td>SP03</td><td>FWD inhibit (FWD-IH)</td><td rowspan="2">This parameter sets the limit of moving in forward and reverse directions.
When the FWD/REV inhibit signal is input, either forward or reverse rotation, whichever corresponds to the input signal, stops.
The rotary drive corresponding to the input inhibit signal is turned OFF. If pulse signals continue to be input in the inhibited direction, an [AL60: Excessive deviation alarm] will be generated.


Also, for the position control and speed control, you can change the operation during the inhibit status to lock the servo using [SP65: FWD/REV inhibit operation].
It is also possible to reverse the inhibited direction with [SP50: Command polarity] (This is available for HA-800 software Version 3.x or later).</td><td>0104</td><td rowspan="2">P.S.T</td></tr>
<tr><td>SP04</td><td>REV inhibit (REV-IH)</td><td>0105</td></tr>
</table>

P: Position control S: Speed control T: Torque control

<table>
<tr><th>Parameter No.</th><th>Signal name (Abbreviation)</th><th>Function</th><th>Default setting</th><th>Applicable control mode</th></tr>
<tr><td>SP05</td><td>FWD enable (FWD-EN)</td><td rowspan="2">This parameter determines the rotary operation status of the actuator relative to the speed command value according to the input status of FWD/REV enable signals when the actuator is operating in the speed control mode.
The SP05 and SP06 statuses, speed command polarities (operation directions), and the operating statuses are shown in the table below. (The table below is for when [SP50: Command polarity] is 0; when SP50=1 or 2, the polarities are the reverse of those in the table below.)
<table>
<tr><th colspan="2">Signal input</th><th rowspan="2">Selected speed command SP09 and SP10 external (analog) speed command input</th><th rowspan="2">Operation direction Operating status</th></tr>
<tr><th>FWD enable SP05</th><th>REV enable SP06</th></tr>
<tr><td rowspan="3">Enabled</td><td rowspan="3">Enabled</td><td>External speed command (positive voltage)</td><td rowspan="3">Zero speed*</td></tr>
<tr><td>External speed command (negative voltage)</td></tr>
<tr><td>Internal speed command 1, 2 and 3</td></tr>
<tr><td rowspan="3">Enabled</td><td rowspan="3">Disabled</td><td>External speed command (positive voltage)</td><td>FWD rotation</td></tr>
<tr><td>External speed command (negative voltage)</td><td>REV rotation</td></tr>
<tr><td>Internal speed command 1, 2 and 3</td><td>FWD rotation</td></tr>
<tr><td rowspan="3">Disabled</td><td rowspan="3">Enabled</td><td>External speed command (positive voltage)</td><td>REV rotation</td></tr>
<tr><td>External speed command (negative voltage)</td><td>FWD rotation</td></tr>
<tr><td>Internal speed command 1, 2 and 3</td><td>REV rotation</td></tr>
<tr><td rowspan="3">Disabled</td><td rowspan="3">Disabled</td><td>External speed command (positive voltage)</td><td rowspan="3">Zero speed*</td></tr>
<tr><td>External speed command (negative voltage)</td></tr>
<tr><td>Internal speed command 1, 2 and 3</td></tr>
</table>
*: One of two statuses can be selected for zero speed. Select one of the two operations for zero speed by enabling or disabling [SP52: Zero clamp setting].
When zero clamp (SP52) is enabled: In the same way as the system switches to the position control mode, the actuator is forcibly stopped so that the position deviation becomes zero (current value is maintained). (Perform position control (positioning) at the position where the speed command value is zero.)
When zero clamp (SP52) is disabled: The actuator stops when the speed command value is zero in the speed control mode. If external torque is input, the actuator may rotate because of the torque.</td><td>0006</td><td rowspan="2">S</td></tr>
<tr><td>SP06</td><td>REV enable (REV-EN)</td><td>0007</td></tr>
</table>

P: Position control S: Speed control T: Torque control

<table>
<tr><th>Parameter No.</th><th>Signal name (Abbreviation)</th><th>Function</th><th>Default setting</th><th>Applicable control mode</th></tr>
<tr><td>SP07</td><td>FWD selection (FWD-SEL)</td><td rowspan="2">This parameter determines the operating status of the actuator relative to the torque command value according to the input status of FWD/REV selection signals while the actuator is operating in the torque control mode.
If FWD/REV selection is assigned to a CN2 input pin with [SP07: FWD selection input setting] or [SP08: REV selection input setting], the operating status of the actuator is determined according to the set operation or whether the signal is enabled or disabled. (The table below is for when [SP50: Command polarity] is 0; when SP50=1 or 2, the polarities are the reverse of those in the table below.)
<table>
<tr><th colspan="2">Signal input</th><th rowspan="2">External (analog) torque command input</th><th rowspan="2">Operation directions
Operating status</th></tr>
<tr><th>FWD selection SP07</th><th>REV selection SP08</th></tr>
<tr><td rowspan="2">Enabled</td><td rowspan="2">Disabled</td><td>External torque command (positive voltage)</td><td rowspan="2">Zero torque</td></tr>
<tr><td>External torque command (negative voltage)</td></tr>
<tr><td rowspan="2">Enabled</td><td rowspan="2">Disabled</td><td>External torque command (positive voltage)</td><td>FWD rotation</td></tr>
<tr><td>External torque command (negative voltage)</td><td>REV rotation</td></tr>
<tr><td rowspan="2">Disabled</td><td rowspan="2">Enabled</td><td>External torque command (positive voltage)</td><td>REV rotation</td></tr>
<tr><td>External torque command (negative voltage)</td><td>FWD rotation</td></tr>
<tr><td rowspan="2">Disabled</td><td rowspan="2">Disabled</td><td>External torque command (positive voltage)</td><td rowspan="2">Zero torque</td></tr>
<tr><td>External torque command (negative voltage)</td></tr>
</table></td><td>0006</td><td rowspan="2">T</td></tr>
<tr><td>SP08</td><td>REV selection (REV-SEL)</td><td>0007</td></tr>
<tr><td>SP09</td><td>Internal speed command selection 1 (SPD-SEL1)</td><td rowspan="2">The driver lets you select a rotation speed command input proportional to an external command voltage value or one of three internal speed command values that have been set.
For internal speed commands, set desired motor shaft rotation speeds (r/min) in [AJ8, 9 and 10: internal speed commands 1, 2 and 3].
In the speed control mode, one of the external speed command and internal speed commands 1, 2 and 3 shown in the table below is selected according to the input status of internal speed command selections 1 and 2.
<table>
<tr><th>Internal speed command selection 1</th><th>Internal speed command selection 2</th><th>Selected speed command</th></tr>
<tr><td>Disable</td><td>Disable</td><td>External speed command</td></tr>
<tr><td>Enable</td><td>Disable</td><td>Internal speed command 1</td></tr>
<tr><td>Disable</td><td>Enable</td><td>Internal speed command 2</td></tr>
<tr><td>Enable</td><td>Enable</td><td>Internal speed command 3</td></tr>
</table></td><td>0000</td><td rowspan="2">S</td></tr>
<tr><td>SP10</td><td>Internal speed command selection 2 (SPD-SEL2)</td><td>0000</td></tr>
</table>

P: Position control S: Speed control T: Torque control

<table>
<tr><th>Parameter No.</th><th>Signal name (Abbreviation)</th><th>Function</th><th>Default setting</th><th>Applicable control mode</th></tr>
<tr><td>SP11</td><td>Internal speed limit selection 1
(SPD-LMT1)</td><td rowspan="2">When the actuator is operating in the position control mode, the speed can be limited to the speed specified by an external speed command voltage or the speeds set in [AJ8, 9 and 10: Internal speed commands 1, 2 and 3].
The speed limit value is selected by internal speed limit selections 1 and 2.

Selected statuses of internal speed limit selections 1 and 2 and internal speed commands 1, 2 and 3
<table>
<tr><th>Internal speed limit selection 1</th><th>Internal speed limit selection 2</th><th>Selected speed command</th></tr>
<tr><td>Disable</td><td>Disable</td><td>The speed is limited according to the external speed command value.*</td></tr>
<tr><td>Enable</td><td>Disable</td><td>The speed is limited according to internal speed command 1.</td></tr>
<tr><td>Disable</td><td>Enable</td><td>The speed is limited according to internal speed command 2.</td></tr>
<tr><td>Enable</td><td>Enable</td><td>The speed is limited according to internal speed command 3.</td></tr>
</table>
*: This is the operation when [SP56: External speed limit enable/disable] is set to 1 (enable).If this parameter is set to 0 (disable), speed limit is not performed.</td><td>0000</td><td rowspan="2">P</td></tr>
<tr><td>SP12</td><td>Internal speed limit selection 2
(SPD-LMT2)</td><td>0000</td></tr>
</table>

P: Position control S: Speed control T: Torque control

<table>
<tr><th>Parameter No.</th><th>Signal name (Abbreviation)</th><th>Function</th><th>Default setting</th><th>Applicable control mode</th></tr>
<tr><td>SP13</td><td>Torque limit
(TRQ-LMT)</td><td>The driver can limit the output torque to the value set in [AJ11: Torque limit value] or less.
If this signal is assigned to CN2, the actuator's output torque is limited according to the set operation based on whether the signal is enabled or disabled.
<table>
<tr><th>Torque limit input</th><th>Control modes</th><th>Operation</th></tr>
<tr><td rowspan="3">Disable</td><td>Position control</td><td>The torque is limited to the external torque limit.*</td></tr>
<tr><td>Speed control</td><td>The torque is limited to the external torque limit.*</td></tr>
<tr><td>Torque control</td><td>The torque is not limited.</td></tr>
<tr><td rowspan="3">Enable</td><td>Position control</td><td>The torque is limited to the set torque limit value.</td></tr>
<tr><td>Speed control</td><td>The torque is limited to the set torque limit value.</td></tr>
<tr><td>Torque control</td><td>The torque is limited to the set torque limit value.</td></tr>
</table>
*: This is the operation when [SP57: External torque limit enable/disable] is set to 1 (enable).If this parameter is set to 0 (disable), torque limit is not performed.</td><td>0000</td><td>P.S</td></tr>
<tr><td>SP14</td><td>Electronic gear selection
(G-SEL)</td><td>The driver has 2 types of built-in electronic gear functions to allow the actuator resolution to be changed electrically during position control. If this signal is assigned to CN2, you can select one of 2 built-in electronic gears according to the set operation or whether the signal is ON or OFF. The electronic gear selection function is enabled even when the signal is not assigned to CN2.
<table>
<tr><th>Electronic gear selection input</th><th>Operation</th></tr>
<tr><td>Disable</td><td>Electronic gear 1 is selected.</td></tr>
<tr><td>Enable</td><td>Electronic gear 2 is selected.</td></tr>
</table>
Electronic gear 1 is determined by the values set in system parameters SP44 and SP45.
Electronic gear 2 is determined by the values set in system parameters SP46 and SP47.
For details, refer to [SP44 to 47: Electronic gear setting](P8-6).
* With the SHA-CG series, [SP14: Electronic gear selection] is only enabled when [SP67: Output shaft divide function setting] is 0 (default value).For details, refer to [SP67: Output shaft divide function setting] (P8-13).</td><td>0000</td><td>P</td></tr>
</table>

P: Position control S: Speed control T: Torque control

<table>
<tr><th>Parameter No.</th><th>Signal name (Abbreviation)</th><th>Function</th><th>Default setting</th><th>Applicable control mode</th></tr>
<tr><td>SP15</td><td>Control mode selection (CON-SEL)</td><td>The driver can operate in one of three control modes of position control, speed control, and torque control.With the control mode selection, you can switch between the 2 control modes that have been selected from the 3 control modes with [SP41: Control mode switching setting].
The control mode selection function is enabled even when the signal is not assigned to CN2.

<table>
<tr><th>SP41
Set value of control mode selection</th><th>Control modes selection</th><th>Operation</th></tr>
<tr><td rowspan="2">0</td><td>Disable</td><td>Position control</td></tr>
<tr><td>Enable</td><td>Speed control</td></tr>
<tr><td rowspan="2">1</td><td>Disable</td><td>Position control</td></tr>
<tr><td>Enable</td><td>Torque control</td></tr>
<tr><td rowspan="2">2</td><td>Disable</td><td>Speed control</td></tr>
<tr><td>Enable</td><td>Torque control</td></tr>
</table>

Caution
To switch the operation to the position control mode and other control mode, after the control mode signal has been input, the zero speed judgment value is enabled first and then the actual operation mode is switched.</td><td>0008</td><td>P.S.T</td></tr>
<tr><td>SP16</td><td>Position command disable (INHIBIT)</td><td>While the driver is operating in the position control mode, the command pulse currently input becomes disabled when the INHIBIT signal input is enabled.</td><td>0000</td><td>P</td></tr>
</table>

5-4 Inputs in each control mode

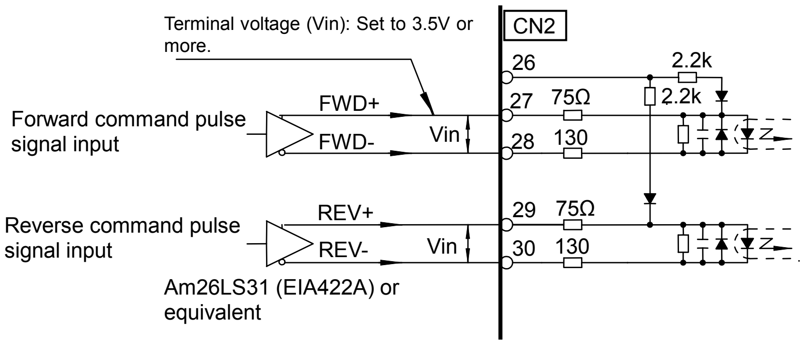
The following explains the input signals corresponding to pins 26 to 34 of the CN2 connector for each control mode (position command mode, speed command mode, and torque command mode).

Position command mode

Pulse train input connection pattern and power supply voltage

This parameter selects line driver connection, +24V input voltage or +5V open collector.
The driver has no internal power supply built in for input signals. Provide an external power supply.

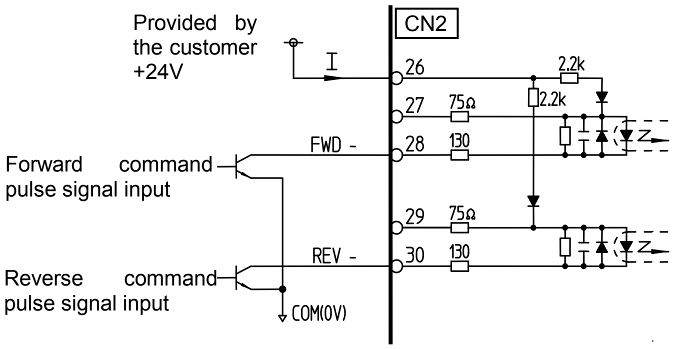
- **Line collector type**



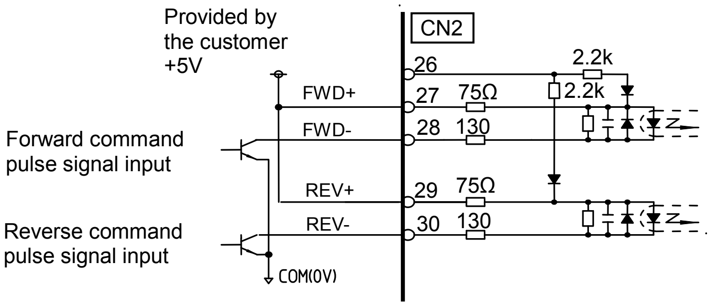
Caution

- Use a line driver conforming to the EIA-422A standard. If a line driver conforming to other standard is used, the system may not operate correctly. In such cases, consult us on technical details.

- **Open collector type**
  24V
  Supply voltage: +24V ± 10%
  Input current (I): 16 mA, standard (20 mA or less)



5V
Supply voltage: +5V ± 10%
Input current (I): 16 mA, standard (20 mA or less)



5

I/O signals

Caution

- If necessary, provide an external-current limiting resistor for each input signal (FWD- and REV-).
- With drivers of open collector type, the maximum response frequency is 200kHz and duty is 50% ± 10%. Since the noise resistance drops compared to drivers of line collector type, use of drivers of line collector type is recommended whenever possible.

Pulse input system

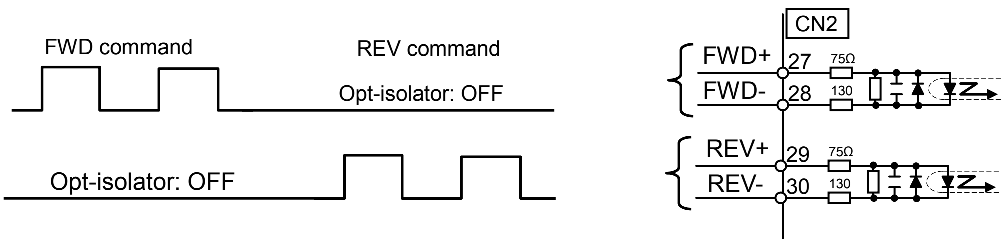
3 input command signal patterns of 2-pulse train, single-pulse train and 2-phase pulse train are available.
Set a desired pattern according to [SP42: Command pulse input pattern setting] (P8-5).

Caution

- Even when a command pulse is input, the pulse will be ignored if the actuator's servo is OFF.

(1) 2-pulse train (FWD/REV pulse train)

The FWD command is input to the FWD port, while the REV command is input to the REV port.

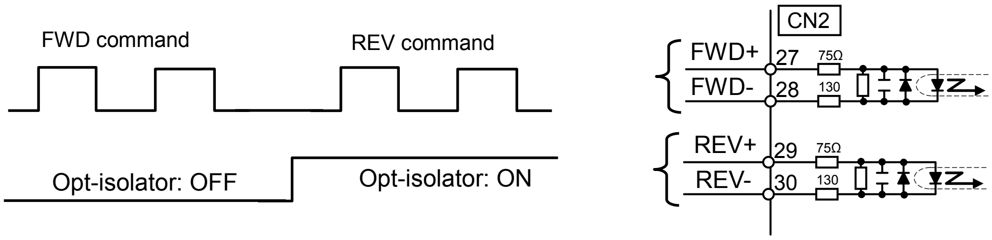


Caution

- Use the negative logic for command pulse signals. A negative logic circuit determines a condition of low voltage level (OFF) as 1 and that of high voltage level (ON) as 0. If [2-pulse train] is selected, the opt-isolator to which no pulse is input should be in OFF state. In ON status, pulses are ignored.

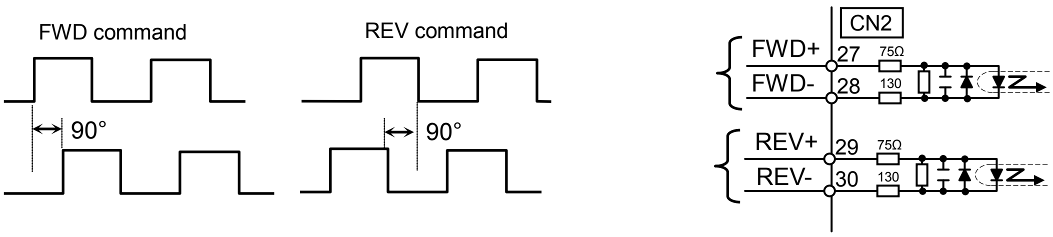
(2) Single-pulse train (code + pulse train)

Command pulses are input to the FWD port only, and only the code indicating the rotation direction is input to the REV port.



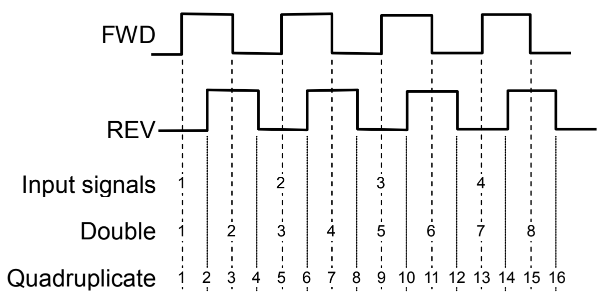
(3) 2-phase pulse train (2-phase pulse train with 90° phase difference)

For the FWD command, the pulse input to the FWD port has a phase advanced by 90° relative to the pulse input to the REV port.
For the REV command, the pulse input to the REV port has a phase advanced by 90° relative to the pulse input to the FWD port.



Input signal multiplication

With 2-phase pulse train input signals, the input signal can be multiplied to double or quadruple the number of movement pulses relative to 1 input signal pulse. Set a desired multiplication using [SP43: Multiplication of 2-phase input setting] (P8-5).



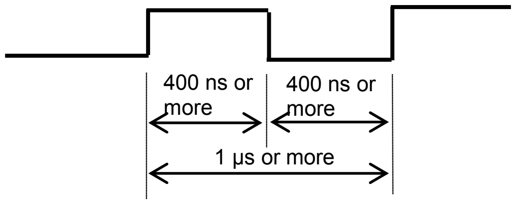
5

I/O signals

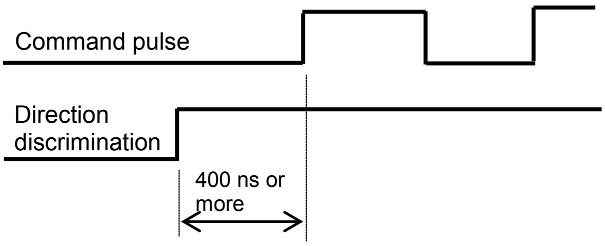
Pulse time condition

For command pulses, input those satisfying the following conditions.

- The maximum response frequency of the HA-800A's command pulse input circuit is 1MHz (or 200kHz if the 2-phase pulse train or open collector is selected). Input command pulses within a duty range of 50 ± 10%.



- If the single-pulse train is selected, command pulses in the specified direction should be input at least 400 ns after the direction discrimination signal has been input.



Caution

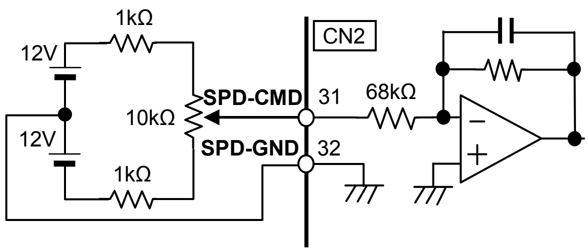
- The time in the above figure is based on the line-driver method. Under the open collector method, assume that the time will be five times longer.

Speed command mode

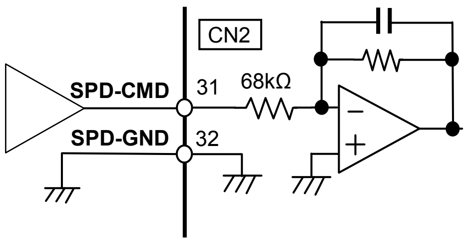
Example of speed command input circuit

Input impedance: 68kΩ

◆ Example of command using a variable resistor



◆ Example of command using an operation amplifier



Setting

Input speed commands using voltage values. The motor rotation speed and speed command voltage are determined according to the value set in [SP51: Speed input factor].

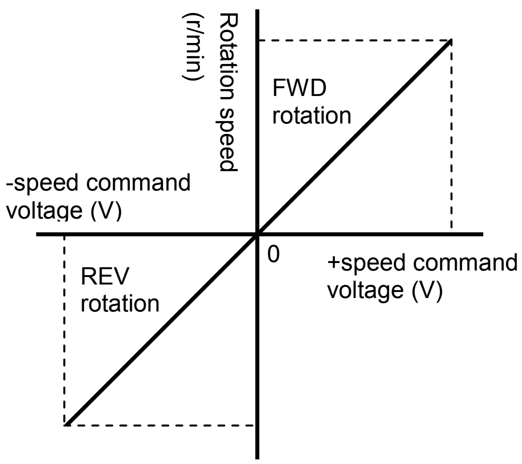
$$\text{Motor rotation speed} = \text{Speed command voltage} \times \frac{\text{Speed input factor}}{10.0\text{V}}$$

The motor rotation direction is specified with the polarity of the speed command voltage and [SP51: Forward start input setting] and [SP06: Reverse start input setting] and [SP50: Command polarity].

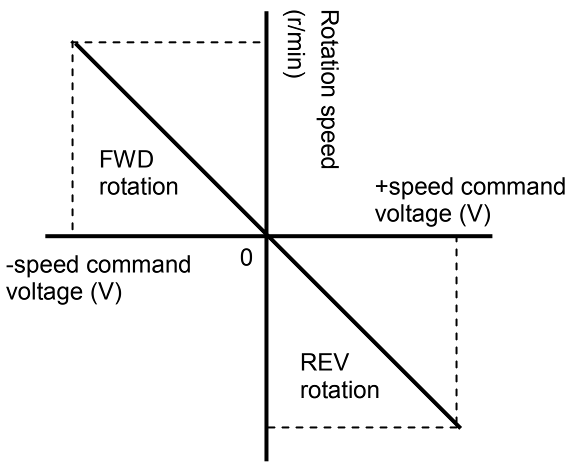
Caution

- The default setting for the value of [SP51: Speed input factor] is set according to the max. rotational speed of the actuator combined with the driver.
- The permissible max. rotational speed depends on the actuator. The default setting for [SP51: Speed input factor] is set to the maximum value permitted by the motor shaft. For details, refer to [Appendix-1 Factory settings] (PA-1).

FWD enable is enabled



REV enable is enabled



Torque command mode

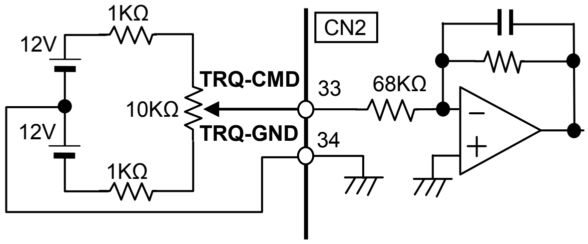
CAUTION

Torque commands control the motor torque. The output torque of the actuator is subject to a harmonic speed reducer loss of 20 to 30%. If the actuator's torque must be controlled accurately, provide a control system that uses a torque sensor on the output shaft.

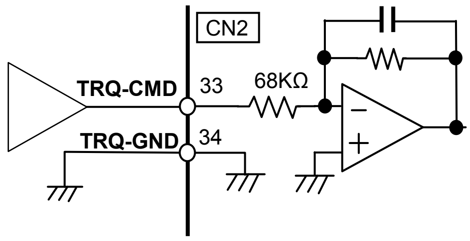
Example of torque command input circuit

Input impedance: 68kΩ

◆ Example of command using a variable resistor



◆ Example of command using an operation amplifier



Setting

Input torque commands using voltage values. The motor output torque and torque command voltage are determined according to the value set in [SP53: Torque input factor].

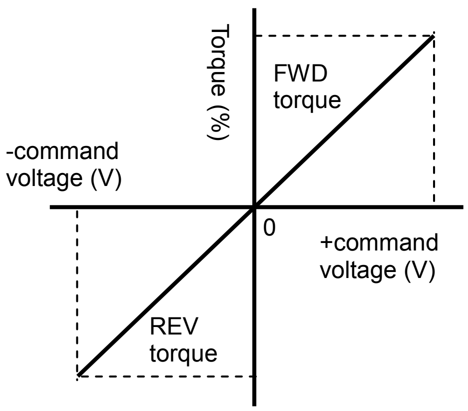
$$\text{Output torque (\%)} = \text{Torque command voltage} \times \frac{\text{Torque input factor}}{10.0\text{V}}$$

The motor torque direction is specified with the polarity of the torque command voltage and [SP07: Forward select input setting] and [SP08: Reverse select input setting] and [SP50: Command polarity].

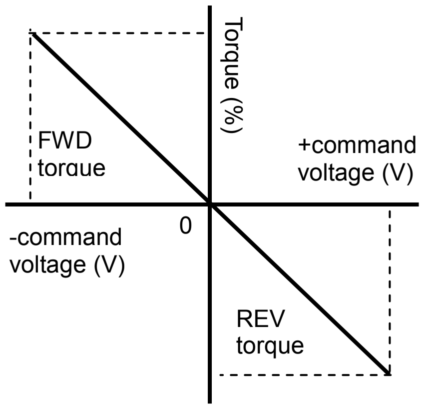
Caution

- The default setting for the value of [SP53: Torque input factor] is set according to the maximum torque of the actuator combined with the driver.
- Be sure to pay full attention to the operating speed as the torque control mode does not include a speed limiting function.

FWD selection is enabled



REV selection is enabled



5

I/O signals

5-5 Output signals: System parameter SP20 to SP26

The following explains the details of output signals.

The output signals are explained in the order of pin numbers of CN2. Desired output signals can be set to pin No. 16 to 22 using the settings of system parameters SP20 to SP26. For details, refer to [Details of output signals] (P5-26).
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

- **CN2 connector (output)**

Pin No.	Signal	Available parameter No.	
		parameter No.	Default setting (PSF-800) *
16	Output 1 (operation preparation complete)	SP20	0001(1)
17	Output 2 (servo-ON input enable)	SP21	0002(2)
18	Output 3 (alarm output)	SP22	0103(259)
19	Output 4 (in-position complete)	SP23	0004(4)
20	Output 5 (torque limiting output)	SP24	0008(8)
21	Output 6 (zero speed output)	SP25	0009(9)
22	Output 7 (warning output)	SP26	0021(21)
23	Phase Z open collector output	—	
24	Output signal common	—	
25	Output signal common	—	
40	Current value data output+ (LD)	—	
41	Current value data output- (LD)	—	
42	Phase output-A+ (LD)	—	
43	Phase output-A- (LD)	—	
44	Phase output-B+ (LD)	—	
45	Phase output-B- (LD)	—	
46	Phase output-Z+ (LD)	—	
47	Phase output-Z- (LD)	—	
48	Monitor COM	—	
49	Ground	—	
50	Ground	—	

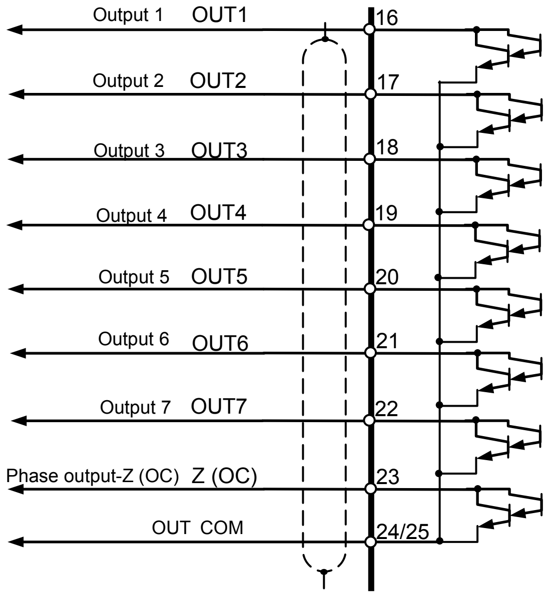
One of 22 signals can be assigned as desired.

* Values in parentheses ( ) are ones when PSF-800 parameters are displayed.

Output signal connection circuit

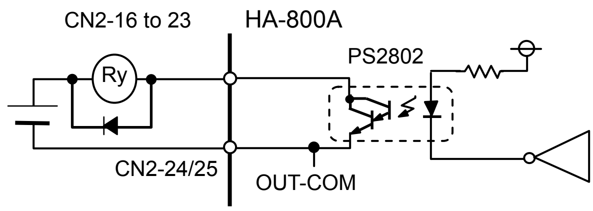
Specifications of output ports

Open-collector output opt-isolator insulation
Voltage: DC24V or less
Current: 40 mA or less/port



How to connect

Connect an output signal between each output port and [CN2-24/25: Output signal common OUT-COM].



Output signal function (logic)

- **Function (logic) definition**

		Transistor output signal status	
		Transistor ON	Transistor OFF
Logic setting	00	Enable	Disable
	01	Disable	Enable

Enabled: The function of the output signal is enabled.
Disabled: The function of the output signal is disabled.

- **How to change function (logic)**
Input signal functions can be changed using system parameters or servo parameter setting software PSF. For the operation method of the setting software PSF, refer to [Chapter 10 Communication software].

5

I/O signals

Output signal list

The output signals that can be assigned to outputs 1 to 7 are explained below.
The signals that can be used are limited by the number of connector pins. Accordingly, select desired signals and assign them to output pins if you wish to use signals other than signals set as default. When setting with the driver's front display panel, refer to [Operation outline of system parameter mode] (P6-8). When setting with the PSF-800 communication software, refer to [Assigning I/O signals] (P10-13).
For the output signal logic, refer to P5-24.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value		Signal name	Abbreviation	Applicable control mode	Default setting	
Logic specification	Signal specification				Assigned pin	Logic
00 / 01	00	No assignment				
00 / 01	01	Operation preparation complete	READY	P.S.T	16	Normally open
00 / 01	02	Servo ON input enable	S-READY	P.S.T	17	Normally open
00 / 01	03	Alarm	ALARM	P.S.T	18	Normally closed
00 / 01	04	In-position complete	IN-POS	P	19	Normally open
00 / 01	05	Attained speed	HI-SPD	P.S.T	—	—
00 / 01	06	Attained torque	HI-TRQ	P.S.T	—	—
00 / 01	07	Speed limiting	SLMT-OUT	P	—	—
00 / 01	08	Torque limiting	TLMT-OUT	P.S	20	Normally open
00 / 01	09	Zero speed	ZERO-SPD	P.S.T	21	Normally open
00 / 01	10	Control mode	CNT-MOD	P.S.T	—	—
00 / 01	11	DB status output	DB-OUT	P.S.T	—	—
00 / 01	12	Alarm code 1	ALM-COD1	P.S.T	—	—
00 / 01	13	Alarm code 2	ALM-COD2	P.S.T	—	—
00 / 01	14	Alarm code 3	ALM-COD3	P.S.T	—	—
00 / 01	15	Battery voltage low	BAT-LOW	P.S.T	—	—
00 / 01	16	Overload status	OVL-OUT	P.S.T	—	—
00 / 01	17	Cooling fan stopped	FAN-STP	P.S.T	—	—
00 / 01	18	Main circuit voltage low	PWR-LOW	P.S.T.	—	—
00 / 01	19	FWD inhibit input effective	FIB-OUT	P.S.T	—	—
00 / 01	20	REV inhibit input effective	RIB-OUT	P.S.T	—	—
00 / 01	21	Warning		P.S.T	22	Normally open

Caution

- The cooling fan stop output function is available only for HA-800A-6.
- The DB status output function is available only for HA-800A-1/3/6.

5-6 Details of output signals

The following explains the output signals assigned to outputs 1 to 7 (pins 16 to 22 of CN2).
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Signal name (Abbreviation)	Function	Applicable control mode
01	Operation preparation complete (READY)	This is an operation preparation complete signal output of the driver. When the driver's servo-ON signal input is enabled without any causes of alarm, the operation preparation complete signal is also enabled. If the servo-ON signal is disabled, this signal is also disabled. When an alarm generates, this is disabled and the servo becomes free.	P.S.T
02	Servo ON input enable (S-READY)	This signal indicates that the driver is free from alarms and the servo-ON signal can be input. This signal is disabled when an alarm is present.	P.S.T
03	Alarm (ALARM)	This signal is output in an alarm condition where the driver has detected an error. The servo becomes free.	P.S.T
04	In-position complete (IN-POS)	This signal indicates that the deviation counter value is inside the values set in [AJ04: In-position range] (+set value to - set value). The driver only monitors the status of deviation counter and this signal does not affect the servo control directly.	P
05	Attained speed (HI-SPD)	This signal indicates that the motor rpm has reached or exceeded the value set in [AJ05: Attained speed judgment value]. The driver only monitors the status of attained speed and this signal does not affect the servo control directly.	P.S.T
06	Attained torque (HI-TRQ)	This signal indicates that the actuator's output torque has reached or exceeded the value set in [AJ06: Attained torque judgment value]. The driver only monitors the attained torque status and this signal does not affect the servo control directly.	P.S.T
07	Speed limiting (SLMT-OUT)	This signal indicates that the motor speed is limited to the speed limit selected by [SP11, SP12: Internal speed limits 1 and 2 inputs].	P
08	Torque limiting (TLMT-OUT)	This signal indicates that the actuator's torque is limited by an internal torque limit input or external torque limit input.	P.S
09	Zero speed (ZERO-SPD)	This signal indicates that the motor rpm has dropped to or below the speed set in [AJ07: Zero speed judgment value]. Control mode change from position control to other control, or from other control mode to position control, is prohibited unless the zero speed output is enabled.	P.S.T
10	Control modes (CNT-MOD)	The signal that has been input as the control mode input signal is output.	P.S.T
11	Dynamic brake actuated (DB-OUT)	When [SP55: Dynamic brake enable/disable] is set to 01: Enable, this signal indicates that the dynamic brake is operating . This is actuated when the power is cut OFF, the servo is turned OFF, or an alarm or warning [UA93: Main circuit voltage low] is generated. In the HA-800A-24, this function is disabled (output indeterminate).	P.S.T
12	Alarm code 1 (ALM-COD1)	When a driver alarm or warning is present, whether it is an alarm or warning is output using a 3-bit code. Alarm code output 1 outputs the LSB of this 3-bit code. For details on alarm codes, refer to [Alarm List] (P11-1) and [Warning List] (P11-14).	P.S.T
13	Alarm code 2 (ALM-COD2)		
14	Alarm code 3 (ALM-COD3)		

5

I/O signals

<table>
<tr><th>Set value</th><th>Signal name (Abbreviation)</th><th>Function</th><th>Applicable control mode</th></tr>
<tr><td>15</td><td>Battery voltage low
(BAT-LOW)</td><td>When an absolute encoder is combined, this signal indicates that the multi revolution data backup voltage is low. For details, refer to the table below.
<table>
<tr><th>Encoder</th><th>Voltage low detection condition</th><th>Recovery condition</th></tr>
<tr><td>13-bit absolute encoder</td><td>The backup battery voltage is 2.8V or less.</td><td>The backup battery voltage has become 3.00V or more.</td></tr>
<tr><td>17-bit absolute encoder</td><td>SHA series (excluding SHA20): The voltage of the encoder’s multi revolution data backup circuit is 3.1V or less
SHA20 and FHA-Cmini series: The voltage of the backup battery is 3.1V or less.</td><td>SHA series (excluding SHA20): When the voltage of the encoder's multi revolution data backup circuit was 3.1V or more, alarms are cleared and the encoder power supply has been reconnected.
SHA20 and FHA-Cmini series: The voltage of the backup battery is 3.1V or more.</td></tr>
</table></td><td>P.S.T</td></tr>
<tr><td>16</td><td>Overload status
(OVL-OUT)</td><td>This signal indicates that the actuator is operating in an overload status and that if the operation is continued in this condition, an overload alarm may generate.
The overload status output indicates that the overload rate is 50% or more where 100% indicates a condition where an overload alarm is present. The alarm will be reset automatically when the overload rate drops to 50% or below.</td><td>P.S.T</td></tr>
<tr><td>17</td><td>Cooling fan stopped
(FAN-STP)</td><td>This signal indicates that the cooling fan is stopped for some reason. If operation is continued with the cooling fan stopped, the HA-800 driver temperature may rise and the product life will decrease or an unexpected accident may occur. Remove the cause of stopping as soon as possible.
This function is available only for HA-800-6.</td><td>P.S.T</td></tr>
<tr><td>18</td><td>Main circuit voltage low
(PWR-LOW)</td><td>This signal indicates that the main circuit voltage has dropped to the level specified below:
Input voltage specification = 200V: DC190V or below (DC220V or less for Ver. 2.02 or older)
Input voltage specification = 100V: DC70V or below (DC100V or less for Ver. 2.02 or older)</td><td>P.S.T</td></tr>
<tr><td>19</td><td>FWD inhibit input in effect
(FIB-OUT)</td><td>This signal indicates that the FWD inhibit input is enabled and FWD rotation is inhibited.
The FWD inhibit input in effect output will be disabled once the cause that enabled the FWD inhibit input is removed.</td><td>P.S.T</td></tr>
<tr><td>20</td><td>REV inhibit input in effect
(RIB-OUT)</td><td>This signal indicates that the REV inhibit input is enabled and REV rotation is inhibited.
The REV inhibit input in effect output will be disabled once the cause that enabled the REV inhibit input is removed.</td><td>P.S.T</td></tr>
<tr><td>21</td><td>Warning
(WARNING)</td><td>It is output in warning status.
The warning output will be disabled once the cause of the warning status is removed.</td><td>P.S.T</td></tr>
<tr><td>22</td><td>Phase Z (OC)
(Z)</td><td>The encoder's phase Z pulse signal is output in via an open collector. This signal is output only by 1 pulse per motor revolution.
The signal may be used with the origin sensor signal of an automatic mechanism to recognize the accurate origin position, etc.</td><td>P.S.T</td></tr>
</table>

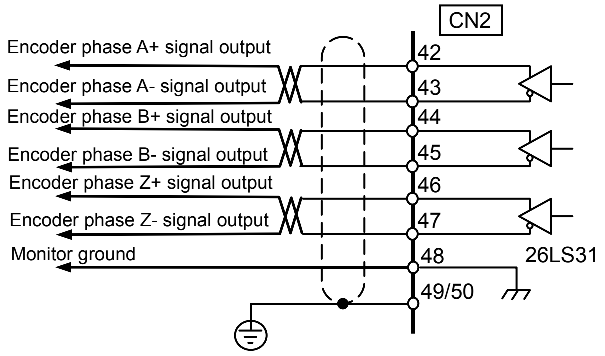
5-7 Monitor output

The following explains how to output the encoder signal monitor output and current value data output signals from the CN2 connector and to output the speed, current analog monitor and status digital monitor signals from the CN9 connector.

Encoder output

The encoder's phase A, B, and Z signals are output via a line driver (26LS31).
Receive the signals by a line receiver (AM26LS32 or equivalent).
For details on signals, refer to the following according to the actuator model you use.

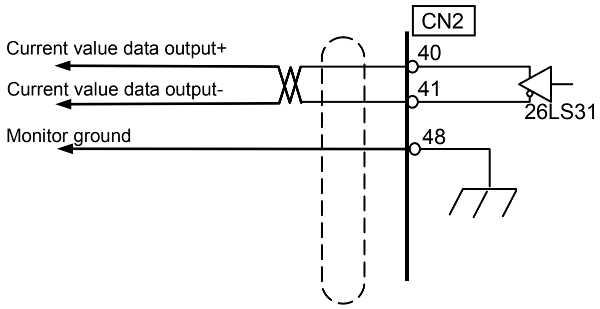
Encoder type	Actuator model	Driver model	Details
17-bit absolute encoder (17-bit encoder incremental model)	SHA series FHA-Cmini series	HA-800A-*D/E-100/200	P4-11
13-bit absolute encoder	FHA-C series	HA-800A-*A-100/200	P4-21
4-wire wire-saving incremental encoder	FHA-C series	HA-800A-*C-100/200	P4-28
4-wire wire-saving incremental encoder	FHA-Cmini series	HA-800A-*C-100/200	
14-wire incremental encoder	RSF/RKF series	HA-800A-*B-100/200	



Current value data output

This is used to acquire the current value data when the servo is ON in order to manage the absolute position with the absolute encoder.
The current value is sent divided into 9 times and output with the line collector (26LS31), so receive using a line receiver (AM26LS32 or equivalent).
For details, refer to [Outputting the current value data from the pins CN2-40 and 41] (P4-9).

Output format	Start-stop
Communication speed	9,600 bps
Stop bit	1 bit
Data length	8 bits
Parity bit	Even parity
Format	LSB first



Analog waveform monitoring

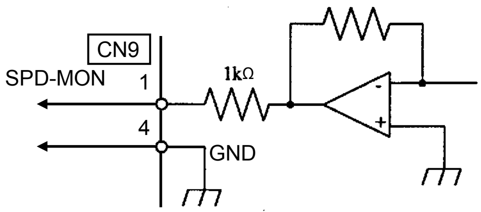
Monitored analog speed/current waveforms can be output from the CN9 connector.
An optional monitor cable is available for observing waveforms using an oscilloscope.
Model code: EWA-MON01-JST4

Speed monitor: SPD-MON

The port outputs a voltage signal proportional to the motor rotation speed (speed input factor per 10V). The relationship of output voltage and rotation speed is determined by the value set in [SP51: Speed input factor] (For details, refer to P8-9). Take note that the output remains unstable after the power is input until the [Servo-ON input enable: S-READY] signal is output. (A maximum of approx. ±15V may be output.)

$$\text{Motor rotation speed (r/min)} = \text{Speed monitor output voltage} \times \frac{\text{Speed input factor}}{10.0\text{V}}$$

- **Specifications**
  Output voltage range: -10 to +10V
  Output impedance: 1kΩ



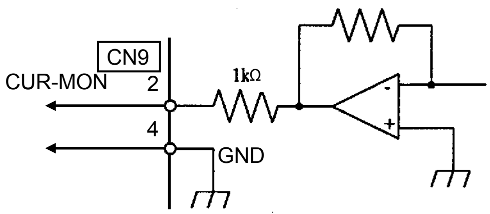
- **Connection method**
  Plug the connector for the optional monitor cable (EWA-MON01-JST4) into CN9 and check the waveform between [CN9-1 speed monitor: SPD-MON] and [CN9-4 monitor ground: GND] using an oscilloscope.

Current monitor: CUR-MON

The motor current is output as voltage. The voltage is output based on the maximum motor current being +10V. Take note that the output remains unstable after the power is input until the [Servo-ON input enable: S-READY] signal is output. (A maximum of approx. ±15V may be output.)

$$\text{Current monitor output voltage (V)} = \text{Actuator current} \times \frac{10.0\text{V}}{\text{Max. current}}$$

- **Specifications**
  Output voltage range: -10 to +10V
  Output impedance: 1kΩ



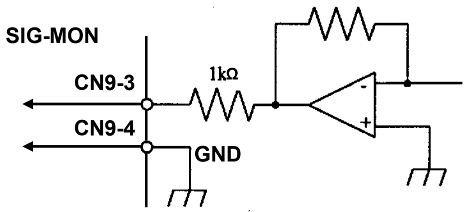
- **How to connect**
  Plug the supplied connector into CN9 and check the waveform between [CN9-2 current monitor: CUR-MON] and [CN9-4 monitor ground: GND] using an oscilloscope.

Digital signal monitor

The signal waveform set in [SP40: CP3 output signal setting] (For details, refer to P8-4) is output. The output voltage is 0V for Low and 3.3V for High. Take note that the output remains unstable after the power is input until the [Servo-ON input enable: S-READY] signal is output.

Signal monitor: SIG-MON

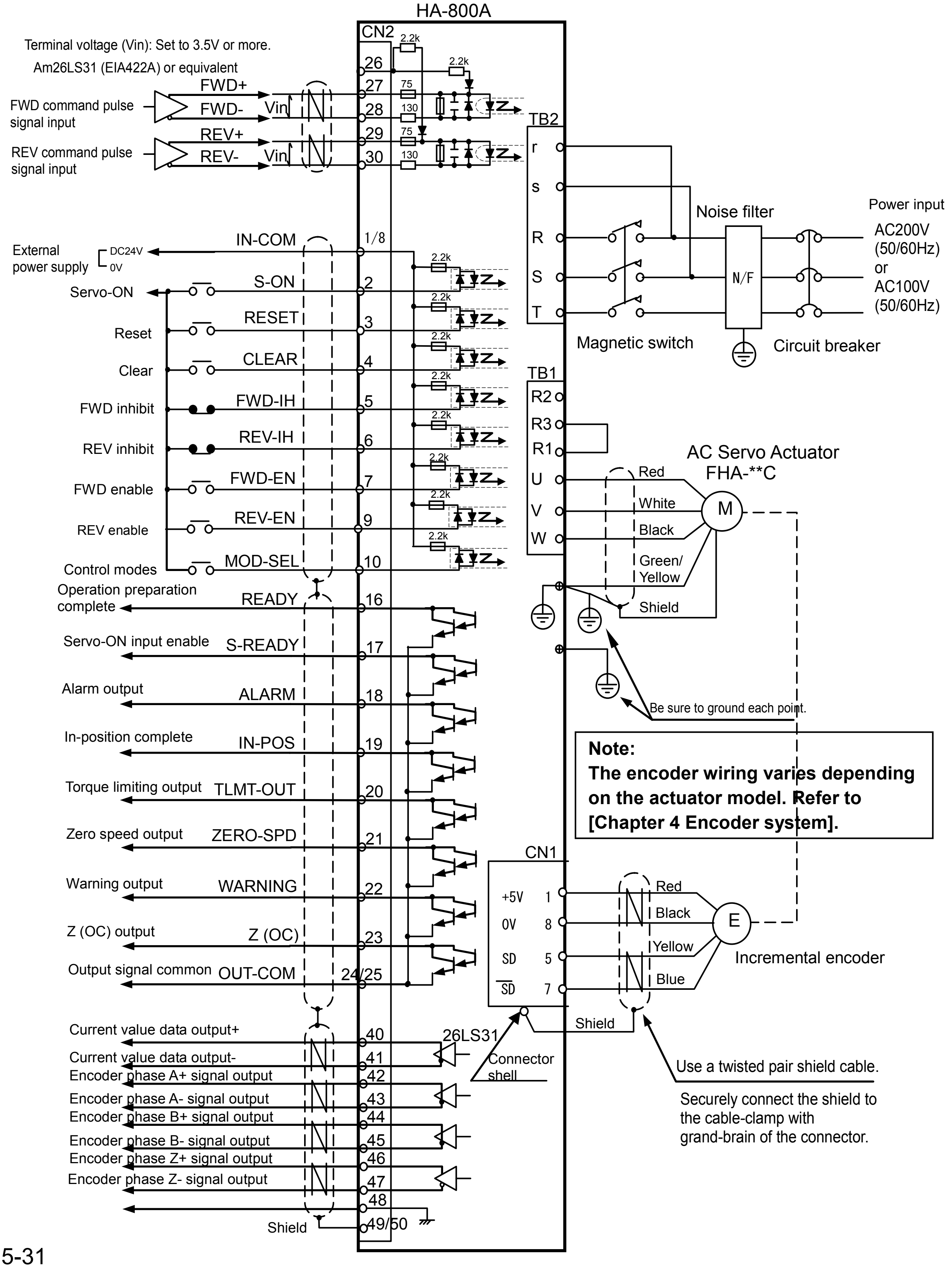
- **Specifications**
  Output voltage range: 0 or 3.3V
  Output impedance: 1kΩ



- **How to connect**
  Plug the supplied connector into CN9 and check the waveform between [CN9-3 signal monitor: SIG-MON] and [CN9-4 monitor ground: GND] using an oscilloscope.

5-8 Connection example in control mode

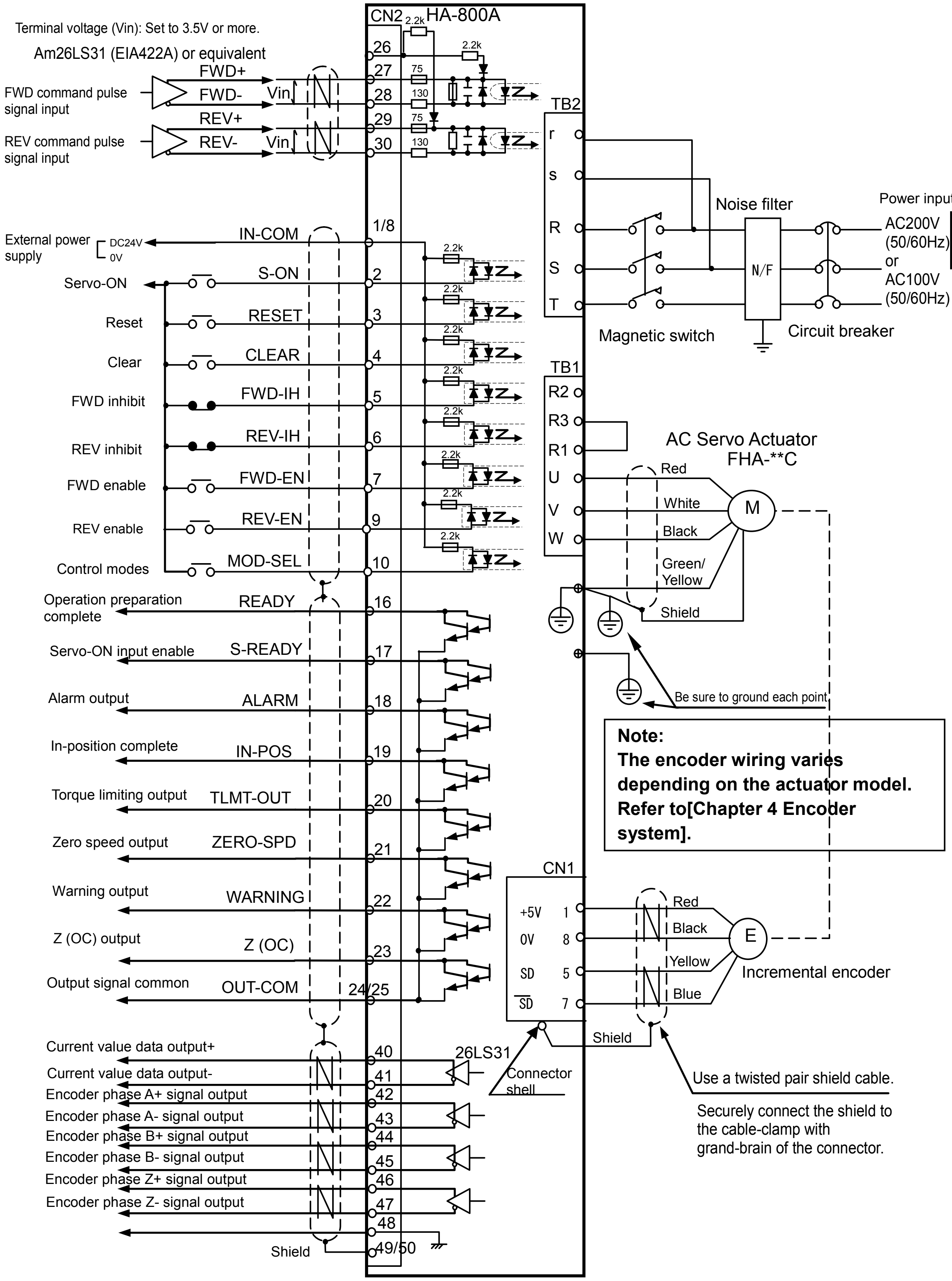
Connection example with default settings



Note:
The encoder wiring varies depending on the actuator model. Refer to [Chapter 4 Encoder system].

Connection example in position control mode

The line driver command pattern in the position control mode is shown in the connection example for 2-pulse train.

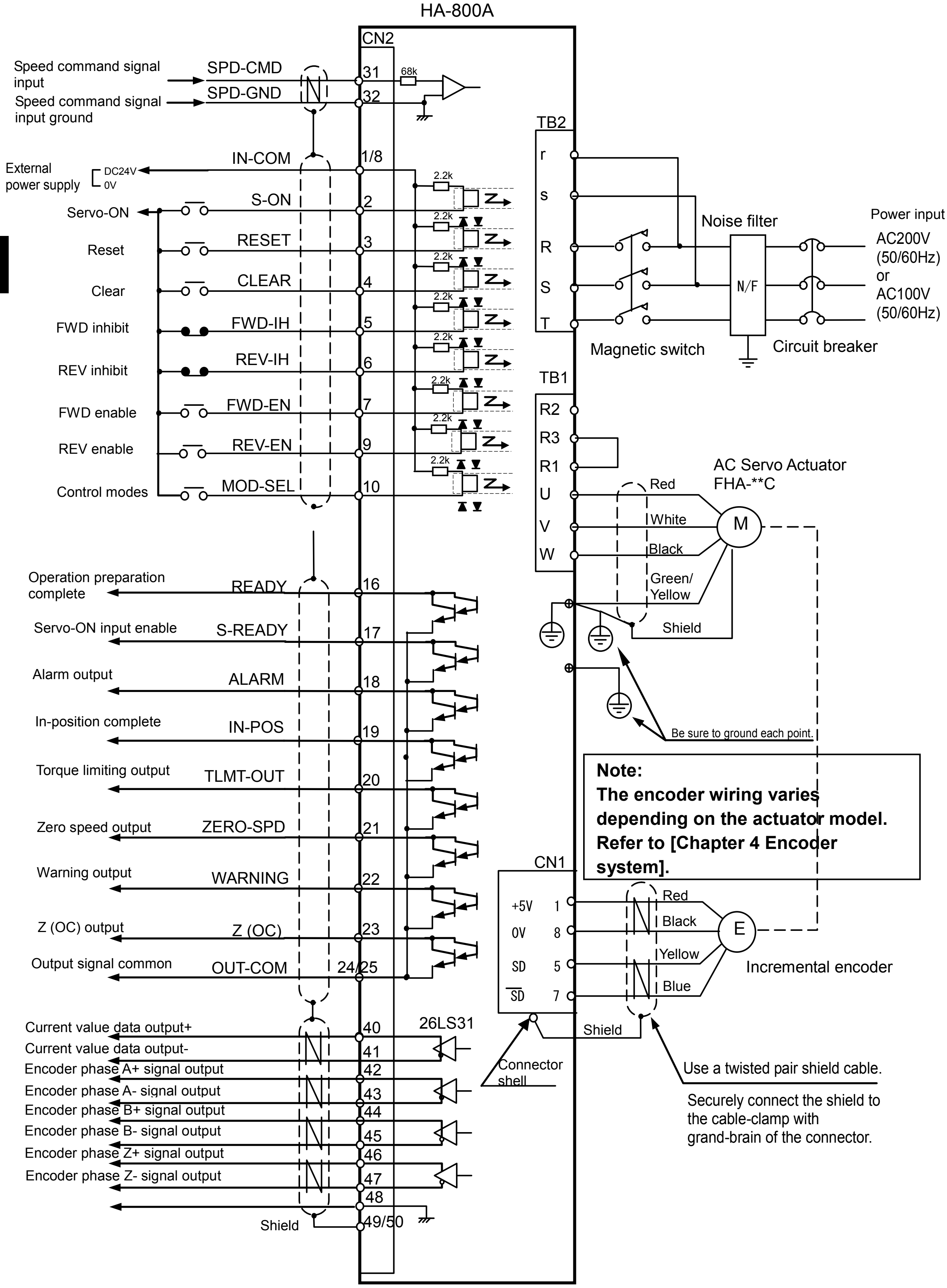


5

I/O signals

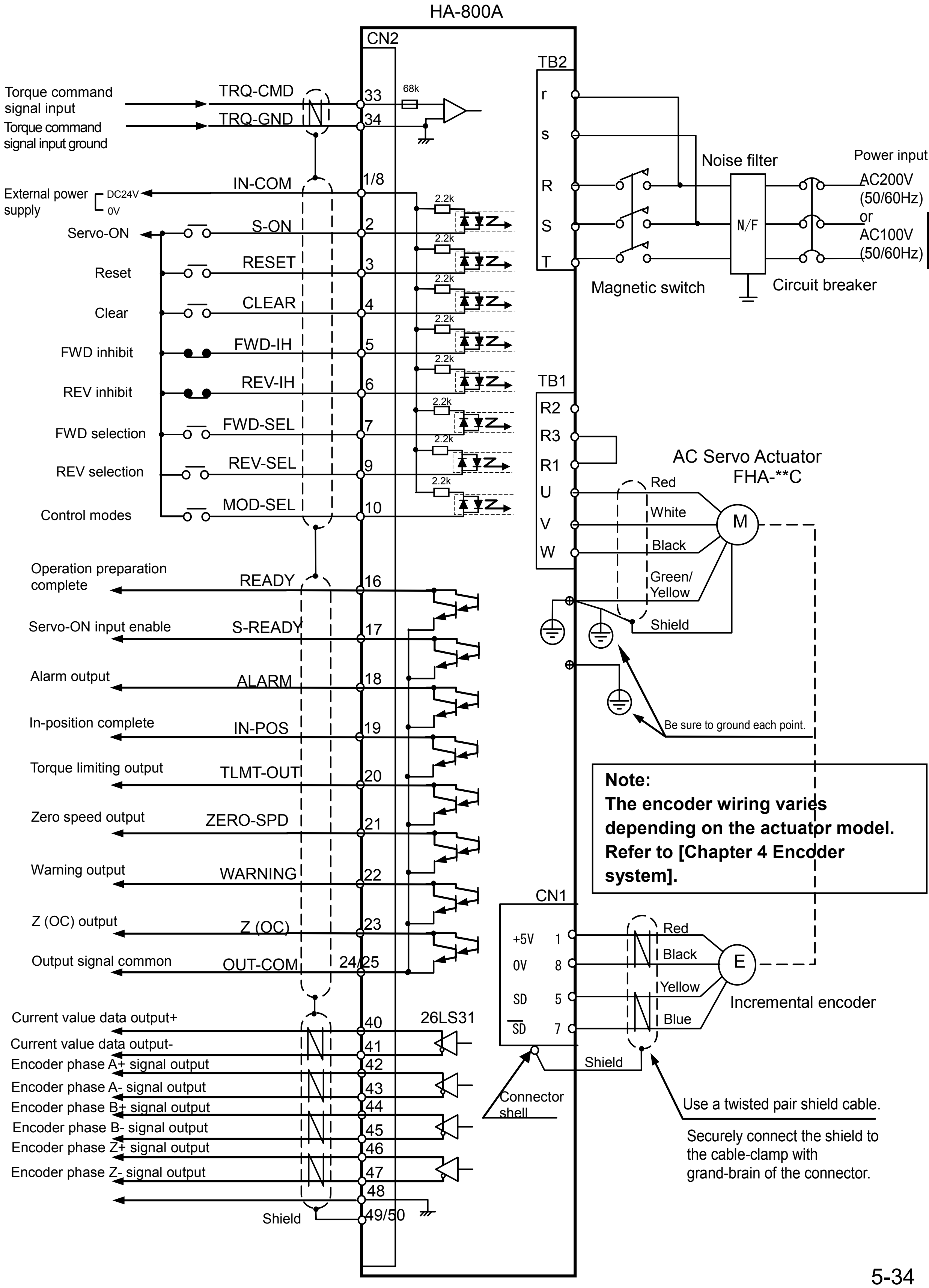
Connection example in speed control mode

A connection example in the speed control mode is shown.



Connection example in torque control mode

A connection example in the torque control mode is shown.



Note:
The encoder wiring varies depending on the actuator model. Refer to [Chapter 4 Encoder system].

Chapter 6

Panel display and operation

How to operate the display, operation buttons on the driver's front panel and overview of operation in each mode is explained in this chapter.

6-1 Operating display panel

The front display panel has a 5-digit LED display and 4 operation keys. You can perform all display, tuning, setting and other operations on this display panel.

Overview of modes

The display panel is operated in the 5 modes specified below.

Status display mode (d00 to d15)

Position/speed commands to the driver, current position information from the motor encoder, condition of cumulative pulses in the deviation counter and code number of the actuator to be combined are shown.
For details, refer to [Status display mode] (P7-1).

Alarm mode (AL, A1 to A8, AHcLr)

Present alarms and up to 8 most recent alarm histories are shown. Also, the alarm history can be deleted in the alarm mode. We recommend to clear the alarm history after the system is complete.
When an alarm occurs, the display panel switches to the alarm mode, regardless of the present mode, and shows the present alarm code.
Various parameters can be displayed or changed even when an alarm is present.
For details, refer to [Alarm mode] (P7-9).

Tune mode (AJ00 to AJ59)

You can display or change the parameters for servo gains, internal speed commands, etc.
Tune mode parameters can be changed even when the actuator is operating. Changes are reflected in real time.
For details, refer to [Chapter 7 Tune mode].

System parameters

- **Input signals (SP00 to SP19)**
  These parameters set the functions associated with the driver's input signals and their assignments to CN2. The set values will become effective when the driver power supply is reconnected.
  For details, refer to [Input signals: System parameter SP00 to SP16] (P5-3).

- **Output signals (SP20 to SP39)**
  These parameters set the functions associated with the driver's output signals and their assignments to CN2. The set values will become effective when the driver power supply is reconnected.
  For details, refer to [Output signals: System parameter SP20 to SP26] (P5-23).

- **Function extension signals (SP40 to SP79)**
  These parameters set switching in the control mode, electronic gear, extension of functions, etc. The set values will become effective when the HA-800A driver power supply is reconnected.
  For details, refer to [Function extension parameter] (P8-3).

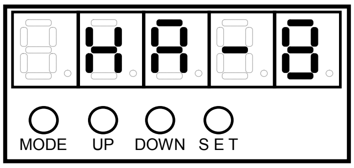
Test modes (T00 to T11)

In the test mode, you can monitor I/O signals, operate output signals, initialize parameters, and perform multi revolution clear and auto-tuning. You can also check the connection with the host controller and operating status without having to drive the actuator.
For details, refer to [Chapter 9 Test mode].

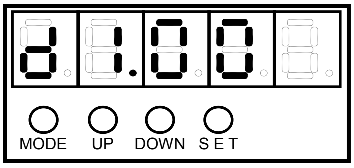
Initial panel display

The following explains the panel display shown when the driver is started normally and while an alarm is present.

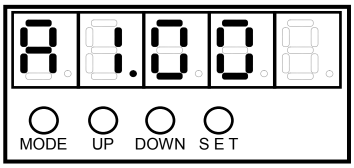
Display upon control power supply ON



When the driver's control power supply is turned ON, the driver model HA-800 is shown at the far right of the panel display.

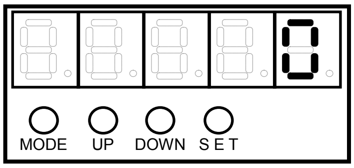


The display software version is shown for approx. 1 second.



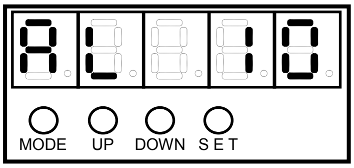
The control software version is shown for approx. 1 second.

Normal

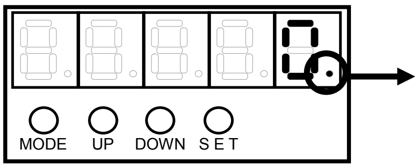


The status data set by [SP54: Status display setting] is shown.

Alarm



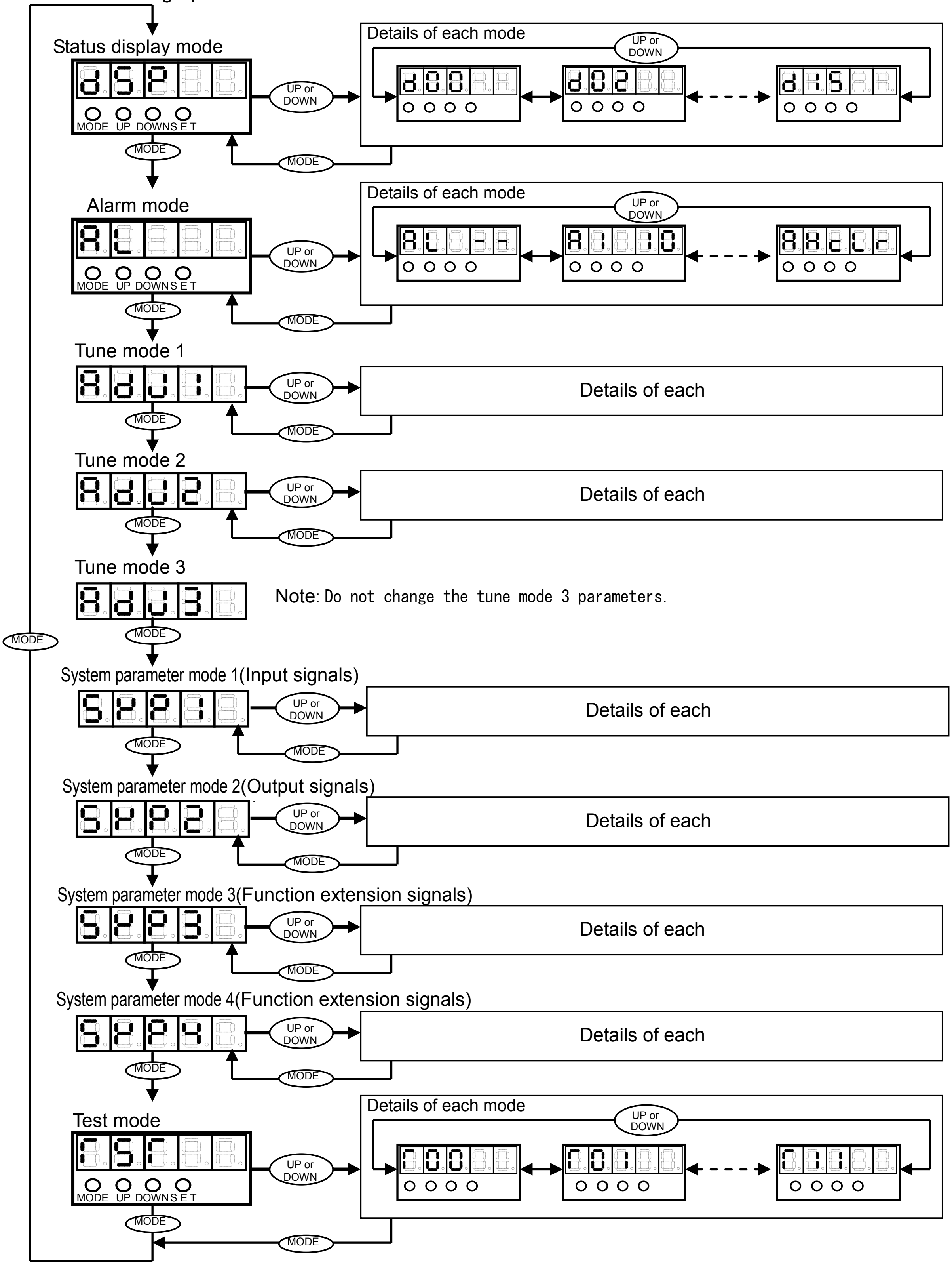
The driver starts in the alarm mode and shows the present alarm.
If multiple alarms or warnings are present, they are shown one by one at an interval of approx. 500 ms.



The decimal point in the fifth digit indicates the servo-ON
Lit: Servo-ON
Unlit: Servo-OFF

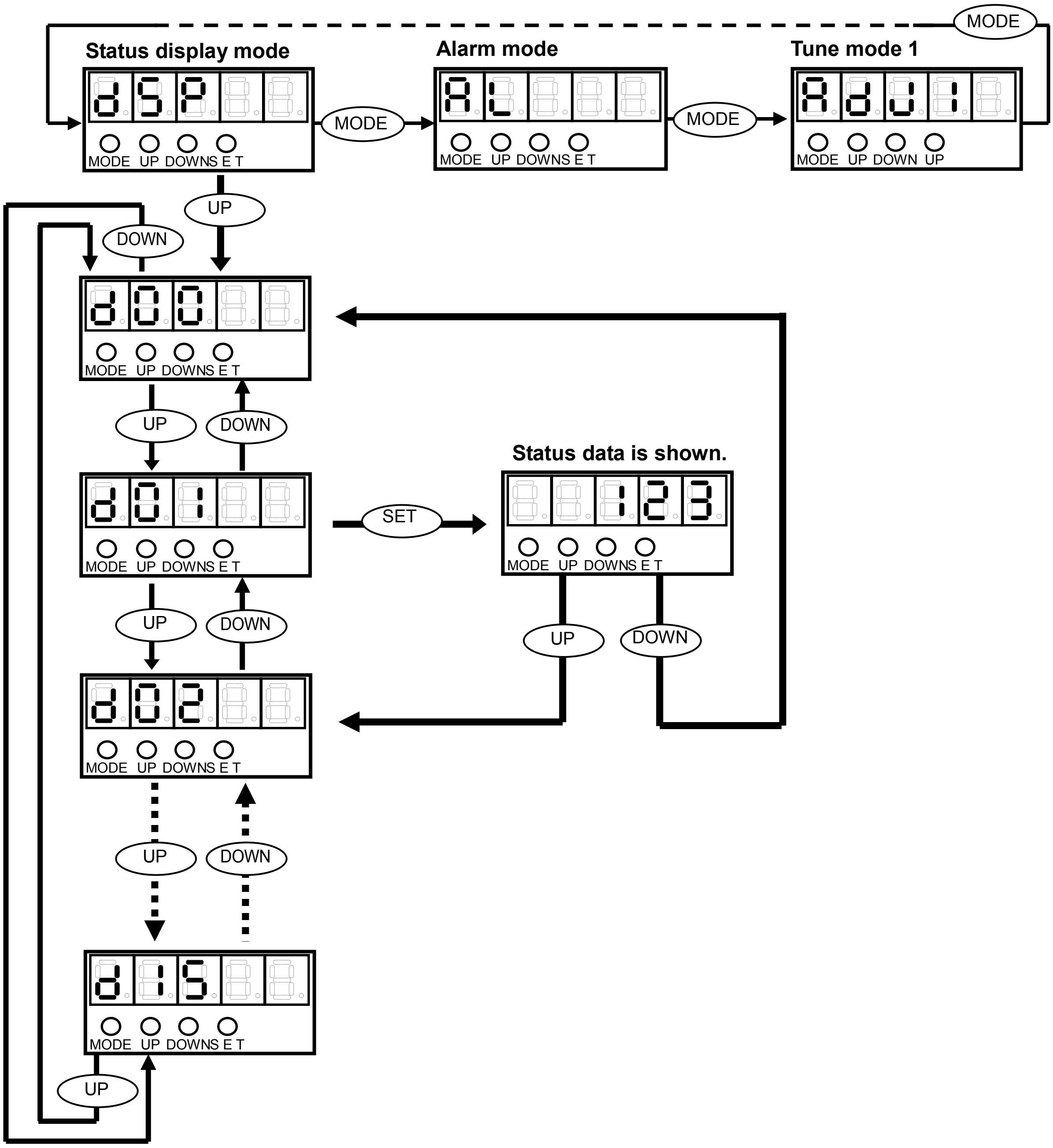
Panel display hierarchy

The display hierarchy of the display panel is shown below.
When an alarm occurs, the display panel switches to the alarm mode, regardless of the present mode, and shows the present alarm code. Even when an alarm is present, you can still switch to other mode and check or change parameters.



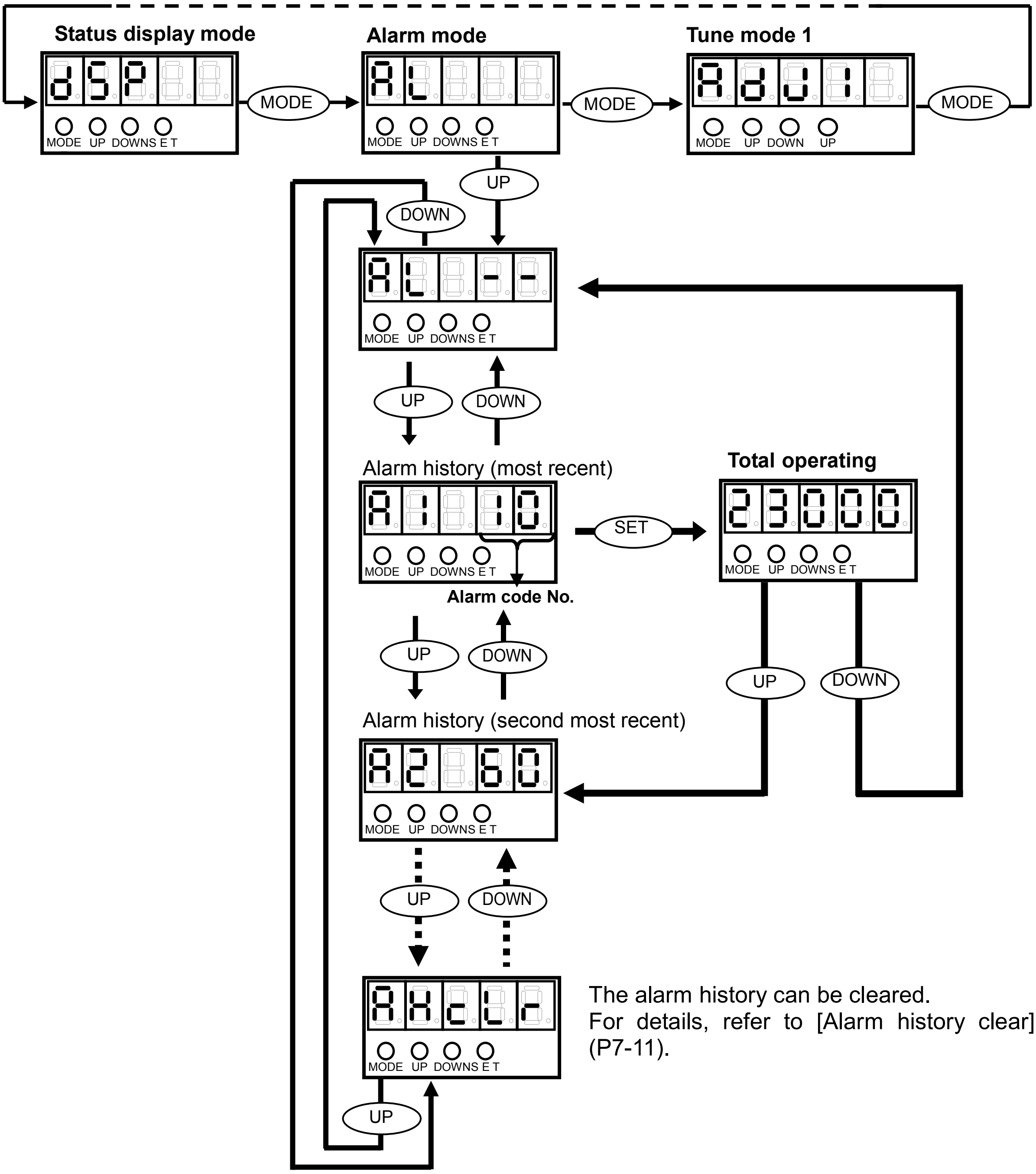
Operation outline of status display mode

An overview of operations in the status display mode is shown below.
To prevent malfunction, a button is recognized as enabled when it has been pressed for at least 0.1 second and 1 second or less.
* For details on data displayed, refer to Chapter 7.



Operation outline of alarm mode

An overview of operations in the alarm mode is shown below.
To prevent malfunction, a button is recognized as enabled when it has been pressed for at least 0.1 second and 1 second or less.
* For the overview on alarms, refer to P7-9.
* For details on alarms, refer to [Chapter 11 Troubleshooting].



The alarm history can be cleared.
For details, refer to [Alarm history clear] (P7-11).

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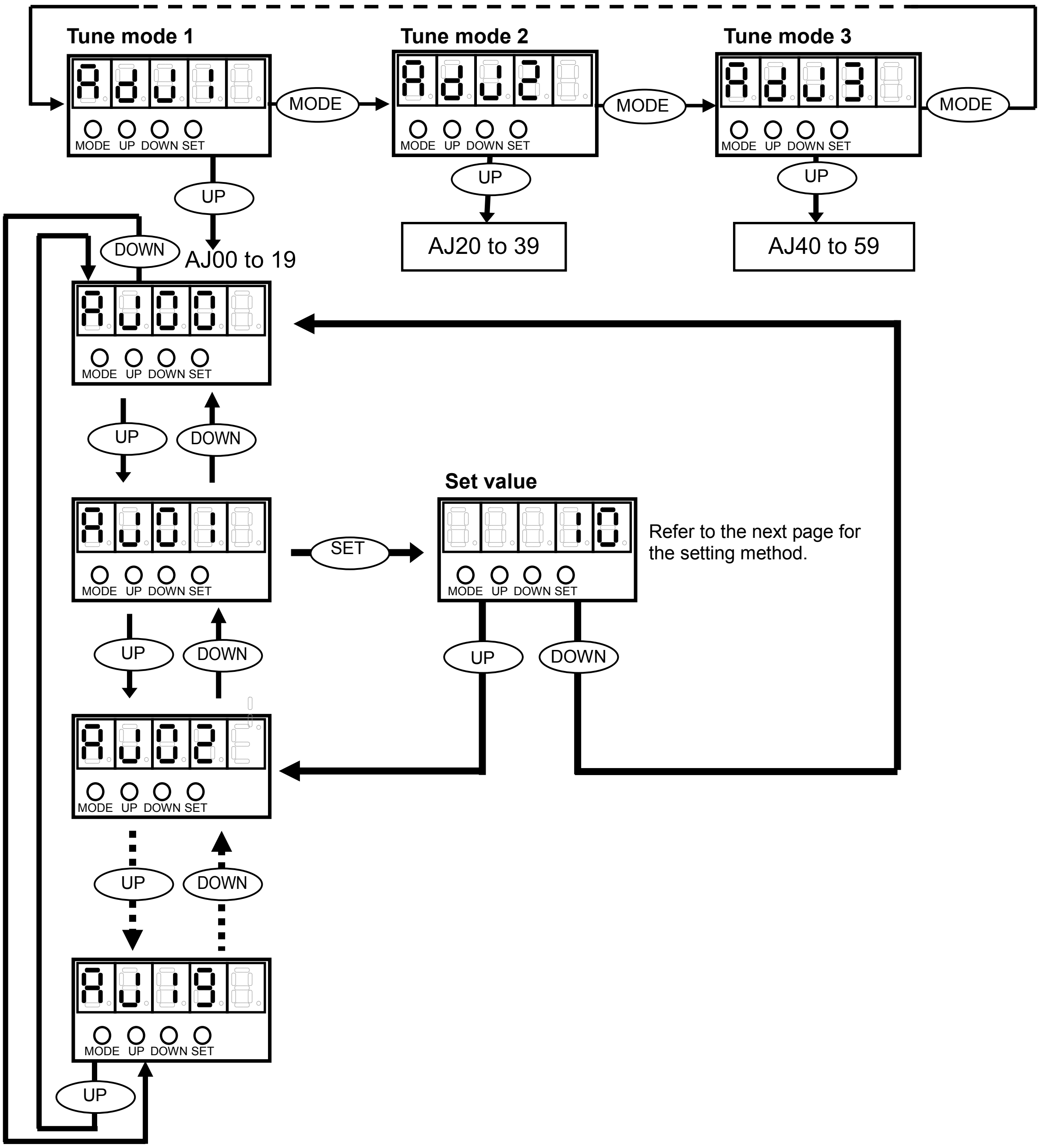
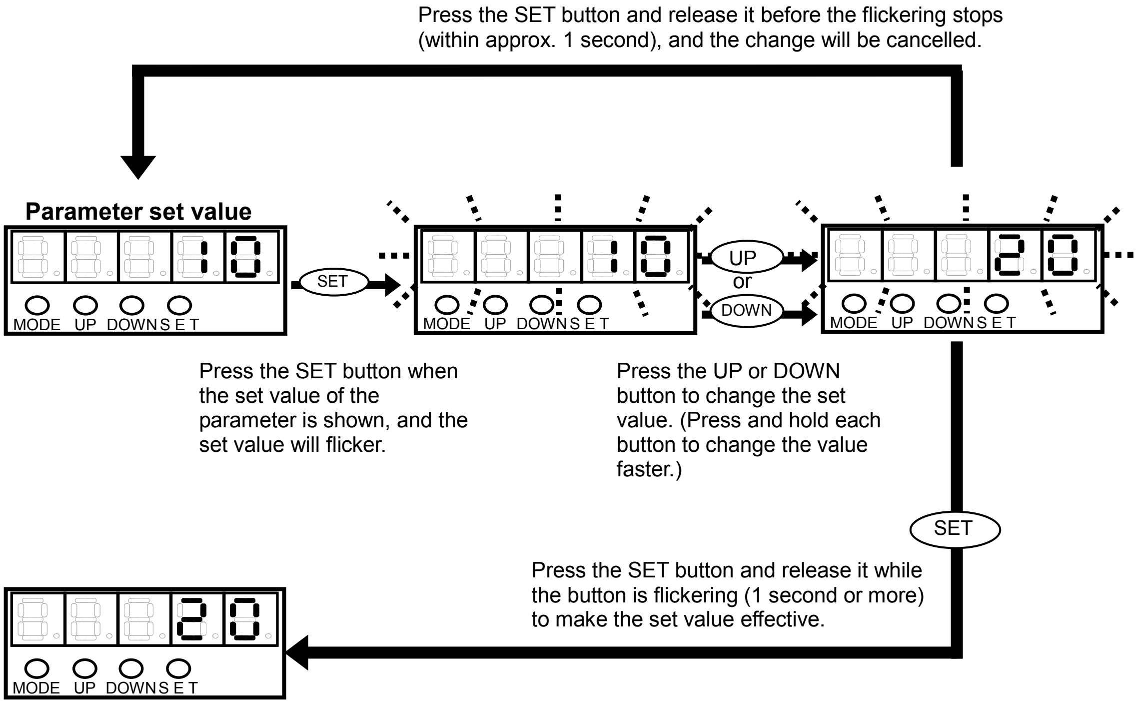
Panel display and operation

Operation outline of tune mode

An overview of operations in the tune mode is shown below.
To prevent malfunction, a button is recognized as enabled when it has been pressed for at least 0.1 second and 1 second or less.
* For details on the tune mode, refer to [Tune mode] (P7-12).



How to change set value



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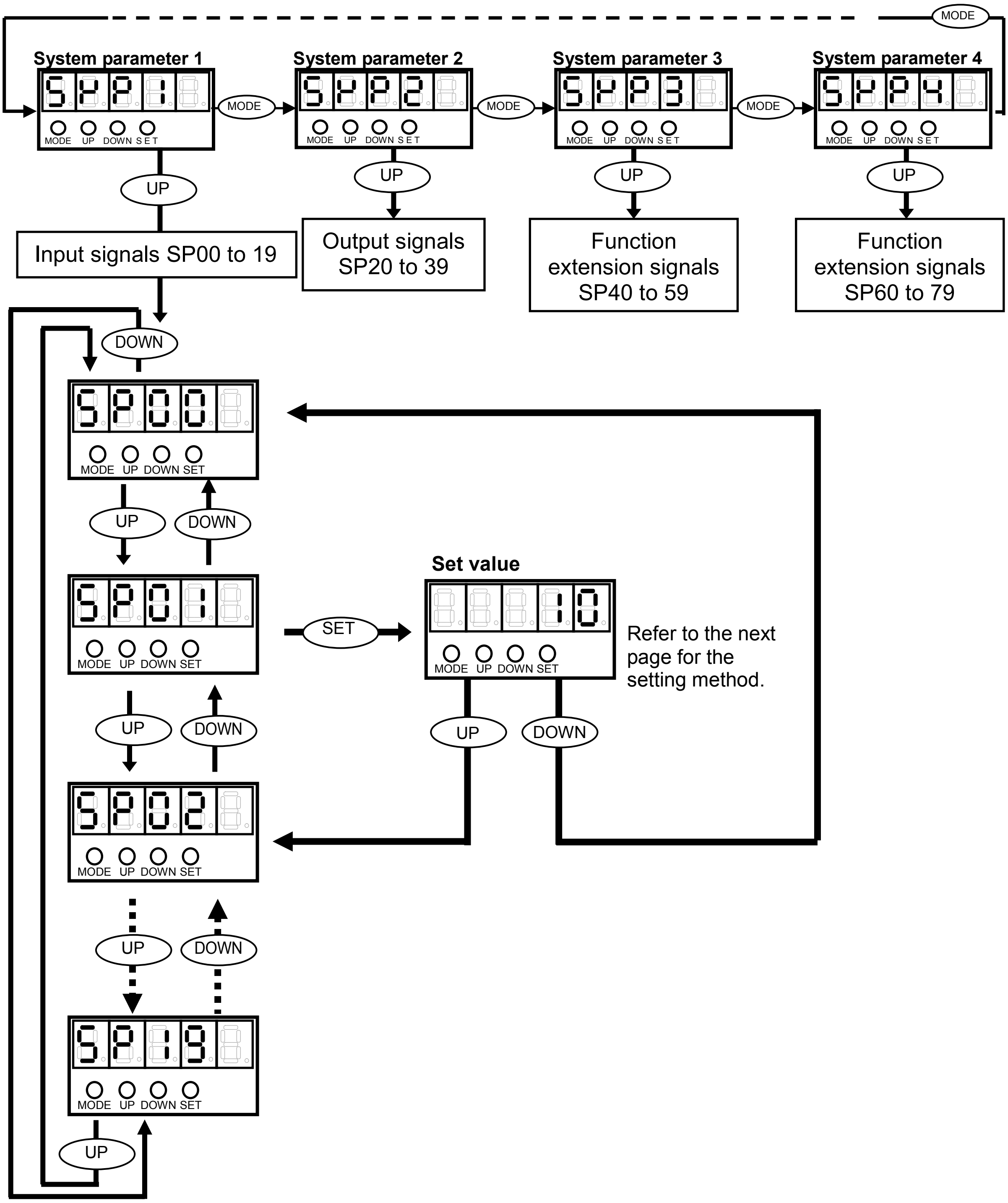
Panel display and operation

Operation outline of system parameter mode

An overview of operations in the system parameter mode is shown below.
To prevent malfunction, a button is recognized as enabled when it has been pressed for at least 0.1 second and 1 second or less.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

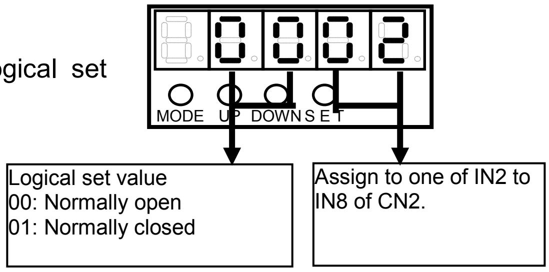


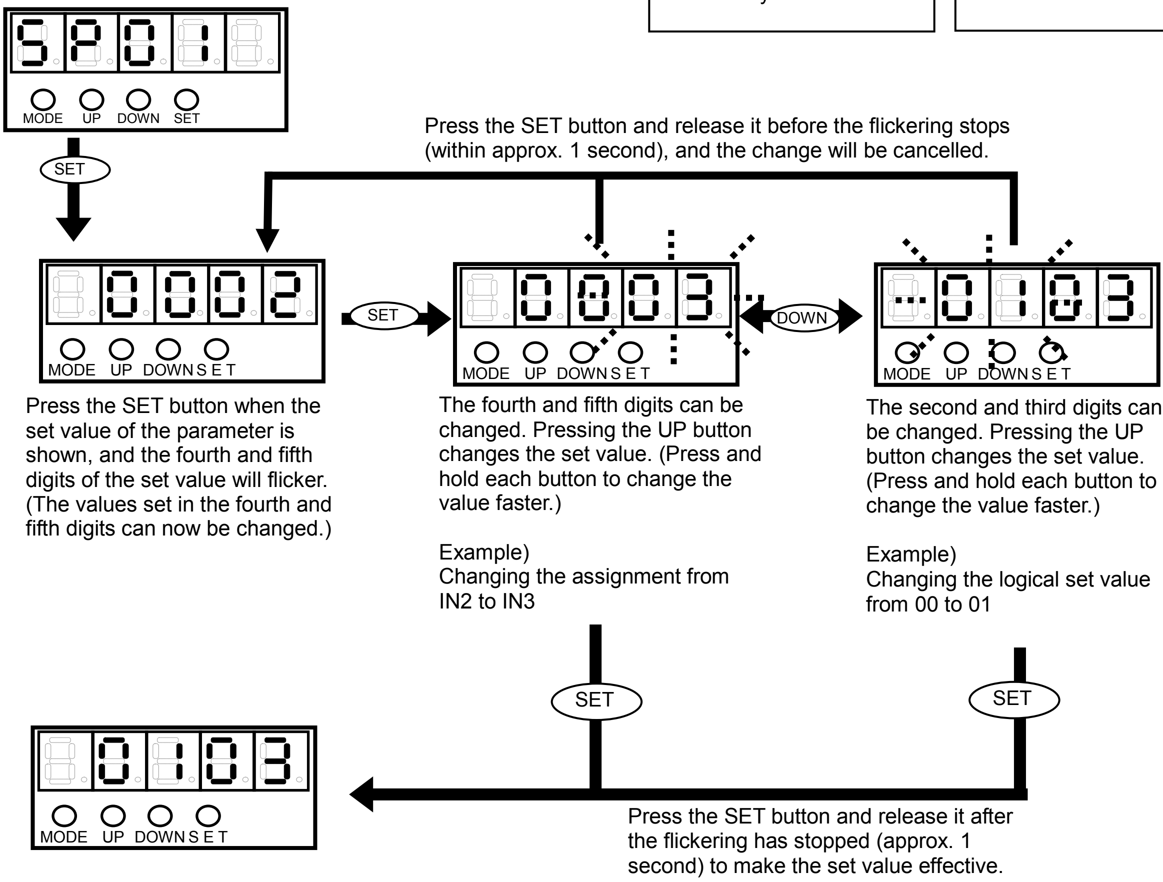
How to set input signals (SP00 to 16)

* For details on input signals, refer to P5-9.

Example) Setting [SP01: Reset input setting]

Change the input signal from IN2 to 3 and logical set value from 00 to 01.





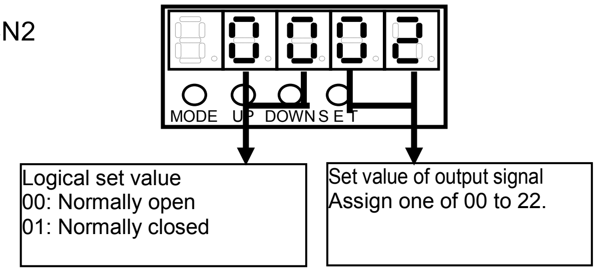
How to set output signals (SP20 to 26)

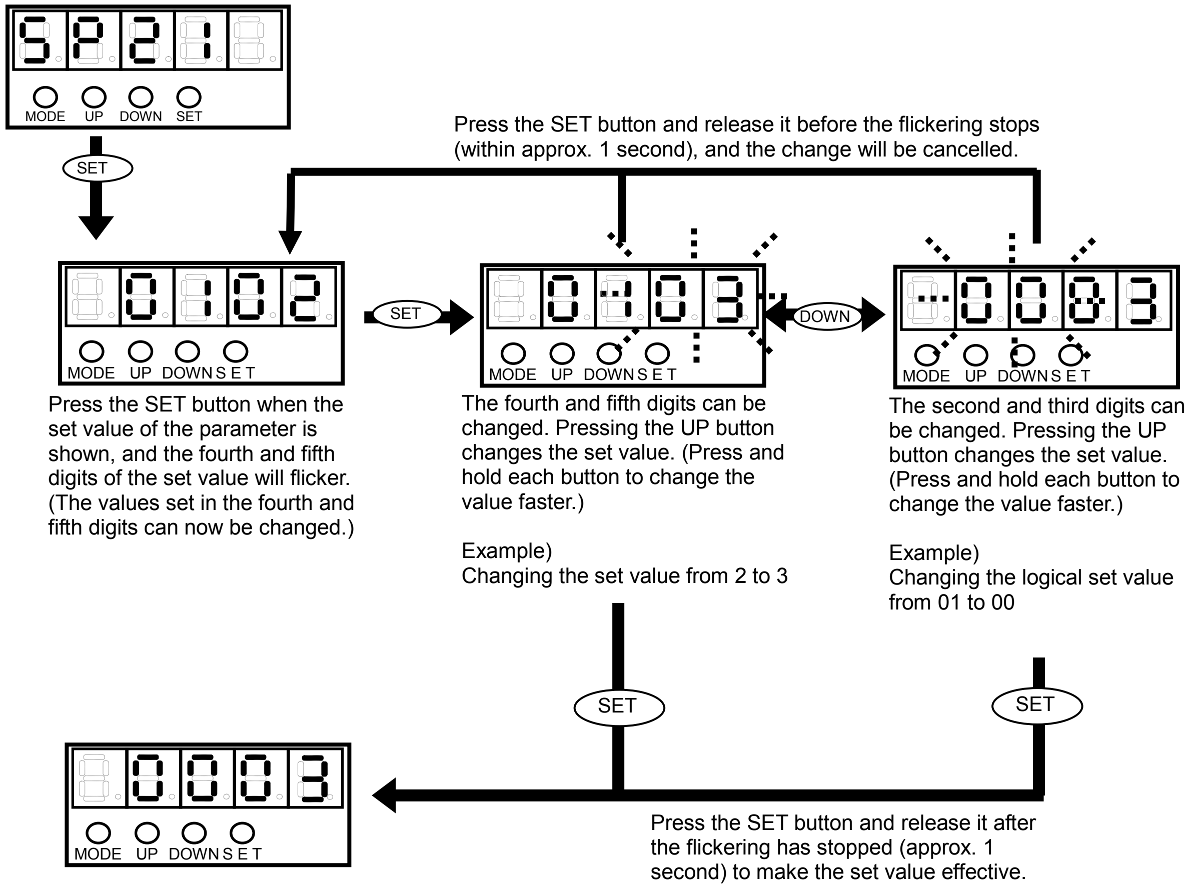
* For details on output signals, refer to P5-26.

Example) Assigning [03: Alarm output] to pin 17 of CN2

Logic circuit setting 01→00

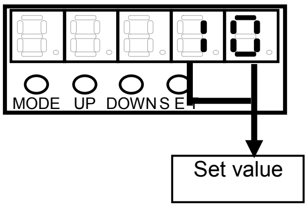
Set value of output signal 02→03

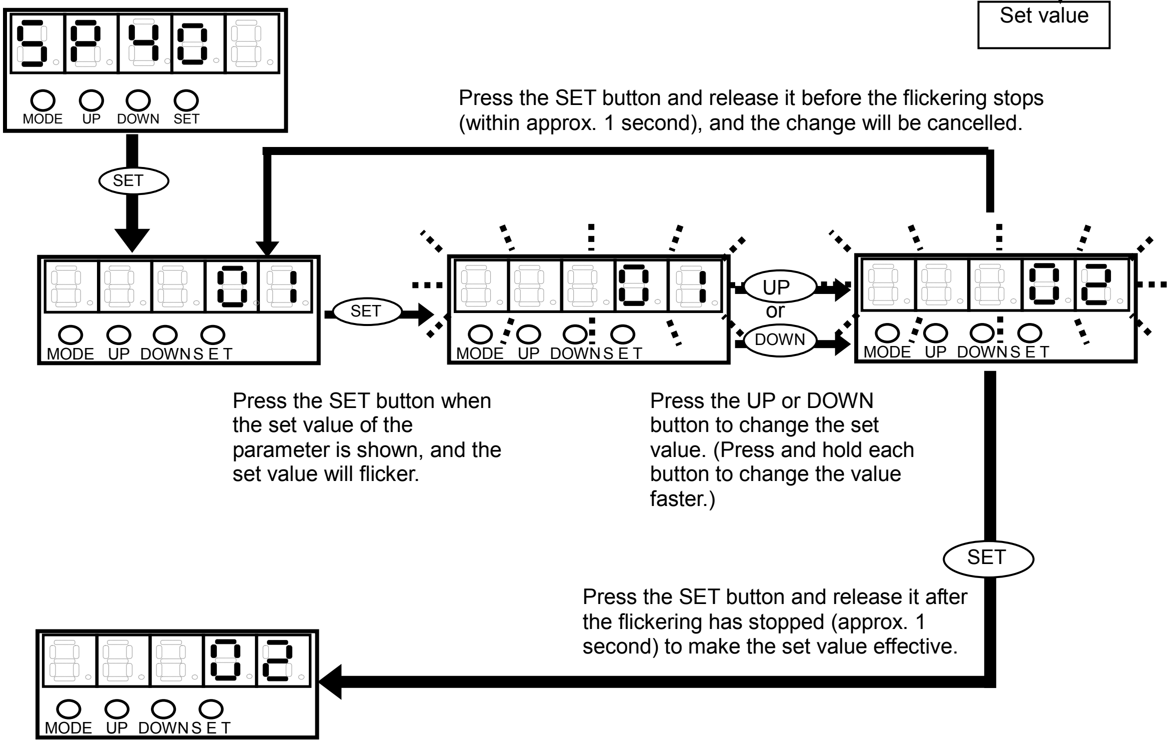




How to set function extension signals (SP**)

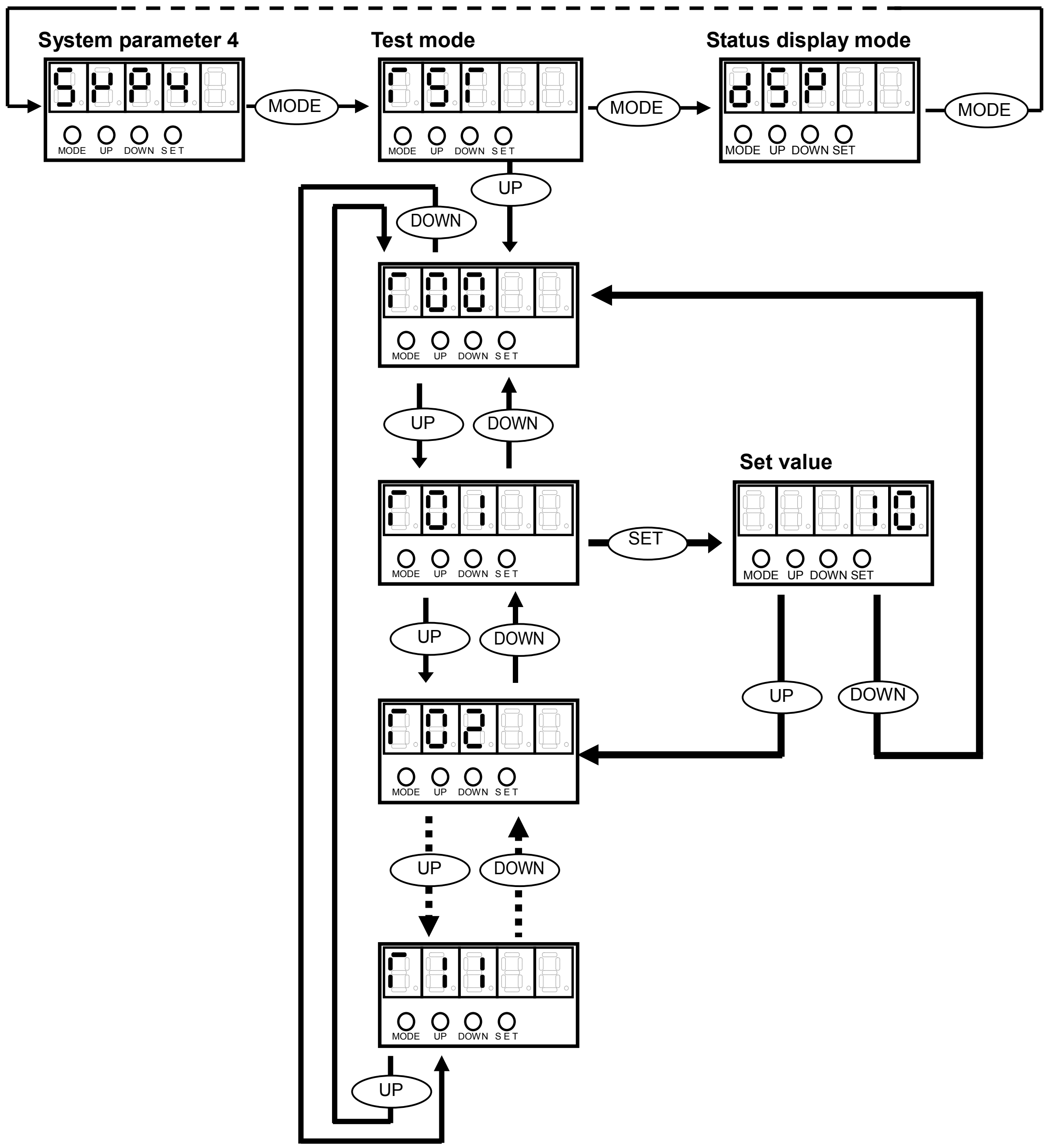
Example) Changing [SP40: CN9-CP3 output signal setting] to 2





Operation outline of test mode

An overview of operations in the test mode is shown below.
To prevent malfunction, a button is recognized as enabled when it has been pressed for at least 0.1 second and 1 second or less.
* For details on test mode, refer to [Chapter 9 Test mode].



Chapter 7

Status display mode/alarm mode/tune mode

This chapter explains information displayed in the status display mode and alarm mode. Operations and details of servo loop gains, various judgment criteria and acceleration/deceleration time setting during speed control performed in the tune mode are explained.

7-1 Status display mode

In the status display mode, position/speed commands to the driver, current position information from the motor/encoder, condition of cumulative pulses in the deviation counter, I/O signal statuses, load condition and code number of the actuator to be combined are shown, among others. These items help diagnose errors and troubles.

Status display mode list

If the driver is normal when the power supply is turned ON, [d00: Motor rotation speed indication] is shown.(Default setting)
To change the displayed items, set desired items by referring to [SP54: Status display setting] (P8-10).

Mode No.	Name	Description	Default	Unit	Details
d00	Motor rotation speed indication	The current rotation speed of the motor shaft is shown. The rotation speed of the actuator's output shaft is obtained by dividing the displayed value by the reduction ratio of the actuator. Rotation direction signal None: FWD - : REV	--	r/min	--
d01	Error pulse count display (Low)	The number of error pulses in position control is shown. Deviation direction symbol None: Deviation in REV rotation - : Deviation in FWD rotation	--	pulse	P7-3
d02	Error pulse count display (High)				
d03	Output torque monitor	The value of the output torque currently generated by the actuator is shown. 100% indicates the specified maximum output torque of the actuator. Torque direction symbol None: FWD torque - : REV torque	--	%	--
d04	Overload rate display	Current overload status of the actuator is shown.	--	%	
d05	Feedback pulse display (Low)	The encoder feedback pulses are shown. Absolute encoder: The current encoder value is shown. Incremental encoder: Cumulative feedback pulses since the power ON, multiplied by 4	--	pulse	P7-5
d06	Feedback pulse display (High)				
d07	Command pulse display (Low)	Command pulses to the driver are shown. Absolute encoder: Current encoder value upon power ON, plus command pulses: Incremental encoder Cumulative command pulses since the power ON corresponding to 0 pulses	--	pulse	P7-5
d08	Command pulse display (High)				
d09	Command pulse frequency display	The command pulse frequency input to the command pulse input port is shown.	--	kHz	--
d10	Main circuit power voltage	The rectified main circuit power voltage is shown.	--	V	--
d11	Speed command voltage	The speed command input voltage currently input to the driver is shown.	--	V	P7-6
d12	Torque command voltage	The torque command input voltage currently input to the driver is shown.	--	V	P7-6
d13	Applicable actuator code	The actuator code number is shown.	--	--	P7-7

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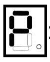
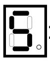
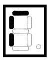
Status display mode/alarm mode/tune mode

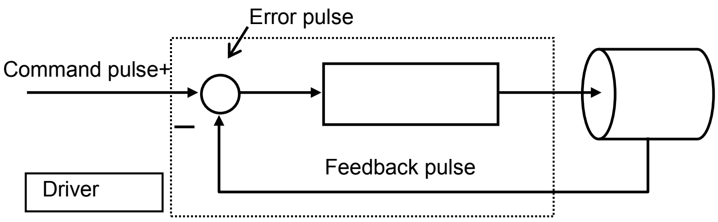
Mode No.	Name	Description	Default	Unit	Details
d14	Control mode	The current control mode is shown. : Position control : Speed control : Torque control	--	--	--
d15	Discharge time	An approximate total power ON time is shown. 0 to 99,999	--	h	--
d16	Regenerative power (HA-800-24 only)	It indicates absorbed power of regenerative resistor as percentage.	--	%	P7-8

7-2 Details of status display mode

The following explains details of the status display mode. Detailed explanations for simple items are omitted. Refer to the [Status display mode list] (P7-1).

d01, 02: Error pulse count display

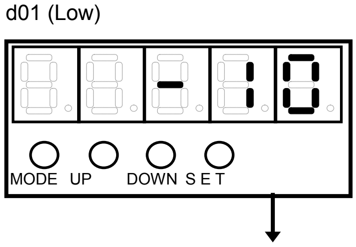
The deviation between command pulses and feedback pulses during position control is shown.d01 indicates the lower 4 digits, while d02 indicates the upper 4 digits.
The driver continues to output a rotation command until there is no longer difference (error pulse) between the feedback pulses fed back from the encoder and command pulses output to the actuator.



7

d01 indicates the lower 4 digits, while d02 indicates the upper 4 digits.

Display example)



The lower 4 digits of the error pulse (multiplied by 4) are shown.
Unit: Pulse (Example) = -10 pulses

Relational items	d05, d06, d07, d08

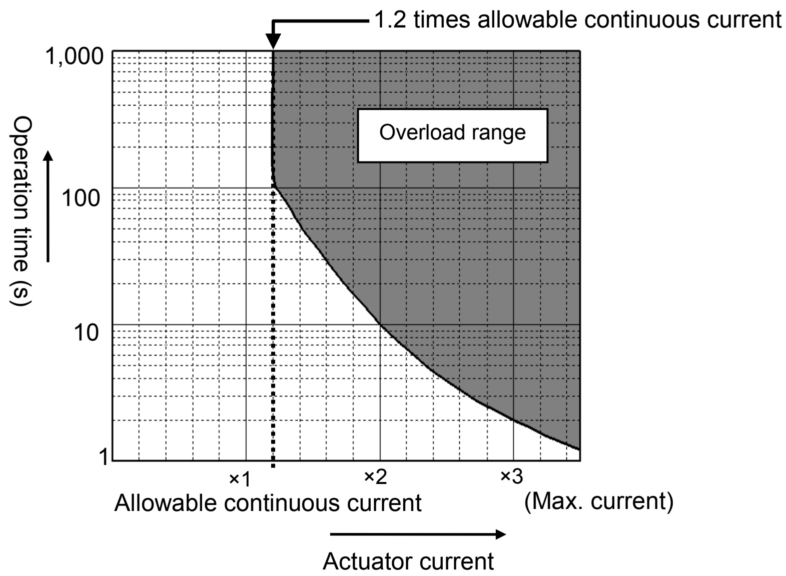
d04: Overload rate display

The current overload status of the actuator (unit: %) is shown.
If the value reaches 100, the overload protective function shuts off the motor current and simultaneously [AL20: Overload] is displayed.
When you want to set a higher servo gain to shorten the positioning period, the higher servo gain is permitted if the overload rate remains 0 after the actual operation.
In addition, a system with a greater inertia can also be used as long as the overload rate remains 0.
If the overload rate gradually increases, on the other hand, the servo gain must be decreased or other measures are required.

The driver always monitors the actuator current for the detection of overload rate, and if the current and its discharge time exceed the curve shown below, an overload alarm generates.

Example)

Current at least 1.2 times the allowable continuous current of the actuator has been supplied for an extended period of time.
Current at least 3 times the allowable continuous current of the actuator has been supplied for approx. 2 seconds.



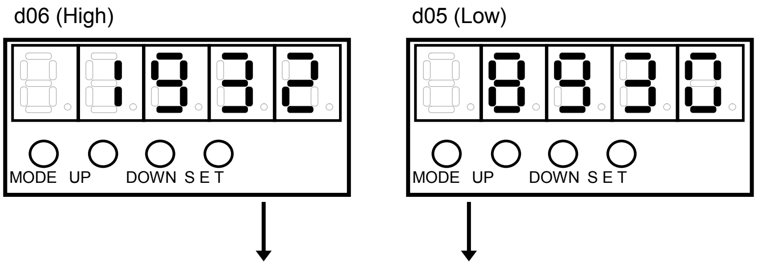
d05, 06: Feedback pulse display

Feedback pulses from the encoder are shown.

- Absolute encoder: The current encoder value is shown.
- Incremental encoder: Cumulative feedback pulses since the power ON, multiplied by 4

d05 indicates the lower 4 digits, while d06 indicates the upper 4 digits.

Display example)



Feedback pulse: [19328930] is shown.

Display range: 0 to ±99999999
When the feedback pulses increase to a 9-digit figure, the highest digit is ignored and only the lower 8 digits are shown.

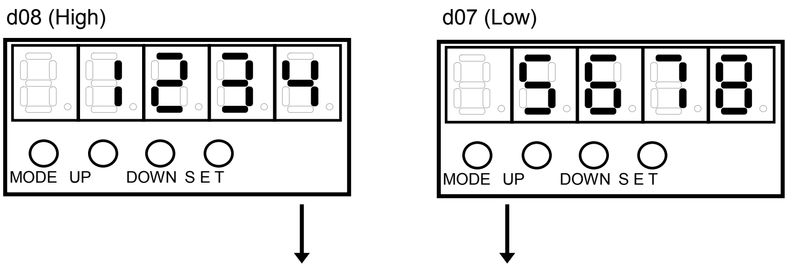
d07, 08: Command pulse display

The command pulse value input to the driver is shown.

- Absolute encoder: Current encoder value at the power ON, plus command pulses
- Incremental encoder: 0 at the power ON, plus command pulses

d07 indicates the lower 4 digits, while d08 indicates the upper 4 digits.

Display example)



Command pulse: [12345678] is shown.

Display range: 0 to ±99999999
When the command pulses increase to a 9-digit figure, the highest digit is ignored and only the lower 8 digits are shown.

Relational items	d01, d02, d05, d06

d11: Speed command voltage

The speed command input voltage (unit: V) currently input to the driver is shown.
The speed command input voltage and motor rotation speed are associated by the parameter [SP51: Speed input factor].
The actuator's output shaft rotation speed is obtained by dividing motor rotation speed by the reduction ratio of the actuator. In other words, the actuator's output shaft rotation speed is obtained by the following formula:

$$\text{Output shaft revolution} = \frac{\text{Speed input factor}}{\text{Reduction ratio}} \times \frac{\text{Speed command input voltage}}{10}$$

In actual operation, the actuator may move slightly even when the speed command voltage is 0, instead of remaining standstill, depending on the offset voltage. In this condition, adjust [AJ14: Speed command offset] in the tune mode or [T06: Speed command auto-offset] in the test mode.

Relational items	SP32, AJ14, T06

d12: Torque command voltage

The torque command input voltage (unit: V) currently input to the driver is shown.
The torque command input voltage and actuator output torque are associated according to the value set in [SP53: Torque input factor] parameter.

$$\text{Output torque} = \text{Torque command input factor} \times \frac{\text{Torque command input voltage}}{10}$$

In actual operation, the actuator may generate a slight torque even when the torque command voltage is 0, depending on the offset voltage. In this condition, adjust [AJ15: Torque command offset] in the tune mode or [T07: Torque command auto-offset] in the test mode.

Relational items	SP53, AJ15, T07

d13: Applicable actuator code

The actuator applicable to this driver is indicated by a code number.
The relationship of code numbers and actuators is as follows:

Codes of SHA series actuators

Encoder		Absolute					
Voltage specification	Reduction ratio	1/11	1/51	1/81	1/101	1/121	1/161
200 V	SHA20AxxxSG	-	5311	5321	5331	5341	5351
	SHA25AxxxSG/HP	5801	5011	5021	5031	5041	5051
	SHA32AxxxSG/HP	5811	5111	5121	5131	5141	5151
	SHA40AxxxSG	-	5211	5221	5231	5241	5251
	SHA58AxxxSG	-	-	5421	5431	5441	5451
	SHA65AxxxSG	-	-	5521	5531	5541	5551
100V	SHA25AxxxSG	-	5611	5621	5631	5641	5651

Encoder		Absolute				
Voltage specification	Reduction ratio	1/50	1/80	1/100	1/120	1/160
200 V	SHA25AxxxCG	8011	8021	8031	8041	8051
	SHA32AxxxCG	8111	8121	8131	8141	8151
	SHA40AxxxCG	8211	8221	8231	8241	8251
	SHA58AxxxCG	-	8321	8331	8341	8351
	SHA65AxxxCG	-	8421	8431	8441	8451

Encoder		Output shaft single revolution absolute model				
Voltage specification	Reduction ratio	1/50	1/80	1/100	1/120	1/160
200 V	SHA25AxxxCG-S	8012	8022	8032	8042	8052
	SHA32AxxxCG-S	8112	8122	8132	8142	8152
	SHA40AxxxCG-S	8212	8222	8232	8242	8252
	SHA58AxxxCG-S	-	8322	8332	8342	8352
	SHA65AxxxCG-S	-	8422	8432	8442	8452

Codes of FHA-C and FHA-Cmini series actuators

Encoder		Incremental				Absolute		
Voltage specification	Reduction ratio	1/30	1/50	1/100	1/160	1/50	1/100	1/160
200V	FHA-8C	6204	6214	6234	-	-	-	-
	FHA-11C	6404	6414	6434	-	-	-	-
	FHA-14C	6604	6614	6634	-	-	-	-
	FHA-17C	-	5217	5237	5247	5218	5238	5248
	FHA-25C	-	5417	5437	5447	5418	5438	5448
	FHA-32C	-	5617	5637	5647	5618	5638	5648
	FHA-40C	-	5717	5737	5747	5718	5738	5748
100V	FHA-8C	6304	6314	6334	-	-	-	-
	FHA-11C	6504	6514	6534	-	-	-	-
	FHA-14C	6704	6714	6734	-	-	-	-
	FHA-17C	-	5117	5137	5147	5118	5138	5148
	FHA-25C	-	5317	5337	5347	5318	5338	5348
	FHA-32C	-	5517	5537	5547	5518	5538	5548

Codes of RSF series actuators

Encoder		Incremental	
Voltage specification	Reduction ratio	1/50	1/100
200V	RSF-17A	7365	7375
	RSF-20A	7465	7475
	RSF-25A	7575	7575
	RSF-32A	7665	7675

d16: Regenerative power (HA-800-24 only)

It indicates absorbed power of regenerative resistor as percentage (unit: %).
The value can be converted to absorbed power of resistor using the following formula.

$$\text{Regenerative resistor absorption power [W]} = 16000\text{[W]} \times \frac{\text{Motor display value [\%]}}{100\text{[\%]}}$$

* The regenerative power varies depending on input voltage, load conditions, and operation pattern. Take sufficient margin in evaluation tests of your systems.
* This status display function is available only for HA-800A-24. With the HA-800A-1, 3 and 6, the power absorbed by regenerative resistor is unrelated.

7-3 Alarm mode

In the alarm mode, present alarms and warnings as well as up to 8 most recent alarm histories and total operating hours when each alarm occurred are shown. The alarm history can also be cleared in this mode. The following items are shown in the alarm mode. Note, however, that warnings are not stored in the alarm history.

Alarm display

The following items are shown in the alarm mode:

<table>
<tr><th>Mode No.</th><th>Name</th><th>Description</th><th>Details</th></tr>
<tr><td>AL</td><td>Present alarm/warning display</td><td>The present alarm/warning is shown.</td><td>P7-10</td></tr>
<tr><td>A1</td><td>Alarm history 1 and time of occurrence</td><td rowspan="8">Alarm history is shown by a code number. When the SET button on the panel is pressed while the history is displayed, the total operating hours (unit: h) of the driver when the applicable alarm occurred is shown. Note that the total operating hours is approximate.</td><td rowspan="8">--</td></tr>
<tr><td>A2</td><td>Alarm history 2 and time of occurrence</td></tr>
<tr><td>A3</td><td>Alarm history 3 and time of occurrence</td></tr>
<tr><td>A4</td><td>Alarm history 4 and time of occurrence</td></tr>
<tr><td>A5</td><td>Alarm history 5 and time of occurrence</td></tr>
<tr><td>A6</td><td>Alarm history 6 and time of occurrence</td></tr>
<tr><td>A7</td><td>Alarm history 7 and time of occurrence</td></tr>
<tr><td>A8</td><td>Alarm history 8 and time of occurrence</td></tr>
<tr><td>AHcLr</td><td>Alarm history clear</td><td>The history of up to 8 most recent alarms is cleared.</td><td>P7-11</td></tr>
</table>

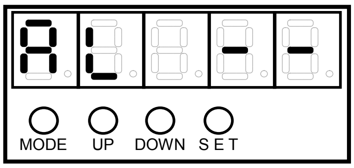
7-4 Alarm list

A list of alarms and warnings is shown.

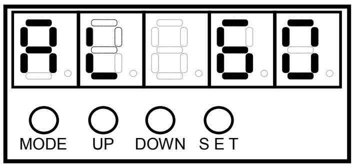
AL: Present alarm/warning display

The driver shows the code number of the present alarm/warning.
If multiple alarms (warnings) are output, all alarm (warning) codes are shown one by one at an interval of approx. 500 ms. If no alarm (warning) is present, [--] is shown.
Even when an alarm (warning) is output, you can still switch to a mode other than the alarm mode and display various parameters and status data.

Display when no alarm is present



Display when an alarm is present



Example) An error counter overflow alarm is present.

The relationship of displayed code numbers and alarms/warnings is shown below.
For details, refer to [Chapter 11 Troubleshooting].

Alarms

Code No.	Alarms	Code No.	Alarms	Code No.	Alarms
01	Emergency stop	46	Overheated dynamic brake*4	71	Memory failure (EEPROM)
10	Overspeed	47	Damaged power circuit	76	FPGA configuration error
20	Overload	50	Encoder disconnection	73	FPGA setting error
30	IPM error (overcurrent)	51	Encoder receiving error*1, *2	76	Processor error
40	Overvoltage	52	UVW error*1	81	System failure*3
41	Regenerative resistor overheat	53	System failure*2	82	Single rotation data error*3
42	Overregeneration*4	54	Multi revolution overflow*2	83	Multi revolution data error*3
43	Missing phase*4	55	Multi revolution data error*2	84	BUSY error*3
44	Control power supply low*4	60	Error counter overflow	85	Overheat error*3
45	Main circuit voltage low*4	70	Memory failure (RAM)	86	Communication error*3

*1: Displayed only when an incremental encoder is used.
*2: Displayed only when a 13-bit absolute encoder is used.
*3: Displayed only when a 17-bit absolute encoder is used (including 17-bit encoder incremental model)
*4: Displayed HA-800A-24 only.

Warning

Code No.	Alarms	Code No.	Alarms	Code No.	Alarms
90	Overload status	93	Main circuit voltage low	99	Wrong actuator
91	Battery voltage low	97	FWD inhibit input effective		
92	Cooling fan stopped	98	REV inhibit input effective		

AHcLr: Alarm history clear

The history of up to 8 most recent alarms stored in the driver is cleared.

1 **Press the SET button when [AHcLr] is displayed.**

[AHcLr] flickers.

2 **Press the SET button again.**

The alarm history is cleared and flickering of [AHcLr] stops and becomes lit.
To not clear the alarm history, pressing the UP or DOWN button cancels the alarm history clear, after which the content of A8 or AL is displayed.

7-5 Tune mode

You can read and change parameters relating to actuator operations.
The following items can be changed.

Mode	Code	Parameters	Default	Details
Tune mode 1	AJ00	Position loop gain	*1	P7-13
	AJ01	Speed loop gain	*1	P7-13
	AJ02	Speed loop integral compensation	*1	P7-14
	AJ03	Feed-forward gain	0	P7-14
	AJ04	In-position range	*1	P7-14
	AJ05	Attained speed judgment value	2000	P7-15
	AJ06	Attained torque judgment value	50	P7-15
	AJ07	Zero speed judgment value	10	P7-15
	AJ08	Internal speed command 1	500	P7-16
	AJ09	Internal speed command 2	1000	P7-16
	AJ10	Internal speed command 3	1500	P7-16
	AJ11	Torque limit	100	P7-16
	AJ12	Acceleration time constant	1	P7-17
	AJ13	Deceleration time constant	1	P7-17
	AJ14	External speed command offset	0	P7-18
	AJ15	External torque command offset	0	P7-18
	AJ16	Speed monitor offset	*2	P7-18
	AJ17	Current monitor offset	*2	P7-18
	AJ18	System reservation *3	--	--
	AJ19	System reservation *3	--	--
Tune mode 2	AJ20	Feed-forward filter	1	P7-19
	AJ21	Load inertia moment ratio	100	P7-19
	AJ22	Torque constant compensation factor	100	P7-19
	AJ23	Spring constant compensation factor	100	P7-20
	AJ24	Positioning Automatic Gain	0	P7-20
	AJ25 to 39	System reservation *3	--	--
Tune mode 3	AJ40 to 59	System reservation *3	--	--

*1: It varies depending on the applicable actuator.
Refer to the values of applicable actuator that are the targets of Appendix 1 [Default settings].
*2: It varies depending on the driver.
*3: Do not change the parameters that are in the system reserved areas. The default setting of the system reservation may vary depending on the model/version. If the set values change when the parameters are transferred between different models, it does not affect the product functions.
To perform the data comparison with the backed up parameter files or writing the backed up parameter files to the driver using PSF-800 communication software, refer to [10-5. Saving and reading set values].

7-6 Details of tune mode

The following explains the details of settings in the tune mode.

AJ00: Position loop gain

Adjust the proportional gain of the position feedback loop.
The relation between the set value and actuator operation is as follows:

- Increasing the set value: The position deviation decreases and following accuracy relative to the command increases, but setting too high a value makes the servo system unstable and prone to vibration (hunting).
- Decreasing the set value: Setting too low a value results in poor following accuracy relative to the command.

Set the highest gain within the limits of no vibration (hunting) and minimum overshoot.
Perform a trial operation with a higher servo gain to shorten the positioning period. If the value of [d04: Overload rate display] remains 0 in the status display mode after the actual operation, the higher servo gain can be used.

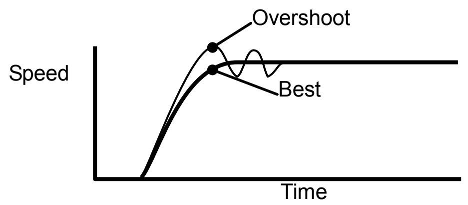
Set value	Function	Unit	Default
10 to 9999	Set the proportional gain of the position feedback loop.	-	*
Relational items	AJ01, AJ02, AJ03, d04		

*: The default varies depending on the applicable actuator. Refer to [Default settings] (PA-1) in the appendix.

AJ01: Speed loop gain

Adjust the proportional gain of the speed feedback loop.
The relation between the set value and actuator operation is as follows:

- Increasing the set value: Servo rigidity increases along with response, but setting too high a value makes the servo system unstable and prone to vibration (hunting) and overshoot.
- Decreasing the set value: Setting too low a value leads to poor response and following accuracy.



Set value	Function	Unit	Default
HA-800-1: 0.1 to 999.9 Except HA-800-1: 1 to 9999	Set the proportional gain of the speed feedback loop.	-	*
Relational items	AJ00, AJ02, AJ03		

*: The default varies depending on the applicable actuator. Refer to [Default settings] (PA-1) in the appendix.

7

Status display mode/alarm mode/tune mode

AJ02: Speed loop integral compensation

Set this parameter to reduce the speed fluctuation due to load fluctuation.
The relation between the set value and actuator operation is as follows:

- Increasing the set value: Vibration (hunting) is eliminated and response becomes slower upon load fluctuation.
- Decreasing the set value: Response upon load fluctuation increases, but setting too low a value causes vibration (hunting).

Set value	Function	Unit	Default
1 to 9999	Set the speed loop integral compensation value.	-	*
Relational items	AJ00, AJ01, AJ03		

*: The default varies depending on the applicable actuator. Refer to [Default settings] (PA-1) in the appendix.

AJ03: Feed-forward gain

Set this parameter to perform feed-forward control associated to reduce the delay relative to the command. Set 0, if feed-forward control is not performed.
The relation between the set value and actuator operation is as follows:

- Increasing the set value: Tendency of mechanical shock and vibration (hunting) increases.

Set value	Function	Unit	Default
0 to 100	Set the feed-forward gain.	-	0
Relational items	AJ20, AJ21, AJ22, AJ23, SP69		

Caution

- When using the feed-forward control function, be sure to reference [Applied servo gain adjustment function] (P3-17) and understand the notices.

AJ04: In-position range

Set the pulse condition for outputting an in-position output signal during position-controlled operation.
An in-position complete signal is output when the error pulse count (command pulses - feedback pulses) is inside the range of +in-position range to -in-position range. Output signals are assigned by SP20 to 26.(P6-10)
* The setting value of AJ04 is the encoder pulse units.

Set value	Function	Unit	Default
0 to 9999	Set the range in which to output an in-position output signal.	Pulse	*
Relational items	SP20 to 26		

*: The default varies depending on the applicable actuator. Refer to [Default settings] (PA-1) in the appendix.

AJ05: Attained speed judgment value

Set the speed condition for outputting an attained speed output signal.
An attained speed judgment signal is output when the actuator's motor shaft rotation speed rises to the attained speed judgment value or above. Output signals are assigned by SP20 to 26.(P6-10)

Set value	Function	Unit	Default
1 to 9999	Set the condition for outputting an attained speed output signal.	r/min	2000
Relational items	SP20 to 26		

AJ06: Attained torque judgment value

Set the torque condition for outputting an attained torque output signal.
An attained torque judgment signal is output when the actuator's output torque rises to the attained torque judgment value or above. Output signals are assigned by SP20 to 26.(P6-10)

Set value	Function	Unit	Default
1 to 100	Set the condition for outputting an attained torque output signal.	%	50
Relational items	SP20 to 26		

AJ07: Zero speed judgment value

A zero speed output signal is output when the actuator's motor shaft rotation speed drops to the zero speed judgment value or below. Output signals are assigned by SP20 to 26.(P6-10)

Set value	Function	Unit	Default
0 to 100	Set the zero speed judgment value.	r/min	10
Relational items	SP20 to 26		

Caution

- Switching from the position control mode to other control mode, or from other control mode to the position control mode, is prohibited unless a zero speed output signal is output.

AJ08 to 10: Internal speed command 1 to 3

Set the speed command for speed control without using any external speed command (analog voltage speed command). This function is useful when performing a trial run or diagnosing the system using the actuator alone. Set SP09 and SP10 to operate the actuator accordingly.(P5-12)
During position control, the value set here functions as the speed limit. During position control, the speed can be limited by the internal speed command input 1 or 2. Set SP11 and SP12 to execute the limit functions.(P5-13)

Set value	Function	Unit	Default
1 to maximum rotational speed of applicable actuator x Reduction ratio*	Set the internal speed command.	r/min	500/1000/1500
Relational items	SP09, SP10,SP11,SP12, SP20 to 26		

*: No negative values are allowed.

AJ11: Torque limit

During position control or speed control, the torque is limited to the set torque limit when the internal torque limit input is enabled. Set SP13 for internal torque limit input.(P5-14)

Set value	Function	Unit	Default
1 to 100	Set the torque limit.	%	100
Relational items	SP13, SP20 to 26		

Caution

- If torque is limited during position control, depending on the set torque limit the error pulses may increase and the actuator behavior may become unstable the moment the torque limit input is cancelled. Carefully set the torque limit to be applied during position control.

AJ12: Acceleration time constant

Set the time over which the actuator will accelerate from the standstill state to the value set in function extension mode parameter [SP51: Speed input factor] during speed control.

Set value	Function	Unit	Default
1 to 9999	Set the time over which to accelerate from the standstill state to [SP51: Speed input factor].	ms	1

Caution

- [AJ12: Acceleration time constant] and [AJ13: Deceleration time constant] are used during speed control. See below for details:
- When the speed command changes, the speed command in the driver will change based on this set value. Refer to the following for the conditions in which the acceleration time constant AJ12 and deceleration time constant AJ13 are applied.
  - External (Analog voltage) speed command change: [AJ12: Acceleration time constant]
  - Internal speed command change (Switch): [AJ12: Acceleration time constant]
  - Switching between external speed command and internal speed command: [AJ12: Acceleration time constant]
  - Speed command change when FWD enable SP05 or REV enable SP06 is enabled (Speed change from zero to FWD/REV rotation): [AJ12: Acceleration time constant]
  - Speed command change when FWD enable SP05 or REV enable SP06 is disabled (Speed change from FWD/REV rotation to zero speed): [AJ13: Deceleration time constant]

Operation example

(1) Input a FWD enable signal after a positive speed command has been input
⇒ The actuator operates according to the acceleration time constant.
(2) Input a negative speed command in the condition in (1)
⇒ The actuator operates according to the acceleration time constant.
(3) Change the speed command to 0V in the condition in (1)
⇒ The actuator operates according to the acceleration time constant.
(4) Also input a REV enable signal in the condition in (1)
⇒ The actuator operates according to the deceleration time constant.
(5) Turn the FWD enable signal OFF in the condition in (1)
⇒ The actuator operates according to the deceleration time constant.

AJ13: Deceleration time constant

Set the time over which the motor rpm will decelerate from the value set in system parameter [SP51: Speed input factor] to [0 r/min].For details, refer to [AJ12: Acceleration time constant].

Set value	Function	Unit	Default
1 to 9999	Set the time over which to decelerate to 0 r/min.	ms	1

AJ14: External speed command offset

During speed control, the motor may rotate slightly even when the input command voltage is set to 0V. This problem may occur when the external command input voltage has an offset of a few mV. External speed command offset is a function that absorbs this error to prevent slight rotation of the motor.
Set the input command voltage to 0V and change the offset value to find a value at which the motor stops.
Use [T06: Automatic adjustment of speed command offset] to adjust automatically. For details, refer to [T06: Speed command offset automatic adjustment] (P9-8).

Set value	Function	Unit	Default
-9999 to 9999	Set the offset value for input command voltage.	mV	0

AJ15: External torque command offset

During torque control, the motor may rotate slightly even when the input command voltage is set to 0V. This problem may occur when the external command input voltage has an offset of a few mV. External torque command offset is a function that absorbs this error to prevent slight rotation of the motor.
Set the input command voltage to 0V and change the offset value to find a value at which the motor stops.
Use [T07: Automatic adjustment of torque command offset] to adjust automatically. For details, refer to [T07: Torque command offset automatic adjustment] (P9-9).

Set value	Function	Unit	Default
-9999 to 9999	Set the offset value for input command voltage.	mV	0

AJ16: Speed monitor offset

Adjust the speed monitor output offset currently output to CN9.Though the speed monitor offset has been adjusted at the factory, readjust it if necessary. The adjustment range of -2048 to 2047 corresponds to -10 to +10V.
This offset value is not initialized with parameter initialization and the value is retained.

Set value	Function	Unit	Default
-2048 to 2047	Set the offset value for speed monitor output.	-	*

*: The default value varies depending on the driver.

AJ17: Current monitor offset

Adjust the current monitor output offset currently output to CN9. Though the current monitor offset has been adjusted at the factory, readjust it if necessary. The adjustment range of -2048 to 2047 corresponds to -10 to +10V.
This offset value is not initialized with parameter initialization and the value is retained.

Set value	Function	Unit	Default
-2048 to 2047	Set the offset value for current monitor output.	-	*

*: The default value varies depending on the driver.

AJ20: Feed-forward filter

Set the filter frequency to be used in feed-forward control.
Setting a higher value increases the response, but mechanical shock or vibration (hunting) will occur more easily if the value is too high. (Refer to [Applied servo gain adjustment function] (P3-18).)

Set value	Function	Unit	Default
1 to 2000	Set the filter frequency.	Hz	1
Relational items	AJ03, AJ21, AJ22, AJ23, SP69		

Caution

- When using the feed-forward control function, be sure to reference [Applied servo gain adjustment function] (P3-18) and understand the notices.

AJ21: Load inertia moment ratio

Set the load inertia moment ratio relative to self-inertia moment to be used in feed-forward control. Feed-forward control is performed based on the value set here. (Refer to [Applied servo gain adjustment function] (P3-18).)

Set value	Function	Unit	Default
1 to 1000	Sets the load inertia moment ratio.	%	100
Relational items	AJ03, AJ20, AJ22, AJ23, SP69		

Caution

- When using the feed-forward control function, be sure to reference [Applied servo gain adjustment function] (P3-18) and understand the notices.

AJ22: Torque constant compensation factor

Variation in the actuator torque constant used in feed-forward control is compensated for. Feed-forward control is performed based on the value set here. (Refer to [Applied servo gain adjustment function] (P3-18).)

Set value	Function	Unit	Default
1 to 200	Set the torque constant compensation factor for the actuator.	%	100
Relational items	AJ03, AJ20, AJ21, AJ23, SP69		

Caution

- When using the feed-forward control function, be sure to reference [Applied servo gain adjustment function] (P3-18) and understand the notices.

AJ23: Spring constant compensation factor

Variation in the actuator spring constant used in feed-forward control is compensated for. Feed-forward control is performed based on the value set here. (Refer to [Applied servo gain adjustment function] (P3-18).)

Set value	Function	Unit	Default
1 to 200	Set the spring constant compensation factor for the actuator.	%	100
Relational items	AJ03, AJ20, AJ21, AJ22, SP69		

Caution

- When using the feed-forward control function, be sure to reference [Applied servo gain adjustment function] (P3-18) and understand the notices.

AJ24: Positioning Automatic Gain

Can adjust set gain when "SP60: Positioning Automatic Gain Setting Enabled/Disabled" is enabled.

* Can be used with HA-800 software version 2.04 or later.

Set value	Function	Unit	Default
-50 to 100	Allows setting of positioning automatic gain increase/decrease.	%	0
Relational item	SP60		

Chapter 8

System parameter mode

Details of how to assign I/O signals and set their logics, as well as extended functions such as control mode selection, pulse input system selection and electronic gear setting, etc., are explained in this chapter.

8-1 System parameter mode

The following explains the parameters that can be operated/displayed in each operation mode.
The settable parameters are explained below. Detailed explanation on function extension parameters SP40 onward are explained in this chapter. For details on other system parameters, refer to [Chapter 5 I/O signals].

* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Mode	Code	Parameters	Mode	Code	Parameters
System parameter 1 (Input signals)	SP00	Emergency stop input setting	System parameter 3 (Function extension signals)	SP40	CP3 output signal setting
	SP01	Reset input setting		SP41	Control mode switching setting
	SP02	Clear input setting		SP42	Command pulse input pattern
	SP03	FWD inhibit input setting		SP43	Multiplication of 2-phase input
	SP04	REV inhibit input setting		SP44	Electronic gear 1 numerator
	SP05	FWD enable input setting		SP45	Electronic gear 1 denominator
	SP06	REV enable input setting		SP46	Electronic gear 2 numerator
	SP07	FWD selection input setting		SP47	Electronic gear 2 denominator
	SP08	REV selection input setting		SP48	Deviation clear upon servo-ON
	SP09	Internal speed command 1 input setting		SP49	Allowable position deviation
	SP10	Internal speed command 2 input setting		SP50	Command polarity
	SP11	Internal speed limit 1 input setting		SP51	Speed input factor
	SP12	Internal speed limit 2 input setting		SP52	Zero clamp
	SP13	Internal torque limit input setting		SP53	Torque input factor
	SP14	Electronic gear selection input setting		SP54	Status display setting
	SP15	Control mode selection input		SP55	DB enable/disable setting
	SP16	INHIBIT input setting		SP56	External speed limit enable/disable
	SP17	System reservation		SP57	External torque limit enable/disable
	SP18	System reservation		SP58	System reservation
	SP19	System reservation		SP59	Angle compensation enable/disable setting
System parameter 2 (Output signals)	SP20	CN2-pin 16: Signal assignment and function setting	System parameter 4 (Function extension signals)	SP60	Automatic positioning gain setting enable/disable setting
	SP21	CN2-pin 17: Signal assignment and function setting		SP61	Encoder monitor output pulses
	SP22	CN2-pin 18: Signal assignment and function setting		SP62	System reservation
	SP23	CN2-pin 19: Signal assignment and function setting		SP63	System reservation
	SP24	CN2-pin 20: Signal assignment and function setting		SP64	Regenerative resistor selection (HA-800-24 only)
	SP25	CN2-pin 21: Signal assignment and function setting		SP65	FWD/REV inhibit operation
	SP26	CN2-pin 22: Signal assignment and function setting		SP66	Absolute encoder function setting

Mode	Code	Parameters	Mode	Code	Parameters
	SP27 to SP39	System reservation		SP67	Output shaft divide function setting
				SP68	System reservation
				SP69	Feed-forward control function setting
				SP70 to SP79	System reservation

Do not change the parameters that are in the system reserved areas. The default setting of the system reservation may vary depending on the model/version. If the set values change when the parameters are transferred between different models, it does not affect the product functions.
To perform the data comparison with the backed up parameter files or writing the backed up parameter files to the driver using PSF-800 communication software, refer to [10-5. Saving and reading set values].

8-2 Function extension parameter

The function extension parameters SP40 onward are explained below. For details on other system parameters, refer to [Chapter 5 I/O signals].

Parameters No	Name	Default
SP40	CP9-CP3 output signal setting	00
SP41	Control mode switching setting	0
SP42	Command pulse input pattern setting	0
SP43	Multiplication of 2-phase input	1
SP44	Electronic gear 1 numerator	1
SP45	Electronic gear 1 denominator	1
SP46	Electronic gear 2 numerator	1
SP47	Electronic gear 2 denominator	1
SP48	Deviation clear upon servo-ON	1
SP49	Allowable position deviation	*1
SP50	Command polarity	0
SP51	Speed input factor	*1
SP52	Zero clamp	0
SP53	Torque input factor	100
SP54	Status display setting	d00
SP55	DB enable/disable setting	1
SP56	External speed limit enable/disable	0
SP57	External torque limit enable/disable	0
SP58	System reservation *3	-
SP59	Angle compensation enable/disable setting	0
SP60	Automatic positioning gain setting enable/disable setting	*1
SP61	Encoder monitor output pulses	*1
SP62 SP63	System reservation *3	-
SP64	Regenerative resistor selection (HA-800-24 only)	0
SP65	FWD/REV inhibit operation	0
SP66	Absolute encoder function setting	*4
SP67	Output shaft divide function setting	0
SP68	System reservation *3	-
SP69	Feed-forward control function setting	*1
SP70 to SP79	System reservation *3	-

*1: It varies depending on the applicable actuator. Refer to the values of applicable actuator that are the targets of Appendix 1 [Default settings].
*2: The system parameters (SP00 to 79) are enabled by reconnecting the control power supply after changing the setting.
*3: Do not change the parameters that are in the system reserved areas. The default setting of the system reservation may vary depending on the model/version. If the set values change when the parameters are transferred between different models, it does not affect the product functions. To perform the data comparison with the backed up parameter files or writing the backed up parameter files to the driver using PSF-800 communication software, refer to [10-5. Saving and reading set values].
*4: HA-800A-*D: SP66=0, HA-800A-*E: SP66=1

SP40: CN9-CP3 output signal setting

Set the monitor output signal to pin 3 of CN9.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Description	Default
01	Operation preparation complete	00
02	Alarm output	
03	In-position output	
04	Attained speed output	
05	Attained torque output	
06	Zero speed output	
07	Control mode output	

SP41: Control mode switching setting

You can switch between 2 control modes among position control, speed control and torque control.
The control mode to switch to is determined according to the input signal for control mode selection CON-SEL.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Input signals Status of control mode selection input setting SP15		Default
	Enable	Disable	
0	Speed control	Position control	0
1	Torque control	Position control	
2	Torque control	Speed control	

Caution

- Switching from the position control mode to another mode or from another control mode to the position control mode is prohibited unless the motor rpm is equal to or below the value set in [AJ07 zero speed judgment value].
  The zero speed judgment function can be assigned to an output signal of CN2 via a system parameter.

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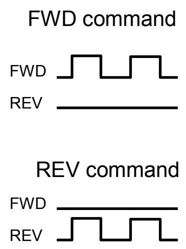
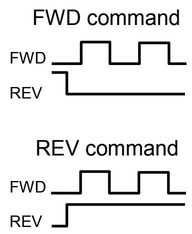
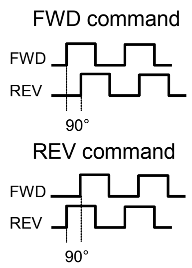
System parameter mode

SP42: Command pulse input pattern setting

Set the command pulse input method to be used during position control.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Input pattern	FWD (Forward command pulse signal) CN2-27, 28	REV (Reverse command pulse signal) CN2-29, 30	Default
0		Forward	Reverse	0
1		Pulse input	Polarity	
2		Phase A	Phase B	

SP43: Multiplication of 2-phase input setting

When the set value in [SP42: Command pulse input pattern setting] is [2: 2-phase pulse input], the input signals can be multiplied to double or quadruple the movement pulses for each original input signal pulse.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Default
1	Movement pulses are the same as input pulses.	1
2	Movement pulses are doubled.	
3	Movement pulses are quadrupled.	
4	Movement pulses are quadrupled.	

SP44 to 47: Electronic gear setting

This can be set to make the displacement of the driven actuator mechanism per input pulse an integer. Use [SP14: Electronic gear selection input] to select electronic gear 1 or 2.
With the SHA-CG series, electronic gear selection is enabled when [SP67: Output shaft divide function setting] is 0 (default value).For details, refer to [SP67: Output shaft divide function setting] (P8-13).

Rotary operation

$$\frac{\text{Electronic gear numerator 1(SP44)}}{\text{Electronic gear denominator 1(SP45)}} = \frac{\text{Travel angle per input pulse}}{\text{Reduction ratio of load mechanism}} \times \text{Actuator resolution} \times \frac{1}{360}$$

Linear operation

$$\frac{\text{Electronic gear numerator 1(SP44)}}{\text{Electronic gear denominator 1(SP45)}} = \frac{\text{Travel distance per input pulse}}{\text{Feed pitch of load mechanism}} \times \text{Actuator resolution} \times 1$$

Set integers for both the denominator and numerator based on this formula: Electronic gear numerator 2 (SP46)/electronic gear denominator 2 (SP47) shall also conform to the above formula.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Parameter No.	Name	Set value	Default
44	Electronic gear 1 numerator	1 to 9999	1
45	Electronic gear 1 denominator		
46	Electronic gear 2 numerator		
47	Electronic gear 2 denominator		

The electronic gear is a function that sets and changes the amount the actuator rotates for 1 operation command pulse from the host device. In the factory status, the actuator output shaft rotates through single revolution when the number of pulses for the output shaft resolution (depends on the actuator) is input.

Ex） To set FHA-25C-100-E250 (output shaft resolution: 1000000 pls/r) to 360,000 pls/r (0.001 deg/pulse)

$$\frac{\text{1000000 (actuator resolution)}}{\text{360000 (resolution)}} = \frac{25}{9}$$

If [SP44: Electronic gear 1 numerator] is set to [25] and [SP45: Electronic gear 1 denominator] is set to [9], the FHA-25C-100-E250 resolution can be used treated as [360,000 pls/r].

Also, set the output shaft rotation speed referencing command pulse frequency [Hz] = output shaft rotation speed [r/min]/60 x number of output shaft divisions.

The permitted command pulse input frequency on the HA-800A is 1 MHz (for the line collector type; 200 kHz for the open collector type), so the max. motor rpm is restricted to max. motor rpm [r/min] = 1 x 106 / encoder resolution 217 x 60 x electronic gear ratio.

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System parameter mode

SP48: Deviation clear upon servo-ON setting

The deviation can be reset to 0 when the servo-ON signal is input. However, the position deviation data stored when the servo-ON input was OFF may be lost and the actuator may not return to its original position.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Default
0	When the servo is turned ON while there is a deviation, the actuator will move by the deviation.	1
1	Clear the deviation to zero before turning ON the servo.	

CAUTION

When 0 is set and the control circuit power remains input even while the servo ON input is OFF, position error pulses will generate if the stopped position of the load mechanism moves due to gravity, human force, etc. If the servo-ON input is turned ON in this condition, the actuator will move at the maximum current to make this error pulse count to 0. Accordingly, the facility may be damaged.

SP49: Allowable position deviation

Set the allowable value of position deviation. If a deviation exceeding this value is generated, [AL60: Excessive deviation] is generated and the servo will be turned OFF.
* The setting value of SP49 is the encoder pulse units.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Description	Unit	Default
1 to 9999	Allowable value of position deviation	x 1,000 pulses	*

*: The default varies depending on the applicable actuator. Refer to [Default settings] (PA-1) in the appendix.

SP50: Command polarity

This sets the actuator rotation direction when an operation command (pulse command, speed command, torque command) is given.
This parameter affects the commands and monitoring that use pulse commands and analog voltage commands. It does not affect test operation and other operations performed from the PSF-800 or HA-800A panel.
It is also possible to reverse not only the rotation directions, but also the system coordinate directions, including forward/reverse inhibit signals, monitoring polarities, etc.
* Coordinate direction reversing (SP50=2) is available for HA-800 software version 3.x or later.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Default
0	Do not reverse the rotation direction. Rotates forward (clockwise rotation) with forward (FWD) command	0
1	Reverse the rotation direction. Rotates in reverse (counter-clockwise rotation) with forward (FWD) command.	
2*	Reverse the coordinate direction. Rotates in reverse (counter-clockwise rotation) with forward (FWD) command.	

*: With the SHA-SG/HP series, rotation is in the opposite directions from those above.

The following shows the range affected by command polarity.

○: Affected by SP50 setting x: Not affected by SP50 setting

Input signals	SP50 1	SP50 2
SP03: FWD inhibit	×	○
SP04: REV inhibit	×	○
SP05: FWD enable	○	○
SP06: REV enable	○	○
SP07: FWD selection	○	○
SP08: REV selection	○	○
Pulse command pulse	○	○
Speed command input	○	○
Torque command input	○	○

Output signals	SP50 1	SP50 2
FWD inhibit input in effect	×	×
REV inhibit input in effect	×	×
Current value data output *1	×	○
Encoder monitor *2	×	×
13bitABS Current value data output *3	×	×
Analog speed monitor	×	×
Analog current monitor	×	×

Display panel	SP50 1	SP50 2
T04: JOG operation	×	×
T09: Auto-tuning	○	○
d00: Motor rpm	×	×
d01,02: Error pulse	×	×
d03: Output torque	×	×
d05,06: Feedback pulse	×	×
d07,08: Command pulse	×	×
d11: Speed command voltage	×	×
d12: Torque command voltage	×	×

PSF-800	SP50 1	SP50 2
JOG operation	×	×
Program operation	×	×
Auto-tuning	○	○
Status display Motor rotation speed	×	×
Status display Torque	×	×
Status display Feedback pulse	×	×
Status display Command pulse	×	×
Status display Error pulse	×	×
Waveform monitoring Feedback speed	×	×
Waveform monitoring Command speed	×	×
Waveform monitoring Error pulse	×	×

*1: Refer to [Outputting the current value data from the pins CN2-40 and 41] (P4-9).
*2: Refer to [Encoder phase A, B and Z signal outputs] (P4-11) (P4-21) (P4-28)
*3: For details, refer to [Outputting the current value data from the pins CN2-42 to 47 (HA-655 driver mode)] (P4-19).

SP51: Speed input factor setting

Set the motor rotation speed to be applied during speed control when the input voltage set in [CN2-31 speed command input] is 10V.The relationship of input voltage and motor rotation speed is determined by the following formula based on this factor:

$$\text{Motor rotation speed r/min} = \text{Input command voltage V} \times \frac{\text{Speed input factor}}{10.0\text{V}}$$

The voltage obtained by the following formula is output for [CN9-1 speed monitor output]:

$$\text{Speed monitor output voltage V} = \text{Rotation speed r/min} \times \frac{10.0\text{V}}{\text{Speed input factor}}$$

* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Unit	Default
1 to maximum motor rotation speed	Set the speed input factor.	r/min	*

*: The default varies depending on the applicable actuator. Refer to [Default settings] (PA-1) in the appendix.

SP52: Zero clamp

This function forcibly stops the actuator rotation by switching to the position control mode when the FWD enable and REV enable signals are both ON or both OFF during speed control.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Default
0	Disable	0
1	Enable	

SP53: Torque input factor setting

Set the motor output torque to be applied during torque control when the input voltage set by the torque command input (CN2-33) is 10V.The relationship of input voltage and motor output torque is determined by the following formula based on this factor:

$$\text{Motor output torque \%} = \text{Input command voltage V} \times \frac{\text{Torque input factor}}{10.0\text{V}}$$

100% = maximum current.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Unit	Default
1 to 100	Set the torque input factor.	%	100

SP54: Status display setting

Set what will be displayed in the status display mode after the control power supply is turned ON.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Default
d00 to d16 (0 to 16)	Status display mode number to be displayed	d00 (0)

The set values in the parenthesis are for when using PSF-800.

SP55: DB enable/disable setting

Set whether to enable or disable the dynamic brake.
Use this parameter for HA-800A-1, 3, and 6. In HA-800A-24, the dynamic brake operation is interlinked with the main circuit DC voltage. It is not possible to change the operation by the SP55 setting. Use HA-800A-24 by setting SP55 = 1.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Default
0	Disable	1
1	Enable	

SP56: External speed limit enable/disable

When the actuator is operating in the position control mode, set this parameter to limit the speed according to the command voltage currently input to the external speed command input (pin 31 of CN2). The relationship of voltage and speed conforms to the value set in [SP51: Speed input factor].
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Default
0	Disable	0
1	Enable	

SP57: External torque limit enable/disable

Set this parameter to limit torque according to the command voltage set by the external torque command input (pin 33 of CN2) during position control or speed control. The relationship between the command voltage and torque is set with [SP53: Torque input factor].
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Default
0	Disable	0
1	Enable	

SP59: Angle compensation enable/disable setting

Set the angle compensation to be applied when a FHA mini series (FHA-8C/11C/14C) driver is combined with the actuator.
This function analyzes the angle transmission error beforehand and compensates for this erroneous difference to improve uni-directional positional accuracy.
The function improves the uni-directional positioning accuracy by approx. 30% than the value without compensation. (30% is not a guaranteed value. The actual improvement rate is different depending on the actuator.)
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Default
0	Do not compensate	0
1	Compensate	

SP60: Automatic positioning gain setting enable/disable setting

The automatic gain setting function can be used during positioning when a FHA mini series (FHA-8C/11C/14C) driver is combined. This function automatically increases the speed loop gain when the error pulse count is small, to shorten the positioning period.
The speed command value of position loop is proportional to the error pulse and thus the positioning speed drops when the error pulse is small. In the case, response can be improved by raising the speed loop gain and increasing the current command value.
If the speed loop gain set in [AJ01: Speed loop gain] is greater than the automatically set value, the value set in AJ01 becomes effective.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Unit	Default
0	Do not set	-	*
1	Set		

*: The default varies depending on the applicable actuator. Refer to [Default settings] (PA-1) in the appendix.

SP61: Encoder monitor output pulses

Set the number of pulses to be output to the encoder monitor output terminal (CN2-42 to 48) per motor revolution when a 17-bit absolute encoder is combined.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Unit	Default
1 to 8192	Number of pulses output to the encoder monitor output terminal	Pulse	*

*: The default varies depending on the applicable actuator. Refer to [Default settings] (PA-1) in the appendix.

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System parameter mode

SP64: Regenerative resistor selection (HA-800-24 only)

Set this parameter on HA-800A-24 according to the connected regenerative resistor.
At our factory default, the wiring is set such that set value [0: Use a built-in regenerative resistor] as well as built-in regenerative resistors are used.

* Make sure to set the value to [0] if you use built-in regenerative resistors.
* Set the value to [1], if you use an external regenerative resistor because the circuit power is large.
* Do not use the set value [2]. (This setting is for maintenance purpose.)
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Unit	Default
0	Use built-in regenerative resistor	-	0
1	Use external regenerative resistor		
2	Setting prohibited		

SP65: FWD/REV inhibit operation

Set the operation for when FWD/REV inhibit is input during the position control and speed control.

* This is available for HA-800 software version 2.03 or later.
* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Set value	Function	Unit	Default
0	Does not generate the torque in the inhibited direction.	-	0
1	Stopped by locking the servo.		

SP66: Absolute encoder function setting

A 17-bit absolute encoder can be used as an incremental encoder. When using as an incremental encoder, the backup battery is not required.
For the actuator for the 17-bit encoder incremental model (combined with driver: HA-800A-*E), connect the backup battery and if SP66=0 is set, the encoder can be used as a 17-bit absolute encoder.

* This is available for HA-800 software version 3.x or later.
* Changes to system parameter settings (SP00 to 79) are put into effect by changing the setting, then turning control power supply OFF, then ON again.

Set value	Function	Unit	Default
0	Use as an absolute encoder.	-	*
1	Use as an incremental encoder.		

*: HA-800A-*D;SP66=0, HA-800A-*E;SP66=1

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System parameter mode

SP67: Output shaft divide function setting

When using for position control combined with an SHA-CG series unit, you can set the actuator resolution.
The corresponding electronic gear value is set automatically from the output shaft divide function setting and the applicable actuator.
For the operation commands and monitor signals affected by the output shaft divide function setting, see the table on the next page.
The electronic gear (selected with SP44/SP45, SP46/SP47, SP14) and the output shaft divide function cannot be combined. The electronic gear setting is only in effect when SP67=0.
Also, if you change the setting, the origin needs to be set again. Be sure to change the value before setting the origin. For details on the origin setting, refer to [Origin setting] (P4-8).

When the output shaft divide function is set, set the output shaft speed referencing command pulse frequency [Hz] = Output shaft speed [r/min]/60 x number of output shaft divisions.

Ex) With the SHA25A50CG (reduction ratio 50), to set SP67=2 and set the output shaft speed to 50 [r/min]

Command pulse frequency = 50 [r/min]/60 x 360000 = 300 [kHz]

* This is available for HA-800 software version 3.x or later.
* Changes to system parameter settings (SP00 to 79) are put into effect by changing the setting, then turning control power supply OFF, then ON again.

Set value	Function	Unit	Default
0	According to electronic gear settings (SP14, SP44/SP45, SP46/SP47)	-	0
1	Division of single output shaft rotation into 36,000 parts (equivalent to 0.01 degree resolution)		
2	Division of single output shaft rotation into 360,000 parts (equivalent to 0.001 degree resolution)		
3	Division of single output shaft rotation into 3,600,000 parts (equivalent to 0.0001 degree resolution)		

Caution

- [SP67: Output shaft divide function setting] is the function that sets the operation command resolution. It does not guarantee the precision of positioning on the output shaft. For details on the output shaft positioning precision, refer to [AC Servo Actuator SHA Series Manual].
- After setting the operation sequence on the host device, when [SP44-47: Electronic gear numerator/denominator] or [SP67: Output shaft divide function setting] is changed, the displacement, speed, and acceleration/deceleration time change a great deal from operations before the change, so always check and revise the operating data setting before operating.
- The output shaft divide function setting is achieved using the electronic gear function, so the speed setting and acceleration/deceleration and acceleration/deceleration time settings operate with multiples of the automatically set electronic gears. (For their values, refer to the table below.
- When 3,600,000 division (SP67=3) is used, the permitted command pulse input frequency on the HA-800A is 1 MHz (line collector type), so the max. motor rpm is restricted to max. motor rpm [r/min] = 1×10^6 / encoder resolution $2^{17} \times 60 \times$ electronic gear ratio.
  For the max. rotational speed for each speed reduction ratio, refer to the table below.

Reduction ratio	SP67=3	
	Output shaft max. rotational speed [r/min]	Max. motor rpm [r/min]
50	16.7	833.3
80		1333.3
100		1666.7
120		2000.0
160		2666.7

○: Affected by SP67 setting x: Not affected by SP67 setting

Input signals	
SP03: FWD inhibit	×
SP04: REV inhibit	×
SP05: FWD enable	×
SP06: REV enable	×
SP07: FWD selection	×
SP08: REV selection	×
Pulse command pulse	○
Speed command input	×
Torque command input	×

Display panel	
T04: JOG operation	×
T09: Auto-tuning	×
d00: Motor rpm	×
d01,02: Error pulse	×
d03: Output torque	×
d05,06: Feedback pulse	×
d07,08: Command pulse	×
d11: Speed command voltage	×
d12: Torque command voltage	×

PSF-800	
JOG operation	×
Program operation	×
Auto-tuning	×
Status display Motor rotation speed	×
Status display Torque	×
Status display Feedback pulse	×
Status display Command pulse	×
Status display Error pulse	×
Waveform monitoring Feedback speed	×
Waveform monitoring Command speed	×
Waveform monitoring Error pulse	×

Output signals	
FWD inhibit input in effect	×
REV inhibit input in effect	×
Current value data output *1	○
Encoder monitor *2	×
13bitABS Current value data output *3	×
Analog speed monitor	×
Analog current monitor	×

*1: Refer to [Outputting the current value data from the pins CN2-40 and 41] (P4-9).
*2: Refer to [Encoder phase A, B and Z signal outputs] (P4-11) (P4-21) (P4-28)
*3: For details, refer to [Outputting the current value data from the pins CN2-42 to 47 (HA-655 driver mode)] (P4-19).

Electronic gear values for when output shaft divide function set

	SP67=1 36,000 divisions			SP67=2 360,000 divisions			SP67=3 3,600,000 divisions		
Reduction ratio	Numerator	Denominator	Numerator/denominator	Numerator	Denominator	Numerator/denominator	Numerator	Denominator	Numerator/denominator
50	8192	45	182.0	4096	225	18.2	2048	1125	1.82
80	65536	225	291.3	32768	1125	29.1	16384	5625	2.91
100	16384	45	364.1	8192	225	36.4	4096	1125	3.64
120	32768	75	436.9	16384	375	43.7	8192	1875	4.37
160	131072	225	582.5	65536	1125	58.3	32768	5625	5.83

SP69: Feed-forward control function setting

This configures the feed-forward control function for position control. For details, refer to [Applied servo gain adjustment function] (P3-18).

* This is available for HA-800 software version 3.x or later.

* Changes to system parameter settings (SP00 to 79) are put into effect by changing the setting, then turning control power supply OFF, then ON again.

Set value	Function	Unit	Default
0	Feed-forward control (previous compatible function)	–	*
1	Feed-forward control		
2	Feed-forward control simple adjustment version (stable operation mode)		
3	Feed-forward control simple adjustment version (normal operation mode)		
4	Feed-forward control simple adjustment version (high-speed operation mode)		
5	Feed-forward control simple adjustment version (manual tune mode)		

*: The default varies depending on the applicable actuator.Refer to [Default settings] (Apx-1) in the appendix.

Caution

- When using the feed-forward control function, be sure to reference [Applied servo gain adjustment function] (P3-18) and understand the notices.

8

System parameter mode

Chapter 9

Test mode

Details of how to check the system operation by auto-tuning via jogging, monitoring of I/O signals and simulated operation of output signals are explained in this chapter.

9-1 Test mode

In the test mode, you can monitor I/O signals and perform JOG operation, auto-tuning, etc.
You can also check the connection with the host controller and operating status without having to drive the actuator.

Mode	Code	Description	Details
Test mode	T00	I/O signal monitor	P9-2
	T01	Output signal operation	P9-3
	T02	JOG speed setting	P9-4
	T03	JOG acceleration/deceleration time constant setting	P9-5
	T04	JOG operation	P9-6
	T05	Parameter initialization	P9-7
	T06	Automatic adjustment of speed command offset	P9-8
	T07	Automatic adjustment of torque command offset	P9-9
	T08	Multi revolution clear	P9-10
	T09	Auto-tuning	P9-11
	T10	Auto-tuning displacement	P9-13
	T11	Auto-tuning level selection	P9-14

9-2 Details of test mode

The following explains the details of the test mode.

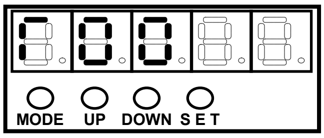
T00: I/O signal monitor

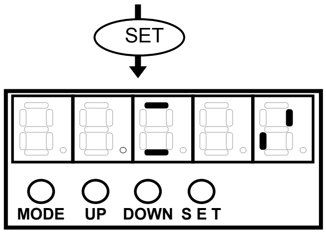
The I/O statuses of assigned pins are reflected and displayed in real time.
The functions of displayed pins are enabled.

1 Press the SET button.

Output signal operation is now permitted.

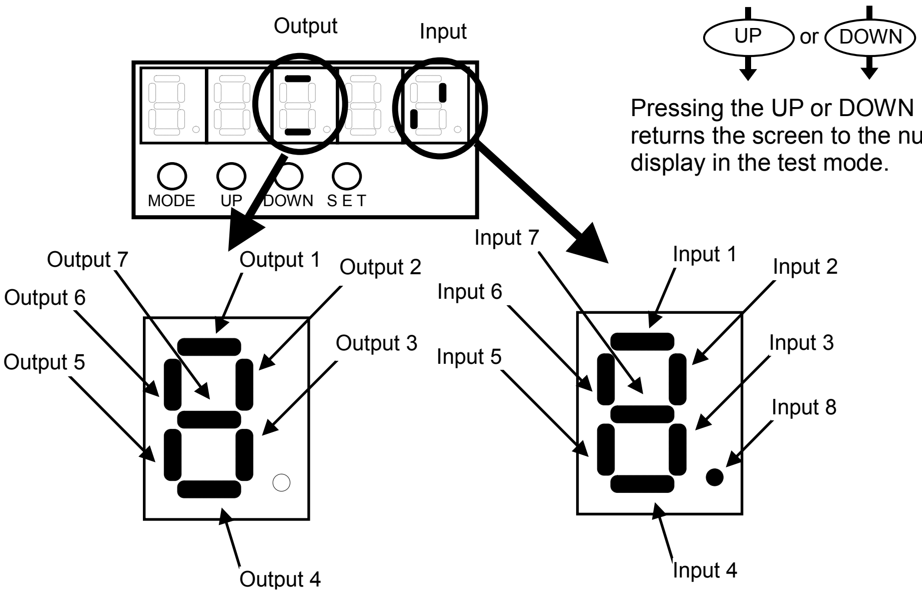
- The display will not switch if the button is pressed for 1 second or longer.





2 The third digit indicates the output status, while the fifth digit indicates the input status.

Lit: ON
Unlit: OFF



Pressing the UP or DOWN button returns the screen to the number display in the test mode.

Caution

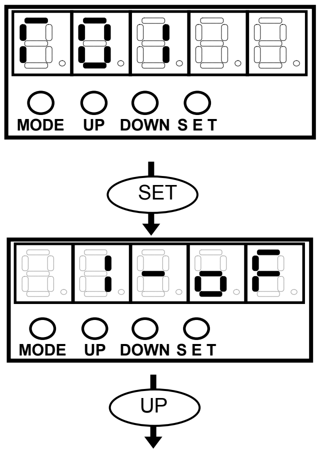
- If FWD inhibit (FWD-IH) or REV inhibit (REV-IH) is assigned to an input pin, the screen will switch to the alarm display when a signal (assigned by the NO logic) is input to the assigned input pin. Monitor I/Os after inputting the FWD or REV inhibit signal.

T01: Output signal operation

Output signals can be turned ON/OFF as desired.

Caution

- Take note that, in this operation, the actual output signals are output and the device may be activated by the operation. Also, the operation can be done even when HA-800A is being automatically operated by the command from the host controller. Please keep this in mind during the actual operation.
- This operation cannot be executed at the same time as the output signal operation from PSF-800.



1 **Press the SET button.**

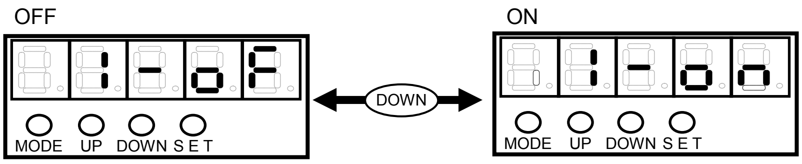
Output signal operation is now permitted.

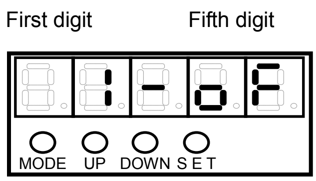
- The display will not switch if the button is pressed for 1 second or longer.

2 **Use the UP button to select the signal to be operated.**

3 **Use the DOWN button to switch the ON/OFF status.**

The output signal shown in the second digit will turn ON/OFF every time the DOWN button is pressed.



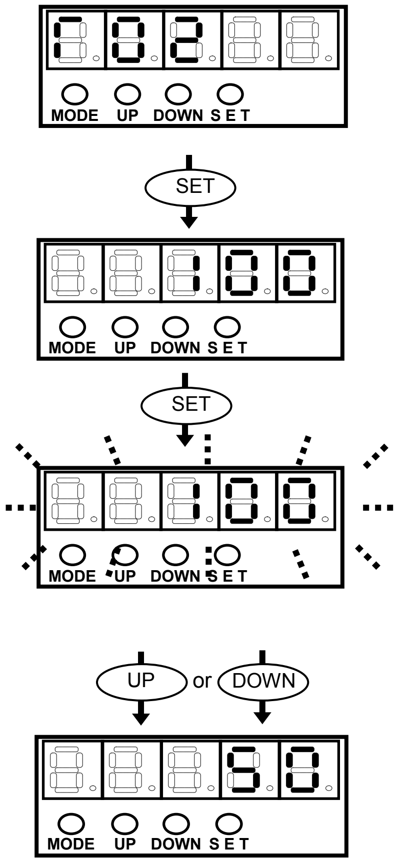


- First digit: Nothing is shown.
- Second digit: The number assigned to the output signal to be operated is shown.
  A number between [1] and [7] is shown, where 1, 2, ..., 7 indicate output 1, 2, ..., 7 can be operated, respectively.
- Third digit: [-] is shown.
- Fourth, fifth digits: The status of the output selected in the second digit is shown.
  on: The signal is ON (output transistor is ON)
  oF: The signal is OFF (output transistor is OFF)

4 **Press the SET button, and the display will return to [T01].**

T02: JOG speed setting

Set the speed of JOG operation.
Although the unit is r/min, this value indicates the actuator's motor rotation speed. The output shaft rotation speed is obtained by dividing the set value by the gear ratio.
Setting range: 10 to 3000
Unit: r/min



1 **Press the SET button.**

The set value of JOG speed is shown. (Unit: r/min)

- The display will not switch if the button is pressed for 1 second or longer.

2 **To change the set value, press the SET button and release it within 1 second.**

The set value flickers to indicate that it can now be changed.

3 **Change the set value.**

Pressing the DOWN button decreases the value, while pressing the UP button increases the value.
(Press and hold each button to change the value faster.)

4 **To confirm the set value, press and hold the SET button until the set value stops flickering.**

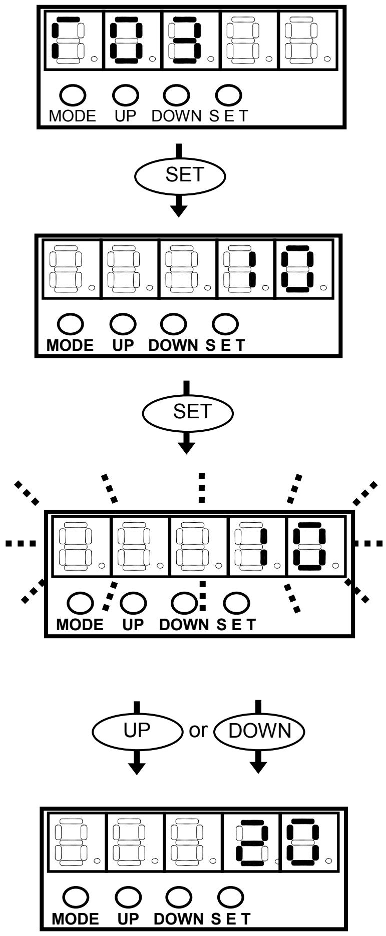
To restore the original set value, release the SET button before the set value stops flickering (within approx. 1 second).

Caution

- The value set here is not stored.
  When the HA-800A driver power is reconnected, it will return to the default value 100.
- Set the speed as low as possible to enable checking.
  Avoid unexpected accidents resulting from high speed.

T03: JOG acceleration/deceleration time constant setting

Set the acceleration/deceleration time constant to be applied during JOG operation.
The value set here corresponds to the time over which the actuator accelerates from the standstill state to [SP51: Speed input factor] or decelerates from the speed set by the speed input factor to the standstill state.
Setting range: 1 to 9999
Unit: ms



1 **Press the SET button.**

2 **To change the set value, press the SET button and release it within 1 second.**

The set value flickers to indicate that it can now be changed.

3 **Change the set value.**

Pressing the DOWN button decreases the value, while pressing the UP button increases the value.
(Press and hold each button to change the value faster.)

4 **To confirm the set value, press and hold the SET button until the set value stops flickering.**

To restore the original set value, release the SET button before the set value stops flickering (within approx. 1 second).

Caution

- The value set here is not stored.
  When the HA-800A driver power is reconnected, it will return to the default value 1.

T04: JOG operation

The actuator can be operated regardless of the input signals from the host. Any input signal operation performed during JOG operation is ignored. The data set in [T02: JOG speed] and [T03: JOG acceleration/deceleration time] is used to perform JOG operation of the actuator.

WARNING

- **Any input other than emergency stop during a JOG operation is ignored. Accordingly, the actuator operates ignoring even the FWD/REV inhibit input signals; operate carefully paying attention to the surrounding conditions.**
- **Do not perform a test run using the communication software PSF-800 simultaneously. The operation becomes unstable.**
- **The speed limit function and torque limit function are disabled during the JOG operation.**

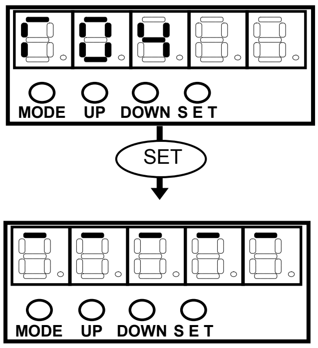
Caution

- A "JOG operation" cannot be started if the actuator servo is ON with a CN2-2 servo-ON input. Turn OFF the CN2-2 servo-ON input.
- Regardless of the setting of [SP50: Command polarity], the rotation is clockwise for the forward command [UP] and counter-clockwise for the reverse command [DOWN].With the SHA-SG/HP series, rotation is in the opposite directions.
- Note that after jog operation, the current value on the host device and the actual machine position differ.

1 Press the SET button when the actuator servo is OFF.

The actuator servo turns ON and JOG operation direction is displayed.

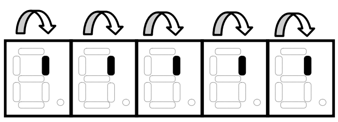
- The display will not switch if the button is pressed for 1 second or longer.



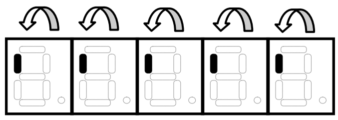
2 Press the UP or DOWN button to rotate the actuator.

- The actuator rotates in the CW (clockwise) direction while the UP button is pressed. (The rotation direction is different depending on the actuator.) Release the UP button, and the actuator will stop.
- The actuator rotates in the CCW (counterclockwise) direction while the DOWN button is pressed. (The rotation direction is different depending on the actuator.) Release the DOWN button, and the actuator will stop.

Press the UP button, and the actuator will rotate in the CW direction.



Press the DOWN button, and the actuator will rotate in the CCW direction.



3 To end the operation, press the SET button.

The actuator servo turns OFF and the screen returns to the test mode number display.

- The display will not switch if the button is pressed for 1 second or longer.
- Here, the actuator servo is OFF. To turn ON the servo, turn ON [CN2-2: Servo-ON input]. (The servo turns OFF even when the servo-ON input is ON. Turn OFF the input and then turn it ON again.)

9

Test mode

T05: Parameter initialization

The tune mode parameters (excluding AJ16 and AJ17) and system parameters are reset to their default settings.

Caution

- Perform this operation while the servo is OFF. After the initialization, be sure to reconnect the HA-800A driver power.
- All parameters are initialized (excluding AJ16 and AJ17). Since the I/O signal assignments and control mode settings are also initialized, it is recommended that you write down the necessary parameters or save them using PSF-800 before the initialization.

1 **Press the SET button.**

The HA-800A driver displays the motor code of the applicable actuator currently set.

- The display will not switch if the button is pressed for 1 second or longer.

2 **Press the SET button.**

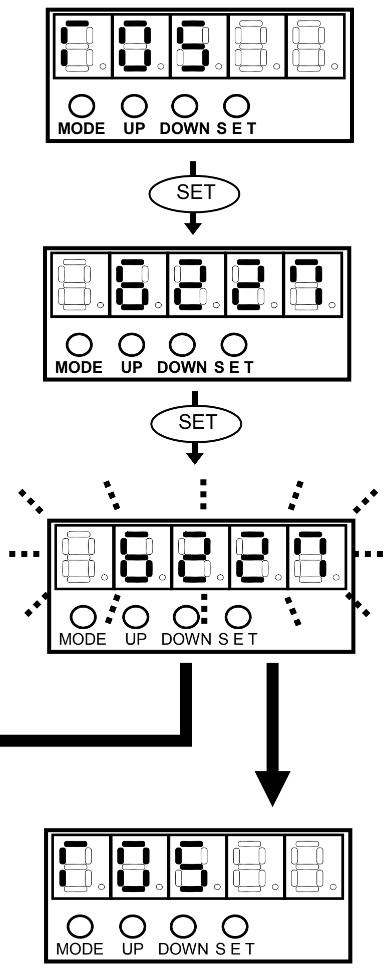
The displayed motor code flickers.

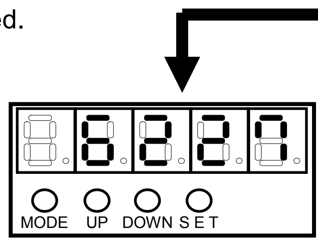
- To cancel the parameter initialization, press the UP or DOWN button. The screen returns to the test mode number display.

3 **Press and hold the SET button until the display stops flickering and becomes lit, and then release the button. (Approx. 1 second or more)**

The motor code is initialized and the screen returns to the test mode number display.

- If the SET button is released before the display stops flickering and becomes lit, the motor code is not initialized and remains displayed.





If the button is released before the flickering stops and becomes lit, the motor code remains displayed and parameters are not initialized.

When the button is released after the flickering has stopped and become lit, the screen changes to the test mode number display, at which point the parameter initialization is already complete.

9

Test mode

T06: Automatic adjustment of speed command offset

The offset for speed command input circuit is adjusted automatically.

1 Press the SET button.

The HA-800A driver displays the speed command offset currently set.

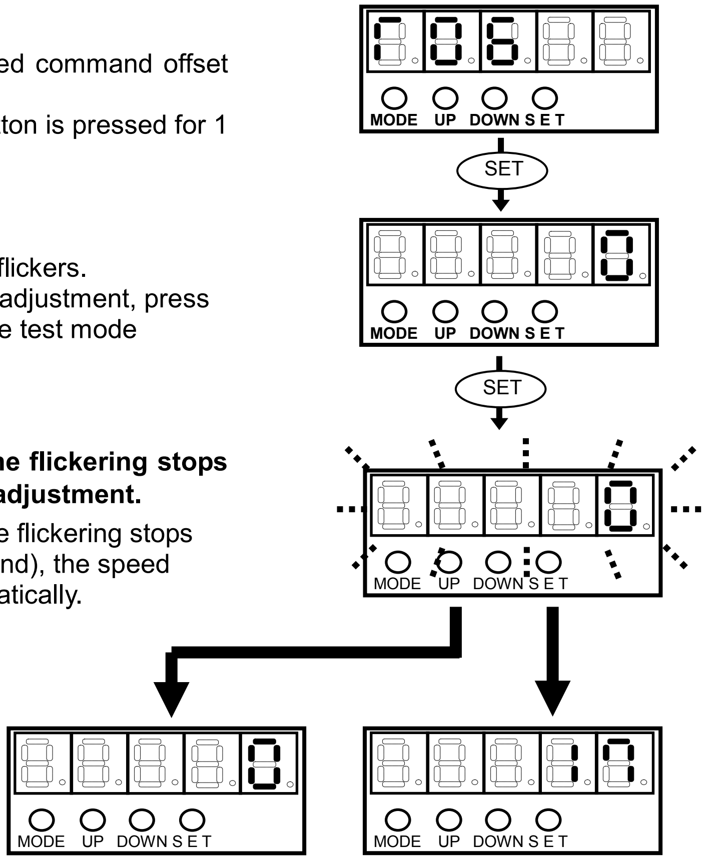
- The display will not switch if the button is pressed for 1 second or longer.

2 Press the SET button.

The displayed speed command offset flickers.
If you don't want to perform automatic adjustment, press the UP or DOWN button to return to the test mode number display.

3 Press and hold the SET button until the flickering stops and becomes lit to perform automatic adjustment.

If the SET button is released before the flickering stops and becomes lit (within approx. 1 second), the speed command offset is not adjusted automatically.



If the button is released before the flickering stops and becomes lit, automatic offset adjustment is not performed.

Automatic offset adjustment for speed command is performed after the SET button has been held until the flickering stops and it becomes lit.

T07: Automatic adjustment of torque command offset

The offset for torque command input circuit is adjusted automatically.

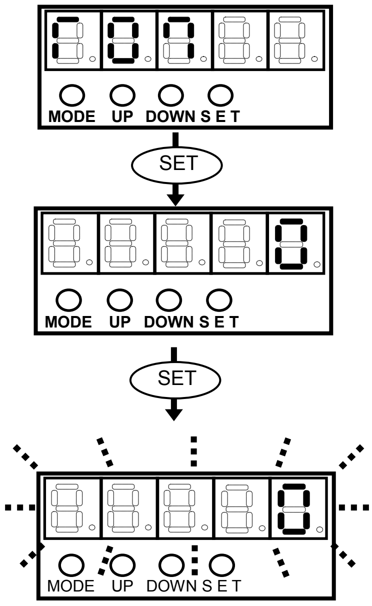
1 Press the SET button.

The HA-800A driver displays the torque command offset currently set.

- The display will not switch if the button is pressed for 1 second or longer.

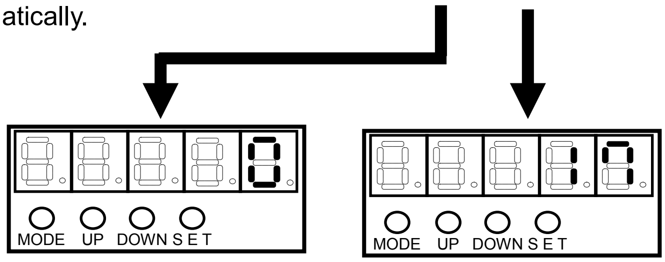
2 Press the SET button.

The displayed torque command offset flickers.
If you don't want to perform automatic adjustment, press the UP or DOWN button to return to the test mode number display.



3 Press and hold the SET button until the flickering stops and becomes lit to perform automatic adjustment.

If the SET button is released before the flickering stops and becomes lit (within approx. 1 second), the torque command offset is not adjusted automatically.



If the button is released before the flickering stops and becomes lit, automatic offset adjustment is not performed.

Automatic offset adjustment for torque command is performed after the SET button has been held until the flickering stops and it becomes lit.

T08: Multi revolution clear

Encoder multi revolution data can be cleared when an actuator equipped with a 13-bit absolute encoder or 17-bit absolute encoder is combined.
This parameter is also used when setting the origin. With a SHA series, FHA-C absolute system, FHA-Cmini absolute system, the multi revolution counter value must be set to zero at the origin.

Caution

- A multi revolution clear command cannot be executed while the actuator servo is ON.
- After the multi revolution clear command, reconnect the HA-800A driver power.
  If the power is not reconnected, the servo cannot be turned ON and thus commands cannot be accepted.

1 **Move the actuator to its origin via manual JOG operation. (Only when setting the origin)**

2 **Display [T08: Multi revolution clear] in the test mode.**

3 **Press and hold the SET button for at least 0.1 second.**

[cLr] is shown.

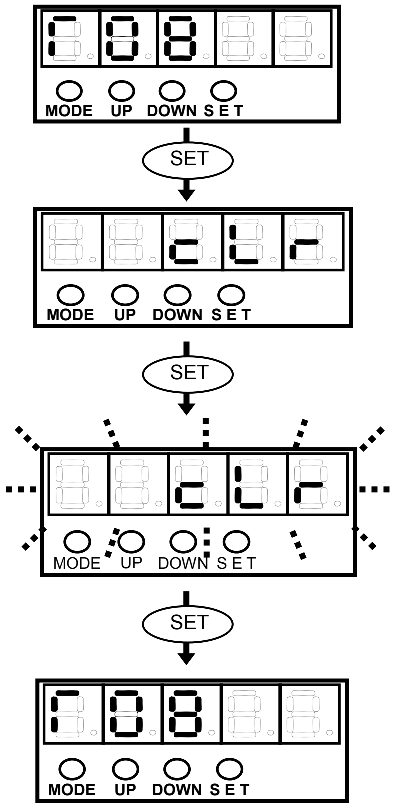
4 **Press the SET button.**

Displayed [cLr] flickers.

- If you don't want to clear the multi revolution data, press the UP or DOWN button. The screen returns to the test mode number display.

5 **Continue to hold the SET button until the flickering stops and becomes lit. (Approx. 5 seconds or more)**

- The multi revolution clear command is executed and the screen changes to the test mode number display.
- If the SET button is press and hold, and released before the flickering stops and becomes lit (within approx. 5 seconds), the multi revolution clear command is not executed and [cLr] remains displayed.



T09: Auto-tuning

The load is estimated and auto-tuning is performed to set an optimal servo gain.

Since the actuator moves to estimate the load, perform auto-tuning after thoroughly confirming safety.
By default, the motor shaft moves 6,000 degrees in the clockwise direction as seen from the output shaft, then 6,000 degrees in the counter-clockwise direction. The corresponding rotation angle of the actuator output shaft is obtained by 1/reduction ratio. In certain situations such as when the displacement of the system is limited, change the displacement by [T10: Auto-tuning displacement].
Note that during operation for an operation command (pulse command, speed command, torque command), if auto-tuning is executed, the auto-tuning has priority.

Caution

- Auto-tuning is not performed until a signal is input to the CN2-2 pin and the actuator servo is turned ON. (A signal must be input to the CN2-2 pin.)
- Perform auto-tuning after canceling FWD inhibit or REV inhibit. (Cancel FWD/REV inhibit by inputting a signal to the CN2 or setting SP03/SP04.)
- Note that the rotation directions depend on the [SP50: Command polarity] setting.
- Do not execute the PSF-800 waveform monitoring during auto-tuning.
- Note that after auto-tuning, the current value on the host device and the actual machine position differ.

1 Input the servo-ON signal via CN2.

This turns ON the servo.

2 While [T09] is displayed, press the SET button.

[-A.c.] is shown.

- The display will not switch if the button is pressed for 1 second or longer.

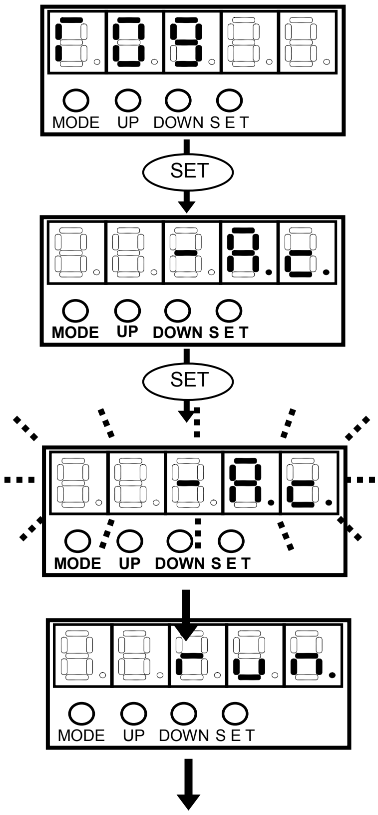
3 Press the SET button.

Displayed [-A.c.] flickers.

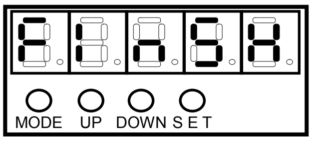
4 Press and hold the SET button for at least 0.1 second.

[-A.c.] changes to [run.], after which it moves in the clockwise direction by the travel angle set in [T10: Auto-tuning angle setting].After that, the actuator moves in the counter-clockwise direction by the displacement set in [T10: Auto-tuning travel angle setting].
If the main circuit power has not been turned ON or actuator does not move (= a servo alarm is output), [-A.c.] does not change to [run.].

- To cancel the auto-tuning, press the UP or DOWN button. The screen returns to the test mode number display.



- The actuator moves in forward/reverse directions for a while to estimate the load. When the load has been estimated, [run.] changes to [FInSH] to indicate that the auto-tuning is complete.
  Pressing the UP or DOWN button on this display returns the screen to the test mode number display.



Caution

- If the load varies greatly with the rotation position or if the speed limit and torque limit functions are enabled, it is not possible to estimate the load properly, so auto-tuning is impossible. Adjust manually.

T10: Auto-tuning displacement

Set the displacement of the motor during auto-tuning.
Setting range: 1500 to 6000°
Unit angle (°)

1 **While [T10] is displayed, press the SET button.**

The auto-tuning displacement is displayed.

- The display will not switch if the button is pressed for 1 second or longer.

2 **Press the SET button.**

The auto-tuning displacement flickers.

3 **Press the UP or DOWN button to change the auto-tuning displacement.**

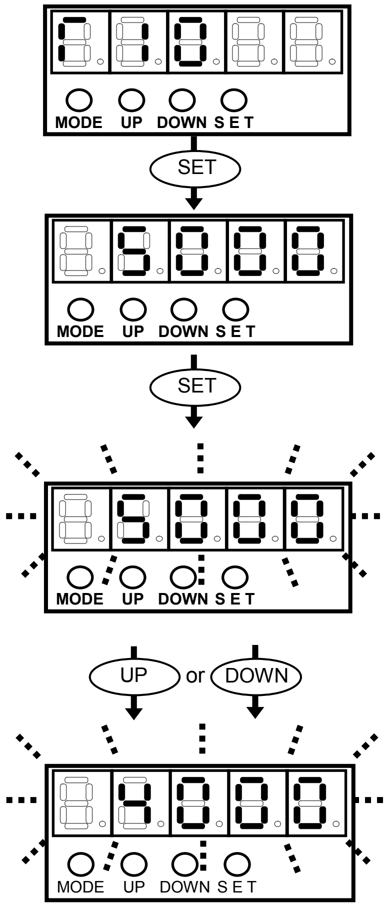
The value is set in angle (°) and the setting range is 1500 to 6000° (motor shaft).

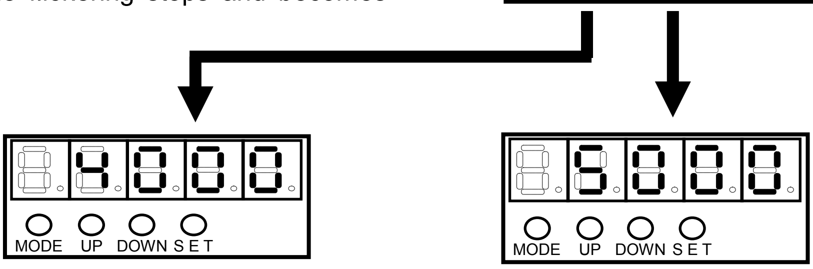
- The load estimated by auto-tuning is subject to a maximum erroneous difference of approx. ±15%. To minimize the erroneous difference, set the auto-tuning displacement as long as possible.

4 **Hold the SET button until the auto-tuning displacement stops flickering and becomes lit.**

The set value becomes effective.

- If you don't want to apply the set value, release the SET button before the flickering stops and becomes lit.





Hold the SET button until the flickering stops and becomes lit and then release the button to make the set value effective.

If the SET button is released before the flickering stops and becomes lit, the set value is not applied.

Caution

- The set value of auto-tuning displacement is not saved. When the HA-800A driver is restarted, the set value returns to the default (6000°).

T11: Auto-tuning level selection

Select the level of auto-tuning. Increasing the value set here improves the response, but vibration may also increase depending on the system.

1 While [T11] is displayed, press the SET button.

The auto-tuning level selection is displayed.

- The display will not switch if the button is pressed for 1 second or longer.

2 Press the SET button.

The auto-tuning level selection flickers.

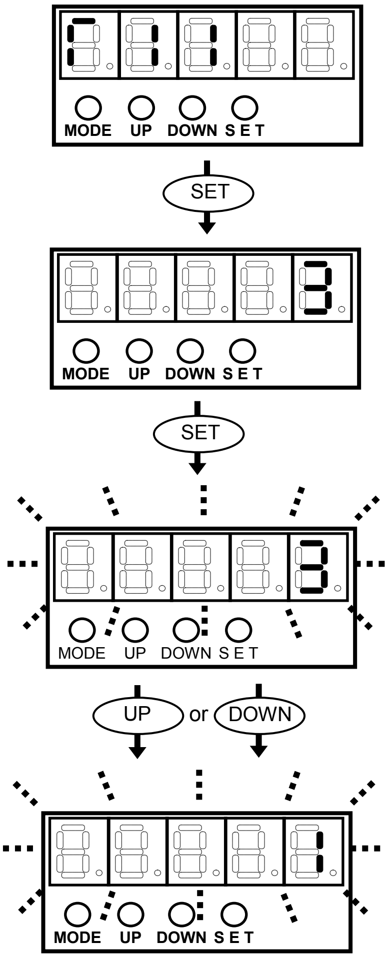
3 Press the UP or DOWN button to change the auto-tuning level.

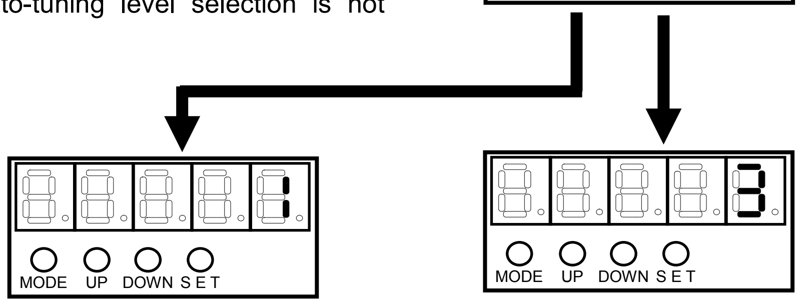
The setting range is 1 to 5.

4 Hold the SET button until the auto-tuning level selection stops flickering and becomes lit.

The set value becomes effective.

- If you don't want to apply the set value, release the SET button before the flickering stops and becomes lit. The set value of auto-tuning level selection is not saved.





Hold the SET button until the flickering stops and becomes lit and then release the button to make the set value effective.

If the SET button is released before the flickering stops and becomes lit, the set value is not applied.

Caution

- The set value of auto-tuning level is not saved.
  When the HA-800A driver is restarted, the set value returns to the default (3).

Chapter 10

Communication software

How you can use the dedicated personal computer software to check I/O signal statuses, rotation speeds and other servo statuses, perform auto-tuning, set parameters, assign I/O signals and monitor servo operation waveforms are explained in this chapter.

10-1 Overview

PSF-800 is a communication software program that lets you change driver parameters and monitor operation waveforms, etc., from a personal computer.

Operating environment

PSF-800 needs the following environment to operate correctly.
Be sure to use PSF-800 in the following environment to prevent malfunction.

Item	Environment
Computer	Personal computer running Windows® ME, Windows® NT, Windows® 2000, Windows® Xp, Windows Vista®*1, or Windows® 7*1, having a built-in RS-232C communication port or USB port
OS	Windows® ME, Windows® NT, Windows® 2000, Windows® Xp, Windows Vista®*1, Windows® 7*1
Memory	Memory size required by each OS or more
Hard disk	Free disk space of 3 MB or more (Additional free disk space is needed if created data will be saved.)
Display	256 colors or more
Others	・Microsoft® Mouse, Microsoft® IntelliMouse® or other compatible pointing device ・Printer operating on the specified OS, if created data will be printed

*1: Successful operation has been verified on Windows Vista®, and Windows 7®, but it is not guaranteed.

* Microsoft Windows and IntelliMouse are registered trademarks and trademarks of Microsoft Corporation in the United States for use in the United States, Japan and other countries.
* Microsoft Windows Operating System is the full name of Windows.

Caution

- Download the latest version of PSF-800 from our web site.

10

Communication software

Setup

1 **Download PSF-800.**

Download the software from our website (http://www.hds.co.jp).

2 **Install PSF-800.**

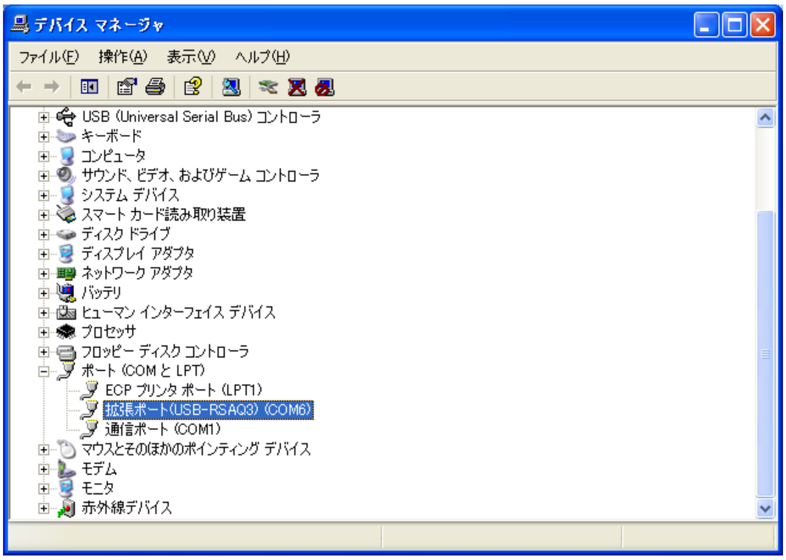
Extract the files from the downloaded folder and run SETUP.EXE to set up the software according to the on-screen instructions.

- **Using a USB port**

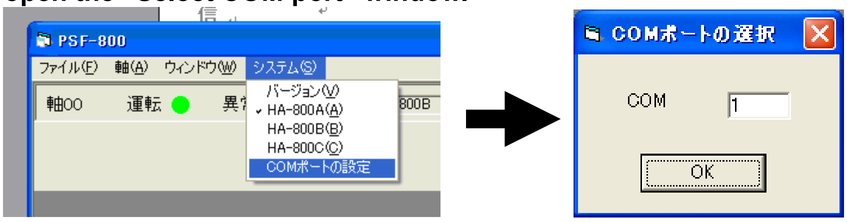
If a USB port is used, you need an adapter to convert the USB port to a RS-232C port. (USB-RSAQ3 IO Data, etc.)
The built-in RS-232C port of the personal computer is normally assigned to COM1. However, this assignment changes if a USB conversion adapter is used. Perform the following setting procedure:

(1) Go to "Control Panel", open "System", and display "Device Manger".

(2) Check the port assignments (COM and LPT1).
(In the following example, COM6 is assigned.)



(3) Choose “System (S)” from the menu, and then scroll down to “Select COM port” to open the “Select COM port” window.



Set the verified port number from (2), and then click the "OK" button. Next, start the PSF-800 to make the COM port number set earlier effective.

(4) A VB6 runtime library is needed to run PSF-800.
If this VB6 runtime library is not yet installed, the following message is shown on the personal computer. Take note that the files you have downloaded from our website do not include the VB6 runtime library.

If the VB6 runtime library is not yet installed, you can download it from the following URL:
http://www.vector.co.jp/soft/win95/util/se188840.html

3 Confirm the installation.

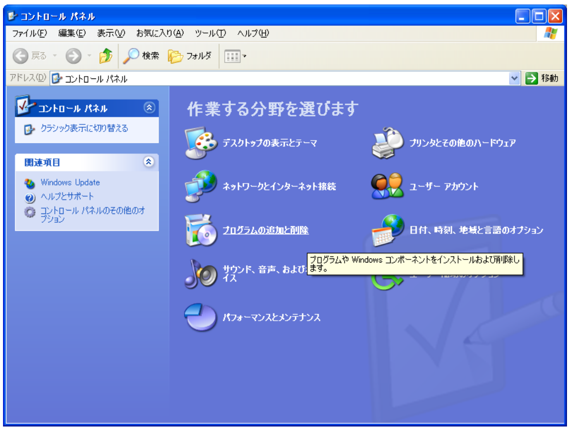
When the installation is complete, use a dedicated communication cable* to connect the personal computer and HA-800.Start and then shut down PSF-800 to confirm that the software has been installed correctly.
Start PSF-800 after turning on the control circuit power of the HA-800.
If the connection is unstable, use toroidal core for the communication cable.

*: Dedicated communication cable
RS-232C communication cable: EWA-RS03

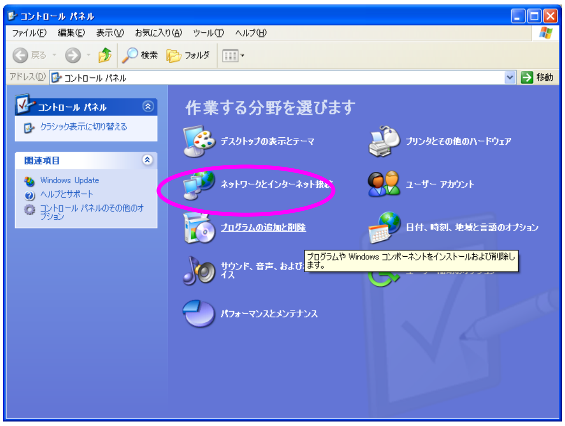
Uninstalling the software

To uninstall PSF-800 from the hard disk, follow the procedure below. Once uninstalled, PSF-800 can no longer be started on that personal computer. To use PSF-800 again, reinstall it according to the installation procedure.

1 **Open "Control Panel".**

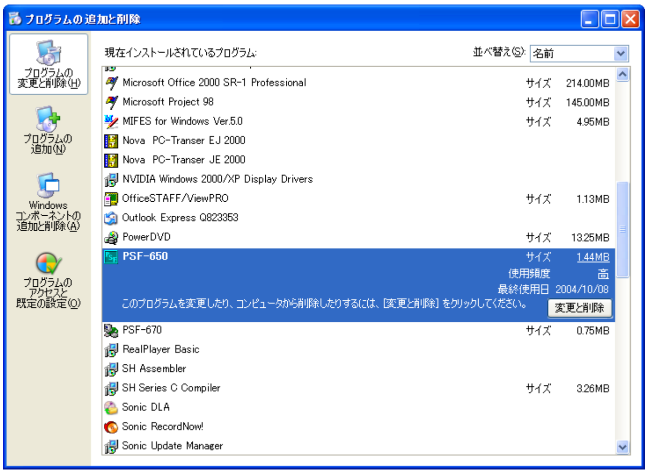


2 **Click "Add/Remove Programs".**



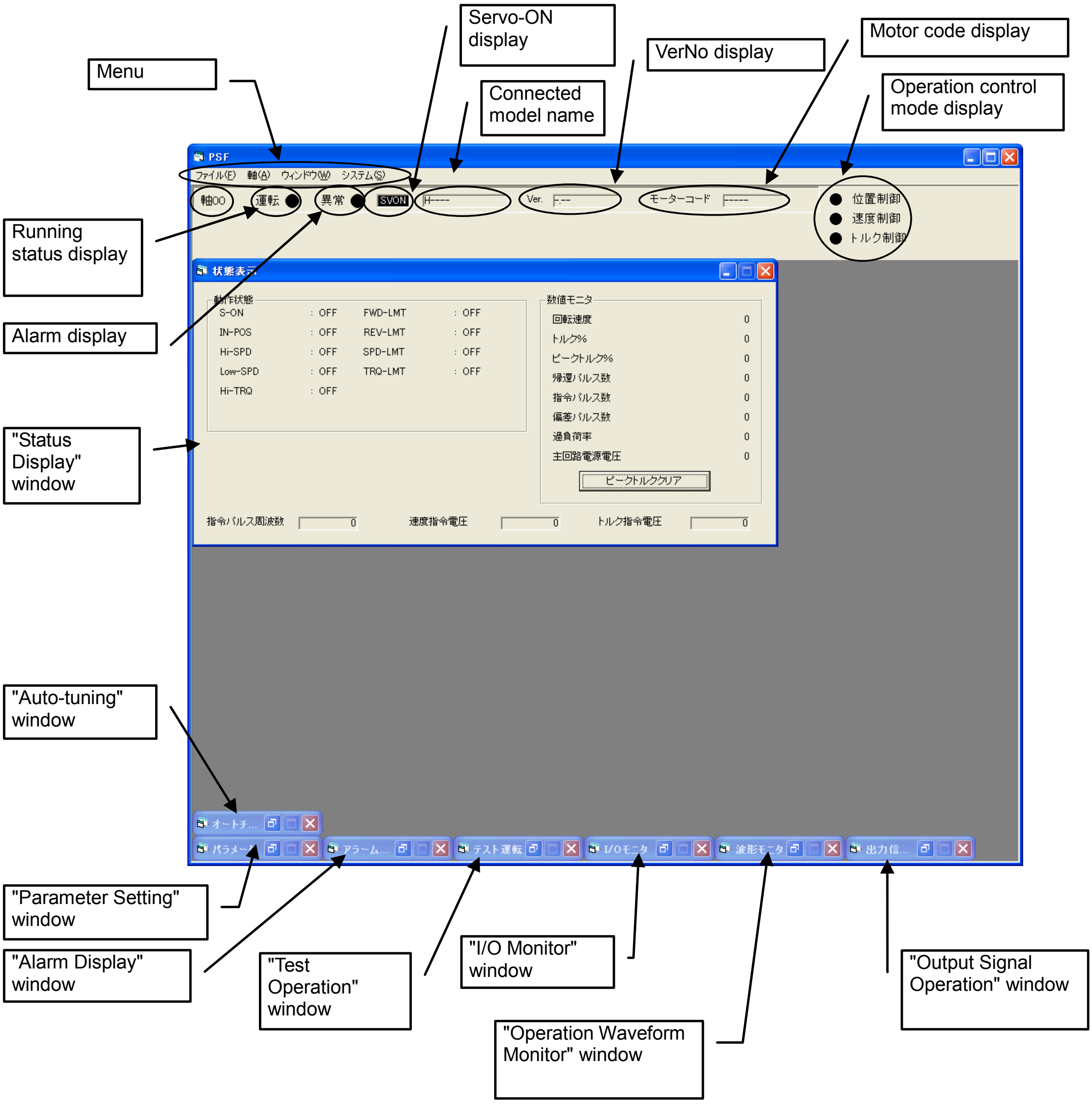
3 **Select and remove the PSF-800 program.**

Select PSF-800 and then click the "Change/Remove" button, and PSF-800 will be uninstalled from the hard disk.



Initial screen

The initial screen of PSF-800 is shown below.



Menu

- **"File"**

"Open"········· Read parameter set value, test operation patterns or waveform monitoring data from files by setting parameters, performing test operations or operating the waveform monitoring function.

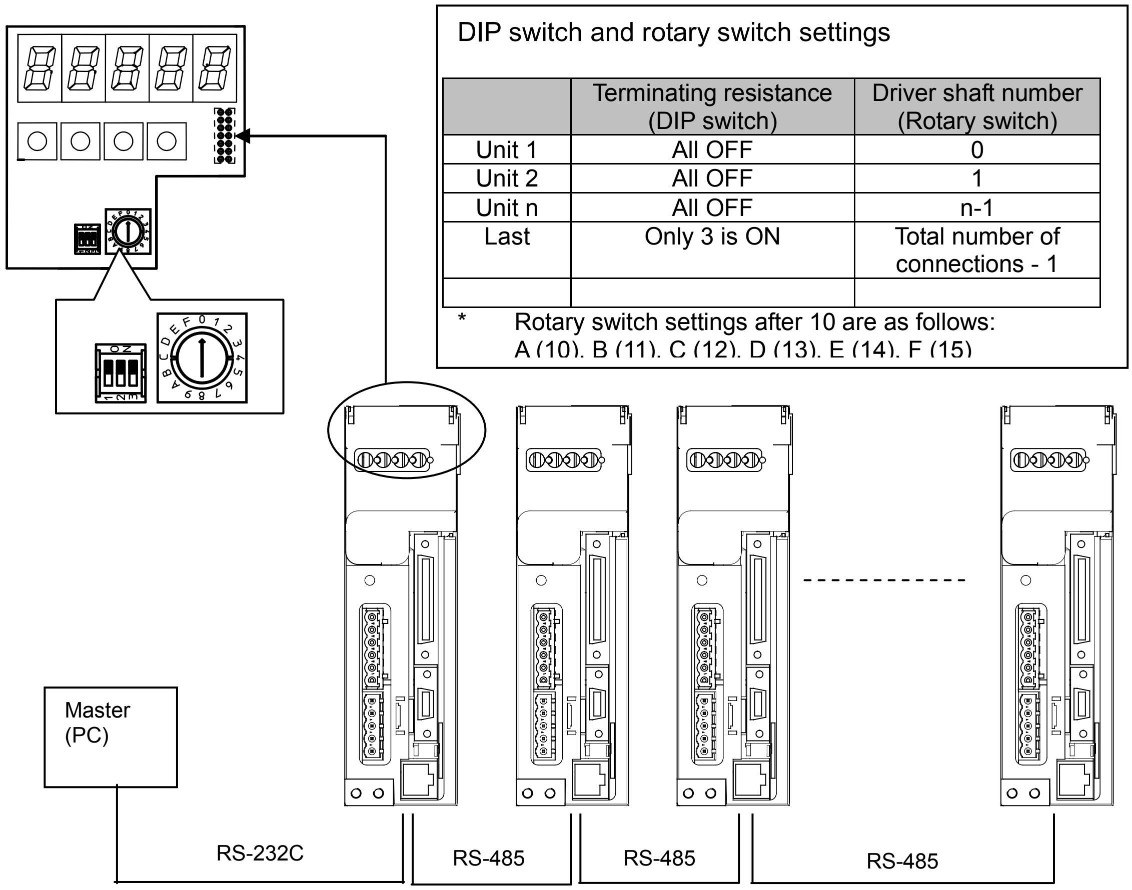
"Save As"····· Save parameter set value, test operation patterns or waveform monitoring data to files after setting parameters, performing test operations or operating the waveform monitoring function.

"Exit"··········· Exit the program.

- **"Axis"**

PSF-800 can be connected to and operate up to 16 HA-800A units (only one unit can be connected/operated in the case of HA-800B and HA-800C). If multiple axes are connected, go to the Axis menu to set the axis number of each unit to communicate with.

Connection example of PSF-800 and HA-800A



DIP switch and rotary switch settings

	Terminating resistance (DIP switch)	Driver shaft number (Rotary switch)
Unit 1	All OFF	0
Unit 2	All OFF	1
Unit n	All OFF	n-1
Last	Only 3 is ON	Total number of connections - 1

* Rotary switch settings after 10 are as follows:
A (10), B (11), C (12), D (13), E (14), F (15)

Between PC and driver
Dedicated communication cable
Model No.: EWA-RS03 (option)

Between drivers
Modular 2-division connector RJ-25, RJ-11 (6-polar 6-core)
・Model No.: 186-3082 (RS Components)
Modular cable RJ-11 (6-polar 4-core) straight
・Model No.: TEL-FC-5 (Sanwa Supply)
* Provided by the customer.

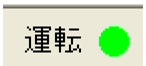
- **"Window"**

Although the status display screen opens when the software is started, you can change the initial screen in the Window menu.

Detailed display area

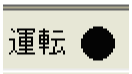
- **Axis number display**
  If connected to PSF-800, up to 16 HA-800A units can be operated from the software.
  The axis number display shows the axis number of the unit currently operated.

- **Running status display**
  A steady green light comes on when the HA-800 is connected to PSF-800 and its power supply is turned ON.



(Green)

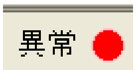
HA-800 power supply ON



(Unlit)

The HA-800 power supply is OFF or PSF-800 is offline.

- **Alarm display**
  A red light flickers when the HA-800 is generating an alarm.



(Red)

Alarm is generating.

(Unlit)

No alarm

- **Excited status display**
  A steady red light comes on when the actuator servo is ON.

(Red)

Servo ON

(Unlit)

Servo OFF

- **Connected model name display**
  The model name of the connected HA-800 is shown.

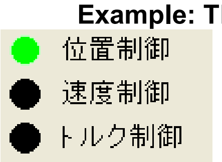
(Example: General-purpose (position command, speed command, torque command) specification)

HA-800B: MECHATROLINK communication specification
HA-800C: CC-Link specification

- **Version number display**
  The software version of the connected HA-800 is shown.

- **Motor code display**
  The code number of the applicable actuator set in the HA-800 is shown.

- **Operation control mode display**
  The operation mode of the HA-800 is shown. The steady green light indicates the mode in which the HA-800 is currently operating.
  Example: The HA-800 is operating in the position control mode

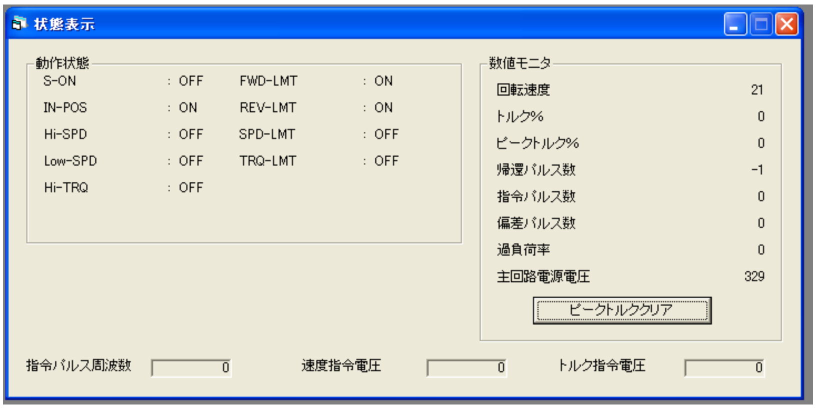


(Green)
(Unlit)
(Unlit)

10
Communication software

Status display

In the "Status Display" window, you can monitor the operating status and values.



Operating status display

Name	Explanation
S-ON	ON is shown if the actuator servo is ON.
IN-POS	ON is shown during position control if the deviation counter value is within the in-position range set by an adjustment parameter.
Hi-SPD	ON is shown if the motor speed drops to or above the attained speed judgment set by an adjustment parameter.
Low-SPD	ON is shown if the motor speed drops to or below the zero speed judgment value set by an adjustment parameter.
Hi-TRQ	ON is shown during torque control if the motor's output torque rises to or above the attained torque judgment value set by an adjustment parameter.
FWD-LMT	ON is shown if the FWD inhibit signal is enabled.
REV-LMT	ON is shown if the REV inhibit signal is enabled.
SPD-LMT	ON is shown if the motor rotation speed is limited.
TRQ-LMT	If the driver's output torque is set to torque limiting, ON is shown.

10

Communication software

Value monitor

Name	Explanation
Motor rpm	The rotation speed [r/min] of the motor is shown.
Torque	It displays the current torque value %, setting the maximum output torque of the actuator to be 100%.
Peak torque	It displays the output torque peak value %, by setting the maximum output torque of the actuator as 100%. Clicking the "Clear Peak Torque" button clears this field.
Feedback pulses	The value of the encoder feedback pulse counter is shown.
Command pulses	The value of the driver command pulse counter is shown.
Error pulses	The value calculated by subtracting the feedback pulse counter value from the command pulse counter value (deviation) is shown.
Overload rate	The overload rate is shown. If this value is not 0, the actuator is overloaded.
Main circuit power voltage	The rectified AC voltage [V] of the main circuit is shown.
Regenerative power	It indicates absorbed power of regenerative resistor as percentage (unit: 0.01%). The value can be converted to absorbed power of resistor using the following formula. $\text{Regenerative resistor absorption} = 16000\ (\text{W}) \times \dfrac{\text{Display value [0.01\%]}}{10000\ [0.01\%]}$ Ex) When display value = 10, resistor absorption power = 16W *This value monitor is available only for HA-800A-24. With the HA-800A-1, 3 and 6, the power absorbed by regenerative resistor is unrelated.

Name	Explanation
Command pulse frequency	The command pulse frequency [kHz] input to the command pulse input port is shown.
Speed command voltage	The speed command input voltage [0.1V] currently input to the driver is shown. Example) When display value = 20, speed command input voltage = 2.0 V
Torque command voltage	The torque command input voltage [0.1V] currently input to the driver is shown.

10-2 Auto-tuning

Auto-tuning is a function that allows the driver to estimate the load and automatically adjust the servo gain to an appropriate value. The auto-tuning method is explained below.

WARNING	**Since the actuator moves to estimate the load, perform auto-tuning after thoroughly confirming safety.** **By default, the motor shaft moves 6,000 degrees in the clockwise direction, then 6,000 degrees in the counter-clockwise direction.** **The corresponding rotation angle of the actuator output shaft is obtained by 1/reduction ratio. In certain situations such as when the displacement of the system is limited, change the displacement.** **Note that during operation for an operation command (pulse command, speed command, torque command), if auto-tuning is executed, the auto-tuning has priority.**

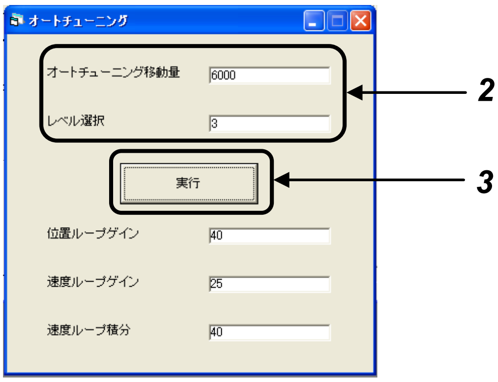
Caution

- Auto-tuning is not performed until a signal is input to the CN2-2 pin and the actuator servo is turned ON. (A signal must be input to the CN2-2 pin.)
- Perform auto-tuning after canceling FWD inhibit or REV inhibit. (Cancel FWD/REV inhibit by inputting a signal to the CN2 or setting SP03/SP04.).
- Note that the rotation directions depend on the [SP50: Command polarity] setting.
- Do not execute the PSF-800 waveform monitoring during auto-tuning.
- Note that after auto-tuning, the current value on the host device and the actual machine position differ.

1 **Input the servo-ON signal via CN2.**

This turns ON the servo.

2 **Set the auto-tuning displacement and level in the "Auto-tuning" window.**

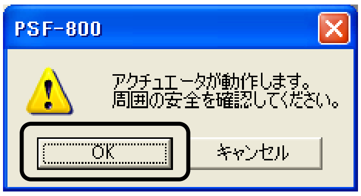


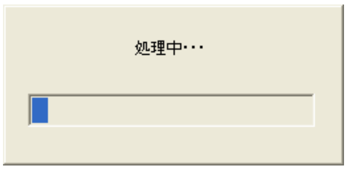
Set value	Explanation
Auto-tuning displacement	Set the travel angle by which the motor shaft turns when estimating the load. The displacement of the actuator's output shaft is calculated by 1/reduction ratio. A desired value of 1,500 to 6,000 degrees can be set. Set as large a value as possible to improve the accuracy of load estimation.
Level selection	Select the level of auto-tuning. A desired value between 1 and 5 can be set. The higher the level, the higher the servo rigidity becomes after tuning.

3 **Click the "Execute" button.**

4 **When an alert message is displayed, click the "OK" button if no problem is found.**

Auto-tuning is performed and the motor rotates. A progress screen is displayed during auto-tuning. Perform auto-tuning after thoroughly checking the condition of equipment and surrounding areas.





5 **When the auto-tuning is completed, the servo gain is displayed.**

After the auto-tuning, the [position loop gain], [speed loop gain], [speed loop integral compensation] and [load inertia moment ratio] are changed to values appropriate for the estimated load.

Caution

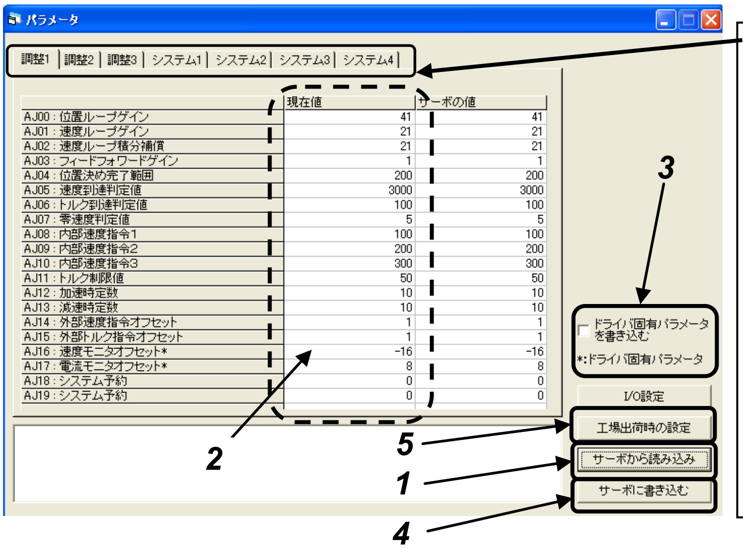
- If the load varies greatly with the rotation position, if the speed limit and torque limit functions are enabled, it is not possible to estimate the load properly, so auto-tuning is impossible. Adjust manually.

10-3 Parameter setting

In the "Parameter Setting" window, you can check and change the values set in tune mode parameters and system parameters.

10-3-1. Editing and initializing internal parameters of the driver

The following explains how to edit the set values for internal parameters of the driver during communication.



Adjustment 1: The set values for adjustment mode parameters AJ00 to AJ19 can be checked and changed.
Adjustment 2: The set values for adjustment mode parameters AJ20 to AJ39 can be checked and changed.
Adjustment 3: This is reserved for the system.
System 1: The set values for system parameters SP00 to SP19 can be checked and changed.
System 2: The set values for system parameters SP20 to SP39 can be checked and changed.
System 3: The set values for system parameters SP40 to SP59 can be checked and changed.
System 4: The set values for system parameters SP60 to SP79 can be checked and changed.

1 **Open the "Parameter Setting" window.**
In the "Parameter Setting" window, click the "Load from Servo" button.

The currently set values are loaded from the driver and displayed in the [Servo Value] and [Current Value].

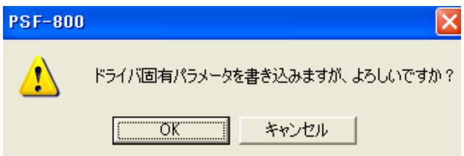
2 **Click the "Current Value" field of the parameter you want to change, and enter the desired value.**

The parameter you have changed illuminates in red.

3 **Select the "Write driver-specific parameters" check box if you want to write the driver-specific parameters (AJ16: Speed monitor offset, AJ17: Speed monitor offset).**

4 **Click the "Write to Servo" button.**

The new value (the contents of the [Current Value]) is transferred to the driver.
When the "Write driver-specific parameters" check box is selected, a verification screen appears.
Click the "OK" button to write the parameters. Click the Cancel button if you don't want to write the parameters.



*The [Servo Value] display will not be updated after [Write to Servo] is executed.
Executing [Load from Servo] updates the [Servo Value] and the latest set values after the writing for internal parameters of the driver are displayed.

Caution

- If the writing cannot be executed correctly due to the communication errors etc., a warning message is displayed.
  Execute [Write to Servo] again.

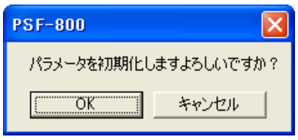
Procedure to reset parameters to their defaults (factory-set values)

Caution

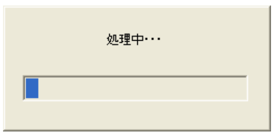
- Perform this operation while the servo is OFF. After the initialization, be sure to reconnect the HA-800A driver power.
- All parameters are initialized (excluding AJ16 and AJ17).
  Since the I/O signal assignments and control mode settings are also initialized, it is recommended that you write down the necessary parameters or SAVE them before the initialization. The parameters can be saved or read for the set values on a PC in accordance with [10-5 Saving the set values].

5 **Click the “Default Settings” button.**

Verification screen is shown. Click the "OK" button to initialize. Click the "Cancel" button to stop initialization.



6 **A progress screen is displayed. Wait for a while, and the values will return to their defaults.**



10 Communication software

10-4 Assigning I/O signals

The following explains how to assign I/O signals to/from the host device. For the I/O signals, refer to [Chapter 5 I/O signals].

Assigning input signals

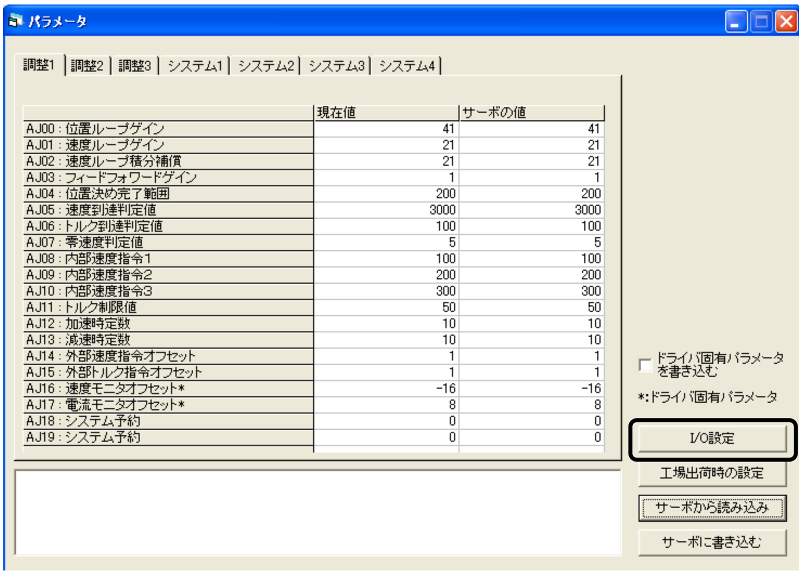
In the "Input Signals" tab of the "I/O Setting" window, you can set how various input settings are assigned to input pins, along with the applicable logics. You can select desired input pins from among the input pins IN1 to IN8 of the CN2 connector (pins 2 to 7, 9 and 10 of CN2).
Multiple input settings can be assigned to one input pin. It is also possible not to assign any input pin to a given input setting.

Caution

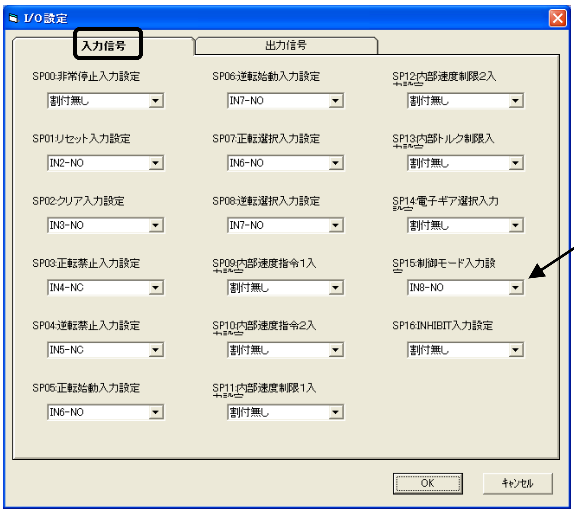
- Multiple input signals can be assigned to one pin. Unnecessary signals should be deleted from the pin assignments. If unnecessary signals are assigned, the system will not operate as expected.
- With signals that are not assigned to pins, their functions are enabled. For example, setting the normally closed (contact B) logic without assigning the emergency stop signal to a pin will cause the system to remain in an emergency stop state. The functions of all other input signals are also enabled. So, exercise caution that setting the normally closed (contact B) logic will enable the functions of these other signals at all times.

1 **In the "Parameter Setting" window, click the "I/O Setting" button.**

Click the "Load from Servo" button to activate.



2 **Click the "Input Signals" tab and select the input pins to which to set various input signals.**



Set the assignment and logic for each input signal.
(Example) Assign the control mode selection input to input 8 (pin 10 of CN2) with the normally open logic (enabled when the opt-isolator is ON).

3 **When all settings are completed, click the "OK" button.**

4 **Click the "Write to Servo" button.**

The set values are written to the servo.

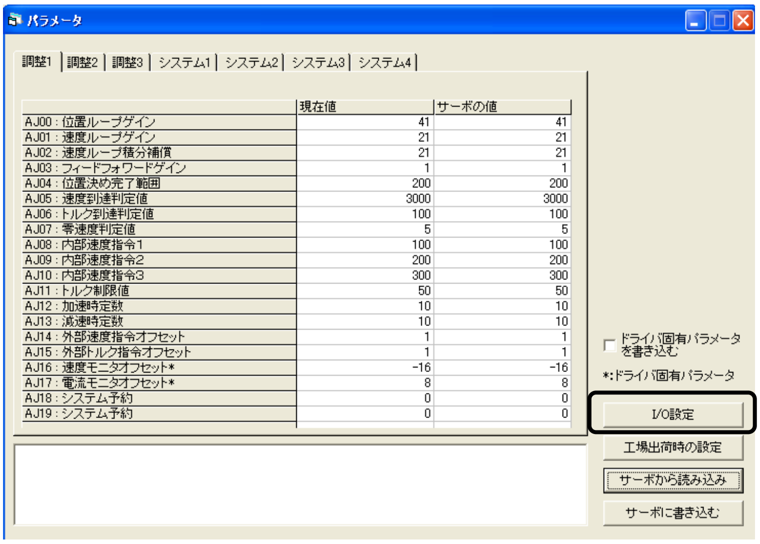
* Changes to system parameter settings (SP00 to 79) are put into effect by changing the setting, then turning control power supply OFF, then ON again.

Assigning output signals

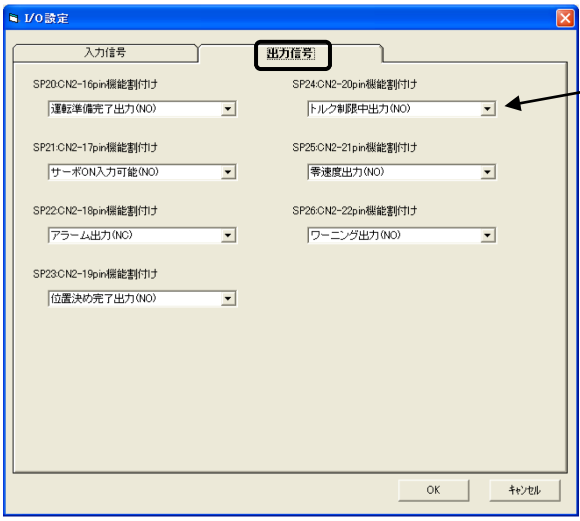
In the "Output Signals" tab of the "I/O Setting" window, you can assign output signals to respective output pins, along with the applicable logics. Multiple output signals cannot be assigned to one pin.

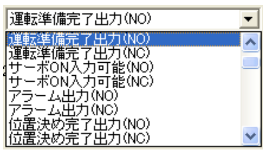
1 **In the "Parameter Setting" window, click the "I/O Setting" button.**

Click the "Load from Servo" button to activate.



2 **Click the "Output Signals" tab and select the output signal for each output pin.**





Assign the signal to the output port.
(Example) Assign the torque limiting signal to [SP24: Pin 20 of CN2] based on the normally open logic (enabled when the opt-isolator is ON).

3 **When all settings are completed, click the "OK" button.**

4 **Click the "Write to Servo" button.**

The set values are written to the servo.

* Changes to system parameter settings (SP00 to 79) are put into effect by changing the setting, then turning control power supply OFF, then ON again.

10-5 Saving and reading set values

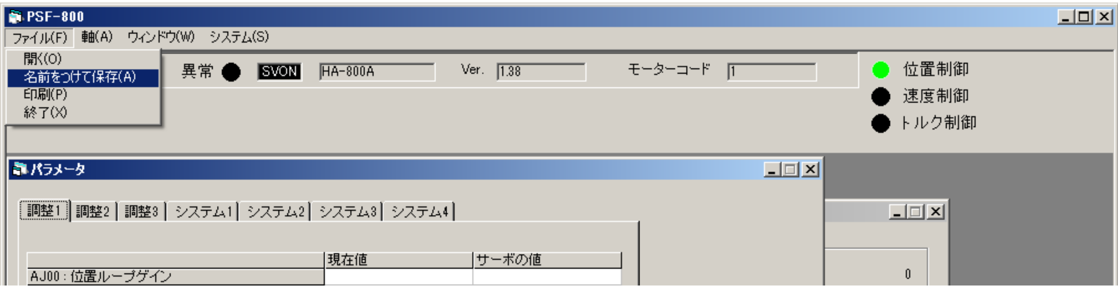
The following explains how to back up the set values to a personal computer.
Save parameter set value, test operation patterns, and waveform monitor data in files from the parameter setting, test operation, and waveform monitoring windows, respectively. Execute saving and reading set values for each window with the each window open. The following explains procedures within the parameter window.

10-5-1. Saving set parameter values

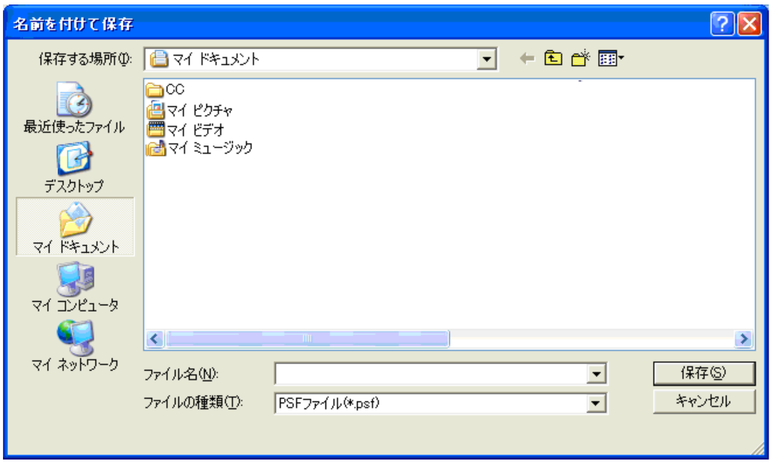
The following explains how to back up the set values for internal parameters of the driver to a personal computer.

Saving procedure

1 **Open the "Parameter Setting" window. (Same as step 1 in 10-3-1)**
In the "Parameter Setting" window, click the "Load from Servo" button.
The currently set values are loaded from the driver and displayed in the [Servo Value] and [Current Value].
Select "Save As" from the "File" menu.



2 **Set a desired folder and file name, and click the "Save" button.**



Caution

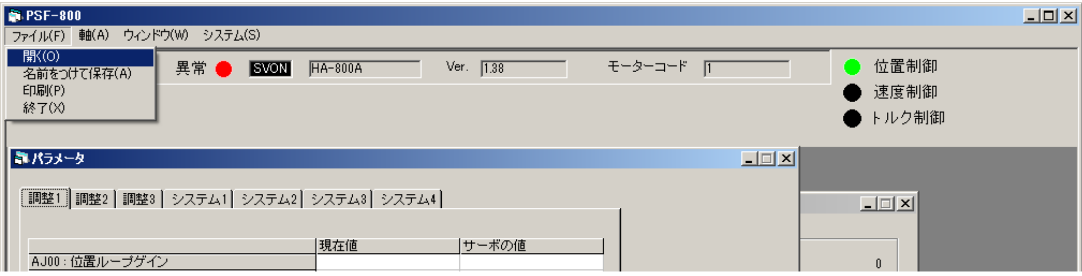
- Be sure to perform "Load from Servo" before performing "Save As" .
- The parameters saved by this operation are [Adjustment 1], [Adjustment 2], [Adjustment 3], [System 1], [System 2], [System 3], [System 4].

10-5-2. Reading saved set value files

The following explains how to read set values backed up on a personal computer.
The set values can be compared or copied while connected to the driver, or saved set values can be checked offline while disconnected from the driver.

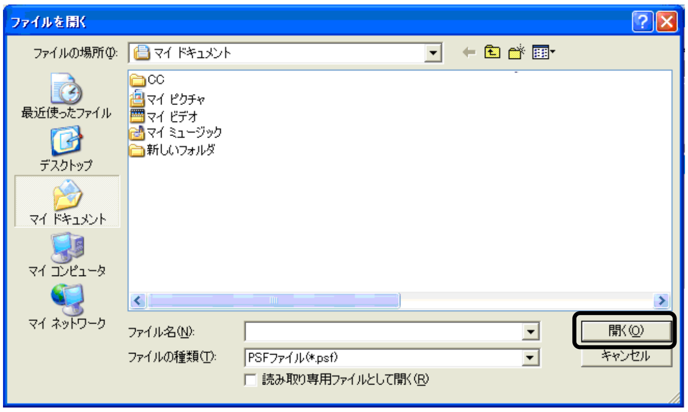
Loading procedure

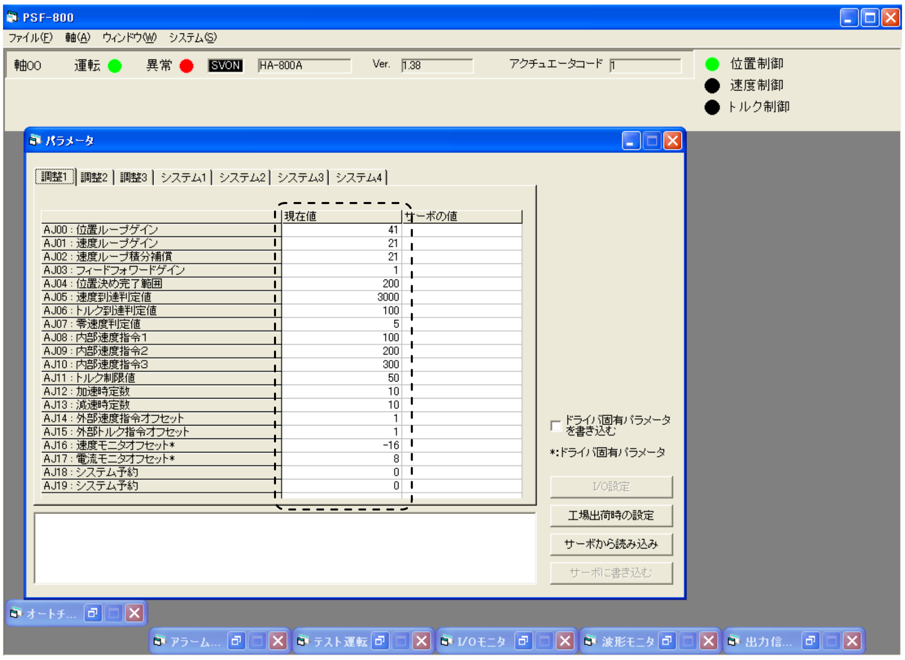
1 Open the "Parameter Setting" window.
Select "Open" from the "File" menu.



2 Set a desired file name, and click the "Open" button.

The set values for the saved settings file are loaded and displayed in the [Current Value].





10-5-3. Comparing a saved settings file with internal set values of the driver

The following explains how to compare the set values backed up on a personal computer with internal parameters of the driver during communication. *Comparison is a function that can be used with the parameter window only.

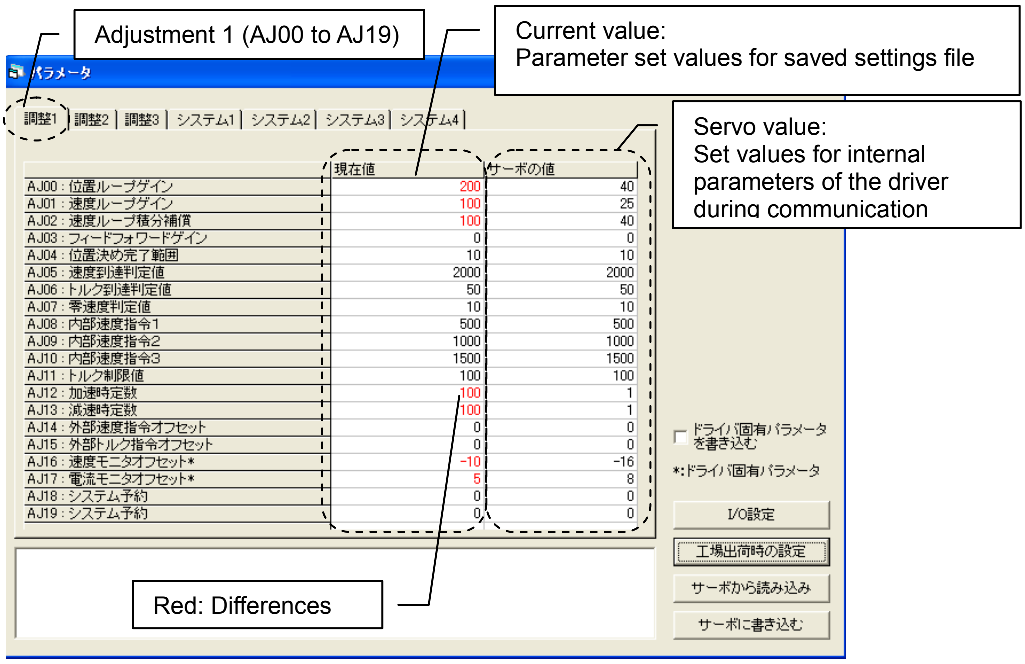
Comparison procedures

1 **Read the internal parameters of the driver during communication. (Same as step 1 in 10-3-1)**
Open the "Parameter Setting" window.
In the "Parameter Setting" window, click the "Load from Servo" button.

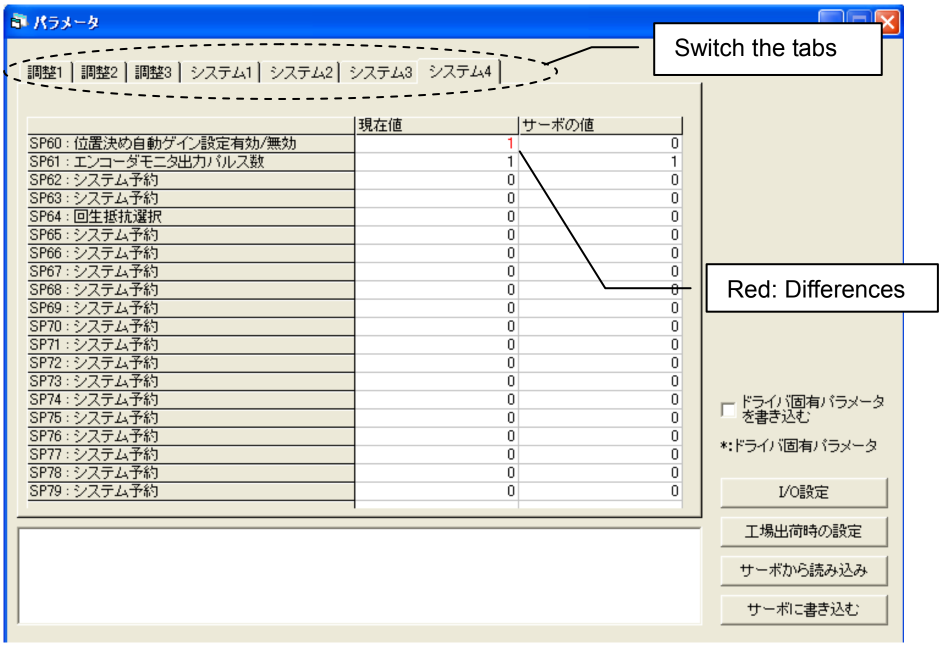
The currently set values are loaded from the driver (internal parameters of the driver during communication) and displayed in the [Servo Value] and [Current Value].

2 **Read the saved settings file. (Same as steps 1 to 2 in 10-5-2)**
Select "Open" from the "File" menu.
Set a desired file name, and click the "Open" button.

The set values for the saved settings file are loaded and displayed in the [Current Value].
The differences between the set values for the saved settings file and the set values for the internal parameters of the driver during communication are displayed in red.



3 **Switch the tabs to check all the comparison results.**
Switch the tabs to check the comparison results for all the following parameters: [Adjustment 1], [Adjustment 2], [Adjustment 3], [System 1], [System 2], [System 3], [System 4].



Caution

- The default setting of the system reservation may vary depending on the model/version. Therefore, the differences in the system reservation can be seen in the comparison results, but this is not a problem (It does not affect the product functions).

10-5-4. Writing a saved settings file to the driver

The following explains how to write (copy) the set values backed up on a personal computer to the internal parameters of the driver during communication.

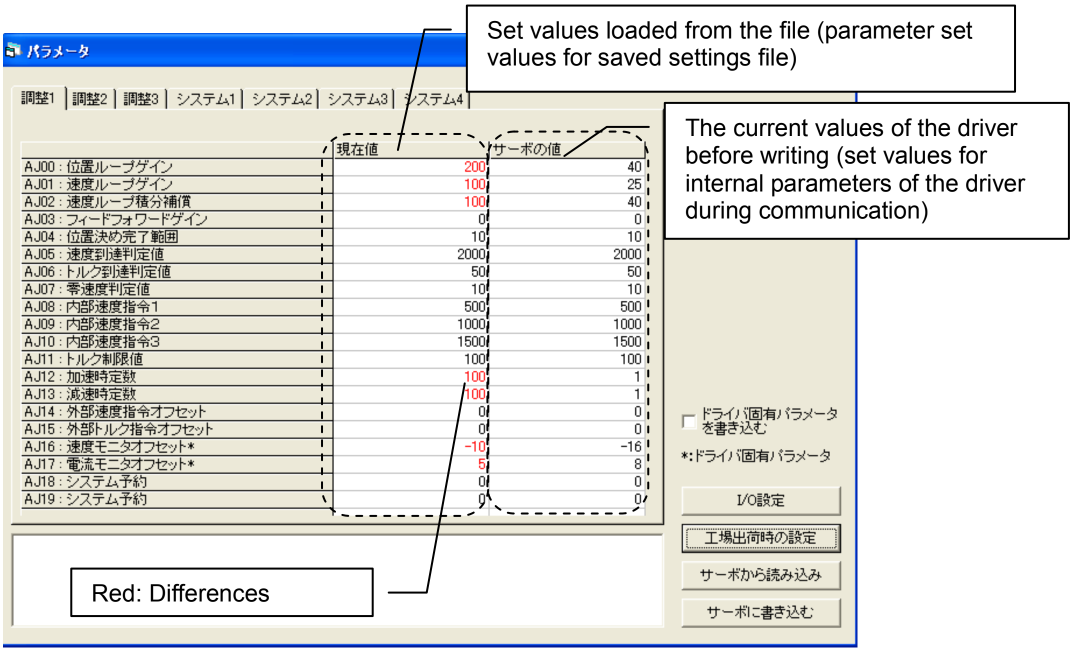
Comparison procedures

1 **Read the internal parameters of the driver during communication. (Same as step 1 in 10-3-1)**
Open the "Parameter Setting" window.
In the "Parameter Setting" window, click the "Load from Servo" button.

The currently set values are loaded from the driver (internal parameters of the driver during communication) and displayed in the [Servo Value] and [Current Value].

2 **Read the saved settings file. (Same as steps 1 to 2 in 10-5-2)**
Select "Open" from the "File" menu.
Set a desired file name, and click the "Open" button.

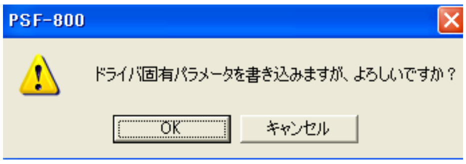
The set values for the saved settings file are loaded and displayed in the [Current Value].
The differences between the set values for the saved settings file and the set values for the internal parameters of the driver during communication are displayed in red.



3 **Select the "Write driver-specific parameters" check box if you want to write the driver-specific parameters (AJ16: Speed monitor offset, AJ17: Speed monitor offset). (Same as step 3 in 10-3-1)**

4 Click the "Write to Servo" button. (Same as step 4 in 10-3-1)

The set values for the saved settings file displayed in the [Set Value] is written to the driver during communication.
When the “Write driver-specific parameters” check box is selected, a verification screen appears.
Click the “OK” button to write the parameters. Click the Cancel button if you don’t want to write the parameters.



*The [Servo Value] display will not be updated after [Write to Servo] is executed.
Executing [Load from Servo] updates the [Servo Value] and the latest set values after the writing for internal parameters of the driver are displayed.

Caution

- If the writing cannot be executed correctly due to the communication errors etc., a warning message is displayed.
  Execute [Write to Servo] again.
- If the warning message is displayed repeatedly, perform the parameter comparison and identify the parameters that cannot be copied.
  As a result of comparison, if the parameter displayed as different (the parameter that cannot be written (copied)) is the system reservation only, it does not affect the product functions.

Caution

- The parameters written (copied) by this operation are [Adjustment 1], [Adjustment 2], [Adjustment 3], [System 1], [System 2], [System 3], [System 4].

10-6 Test operation

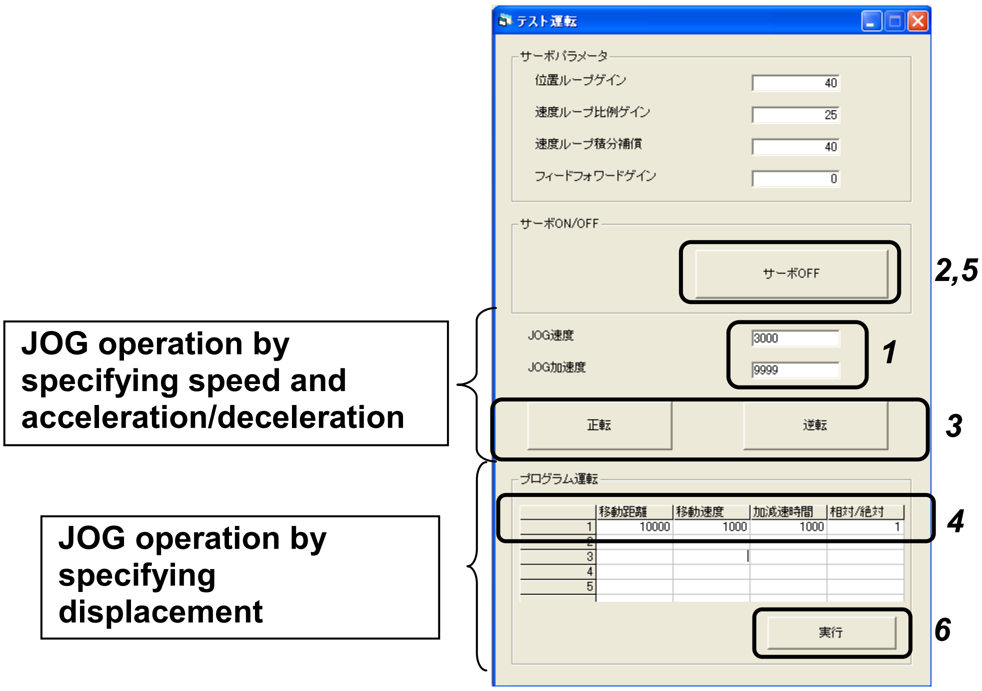
You can specify a speed to perform simple JOG operation, or perform JOG operation by specifying a displacement.

WARNING

- **Any input other than emergency stop during a JOG operation is ignored. Accordingly, the actuator operates ignoring even the FWD/REV inhibit input signals; operate carefully paying attention to the surrounding conditions.**
- **Do not perform T04 JOG operation by pressing the driver push-button simultaneously. The operation becomes unstable.**
- **The speed limit function and torque limit function are disabled during the JOG operation.**

Caution

- A "JOG operation" cannot be started if the actuator servo is ON with a CN2-2 servo-ON input. Turn OFF the CN2-2 servo-ON input.
- In test operation, as seen from the output shaft side and regardless of [SP50: Command polarity]
  During jog operation: When forward, displacement set: Rotates in the clockwise direction for positive travel distance setting
  During jog operation: When reverse, displacement set: Rotates in the counter-clockwise direction for negative travel distance setting
  With the SHA-SG/HP series, rotation is in the opposite directions.
- Note that after test operation, the current value on the host device and the actual machine position differ.



JOG operation (executing jog operations with speed and acceleration/deceleration specified)

1 **Set the JOG speed (r/min) and JOG acceleration/deceleration time (ms)*1.**

2 Click the "Servo-ON" button to activate the servo-ON of the actuator.

The button text changes to "Servo OFF".

3 Bring the mouse cursor to the "FWD" button. The actuator moves in the forward direction while the "FWD" button is held down with the mouse. To move the actuator in the reverse direction, click the "REV" button.

Program operation (JOG operation by specifying displacement)

1 Set the travel distance (pulses), rotation speed (r/min), acceleration/deceleration time (ms)

The electronic gear settings (including SP67: Output shaft divide function settings) do not function in jog operations. Set the desired travel distance (pulses) based on the output shaft resolution.

2 Click the "Servo-ON" button to activate the servo-ON of the actuator.

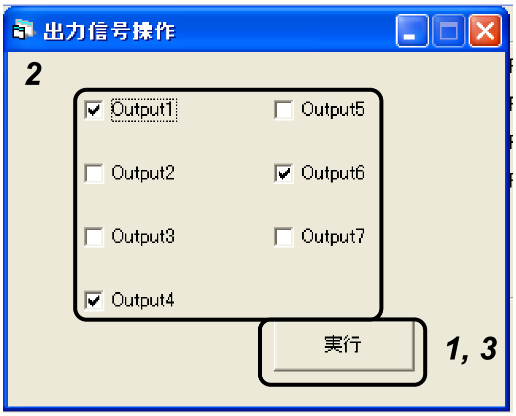
The button text changes to "Servo OFF".

3 Click the desired number (1 to 5), then click the "Execute" button to start program operation. The actuator will stop after moving the specified travel distance.

*1: Set the acceleration/deceleration time for the time the actuator reaches its max. rotational speed from standstill.

10-7 Output signal operation

The signals corresponding to outputs 1 to 7 can be turned ON/OFF as desired.



1 **Click the "Execute" button.**

2 **Select the signal you want to output.**

The selected signal turns ON.
This can be used to check/verify with your host devices.

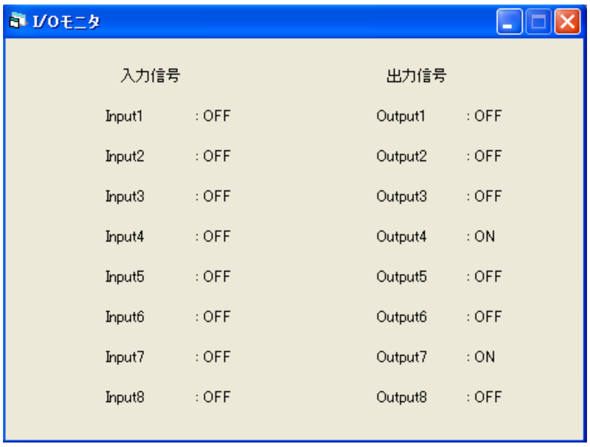
3 **If you click "Execute" button again, the output signal operation is ended and the operated output signal return to the original status.**

Caution

- This cannot be used at the same time as the [T01: Output signal operation] performed by operating the driver panel.
- Take note that, in this operation, the actual output signals are output and the device may be activated by the operation. Also, the operation can be done even when HA-800A is being automatically operated by the command from the host controller. Please keep this in mind during the actual operation.
- This operation cannot be executed at the same time as the output signal operation from test mode.

10-8 IO monitor

The statuses of pins to which input signals and output signals are assigned can be monitored.



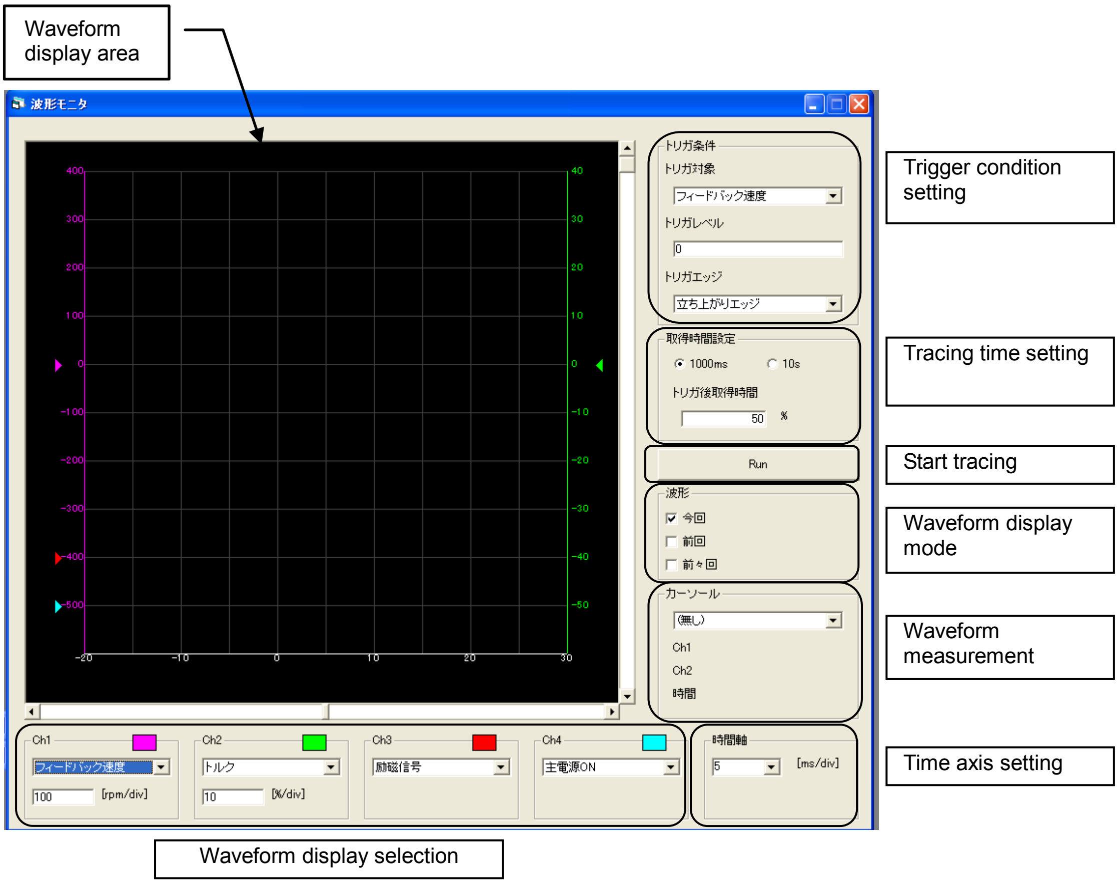
The statuses of input and output signal pins are displayed.
The following statuses are available:

Input signals
- ON: Input received
- OFF: No input

Output signals
- ON: Outputting
- OFF: Output OFF

10-9 Waveform monitoring

In addition to speed and torque, waveforms of various status signals can be displayed.



How to obtain waveform

1 **Select the desired waveform using the waveform display selection.**

Different speeds and torques can be selected for Ch1 and Ch2.After selecting the torque and speed, also set the 1 division display.

2 **Set the trigger condition.**

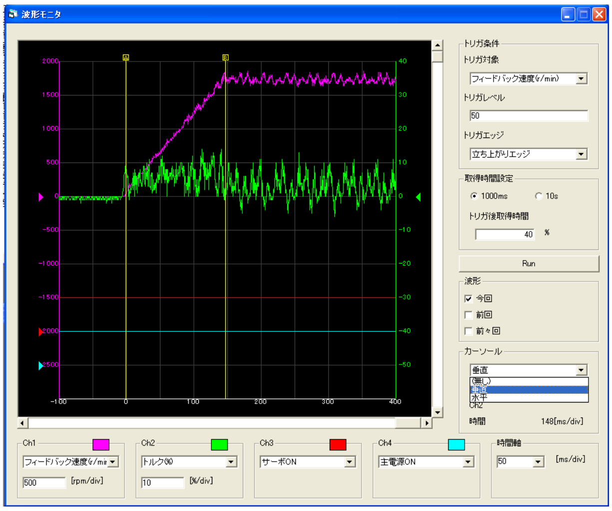
3 **Set the tracing time.**

If "1000ms" is selected, you can set a desired value between 5 and 100 ms/div as the time axis range to be displayed. If "10s" is selected, a desired value between 100 and 1,000 ms/div can be selected. Select the time axis setting from the pull-down menu.

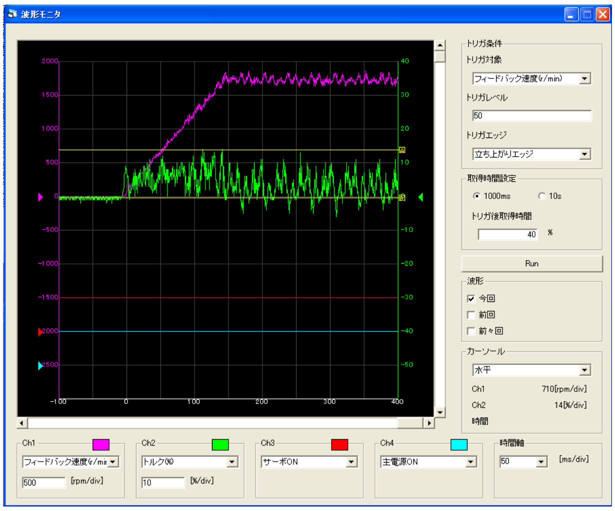
4 Click the "Run" button.

If the "Run" button shows "Stop", the trigger is waited. The system waits for a trigger and when the set trigger level is reached, it acquires waveform and displays it in the waveform display area. It takes some time to acquire waveforms.

- You can select an appropriate waveform display mode to display the current waveform together with the last waveform or waveform acquired before the last.
- In the waveform measurement area, you can perform time axis measurement and speed/torque measurement.
  It takes some time to acquire waveforms.
- You can also use the waveform display selection to change the waveform displayed after acquiring the waveform.



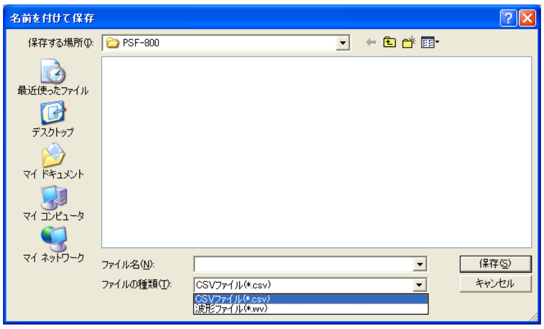
Time axis measurement
(measurement of rise time)



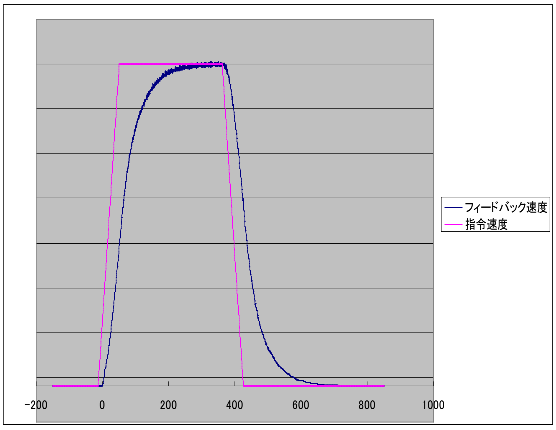
Speed/torque
measurement

5 **You can select "Save As" from the "File" menu to save the waveform data.**

You can assign the CSV format and wv format of the waveform data. If saving waveform data in the CSV format, you can read it using Excel. However, with the PSF-800, it is not possible to show the waveform data by opening it from the File menu. If saving waveform data in the wv format, you cannot read it using Excel, etc. However, you can display the waveform data with the PSF-800 by selecting Open in the File menu.

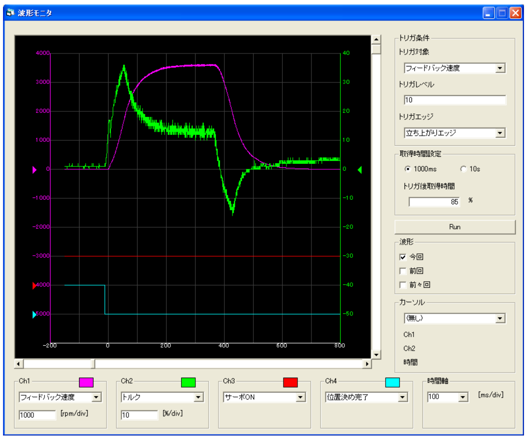


・CSV format



Excel display available.

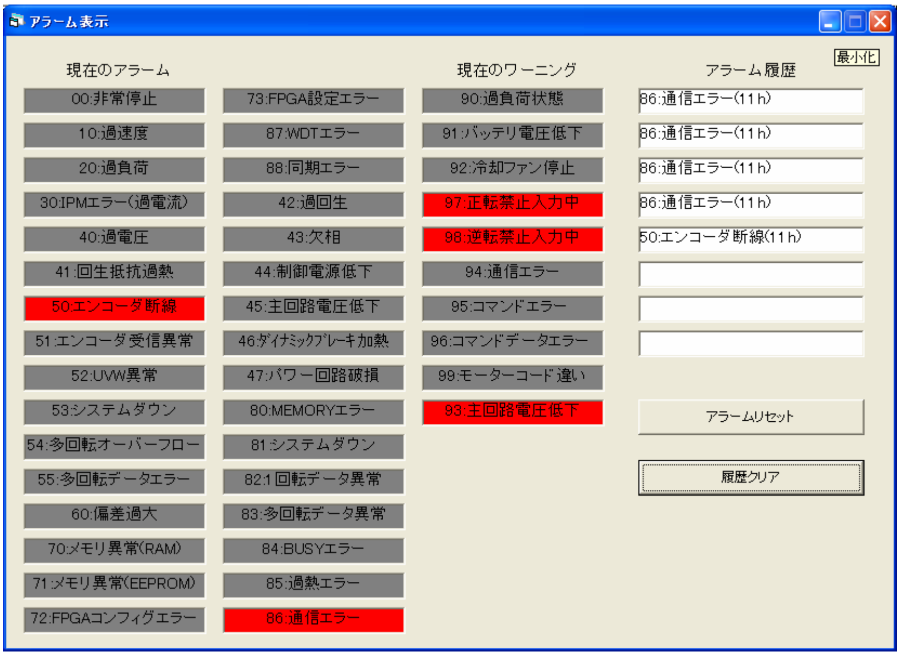
・wv format



Able to read the waveform on the PSF-800 again.

10-10 Alarms

If the HA-800A driver is generating an alarm or warning, you can check the content of the alarm/warning. A present alarm or warning is shown in the red border, as illustrated below.
You can also display and check the history of up to 8 most recent alarms.



Alarm reset

A resettable alarm whose status has been removed can be reset using the "Alarm Reset" button.

Clear history

You can clear the history of up to 8 most recent alarms using the "Clear History" button.

10

Communication software

Chapter 11

Troubleshooting

Details of how driver alarms and warnings generate are explained in this chapter.

11-1 Alarms and remedial actions

The driver has built-in functions to display alarms and warnings that generate during actuator operation and protect against abnormal events.

Alarm: If the actuator or driver enters an abnormal state, the driver generates an alarm and outputs an alarm signal, while turning OFF the servo loop at the same time.

Warning: A warning is displayed before the actuator or driver generates an alarm. The servo loop remains ON. Remove the cause of the warning as soon as possible.

If the actuator or driver's protective function is actuated, the actuator stops moving (servo-OFF of the motor) and the applicable 2-digit alarm code appears on the display. At the same time, the 3-bit code is output to the host device.

In addition, up to 8 most recent alarms and total operating hours (unit: h) of the driver when each alarm occurred are also displayed.

For the alarm history, refer to [Alarm mode] (P7-9).

Alarm list

The following alarms are displayed.

Alarm code	Alarm name	3-bit code	Alarm code[*1]			Alarm clear
			ALM-CO D3	ALM-CO D2	ALM-CO D1	
AL01	Emergency stop	100	1	0	0	Possible[*5]
AL10	Overspeed	110	1	1	0	Impossible
AL20	Overload	100	1	0	0	Possible[*5]
AL30	IPM error (overcurrent)	110	1	1	0	Impossible
AL40	Overvoltage	110	1	1	0	Impossible
AL41	Regenerative resistor overheat	110	1	1	0	Impossible
AL42	Overregeneration[*6]	110	1	1	0	Impossible
AL43	Missing phase[*6]	110	1	1	0	Impossible
AL44	Control power voltage low[*6*7]	110	1	1	0	Impossible
AL45	Main circuit voltage low[*6]	110	1	1	0	Impossible
AL46	Overheated dynamic brake[*6]	110	1	1	0	Impossible
AL47	Damaged power circuit	110	1	1	0	Impossible
AL50	Encoder disconnection	111	1	1	1	Impossible
AL51	Encoder receiving error[*1, *2]	111	1	1	1	Impossible
AL52	UVW error[*2]	111	1	1	1	Impossible
AL53	System failure[*3]	111	1	1	1	Impossible
AL54	Multi revolution overflow[*3]	111	1	1	1	Impossible
AL55	Multi revolution data error[*3]	111	1	1	1	Impossible
AL60	Excessive deviation	100	1	0	0	Possible[*5]
AL70	Memory failure (RAM)	101	1	0	1	Impossible
AL71	Memory failure (EEPROM)	101	1	0	1	Impossible
AL72	FPGA configuration error	111	1	1	1	Impossible
AL73	FPGA setting error	111	1	1	1	Impossible
AL76	Processor error[*7*8]	010	0	1	0	Impossible
AL80	MEMORY error[*4]	111	1	1	1	Impossible
AL81	System failure[*4]	111	1	1	1	Impossible
AL82	Single rotation data error[*4]	111	1	1	1	Impossible
AL83	Multi revolution data error[*4]	111	1	1	1	Impossible
AL84	BUSY error[*4]	111	1	1	1	Impossible
AL85	Overheat error[*4]	111	1	1	1	Impossible
AL86	Communication error[*4]	111	1	1	1	Impossible

*1: If an alarm code output is assigned to an output signal (one of pins 16 to 22 of CN2) and the signal function is set to 01 (values set in the second and third digits), read 1 as 0, and 0 as 1.
For the assignment of output signals and setting of their functions, refer to [Chapter 5 I/O signals].

*2: These alarms may generate when an incremental encoder is combined.

*3: These alarms may generate when a 13-bit absolute encoder is combined.

*4: These alarms may be generated when combining with a 17-bit absolute encoder (including the 17-bit encoder incremental model).

*5: Once alarms are reset using the alarm clear input, the servo will not turn ON even if [CN2-2: S-ON input] is ON. After the reset, turn OFF [CN2-2: S-ON] and then turn it ON again.
During position-controlled operation, alarms can be reset using the alarm reset signal, but the deviation will not be cleared. If an alarm generates, clear the deviation using the clear signal and then reset the alarm using the alarm reset signal. (If [SP48: Deviation clear upon servo-ON] is set to 1, deviation is automatically cleared to 0 when the servo turns ON.)

*6: This alarm may generate in HA-800A-24.

*7: This alarm is not stored in the alarm history.

*8: The alarm code (3-bit code) may become indeterminable depending on the occurrence condition of alarm.

Remedial action for alarm

Remedial actions are explained for respective alarms.

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL01	Emergency stop	An emergency stop signal was input.	The alarm occurs when the control circuit power is turned ON:	● The emergency stop input is assigned to CN2: → Check wiring and connector of emergency stop input signal. → Check the logic and status of the emergency stop signal. ● The emergency stop input is not assigned to CN2: → Set the signal logic to normally open.
			The alarm occurs during operation:	● Cancel the emergency stop signal and reconnect the control power supply or input a reset signal. ● Wrong emergency stop signal wiring → Check wiring and connector of emergency stop input signal. ● Malfunction due to noise → Check the noise environment. ● Control circuit error → Contact our sales office.
AL10	Overspeed	The motor rotation speed exceeded the maximum rotation speed of the motor.	The alarm occurs when the control circuit power is turned ON:	Control circuit error → Contact our sales office.
			The alarm occurs due to high-speed actuator rotation when a rotation command is input:	● Overshoot due to inappropriate gain adjustment → Adjust [AJ00: Position loop gain], [AJ01: Speed loop gain] and [AJ02: Speed loop integral compensation] to match the load condition. ● Excessive command pulse frequency → Lower the command output pulse frequency on the host device. Set a frequency not exceeding the maximum rotation speed of the actuator (r/min). ● Inappropriate electronic gear setting → The command frequency is too large for [SP44, 45, 46, 47: Electronic gear setting] or [SP67: Output shaft divide function setting]. Set appropriate electronic gear. Alternatively, modify the command frequency.

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL10	Overspeed	The motor rotation speed exceeded the maximum rotation speed of the motor.	The alarm occurs due to high-speed actuator rotation when a rotation command is input:	● Wrong speed input factor setting → Set the correct speed input factor in [SP51: Speed input factor]. ● Excessive torque command input voltage → Lower the torque command output voltage on the host device. ● Wrong torque input factor setting → Set the correct torque input factor in [SP53: Torque input factor].
AL20	Overload	The allowable continuous current was exceeded.	The alarm also occurs when only the actuator is operated (no load):	● Wrong motor or encoder connection → Connect the motor/encoder correctly by referring to [Chapter 2 Installation/wiring]. ● Large friction torque → Confirm that holding brake is released.
			The alarm occurs when the control circuit power is turned ON:	● Control circuit error → Contact our sales office.
			The alarm occurs during operation:	● Current 1.2 times the allowable continuous current or more was supplied for an extended period of time. ● Current 3 times the allowable continuous current was supplied for approx. 2 seconds. → Review the effective load rate of the actuator, and then reconnect the power supply to resume the operation. ● Large friction torque and load torque → Confirm that holding brake is released. → Confirm that the actuator output torque is sufficient to handle load torque.
			The alarm occurs after the actuator exhibits hunting:	● Hunting due to inappropriate gain adjustment → Adjust [AJ00: Position loop gain], [AJ01: Speed loop gain] and [AJ02: Speed loop integral compensation] in the tune mode to match the load condition.

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL30	IPM error (overcurrent)	The servo current control element detected an overcurrent.	The alarm occurs when the control circuit power is turned ON:	● Control circuit error → Contact our sales office.
			The alarm occurs when [CN2-2: Servo-ON] is input (ON):	● Control circuit error → Contact our sales office.
			The alarm occurs when [CN2-2: Servo-ON] is input (ON), but a normal condition is restored once the motor cable (U, V, W) is disconnected:	● Short-circuit the motor cable → Inspect/reconnect or replace/repair the connection points of the motor cable. ● Short-circuit the motor coil → Contact our sales office. (Replace the actuator.)
			The alarm occurs during acceleration or deceleration:	● The load inertia moment (inertia) is excessive or acceleration/deceleration time is too short. → Lower the load inertia moment. → Increase the time set in [AJ12: Acceleration time constant] or [AJ13: Deceleration time constant] in the tune mode. ● The gain is too high or too low. → Adjust [AJ00: Position loop gain], [AJ01: Speed loop gain] and [AJ02: Speed loop integral compensation] in the tune mode to match the load condition. ● Faulty wiring of regenerative resistor (HA-800A-24) → Resistance of an external regenerative resistor is low. Or it is short-circuited. It is connected in parallel with a built-in regenerative resistor.
			The alarm occurs during operation (operation can be resumed after 4 to 5 minutes):	● Overload → Review the effective load rate of the actuator and lower the load rate. ● The ambient temperature of the driver is 50℃ or above. → Review the installation location and cooling system of the driver.
			The alarm occurs when cutting the main circuit power OFF:	● Faulty wiring of regenerative resistor (HA-800A-24) → Resistance of an external regenerative resistor is low. Or it is short-circuited. It is connected in parallel with a built-in regenerative resistor.

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL40	Overvoltage	The main circuit voltage exceeded approx. 400 VDC.	The alarm occurs during operation:	● Excessive load inertia moment → The built-in regenerative resistor does not function. Connect short bar to R1 and R3 terminals. → Connect a regenerative resistor to the R1 and R2 terminals. → Increase the deceleration time. → Lower the maximum speed. → Lower the load inertia moment. ● Overvoltage detection circuit error → Contact our sales office.
AL41	Regenerative resistor overheat	The thermal switch installed on the regenerative resistor actuated.	The alarm occurs during deceleration:	● Insufficient regenerative resistor capacity → Install an external regenerative resistor to raise the regenerative absorption capacity. → When using an external regenerative resistor in HA-800A-24, set [SP64: Regenerative resistor selection] to [1: Use external regenerative resistor]. ● Regenerative energy processing circuit error → Contact our sales office.
			The alarm occurs after turning the main circuit power ON (HA-800A-24):	● The regenerative resistor is not properly wired or not connected. →Connect the regenerative resistor correctly.
			When an external regenerative resistor is used (HA-800A-24):	● The regenerative resistor is not properly wired or not connected. →Connect the regenerative resistor correctly. ● The parameter setting of regenerative resistor selection (SP64) is wrong. → Change the setting of system parameter SP64 and select an external regenerative resistor.
AL42	Overregeneration (HA-800A-24)	A regenerative resistor absorbed significantly excessive regenerative energy.	The alarm occurs during deceleration:	● Insufficient regenerative resistor capacity → Install an external regenerative resistor to raise the regenerative absorption capacity and change the setting of system parameter SP64. ● Regenerative energy processing circuit error → Contact our sales office. (Replace the HA-800A driver.) ● Load inertia exceeds the adaptive range. → Review the configuration and use the resistor with load inertia within the adaptive range. → Suppress the rotation low to reduce regenerative energy.
			The alarm occurs after turning the main circuit power ON:	● The regenerative resistor is not properly wired or not connected. → Connect the regenerative resistor correctly. → Connect a short bar correctly when using a built-in regenerative resistor.

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Troubleshooting

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL42	Overregeneration (HA-800A-24)	A regenerative resistor absorbed significantly excessive regenerative energy.	When an external regenerative resistor is used:	● The regenerative resistor is not properly wired or not connected. → Connect the regenerative resistor correctly. ● The parameter setting of regenerative resistor selection (SP64) is wrong. → Change the setting of system parameter SP64 and select an external regenerative resistor.
AL43	Missing phase (HA-800A-24)	Single-phase power supply was supplied to the main circuit power input (R, S, T) areas.	The alarm occurs after turning the main circuit power ON:	● Wrong wiring → One phase of 3-phase power supply is not correctly connected. ● Low input voltage → Correct input voltage to a value within the specification range. ● Disconnection of 1 main circuit fuse built into the driver → One of the 2 built-in fuses for 3-phase power supply is disconnected. Ground-fault or faulty wiring of motor output, ground-fault or faulty wiring of regenerative connection terminal → Check the wiring conditions and replace the driver. (The alarm may occur again if you replace the driver without removing the cause.) If the protective fuse gets disconnected, it must be repaired.
AL44	Control power voltage low (HA-800A-24)	The voltage of the control power supply input (r, s) areas dropped.	The alarm occurs during operation:	● Low input voltage → Correct input voltage to a value within the specification range. ● Momentary power failure occurred. → Review the wiring and power supply environment to prevent power failure.
AL45	Main circuit voltage low (HA-800A-24)	Although the main circuit power (R, S, T) is supplied, the main circuit DC voltage dropped.	The alarm occurs when the main circuit power is turned ON:	● It occurs in case of faulty wiring (not wired) of short bar, faulty wiring of DC reactor, and/or open-circuit between DL1 and DL2. → Connect a short bar or DC reactor correctly between driver terminal blocks DL1 and DL2. ● The alarm occurs when a protective fuse built into the driver (2 built-in fuses for 3-phase power supply) is disconnected due to driver damage, faulty wiring, etc. → Check the wiring conditions and replace the driver. (The alarm occurs again if you replace the driver without removing the cause.) If the protective fuse gets disconnected, it must be repaired.

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL46	Overheated dynamic brake (HA-800A-24)	The dynamic brake circuit generated abnormal heat:	The alarm occurs after stopping the dynamic brake:	● The dynamic brake stopped under the conditions where load inertia is excessive or an excessive negative load is connected. → Review the load.
			The alarm occurs when the control power supply is turned ON:	● Driver damage. The driver was damaged when the dynamic brake stopped previously. → Review the load. If the protective fuse gets disconnected, it must be repaired.
A47	Damaged power circuit	The alarm occurs due to errors in the driver power circuit. It cannot be reset.	● The alarm occurs when the control power supply is turned ON: ● The alarm occurs when the servo is ON:	● HA-800A driver power circuit error → Contact our sales office. (Replace the HA-800A driver.)
AL50	Encoder disconnection	Encoder signals have been cut off.	The alarm occurs when the control circuit power is turned ON:	● Non-connection or poor connection of the encoder connector (CN1) or broken encoder wire → Securely connect the encoder connector again. Or, replace the cable. ● Control circuit diagram error ● Internal encoder damage → Contact our sales office.
			The alarm occurs during operation (a normal condition is restored when the actuator cools down):	● Encoder malfunction due to rise in actuator temperature → Review the installation location and cooling system of the actuator.
AL51	Encoder receiving error*1	Encoder serial data cannot be received accurately.	The alarm occurs when the control circuit power is turned ON:	● Non-connection or poor connection of the encoder connector (CN1) or broken encoder wire → Securely connect the encoder connector again. Or, replace the cable. ● Control circuit diagram error ● Internal encoder damage → Contact our sales office.
			The alarm sometimes occurs during operation:	● Malfunction due to external noise → Suppress noise according to [Suppressing noise] (P2-14).

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL52	UVW error	Encoder phase UVW signal error	The alarm occurs when the control circuit power is turned ON:	● Non-connection or poor connection of the encoder connector (CN1) or broken encoder wire → Securely connect the encoder connector again. Or, replace the cable. ● Control circuit diagram error ● Internal encoder damage → Contact our sales office.
			The alarm sometimes occurs during operation:	● Malfunction due to external noise → Suppress noise according to [Suppressing noise] (P2-14).
AL53	System failure*1	Encoder multi revolution data has been lost.	The alarm occurs when the power supply is turned ON for the first time after the purchase:	● The encoder holds no multi revolution data. → Clear the multi revolution data using [T08: Multi revolution clear] in the test mode.
			The control power supply is cut off while the buttery voltage low warning is occurring:	● Replace the battery. → Clear the multi revolution data using [T08: Multi revolution clear] in the test mode. Reconnect the power and perform originating.
AL53	System failure*1	Encoder multi revolution data has been lost.	The power supply was turned ON after the encoder and driver had been left disconnected for an extended period of time:	● Non-connection or poor connection of the encoder connector (CN1) ● Non-connection or poor connection of the battery connector → Connect the encoder connector and battery connector properly. ● Driver control circuit error ● Internal encoder damage → Contact our sales office.
AL54	Multi revolution overflow*1	The multi revolution counter value of the absolute encoder exceeded a range of +4,095 to -4,096 revolutions (motor shaft).	The alarm occurs when the control circuit power is turned ON:	● Driver control circuit error ● Internal encoder damage → Contact our sales office.
			The alarm occurs during operation:	● The actuator turned in one direction and the multi revolution counter value exceeded a range of +4,095 to -4,096 revolutions (motor shaft). → Clear the multi revolution data using [T08: Multi revolution clear] in the test mode.

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Troubleshooting

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL55	Multi revolution data error*1	The rotation angular acceleration and rotation speed of the motor exceeded the allowable response range. (The actuator moved at a speed exceeding the encoder's allowable range while the driver power supply is turned OFF.)	The alarm occurs when the control circuit power is turned ON:	● The actuator's output shaft moved when the driver power was not supplied. → Clear the multi revolution data using [T08: Multi revolution clear] in the test mode. ● Driver control circuit error ● Internal encoder damage → Contact our sales office.
AL60	Excessive deviation	The deviation counter value exceeded the pulse count set in [SP49: Allowable position deviation].	The alarm occurs while the control power supply is being turned ON:	● The actuator moved due to external force and resulted in excessive deviation. → Stop the actuator and reconnect the power supply. → Stop the actuator and clear the deviation, and then reconnect the power supply. ● Driver control circuit error → Contact our sales office.
			The alarm occurs during acceleration or deceleration:	● Low gain → Adjust [AJ00: Position loop gain], [AJ01: Speed loop gain] and [AJ02: Speed loop integral compensation] in the tune mode to match the load condition. ● Inappropriate electronic gear setting → The command frequency is too large for [SP44, 45, 46, 47: Electronic gear setting] or [SP67: Output shaft divide function setting].Set appropriate electronic gear. Alternatively, modify the command frequency.

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL60	Excessive deviation	The deviation counter value exceeded the pulse count set in [SP49: Allowable position deviation].	The alarm occurs during acceleration or deceleration:	● Excessive command pulse frequency → Lower the command output pulse frequency on the host device. The frequency should not exceed the actuator's rated rotation speed (r/min) multiplied by 60. ● Excessive load inertia moment → Lower the load inertia moment. → Slowly increase/decrease the command pulse frequency on the host device.
			The speed does not rise with the command, and the alarm occurs sometime after that:	Cause: The input signal FWD inhibit or REV inhibit is enabled. ● The signal logic is set to normally closed for [SP03: FWD inhibit input setting] and [SP04: REV inhibit input setting], but the signals are not assigned to CN2. → Assign the signals to CN2 and wire them according to the normally closed logic. ● The respective signals are assigned to CN2 and their logic is set to normally closed for [SP03: FWD inhibit input setting] and [SP04: REV inhibit input setting], but the assigned pins are open. → Wire the signals according to the normally closed logic. ● The respective signals are assigned to CN2 and their logic is set to normally open for [SP03: FWD inhibit input setting] and [SP04: REV inhibit input setting], but the assigned pins are closed. → Wire the signals according to the normally open logic. ● Large friction torque and load torque → Confirm that holding brake is released. → Confirm that the actuator output torque is sufficient to handle load torque.
			The actuator does not rotate and the alarm occurs:	● Poor motor cable connection or wrong phase order → Connect the motor cable wires and terminals securely. → Connect the motor wires and terminals in the correct phase order. ● Poor connection of the encoder connector (CN1) → Securely connect the encoder connector again. ● Large friction torque and load torque → Confirm that holding brake is released. → Confirm that the actuator output torque is sufficient to handle load torque.

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL70	Memory failure (RAM)	An error occurred in the driver's RAM memory.	● The alarm occurs when the control circuit power is turned ON: ● The alarm occurs during operation:	● Driver control circuit error → Contact our sales office.
AL71	Memory failure (EEPROM)	An error occurred in the driver's EEPROM memory.	● The alarm occurs when the control circuit power is turned ON: ● The alarm occurs during operation:	● Driver control circuit error → Contact our sales office.
AL72	FPGA Configuration error	The FPGA initialization was not successful when the driver was started.	The alarm occurs when the control circuit power is turned ON:	● Driver control circuit error → Contact our sales office.
AL73	FPGA setting error	The FPGA did not start properly when the driver was started.	The alarm occurs when the control circuit power is turned ON:	● Driver control circuit error → Contact our sales office.
AL76	Processor error	Reconnect the driver's control power supply.	—	● If the processor error is not restored even after the control power supply is reconnected, contact our sales office.
AL80	MEMORY error*2	An EEPROM memory failure occurred in the 17-bit absolute encoder.	The alarm occurs when the control circuit power is turned ON:	● Driver control circuit error or encoder error → Contact our sales office.
AL81	System failure*2	SHA series (excluding SHA20): The voltage of the backup power supply in the absolute encoder or external battery voltage, whichever was higher, dropped to 2.85V or below. SHA20 and FHA-Cmini series: The voltage of the backup battery dropped to 2.85V or below. Stored multi revolution data is lost.	—	This alarm can be reset by executing [T08: Multi revolution data clear] in the test mode, or by assigning the reset input to CN2 using [SP01: Reset input setting] and then activating the reset signal and reconnecting the power. ● Low backup battery voltage → Replace the battery by referring to [Normal operation] (P3-22). ● 17-bit absolute encoder error → Contact our sales office. (Replace the actuator.) ● This alarm may occur if CN1 is pulled off while the driver control power supply is active.

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL82	Single revolution data error*2	Inconsistency occurred between the single revolution data managed by the 17-bit absolute encoder at 2 locations.	The alarm occurs after actuator operation:	This alarm can be reset by executing [T08: Multi revolution data clear] in the test mode, or by assigning the reset input to CN2 using [SP01: Reset input setting] and then activating the reset signal and reconnecting the power. ● 17-bit absolute encoder error → Contact our sales office. (Replace the actuator.)
AL83	Multi revolution data error*2	Inconsistency occurred between the multi revolution data managed by the 17-bit absolute encoder at 2 locations.	The alarm occurs during operation:	● Malfunction due to external noise → Suppress noise according to [Suppressing noise] (P2-14).
AL84	BUSY error*2	The position could not be specified when the 17-bit absolute encoder was started because the actuator was operating at a constant speed or above.	–	● The actuator is operating at a constant speed or above when the encoder is started. → Start the encoder when the actuator is operating at a constant speed or below (ideally the actuator should be stopped). SHA series (excluding SHA20): 300 r/rpm or less SHA20 and FHA-Cmini series: 250 r/rpm or less ● 17-bit absolute encoder error → Contact our sales office. (Replace the actuator.)
AL85	Overheat error*2	The board temperature in the 17-bit absolute encoder reached or exceeded 95℃.	–	● The board temperature in the 17-bit absolute encoder reached or exceeded 95℃. → Remove possible causes of actuator overheat, such as eliminating sudden starts and improving the heat radiation condition. ● 17-bit absolute encoder error → Contact our sales office. (Replace the actuator.)
		The driver's heat sink temperature reached or exceeded 106℃.	–	● The driver's heat sink temperature reached or exceeded 106℃. → Remove possible causes of actuator overheat, such as eliminating sudden starts and improving the heat radiation condition.

Alarm code	Alarm name	Description	Condition at occurrence	Action
AL86	Communication error[*2]	Data could not be received in the driver at least 4 consecutive times.	–	● Defective encoder connector (CN1) → Confirm that the encoder connector is inserted securely. → Confirm that the encoder lead lines are soldered properly. → Check the encoder extension connector for poor contact. ● Malfunction due to noise, etc. → Confirm that the ground wire is connected properly. → Confirm that the encoder cable is shielded properly. → Confirm that the encoder and motor wires are not bundled together.
Not lit		LED display is not turned ON even when the control power supply is turned ON.	The alarm occurs when the control circuit power is turned on:	● The overload protective function in the driver internal power supply circuit was activated due to a short period of power failure, etc. → Cut off the control power supply, wait for about one minute, and reconnect the power. ● Fuse disconnection in the driver → Contact our sales office.

*1: This alarm does not occur when an actuator equipped with a 17-bit absolute encoder is combined.

*2: AL80 to AL86: These alarms may occur when an actuator equipped with a 17-bit absolute encoder is combined. With the 17-bit encoder incremental model, if AL80-AL86 is generated, then after the power is turned OFF then ON again, if AL80-AL86 is generated again, an abnormality in the 17-bit encoder is conceivable. Contact our sales office.

11-2 Warnings and remedial actions

This driver has warning functions to output various conditions before the corresponding protective functions are actuated. If a warning generates, the warning number appears on the display.
If a warning output is assigned to an output signal via a system parameter, the signal is output to the I/O signal connector (CN2).
Although the actuator can be controlled while warnings are present, remove the cause of each warning as soon as possible. (If [UA93: Main circuit voltage low] or [UA99: Wrong actuator] occurs, the actuator cannot be controlled.)

Warning list

A list of alarms that may be displayed is shown below.

Warning code	Warning name	3-bit code	Alarm code		
			ALM-COD3	ALM-COD2	ALM-COD1
90	Overload status	001	0	0	1
91	Battery voltage low	001	0	0	1
92	Cooling fan stopped	001	0	0	1
93	Main circuit voltage low	001	0	0	1
97	FWD inhibit input effective	001	0	0	1
98	REV inhibit input effective	001	0	0	1
99	Wrong actuator	001	0	0	1

Remedial action for warning

Details of each warning are explained.

Warning code	Warning name	Description
UA 90	Overload status	The driver is overloaded. If the warning is ignored and actuator operation is continued, an overload error (AL20) will occur. Take an appropriate action by referring to the section of overload alarm.
UA 91	Battery voltage low	The data backup battery voltage of the absolute encoder dropped to the voltage specified below. Although the actuator operates, leaving the problem uncertified will cause the battery voltage to drop further, resulting in encoder data to be unable to be retained. Replace the battery with a new one as soon as possible. For the SHA series, if the backup capacitor in the encoder is fully charged when power is being supplied to the driver, the backup battery does not detect a drop in voltage. The backup capacitor in the encoder is discharged when the driver's power is turned OFF, and the backup battery does not detect a drop in voltage until the voltage is low. ● 13-bit absolute encoder DC2.8V or below (The warning will be reset automatically when the battery is replaced with a new one.) ● 17-bit absolute encoder (SHA20 and FHA-Cmini series) DC3.1V or less (The warning will be reset automatically when the battery is replaced with a new one.) * In Version 2.x and earlier, after the battery is replaced, turning the power back ON releases UA91. ● 17-bit absolute encoder SHA series (excludng SHA20) DC3.1V or less (Replace with a new battery and execute an alarm reset, and then reconnect the power supply.) (1) Replace with a new battery. (2) Input driver alarm reset. (3) The warning is canceled after reconnecting the power supply.
UA 92	Cooling fan stopped (HA-800A-6 only)	The cooling fan installed in the driver stopped operating for some reason. If the actuator is operated at the rated torque, internal elements of the driver may heat to the junction temperature. Remove the cause of the problem as soon as possible. It is also recommended that the cooling fan be replaced after approx. 5 years of continuous operation.
UA 93	Main circuit voltage low	The DC voltage of the main circuit power dropped to the voltage specified below: ● AC200V actuator DC190V or below (DC220V or less for Ver. 2.02 or older) ● AC100V actuator DC70V or below (DC100V or less for Ver. 2.02 or older) The wiring may be wrong. Refer to [Connecting power cables] (P2-5) and wire appropriately. The input voltage may not be within the specification range. Confirm the main circuit power voltage from the d10 main circuit power voltage status display or the PSF-800 status display, and correct the input voltage to a value within the specification range. If this warning generates, the servo turns OFF. Although the warning will be reset automatically when the main circuit voltage recovers, the [Cn2-2: S-ON] signal must be turned OFF and then turned ON again to turn ON the servo.
UA 97	FWD inhibit input effective	This warning generates when the FWD inhibit input that has been assigned to CN2 is enabled. Once the input is disabled, the warning will be reset. Even when the FWD inhibit input is not assigned, this warning still generates when the main circuit power is turned ON if the logic is set to normally closed. If this input is not assigned, set the logic to normally open.

Warning code	Warning name	Description
UA 98	REV inhibit input effective	This warning generates when the REV inhibit input that has been assigned to CN2 is enabled. Once the input is disabled, the warning will be reset. Even when the REV inhibit input is not assigned, this warning still generates when the main circuit power is turned ON if the logic is set to normally closed. If this input is not assigned, set the logic to normally open.
UA 99	Wrong actuator	The connected actuator is different from the applicable actuator set for the driver. Connect the correct actuator and then reconnect the power. The function is available for the following actuators: 17-bit absolute encoder (SHA series and FHA-Cmini series) and 4-wire incremental encoder (FHA-Cmini series/FHA-C series).

Chapter 12

Option

Options you can purchase as necessary are explained.

12-1 Option

Options you can purchase as necessary are explained.

Extension cables

HA-800A drivers are available in various models having different rated output current and supporting different types of encoders. Combinations of drivers, actuators and extension cables (option) are shown below.

Actuator series	Model No.	Input voltage (V)	Encoder type	Combined driver			Extension cables (option)
				HA-800A-1	HA-800A-3	HA-800A-6	
SHA series	20	200	17-bit Absolute	-	HA-800A-3D/E-200	-	Motor wire EWD-MB**-A06-TN3 Encoder wire EWD-S**-A08-3M14
	25	200		-	HA-800A-3D/E -200	-	
	32	200		-	-	HA-800A-6D/E -200	
	40	200		-	-	HA-800A-6D/E -200	
	25	100		-	-	HA-800A-6D/E -100	
FHA-Cmini series	8	200	4 wires, wire-saving type Incremental	HA-800A-1C-200	-	-	Motor wire EWC-M**-A06-TN3 Encoder wire EWC-E**-M06-3M14
	11	200		HA-800A-1C-200	-	-	
	14	200		HA-800A-1C-200	-	-	
	8	100		HA-800A-1C-100	-	-	
	11	100		HA-800A-1C-100	-	-	
	14	100		HA-800A-1C-100	-	-	
	8	200	17-bit Absolute	HA-800A-1D/E -200	-	-	Motor wire EWC-M**-A06-TN3 Encoder wire EWD-S**-A08-3M14
	11	200		HA-800A-1D/E -200	-	-	
	14	200		HA-800A-1D/E -200	-	-	
	8	100		HA-800A-1D/E -100	-	-	
	11	100		HA-800A-1D/E -100	-	-	
	14	100		HA-800A-1D/E -100	-	-	
FHA-C series	17	200	4 wires, wire-saving type Incremental	-	HA-800A-3C-200	-	Motor wire EWC-MB**-M08-TN3 Encoder wire EWC-E**-B04-3M14
	25	200		-	HA-800A-3C-200	-	
	32	200		-	-	HA-800A-6C-200	
	40	200		-	-	HA-800A-6C-200	
	17	200	13-bit Absolute	-	HA-800A-3A-200	-	Motor wire EWC-MB**-M08-TN3 Encoder wire EWC-S**-B08-3M14
	25	200		-	HA-800A-3A-200	-	
	32	200		-	-	HA-800A-6A-200	
	40	200		-	-	HA-800A-6A-200	
	17	100	4 wires, wire-saving type Incremental	-	HA-800A-3C-100	-	Motor wire EWC-MB**-M08-TN3 Encoder wire EWC-E**-B04-3M14
	25	100		-	-	HA-800A-6C-100	
	32	100		-	-	HA-800A-6C-100	
	17	100	13-bit Absolute	-	HA-800A-3A-100	-	Motor wire EWC-MB**-M08-TN3 Encoder wire EWC-S**-B08-3M14
	25	100		-	-	HA-800A-6A-100	
	32	100		-	-	HA-800A-6A-100	
RSF series	17	200	14 wires Incremental	-	HA-800A-3B-200	-	Motor wire EWA-M**-A04-TN3 Encoder wire EWA-E**-A15-3M14
RSF/RKF series	20	200		-	HA-800A-3B-200	-	
	25	200		-	HA-800A-3B-200	-	
	32	200		-	-	HA-800A-6B-200	

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Option

Actuator series	Model No.	Encoder type	Combined driver HA-800A-24	Extension cables (option)
SHA series	40	17-bit Absolute	HA-800A-24D/E	Motor wire EWD-MB**-A06-TMC Encoder wire EWD-S**-A08-3M14
	58		HA-800A-24D/E	Motor wire EWD-MB**-D09-TMC Encoder wire EWD-S**-D10-3M14
	65		HA-800A-24D/E	

** in the extension cable model indicates the cable length.
Select a desired length from the following 3 types:
03: 3m, 05: 5m, 10: 10m

Dedicated communication cable

Use a dedicated communication cable to connect this driver to a personal computer.

Dedicated communication cable

Model	EWA-RS03
Specifications	D-sub 9 pin (female) 1.6m

Connectors

The CN1, CN2, motor-wire and power-supply connectors of this driver are shown below.

Connector model

CNK-HA80A-S1 : CN1 type/CN2 type/motor-wire type/power-supply type --- 4 types
CNK-HA80A-S2 : CN2 type/power-supply type --- 2 types
CNK-HA80A-S1-A: CN1/CN2 type --- 2 types
CNK-HA80A-S2-A: CN2 type --- 1 type

	CN1 type	CN2 type	Motor-wire type	Power-supply type
Manufacturer	Sumitomo 3M	Sumitomo 3M	Phoenix Contact	Phoenix Contact
Model	Connector: 10114-3000PE Cover: 10314-52F0-008	Connector: 10150-3000PE Cover: 10350-52F0-008	FKIC2,5/5-ST-5.08	FKC2,5/5-ST-5.08

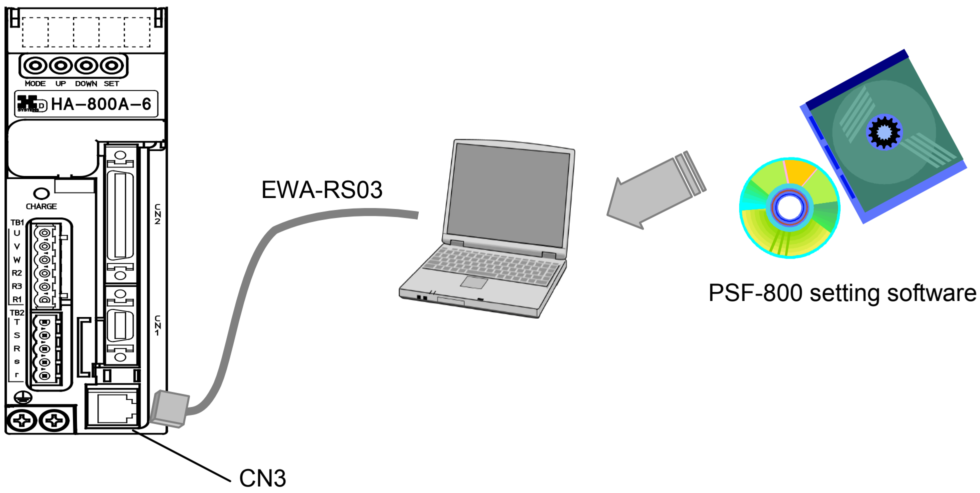
Servo parameter setting software

This software lets you set various servo parameters of your HA-800A driver from a personal computer. Use an EIA-232C cable to connect the CN3 connector on the HA-800A driver to a personal computer in which the servo parameter setting software PSF-800 is installed, and you can change various servo parameters in the driver.
You can download this servo parameter setting software from our website (http://www.hds.co.jp/).

Model	PSF-800
Supported operating systems	Windows® ME, Windows® NT, Windows® 2000, Windows® Xp, Windows Vista®*1, Windows® 7*1
What you need	Dedicated communication cable (EWA-RS03)

*1: Successful operation has been verified on Windows Vista®, and Windows 7®, but it is not guaranteed.

*Microsoft Windows and IntelliMouse are registered trademarks and trademarks of Microsoft Corporation in the United States for use in the United States, Japan and other countries.
* Microsoft Windows Operating System is the full name of Windows.

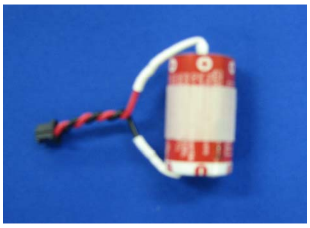


Backup battery

This battery is used to retain multi revolution data of the absolute encoder in the event that the power supply is cut off. All drivers of absolute encoder model are shipped with this battery pre-assembled.

Model code: HAB-ER17/33-2

Battery type	Lithium battery
Manufacturer	Hitachi Maxell, Ltd.
Manufacturer model	ER17/33 (3.6V 1,600 mAh)



Data retention time

Data retention time	Approx. 1 year after the power is cut off
Conditions	Unused power is turned OFF, ambient temperature: 25°C, axis stopped, continuous use (The actual life varies depending on the condition of use.)

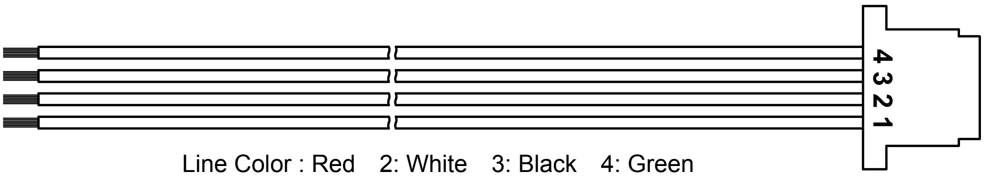
Caution

- A battery purchased separately from the battery manufacturer does not come with connector wires or removal tape. Prepare them on your own and attach them to the battery before use.

Monitor cable

Use this signal cable to measure speed, torque and other signals using an oscilloscope.

Model	EWA-MON01-JST4



Line Color : Red 2: White 3: Black 4: Green

12 Option

Appendix

The list of default parameters and regenerative resistors are explained.

A-1 Default settings

The standards parameter values set as a default for each applicable actuator are shown below.

SHA series (voltage: 200V)

	Actuator model No.	SHA20-SG					SHA25-SG/HP					
	Actuator reduction ratio	51	81	101	121	161	11	51	81	101	121	161
	Combined driver	HA-800A-3D/E-200					HA-800A-3D/E-200					
d13	Applicable actuator Code	5311	5321	5331	5341	5351	5801	5011	5021	5031	5041	5051
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	20	20	20	20	20	25	25	25	25	25	25
AJ02	Speed loop integral compensation (default)	20	20	20	20	20	20	20	20	20	20	20
AJ04	In-position range (default)	150	150	150	150	150	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	6000	6000	6000	6000	6000	5600	5600	5600	5600	5600	5600
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0	0	0

	Actuator model No.	SHA32-SG/HP					
	Actuator reduction ratio	11	51	81	101	121	161
	Combined driver	HA-800A-6D/E-200					
d13	Applicable actuator Code	5811	5111	5121	5131	5141	5151
AJ00	Position loop gain (default)	40	40	40	40	40	40
AJ01	Speed loop gain (default)	56	56	56	56	56	56
AJ02	Speed loop integral compensation (default)	70	70	70	70	70	70
AJ04	In-position range (default)	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	4800	4800	4800	4800	4800	4800
SP60	Automatic gain (default)	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	0	0	0	0	0	0

	Actuator model No.	SHA40-SG					SHA40-SG				
	Actuator reduction ratio	51	81	101	121	161	51	81	101	121	161
	Combined driver	HA-800A-6D/E-200					HA-800A-24D/E-200				
d13	Applicable actuator Code	5211	5221	5231	5241	5251	5211	5221	5231	5241	5251
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	80	80	80	80	80	8	8	8	8	8
AJ02	Speed loop integral compensation (default)	60	60	60	60	60	60	60	60	60	60
AJ04	In-position range (default)	150	150	150	150	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0	0

	Actuator model No.	SHA58-SG				SHA65-SG			
	Actuator reduction ratio	81	101	121	161	81	101	121	161
	Combined driver	HA-800A-24D/E-200				HA-800A-24D/E-200			
d13	Applicable actuator Code	5421	5431	5441	5451	5521	5531	5541	5551
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	26	26	26	26	30	30	30	30
AJ02	Speed loop integral compensation (default)	60	60	60	60	60	60	60	60
AJ04	In-position range (default)	150	150	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	3000	3000	3000	3000	2800	2800	2800	2800
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0

	Actuator model No.	SHA25-CG(-S)					SHA32-CG(-S)				
	Actuator reduction ratio	50	80	100	120	160	50	80	100	120	160
	Combined driver	HA-800A-3D/E-200					HA-800A-6D/E-200				
d13	Applicable actuator Code	8011 8012	8021 8022	8031 8032	8041 8042	8051 8052	8111 8112	8121 8122	8131 8132	8141 8142	8151 8152
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	25	25	25	25	25	56	56	56	56	56
AJ02	Speed loop integral compensation (default)	20	20	20	20	20	70	70	70	70	70
AJ04	In-position range (default)	150	150	150	150	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	5600	5600	5600	5600	5600	4800	4800	4800	4800	4800
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	3	3	3	3	3	3	3	3	3	3

	Actuator model No.	SHA40-CG(-S)					SHA40-CG(-S)				
	Actuator reduction ratio	50	80	100	120	160	50	80	100	120	160
	Combined driver	HA-800A-6D/E-200					HA-800A-24D/E-200				
d13	Applicable actuator Code	8211 8212	8221 8222	8231 8232	8241 8242	8251 8252	8211 8212	8221 8222	8231 8232	8241 8242	8251 8252
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	80	80	80	80	80	8	8	8	8	8
AJ02	Speed loop integral compensation (default)	60	60	60	60	60	60	60	60	60	60
AJ04	In-position range (default)	150	150	150	150	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	3	3	3	3	3	3	3	3	3	3

	Actuator model No.	SHA58-CG(-S)				SHA65-CG(-S)			
	Actuator reduction ratio	80	100	120	160	80	100	120	160
	Combined driver	HA-800A-24D/E-200				HA-800A-24D/E-200			
d13	Applicable actuator Code	8421 8422	8431 8432	8441 8442	8451 8452	8521 8522	8531 8532	8541 8542	8551 8552
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	26	26	26	26	30	30	30	30
AJ02	Speed loop integral compensation (default)	60	60	60	60	60	60	60	60
AJ04	In-position range (default)	150	150	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	3000	3000	3000	3000	2800	2800	2800	2800
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	3	3	3	3	3	3	3	3

SHA series (voltage: 100V)

	Actuator model No.	SHA25-SG					SHA25-CG(-S)				
	Actuator reduction ratio	51	81	101	121	161	50	80	100	120	160
	Combined driver	HA-800*-6D/E-100					HA-800A-6D/E-100				
d13	Applicable actuator Code	5611	5621	5631	5641	5651	8611 8612	8621 8622	8631 8632	8641 8642	8651 8652
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	25	25	25	25	25	25	25	25	25	25
AJ02	Speed loop integral compensation (default)	20	20	20	20	20	20	20	20	20	20
AJ04	In-position range (default)	150	150	150	150	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	0	0	0	0	0	3	3	3	3	3

FHA-C 4-wire, wire-saving incremental series (voltage: 200V)

	Actuator model No.	FHA-8C			FHA-11C			FHA-14C		
	Actuator reduction ratio	30	50	100	30	50	100	30	50	100
	Combined driver	HA-800A-1C-200			HA-800A-1C-200			HA-800A-1C-200		
d13	Applicable actuator Code	6204	6214	6234	6404	6414	6434	6604	6614	6634
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	35	35	35	45	45	45	80	80	80
AJ02	Speed loop integral compensation (default)	20	20	20	20	20	20	20	20	20
AJ04	In-position range (default)	10	10	10	10	10	10	10	10	10
SP49	Allowable position deviation (default)	100	100	100	100	100	100	100	100	100
SP51	Speed input factor (default)	6000	6000	6000	6000	6000	6000	6000	6000	6000
SP60	Automatic gain (default)	1	1	1	1	1	1	1	1	1
SP61	Encoder monitor Output pulses (default)	1	1	1	1	1	1	1	1	1
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0

FHA-C 4-wire, wire-saving incremental series (voltage: 100V)

	Actuator model No.	FHA-8C			FHA-11C			FHA-14C		
	Actuator reduction ratio	30	50	100	30	50	100	30	50	100
	Combined driver	HA-800A-1C-100			HA-800A-1C-100			HA-800A-1C-100		
d13	Applicable actuator Code	6304	6314	6334	6504	6514	6534	6704	6714	6734
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	35	35	35	45	45	45	80	80	80
AJ02	Speed loop integral compensation (default)	20	20	20	20	20	20	20	20	20
AJ04	In-position range (default)	10	10	10	10	10	10	10	10	10
SP49	Allowable position deviation (default)	100	100	100	100	100	100	100	100	100
SP51	Speed input factor (default)	6000	6000	6000	6000	6000	6000	6000	6000	6000
SP60	Automatic gain (default)	1	1	1	1	1	1	1	1	1
SP61	Encoder monitor Output pulses (default)	1	1	1	1	1	1	1	1	1
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0

FHA-Cmini absolute series (voltage: 200V)

	Actuator model No.	FHA-8C			FHA-11C			FHA-14C		
	Actuator reduction ratio	30	50	100	30	50	100	30	50	100
	Combined driver	HA-800A-1D-200			HA-800A-1D-200			HA-800A-1D-200		
d13	Applicable actuator Code	6201	6211	6231	6401	6411	6431	6601	6611	6631
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	21	21	21	27	27	27	48	48	48
AJ02	Speed loop integral compensation (default)	20	20	20	20	20	20	20	20	20
AJ04	In-position range (default)	150	150	150	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	6000	6000	6000	6000	6000	6000	6000	6000	6000
SP60	Automatic gain (default)	1	1	1	1	1	1	1	1	1
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0

FHA-Cmini absolute series (voltage: 100V)

	Actuator model No.	FHA-8C			FHA-11C			FHA-14C		
	Actuator reduction ratio	30	50	100	30	50	100	30	50	100
	Combined driver	HA-800A-1D-100			HA-800A-1D-100			HA-800A-1D-100		
d13	Applicable actuator Code	6301	6311	6331	6501	6511	6531	6701	6711	6731
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	21	21	21	27	27	27	48	48	48
AJ02	Speed loop integral compensation (default)	20	20	20	20	20	20	20	20	20
AJ04	In-position range (default)	150	150	150	150	150	150	150	150	150
SP49	Allowable position deviation (default)	1500	1500	1500	1500	1500	1500	1500	1500	1500
SP51	Speed input factor (default)	6000	6000	6000	6000	6000	6000	6000	6000	6000
SP60	Automatic gain (default)	1	1	1	1	1	1	1	1	1
SP61	Encoder monitor Output pulses (default)	8192	8192	8192	8192	8192	8192	8192	8192	8192
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0

FHA-C 4-wire, wire-saving incremental series (voltage: 200V)

	Actuator model No.	FHA-17C			FHA-25C			FHA-32C			FHA-40C		
	Actuator reduction ratio	50	100	160	50	100	160	50	100	160	50	100	160
	Combined driver	HA-800A-3C-200			HA-800A-3C-200			HA-800A-6C-200			HA-800A-6C-200		
d13	Applicable actuator Code	5217	5237	5247	5417	5437	5447	5617	5637	5647	5717	5737	5747
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	25	25	25	50	50	50	80	80	80	120	120	120
AJ02	Speed loop integral compensation (default)	40	40	40	40	40	40	40	40	40	40	40	40
AJ04	In-position range (default)	10	10	10	10	10	10	10	10	10	10	10	10
SP49	Allowable position deviation (default)	100	100	100	100	100	100	100	100	100	100	100	100
SP51	Speed input factor (default)	4800	4800	4800	4500	4500	4500	4000	4000	4000	3500	3500	3500
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	1	1	1	1	1	1	1	1	1	1	1	1
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0	0	0	0

FHA-C 4-wire, wire-saving incremental series (voltage: 100V)

	Actuator model No.	FHA-17C			FHA-25C			FHA-32C		
	Actuator reduction ratio	50	100	160	50	100	160	50	100	160
	Combined driver	HA-800A-3C-100			HA-800A-6C-100			HA-800A-6C-100		
d13	Applicable actuator Code	5117	5137	5147	5317	5337	5347	5517	5537	5547
AJ00	Position loop gain (default)	40	40	40	37	37	37	50	50	50
AJ01	Speed loop gain (default)	50	50	50	50	50	50	120	120	120
AJ02	Speed loop integral compensation (default)	40	40	40	40	40	40	40	40	40
AJ04	In-position range (default)	10	10	10	10	10	10	10	10	10
SP49	Allowable position deviation (default)	100	100	100	100	100	100	100	100	100
SP51	Speed input factor (default)	4800	4800	4800	4500	4500	4500	4000	4000	4000
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	1	1	1	1	1	1	1	1	1
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0

FHA-C absolute series (voltage: 200V)

	Actuator model No.	FHA-17C			FHA-25C			FHA-32C			FHA-40C		
	Actuator reduction ratio	50	100	160	50	100	160	50	100	160	50	100	160
	Combined driver	HA-800A-3A-200			HA-800A-3A-200			HA-800A-6A-200			HA-800A-6A-200		
d13	Applicable actuator Code	5218	5238	5248	5418	5438	5448	5618	5638	5648	5718	5738	5748
AJ00	Position loop gain (default)	40	40	40	40	40	40	40	40	40	40	40	40
AJ01	Speed loop gain (default)	25	25	25	50	50	50	80	80	80	120	120	120
AJ02	Speed loop integral compensation (default)	40	40	40	50	50	50	40	40	40	70	70	70
AJ04	In-position range (default)	10	10	10	10	10	10	10	10	10	10	10	10
SP49	Allowable position deviation (default)	100	100	100	100	100	100	100	100	100	100	100	100
SP51	Speed input factor (default)	4800	4800	4800	4500	4500	4500	4000	4000	4000	3500	3500	3500
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	1	1	1	1	1	1	1	1	1	1	1	1
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0	0	0	0

FHA-C absolute series (voltage: 100V)

	Actuator model No.	FHA-17C			FHA-25C			FHA-32C		
	Actuator reduction ratio	50	100	160	50	100	160	50	100	160
	Combined driver	HA-800A-3A-100			HA-800A-6A-100			HA-800A-6A-100		
d13	Applicable actuator Code	5118	5138	5148	5318	5338	5348	5518	5538	5548
AJ00	Position loop gain (default)	40	40	40	37	37	37	50	50	50
AJ01	Speed loop gain (default)	50	50	50	50	50	50	120	120	120
AJ02	Speed loop integral compensation (default)	40	40	40	50	50	50	40	40	40
AJ04	In-position range (default)	10	10	10	10	10	10	10	10	10
SP49	Allowable position deviation (default)	100	100	100	100	100	100	100	100	100
SP51	Speed input factor (default)	4800	4800	4800	4500	4500	4500	4000	4000	4000
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	1	1	1	1	1	1	1	1	1
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0

RSF 14-wire, wire-saving incremental series (voltage: 200V)

	Actuator model No.	RSF-17A		RSF-20A		RSF-25A		RSF-32A		
	Actuator reduction ratio	50	100	50	100	50	100	50	100	160
	Combined driver	HA-800A-3B-200		HA-800A-3B-200		HA-800A-3B-200		HA-800A-6B-200		
d13	Applicable actuator Code	7365	7375	7465	7475	7565	7575	7665	7675	7685
AJ00	Position loop gain (default)	50	50	30	30	50	50	50	50	50
AJ01	Speed loop gain (default)	30	30	35	35	40	40	50	50	50
AJ02	Speed loop integral compensation (default)	50	50	30	30	50	50	50	50	50
AJ04	In-position range (default)	10	10	10	10	10	10	10	10	10
SP49	Allowable position deviation (default)	100	100	100	100	100	100	100	100	100
SP51	Speed input factor (default)	3000	3000	3000	3000	3000	3000	3000	3000	3000
SP60	Automatic gain (default)	0	0	0	0	0	0	0	0	0
SP61	Encoder monitor Output pulses (default)	1	1	1	1	1	1	1	1	1
SP69	Feed-forward control function setting	0	0	0	0	0	0	0	0	0

A-2 Regenerative resistor

The following explains the built-in regenerative resistor and external regenerative resistance of the driver.

Built-in driver regenerative resistor and regenerative power

Putting a brake on the machine's movement causes the rotational energy of the machine (including the actuator) to be returned to the driver. This electric energy is called regeneration capacity.
The energy returned is called regenerative energy and regenerative energy per unit time is called regenerative power.
Regenerative energy is absorbed as electric energy by the power smoothing capacitor in the driver.
If the regenerative energy produced by braking increases and exceeds the energy absorbable to the capacitor, the excess regenerative energy is absorbed (consumed) by a regenerative resistor.
Different HA-800 drivers come with or without a built-in regenerative resistor, as shown in the table below.
Different HA-800 drivers come with or without a built-in regenerative resistor, as shown in the table below. You can connect an external regenerative resistor to handle the excess regenerative power or regenerative energy that cannot be absorbed (consumed) by the regenerative resistor in the driver.

Input voltage	200V specification/100V specification			
Model	HA-800A-1	HA-800A-3	HA-800A-6	HA-800A-24
Driver’s rated current	1.5 A	3.0 A	6 A	24 A
Regenerative processing	Terminal for mounting external regenerative resistance provided	Regenerative resistor contained Terminal for mounting external regenerative resistance provided		
Power absorbed by built-in regenerative resistor	-	3W max.	8W max.	90W max.
Allowable absorption energy per regenerative operation (holding) when a built-in regenerative resistor is used (repeat cycle)	30J (200V specification) 53J (100V specification) *1 *2	90J (200V specification) 110J (100V specification) *2	220J (200V specification) 260J (100V specification) *2	1600J *2
Allowable absorption energy per regenerative operation (holding) when a built-in regenerative resistor is used (non-repeat cycle)		150J	420J	2400J
Explanation	There is no built-in regenerative resistor. Normally you don't need any external regenerative resistor. Connect an external regenerative resistor if the smoothing capacitor in the driver cannot absorb the regenerative energy fully.	Connect an external regenerative resistor if the regenerative power is greater than the power absorbed by the built-in regenerative resistor.		

*1: Standard value of power absorbed by an electrode capacitor
*2: 200V specification is the standard value for when the input voltage is AC200V. 100V specification is the standard value for when the input voltage is AC100V.

Examination of regenerative energy

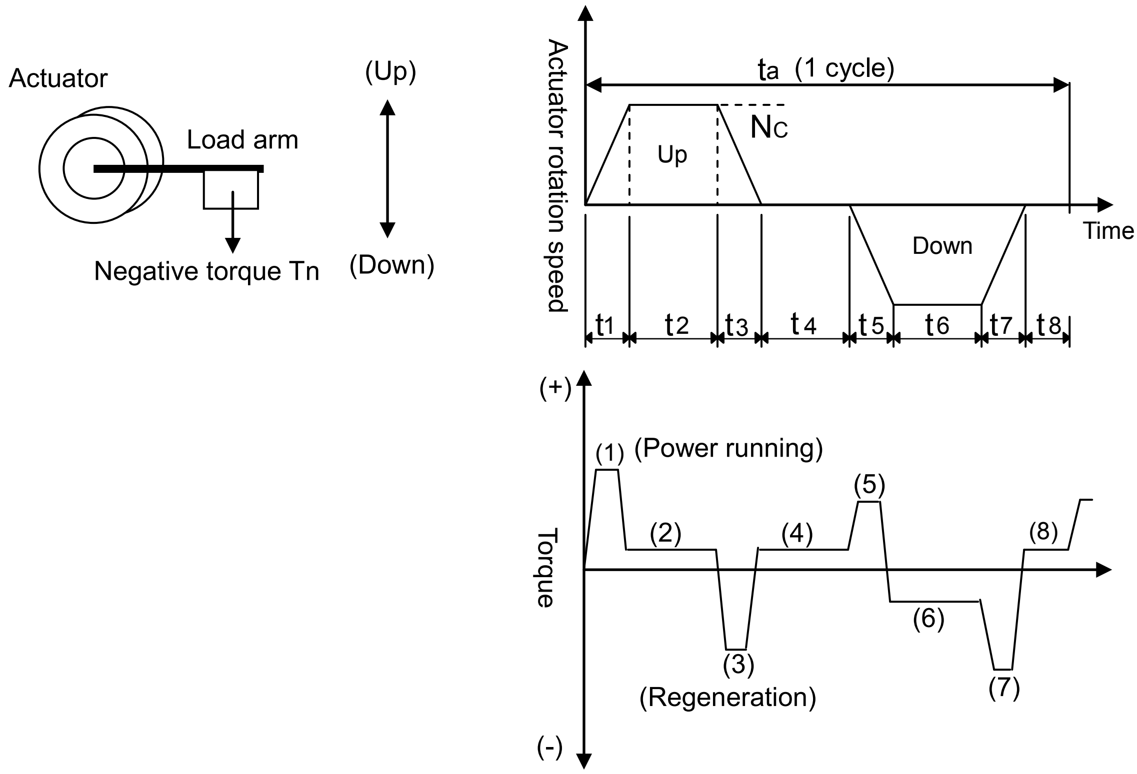
Examine installing a regenerative resistor in the following conditions:

- Drive with high inertia moment and load.
- The system is stopped frequently.
- Continuous regeneration occurs such as when the load moves up and down

In these cases, calculate the regenerative energy and check the power that can be absorbed by the built-in regenerative resistor of the driver. If the regenerative energy is greater, install an external regenerative resistor.

Calculation of regenerative energy

Calculate the regenerative energy by assuming that the machine operates as shown below.



Tn: Negative torque of load Tf: Friction torque of drive-train
Ja: Inertia moment of actuator
Jm: Inertia moment of load
Nc: Max. rotation speed during actuator operation (r/min)

Step	Actuator torque	Energy
(1)	T1 = (Ja + Jm) × {(2π × Nc) / 60} × (1 / t1) + Tn + Tf	E1 = 1/2 × {(2π × Nc) / 60} × Nc × T1 × t1
(2)	T2 = Tn + Tf	E2 = (2π × Nc) / 60} × Nc × T2 × t2
(3)	T3 = - (Ja + Jm) × {(2π × Nc) / 60} × (1 / t3) + Tn + Tf	E3 = 1/2 × {(2π × Nc) / 60} × Nc × T3 × t3
(4),(8)	T4 = Tn	0 (Regenerative energy is 0, because the actuator is stopped.)
(5)	T5 = (Ja + Jm) × {(2π × Nc) / 60} × (1 / t5) - Tn + Tf	E5 = 1/2 × {(2π × Nc) / 60} × Nc × T5 × t5
(6)	T6 = -Tn + Tf	E6 = (2π × Nc) / 60} × Nc × T6 × t6
(7)	T7 = - (Ja + Jm) × {(2π × Nc) / 60} × (1 / t7) - Tn + Tf	E5 = 1/2 × {(2π × Nc) / 60} × Nc × T7 × t7

Of energies E1 to E8, negative energies are added up and the absolute value of this total sum gives the regenerative energy <Es>.
If E3, E6 and E7 are negative in the above example, the total regenerative energy is calculated as follows:

Es = | E3 + E6 + E7 |

Apx
Appendix

Energy absorbed by external regenerative resistor

The table below lists the regenerative energies that can be absorbed by the power smoothing capacitor of the HA-800 driver and capacities of the driver's built-in regenerative resistor R.

Driver model	Energy absorbed by built-in capacitor Ec (J) *1	Built-in regenerative resistor specification		Min. allowable external resistance (Ω)
		Absorption capacity Wi (W) *2	Resistance (Ω)	
HA-800A-1	30	-	-	33Ω - 5%
HA-800A-3	30	3W max.	50Ω ± 5%	33Ω - 5%
HA-800A-6	52	8W max.	33Ω ± 5%	33Ω - 5%
HA-800A-24	78	90W max.	10Ω ± 5%	10Ω - 5%

*1: The value of capacitor-absorbed energy Ec represents the standard absorption level of the capacitor at the driver's main service input voltage AC200V. Energy absorbed by built-in capacitor significantly varies depending on input voltage and drive pattern. It also varies over time. Derate the rated capacity to 50% of the standard absorption level as a guideline and perform the calculation.
*2: Absorption capacity of the built-in regenerative resistor [Wi] refers to the size of regenerative power that can be absorbed by the resistor when its rated capacity is derated.

Calculate the regenerative energy that must be absorbed by the regenerative resistor using each of the values above.
Divide the regenerative energy by the operation cycle time to calculate the regenerative power that needs to be absorbed by the regenerative resistor <We>.

We [W] = (Es - Ec) / ta

If <We> is less than the power absorbed by a built-in regenerative resistor <Wi>, no external regenerative resistor is required. If <We> exceeds <Wi>, select an appropriate external regenerative resistor according to the capacity of <We>. Select a resistance equal to or greater than the applicable minimum allowable resistance shown in the table.
When you use an external regenerative resistor, remove the short bar to separate the built-in regenerative resistor from the circuit. The built-in regenerative resistor stops absorbing regenerative energy and thus stops generating heat. This allows connecting a large external regenerative resistor.
* HA-800A-24 allows monitoring regenerative power.

External regenerative resistor

An external regenerative resistor must be provided by the customer. Select an appropriate regenerative resistor by referring to the example below.

Examples of recommended products

Driver model	Resistor	Remarks
HA-800A-1 HA-800A-3 HA-800A-6	RH220B33ΩJ Iwaki Musen Kenkyusho Co., Ltd.	Allowable absorption power: Approximately 20 to 30W (depends on the cooling conditions) Allowable absorption energy per regenerative operation: 2,200J
HA-800A-24	RH500 20ΩJ (Parallel connection of 2 resistors) Iwaki Musen Kenkyusho Co., Ltd.	Allowable absorption power: Approximately 150W (depends on the cooling conditions) Allowable absorption energy per regenerative operation: 13,000J Connect 2 resistors in parallel. (Refer to the connection example below.)
	RH500 10ΩJ (Parallel connection in series of 4 resistors) Iwaki Musen Kenkyusho Co., Ltd.	Allowable absorption power: Approximately 300W (Varies depending on the cooling conditions) Allowable absorption energy per regenerative operation: 36,000J Connect four resistors in series and parallel. (Refer to the connection example below.)

Derating the external regenerative resistor

- **Rise in regenerative resistor temperature**

  Power resistors used as regenerative resistors consume a large amount of power and become very hot. Accordingly, be sure to derate the rated capacity of your resistor. Without proper derating, the resistor may present problems such as becoming heated to several hundred degrees or failing prematurely.

- **Derating**

  Check the load characteristics of your resistor with its manufacturer. Basically the derating ratio should be 20% or less if the driver is used in a condition of natural convection cooling. Follow the internal standard of your company.

Layout and wiring of external regenerative resistor

- **Layout**

  Regenerative resistors may be heated to 100℃ or more above the ambient temperature. Carefully determine the position of the radiation, installation position, wiring path, etc.

- **Wiring**

  Use flame-resistant wires to wire the resistor by avoiding contact between the wires and resistor body. Be sure to use twisted wires when connecting to the servo amplifier, and keep the wiring distance to no longer than 5m.

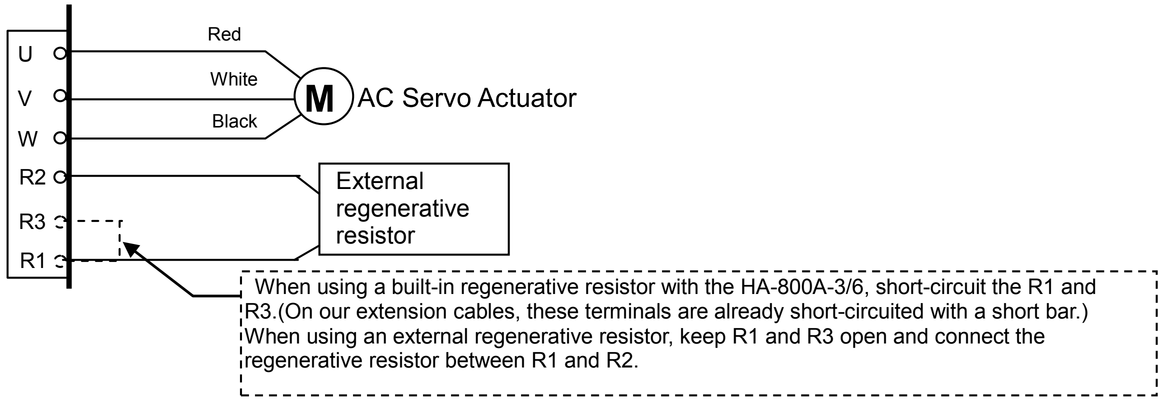
CAUTION

Regenerative resistors become very hot. Determine the position of the radiation, installation position, wiring path, etc. by giving thorough consideration to safety.

- **Connecting to the driver**

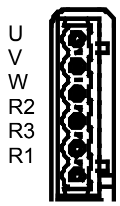
  Connect the external regenerative resistor between the R1 and R2 terminals of the HA-800 driver.

HA-800*-1, -3 and -6

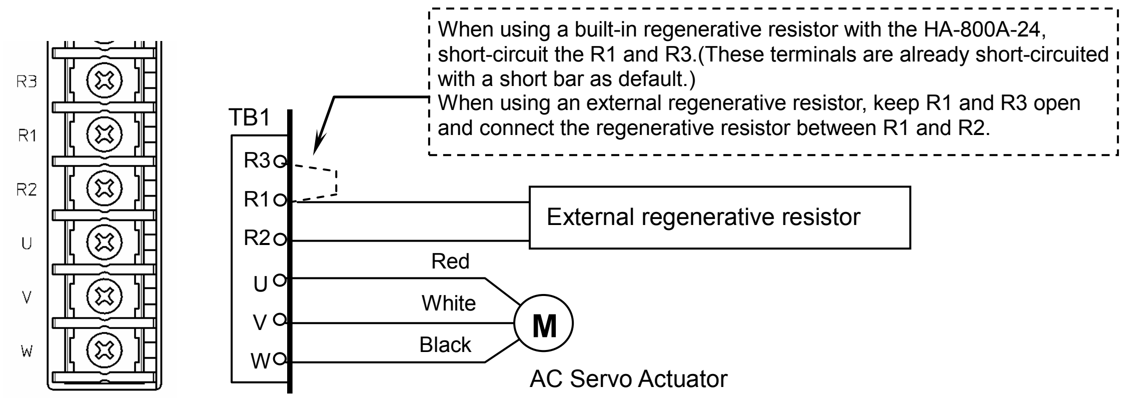


Terminal block for motor connection (for TB1)

Manufacturer	Phoenix Contact
Model	FKIC2.5/6-ST-5.08



HA-800*-24

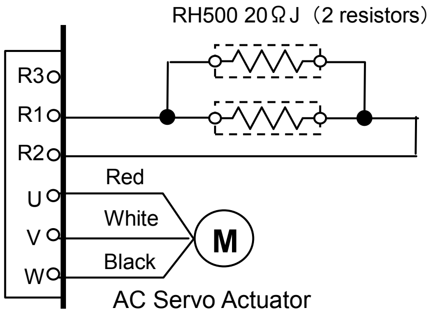


Terminal block for motor connection

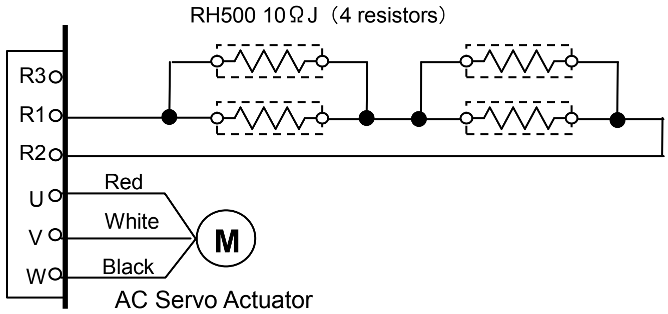
Screw size	Crimp terminal outer diameter	Reference
M4	ϕ8mm	Round crimp terminal (R-type) 3.5-R4 (J.S.T. Mfg. Co., Ltd) 5.5-4NS (J.S.T. Mfg. Co., Ltd)

- **Connection example of external regenerative resistor**

Regenerative power: 150W



Regenerative power: 300W



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Appendix

Allowable load inertia

The following is a list of recommended allowable inertia in a horizontal drive at the max. rotational speed (The input voltages are AC200V for 200V specifications, AC100V for 100V specifications). (The allowable load inertia varies depending on the motor speed, operation pattern, and input voltage etc. during an actual operation.)
When the regenerative resistance (built-in or external) is applied, it should be within the allowable absorption power or allowable absorption energy of regenerative resistance.

SHA series (voltage: 200V)

Actuator model No.		SHA20A-SG				
Actuator reduction ratio		51	81	101	121	161
Combined driver		HA-800A-3D/E-200				
Max. rotational speed	r/min	117.6	74.1	59.4	49.6	37.3
Actuator inertia moment (no brake)	$kg\cdot m^2$	0.23	0.58	0.91	1.30	2.31
	$kgf\cdot cm\cdot s^2$	2.4	6.0	9.3	13.3	23.6
Actuator inertia moment (with brake)	$kg\cdot m^2$	0.26	0.65	1.00	1.44	2.55
	$kgf\cdot cm\cdot s^2$	2.6	6.6	10.2	14.7	26.0
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	$kg\cdot m^2$	0.93	2.3	3.6	5.1	9.1
	$kgf\cdot cm\cdot s^2$	9.5	23	37	52	93
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	$kg\cdot m^2$	1.7	4.3	6.7	9.6	17
	$kgf\cdot cm\cdot s^2$	17.3	44	68	98	173
Allowable load inertia moment when an external regenerative resistor is used	$kg\cdot m^2$	2.4	3.8	4.8	5.8	7.7
	$kgf\cdot cm\cdot s^2$	25	39	49	59	78
	External regenerative resistor	RH220B33ΩJ				

Actuator model No.		SHA25A-SG/HP					
Actuator reduction ratio		11	51	81	101	121	161
Combined driver		HA-800A-3D/E-200					
Max. rotational speed	r/min	509.1	109.8	69.1	55.4	46.3	34.8
Actuator inertia moment (no brake)	$kg\cdot m^2$	0.029	0.56	1.42	2.2	3.2	5.6
	$kgf\cdot cm\cdot s^2$	0.296	5.7	14.4	22	32	57
Actuator inertia moment (with brake)	$kg\cdot m^2$	0.034	0.66	1.66	2.6	3.7	6.6
	$kgf\cdot cm\cdot s^2$	0.347	6.7	17	26	38	67
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	$kg\cdot m^2$	0.034	0.79	2.0	3.1	4.4	7.9
	$kgf\cdot cm\cdot s^2$	0.347	8.1	20.4	31.6	44.9	80.6
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	$kg\cdot m^2$	0.071	1.3	3.4	5.4	7.7	13.8
	$kgf\cdot cm\cdot s^2$	0.724	13.2	34.7	55.1	78.5	140
Allowable load inertia moment when an external regenerative resistor is used	$kg\cdot m^2$	0.288	5.6	8.8	11	14	20
	$kgf\cdot cm\cdot s^2$	2.939	57	90	112	144	201
	External regenerative resistor	RH220B33ΩJ					

Actuator model No.		SHA32A-SG/HP					
Actuator reduction ratio		11	51	81	101	121	161
Combined driver		HA-800A-6D/E-200					
Max. rotational speed	r/min	436.4	94.1	59.3	47.5	39.7	29.8
Actuator inertia moment (no brake)	$kg\cdot m^2$	0.092	2.0	5.1	8.0	11	20
	$kgf\cdot cm\cdot s^2$	0.939	21	52	81	117	207
Actuator inertia moment (with brake)	$kg\cdot m^2$	0.1065	2.3	5.9	9.2	13	23
	$kgf\cdot cm\cdot s^2$	1.087	24	60	94	135	238
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	$kg\cdot m^2$	0.1065	2.3	5.9	9.2	13	23
	$kgf\cdot cm\cdot s^2$	1.087	24	60	94	135	238
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	$kg\cdot m^2$	0.277	6.0	15.3	24	33	60
	$kgf\cdot cm\cdot s^2$	2.827	61.2	156	244	336	612
Allowable load inertia moment when an external regenerative resistor is used	$kg\cdot m^2$	0.930	20	32	40	50	70
	$kgf\cdot cm\cdot s^2$	9.490	200	320	400	510	710
	External regenerative resistor	RH220B33ΩJ					

Actuator model No.		SHA40A-SG									
Actuator reduction ratio		51	81	101	121	161	51	81	101	121	161
Combined driver		HA-800A-6D/E-200					HA-800A-24D/E-200				
Max. rotational speed	r/min	78.4	49.4	39.6	33.1	24.8	78.4	49.4	39.6	33.1	24.8
Actuator inertia moment (no brake)	$kg\cdot m^2$	5.0	13	20	28	50	5.0	13	20	28	50
	$kgf\cdot cm\cdot s^2$	51	130	202	290	513	51	130	202	290	513
Actuator inertia moment (with brake)	$kg\cdot m^2$	6.1	15	24	34	61	6.1	15	24	34	61
	$kgf\cdot cm\cdot s^2$	62	157	244	350	619	62	157	244	350	619
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	$kg\cdot m^2$	1.2	3	4.8	6.8	12.2	40	92	114	137	182
	$kgf\cdot cm\cdot s^2$	12.2	30.6	49	69	124	408	930	1170	1400	1860
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	$kg\cdot m^2$	6.1	15	24	34	61	58	92	114	137	182
	$kgf\cdot cm\cdot s^2$	62.2	153	244	346	622	590	930	1170	1400	1860
Allowable load inertia moment when an external regenerative resistor is used	$kg\cdot m^2$	58	92	114	137	182	58	(92)	(114)	(137)	(182)
	$kgf\cdot cm\cdot s^2$	590	930	1170	1400	1860	590	(930)	(1170)	(1400)	(1860)
	External regenerative resistor	RH220B33ΩJ					Connect two RH500_20ΩJ in parallel, or connect four RH500_10ΩJ in series and parallel.				

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Appendix

Actuator model No.		SHA58A-SG					SHA65A-SG				
Actuator reduction ratio		81	101	121	161		81	101	121	161	
Combined driver		HA-800A-24D/E-200					HA-800A-24D/E-200				
Max. rotational speed	r/min	37.0	29.7	24.8	18.6		34.6	27.7	23.1	17.4	
Actuator inertia moment (no brake)	kg·m^2	96	149	214	379		110	171	245	433	
	kgf·cm·s^2	980	1520	2180	3870		1120	1740	2500	4420	
Actuator inertia moment (with brake)	kg·m^2	106	165	237	420		120	187	268	475	
	kgf·cm·s^2	1090	1690	2420	4290		1230	1910	2740	4850	
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	kg·m^2	111	173	249	441		128	200	288	508	
	kgf·cm·s^2	1133	1765	2541	4500		1306	2041	2939	5184	
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	kg·m^2	212	330	474	840		240	374	536	950	
	kgf·cm·s^2	2160	3360	4830	8570		2440	3810	5460	9690	
Allowable load inertia moment when an external regenerative resistor is used	kg·m^2	290	450	640	1140		360	560	810	1420	
	kgf·cm·s^2	2900	4600	6500	11600		3700	5700	8200	14500	
	External regenerative resistor	Connect two RH500_20ΩJ in parallel, or connect four RH500_10ΩJ in series and parallel.					Connect two RH500_20ΩJ in parallel, or connect four RH500_10ΩJ in series and parallel.				

Actuator model No.		SHA25A-CG(-S)				
Actuator reduction ratio		50	80	100	120	160
Combined driver		HA-800A-3D/E-200				
Max. rotational speed	r/min	112	70	56	46.7	35
Actuator inertia moment (no brake)	kg·m^2	0.50	1.3	2.0	2.9	5.1
	kgf·cm·s^2	5.1	13.0	20	29	52
Actuator inertia moment (with brake)	kg·m^2	0.59	1.5	2.4	3.4	6.1
	kgf·cm·s^2	6.0	15.4	24	35	62
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	kg·m^2	0.7	1.8	2.9	4.1	7.3
	kgf·cm·s^2	7.1	18	30	42	74
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	kg·m^2	1.6	4.1	6.7	9.6	17
	kgf·cm·s^2	16.3	42	68	98	173
Allowable load inertia moment when an external regenerative resistor is used	kg·m^2	5.6	8.8	11	14	20
	kgf·cm·s^2	57	90	112	144	201
	External regenerative resistor	RH220B33ΩJ				

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Appendix

Actuator model No.		SHA32A-CG(-S)				
Actuator reduction ratio		50	80	100	120	160
Combined driver		HA-800A-6D/E-200				
Max. rotational speed	r/min	96	60	48	40	30
Actuator inertia moment (no brake)	kg·m^2	1.7	4.2	6.6	9.5	17
	kgf·cm·s^2	17	43	67	97	173
Actuator inertia moment (with brake)	kg·m^2	2.0	5.0	7.8	11	20
	kgf·cm·s^2	20	51	80	115	204
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	kg·m^2	2.4	6	9.4	13	24
	kgf·cm·s^2	24.5	61	96	133	245
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	kg·m^2	6.4	16	25	36	64
	kgf·cm·s^2	65	163	255	367	653
Allowable load inertia moment when an external regenerative resistor is used	kg·m^2	20	32	40	50	70
	kgf·cm·s^2	200	320	400	510	710
	External regenerative resistor	RH220B33ΩJ				

Actuator model No.		SHA40A-CG(-S)									
Actuator reduction ratio		50	80	100	120	160	50	80	100	120	160
Combined driver		HA-800A-6D/E-200					HA-800A-24D/E-200				
Max. rotational speed	r/min	80	50	40	33.3	25	80	50	40	33.3	25
Actuator inertia moment (no brake)	kg·m^2	4.7	12	19	27	48	4.7	12	19	27	48
	kgf·cm·s^2	48	123	193	278	494	48	123	193	278	494
Actuator inertia moment (with brake)	kg·m^2	5.7	15	23	33	59	5.7	15	23	33	59
	kgf·cm·s^2	58	150	234	337	598	58	150	234	337	598
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	kg·m^2	1.14	3	4.6	6.6	11.8	40	92	114	137	182
	kgf·cm·s^2	12	31	47	67	120	408	930	1170	1400	1860
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	kg·m^2	6.3	16	25	36	65	58	92	114	137	182
	kgf·cm·s^2	64	163	255	367	663	590	930	1170	1400	1860
Allowable load inertia moment when an external regenerative resistor is used	kg·m^2	58	92	114	137	182	58	(92)	(114)	(137)	(182)
	kgf·cm·s^2	590	930	1170	1400	1860	590	(930)	(1170)	(1400)	(1860)
	External regenerative resistor	RH220B33ΩJ					Connect two RH500_20ΩJ in parallel, or connect four RH500_10ΩJ in series and parallel.				

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Appendix

Actuator model No.		SHA58A-CG(-S)					SHA65A-CG(-S)				
Actuator reduction ratio		80	100	120	160		80	100	120	160	
Combined driver		HA-800A-24D/E-200					HA-800A-24D/E-200				
Max. rotational speed	r/min	37.5	30	25	18.8		37.5	30	25	18.8	
Actuator inertia moment (no brake)	kg·m^2	83	130	188	333		96	151	217	386	
	kgf·cm·s^2	850	1328	1912	3399		983	1536	2212	3933	
Actuator inertia moment (with brake)	kg·m^2	94	146	211	374		107	167	240	427	
	kgf·cm·s^2	954	1491	2147	3817		1088	1699	2447	4350	
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	kg·m^2	113	175	253	449		128	200	288	512	
	kgf·cm·s^2	1153	1786	2582	4582		1300	2040	2940	5220	
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	kg·m^2	216	336	485	860		246	384	552	982	
	kgf·cm·s^2	2200	3430	4950	8780		2510	3920	5630	10020	
Allowable load inertia moment when an external regenerative resistor is used	kg·m^2	290	450	640	1140		360	560	810	1420	
	kgf·cm·s^2	2900	4600	6500	11600		3700	5700	8200	14500	
	External regenerative resistor	Connect two RH500_20ΩJ in parallel, or connect four RH500_10ΩJ in series and parallel.					Connect two RH500_20ΩJ in parallel, or connect four RH500_10ΩJ in series and parallel.				

SHA series (voltage: 100V)

Actuator model No.		SHA25A-SG					SHA25A-CG(-S)				
Actuator reduction ratio		51	81	101	121	161	50	80	100	120	160
Combined driver		HA-800A-6D/E-100					HA-800A-6D/E-100				
Max. rotational speed	r/min	94.1	59.2	47.5	39.6	29.8	96	60	48	40	30
Actuator inertia moment (no brake)	kg·m^2	0.56	1.42	2.2	3.2	5.6	0.50	1.3	2.0	2.9	5.1
	kgf·cm·s^2	5.7	14.4	22	32	57	5.1	13.0	20	29	52
Actuator inertia moment (with brake)	kg·m^2	0.66	1.66	2.6	3.7	6.6	0.59	1.5	2.4	3.4	6.1
	kgf·cm·s^2	6.7	17	26	38	67	6.0	15.4	24	35	62
Allowable load inertia moment when a built-in regenerative resistor is used (repeat cycle)	kg·m^2	3.3	8.0	11	14	20	3.7	8.8	11	14	20
	kgf·cm·s^2	33.7	82	112	144	201	38	90	112	144	201
Allowable load inertia moment when a built-in regenerative resistor is used (non-repeat cycle)	kg·m^2	5.6	8.8	11	14	20	5.6	8.8	11	14	20
	kgf·cm·s^2	57	90	112	144	201	57	90	112	144	201
Allowable load inertia moment when an external regenerative resistor is used	kg·m^2	5.6	8.8	(11)	(14)	(20)	5.6	(8.8)	(11)	(14)	(20)
	kgf·cm·s^2	57	90	(112)	(144)	(201)	57	(90)	(112)	(144)	(201)
	External regenerative resistor	RH220B33ΩJ					RH220B33ΩJ				

FHA-Cmini series (voltage: 100V/200V)

Actuator model No.		FHA-8C			FHA-11C			FHA-14C		
Actuator reduction ratio		30	50	100	30	50	100	30	50	100
Combined driver		HA-800A-1*-100 HA-800A-1*-200			HA-800A-1*-100 HA-800A-1*-200			HA-800A-1*-100 HA-800A-1*-200		
Max. rotational speed	r/min	200	120	60	200	120	60	200	120	60
Actuator inertia moment	$kg \cdot m^2$	0.0026	0.0074	0.029	0.0060	0.017	0.067	0.018	0.050	0.20
	$kgf \cdot cm \cdot s^2$	0.027	0.075	0.30	0.061	0.17	0.68	0.18	0.51	2.0
Allowable load inertia moment when a regenerative resistor is disconnected (repeat cycle)	$kg \cdot m^2$	0.0078	0.022	0.087	0.018	0.051	0.20	0.054	0.15	0.60
	$kgf \cdot cm \cdot s^2$	0.081	0.23	0.90	0.18	0.51	2.0	0.54	1.5	6.0
Allowable load inertia moment when a regenerative resistor is not connected (non-repeat cycle)	$kg \cdot m^2$	0.0078	0.022	0.087	0.018	0.051	0.20	0.054	0.15	0.60
	$kgf \cdot cm \cdot s^2$	0.081	0.23	0.90	0.18	0.51	2.0	0.54	1.5	6.0
Allowable load inertia moment when an external regenerative resistor is used	$kg \cdot m^2$	(0.0078)	(0.022)	(0.087)	(0.018)	(0.051)	(0.20)	(0.054)	(0.15)	(0.60)
	$kgf \cdot cm \cdot s^2$	(0.081)	(0.23)	(0.90)	(0.18)	(0.51)	(2.0)	(0.54)	(1.5)	(6.0)
	External regenerative resistor	RH220B33ΩJ			RH220B33ΩJ			RH220B33ΩJ		

FHA-C series (voltage: 200V)

Actuator model No.		FHA-17C			FHA-25C			FHA-32C			FHA-40C		
Actuator reduction ratio		50	100	160	50	100	160	50	100	160	50	100	160
Combined driver		HA-800A-3*-200			HA-800A-3*-200			HA-800A-6*-200			HA-800A-6*-200		
Max. rotational speed	r/min	96	48	27	90	45	28	80	40	25	70	35	22
Actuator inertia moment	$kg \cdot m^2$	0.17	0.67	1.7	0.81	3.2	8.3	1.8	7.1	18.1	4.9	19.5	50
	$Kgf \cdot cm \cdot s^2$	1.7	6.9	17	8.3	33	85	18	72	185	50	200	510
Allowable load inertia moment when a regenerative resistor is disconnected (repeat cycle)	$kg \cdot m^2$	0.54	2.1	5.1	1.26	5.1	12.9	4.7	18	48	3.5	14	36
	$kgf \cdot cm \cdot s^2$	5.4	21	52	12.9	52	132	48	184	490	36	143	378
Allowable load inertia moment when a regenerative resistor is not connected (non-repeat cycle)	$kg \cdot m^2$	0.54	2.1	5.1	2.4	10	25	5.4	21	54	9.8	39	100
	$Kgf \cdot cm \cdot s^2$	5.4	21	52	24	100	260	55	210	550	100	398	1020
Allowable load inertia moment when an external regenerative resistor is used	$kg \cdot m^2$	(0.54)	(2.1)	(5.1)	2.4	10	25	5.4	21	54	15	60	150
	$Kgf \cdot cm \cdot s^2$	(5.4)	(21)	(52)	24	100	260	55	210	550	150	610	1500
	External regenerative resistor	RH220B33ΩJ			RH220B33ΩJ			RH220B33ΩJ			RH220B33ΩJ		

FHA-C series (voltage: 100V)

Actuator model No.		FHA-17C			FHA-25C			FHA-32C					
Actuator reduction ratio		50	100	160	50	100	160	50	100	160			
Combined driver		HA-800A-3*-100			HA-800A-6*-100			HA-800A-6*-100					
Max. rotational speed	r/min	96	48	30	90	45	28	64	32	20			
Actuator inertia moment	kg·m^2	0.17	0.67	1.7	0.81	3.2	8.3	1.8	7.1	18.1			
	Kgf·cm·s^2	1.7	6.9	17	8.3	33	85	18	72	185			
Allowable load inertia moment when a regenerative resistor is disconnected (repeat cycle)	kg·m^2	0.54	2.1	5.1	2.4	10	25	5.4	21	54			
	kgf·cm·s^2	5.4	21	52	24	100	260	55	210	550			
Allowable load inertia moment when a regenerative resistor is not connected (non-repeat cycle)	kg·m^2	0.54	2.1	5.1	2.4	10	25	5.4	21	54			
	Kgf·cm·s^2	5.4	21	52	24	100	260	55	210	550			
Allowable load inertia moment when an external regenerative resistor is used	kg·m^2	(0.54)	(2.1)	(5.1)	(2.4)	(10)	(25)	(5.4)	(21)	(54)			
	Kgf·cm·s^2	(5.4)	(21)	(52)	(24)	(100)	(260)	(55)	(210)	(550)			
	External regenerative resistor	RH220B33ΩJ			RH220B33ΩJ			RH220B33ΩJ					

A-3 List of data retained in the driver

This is a list of data retained in the internal non-volatile memory (EEPROM) of the driver and a list of operations of the set values.
There are two types of data that are retained in the non-volatile memory. They are adjustment parameters and system parameters.

Adjustment parameters AJxx

Symbol	Name	Display, Edit, Save	
		Main unit display panel	Servo parameter setting Software PSF-800 *2
AJ00	Position loop gain	Displaying set values Editing set values	Displaying set values Editing set values Saving a file (psf extension)
AJ01	Speed loop gain		
AJ02	Speed loop integral compensation		
AJ03	Feed-forward gain		
AJ04	In-position range		
AJ05	Attained speed judgment value		
AJ06	Attained torque judgment value		
AJ07	Zero speed judgment value		
AJ08	Internal speed command 1		
AJ09	Internal speed command 2		
AJ10	Internal speed command 3		
AJ11	Torque limit		
AJ12	Acceleration time constant		
AJ13	Deceleration time constant		
AJ14	External speed command offset		
AJ15	External torque command offset		
AJ16	Speed monitor offset		
AJ17	Current monitor offset		
AJ18	System reservation *1		
AJ19	System reservation *1		
AJ20	Feed-forward filter	Displaying set values Editing set values	Displaying set values Editing set values Saving a file (psf extension)
AJ21	Load inertia moment ratio		
AJ22	Torque constant compensation factor		
AJ23	Spring constant compensation factor		
AJ24	Automatic positioning gain		
AJ25	System reservation *1		
AJ26	System reservation *1		
AJ27	System reservation *1		
AJ28	System reservation *1		
AJ29	System reservation *1		
AJ30	System reservation *1		
AJ31	System reservation *1		
AJ32	System reservation *1		
AJ33	System reservation *1		
AJ34	System reservation *1		
AJ35	System reservation *1		
AJ36	System reservation *1		
AJ37	System reservation *1		
AJ38	System reservation *1		
AJ39	System reservation *1		
AJ40 to AJ59	System reservation *1	Displaying set values	Displaying set values Saving a file (psf extension)

*1: Do not change the parameters that are in the system reserved areas. The default setting of the system reservation may vary depending on the model/version.
*2: If the set values change when the parameters are transferred between different models using PSF-800, it does not affect the product functions.

System parameter SP00-39

* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Symbol	Name	Display, Edit, Save Main unit display panel	Display, Edit, Save Servo parameter setting Software PSF-800 *2
SP00	Emergency stop input setting	Displaying set values Editing set values	Displaying set values Editing set values Saving a file (psf extension)
SP01	Reset input setting		
SP02	Clear input setting		
SP03	FWD inhibit input setting		
SP04	REV inhibit input setting		
SP05	FWD enable input setting		
SP06	REV enable input setting		
SP07	FWD selection input setting		
SP08	REV selection input setting		
SP09	Internal speed command 1 input setting		
SP10	Internal speed command 2 input setting		
SP11	Internal speed limit 1 input setting		
SP12	Internal speed limit 2 input setting		
SP13	Internal torque limit input setting		
SP14	Electronic gear selection input setting		
SP15	Control mode selection input setting		
SP16	INHIBIT input setting		
SP17	System reservation *1		
SP18	System reservation *1		
SP19	System reservation *1		
SP20	CN2-pin 16: Signal assignment and function setting	Displaying set values Editing set values	Displaying set values Editing set values Saving a file (psf extension)
SP21	CN2-pin 17: Signal assignment and function setting		
SP22	CN2-pin 18: Signal assignment and function setting		
SP23	CN2-pin 19: Signal assignment and function setting		
SP24	CN2-pin 20: Signal assignment and function setting		
SP25	CN2-pin 21: Signal assignment and function setting		
SP26	CN2-pin 22: Signal assignment and function setting		
SP27	System reservation *1		
SP28	System reservation *1		
SP29	System reservation *1		
SP30	System reservation *1		
SP31	System reservation *1		
SP32	System reservation *1		
SP33	System reservation *1		
SP34	System reservation *1		
SP35	System reservation *1		
SP36	System reservation *1		
SP37	System reservation *1		
SP38	System reservation *1		
SP39	System reservation *1		

*1: Do not change the parameters that are in the system reserved areas. The default setting of the system reservation may vary depending on the model/version.
*2: If the set values change when the parameters are transferred between different models using PSF-800, it does not affect the product functions.

System parameter SP40-79

* The setting change of the system parameters (SP00 to 79) is enabled by reconnecting the control power supply after changing the setting.

Symbol	Name	Display, Edit, Save	
		Main unit display panel	Servo parameter setting Software PSF-800 *2
SP40	CN9-CP3 output signal setting	Displaying set values Editing set values	Displaying set values Editing set values Saving a file (psf extension)
SP41	Control mode switching setting		
SP42	Command pulse input pattern setting		
SP43	Multiplication of 2-phase input		
SP44	Electronic gear 1 numerator		
SP45	Electronic gear 1 denominator		
SP46	Electronic gear 2 numerator		
SP47	Electronic gear 2 denominator		
SP48	Deviation clear upon servo-ON		
SP49	Allowable position deviation		
SP50	Command polarity		
SP51	Speed input factor		
SP52	Zero clamp		
SP53	Torque input factor		
SP54	Status display setting		
SP55	DB enable/disable setting		
SP56	External speed limit enable/disable		
SP57	External torque limit enable/disable		
SP58	System reservation *1		
SP59	Angle compensation enable/disable setting		
SP60	Automatic positioning gain Setting enable/disable setting	Displaying set values Editing set values	Displaying set values Editing set values Saving a file (psf extension)
SP61	Encoder monitor output pulses		
SP62	System reservation *1		
SP63	System reservation *1		
SP64	Regenerative resistor selection		
SP65	FWD/REV inhibit operation		
SP66	Absolute encoder function setting		
SP67	Output shaft divide function setting		
SP68	System reservation *1		
SP69	Feed-forward control function setting		
SP70	System reservation *1		
SP71	System reservation *1		
SP72	System reservation *1		
SP73	System reservation *1		
SP74	System reservation *1		
SP75	System reservation *1		
SP76	System reservation *1		
SP77	System reservation *1		
SP78	System reservation *1		
SP79	System reservation *1		

*1: Do not change the parameters that are in the system reserved areas. The default setting of the system reservation may vary depending on the model/version.
*2: If the set values change when the parameters are transferred between different models using PSF-800, it does not affect the product functions.

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Appendix

A-4 Driver replacement procedures

The following explains the procedures to replace the HA-800A driver for maintenance.

Procedures	Description		Places to check/Manual
1	Checking the items (items to be replaced)	Check the nameplate of the driver currently used before the replacement. Check the type (TYPE) and combined actuator (ADJ.). • TYPE: ____________ • Combined actuator (ADJ.): ____________	Nameplate on the side of the driver main unit 2-1 Receiving inspection
2	Checking the items (new items)	Check the nameplate of the new driver. Check that the type (TYPE) and combined actuator (ADJ.) are the same as the ones currently used. * If the type and combined actuator are different, it cannot be replaced.	
3	Checking the switch settings	Check the switch settings of the driver currently used before the replacement. • Rotary switch (SW5) communication device number setting: ____________ • Dip switch (SW6) communication setting: Left side OFF (Down) Center OFF OFF(Down) Right side ____________ * The left side and the center dip switches (SW6) do not have any functions. They are normally switched OFF (Down). * These switch settings are the communication settings with the PSF-800 communication software. As a default, SW5 = 0 and SW6 = All OFF (Down).	Front side of the driver main unit, inside of the LED display cover 1-9 Name and function of each part of a display panel
4	Saving parameters *1	Save the parameters set in the driver currently used (retained in EEPROM) before the replacement. [Adjustment parameters] [System parameters] • Name of the file to save (psf extension): ____________	PSF-800 Communication software 10-5-1 Saving set values

*1: If the parameter settings have not been changed and the default settings are used, and the new driver has the default parameter settings, it is not necessary to save/write the parameters.
If you do not know the using condition, save/write the parameters.

CAUTION

This work requires wiring changes. Exercise caution to prevent accidents such as electric shock.

CAUTION

When replacing the actuator/motor, adjustment of the device/machine coordinate settings may be required. Replace according to the specifications of the system, which includes the device main unit and host controller.

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Appendix

Procedures		Description	Places to check/Manual
5	Replacing items	(1) Disconnect the power to the driver. After confirming that the CHARGE lamp is turned OFF (or wait until the lamp is turned OFF), disconnect **all the wiring** from the driver to be replaced. (2) Remove the driver to be replaced from the control board. (3) Install the new driver on the control board. (4) **Connect the power wiring (TB2 or r, s, R, S, T)** and **ground wire** to the new driver. (5) Connect the **personal computer communication cable (CN3)** to the new driver. * (4)(5) By not connecting the actuator wiring, unexpected actuator operation can be avoided if an incorrect operation command is input during the replacement work.	
6	Turn ON the control power supply	Connect the control power (r, s) to the new driver. Check that the driver starts and LED display (7 segment LED) lights up. * At this time, an alarm may be displayed due to incomplete wiring or parameters not set. It does not affect the replacement work, so proceed to the next step of the procedure. * By supplying the control power (r, s) only, the driver main power supply is not charged. The time waiting for the CHARGE lamp to turn OFF (discharged) can be shortened during wiring work in step 8. * If the main power supply (R, S, T) cannot be connected separately, it is not a problem to connect both control power (r, s) and main power supply (R, S, T) simultaneously. In this case, perform the wiring work in step 8 after the CHARGE lamp is turned OFF (discharged) to prevent electrical shock.	
7	Writing parameters	Write the parameters saved in [4. Saving parameters] to the new driver. [Adjustment parameters] [System parameters]	PSF-800 Communication software 10-5-4. Writing a saved settings file to the driver
8	Wire connection	Disconnect the power to the new driver. After confirming that the CHARGE lamp is turned OFF (or wait until the lamp is turned OFF), connect **all the wiring**.	
9	Switch settings	Set the switch status noted in [3. Checking the switch settings] to the new driver.	Front side of the driver main unit, inside of the LED display cover 1-9 Display panel
		This completes the driver replacement work.	

CAUTION

This work requires wiring changes. Exercise caution to prevent accidents such as electric shock.

CAUTION

When replacing the actuator/motor, adjustment of the device/machine coordinate settings may be required. Replace according to the specifications of the system, which includes the device main unit and host controller.

A-5 Notices for using SHA-CG(-S)

This explains the notices for when using the SHA-CG(-S).

Caution

- When using the SHA-CG series, always check the necessary setting, referencing [17-bit absolute encoder] (P4-4).

The SHA-CG(-S) has the following two features that differentiate it from previous SHA series (SHA-SG/HP).

1. **Output shaft single revolution absolute model**
2. **Output shaft divide function**

1. Output shaft single revolution absolute model

The SHA-CG output shaft single revolution absolute model (SHA-CG-S) assumes a machine that only moves the index table in one direction. When the machine continues to rotate in just one direction, the absolute encoder eventually exceeds the number of revolutions that can be detected with multi-revolution detection and it becomes impossible to manage position information accurately.

Therefore, each time the output shaft turns through single revolution, the cumulative multi revolution counter is cleared to 0 to achieve the output shaft single revolution absolute function. This is how position information is accurately managed when the shaft continuously turns in just one direction.

When using this function, set [SP66: Absolute encoder function setting] to 0.

Also, with the SHA-CG output shaft single revolution model, for the default current value data read-out signals at the time when the servo comes ON, the range for the CN2-40, 41 current value data output is [0～2^{17} x speed reduction ratio -1] pulses.

2. Output shaft divide function

With the SHA-CG series, in order to make it easier to make the settings for performing index table and other indexing operations in units of the output shaft angle, operation commands can be set in the actuator in angle units with [SP67: Output shaft divide function setting] and the setting on the host device can be omitted.

With the [SP67: Output shaft divide function setting], the corresponding electronic gear value is set automatically from the SP67 setting and the applicable actuator. The output shaft divide function and the electronic gears cannot be used together.

SP67=0: According to electronic gear settings (SP14、SP44/SP45, SP46/SP47)
SP67=1: Division of single output shaft rotation into 36,000 parts (equivalent to 0.01 degree resolution)
SP67=2: Division of single output shaft rotation into 360,000 parts (equivalent to 0.001 degree resolution)
SP67=3: Division of single output shaft rotation into 3,600,000 parts (equivalent to 0.0001 degree resolution)

The SP67 setting automatically changes the output range for the CN2-40, 41 current value data output.

Also, set the output shaft rotation speed referencing command pulse frequency [Hz] = output shaft rotation speed [r/min]/60 x number of output shaft divisions.

Example) To set SP67=2 (one rotation of output shaft divided into 360,000 parts) and set the output shaft rotational speed to 50 [r/min]

Command pulse frequency = 50 [r/min]/60 x 360000 = 300 [kHz]

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Appendix

When configuring an absolute system using the SHA-CG(-S), connect the CN2-40, 41 current value data output to the host device and manage the coordinates with the host device. For details, refer to [17-bit absolute encoder] (P4-4).
Note that the output range and polarity of the CN2-40, 41 current value data output depends on [SP67: Output shaft divide function setting] and [SP50: instruction polarity] setting. For details, refer to [Outputting the current value data from the pins CN2-40 and 41] (P4-9).

Model	Setting	Output range	Unit
SHA-CG	SP67=0	-4294967296 to 4294967295	pls
	SP67=1	-23592960 to 23592960*1	pls (×0.01deg equivalent)
	SP67=2	-235929600 to 235929600*1	pls (×0.001deg equivalent)
	SP67=3	-2359296000 to 2359296000*1	pls (×0.0001deg equivalent)
SHA-CG-S	SP67=0	0 to 20971519*2	pls
	SP67=1	0 to 35999	pls (×0.01deg equivalent)
	SP67=2	0 to 359999	pls (×0.001deg equivalent)
	SP67=3	0 to 3599999	pls (×0.0001deg equivalent)

*1: On the SHA=CG, when SP67=1, 2, or 3, the output range depends on the speed reduction range of the actuator and is the range of the calculated angle values of the multi revolution detection range. The output range is from [2^{32}/(2^{17} x speed reduction ratio) x number of output divisions to (2^{32}-1)/(2^{17} x speed reduction ratio) x number of output divisions].
*2: On the SHA=CG, when SP67=0, the output range depends on the speed reduction ratio of the actuator. The output range is [0～2^{17} x speed reduction ratio － 1].

Caution

- [SP67: Output shaft divide function setting] is the function that sets the operation command resolution. It does not guarantee the precision of positioning on the output shaft. For details on the output shaft positioning precision, refer to [AC Servo Actuator SHA Series Manual].
- With the SHA-CG series, the CN2-40, 41 current value data output range depends on the value of [SP67: Output shaft divide function setting].
- The output shaft divide function setting is achieved using the electronic gear function, so the speed setting and acceleration/deceleration and acceleration time settings operate with multiples of the automatically set electronic gears. (For their values, refer to the table below.
- When SP67=3 is used, the permitted command pulse input frequency on the HA-800A is 1 MHz, so the max. motor rpm is restricted to Max. motor rpm [r/min] = 1 x 10^6 / encoder resolution 2^{17} x 60 x electronic gear ratio.
  For the max. rotational speed for each speed reduction ratio, refer to the table below.

Reduction ratio	SP67=3	
	Output shaft max. rotational speed [r/min]	Max. motor rpm [r/min]
50	16.7	833.3
80		1333.3
100		1666.7
120		2000.0
160		2666.7

Electronic gear value for when output shaft divide function is set

	SP67=1 36,000 divisions			SP67=2 360,000 divisions			SP67=3 3,600,000 divisions		
Reduction ratio	Numerator	Denominator	Numerator/ denominator	Numerator	Denominator	Numerator/ denominator	Numerator	Denominator	Numerator/ denominator
50	8192	45	182.0	4096	225	18.2	2048	1125	1.82
80	65536	225	291.3	32768	1125	29.1	16384	5625	2.91
100	16384	45	364.1	8192	225	36.4	4096	1125	3.64
120	32768	75	436.9	16384	375	43.7	8192	1875	4.37
160	131072	225	582.5	65536	1125	58.3	32768	5625	5.83

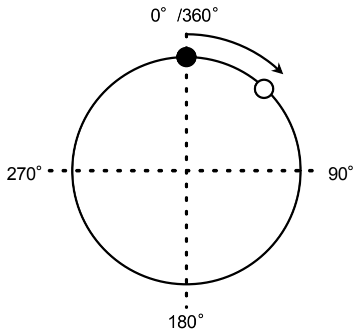
Examples of combined operations

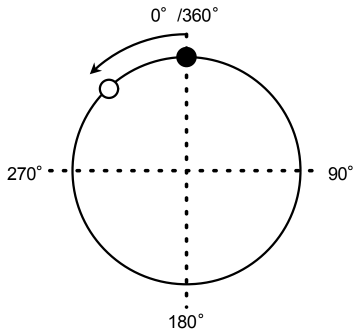
Ex. 1: SHA-CG, when output shaft divide function is not used (SP67=0)
Ex. 2: SHA-CG, when output shaft divide function is used (SP67=1)
Ex. 3: SHA-CG-S (output shaft 1 revolution absolute model), when output shaft divide function is not used (SP67=0)
Ex. 4: SHA-CG-S (output shaft 1 revolution absolute model), when output shaft divide function is used (SP67=1)

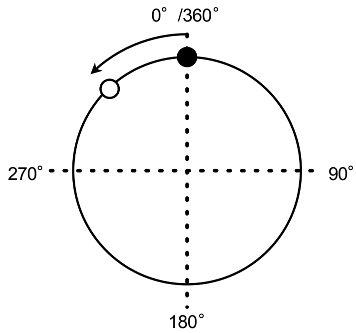
Ex. 1: SHA-CG, when output shaft divide function is not used (SP67=0)

SHA25A50CG (Resolution of output shaft: 6553600 [pls/r]), [SP67: when output shaft divide setting] is 0, electronic gear = 1/1

When Forward command is input (command pulses: 819200)

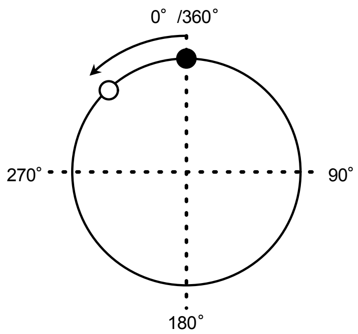
<table>
<tr><th>SP50=0 (default)</th><th>SP50=1</th><th>SP50=2</th></tr>
<tr>
<td>Clockwise rotation with command pulse increase
45° operation to clockwise direction


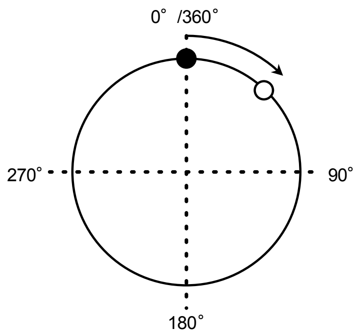
Current value data output
Increase with clockwise rotation
Current value data: 819200</td>
<td>Counter clockwise rotation with command pulse increase
45° operation to counter clockwise direction


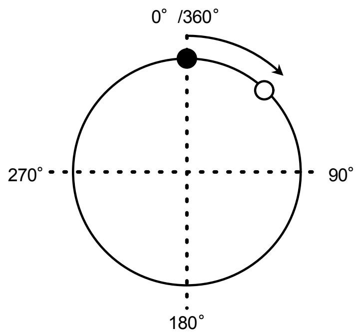
Current value data output
Increase with clockwise rotation
Current value data: -819200</td>
<td>Counter clockwise rotation with command pulse increase
45° operation to counter clockwise direction


Current value data output
Increase with counter-clockwise rotation
Current value data: 819200</td>
</tr>
</table>

When Reverse command is input (command pulses: 819200)

<table>
<tr><th>SP50=0 (default)</th><th>SP50=1</th><th>SP50=2</th></tr>
<tr>
<td>Counter clockwise rotation with command pulse decrease
45° operation to counter clockwise direction


Current value data output
Increase with clockwise rotation
Current value data: -819200</td>
<td>Clockwise rotation with command pulse decrease
45° operation to clockwise direction


Current value data output
Increase with clockwise rotation
Current value data: 819200</td>
<td>Clockwise rotation with command pulse decrease
45° operation to clockwise direction


Current value data output
Increase with clockwise rotation
Current value data: -819200</td>
</tr>
</table>

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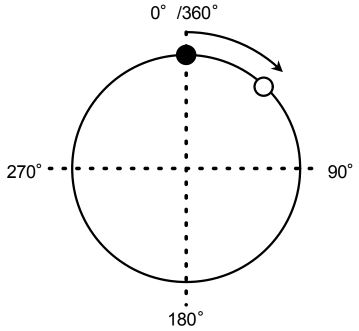
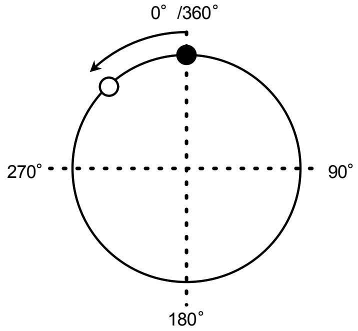
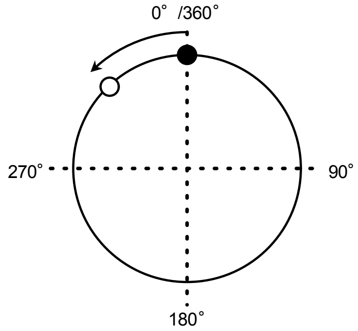
Appendix

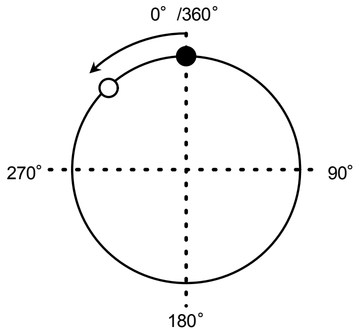
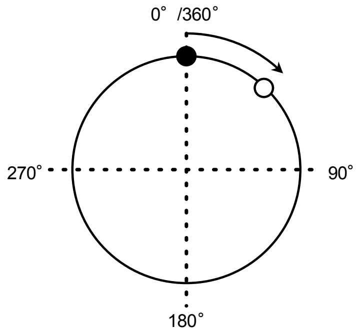
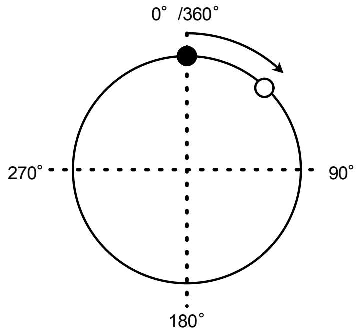
Ex. 2: SHA-CG, when output shaft divide function is used (SP67=1)

SHA25A50CG (Resolution of output shaft: 6553600 [pls/r]), [SP67: when output shaft divide setting] is 1

When Forward command is input (command pulses: 4500)

SP50=0 (default)	SP50=1	SP50=2
Clockwise rotation with command pulse increase 45° operation to clockwise direction	Counter clockwise rotation with command pulse increase 45° operation to counter clockwise direction	Counter clockwise rotation with command pulse increase 45° operation to counter clockwise direction
		
Current value data output Increase with clockwise rotation Current value data: 4500	Current value data output Increase with clockwise rotation Current value data: -4500	Current value data output Increase with counter-clockwise rotation Current value data: 4500

When Reverse command is input (command pulses: 4500)

SP50=0 (default)	SP50=1	SP50=2
Counter clockwise rotation with command pulse decrease 45° operation to counter clockwise direction	Clockwise rotation with command pulse decrease 45° operation to clockwise direction	Clockwise rotation with command pulse decrease 45° operation to clockwise direction
		
Current value data output Increase with clockwise rotation Current value data: -4500	Current value data output Increase with clockwise rotation Current value data: 4500	Current value data output Increase with clockwise rotation Current value data: -4500

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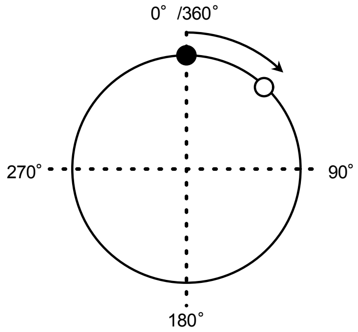
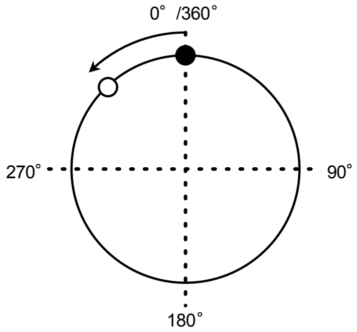
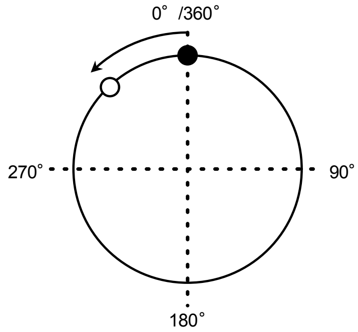
Appendix

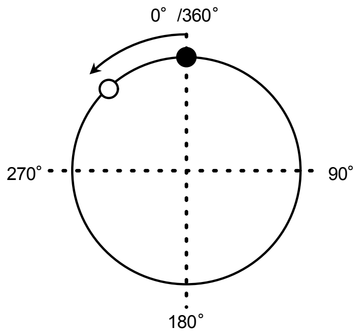
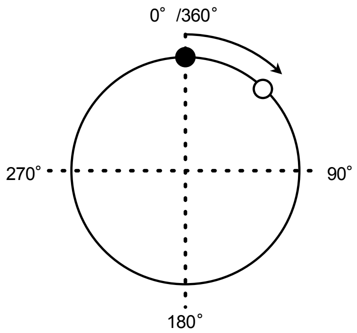
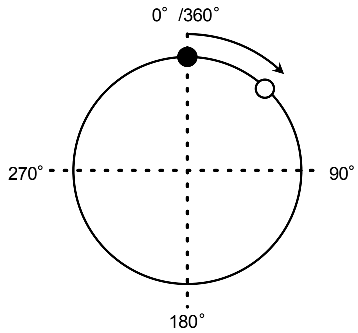
Ex. 3: SHA-CG-S (output shaft 1 revolution absolute model), when output shaft divide function is not used (SP67=0)

SHA25A50CG-S (Resolution of output shaft: 6553600 [pls/r]), [SP67: when output shaft divide setting] is 0, electronic gear = 1/1

When Forward command is input (command pulses: 819200)

SP50=0 (default)	SP50=1	SP50=2
Clockwise rotation with command pulse increase 45° operation to clockwise direction  Current value data output Increase with clockwise rotation Current value data: 819200	Counter clockwise rotation with command pulse increase 45° operation to counter clockwise direction  Current value data output Increase with clockwise rotation Current value data: 5734400	Counter clockwise rotation with command pulse increase 45° operation to counter clockwise direction  Current value data output Increase with clockwise rotation Current value data: 819200

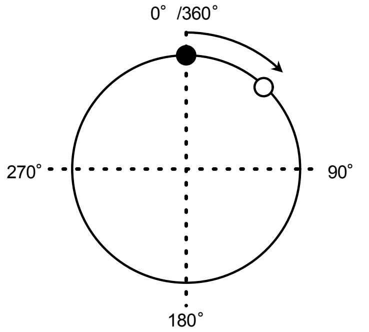
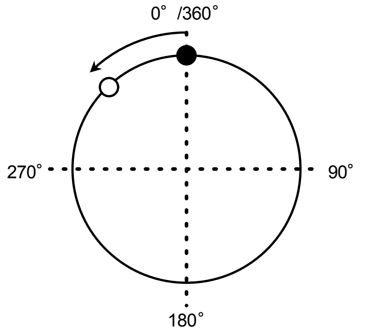
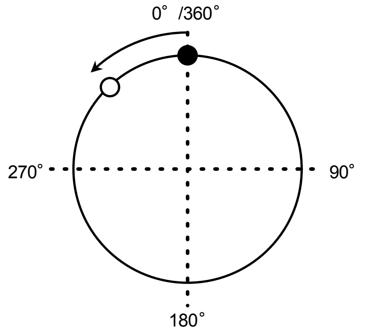
When Reverse command is input (command pulses: 819200)

SP50=0 (default)	SP50=1	SP50=2
Counter clockwise rotation with command pulse decrease 45° operation to counter clockwise direction  Current value data output Increase with clockwise rotation Current value data: 5734400	Clockwise rotation with command pulse decrease 45° operation to clockwise direction  Current value data output Increase with clockwise rotation Current value data: 819200	Clockwise rotation with command pulse decrease 45° operation to clockwise direction  Current value data output Increase with clockwise rotation Current value data: 5734400

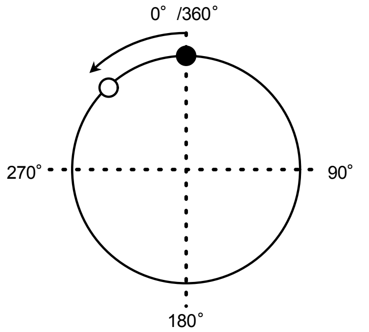
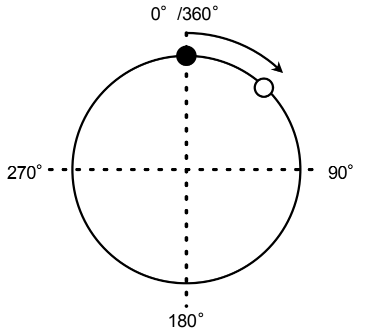
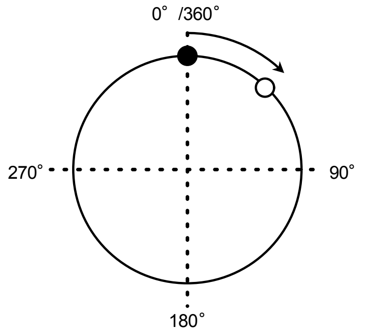
Ex. 4: SHA-CG-S (output shaft 1 revolution absolute model), when output shaft divide function is used (SP67=1)

SHA25A50CG-S (Resolution of output shaft: 6553600 [pls/r]), [SP67: when output shaft divide setting] is 1

When Forward command is input (command pulses: 4500)

SP50=0 (default)	SP50=1	SP50=2
Clockwise rotation with command pulse increase 45° operation to clockwise direction  Current value data output Increase with clockwise rotation Current value data: 4500	Counter clockwise rotation with command pulse increase 45° operation to counter clockwise direction  Current value data output Increase with clockwise rotation Current value data: 31500	Counter clockwise rotation with command pulse increase 45° operation to counter clockwise direction  Current value data output Increase with clockwise rotation Current value data: 4500

When Reverse command is input (command pulses: 4500)

SP50=0 (default)	SP50=1	SP50=2
Counter clockwise rotation with command pulse decrease 45° operation to counter clockwise direction  Current value data output Increase with clockwise rotation Current value data: 31500	Clockwise rotation with command pulse decrease 45° operation to clockwise direction  Current value data output Increase with clockwise rotation Current value data: 4500	Clockwise rotation with command pulse decrease 45° operation to clockwise direction  Current value data output Increase with clockwise rotation Current value data: 31500

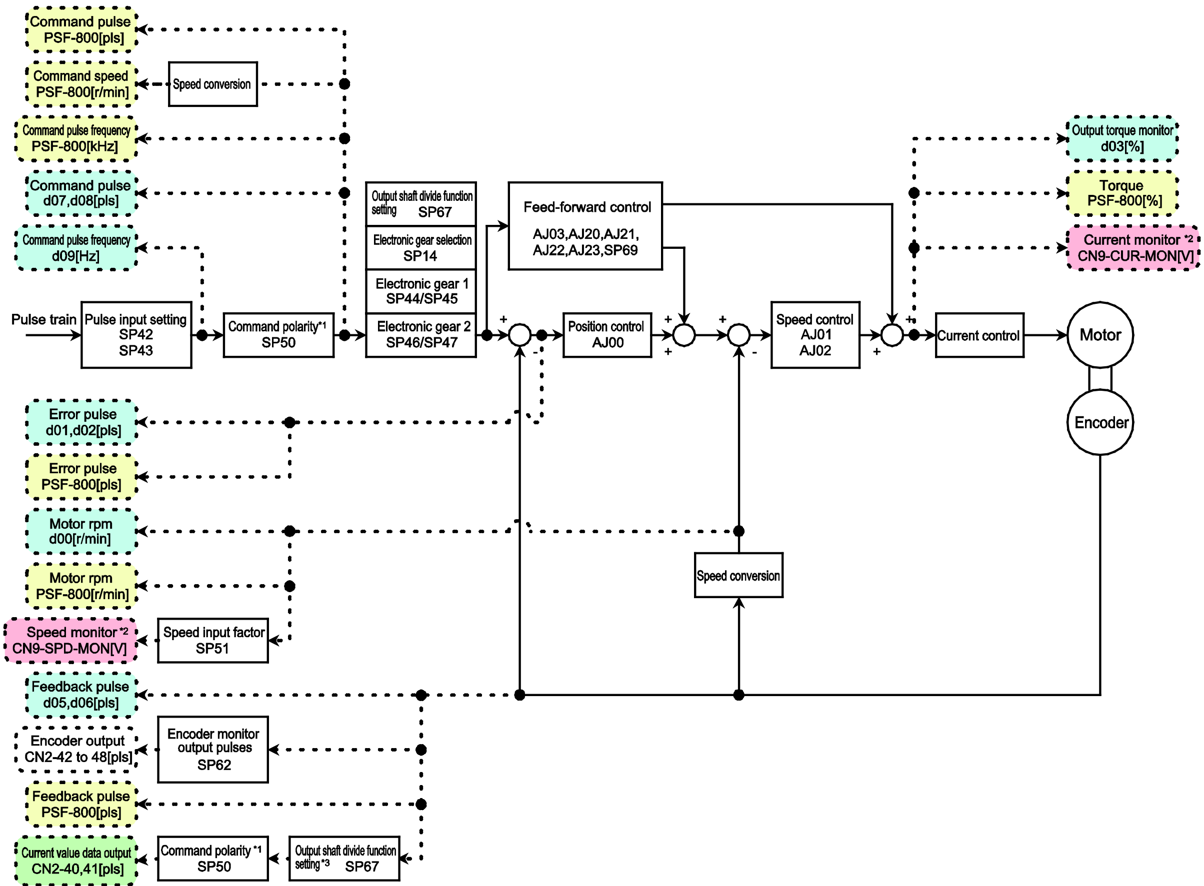
Apx

Appendix

A-6 Control block diagram

An internal control block diagram of this driver is shown here.

Position control mode



*1: When [SP50: Command polarity] is set to 0, this is equivalent to multiplying the command pulses by +1. When it is set to 1 or 2, this is equivalent to multiplying the command pulses by -1.When it is set to 0 or 1, this is equivalent to multiplying [CN2-40, 41 current value data output] by +1. When it is set to 2, this is equivalent to multiplying [CN2-40, 41 current value data output] by -1.

*2: For details on the calculation of the motor rpm [r/min] and current A from the [Speed monitor] and [Current monitor] monitor voltage, refer to [Monitor output] (P5-28).

*3: Converts the encoder pulse units to command pulse units according to [SP67: Output shaft divide function setting].

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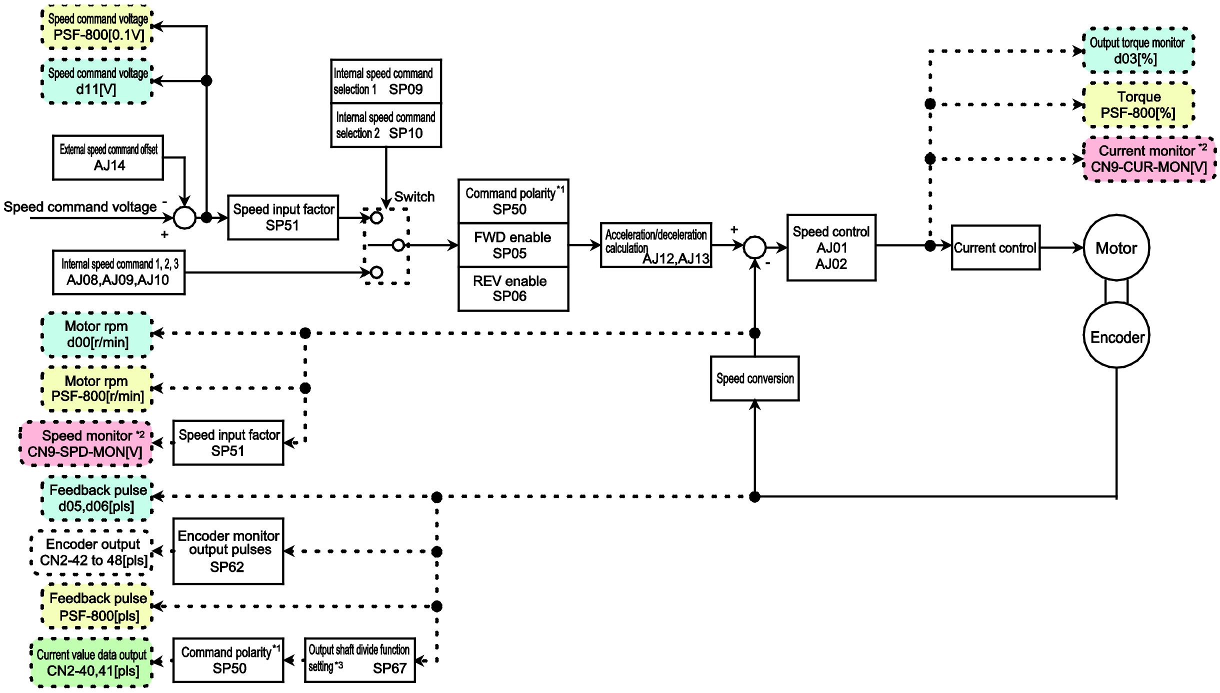
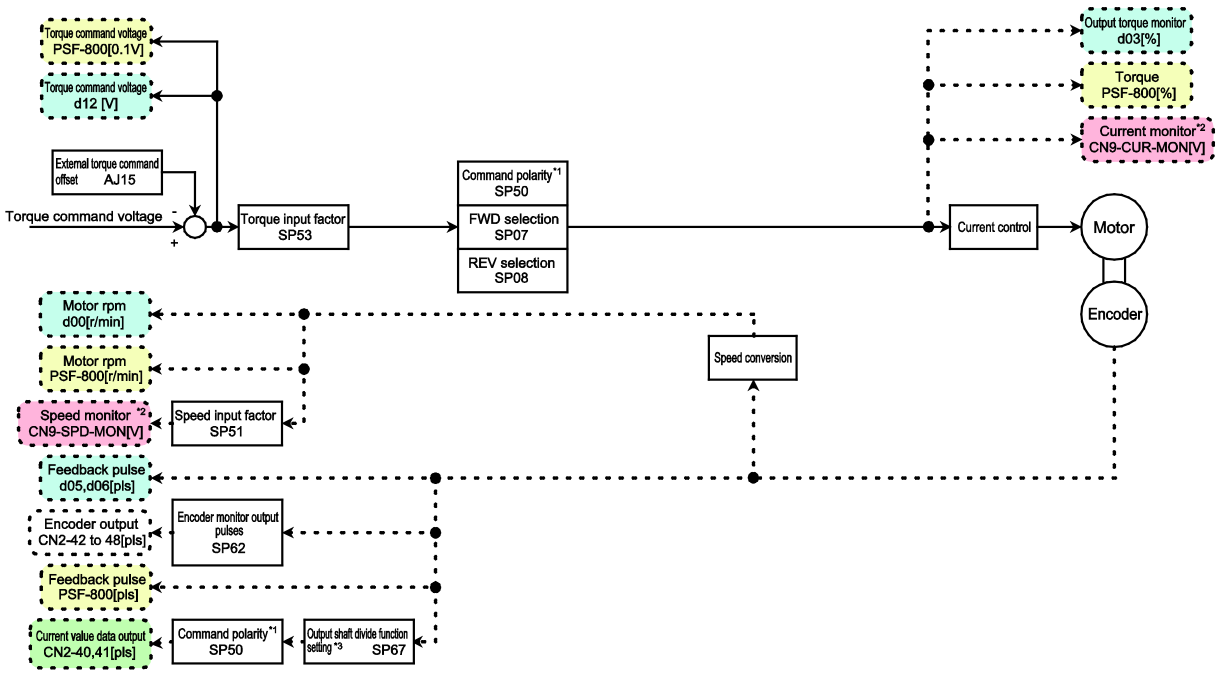
Appendix

Speed control mode



Torque control mode



*1: When [SP50: Command polarity] is set to 0, this is equivalent to multiplying the command pulses by +1. When it is set to 1 or 2, this is equivalent to multiplying the command pulses by -1.When it is set to 0 or 1, this is equivalent to multiplying [CN2-40, 41 current value data output] by +1. When it is set to 2, this is equivalent to multiplying [CN2-40, 41 current value data output] by -1.

*2: For details on the calculation of the motor rpm [r/min] and current A from the [Speed monitor] and [Current monitor] monitor voltage, refer to [Monitor output] (P5-28).

*3: Converts the encoder pulse units to command pulse units according to [SP67: Output shaft divide function setting].

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Warranty period and terms

The warranty period of the HA-800A series and warranty terms are explained below.

■ Warranty period

Under the condition that it is used properly according to each item specified in the manuals and operation manuals, this product is warranted for the period of 1 year after delivery or 2,000 hours of operation (this product), whichever ends first.

■ Warranty terms

If the product fails due to any defect in workmanship or material during the warranty period specified above, the defective product will be repaired or replaced free of charge.

This limited warranty does not apply to any product that has been subject to:

(1) Improper handling or use by the customer;

(2) Modification or repair carried out other than by Harmonic Drive Systems, Inc.;

(3) Failure not attributable to this product; or

(4) Natural disaster or any other event beyond the control of Harmonic Drive Systems, Inc.

The warranty covers only the above-named product purchased from Harmonic Drive Systems, Inc.

Harmonic Drive Systems, Inc. shall not be liable for any consequential damages of other equipment caused by the defective product, or expenses and labor costs for removing and installing the defective product from/to your system.

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HarmonicLinear® BEAM SERVO®

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Certified to ISO14001（HOTAKA Plant）／ISO9001 (TÜV Management Service GmbH)
All specifications and dimensions in this manual subject to change without notice.
This manual is correct as of August 2013.

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