HarmonicDrive®

HA-720 Series

AC servo driver for Direct Drive Motor Manual

- Thank you very much for your purchasing our AC servo driver HA-720 series.
- Be sure to use sufficient safety measures when installing and operating the equipment so as to prevent an accident resulting in a serious physical injury damaged by a malfunction or improper operation.
- 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.

SOFTWARE Ver.30H8

ISO14001
(HOTAKA Plant)
ISO9001

SAFETY GUIDE

For KDU-13 series, HA series
manufactured by Harmonic Drive Systems Inc

Read this manual thoroughly before designing the application, installation, maintenance or inspection of the actuator.

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.

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
- ✶ Machine or devices acting directly on the human body
- ✶ Instruments or devices to transport or carry people
- ✶ Apparatus or devices used in special environments
- ✶ Instruments or devices to prevent explosion

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

Precautions when using a direct drive motor

CAUTIONS FOR DIRECT DRIVE MOTOR AT APPLICATION DESIGNING

CAUTION

Always use under followings conditions:
- The motor is designed to be used for indoor.
- Ambient temperature: 0°C to 30°C
- Ambient humidity: 20% to 80%RH (Non-condensation)
- Vibration: No vibration
- No contamination by water, oil
- No corrosive or explosive gas

CAUTION

Follow exactly the instructions 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 shaft.

CAUTION FOR DIRECT DRIVE MOTOR IN OPERATIONS

CAUTION

Keep limited torques of the actuator.
- Keep limited torques of the actuator.
- Be aware to balance the gravity for load mounting to output shaft.

WARNING

Never connect cables directly to a power supply socket.
- Direct drive motor cannot be operated unless it is connected to dedicated driver.
- Never connect it to commercial power supply directly. Direct drive motor may be damaged and causes fire.

CAUTION

Do not apply shocks to direct drive motor
- Do not apply shocks because direct drive motor is directly connected to high precision encoder.
- If the encoder is damaged, it may cause uncontrollable operation.

CAUTION

Avoid handling of motor by cables.
- Failure to observe this caution may damage the wiring, causing uncontrollable or faulty operation of direct drive motor.

Precautions when using a driver

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.
- Ambient temperature: 0°C to 50°C
- Ambient humidity: less than 90% RH (Non condensation)
- No vibration or shocks
- No dust, dirt, corrosive, inflammable or explosive gas

CAUTION

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.

CAUTION

Pay attention to negative torque by inverse load.
- Inverse load may cause damages of direct drive motor.
- Please consult our sales office, if you intent to apply products for inverse load.

CAUTION

Use a fast-response type ground-fault detector designed for PWM inverters.
- Do not use a time-delay-type ground-fault detector.

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.

WARNING

Do not touch terminals at least 5 minutes after turning OFF power.
- Otherwise, residual electric charges may result in electric shock. Wait for 5 min or more before inspection.
- Make installation of products not easy to touch their inner electric components.

CAUTION

Do not make a voltage resistance test or megger 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.

CAUTION

Do not operate control units by means of power ON/OFF switching.
- Frequent power ON/OFF may result in deterioration of internal circuit elements.
- Start/stop operation should be performed via input signals.

DISPOSAL OF DIRECT DRIVE MOTOR, 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.

Contents

Memo

Chapter 1 Outlines of HA-720 driver

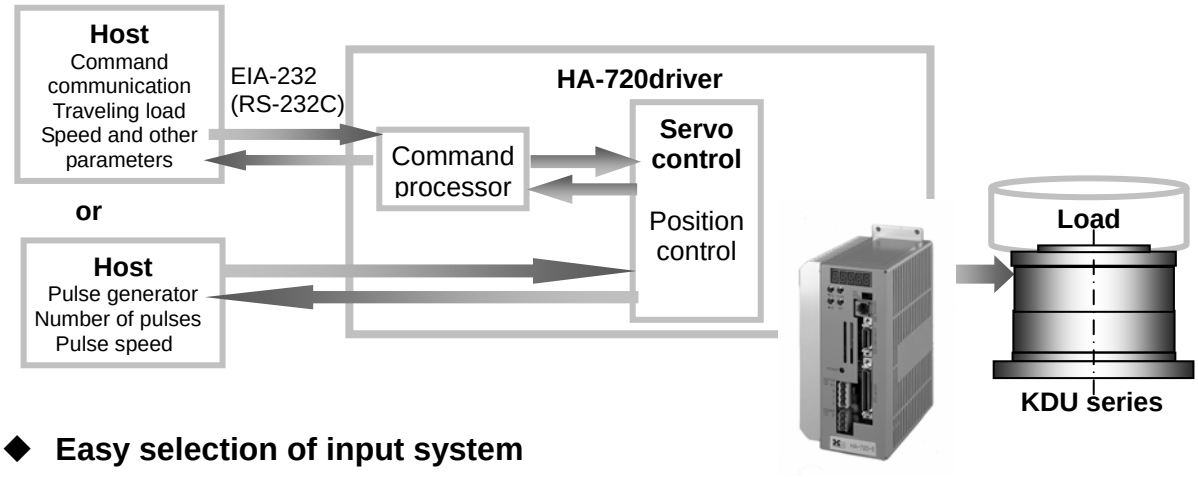
The HA-720 driver is a dedicated driver for driving a direct drive motor in the KDU series featuring a super high resolution and precision control.

The HA-720 drivers provide many superior functions to allow the direct drive motor KDU series to excel in performance.

1-1 Main features

◆ Shaft control function by command communication system or pulse input system.

The driver with a position control function by the command communication system or pulse input system for servo control.



◆ Easy selection of input system

Command communication system or pulse input system can be selected by parameter setting.

◆ High resolution in current detection and enhanced control by high-speed processing

High resolution in current detection by a 16bit A/D converter and 32Mpps encoder pulse frequency promise positioning control in super high resolution.

◆ Analog monitoring function

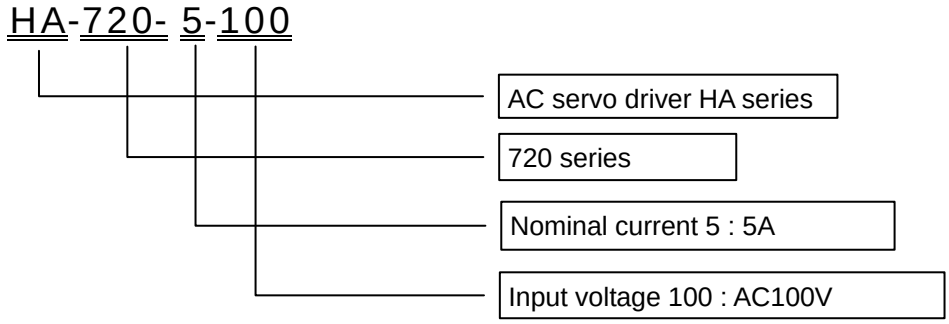
Two channels of analog monitor output circuits are provided for status monitoring of current speed and current torque command value.

Caution **The motor and driver are provided as a combination.**

The HA-720 driver stores the position correction data for combination with the direct drive motor KDU series. On the nameplates of the motor and driver, “SER.N0” shows the same number. For a combination with different numbers, the positioning accuracy of the motor is not guaranteed.

1-2 Model of HA-720 driver

Model and sign of HA-720 driver are described as follows:



◆ **Accessories**

* For I/O signal connector (CN11)	Connector type: Cover type:	10150-3000VE 10350-52F0-008
* For power supply connector (CN1)	Connector type:	231-303/026-000
* Analog monitor connector (CN10)		

● **Optional**

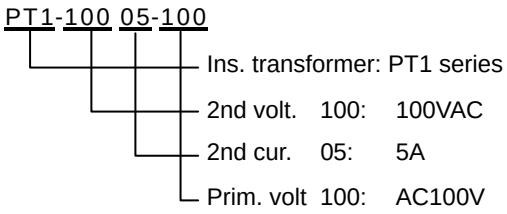
◆ **Extension cables: (optional)**

	Model
for a motor	EWC - MB * * -A04 – WG04
for an encoder	EWC - E * * -J15 - 3M20

* * means cable length: For motor wires; 03: 3m, 05: 5m (2 types)

For encoder wires; 01: 1m, 03: 3m (2 types)

◆ **Isolation single phase transformer (optional):**



1-3 Combinations with direct drive motor

Combinations with HA-720 drivers and direct drive motor KDU series are as follows:

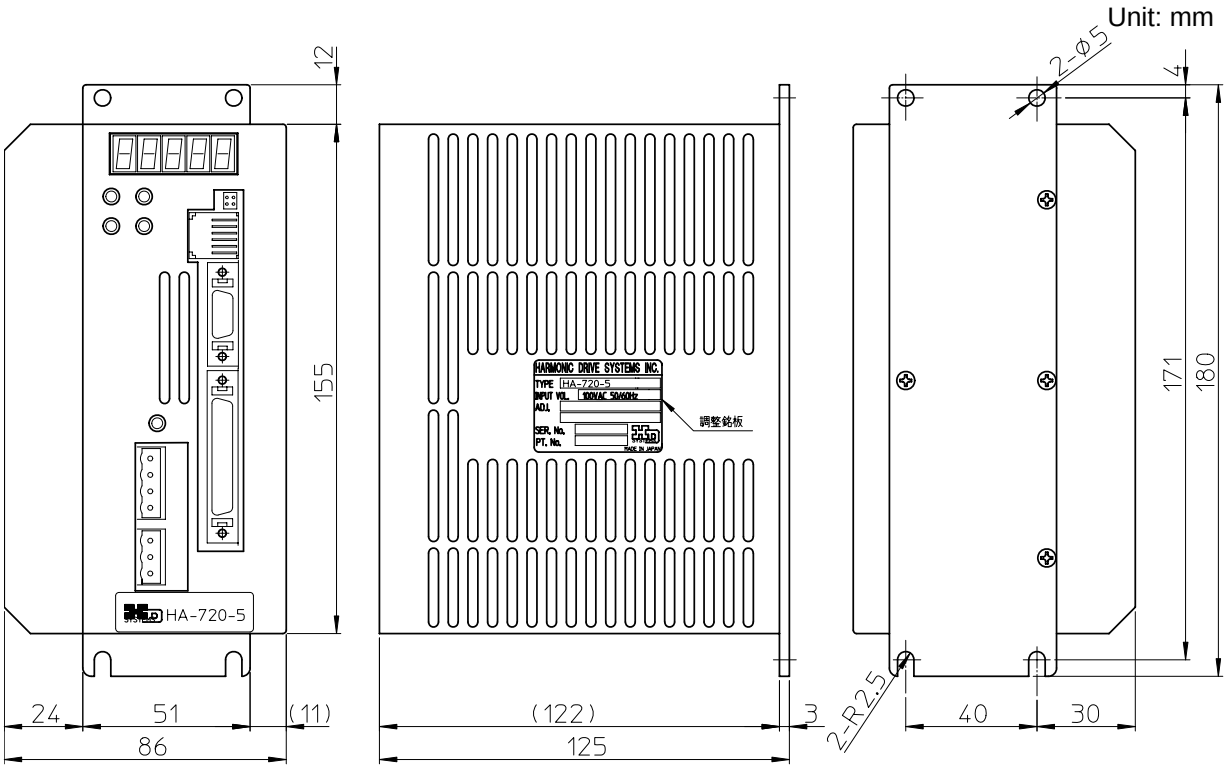
Combinations with driver and motor	KDU-13-S-D	KDU-13-W-D
Driver	HA-720-5-100	
Motor	KDU-13SA-E08-100	KDU-13WA-E08-100

1-4 Specifications of HA-720 drivers

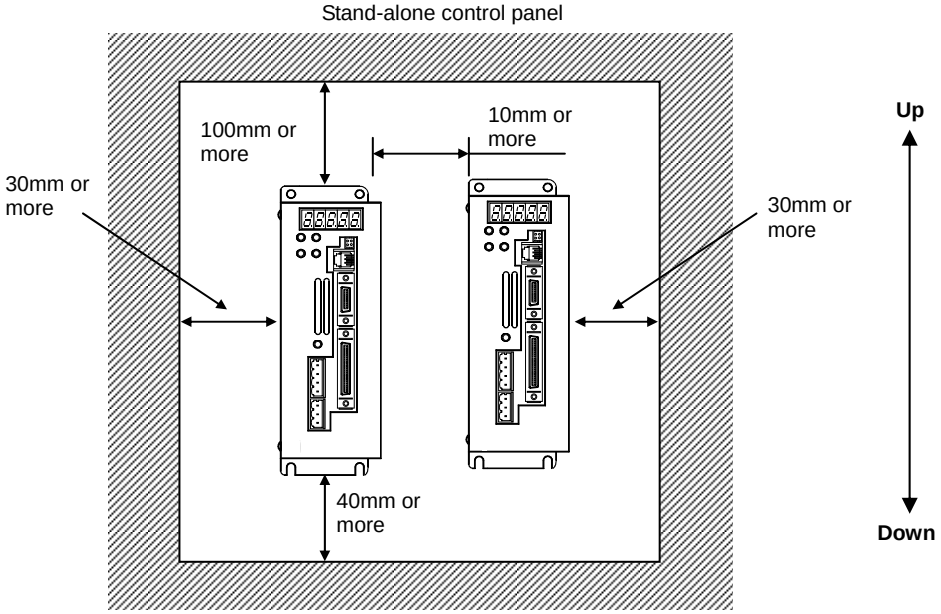
Model	Driver	HA-720-5-100
	Motor	KDU-13SA-E08 ,KDU-13WA-E08
Driver's nominal current		5A
Driver's maximum current		10A
Power supply		AC100V ±10%
Power frequency		50/60Hz
Control functions		Positioning control by pulse input or by command.
Applicable encoder		Incremental: Phase A, B and Z Line driver output
Limit value for position specification		±2,100,000,000 (32bit)
Power control		Sine wave PWM control 20kHz
Construction		Self-cooled type
Installation method		Base mount (wall installation)
Input signal	Command pulse	20Mpps Max. x4 differential input Input mode (1 pulse system, 2 pulse system or 2-phase pulse system)
	Input signal	Servo-ON, FWD inhibit, REV inhibit, dynamic brake, alarm clear, inhibit Origin signal (Insulation by a photo coupler in all cases)
	Output signal	Ready, in-position, alarm code output (Insulation by a photo coupler in all cases)
Command communication	Communication system	EIA-232 (RS-232C)
	Mode setting	Absolute position control, relative position control, jogging, At-origin
	Commands Read/write	Servo operation, input signal operation, position data value change, traveling operation designation, parameter confirmation and change, servo status monitoring and alarm status monitoring and clearing
Data display		LED 7 segments 5 columns: Current monitor, parameters, error codes, etc.
Panel operation keys		4 keys (Parameter check, parameter change, display digit change, memory write and other functions)
Ambient conditions		Operating temperature: 0 to 50°C Storage temperature: -20 to 85°C Operating/storage humidity: below 90%RH (No condensation) Vibration resistance: 4.9 m/s^2(10 to 55Hz) Shock resistance: 19.6m/s^2 Environment: No metal powder, dust, oil mist or corrosive gases, etc. No contamination by water, oil To be used indoors. No direct sunlight.
Mass		1.4kg
Safety standards		Not compliance with RoHS directive

1-5 External drawing of the HA-720 drivers

The HA-720 driver model indication and the mark shown in this manual are as follows:

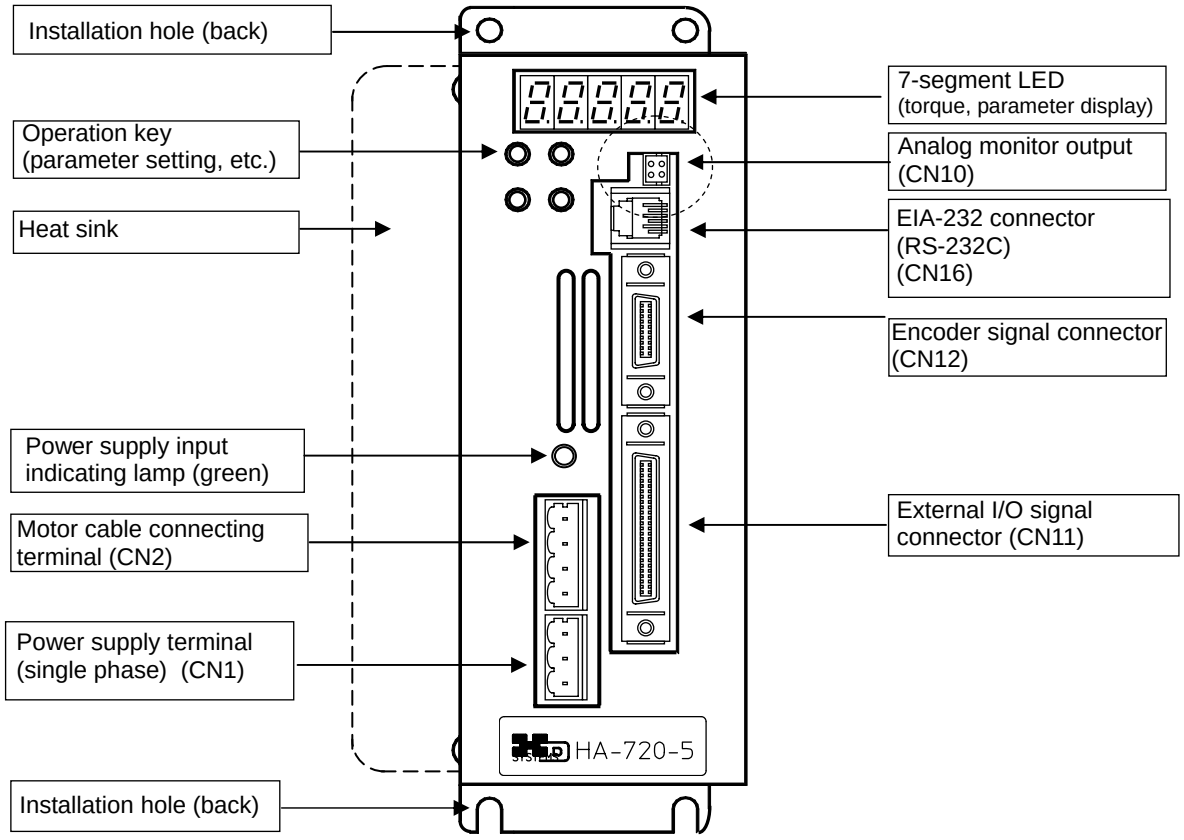


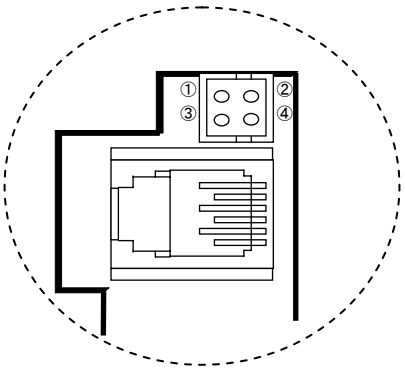
Note: When HA-720 drivers are installed in a cabinet, leave enough ventilation space for cooling as shown below.



1-6 Names and functions of display panel parts

Names of display panel parts





Connector pin assignment for CN10 analog monitor

Functions of the display panel components

◆ **LED display**
The 5-digit 7-segment LED of the HA-720 driver displays information such as the normal output current monitoring state, setting values of each functions, and alarms.

◆ **Operation key**
You can check and change parameters while looking at the LED display.

◆ **Power supply input indicating lamp**
When the 100VAC power is supplied to the power supply connector (CN1), the green LED illuminates.

◆ **CN1: Terminal for 100VAC power supply and ground connection**
The terminal for connection of the 100VAC single-phase power supply. It is the power supply terminal to drive the control circuit of the driver and the direct drive motor.
The terminal for ground connection (earthing). To prevent an electric shock, make sure to connect a grounding (earthing) wire to this terminal.

◆ **CN2: Terminal for motor cable connection :U,V,W**
The cable of the motor is connected. The terminal symbols of the motor and HA-720 driver must be matched. Wrong connection may damage the driver and motor.

◆ **CN10: Analog monitor output connector**
Allows you to monitor the rotation speed and motor driving torque.

◆ **CN11: External I/O signal connector**
The connector for receiving control signals from the host controller.

◆ **CN12: Encoder signal connector**
The connector for cable connection with the position detection encoder (interpolator) of the motor.

◆ **CN16: EIA-232 connector(RS-232C-compatible)**
The connector for connection with host devices such as a PC. It is used for communication such as positioning control with command communication, parameter setting, and alarm state monitoring.

1-7 Overview of the positioning driving methods

You can select pulse command and/or command input as the positioning driving method by the driver.

The factory-shipped driving method is set to pulse command input. To use driving with command input, you need to change parameters.

This section provides examples of operation sequences for pulse command input and command input.

For details, refer to Chapter 7, “Operations.”

1-7-1 Positioning driving sequence using pulse command input (example)

1) Supply the 100VAC power supply to the CN1 terminal.

2) Make sure that Parameter #12=29.
Refer to “Parameter 12: Initial mode” in 5-3 “Parameter details.”
For the method to check the parameter value, refer to 5-4 “Functions of the operation keys on the driver display panel unit.”

3) Input the servo on signal.
The specified current is fed to the motor once automatically upon power-on to perform magnetic pole detection.

1. The output shaft of the motor rotates in the forward and reverse directions about 5 times to detect the magnetic pole upon servo on after the power is turned on. Set up the system configuration so that the rotation does not cause any problem.

2. Do not touch the motor during magnetic pole detection. Otherwise magnetic pole detection may fail.

3. Avoid any torque over the maximum torque during magnetic pole detection. Otherwise magnetic pole detection may fail.

4) If magnetic pole detection is completed successfully without any internal error, the motor enters a servo lock state, and the operation ready signal is outputted.

5) Input the inhibit signal.

6) Positioning rotation operations carry out according to the FWD and REV pulse command input.

7) If the motor operates as specified, it can be judged that there is no problem in the wiring.

1-7-2 Positioning driving sequence using command input (example)

The driver is set to the pulse command method. The following instructions is to change the parameter to the command input method.
For the detailed operation method, refer to 7-1-2 “Trial run using commands.”

XXXX indicates a communication command.

1) Supply the 100VAC power supply to the CN1 terminal.
2) MASK: Disables the I/O signal command at the connector CN11 and gives a higher priority to communication.
3) SVON: Inputs the servo on signal via communication.
   The specified current is fed to the motor once automatically upon power-on to perform magnetic pole detection.

Caution

1. **The output shaft of the motor rotates in the forward and reverse directions about 5 times to detect the magnetic pole upon servo on after the power is turned on. Set up the system configuration so that the rotation does not cause any problem.**
2. **Do not touch the motor during magnetic pole detection. Otherwise magnetic pole detection may fail.**
3. **Avoid any torque over the maximum torque during magnetic pole detection. Otherwise magnetic pole detection may fail.**

4) If magnetic pole detection is completed successfully without any internal error, the motor enters a servo lock state, and the operation ready signal is outputted.
5) INC: Changes to the relative position mode. Operates by position data input via commands.
6) V=XX: Sets the target speed.
7) P=xxxx: Specifies the value of the desired movement. The motor starts to rotate when it is sent to the driver.
8) When the positioning operation is completed, the in-position signal is outputted.
9) SVOF: Turns off the servo, resulting in a servo free state.
10) If the motor operates as specified, it can be judged that there is no problem in the wiring.

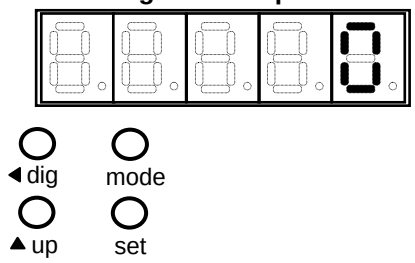
1-8 LED displays and operation keys on the display panel unit

1-8-1 Overview of the LED displays

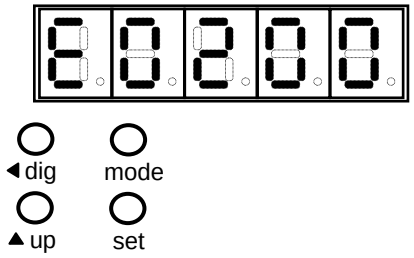
- During normal operation of the driver
  The driver output current is displayed as a percentage (%) of Parameter #3 (motor rated current).

- When an alarm occurs
  The code is outputted at ALM-A, B, and C of CN11. At the same time, the following alarm code is displayed on the LED.
  An alarm code is expressed as a 4-digit hexadecimal bit pattern.
  For details, refer to 8-1-2 “LED alarm display on the driver display panel.”

Only numbers are displayed during normal operation



Exxxx is displayed when an alarm occurs



1-8-2 Overview of the operation key functions

You can operate parameters by using the 4 operation keys in the front of the HA-720 driver.

The functions of the operation keys are as follows.

1) Viewing (checking) a parameter value.
2) Changing a parameter value.
3) Selecting the blinking digit (desired digit).
4) Writing the changed parameter value to the nonvolatile memory of the driver.

(“-” is expressed as blinking decimal points of all values.)

For details, refer to 5-4, “Functions of the operation keys on the driver display panel unit” in Chapter 5.

1-9 Outline of protective functions

The HA-720 driver has the following protective functions that display alarms.

When the driver detects an error, the following processing is carried out. Refer to the table below.

[1] The driver performs necessary servo processing.

[2] The code is outputted from the signal output pins (CN11-31, 33, and 35).

[3] The alarm code is displayed on the LED of the driver front panel.

[4] The same code as [3] can be referred to by using the ALST command via RS-232C communication.

The alarm types include warnings. The driver continues normal operation if only a warning occurs.

If the cause has already been removed, the dynamic brake is released by a reset (the RES command or external reset input), and the operation can be continued by turning on the servo.

However, some alarms produce only a warning and do not trip the dynamic brake.

For details, refer to Chapter 8, “Protective functions.”

1-9-1 Protective function list

Protective function	Description	Driver processing	Signal output (CN11)	LED display
Electronic thermal error	Outputted when the software electronic thermal relay for motor protection trips.	Dynamic brake operation	ALM-A	E0004
Overheat	Outputted when the temperature of the driver heat sink exceeds the allowable temperature (80°C).	Dynamic brake operation	ALM-A	E0008
Parameter error	Outputted when the parameter saved to the nonvolatile memory is invalid.	Dynamic brake operation	ALM-A	E0010
Encoder error	Outputted when a signal error state due to disconnection of the encoder is detected.	Dynamic brake operation	ALM-A	E0200
FWD inhibit input	Outputted when a signal is inputted to the FWD inhibit terminal.	Dynamic brake operation	ALM-B	E0080
REV inhibit input	Outputted when a signal is inputted to the REV inhibit terminal.	Dynamic brake operation	ALM-B	E0040
Overspeed	Outputted when the motor revolution exceeds 109% of the setting value of Parameter 7.	Warning display only	ALM-C	E0400
Excessive error	Outputted when the error counter value exceeds the setting value of Parameter #69 “Allowable position error.”	Warning display only	ALM-C	E0800

Chapter 2 Connector pin configuration

2-1 Pin configuration of CN1 power supply terminal

Pin	Signal name	Description
1	R	Power supply terminal 100VAC 50/60Hz
2	T	
3	FG	Earth terminal

1) Applicable terminal model for cables : Plug : 167992 (Nihon Weidmüller)
Header: 151506 (Nihon Weidmüller)

2) Applicable wire for cables: AWG14 (2.0mm^2)

Use the specified power supply voltage.
If you use a different voltage, the driver may be damaged, or fire may occur.

2-2 Pin configuration of CN2 motor cable connecting terminal

Pin number	Signal name	Description
1	U	U-phase connecting terminal
2	V	V-phase connecting terminal
3	W	W-phase connecting terminal
4	FG	Earth terminal

1) Applicable terminal model for cables: Plug: 166096 (Nihon Weidmüller)
Header: 176750 (Nihon Weidmüller)

2) Applicable wire for cables: AWG16 (1.5mm^2)

3) Maximum wiring length: 5m or less

2-3 Pin configuration of CN11 external I/O signal connector

Pin	Signal name	Symbol	I/O
1	-	-	
2	-	-	
3	-	-	
4	-	-	
5	-	-	
6	-	-	
7	FWD pulse +	FWD+	Input
8	FWD pulse -	FWD-	Input
9	REV pulse +	REV+	Input
10	REV pulse -	REV-	Input
11	Servo on	S-ON	Input
12	-	-	
13	FWD inhibit	FWD-IH	Input
14	-	-	
15	REV inhibit	REV-IH	Input
16	-	-	
17	-	-	
18	-	-	
19	-	-	
20	-	-	
21	Dynamic brake	D-BREK	Input
22	-	-	
23	Alarm clear	A-CLEAR	Input
24	-	-	
25	Inhibit	INHIBIT	Input

Pin	Signal	Symbol	I/O
26	-	-	
27	Operation ready	READY	Output
28	0V common	0V-COM	Output
29	Positioning complete	IN-POS	Output
30	0V common	0V-COM	Output
31	Alarm A	ALM-A	Output
32	0V common	0V-COM	Output
33	Alarm B	ALM-B	Output
34	0V common	0V-COM	Output
35	Alarm C	ALM-C	Output
36	0V common	0V-COM	Output
37	Input signal common	IN-COM	Input
38	-	-	
39	-	-	
40	Digital ground	Dig-GND	
41	Phase-A+ output	A+	Output
42	Phase-A- output	A-	Output
43	Phase B+ output	B+	Output
44	Phase B- output	B-	Output
45	Phase Z+ output	Z+	Output
46	Phase Z- output	Z-	Output
47	-	-	
48	-	-	
49	Origin signal	ORG	Input
50	0V common	0V-COM	Input

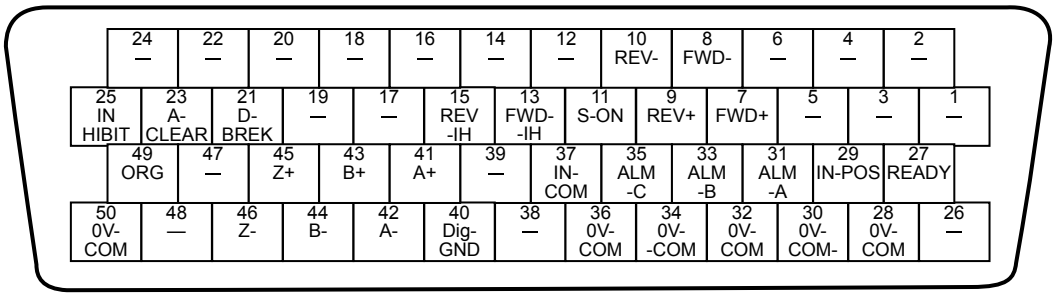
Note: Connect the shielding wire to the ground plate of the connector.

For details, refer to Chapter 3.

1) Applicable terminal model for cables: Cover: 10350-52F0-008 (Mfg by 3M)
   Plug: 10150-3000VE (Mfg by 3M)
2) Applicable wire for cables: 0.2mm^2 or more, shielding wire
3) Maximum wiring length: 3m or less

Caution

Do not make any external connection to the "-" pins. They are connected to internal circuits. Connecting anything may result in failure.
Never connect any power supply or signal.
This may cause damage to the driver.



The pin configuration above is seen from the soldered side.

2-4 Pin configuration of CN12 encoder signal connector

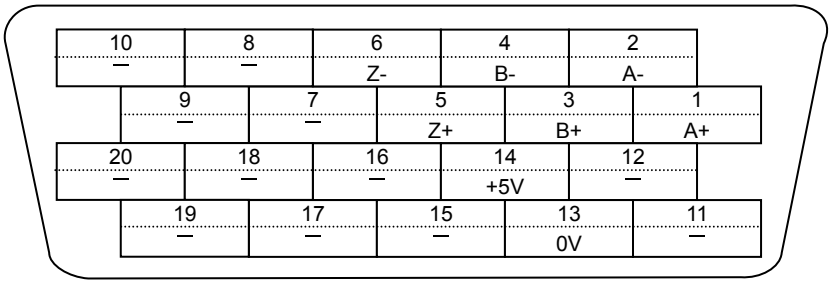
Pin	Symbol	Signal name	Description
1	A	A-phase input	Encoder signal input terminal from the motor. (Line receiver input)
2	$\overline{A}$	A-phase inverting input	
3	B	B-phase input	
4	$\overline{B}$	B-phase inverting input	
5	Z	Z-phase input	
6	$\overline{Z}$	Z-phase inverting input	
7	-	-	Not used
8	-	-	
9	-	-	
10	-	-	
11	-	-	
12	-	-	
13	0V	Encoder power supply common	Power supply terminal for the encoder
14	+5V	Encoder +5V power supply	
15	-	-	Not used
16	-	-	
17	-	-	
18	-	-	
19	-	-	
20	-	-	

Note: Connect the shielding wire to the ground plate of the connector.

1) Applicable terminal model for cables: Cover: 10320-52F0-008
   Plug: 10120-3000VE (Mfg by 3M)
2) Applicable wire for cables: 0.3mm^2 or more, twisted pair shielding wire
3) Maximum wiring length: 10m or less
4) Recommended cable: CC3712 (Mfg by IBS Japan)

Caution

Do not make any external connection to the "-" pins. They are connected to internal circuits. Connecting anything may result in failure.
Never connect any power supply or signal.
This may cause damage to the driver.



The pin configuration above is seen from the soldered side.

2-5 Pin configuration of CN16 EIA-232 connector (RS-232C)

EIA-232-compatible (RS-232C)

PC side

Pin	Signal name	Description
1	-	-
2	RXD	Received data
3	TXD	Transmitted data
4	DTR	Data terminal ready
5	GND	Signal ground
6	DSR	Data set ready
7	RTS	Ready to send
8	CTS	Clear to send
9	-	-

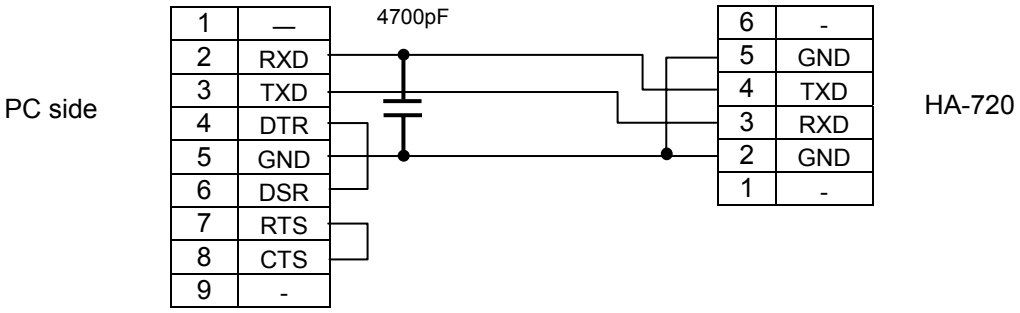
Plug: HDEB-9S (Mfg by Hirose)
Shell: HDE-CTF (Mfg by Hirose)

Driver side Connector CN16

Pin	Signal name	Description
1	-	-
2	GND	Signal ground
3	RXD	Received data
4	TXD	Transmitted data
5	GND	Signal ground
6	-	-

Plug: TM3P-64P (Mfg by Hirose)
Shell: TM5RJ3-66 (Mfg by Hirose)

To create a communication cable, refer to the following figure.
Maximum wiring length of modular cables: 2m or less



Caution

Do not make any external connection to the "-" pins. They are connected to internal circuits. Connecting anything may result in failure.
Never connect any power supply or signal.
This may cause damage to the driver.

● PC communication function

Command operation instructions, monitor displays, and parameter read/write can be performed via the EIA-232 (RS-232C)

2-6 Pin configuration of CN10 analog monitor output connector

Pin	Signal name	Description
1	MON1	Outputs the current speed monitor voltage with its center at +2.5V. The maximum speed of Parameter #7 corresponds to the 1.25V width.
2	A-GND	
3	MON2	Outputs the output current monitor voltage of the driver with its center at +2.5V. The maximum current of the driver corresponds to the 2.5V width.

Note: The analog monitor is designed mainly for oscilloscope observation.
To connect it to the system, measures such as a buffer amplifier, insulation amplifier, and noise filter are required.

Chapter 3 Control I/O signals

The HA-720 driver exchanges signals with the host device via the CN11 connector (50-pin half-pitch connector).

3-1 CN11 I/O signals

3-1-1 Pin numbers and names

The following table shows the pin numbers and names for position control.

Pin	Signal name	Symbol	I/O
1	-	-	
2	-	-	
3	-	-	
4	-	-	
5	-	-	
6	-	-	
7	FWD pulse +	FWD+	Input
8	FWD pulse -	FWD-	Input
9	REV pulse +	REV+	Input
10	REV pulse -	REV-	Input
11	Servo on	S-ON	Input
12	-	-	
13	FWD inhibit	FWD-IH	Input
14	-	-	
15	REV inhibit	REV-IH	Input
16	-	-	
17	-	-	
18	-	-	
19	-	-	
20	-	-	
21	Dynamic brake	D-BREK	Input
22	-	-	
23	Alarm clear	A-CLEAR	Input
24	-	-	
25	Inhibit	INHIBIT	Input

Pin	Signal name	Symbol	I/O
26	-	-	
27	Ready	READY	Output
28	0V common	0V-COM	Output
29	In-position	IN-POS	Output
30	0V common	0V-COM	Output
31	Alarm A	ALM-A	Output
32	0V common	0V-COM	Output
33	Alarm B	ALM-B	Output
34	0V common	0V-COM	Output
35	Alarm C	ALM-C	Output
36	0V common	0V-COM	Output
37	Input signal common	IN-COM	Input
38	-	-	
39	-	-	
40	Digital ground	Dig-GND	
41	Phase-A+ output	A+	Output
42	Phase-A- output	A-	Output
43	Phase-B+ output	B+	Output
44	Phase-B- output	B-	Output
45	Phase-Z+ output	Z+	Output
46	Phase-Z- output	Z-	Output
47	-	-	
48	-	-	
49	Origin	ORG	Input
50	0V common	0V-COM	Input

CAUTION

Do not connect the pins with "-" in the Signal column to the external device.

If you do, failure may occur because it is connected to the internal circuit.

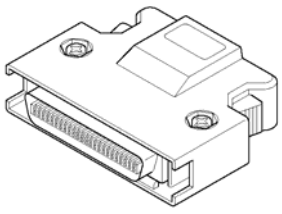
Never connect any power supply or signal.

This may cause damage to the driver.

3-1-2 Type of the I/O signal connector CN11

The type of the CN2 connector is as follows.

Connector: 10150-3000VE (Mfg by 3M)
Cover: 10350-52F0-008 (Mfg by 3M)

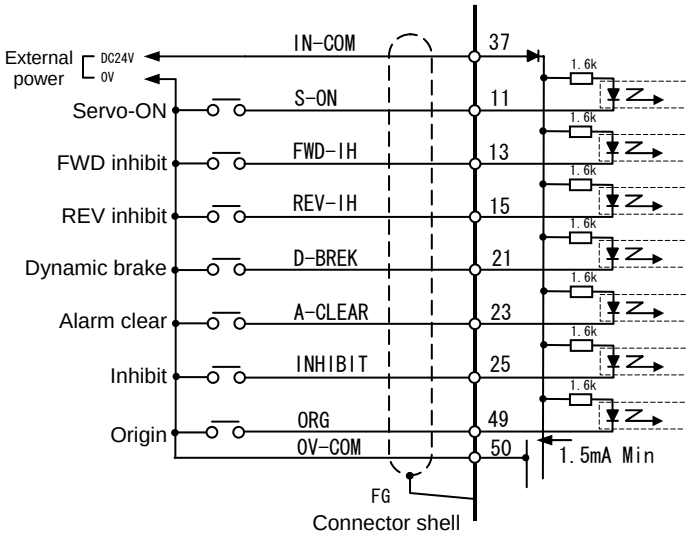


3-2 I/O port connections

This section describes the connection between the I/O ports and a host device used in the position control.

● Input signal

The HA-720 driver provides seven ports for input signals as shown in the figure to the right.



◆ Specifications

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

◆ Connection

The HA-720 driver does not provide the power supply for input signals. Connect a [+24V] external power supply for the signals to [CN11-37: input signal common].

The 0V-COM is 0V of the 24VDC external power supply system.

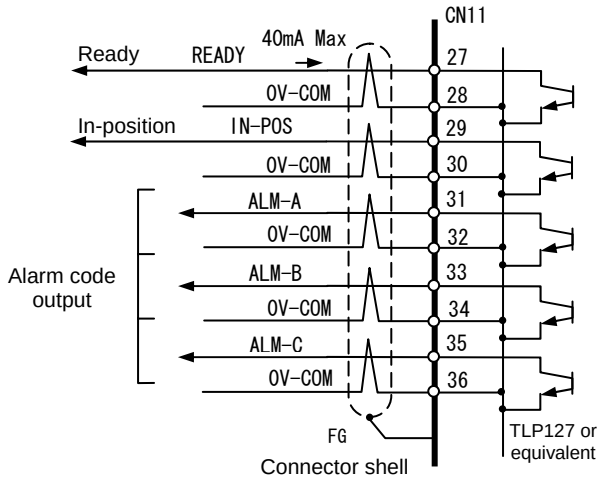
Make sure to connect the shielding wire to the connector shell.

◆ Output signal

The HA-720 driver provides five ports for output signals as shown in the figure to the right.

◆ Specifications

Port: Open collector
Voltage: DC24V or less
Current: 40mA or less (per port)
Every port is insulated by a photocoupler.



◆ Connections

The 0V-COM is 0V of the receiving input circuit power supply system of the host controller.

Make sure to connect the shielding wire to the connector shell.

● Encoder monitor outputs

The HA-720 driver provides 6 ports of 3 signals for encoder monitoring as shown in the figure to the right.

CN11-41 Phase-A+ output: A+ (output signal)
CN11-42 Phase-A- output: A- (output signal)
CN11-43 Phase-B+ output: B+ (output signal)
CN11-44 Phase-B- output: B- (output signal)
CN11-45 Phase-Z+ output: Z+ (output signal)
CN11-46 Phase-Z- output: Z- (output signal)

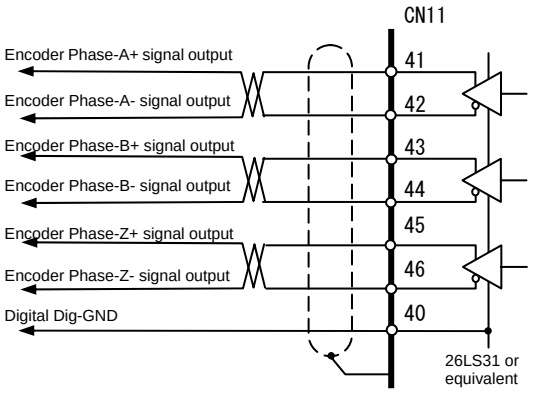
● Function

They output the Phase-A, Phase-B, and Phase-Z signals of the encoder via the line driver (26LS31).

◆ Connections

Receive the signals by line receivers (AM26LS32 or equivalent).

Note: Use the EIA-422A-compatible line receiver.



CN11-40 Digital ground: Dig-GND

● Function

It is connected to 0V of the line receiver circuit of the host controller.

3-3 I/O port functions

CN11-37 Input signal common: INPUT-COM (input)

● Function

This is the common port for inputs: [**CN11-11, 13, 15, 21, 23, 25, 49**]. Supply external power for inputs to this port.

● Connection

Connect [+24V] external power supply for inputs here.

CN11-11 Servo-ON: S-ON (input)

● Function

(1) This turns the servo power for the HA-720 driver ON and OFF.
If the servo-on input signal is turned on after the 100VAC power supply is turned on, the specified current is fed to the motor once automatically upon power-on to perform magnetic pole detection.

1. **The output shaft of the motor rotates in the normal and reverse directions about 5 times to detect the magnetic pole upon servo on after the power is turned on. Set up the system configuration so that the rotation does not cause any problem.**
2. **Do not touch the motor during magnetic pole detection. Otherwise magnetic pole detection may fail.**
3. **Avoid any torque over the maximum torque during magnetic pole detection. Otherwise magnetic pole detection may fail.**

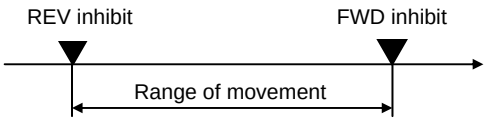
If magnetic pole detection is completed successfully without any internal error, the motor enters a servo lock state, and the ready signal is outputted.
The motor enters the servo lock state (ready state). When the signal is turned off, the motor drive circuit is turned off, resulting in the servo-off state.

(2) The logic can be changed using “Parameter #74: Input pin logic setting.” The factory-setting is 0. The function operates when the photocoupler is turned on by the input signal.

CN11-13 FWD inhibit: FWD-IH (input signal)
CN11-15 REV inhibit: REV-IH (input signal)

● Function

(1) If there is a FWD inhibit or REV inhibit input signal, the dynamic brake operates and the motor stops.
The dynamic brake is released when the alarm reset is inputted. After that, rotation to the opposite direction to the inhibited direction becomes possible when servo-on is inputted.
This input is used to limit the range of movement by using the signals from the limit sensors installed at the operating limits of the driving system.



(2) The logic can be changed using “Parameter #74: Input pin logic setting.” The factory-setting is 0. The function operates when the photocoupler is turned on by the input signal.

CN11-21 Dynamic brake: D-BREK (input signal)

- **Function**

(1) By the input of this signal, the rotation stop braking of the motor operates.
This signal has a higher priority than the servo-on signal.
No current-limiting resistor is incorporated. Therefore, frequent dynamic braking may damage the motor. Use it only in case of a device error.

(2) The logic can be changed using “Parameter #74: Input pin logic setting.” The factory-setting is 0. The function operates when the photocoupler is turned on by the input signal.

CN11-23 Alarm clear: A-CLEAR (input signal)

- **Function**

(1) If the cause of the alarm has been removed, the signal clears the alarm state to make the motor ready for operation. At the same time, the error value is cleared and the error pulse count is set to “0”.
The alarm is cleared at the falling edge of the L level.
The L level must be held for 6msec or more. If any alarm that cannot be cleared occurs, turn off the power, remove the cause of the alarm, and then turn the power back on.

(2) The logic can be changed using “Parameter #74: Input pin logic setting.” The factory-setting is 0. The function operates when the photocoupler is turned on by the input signal.

CN11-25 Inhibit: INHIBIT (input signal)

- **Function**

(1) When the inhibit signal is inputted during the servo-on signal input state, operation that follows the pulse input can be done. When the inhibit signal input is turned off, the pulse input is ignored.

(2) The logic can be changed using “Parameter #74: Input pin logic setting.” The factory-setting is 0. The function operates when the photocoupler is turned on by the input signal.

CN11-49 Origin: ORG (input signal)

- **Function**

(1) This input signal is valid only for command communication.
It is the input signal from the origin sensor upon origin return. It operates at the falling edge from the H level to the L level.
Execution of origin return is done by executing the communication commands HZ+/HZ-.
When the HZ+/HZ- commands are executed, deceleration operation is performed when the origin is inputted.
For details, refer to “4) Origin return operation command” in 4-4-1.

(2) The logic can be changed using “Parameter #74: Input pin logic setting.” The factory-setting is 0. The function operates when the photocoupler is turned on by the input signal.

3-4 Functions of output signals

0V common: 0V-COM (output signal)

● Function

This signal is the common for the output signals CN11-27, 29, 31, 33, and 35. It is the common line for the output signals.

The 0V-COM is 0V of the receiving input circuit power supply system of the host controller.

● Connection

Connect the 0V common paired with the 0V of the receiving input circuit power supply system of the host controller.

CN11-27 Ready: READY (output signal)

● Function

(1) It is the ready signal output of the HA-720 driver. When the signal enters the L level state, operation command signals from the host device become valid.
This signal enters the H level when an alarm occurs.

(2) The logic can be changed using “Parameter #75: Output pin logic setting.” The factory-setting is 0. The transistor turns on during normal operation and turns off when an error is detected.

● Connection

Create an output circuit as specified below.

Voltage: 24VDC or less
Current: 40mA or less (per port)

CN11-29 In-position: IN-POS (output signal)

● Function

(1) It is outputted to indicate completion of positioning operation when the value of the error counter becomes less than the value set in Parameter #28 In-position range. It is used as a signal to check in-position in the host device.

(2) The logic can be changed using “Parameter #75: Output pin logic setting.” The factory-setting is 0. The transistor turns on when the value is within the in-position range setting values, and turns off when the value exceeds the setting.

● Connection

Create an output circuit as specified below.

Voltage: 24VDC or less
Current: 40mA or less (per port)

CN11-31 Alarm A: ALM-A (output signal)
CN11-33 Alarm B: ALM-B (output signal)
CN11-35 Alarm C: ALM-C (output signal)

● Function

(1) When the driver detects an error, it performs necessary processing and outputs alarm codes. For details, refer to Chapter 8, “Protective functions.”

(2) The logic can be changed using “Parameter #75: Output pin logic setting.” The factory-setting is 0. The transistor turns on when the driver detects an error. The transistor turns off during normal operation.

● Connection

Design an output circuit as specified below.

Voltage: 24VDC or less
Current: 40mA or less (per port)

Alarm name	Driver processing	Signal output (CN11)	LED display
Electronic thermal	Dynamic brake operation	ALM-A(CN11-31)	E0004
Overheat	Dynamic brake operation	ALM-A(CN11-31)	E0008
Parameter error	Dynamic brake operation	ALM-A(CN11-31)	E0010
Encoder error	Dynamic brake operation	ALM-A(CN11-31)	E0200
FWD inhibit input	Dynamic brake operation	ALM-B(CN11-33)	E0080
REV inhibit input	Dynamic brake operation	ALM-B(CN11-33)	E0040
Overspeed	Warning display only	ALM-C(CN11-35)	E0400
Excessive error	Warning display only	ALM-C(CN11-35)	E0800

3-5 Details of pulse input signals

3-5-1 Connection of pulse input signals

CN11-7,8 FWD pulse: FWD+, FWD- (input signal)
CN11-9,10 REV pulse: REV+, REV- (input signal)

● Function

They are valid when the mode PUL<29> that is operated by the "Parameter #12: Initial mode" pulse command input is set.

Command pulse signals are inputted from the outside.

The pulse types of the input command signals are 2-pulse method, 1-pulse method, and 2-phase pulse method. It can be set from "System parameter setting mode"→"1: Command pulse input type". The connection method is irrelevant.

Caution **Use an EIA-422A-compatible line driver for pulse output. To use a line driver of other specification, a technical discussion with us is required**

3-5-2 Command pulse mode selection

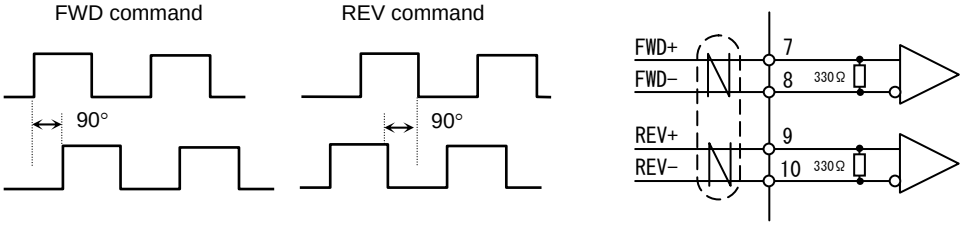
The HA-720 driver provides 2 ports (CN11-7,8 CN11-9,10) for pulse input signals. For the signals inputted to the 2 ports, 3 types can be selected.

● **Setting method** Use the value of the 4th digit of Parameter #9: Command pulse mode. The factory setting is 2-pulse method.

1. 2-phase pulse method (90-degree phase difference 2-phase pulse train)

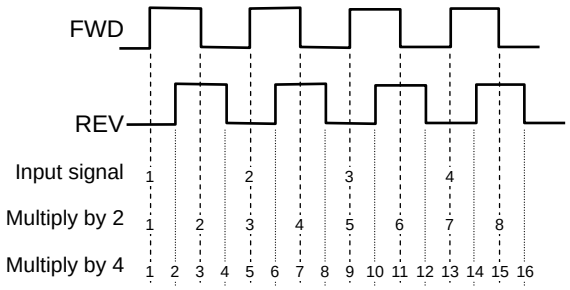
Pulse trains are inputted for both FWD and REV, as shown in the figure. The "FWD command" inputs a pulse train whose phase is 90 degrees in advance of REV to FWD. The "REV command" inputs a pulse train whose phase is 90 degrees in advance of FWD to REV. This method is also called "encoder signal method" or "90-degree phase difference 2-phase pulse train method."

The feedback pulse of the motor's encoder is outputted using this method.



◆ Multiplication of the input signal

If the input signal is "2-phase pulse method," the movement pulse count for one pulse of the original input signal can be multiplied by 2 or 4 by multiplying the input signal.

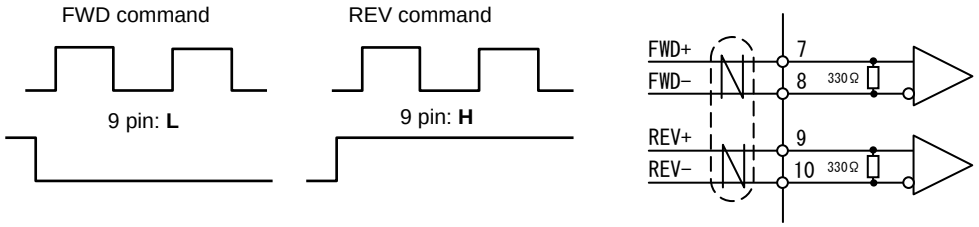


● Setting method

Use the value of the 2nd digit of Parameter #9: Command pulse mode.

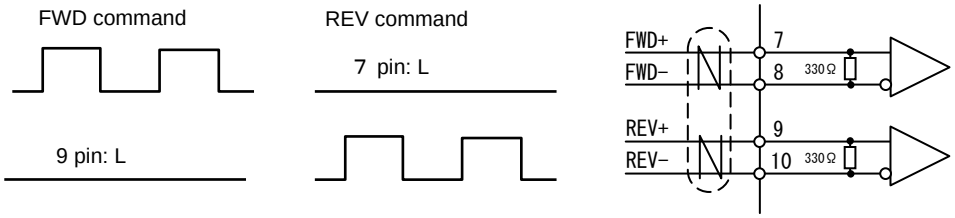
2. 1-pulse method (signed + pulse train)

The command pulse is inputted to the FWD port, and only the sign of the rotation direction is inputted to the REV port, as shown in the figure. The FWD command is OFF and L, and the REV command is ON and H. This method is also called “signed pulse method” or “sign + pulse train method.”



3. 2-pulse method (FWD/REV pulse train)

The FWD command is inputted to the FWD port, and the REV command is inputted to the REV port, as shown in the figure. During input, the other port is in the L state. This method is also called “forward/reverse pulse train method” or “FWD/REV pulse train method.”



Caution **Use negative logic for the command pulse signals in the 2-pulse method. Negative logic is a logic circuit that generates 1 for a low voltage level (OFF) and 0 for a high voltage level (ON). For the “2-pulse method,” the line receiver of the side where no pulse is inputted is determined to be 0.**

3-6 CN10 Analog monitor signal output

3-6-1 Pin numbers and names

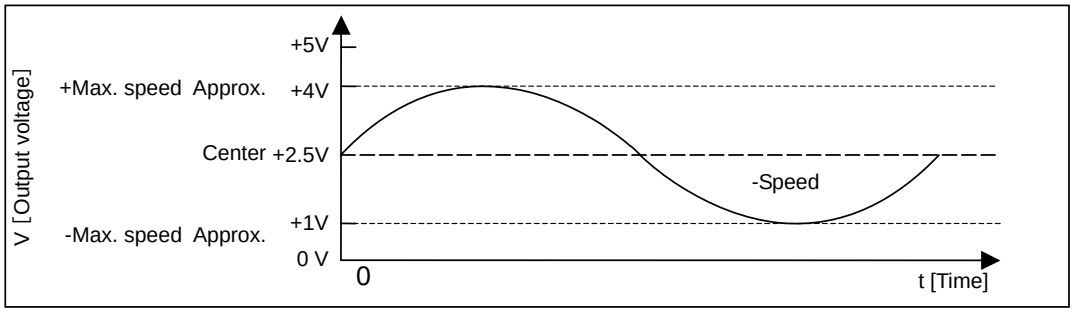
Pin	Signal	Symbol	Line color
1	Monitor signal 1	MON 1	Yellow
2		A-GND	Black
3	Monitor signal 2	MON 2	Red
4		A-GND	Black

(1) The analog monitor is designed mainly for oscilloscope observation.
To connect it to the system, measures such as a buffer amplifier, insulation amplifier, and noise filter are required.

CN10-1 Monitor signal 1: MON 1 (output signal)

- **Function**

It outputs the monitor voltage of the current speed around +2.5V.
The maximum speed of Parameter 7 corresponds to 1.525V.



Example of current speed monitor output

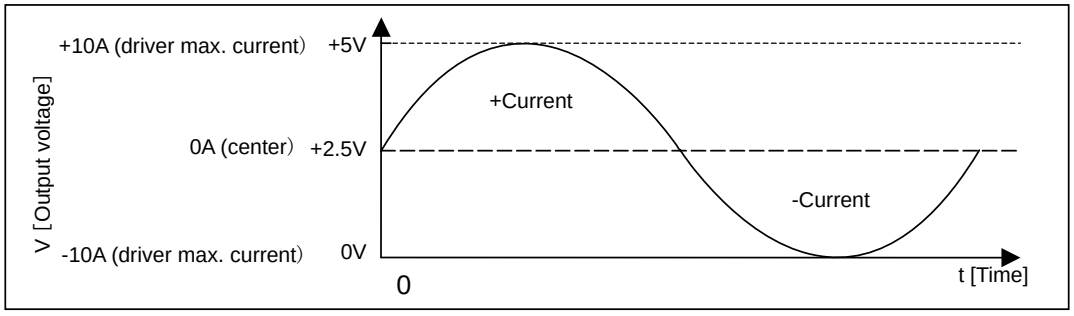
- **Connection**

Connect MON 1 of “CN10-1” and A-GND of “CN10-2”.

CN10-3 Monitor signal 2: MON2 (output signal)

- **Function**

It outputs the monitor voltage of the driver’s output current around +2.5V.
It outputs the current flowing through the motor in voltage.



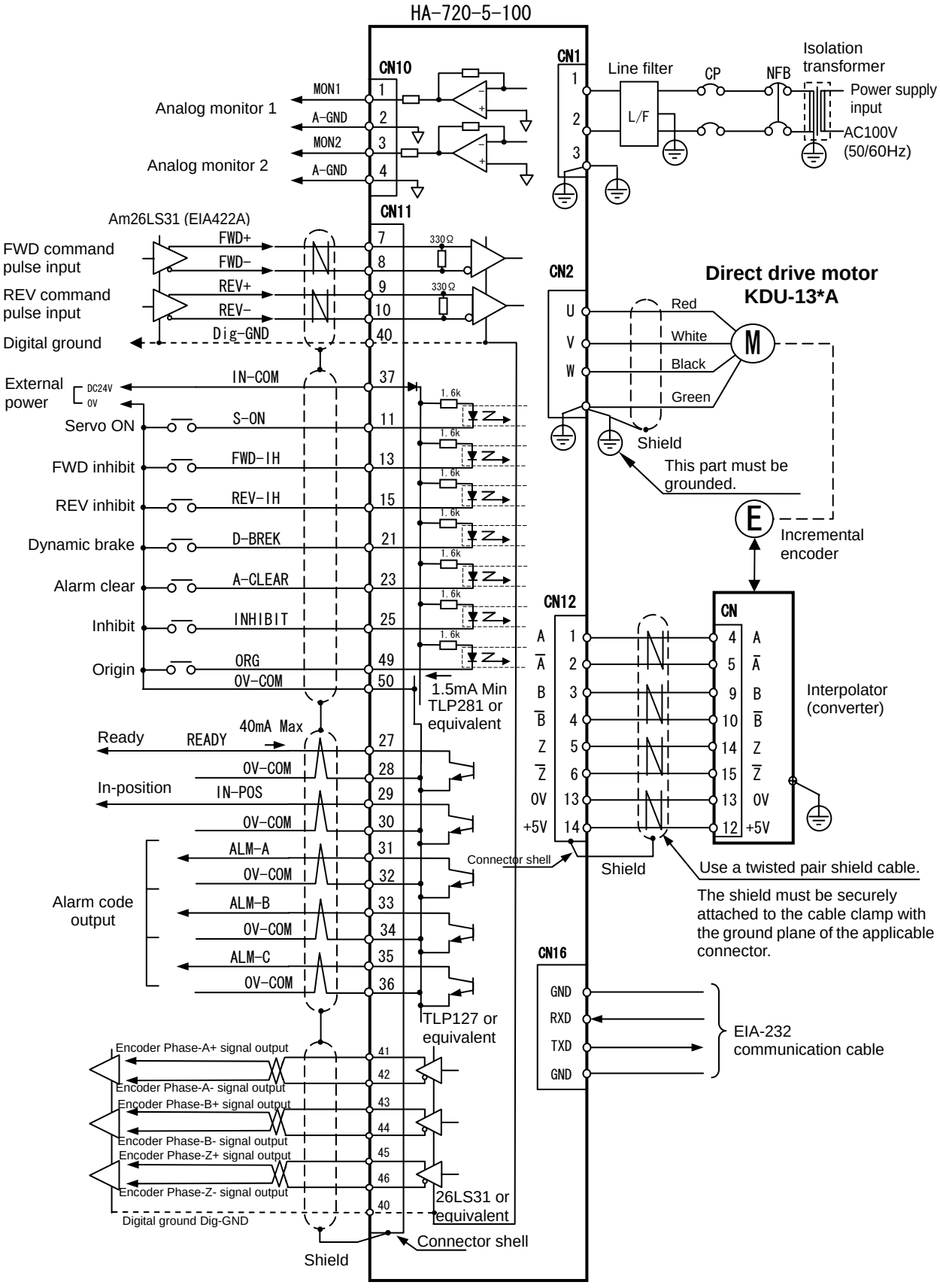
Example of output current monitor output

- **Connection**

Connect MON 2 of “CN10-3” and A-GND of “CN10-4”.

3-7 Connection examples

◆ The figure below shows a connection example in the pulse command input.



Chapter 4 Command language

As a method to send position commands and other control commands to the HA-720 driver, you can select to use communication control using the command language in addition to the I/O signals at CN11.

Transmission of commands and data is performed via the CN16 serial port of the HA-720 driver.

If the driver is not connected to the PC, you can still perform parameter setting by using the operation keys of the HA-720 driver. Refer to 5-4 “Functions of the operation keys on the driver display panel unit” in Chapter 5.

4-1 Communication specifications

1) Communication method

- Asynchronous method via EIA-232
- Communication speed … 1200, 4800, 9600, 19200, or 38400[bps]
- Data unit …1 start bit, 8 data bits, and 1 stop bit, 10 bits in total
  If you select Yes to Even Parity Bit in the driver side, the data unit is 1 start bit, 7 data bits, 1 parity bit, and 1 stop bit, 10 bits in total.

2) Data format

Reception	Command name	[Data]	CR
Transmission	[Data]	CR	

(Note)“CR” indicates a carriage return.

- All transmissions and receptions are done in the ASCII code.
- The driver is not case-sensitive, so both uppercase and lowercase characters can be used.
  Immediately after the main power of the driver is turned on, communication starts at the communication speed specified by the lower 3 digits of Parameter #21 (Communication condition).
  You can change the communication speed to 9600, 19200, or 38400 [bps] by using the BH, BH1, or BH2 command respectively, and to 1200 or 4800 [bps] by using the BL or BM command respectively.

  (Note) In high speed communication, a communication error may occur during download from the host to the driver. Communication speeds below 9600[bps] are recommended as safe communication speeds.
- You can select even parity check (7 data bits) using the 5th digit of Parameter #21 (Communication condition).
  When you turn on the main power while pressing one or more of the 4 push buttons of the driver and hold them 10 seconds or longer, communication starts at 1200[bps] regardless of the setting value of Parameter #21 (Communication condition).
- If any error exists in the data received by the driver, the following string is returned from the driver.

3) Specifying the I/O format

You can select the unit for input and output of parameters and control variables from binary data, decimal data, and hexadecimal data.

Only decimal data can be used for setting with the push buttons of the driver.

◆ To set the input unit for parameters and control variables, do the following.

- **Binary data:** Add the prefix “0b” to the beginning of the data when assigning values to parameters or control variables.
- **Decimal data:** No prefix is required when assigning values to parameters or control variables.
- **Hexadecimal data:** Add the prefix “0x” to the beginning of the data when assigning values to parameters or control variables.

Example:
Entering (1000)d as binary data to Parameter #0 (Encoder basic resolution)

Enter “#0 = 0b1111101000” to the driver.

◆ To set the output unit for parameters and control variables, do the following.

- **Binary data:** Add the prefix “!” to the query string when making the driver return parameter or control variable values.
- **Decimal data:** No prefix is required when making the driver return parameter or control variable values.
- **Hexadecimal data:** Add the prefix “&” to the query string when making the driver return parameter or control variable values.

Example:
Making the driver return the value of Parameter #0 (Encoder basic resolution) as binary data (when 1000 is set as decimal data)

When “!#0” is entered to the driver, the driver returns “0000 0011 1110 1000”.

Example:
Making the driver return the value of Parameter #0 (Encoder basic resolution) as hexadecimal data (when 1000 is set as decimal data)

When “&#0” is entered to the driver, the driver returns “000003E8”.

4) Information returned from the HA-720 in case of a communication error

Communication string	Meaning
E-S (Error-Syntax)	Undefined string received. Incomplete command string was received.
E-C (Error-Communication)	Parity error Form error
E-B (Error-Busy)	Driver reception buffer busy Command processing is not sufficient when communication lines are received in high speed.
E-E (Error-Execute)	Command execution error The driver buffer is busy due to repeated issuances of a transmission string.
E-W (Error-Write)	Parameter write error A parameter write was tried for a write-protected parameter (in WPR transmission).
E-R (Error-Read)	Parameter read error Reading of a past parameter (RPRX) failed.

4-2 Command structure

■ **General syntax**

"Variable name=" sets a value.
Example: Target position setting … P=****

"Variable name" indicates a request to read a value.
Example: Current position check … PACT

■ **Function classification**

The function classification of the command language is as described below.

◆ **Operation mode setting commands** :Specify the operation type of the driver.

- Mode to operate the driver with pulse command input
- Mode to operate the driver by entering the target position and speed via command communication

◆ **Transmission data re-check commands**: Allow you to re-check the transmission data.

◆ **Parameter value read/write commands**: Perform data processing of parameters.

◆ **Input signal selection commands**: Select input signals at CN11 or communication input signals at CN16. Perform data processing of parameters.

◆ **Servo operation setting commands**: Execute relatively simple processing such as start and stop.

◆ **Operation position and operation speed setting commands**: Specify the movement position and speed upon communication operation.

◆ **Current position data setting commands**: Set the current position and target position values.

◆ **State monitor commands**: Monitor the current position data and alarm state.

4-3 Command list

The following tables list the commands

Operation mode setting command

1) Pulse command input command	
PUL <29>	Pulse train input
2) Position specification operation command	
ABS < 3>	Absolute
INC <21>	Incremental
3) Jog operation command	
J+ <129>	Forward rotation movement
J- <131>	Reverse rotation movement
4) Origin return operation command	
HZ+ <137>	Forward rotation movement
HZ -<139>	Reverse rotation movement

Transmission data re-check command

RRX	Return of received data
RTX	Re-transmission of transmitted data

Parameter value read/write command

#**	Reading of the value of Parameter XX
#**=nn	Writing of the value XX to the parameter
WPR	Writing to the nonvolatile memory
RPR	Reading from the nonvolatile memory
RPRX	Reading parameters of the previous generation

Input signal selection command

DIMAS	Higher priority for communication of selected input signals
MASK	Higher priority for communication of all input signals

Servo operation setting command

SVON	Servo on
SVOF	Servo off
DBON	Dynamic brake on
DBOF	Dynamic brake off
FREE	Motor free
G	Operation start
S	Operation stop
RES	Alarm reset
!!!	Restart

Operation position and operation speed setting command

P=***	Specification of displacement or movement position
V=**	Specification of movement speed

Current position data setting command

PS	Origin position setting
PSA	Current position setting
CLR	Setting the current position and target position to 0
PSH	Current position shift setting

Servo state monitor command

PACT	Reading of the current position value
VACT	Reading of the current speed value
PERR	Reading of the current position error value
HOME1	Origin signal input state monitoring
DOST	Output signal state monitoring
ALST	Alarm code monitoring

4-4 Command details

4-4-1 Operation mode setting command

The commands specify the operation type of the driver.

To change the mode via the EIA-232 communication, input and execute each of the following commands.

<Value> next to each command indicates the code number of the mode which is used when it is inputted to Parameter #12 (Initial mode).

By default, the mode upon power-on is one that is set in Parameter #12 (Initial mode).

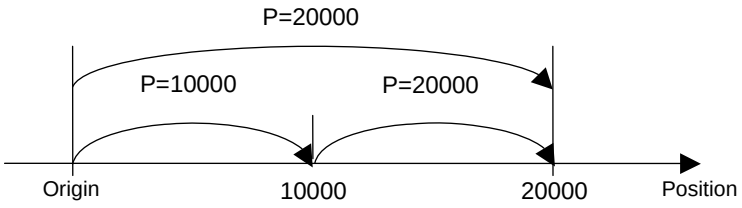
The factory setting is Parameter #12 (Initial mode)=29, which is the pulse command input mode.

1) Pulse command input command

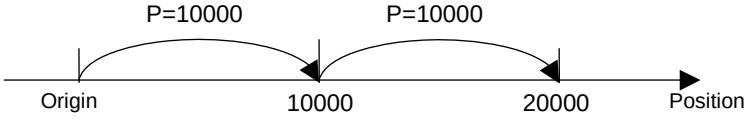
PUL <29> Follows the pulse train from the FWD and REV input pins of CN11 of the HA-720 driver and operates in pool control.

2) Position specification operation command

ABS <3> Operates with input commands by absolute command input.
P=*** recognizes the command data *** as the absolute position target.
To start movement actually, the P=*** command is required.
In mode changes between position control modes such as PUL as described earlier, the position error is held so that no position displacement occurs due to a mode change.
When operation is specified by entering a value of one rotation or more of the encoder resolution, the motor rotates for the specified value of one rotation or more.



INC <21> Operates with commands by incremental command input.
This operation mode specifies the displacement (relative position) from the current position.
When the P=*** command is executed, the data *** is recognized as the increment from the current position (the final target position to be exact).
To start movement actually, the P=*** command is required.



3) Jog operation command

J+ <129> When the J+ command is executed, forward movement is performed at the speed set in Parameter #23 (Jog speed). You can also change the speed by using the V=*** command.
The S command stops the operation.

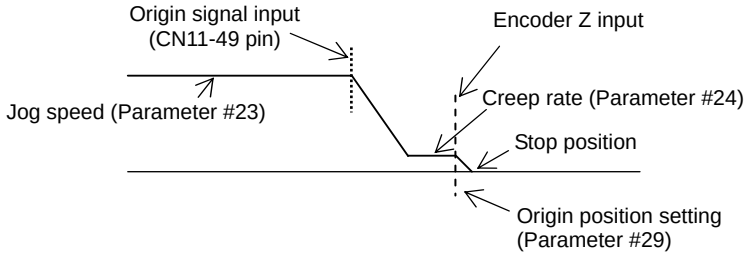
J- <131> When the J- command is executed, reverse movement is performed at the speed set in Parameter #23 (Jog speed). You can also change the speed by using the V=*** command.
The S command stops the operation.

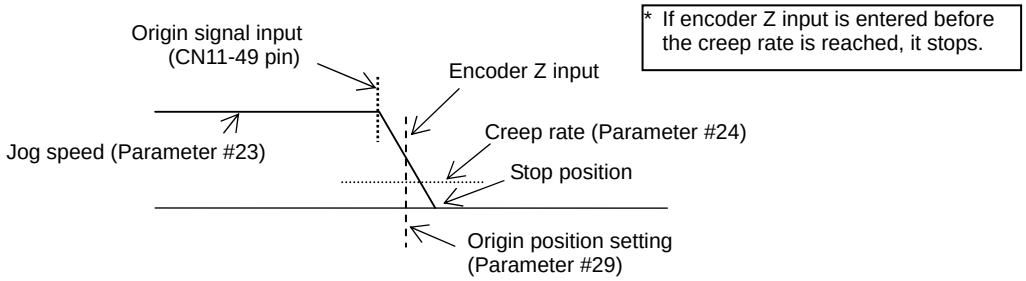
4) Origin return operation command

HZ+ <137> The origin is obtained, and forward movement is performed at the speed set in Parameter #23 (Jog speed).
It decelerates to the speed of Parameter #24 (creep rate) at the input edge of the origin LS signal from CN11, sets the value of Parameter #29 (Origin position setting) to the current position counter inside the driver at the Z-phase edge from the encoder, and then decelerates until it stops (see the figure below).
If the origin LS signal is on from the beginning, it escapes to the reverse direction, and then performs origin return operation again.

HZ- <139> Performs the same operation as HZ+ in the reverse direction.

Operation pattern for HZ+/-





4-4-2 Transmission data re-check command

RRX

Returns the mode, command, and data that the driver just received to the host.
This allows you to check whether the mode, command, and data transmitted by the host are received by the driver successfully.

Example:
ABS..... Transmitted from the host to the driver
RRX..... Transmitted from the host to the driver
"ABS"..... Returned from the driver to the host
(The string in parentheses is the string returned from the driver.)

RTX

Transmits the mode, command, and data that the driver just transmitted to the host again.

Example:
PACT..... Transmitted from the host to the driver
"123"..... Returned from the driver to the host
RRX..... Transmitted from the host to the driver
"PACT" .. Returned from the driver to the host
RTX..... Transmitted from the host to the driver
"123"..... Returned from the driver to the host (not "PACT")
(The string in parentheses is the string returned from the driver.)

4-4-3 Parameter value read/write command

#**

Makes a request to the driver to read Parameter #**.
The driver returns the value of Parameter #**.

#=nn**

Sets the data nn to Parameter #**.
Never set any data to parameters that cannot be changed.
If any data not specified data is set, normal operation may not be possible.
Setting the data does not save it to the nonvolatile memory of the driver.
To save it to the nonvolatile memory of the driver, execute the WPR command.

WPR

Saves the parameter value to the nonvolatile memory of the driver.
This function can also be performed by using the push buttons.
Refer to 5-4 "Functions of the operation keys on the driver display panel unit" in Chapter 5.

RPR

Reads the parameter value from the nonvolatile memory of the driver.

RPRX

Reads the parameter value of the previous generation from the nonvolatile memory of the driver.

4-4-4 Input signal selection command

DIMAS

Sets the bit to ignore in the input command signal of the driver CN11 to give a higher priority to the communication commands from the PC for the commands (servo on, forward/reverse rotation inhibition, dynamic brake, alarm clear, and inhibit) from the input signal pin of the driver CN11.
By default, all the bits are set to 0.
(The input from the input signal port of the driver CN11 has a higher priority.)
To give a higher priority to the communication commands, select a bit from the command input bit list below, and set 1 to the bit.

Example 1:
Giving commands only by using the communication commands from the PC

Input DIMAS=255 to the driver.
(All the commands from the input signal of the driver CN11 become invalid.)

> Tip:
> In the example above, 255 is set in decimal to DIMAS.
> “255” is “(11111111)b” when expressed in binary, and all the 8 command input bits from CN11 of the driver are ignored.

Example 2:
Giving a higher priority to the communication commands for the inhibit signal DIMAS, 7=1

Command input bit list

bit	0 (SVONI)	Servo on
bit	1 (LIMFI)	Forward rotation inhibition
bit	2 (LIMRI)	Reverse rotation inhibition
bit	3 (—)	—
---	---	---
bit	4 (—)	—
bit	5 (DBONI)	Dynamic brake
bit	6 (RES_I)	Alarm clear
bit	7 (RUN_I)	Inhibit

MASK

Sets each bit of the 8 bits to 1 for the commands (servo on, forward/reverse rotation inhibition, dynamic brake, alarm clear, and inhibit) from the input signal pin of the driver CN11.

It is the same as DIMAS=255.

4-4-5 Servo operation setting command

These commands execute relatively simple processing such as start and stop.

1) Servo operation command (the same as I/O signal pin specification)

SVON The same as ON of the servo on input of CN11.
It is valid when the dynamic brake is OFF.

SVOF The same as OFF of the servo on input of CN11.
It is valid when the dynamic brake is OFF.

DBON The same as ON of the dynamic brake input of CN11.
The dynamic brake operates.

DBOF The same as OFF of the dynamic brake input of CN11.
The dynamic brake is released.
After the dynamic brake is released, the motor becomes free.
To continue operation, the SVON input is required again.

FREE Frees the motor.
Unlike SVOF above, it is always valid regardless of ON/OFF of the dynamic brake.

G Starts the movement that was suspended by the S command.
The G command starts capturing of commands.

S Stops the motor in any control mode.
The control mode and target value are not changed, and the motor can be restarted by using the G command above.

RES Resets the alarm signal.
It is the same as ON of the A-CLEAR input of CN11.
It is invalid if there is no alarm.
The position error counter is cleared.

!!! The restart command to the HA-720 driver.
It is almost the same as turning off the main power. However, it does not work when the communication with the host is unavailable or depending on the type of the trouble.

4-4-6 Operation position and operation speed setting command

P=*

This is a useful command for the position setting operation commands ABS and INC. It starts movement to the target position ***.
Set a value in the unit [pulses] of pulse count after multiplication.
The speed can be set by using V=*** below. If no speed is specified, the value of Parameter #22(setting speed) is used.
The direction of rotation is forward if the value has no sign, or reverse if it has a negative sign.

V=**

This is a useful command for the control modes ABS and INC. It sets the movement speed.
Set a value in the unit [r/min].
If the speed is changed during movement, it is changed smoothly using the path as specified by the parameter.

4-4-7 Current position data setting command

PS

Sets the value of Parameter #29 (Origin position setting) to the current position PACT and target position PCOM.

PSA

Sets the value of the current position PACT to the target position PCOM.
It is used to use the current position as the reference.

CLR

Sets 0 to the current position PACT and target position PCOM

PSH

This command is similar to the CLR command above.
The position error PERR is saved, so errors are not accumulated.
The target position PCOM is 0, but the current position PACT does not become precisely 0 because of the position error.
Using this command prevents the 32-bit position control range from being exceeded.

4-4-8 Servo state monitor command

PACT

Indicates the pulse count of the current position after multiplication. The unit is [pulses].

VACT

Indicates the current speed. The unit is [r/min].
For this variable, averaging is done with the filter inside the driver.

PERR

Indicates the pulse count of the current position error after multiplication. The unit is [pulses].

HOME1

Transmits the state of the origin LS signal input from the driver as 1 (on) or 0 (off).

DOST

Returns the state of the output signal as the bit 1 (on) or 0 (off) from the driver.
The names assigned to the bits within the parentheses are also valid.

Status output bit list		
bit	0 (SRDYO)	Operation ready
bit	1 (IPOSO)	Positioning completion
bit	2 (ALC0O)	Alarm A
bit	3 (ALC1O)	Alarm B
bit	4 (ALC2O)	Alarm C

ALST

Returns the alarm code from the driver.
For details of alarm codes, refer to Chapter 8, “Protective functions.”

Chapter 5 Parameters

5-1 Factory-shipped standard parameter settings

The following table shows the standard parameter value settings upon factory shipment.

No	Parameter name	Unit	Factory-shipped value		Setting change
			KDU-13S	KDU-13W	
#0	Encoder basic resolution	pulse/r	2,097,152	2,097,152	Not allowed
#1	Reserved	-	0	0	Not allowed
#2	Reserved	-	222	222	Not allowed
#3	Motor rated current	$\times 10^{-1}$A	20	20	Not allowed
#4	Current limit	%	250	250	Allowed
#5	Reserved	-	0	0	Not allowed
#6	Reserved	-	0	0	Not allowed
#7	Speed limit	r/min	180	160	Allowed
#8	Reserved	-	141	141	Not allowed
#9	Command pulse mode	-	2110	2110	Allowed
#10	Reserved		0	0	Not allowed
#11	Reserved	-	20000	20000	Not allowed
#12	Initial mode	-	29	29	Allowed
#13	Command pulse input coefficient (denominator)	-	100	100	Allowed
#14	Command pulse input coefficient (numerator)	-	100	100	Allowed
#15	Reserved		15000	15000	Not allowed
#16	Reserved		0	0	Not allowed
#17	Position loop time constant	ms	8	8	Allowed
#18	Speed loop time constant	ms	2	2	Allowed
#19	Acceleration loop gain	-	5	5	Allowed
#20	Reserved	-	100	100	Not allowed
#21	Communication condition	-	96	96	Allowed
#22	Setting speed	r/min	10	10	Allowed
#23	Jog speed	r/min	10	10	Allowed
#24	Creep rate	r/min	1	1	Allowed
#25	Acceleration/deceleration time	ms	500	500	Allowed
#26	Jerk time	ms	20	20	Allowed
#27	Reserved		1000	1000	Not allowed
#28	In-position range	±pulse	2	2	Allowed
#29	Origin setting	pulse	0	0	Allowed
#30	Origin detection selection		0	0	Allowed

Note: For the operation method to change parameter values, refer to 5-4 “Functions of the operation keys on the driver display panel unit” in Chapter 5.

Caution

1. **Note that normal operation cannot be done if you change the value of data that cannot be changed.**
2. **Before changing parameter values, save the factory-shipped value to a file or record it.**
3. **When changing parameter values, check the parameter detail information and observe the setting ranges.**

No	Parameter name	Unit	Factory-shipped value		Setting change
			KDU-13S	KDU-13W	
#31	Reserved		16	16	Not allowed
#32	Function selection	-	0	0	Allowed
#33	Reserved		88	88	Not allowed
#34	Reserved		0	0	Not allowed
#35	Reserved		0	0	Not allowed
#36	Reserved		57	57	Not allowed
#37	Reserved		0	0	Not allowed
#38	Reserved		2	2	Not allowed
#39	Acceleration filter	-	1	1	Allowed
#40	Reserved		2104	2104	Not allowed
#41~53	Reserved (for factory adjustment)	-	-	-	Not allowed
#54	Deceleration time	ms	0	0	Allowed
#55	Deceleration jerk time	ms	0	0	Allowed
#56~63	Reserved (for factory adjustment)	-	-	-	Not allowed
#64	Reserved	-	6000	6000	Not allowed
#65	Reserved	-	500	500	Not allowed
#66	Reserved	-	0	0	Not allowed
#67	Reserved	-	24	24	Not allowed
#68	Reserved	-	0	0	Not allowed
#69	Allowable position error	r	-4	-4	Allowed
#74	Input pin logic setting	-	0	0	Allowed
#75	Output pin logic setting	-	0	0	Allowed
#76~96	Reserved (for factory adjustment)	-	-	-	Not allowed

Note: For the operation method to change parameter values, refer to 5-4 “Functions of the operation keys on the driver display panel unit” in Chapter 5.

Caution

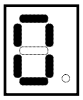
1. **Note that normal operation cannot be done if you change the value of data that cannot be changed.**
2. **Before changing parameter values, save the factory-shipped value to a file or record it.**
3. **When changing parameter values, check the parameter detail information and observe the setting ranges.**

5-2 Checking and changing parameter values

There are the following 2 methods to check and change parameter values.

1) Using the EIA-232 (RS-232C) communication
   Refer to 4-4-3 “Parameter value read/write command” in Chapter 4, “Command language.”
2) Using the operation keys on the driver display panel unit
   Refer to 5-4 “Functions of the operation keys on the driver display panel unit” in Chapter 5.

5-3 Parameter details



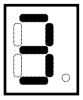
Encoder basic resolution (Cannot be changed)

● Description of the function

The encoder basic resolution of the direct drive motor is set.
(Note) Do not change the parameter value. Otherwise normal operation may not be done.

● Setting value

Unit	Factory-set value
pulse/r	2,097,152



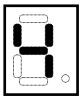
Motor rated current (Cannot be changed)

● Description of the function

The rated current of the direct drive motor is set.
(Note) Do not change the parameter value. Otherwise normal operation may not be done.

● Setting value

Unit	Factory-set value
$X10^{-1}A$	20



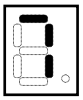
Current limit

● Description of the function

The rate of the maximum current that can be outputted by the motor is defined using the rated current of the direct drive motor as 100%.

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
%	1	250	250



Speed limit

(Valid when the power is turned on again after it is written to the nonvolatile memory)

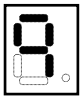
● Description of the function

The rotation speed of the direct drive motor is limited.
If 150% of this value is exceeded, a runaway alarm occurs.

● Setting value

	Unit	Lower limit value	Upper limit value	Factory-set value
KDU-13S	r/min	1	180	180
KDU-13W	r/min	1	160	160

(Caution) Do not set any value that exceeds the upper limit value. Otherwise normal operation may not be done.



Command pulse mode

(Valid when the power is turned on again after it is written to the nonvolatile memory)

● Description of the function

The mode for command pulse input is set.
For details, refer to “3-5-2 Command pulse mode selection.”

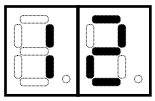
&	#	%	*

* digit: Reserved. Setting value: 0. Do not change.
% digit: Indicates the multiplied value of the input pulse.
Setting value: 1, 2, 4
It becomes valid only when 0 (2-phase pulse method) is selected in the & digit.
digit: Selects the rotation direction.
0: B-phase in advance. CCW rotation at DIR H.
1: A-phase in advance. CW rotation at DIR L.
It becomes valid only when 0 (2-phase pulse method) is selected in the & digit.
& digit: Selects the pulse input type.
0: 2-phase pulse method (90° phase difference 2-phase pulse train)
1: 1-pulse method (sign+pulse train)
2: 2-pulse method(FWD/REV pulse train)

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
-	Note	Note	2110

(Note) Perform setting after checking each digit as shown above. If you set any value other than specified, normal operation may not be done.



Initial mode

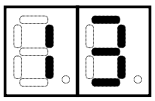
● Description of the function

This indicates the operation mode that is specified upon power on.
The setting value is the code number of the command communication mode.
The factory setting is PUL<29> indicating the pulse train input type.

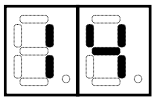
● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
-	Note	Note	29

Note: For details, refer to “4-4-1 Operation mode setting command.” If you set any value other than specified, normal operation may not be done.



Command pulse input coefficient (denominator)



Command pulse input coefficient (numerator)

● Description of the function

The command and the displacement of the real machine are made consistent by multiplying the position command by a factor.
It can be used to perform positioning at the desired speed for a low maximum frequency of the pulse generator with the lower required resolution in order to relate the control unit with angle unit for rotation operation.
The position stop resolution is decreased as the displacement angle per input pulse is increased.

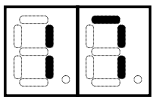
$$\text{Displacement angle} = \frac{\text{Command pulse input coefficient (numerator)}}{\text{Command pulse input coefficient (denominator)}} \times \frac{360}{\text{Encoder resolution (8,388,608 pulse/r)}}$$

The power must be turned on again after the setting change.

● Setting value

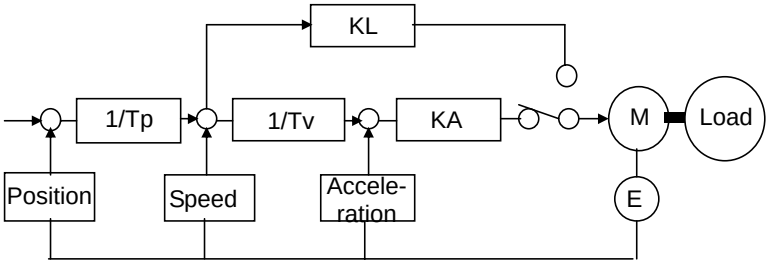
	Unit	Lower limit value	Upper limit value	Factory-set value
Numerator	-	0	32767	100
Denominator	-	0	32767	100

Note: In “4-4-1 Operation mode setting command.”, “1) Pulse command input command” changes the displacement and speed. “2) Position setting operation command” changes only the displacement.



Position loop time constant

● Description of the function



The time constant for the position loop (Tp in the figure) is specified.
A lower setting value produces a greater gain.
Setting a lower value makes rising of position control faster. However, the value may not become too low depending on the rigidity of the system.

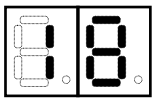
Lower setting value⇒If it is too low, the servo system becomes unstable and susceptible to vibrations (hunting) and overshoot.

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
ms	1	32767	8

"-" indicates μs.

Note: This parameter is valid when it is changed, but the data is not saved unless you write it to the nonvolatile memory. Before turning off the power, you must write it to the nonvolatile memory.



Speed loop time constant

● Description of the function

The time constant for the speed loop (Tv in the figure) is specified.
A lower setting value produces a greater gain.
Setting a lower value makes rising of speed control faster. However, the value may not become too low depending on the rigidity of the system.

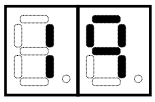
Lower setting value⇒If it is too low, the servo system becomes unstable and susceptible to vibrations (hunting) and overshoot.

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
ms	1	32767	2

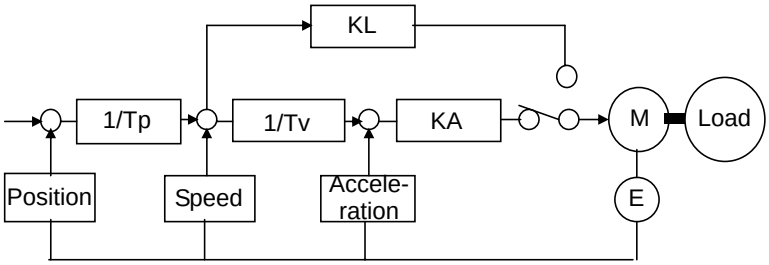
"-" indicates μs.

Note: This parameter is valid when it is changed, but the data is not saved unless you write it to the nonvolatile memory. Before turning off the power, you must write it to the nonvolatile memory.



Acceleration loop gain

● Description of the function



The time constant for the acceleration loop (KA in the figure) is specified.
A higher setting value produces a greater gain.
If this gain is an appropriate value, the error can be reduced faster, converging to the target value. If it is too high or too low, the error becomes greater, diverging from the target value. This acceleration loop is designed to converge to the target value faster than position and speed control.

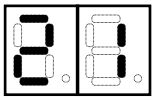
Higher setting value⇒If it is too high, the servo system becomes unstable and susceptible to vibrations (hunting) and overshoot.

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
-	1	32767	5

"-" indicates μs.

Note: This parameter is valid when it is changed, but the data is not saved unless you write it to the nonvolatile memory. Before turning off the power, you must write it to the nonvolatile memory.



Communication condition

(The power must be turned on again after setting change)

● Description of the function

#	%	*	*	*

* digit: Baud rate setting
Sets the baud rate of the EIA-232 (RS-232C) communication.
Enter a 1/100 value.
For example, enter 96 for 9600 (bps).
When the system is restarted by pressing the push button for 10 seconds or more, the parameter setting value is ignored and the system respond at 1200bps.

% digit: Reserved. Setting value:0. Do not change.

digit: Parity check selection
0:Performs no check
1:Performs parity check

● Setting value

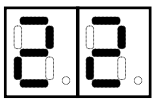
Unit	Lower limit value	Upper limit value	Factory-set value
-	Note	Note	96

(Note) Perform setting after checking the description as shown above. If you set any value other than specified, normal operation may not be done.

Baud rate setting value

Baud rate (bps)	38400	19200	9600	4800	1200
Setting value	384	192	96	48	12

(Caution) In high speed communication, a communication error may occur during download from the host to the driver. Communication speeds below 9600bps are recommended as safe communication speeds.



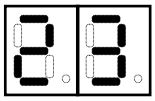
Setting speed

● Description of the function

The maximum rotation speed upon positioning for commands via the EIA-232 (RS-232) communication is specified.

● Setting value

	Unit	Lower limit value	Upper limit value	Factory-set value
KDU-13S	r/min	1	180	10
KDU-13W	r/min	1	160	10



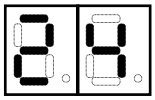
Jog speed

● Description of the function

The speed of jog operation and origin return operation for commands via the EIA-232 (RS-232) communication is specified.

● Setting value

	Unit	Lower limit value	Upper limit value	Factory-set value
KDU-13S	r/min	1	180	10
KDU-13W	r/min	1	160	10



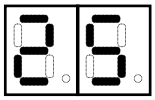
Creep rate

● Description of the function

When the origin signal (CN11-49 pin) is inputted during origin return operation, the speed is decreased to this rate and rotation is done until the Z signal of the encoder is detected.
When Parameter #30 (Origin detection selection) is set to 1, the origin signal input is ignored and rotation is done at this rate from the beginning until the Z signal of the encoder is detected.

● Setting value

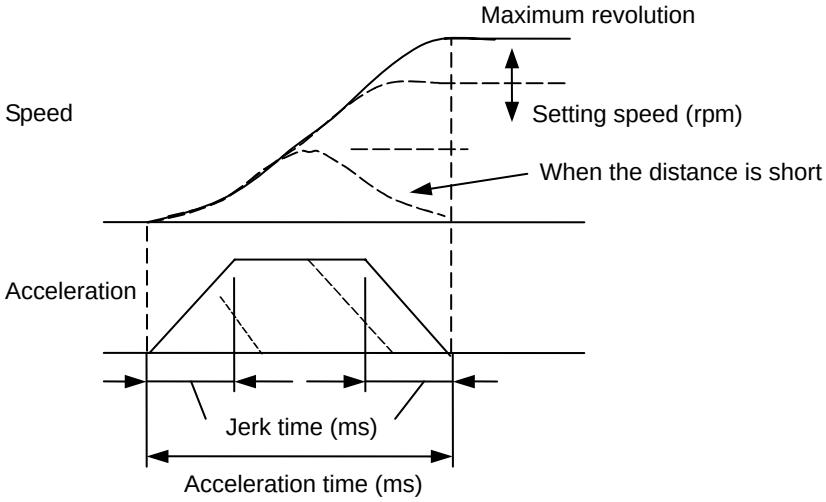
	Unit	Lower limit value	Upper limit value	Factory-set value
KDU-13S	r/min	1	180	1
KDU-13W	r/min	1	160	1



Acceleration/deceleration time

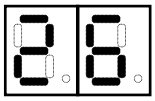
● Description of the function

It is the setting parameter for acceleration time upon S-shaped acceleration/deceleration, as shown in the figure.
The acceleration time for Parameter #7 (Speed limit) is specified.
Set a value in the range between 26 and 20,000.
When the * digit of Parameter #32 (Function selection) is set to 1, the acceleration/deceleration time is changed to the time to reach the setting speed regardless of the value of Parameter #7 (Speed limit).



● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
ms	26	20,000	500



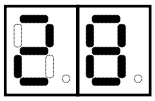
Jerk time

● Description of the function

It is the setting parameter for acceleration time upon S-shaped acceleration/deceleration, as shown in the figure above.
The acceleration rising time for Parameter #7 (Speed limit) is specified.
Set a value that is 40% of Parameter #25 (Acceleration/deceleration time) or less and in the range between 1 and 565.
The jerk time for Parameter #7 (Speed limit) is specified.
When the * digit of Parameter #32 (Function selection) is set to 1, the jerk time is changed to the time to reach the setting speed regardless of the value of Parameter #7 (Speed limit).

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
ms	1	565	20



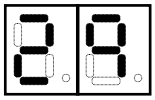
In-position range

● Description of the function

The in-position “IN-POS” (CN-11-29 pin) is outputted when the difference between the command pulse and the feedback pulse from the encoder (position error) is within the setting value.
This value provides state monitoring for position errors and does not directly affect positioning control.

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
±pulse	1	32767	2



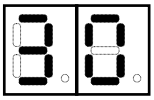
Origin setting

● Description of the function

It indicates the coordinate value set to the origin upon origin return.

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
Pulse	-2,147,483,647	2,147,483,647	0



Origin detection selection

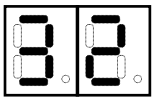
● Description of the function

You can select either waiting for the origin signal at the input pin upon origin return operation or performing origin return operation by omitting input of the origin signal

0: Performs origin detection by the operation of the origin return operation mode (HZ+/-).
For details, refer to “4) Origin return operation command” in “4-4-1 Operation mode setting command.”
1: Performs movement at the creep rate from the beginning by ignoring the origin signal input in the origin return operation mode (HZ+/-), clears the position counter when the first Z phase is detected, and sets the value of origin (#29) to the origin.

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
-	0	1	0



Function selection

● Description of the function

&	#	%	*

* digit: Selects the rotation speed rising/falling acceleration conditions.
  0: Produces acceleration that increase the speed to Parameter #7 (Speed limit) within Parameter #25 (Acceleration/deceleration time). (The acceleration is constant regardless of the command speed.)
  1: Produces acceleration that increase the speed to the target speed specified in V=*** within Parameter #25 (Acceleration/deceleration time). (The acceleration changes depending on the command speed.)

% digit: Reserved. Setting value: 0. Do not change.

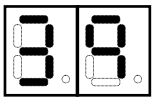
digit: Reserved. Setting value: 0. Do not change.

& digit: Coordinate value clear/save upon servo on selection
  0: Clears the coordinate value
  1: Save the coordinate value

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
-	Note	Note	0

Note: Never set any value other than 0 to the % digit and # digit. If you set any value other than specified, normal operation may not be done.

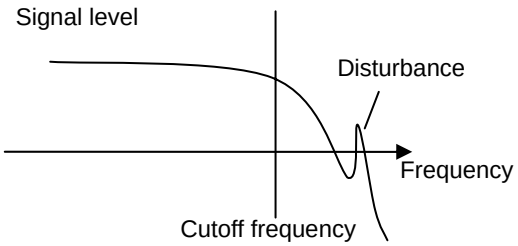


Acceleration filter

● Description of the function

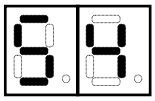
The displacement averaging filter is applied to the acceleration information from the encoder.
It can be used as a measure to reduce high-frequency vibrations for a mechanism with low rigidity.
When 4 is selected, the cutoff frequency is equivalent to about 500Hz.
Setting a greater value removes vibration elements in lower frequencies.
However, the positioning accuracy per pulse becomes lower because of poorer response of the servo loop.

Acceleration filter
1=4k [Hz], 2=2k [Hz], 3=1k [Hz], 4=500 [Hz,
5=250 [Hz], 6=125 [Hz], 7=62 [Hz], 8=31[Hz],



● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
Pulse	1	8	1



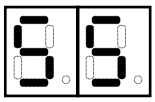
Deceleration time

● Description of the function

The time for deceleration is specified as in Parameter #25 (Acceleration/deceleration time).
When 0 is set, deceleration is performed with the value of Parameter #25 (Acceleration/ deceleration time).

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
ms	0	20,000	0



Deceleration jerk time

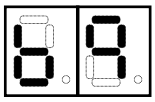
● Description of the function

The time for S-shaped deceleration is specified as in Parameter #26 (Jerk time).
When 0 is set, S-shaped deceleration is performed with the value of Parameter #26 (Jerk time).

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
ms	0	565	0

You can change the acceleration/deceleration time from the maximum revolution to the arrival time to the setting speed by using the setting of Parameter #32 (Function selection).
This parameter is invalid in the pulse command input mode (PUL).



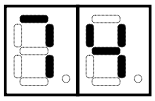
Allowable position error

● Description of the function

The allowable range of the difference between the command pulse and feedback pulse (position error) is specified.
An integer value indicates revolution. "-" indicates fractional revolution. For example, "-4" indicates 1/4 revolution.
An excessive error alarm is displayed when the position error exceeds the value.
Only the alarm is displayed for warning, and servo operation continues.

● Setting value

Unit	Lower limit value	Upper limit value	Factory-set value
r	-10	10	-4



Input pin logic setting

(Valid when the power is turned on again after it is written to the nonvolatile memory)

● Description of the function

The logic of the input signal pin of the connector CN11 can be changed.
The factory setting is #74=0.
0: The function is enabled when the photocoupler of the driver's input signal is on.
1: The function is enabled when the photocoupler of the driver's input signal is off.

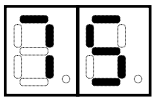
The bit to set 1 to input pin logic

Signal name	S-ON	FWD-IH	REV-IH	D-BREK	A-CLEAR	INHIBIT	ORG
Bit number	0	1	2	5	6	7	8
Bit weight	1	2	4	32	64	128	256

Changing logic

An example of using commands or operation keys on the display panel
Enabling FWD-IH and REV-IH when the photocoupler is off:
Add the bit weights of FWD-IH and REV-IH: 2+4=6. Set #74=6.

An example of change using commands
Changed for each bit number: Set #74,1=1 #74,2=1.
The value after the comma indicates the bit number. The value after "=" indicates the logic.



Output pin logic setting

(Valid when the power is turned on again after it is written to the nonvolatile memory)

● Description of the function

The logic of the output signal pin of the connector CN11 can be changed.
The factory setting is #75=0.
0: The function is operating when the transistor of the driver's output signal is on.
1: The function is operating when the transistor of the driver's output signal is off.

The bit to set 1 to output pin logic

Signal name	READY	IN-POS	ALM-A	ALM-B	ALM-C
Bit number	0	1	2	3	4
Bit weight	1	2	4	8	16

Changing logic

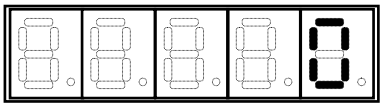
An example of using commands or operation keys on the display panel
Operating READY and IN-POS when the transistor is off:
Add the bit weights of READY and IN-POS: 1+2=3. Set #75=3.

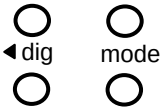
An example of using commands
Changed for each bit number: Set #75,0=1 #75,1=1.
The value after the comma indicates the bit number. The value after "=" indicates the logic.

5-4 Functions of the operation keys on the driver display panel unit

You can operate the parameters by using the 4 operation keys on the front of the HA-720 driver.
The functions of the operation keys are as follows.

Only numbers are displayed during normal operation





1. **Checking the parameter**
2. **Changing the parameter**
3. **Selecting the blinking digit**
4. **Writing the changed parameter to the nonvolatile memory of the driver**

mode: Switches between parameter display and data display.
(For some parameters, switching between data display of the lower 5 digits and upper 5 digits is added. For example, if the data of a parameter is 100000, the lower 5 digits display 00000 and the upper 5 digits display oooo1.)

set: Performs a write.

dig: Selects the digit of which you want to change the value. The selected digit blinks. Parameter numbers have 2 digits. Data have 5 digits.

up: Increments the value of the selected digit. After 9, the value starts from 0 again.

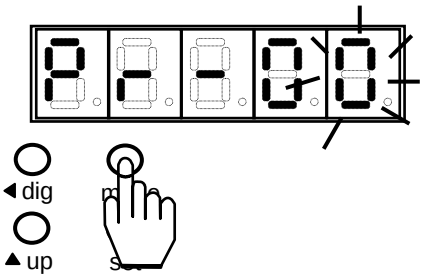
dig+up: When you press the up button while holding the dig button, you can toggle between + and -. (The negative sign is indicated by the blinking decimal points of all values.)

Caution: If no button is pressed for about 10 seconds during operation of the operation keys, the parameter operation state ends automatically.

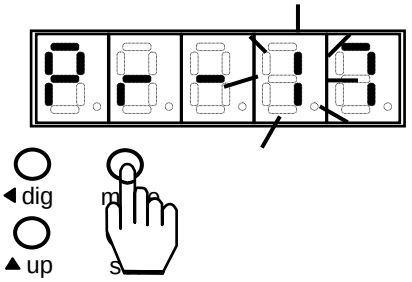
Note:
For a 32-bit long data, 0 is displayed for the digits of the lower 5 digits without any set data. 0 is displayed for the digits of the upper 5 digits without any set data.
The valid range of the data input setting is from -2147483648 to 2147483647.

5-4-1 Checking the parameter

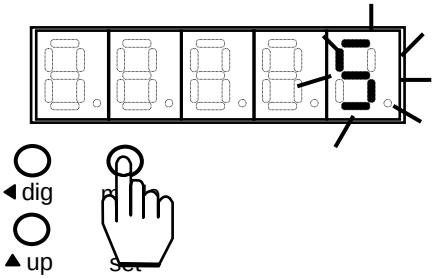
1. Press the mode button once. The LED displays Pr-**. It is the parameter number display.



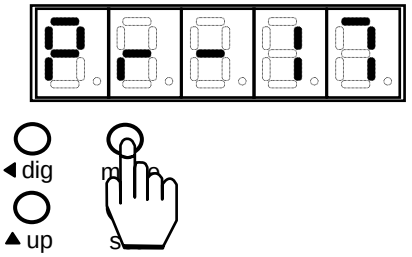
2. The value after “Pr-” is the parameter number. Use the up button to change the blinking digit to the desired parameter number. Use the dig button to select upper digits.



3. When you press the mode button, the 5 digits of the data of the specified parameter number is displayed in decimal, as in “＊＊＊＊＊”.



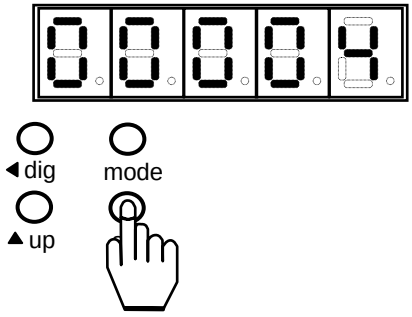
To check another parameter, press the mode button again and repeat the steps 2 and 3.



5-4-2 Changing the parameter

1. Perform the operations in steps 1 through 3 of “Checking the parameter.”

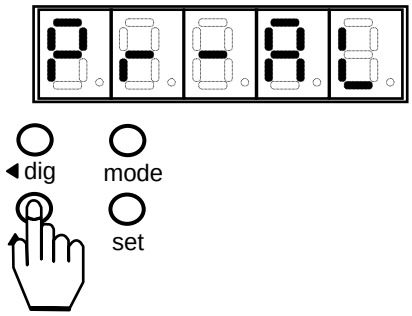
2. Use the dig and up buttons to change the data, and press the set button to confirm the data.
   The confirmed data has not been written to the nonvolatile memory.



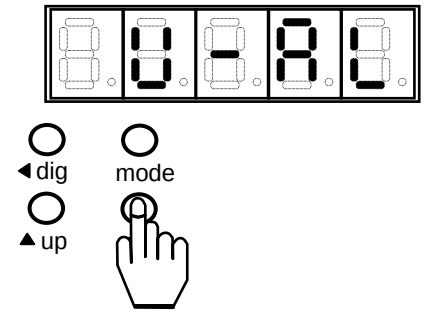
3. To change another parameter, press the mode button again and repeat the steps 1 and 2.

5-4-3 Writing the parameter to the nonvolatile memory

1. Press the mode button to display the parameter, and use the dig and up buttons to change the parameter number to 99 (until Pr-AL is displayed.).



2. Press and hold the set button until the LED stops blinking. During this time, the LED displays U-AL. The value is written to the nonvolatile memory after about 5 seconds. The written data is read when the power is turned on again.



Chapter 6 Installing HA-720 driver

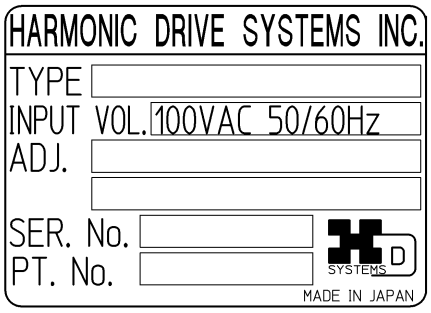
6-1 Receiving Inspection

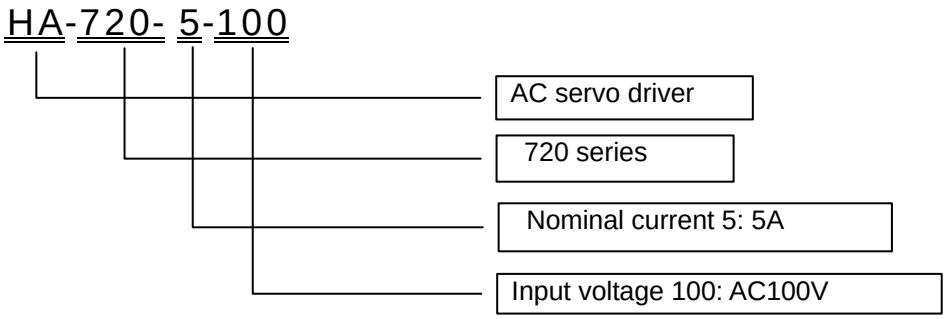
Check the followings when products are received.

- **Inspection procedure**

(1) Check the shipping container and item for any damage that may have been caused during transportation. If the item is damaged, contact us immediately.

(2) There is a nameplate attached to the side of the driver. The type of driver is described in type on nameplate. Check whether the item is the one you ordered by looking at the nameplate. If it is different, immediately contact the dealer whom it was purchased from. The model code is interpreted as follows:





(3) Accessories: The following connectors are attached to the driver.

* For the I/O signal connector (CN11)	Connector type:	10150-3000VE
	Cover type:	10350-52F0-008
* For the power supply connector (CN1)	Connector type:	231-303/026-000
* Analog monitor connector (CN10)		

(4) The position correction data is stored in the combined driver for increased absolute positioning accuracy of the direct drive motor. Therefore, use the specified combination of the motor and driver. On the nameplate, “ADJ.” shows the model of the motor to be combined with the HA-720 driver, and “SER.NO” shows the same number as the combined motor. To make sure to use the correct motor to be combined, prepare them at the same time.

Caution **The motor and driver are provided as a combination.**
The HA-720 driver stores the position correction data for combination with the direct drive motor KDU series. On the nameplates of the motor and driver, “SER.NO” shows the same number. For a combination with different numbers, the positioning accuracy of the motor is not guaranteed.

(5) Do not connect it to any power supply with a voltage other than the voltage shown in “INPUT VOL.” on the nameplate.

Do not supply voltage other than the voltage specified on the label.
The wrong power supply voltage may damage the HA-720 driver resulting physical injury and fire.
100: Single phase, 100VAC power supply

6-2 Notices on handling

The drivers are electronic devices. Handle them with care and take the following precautions:

(1) Do not drop screws, solder balls, wire chips, or any other foreign objects into the through the ventilation of HA-720 driver. Failure to observe this caution may result in burns.

(2) Do not insert electric wire, steel wire, or a screwdriver into the through the ventilation of HA-720 driver. Failure to observe this caution may result in electric shock or personal injury.

(1) Because the cover is made of steel plate, do not apply excess force or shock.

(2) The vibration resistance of the HA-720 driver is 4.9m/s^2 (10 to 55Hz). Do not mount or transport the HA-720 driver in a manner where it would be subjected to high levels of vibration, such as directly mounting on vehicles.

(3) Do not put the HA-720 driver on the place from where it can easily fall down.

(4) Do not put anything on the HA-720 driver. The case of the driver may break.

(5) The allowable storage temperature is from -20°C to +85°C. Do not expose it to sunlight for long periods of time, and do not store it in areas where temperatures are likely to fluctuate greatly.

(6) The allowable storage relative humidity is less than 90%. Do not store it in highly humid place or in areas where temperatures are likely to fluctuate greatly.

(7) Do not store the HA-720 driver in areas where in corrosive gas or particles may be present.

(8) To protect the rush current suppressor circuit within the driver, the driver input power supply should not be turned on and of repeatedly more than 2 times within one minute. If you want to turn it on and off more than this condition, wait for 5 minutes or more before turning it on. Failure to observe this condition may result in failure of the internal circuit of the driver.

6-3 Location and installation

6-3-1 Environment of location

The environmental conditions of the location are described blow. Decide the location by definitely observing the following conditions.

- ◆ Service temperature: 0°C to 50°C
  Use the driver in a cabinet. The temperature in the cabinet may be higher than the atmosphere because of power loss of the housed devices and its size. Plan the cabinet size, ventilation system, and device locations so the ambient temperature of the driver, which is always 50°C or less.
- ◆ Service humidity: 90% or less relative humidity, without condensation
  Make sure that water condensation does not occur due to fluctuating temperatures in the storage area or because of frequent heat-and-cool (run-and-stop) operations.
- ◆ Vibration resistance: 4.9m/sec^2 (0.5G) (10Hz to 55Hz) or less
  When there is a great deal of vibration near the driver, attach a shock absorber under the base to dampen the vibration.
- ◆ Shock resistance: 19.6m/s^2 (2G) or less
- ◆ Make sure that dust, dirt, water condensation, metal powder, corrosive gas, water, water drops, or oil mist is not exposed to the HA-720 driver.
  Do not install the driver in a corrosive gas environment, because the gas may cause damage to connecting parts (connectors, etc.).
- ◆ Install the driver in a cabinet. Do not expose it to the sunlight.

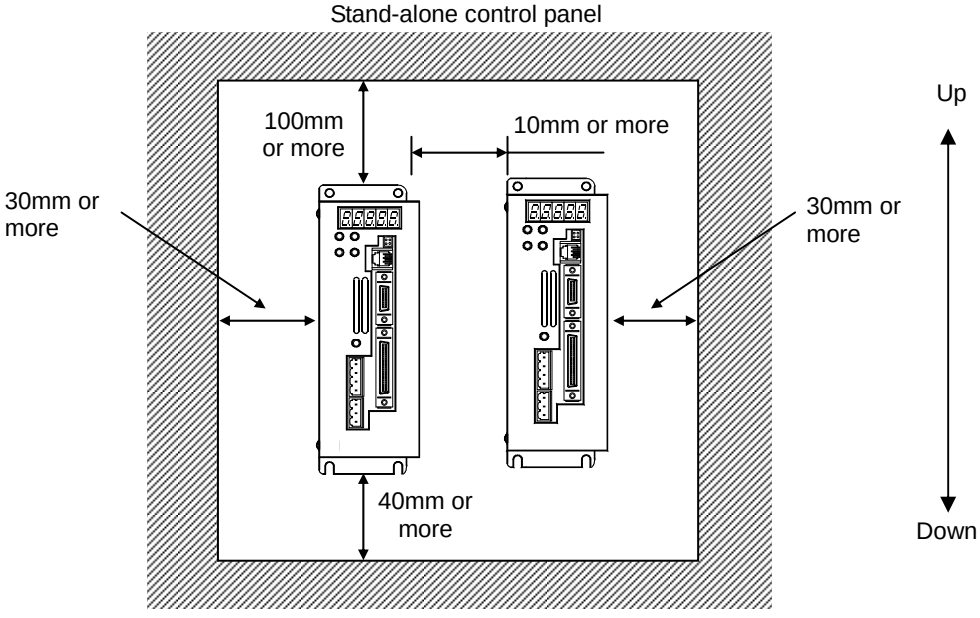
6-3-2 Notices on installation

Install the driver vertically and allow for wide spaces for air to flow sufficiently.

Leave 10mm or more from walls, 40mm or more from floor and 100mm or more from ceiling, and adjacent devices as shown the figure below.

When planning the ventilation system for the cabinet, refer to the table below, which lists the power consumption of the driver.

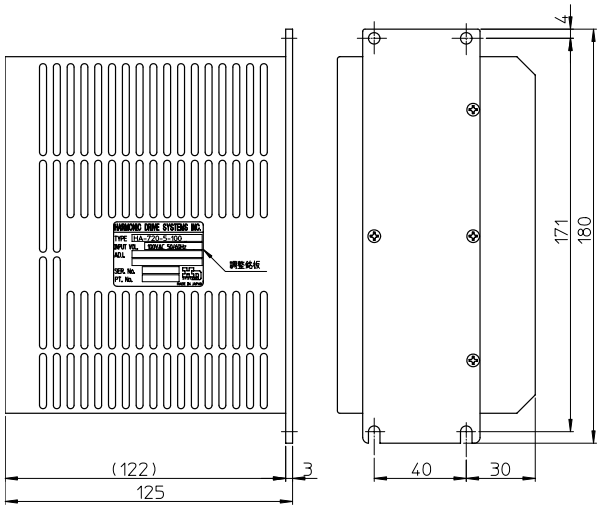
Driver	HA-720-5
Power loss	30W



6-3-3 Installing

The HA-720 driver should be mounted on a wall as shown in the figure to the right.

Two mounting holes are provided on the back of the driver as shown. The thickness of the wall should be 2mm or more.



● Procedure

(1) Screw an M4 machine screw in the tapped hole on the wall, and stop screwing it in the middle.

(2) Put the lower mounting hole (cut hole) of the back of the HA-720 driver on the M4 screw.

(3) Screw tightly through the upper mounting hole with M4 screws.

(4) Tighten the lower M4 screws.

6-4 Suppressing noise

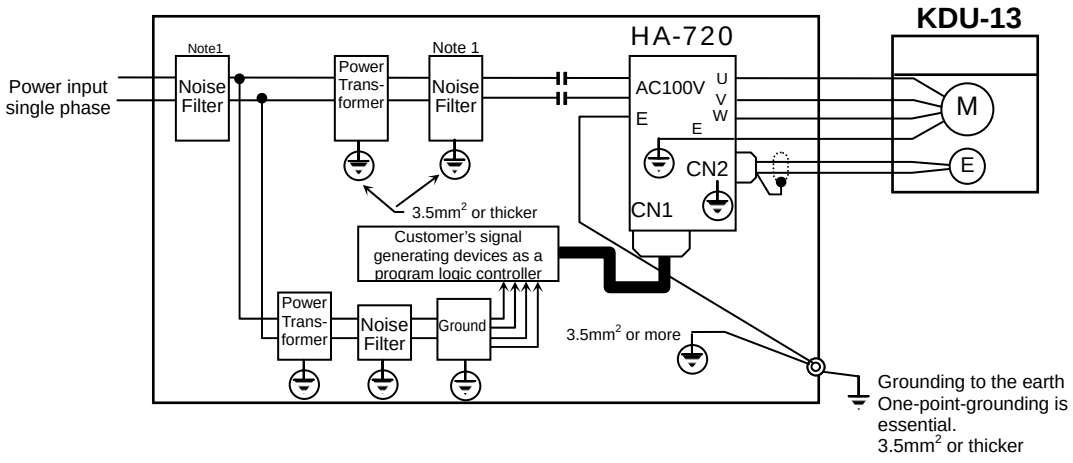
The HA-720 driver employs a power element (IPM) with a PWM control for main circuit. As the element generates switching noise by high-speed power switching, the noise may cause incorrect motion of other equipment or radio noise interference due to poor cabling or poor grounding.

In addition, it is necessary to provide proper cable management in order to suppress incorrect motion of the HA-720 driver by external noise from hosts, which contain electronic components, such as a CPU.

To prevent troubles by noise emissions always install cabling and grounding described below.

6-4-1 Devices for grounding

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



Note 1: For the grounding line filters refer to 6-4-2 “installing noise filter” in Chapter 6.

◆ Grounding motor frame

When direct driver motors are grounded at driven machine through the motor frame, current flows through floating capacity (Cf) of the motor from power amplifier of the driver. To avoid influence of the current, always connect the ground terminal (motor frame) of the motor to the ground terminal of the direct drive motor, and connect the ground terminal of the driver to the ground directly.

◆ Grounding ducts

When the motor cables are housed in a metal conduit or a metal box, ground their metal parts. The ground should be connected to earth at a single point.

6-4-2 Installing noise filters

Noise filters are recommended to guard against incorrect motion caused by impulse noise that may be emitted from power line and to suppress noise emissions to the line from inside of the driver.

When plural drivers are used, ground noise filters for each driver.

Select bi-directional noise filters that can suppress external and internal noise.

Recommended noise filters are listed in the figure below:

driver	Model	Rated specification	Manufacturer
HA-720-5	SUP-P5H-EPR	250V, 5A	Okaya electric.

Install the noise filters and the HA-720 driver as near as possible with one another.

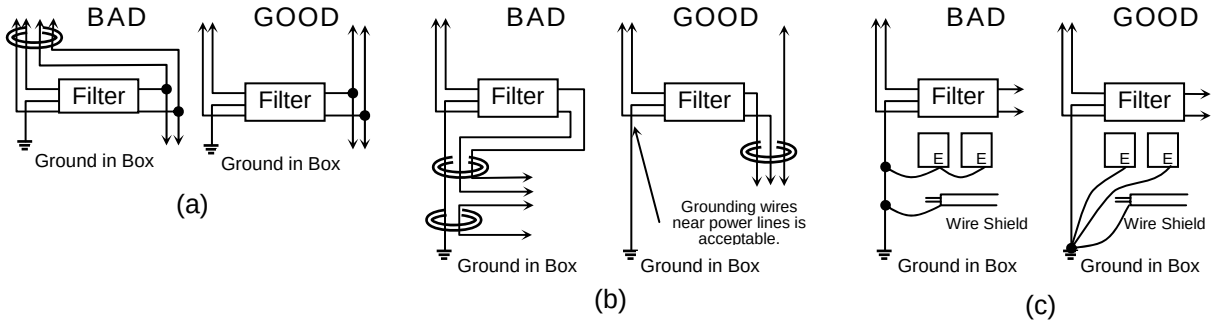
Install the noise filters to the lines of the electric devices other than the HA-720 driver in the same way. Always install the noise filters to the source of high frequency noise, such as electric welders and electrical discharge machines.

Since the encoder of super high resolution is used, required precision may not be satisfied due to the external noise. In case of installing the noise filters, incorrect use of noise filters can seriously reduce its effectiveness. Inspect them with the following instructions:

◆ Separate the filtered side and the unfiltered side of the power supply cables from each other. Do not bundle both together. Do not encase them within the same duct.

◆ Do not bundle the grounding cable with the filtered side of power cables or signal wires. Do not encase them within the same duct.

◆ Avoid daisy-chain wiring of ground cables. Ground them to a frame box or ground plate at a single point



6-4-3 Instructions for cabling

In addition to the noise suppression mentioned previously, the following instructions for cabling must be observed.

(1) Use shielded cables for I/O signals. When several drivers are used, prepare I/O signal cables for each driver individually.

(2) Use twisted pair shielded cables for encoder signal cables.
To improve noise immunity, a choke coil must be added to the driver side of the encoder cable.

(3) Make the length of signal cables as short as possible.

(a) I/O signal cable: 3m or less

(b) Encoder signal cable: 10m or less, however, conductor resistance of cable is less than 0.05 ohm/m.

(4) Install surge absorption devices to magnetic relays coils, magnetic switches (conductor), and solenoids.

(5) Separate power cables (strong electric circuit, such as power source cables and motor cables) and I/O signal cables in 30cm or more. Do not encase both cables in one pipe or duct, and do not bundle them.

(6) As the HA-720 driver is designed for industrial use, it provides no specific radio interference provisions.
Accordingly, line filters should be inserted for the power supply cables in the event that the driver:

- is used in the vicinity of private residences.
- causes apparent radio interference.

6-5 Connecting power cables

6-5-1 Instructions for power supply

Before connecting the power cable to the HA-720 driver, completely disconnect the power cable from power supply.

Failure to observe this caution may result in electric shock while connecting the cable.

(1) Connect the power cable to the HA-720 driver only after installing the driver on a wall.

(2) Ground the HA-720 driver, to avoid electric shock, malfunctions caused by external noise, and for the suppression of radio noise emissions.

6-5-2 Allowable size of cables

The minimum allowable wire sizes of power cables, ground wires, and other cables are listed below. We recommend wires as thick as possible.

Terminal, connector	Symbol	Allowable Wire Sizes (mm^2)
Power Supply terminal	POWER	1.25
Motor connection terminal	U, V, W, E	0.75
Grounding terminal	E	3.5
External I/O connector	CN11	0.2mm^2 shield cable
Encoder connector	CN12	0.3mm^2 twist pair shielded cable

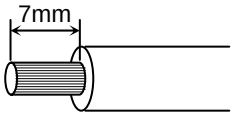
Note 1. When bundling wires or encasing into conduits (duct, hard plastic or metal pipes), use the wire of one upper size.

Note2. In hot environments, such as the temperature in a cabinet, use heat-resistant cable, (IV or HIV).

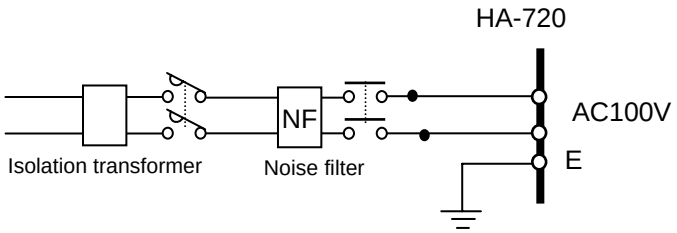
6-5-3 Connecting power cables

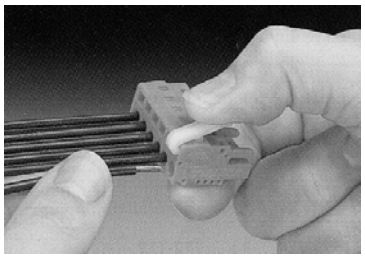
The terminal block for the power is located on the front panel of the HA-720 driver. Connect cables to each terminal as follows. Use the attached operation lever as shown below for connection.

Shown the figure to the right, strip the end of wires of the power supply cable and the motor cable, and connect wires to each terminal firmly.



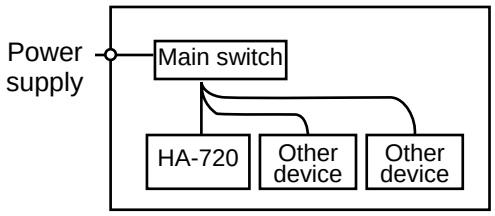
Insert “isolation transformer” and “noise filter” into power line to avoid electric shock, malfunctions caused by external noise, and for the suppression of radio noise emissions.



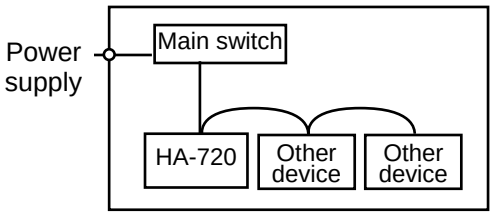


Plug:167992
(Nihon Weidmüller)

The input power supply of HA-720 driver contains a rush current suppress circuit of capacitor type. Although the circuit reduces line voltage fluctuation, avoid daisy-chain wiring of the power lines, and connect units with a main switch.



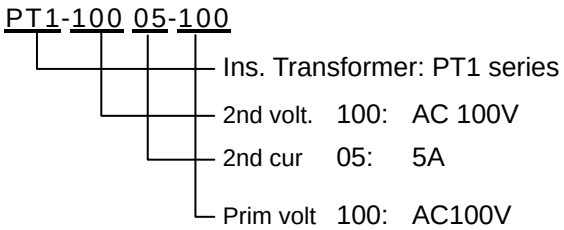
Good cable management



Bad cable management

6-5-4 Isolation transformer (Optional)

The use of an isolation transformer is recommended on power supply of HA-720 driver to prevent problems caused by improper grounding and external noises. (See 10-4 “isolation transformer” in Chapter 10.



Optional transformers are available as follows:

Isolation transformer	Driver	Direct drive motor
PT1-10005-100	HA-720-5-100	KDU-13S, KDU-13W

6-5-5 Protecting power lines

We recommended protecting the power line from rush current at power-ON by installing a circuit breaker (MCB) or circuit protector on power line. Select the recommended circuit breakers or circuit protector using the table below.

Current interruption capacity of circuit protector (A)	Note 1	5
Required capacity per driver (kVA)	Note 2	0.2
Rush current at power ON (A)	Note 3	8

Note 1: Use motor breaker for breaker, and time-delay type for circuit protector.
Note 2: The value is for continuous duty at rated output of actuator.
Note 3: The values are quoted at ambient temperature of 25 °C.

6-6 Connecting a ground wire

The minimum allowable size of ground wire is listed in the table below. Use the thickest wire possible.

Terminals and Connectors	Symbol	Allowable Wire Sizes (mm^2)
Ground (E) terminal	Ground mark	3.5

The HA-720 driver provides ground terminals as shown the figure to the right. Connect the ground wire from the cabinet to either terminal and connect the ground wire from the motor to the other terminal.

The leakage current is at least 10mA.

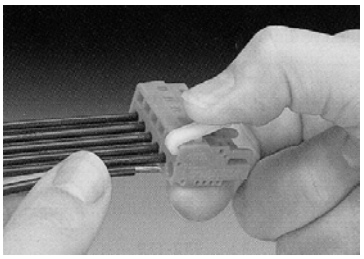
Connect wires, which have a section of at least 3.5 mm^2 to ground terminals.

6-7 Connecting motor cables

Connect the motor cable to [U, V, W] terminals of the HA-720 driver as shown in the figure below.

Use the attached operation lever as shown below for connection.

Check the phase order of motor cable with manual in advance, and connect the same terminals that correspond to each other. For working on the connection cables, see 6-5-3 “connecting power cable” in Chapter 6.



Plug:166096
(Nihon Weidmüller)

6-8 Connecting the encoder and the I/O cables

6-8-1 Preparing the encoder cable and the I/O cable

Follow these instructions for the preparation of the encoder cable and the I/O cable.

(1) Use twisted pair cables of required numbers of cores for I/O signal cables and for encoder signal cables. When several drivers are used, install I/O signal cables for each driver individually.

(2) Make the length of signal cables as short as possible.

1) I/O signal cable: 3m or less

2) Encoder signal cable: 10m or less, however, conductor resistance of cable is less than 0.04 ohm/m.

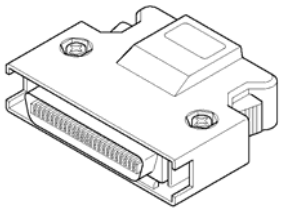
(3) Separate power cables (such as power source cables and motor cables) and I/O signal cables in 30cm or more. Do not encase both cables in one pipe or duct, and do not bundle them.

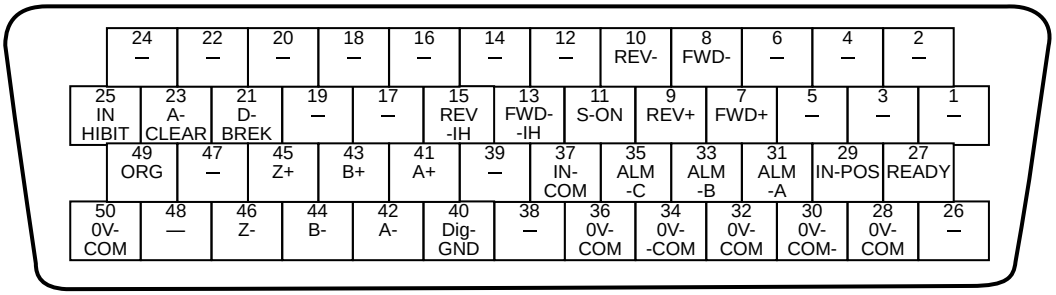
Terminals and Connectors	Symbol	Allowable Wire Sizes (mm^2)
External I/O Signal Port	CN11	$0.2mm^2$ twist pair, or twist pair whole-shielded cable
Encoder Port	CN12	$0.3mm^2$ twist pair shielded cable

6-8-2 Pin layouts of external I/O connector (CN11)

The models and the pin configuration of the encoder connector are as follows:

Plug: model: 10150-3000VE manufacturer: 3M
Shell: model: 10350-52F0-008 manufacturer: 3M





The pin configuration above is seen from the soldered side.

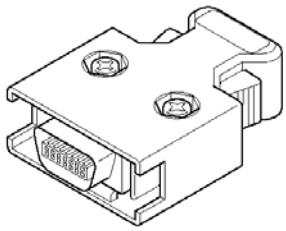
Caution

Do not make any external connection to the "-" pins. They are connected to internal circuits. Connecting anything may result in failure.
Never connect any power supply or signal.
This may cause damage to the driver.

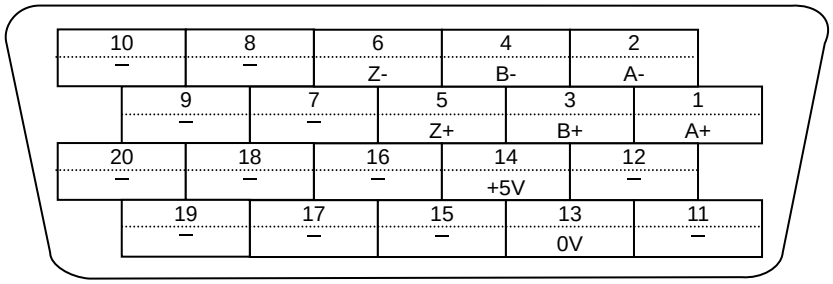
6-8-3 Pin layouts of the encoder connector (CN2)

The models and the pin configuration of the encoder connector are as follows:

Plug: model: 10120-3000VE manufacturer: 3M
Shell: model: 10320-52F0-008 manufacturer: 3M



Caution) Do not make any external connection to the "-" pins. They are connected to internal circuits. Connecting anything may result in failure.



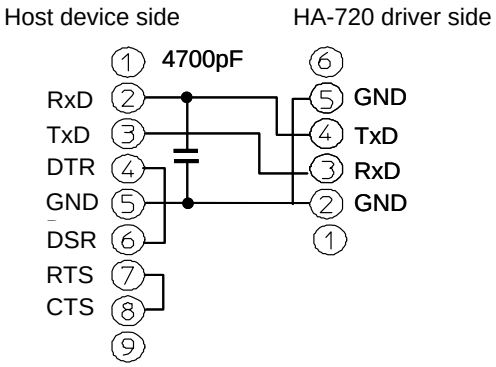
The pin configuration above is seen from the soldered side.

Caution

Do not make any external connection to the "-" pins. They are connected to internal circuits. Connecting anything may result in failure.
Never connect any power supply or signal.
This may cause damage to the driver.

6-8-4 EIA-232 (RS-232C) cable specifications

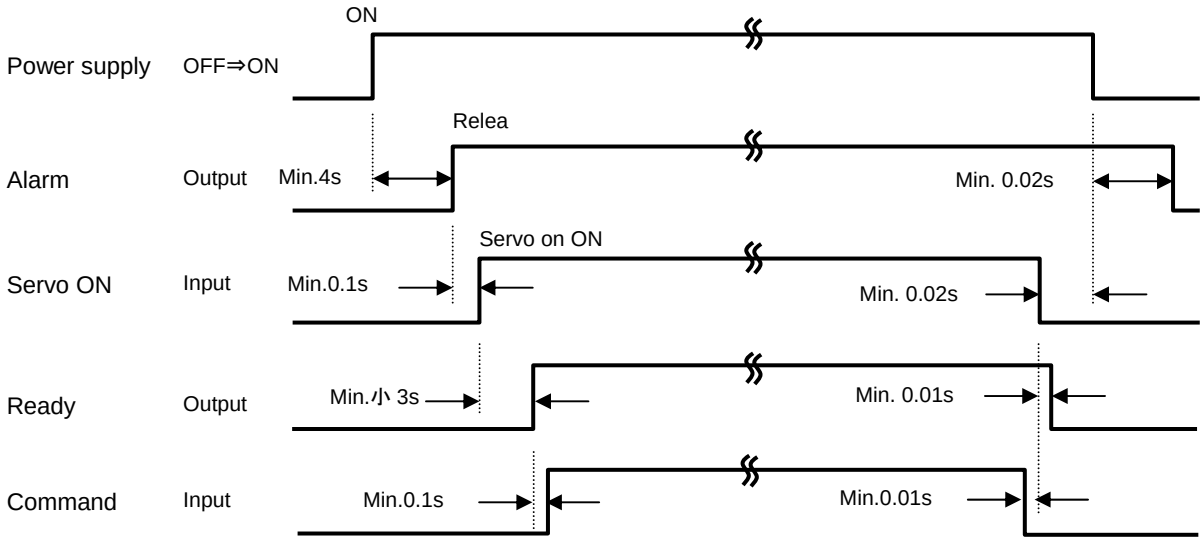
For the EIA-232 (RS-232) cable to connect the HA-720 driver and the host device, refer to the pin assignment as shown in the figure below.



6-9 Power ON and OFF sequences

Plan the sequence circuit on host device to turn on the power to HA-720 and shut it off at the following timing.

● Power on/off sequences



Caution

1. **The output shaft of the motor rotates in the forward and reverse directions about 5 times to detect the magnetic pole upon servo on after the power is turned on. Set up the system configuration so that the rotation does not cause any problem.**
2. **Do not touch the motor during magnetic pole detection. Otherwise magnetic pole detection may fail.**
3. **Avoid any torque over the maximum torque during magnetic pole detection. Otherwise magnetic pole detection may fail.**

Chapter 7 Operations

Follow these instructions prior to operations.

When electric power is active, do not make any wiring works.
In advance of wiring work, shut off electric power supply to be free from electric shock.

1. **Inspect the cabling before turning the power ON and correct poor cabling if necessary.**
   - **(1) Is the cabling correct?**
   - **(2) Is there any temporary cabling? Are all wires connected to the terminals?**
   - **(3) Are there any loose terminal connections?**
   - **(4) Are the wires grounded properly?**
2. **Clean around the equipment. Make sure there are no wire chips or tools in the equipment.**
3. **When two or more people work together, a meeting must be held regarding the operation before the power is turned on for safety of all.**
4. **To protect the rush current suppressor circuit within the driver, the driver input power supply should not be turned on and of repeatedly more than 2 times within one minute. If you want to turn it on and off more than this condition, wait 5 minutes or more before turning it on. Failure to observe this condition may result in failure of the internal circuit of the driver.**

7-1 Trial run

1. Complete the trial run before actual operation.
2. Drive the actuator only during the trial run; disconnect the actuator from the driven mechanism or load.

● Trial run method

The following 2 types of methods can be selected for trial runs.

(1) Using pulse commands of I/O signal (CN11)
(2) Using commands via EIA-232 communication (CN16)

* The factory setting is the pulse command method. To use the command method, you need to change parameters.

● Reason for the trial run of motor itself

(1) Verifying the power cable wiring

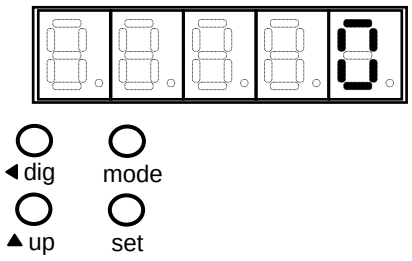
(2) Verifying the motor cable wiring (the motor cable and the encoder cable)

(3) Verifying the I/O signal communication with the host device

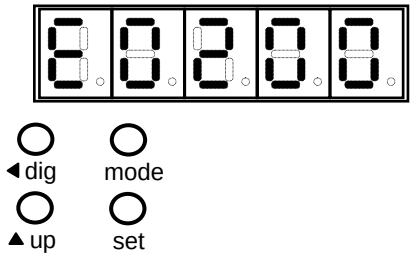
7-1-1 Trial run using pulse commands (example)

1) Feed the 100VAC power supply to CN1.
Make sure that there is no error.
If there is any error, the power supply connection is defective. Turn off the power and check the power supply wiring again.

Only numbers are displayed during normal operation



Exxxx is displayed when an alarm occurs



2) Check that Parameter #12=29.
"29" indicates the pulse train command input mode.
This value is factory setting value.
If the value is different, change Parameter #12 to 29. For the methods to read and change parameters, refer to 5-4 "Functions of the operation keys on the driver display panel unit" in Chapter 5.

3) Input the servo on signal.
Input the signal to the driver connector CN11-11 pin. The specified current is fed to the motor and motor magnetic pole detection is done automatically.

Caution

1. **The output shaft of the motor rotates in the forward and reverse directions about 5 times to detect the magnetic pole upon servo on after the power is turned on. Set up the system configuration so that the rotation does not cause any problem.**
2. **Do not touch the motor during magnetic pole detection. Otherwise magnetic pole detection may fail.**
3. **Avoid any torque over the maximum torque during magnetic pole detection. Otherwise magnetic pole detection may fail.**

4) If magnetic pole detection is completed successfully without any internal error, the motor enters a servo lock state, and the operation ready signal (CN-11-27 pin) is outputted.

5) Input the inhibit signal (CN-11-25 pin). It is ready for pulse input operation.

6) Input the necessary pulse to the FWD pulse (CN-11-7 to 8 pins) of the driver. Check that the specified operation is performed. Also, input necessary pulse to the REV pulse command input (CN-11-9 to 10 pins). Check that the specified operation is performed.

Note: If the motor doesn't operate while pulses are outputted from the host controller to the driver, refer to 3-2 "I/O port connections" in Chapter 3 again.

7) When you confirm normal operation, turn off the inhibit signal and servo on signal, and turn off the power supply.

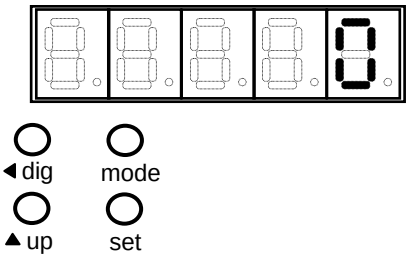
7-1-2 Trial run using commands (example)

For descriptions of the commands, refer to Chapter 4 “Command language.”

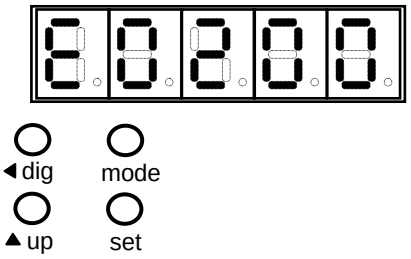
The XXXX notation shown below indicates a communication command.

1) Feed the 100VAC power supply to CN1.
   Make sure that there is no error.
   If there is any error, the power supply connection is defective. Turn off the power and check the power supply wiring again.

Only numbers are displayed during



Exxxx is displayed when an alarm occurs



2) The factory-shipped communication speed of RS-232C is 9600bps. Start host communication at this speed.

3) MASK Disables the input signal at CN11 and gives a higher priority to communication.

4) SVON Inputs the servo on signal. The specified current is fed to the motor and motor magnetic pole detection is done automatically.

Caution

1. **The output shaft of the motor rotates in the forward and reverse directions about 5 times to detect the magnetic pole upon servo on after the power is turned on. Set up the system configuration so that the rotation does not cause any problem.**
2. **Do not touch the motor during magnetic pole detection. Otherwise magnetic pole detection may fail.**
3. **Avoid any torque over the maximum torque during magnetic pole detection. Otherwise magnetic pole detection may fail.**

5) If magnetic pole detection is completed successfully without any internal error, the motor enters a servo lock state and becomes ready for operation. Send SRDYS and make sure that the value is changed to 1.

6) INC<21> Changes to the relative position mode. Operates by position data input via commands.

7) V=XX Sets the speed. (Example: V=5)

8) P=xxxx Specifies the value of the desired movement in pulse count. The motor starts to rotate when it is sent to the driver.
   (Example: P=10000)

9) Check the normal operation of the motor.

10) SVOF Turns off the servo, resulting in a servo free state.

11) Turn off the power. The trial run operation is completed.

7-1-3 Example of a trial run using a real machine (pulse input command)

1) Install the direct drive motor to the real machine.

2) Set the parameter values by referring to the following parameter approximate values for the moment of load inertia.
#17: Position loop time constant, #18: Speed loop time constant, #19: Acceleration loop gain

Moment of load inertia Kgm^2	Parameter approximate value for motor KDU-13S		
	#17	#18	#19
0.02	8	2	5
0.03	8	2	30
0.05	8	2	70
0.1	8	2	120
0.2	8	2	170
0.4	8	2	200
0.5	8	2	220

Moment of load inertia Kgm^2	Parameter approximate value for motor KDU-13W		
	#17	#18	#19
0.05	8	2	5
0.1	8	2	30
0.2	8	2	40
0.3	8	2	70
0.5	8	2	120
0.7	8	2	140
1.0	8	2	200

3) Input the servo on signal.
Input the signal to the driver connector CN11-11 pin. The specified current is fed to the motor and motor magnetic pole detection is done automatically.

1. **The output shaft of the motor rotates in the forward and reverse directions about 5 times to detect the magnetic pole upon servo on after the power is turned on. Set up the system configuration so that the rotation does not cause any problem.**
2. **Do not touch the motor during magnetic pole detection. Otherwise magnetic pole detection may fail.**
3. **Avoid any torque over the maximum torque during magnetic pole detection. Otherwise magnetic pole detection may fail.**

4) If magnetic pole detection is completed successfully without any internal error, the motor enters a servo lock state, and the operation ready signal (CN-11-27 pin) is outputted.

5) Input the inhibit signal (CN-11-25 pin). It is ready for pulse input operation.

6) Input the low speed pulse to CN11-7 to 10 pins and check that there is no error.

7) If the operation is unstable, adjust the gain.
Change Parameters #17 (Position loop time constant), #18 (Speed loop time constant), and #19 (Acceleration loop gain) to search for optimal values.
For the methods to read and change parameters, refer to 5-4 “Functions of the operation keys on the driver display panel unit” in Chapter 5. For details on parameters, refer to 5-3 “Parameter details” in Chapter 5.

8) Operates the motor with the desired displacement and speed to search for the optimal parameter values.

9) Write the optimal parameter values to the nonvolatile memory of the driver. Refer to 5-4-3 “Writing a parameter to the nonvolatile memory” in Chapter 5.

10) Turn off the inhibit signal and servo on signal sequentially, and turn off the power.
Trial run operation is now completed.

7-1-4 Example of a trial run using a real machine (commands)

1) Install the direct drive motor to the real machine.

2) Perform steps 1 through 6 in 7-1-2 “Trial run using commands (example).”

3) Set the “Parameter value read/write command #**=n” by referring to the following parameter approximate values for the moment of load inertia.
For the methods to read and change parameters, refer to Chapter 4 “Command language.” For details of parameters, refer to 5-3 “Parameter details” in Chapter 5.

#17: Position loop time constant, #18: Speed loop time constant, #19: Acceleration loop gain

Moment of load inertia Kgm^2	Parameter approximate value for motor KDU-13S		
	#17	#18	#19
0.02	8	2	5
0.03	8	2	30
0.05	8	2	70
0.1	8	2	120
0.2	8	2	170
0.4	8	2	200
0.5	8	2	220

Moment of load inertia Kgm^2	Parameter approximate value for motor KDU-13W		
	#17	#18	#19
0.05	8	2	6
0.1	8	2	30
0.2	8	2	40
0.3	8	2	70
0.5	8	2	120
0.7	8	2	140
1.0	8	2	200

4) V=XX Sets the speed. (Example: V=1)

5) P=xxxx Specifies the displacement in pulse count. The motor starts to rotate when it is sent. (Example: P=10000)

6) If the operation is unstable, adjust the gain.
Change Parameters #17 (Position loop time constant), #18 (Speed loop time constant), and #19 (Acceleration loop gain) to search for optimal values by using the “Parameter value read/write command #**=n”.

7) Operates the motor with the desired displacement and speed to search for the optimal parameter values.

8) Write the optimal parameter values to the nonvolatile memory of the driver. Refer to 4-4-3 “Parameter value read/write command” in Chapter 4.

9) SVOF Turns off the servo, resulting in a servo free state.

10) Turn off the power. Trial run operation is now completed.

7-2 Normal operation

As the HA-720 driver runs by commands from a host device, no special intervention is required for normal operations. In this section, instructions for daily operations and maintenance are explained.

7-2-1 Notices for daily operations

1. **Do not make any wiring while power is active.**
   Disconnecting wires or connectors while power is active may cause electric shock or abnormal mechanical motion resulting in serious physical injury.
2. **Do not touch terminals for at least five minutes after power has been shut off.**
   Even during power-OFF, electric charge remains in the driver. Do not touch terminals at least five minutes from power-OFF to avoid electric shock.
3. **Do not operate drivers with frequent ON/OFF operation.**
   Frequent power ON/OFF operation may cause deterioration of electronic elements.
   Start/stop operation of motor should be performed by using input signals.

7-2-2 Daily maintenance

Since the HA-680 driver employs highly reliable parts, no special daily maintenance is required except the maintenance under user's rules for electronic equipment.

1. **Shut down electric power before maintenance.**
   Maintenance while power is active may cause electric shock.
2. **Do not touch terminals for at least five minutes after power has been shut off.**
   Even during power-OFF, electric charge remains in the driver. Do not touch terminals at least five minutes from power-OFF to avoid electric shock.
3. **Do not perform megger and voltage resistance tests.**
   These tests cause damage to the HA-720 driver circuit that results in abnormal motion.

Check point	Interval	Inspection standard	Treatment
Terminal screws	Yearly	No loosen screws	Tightening screws
Exterior	Yearly	No dust or metal chips on the case	Cleaning
Interior Circuitry	Yearly	No color change, no faults, no abnormalities	Consult with Harmonic Drive Systems

Chapter 8 Protective functions

8-1 Overview of the protective functions

The HA-720 driver has the following protective functions that display alarms.

When the driver detects an error, the following processing is carried out.

[1] The driver performs necessary servo processing (dynamic brake operation).

[2] The alarm code is outputted from the signal output pins (CN11-31, 33, and 35).

[3] The alarm code is displayed on the LED of the driver front panel.

[4] The same code as [3] can be referred to by using the ALST command via EIA-232 communication.

Clearing an alarm:

If the cause has already been removed, the dynamic brake is released by a reset (the RES command or external reset input), and the operation can be continued by turning on the servo.

The alarm types include warnings. The driver continues normal operation if only a warning occurs.

However, some alarms produce only a warning and do not operate the dynamic brake.

8-1-1 Protective function list

Protective function	Description	Driver processing	Signal output (CN11)	LED display
Electronic thermal error	Outputted when the software electronic thermal relay for motor protection operates.	Dynamic brake operation	ALM-A	E0004
Overheat	Outputted when the temperature of the driver heat sink exceeds the allowable temperature (80℃).	Dynamic brake operation	ALM-A	E0008
Parameter error	Outputted when the parameter saved to the nonvolatile memory is invalid.	Dynamic brake operation	ALM-A	E0010
Encoder error	Outputted when a signal error state due to disconnection of the encoder is detected.	Dynamic brake operation	ALM-A	E0200
FWD inhibit input	Outputted when a signal is inputted to the FWD inhibit terminal.	Dynamic brake operation	ALM-B	E0080
REV inhibit input	Outputted when a signal is inputted to the REV inhibit terminal.	Dynamic brake operation	ALM-B	E0040
Overspeed	Outputted when the motor revolution exceeds 109% of the setting value of Parameter 7.	Warning display only	ALM-C	E0400
Excessive error	Outputted when the error counter value exceeds the setting value of Parameter #69 “Allowable position error.”	Warning display only	ALM-C	E0800

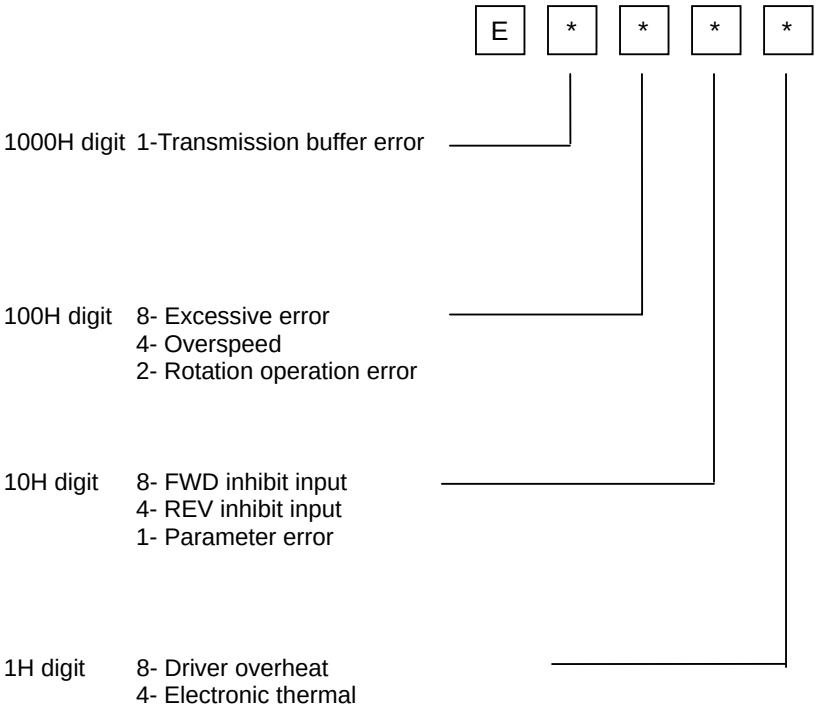
8-1-2 LED alarm display on the driver display panel

■ During normal operation of the driver

The driver output current is displayed as a percentage (%) of the motor rated current (Parameter #3).

■ When an alarm occurs

The code is outputted at ALM-A, B, and C of CN11. At the same time, the following alarm code is displayed on the LED.
An alarm code is expressed as a 4-digit hexadecimal bit pattern.



<<Display Example>>

When REV inhibit input and electronic thermal occur: The LED displays “E0044”.

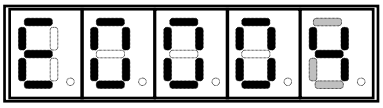
When driver overheat and electronic thermal occur: The LED displays “E000C”.

Overspeed (E0400) and excessive error (E0800) display a warning only, and the driver operates normally.

Warning

1. **During failure diagnosis, never perform wiring operation with the power turned on. Before performing wiring operation, turn off the power.**
2. **Organize the surroundings of the device. Especially, check thoroughly for remaining cut wires or tools inside the device.**
3. **When two or more people work together, a meeting must be held regarding the operation before the power is turned on for safety of all.**

8-2 Details of the protective functions



Electronic thermal error

● Description

Outputted when the software electronic thermal relay for motor protection operates.
The servo is turned off, and the dynamic brake operates.
ALM-A (31 pin output of CN11)

● Occurrence

(1) During operation

◆ Cause 1: Excessive operations were given to the motor frequently.

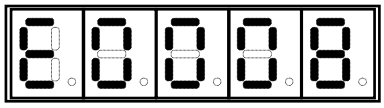
⇒Remedy: Alleviate the rotation operation conditions.

(2) Upon power-on

◆ Cause 1: The element of the control circuit of the HA-720 driver malfunctioned.

⇒Remedy: Contact one of our service or sales offices. (Replace the HA-720 driver.)

Also check for inappropriate environmental conditions in the installation location by referring to 6-3 “Location and installation” in Chapter 6.



Overheat

● Description

Outputted when the temperature of the driver’s internal element exceeds 80℃.
The servo is turned off, and the dynamic brake operates.
ALM-A (31 pin output of CN11)

● Occurrence

(1) During operation

◆ Cause 1: Excessive operations were given to the motor frequently.

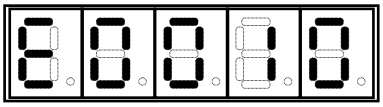
⇒Remedy: Alleviate the rotation operation conditions.

(2) Upon power-on

◆ Cause 1: An error of the control circuit of the HA-720 driver occurred.

⇒Remedy: Contact one of our sales offices.(Replace the HA-720 driver.)

Also check for inappropriate environmental conditions in the installation location by referring to 6-3 “Location and installation” in Chapter 6.



Parameter error

● Description

Outputted when the parameter saved to the nonvolatile memory is invalid.
The servo is turned off, and the dynamic brake operates.
ALM-A (31 pin output of CN11)

● Remedy

When a parameter error occurs, turn on the power while pressing any one of the 4 push buttons of the driver, and write the parameter again to the driver.
The parameter error can be avoided by turning the power on again after that.
To write a parameter to the driver, you can issue the WPR command from the host, or use the operation keys of the driver.
(For the method to use the operation keys of the driver, refer to 5-4 “Functions of the operation keys on the driver display panel unit” in Chapter 5.)

● Occurrence

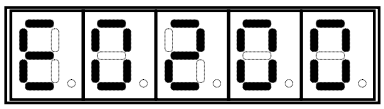
(1) Upon memory save

◆ Cause 1: Data could not be written successfully using the communication WPR command.

⇒Remedy: Check that the parameter you tried to write is appropriate.

◆ Cause 1: Data could not be written successfully using the communication WPR command.

⇒Remedy: Change the communication speed to 9800bps or less.



Encoder error

● Description

Outputted when a signal error state such as disconnection of the encoder or encoder output circuit failure is detected.
The servo is turned off, and the dynamic brake operates.
ALM-A (31 pin output of CN11)

● Occurrence

◆ Cause 1: The encoder cable is not wired correctly, or it is disconnected.

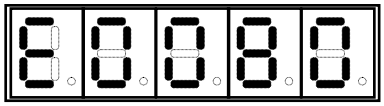
⇒Remedy: Check that the encoder wiring is correct.

◆ Cause 1: Noise exists in the encoder cable.

⇒Remedy: Check that the shielding line connection of the encoder cable is secured, the actuator is grounded, and the driver is grounded.

◆ ◆ Cause 2: The encoder is internally damaged, or the driver is damaged.

⇒Remedy: Contact one of our sales offices. (Replace the motor or driver.)



FWD inhibit input

● Description

When the signal is inputted to the FWD inhibit input, the dynamic brake operates and the rotation stops.
To allow rotation in the reverse direction, do the following.

(1) Release the dynamic brake by clearing the alarm (RES or alarm clear signal input).

(2) Rotation in the reverse direction is allowed.
ALM-A (31 pin output of CN11)

● Occurrence

◆ Cause 1: A command for operation exceeding the operating limit was issued.

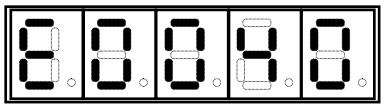
⇒Remedy: Correct the operation command data.

◆ Cause 2: The FWD inhibit sensor failed.

⇒Remedy: Remove the cause of the failure.

◆ Cause 3: The FWD inhibit sensor is disconnected.

⇒Remedy: Provide correct wiring.



REV inhibit input

● Description

When the signal is inputted to the REV inhibit input, the dynamic brake operates and the rotation stops.
To allow rotation in the forward direction, do the following.

(1) Release the dynamic brake by clearing the alarm (RES or alarm clear signal input).

(2) Rotation in the forward direction is allowed.
ALM-A (31 pin output of CN11)

● Occurrence

◆ Cause 1: A command for operation exceeding the operating limit was issued.

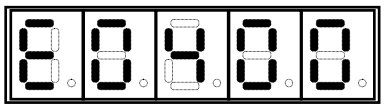
⇒Remedy: Correct the operation command data.

◆ Cause 2: The REV inhibit sensor failed.

⇒Remedy: Remove the cause of the failure.

◆ Cause 3: The REV inhibit sensor is disconnected.

⇒Remedy: Provide correct wiring.



Overspeed

● Description

Outputted when the motor rotation speed reaches 109% of the setting value of Parameter 7 (speed limit).

● Occurrence

◆ Cause 1: A forced rotation error to the motor output shaft occurred.

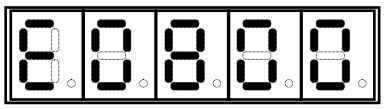
⇒Remedy: Design the mechanism so that it doesn't rotate while the motor output shaft is rotating with an external force exerted on it.

◆ Cause 2: The encoder cable is disconnected or the wiring is defective.

⇒Remedy: Check the state of the encoder cable and wiring.

◆ Cause 3: An error of the control circuit of the HA-720 driver occurred.

⇒Remedy: Contact one of our sales offices. (Replace the HA-720 driver.)



Excessive error

● Description

Outputted when the error value exceeds the setting value of Parameter #69 “Allowable position error.”

● Occurrence

(1) Upon power-on

◆ Cause 1: An error of the control circuit of the HA-720 driver occurred.

⇒Remedy: Contact one of our sales offices. (Replace the HA-720 driver.)

(2) During acceleration or deceleration

◆ Cause 1: The moment of load inertia was excessive.

⇒Remedy 1: Reduce the moment of load inertia.

⇒Remedy 2: Perform slow-up/slow-down of the command pulse frequency of the host device.

◆ Cause 2: The value of ”excessive error range” or “gain” of “parameter” is too low.

⇒Remedy: Either use a broader “excessive error range” or adjust “17: Position loop time constant”, “18: Speed loop time constant”, and “19: Acceleration loop gain” in the parameter setting mode.

◆ Cause 3: The “command pulse frequency” value is too high.

⇒Remedy: Lower the “command output pulse frequency” of the host device.

(3) After a while when the speed doesn’t increase following the command

◆ Cause 1: The encoder cable or motor cable was broken.

⇒Remedy: Check the state of the encoder cable and motor cable.

(4) Due to failure of the external machine system

◆ Cause 1: For the actuator that tried to rotate with a command pulse input, rotation operation could not be done due to an obstacle in the machine system and the error pulse exceeded the allowable value.

⇒Remedy: Remove the obstacle in the machine system.

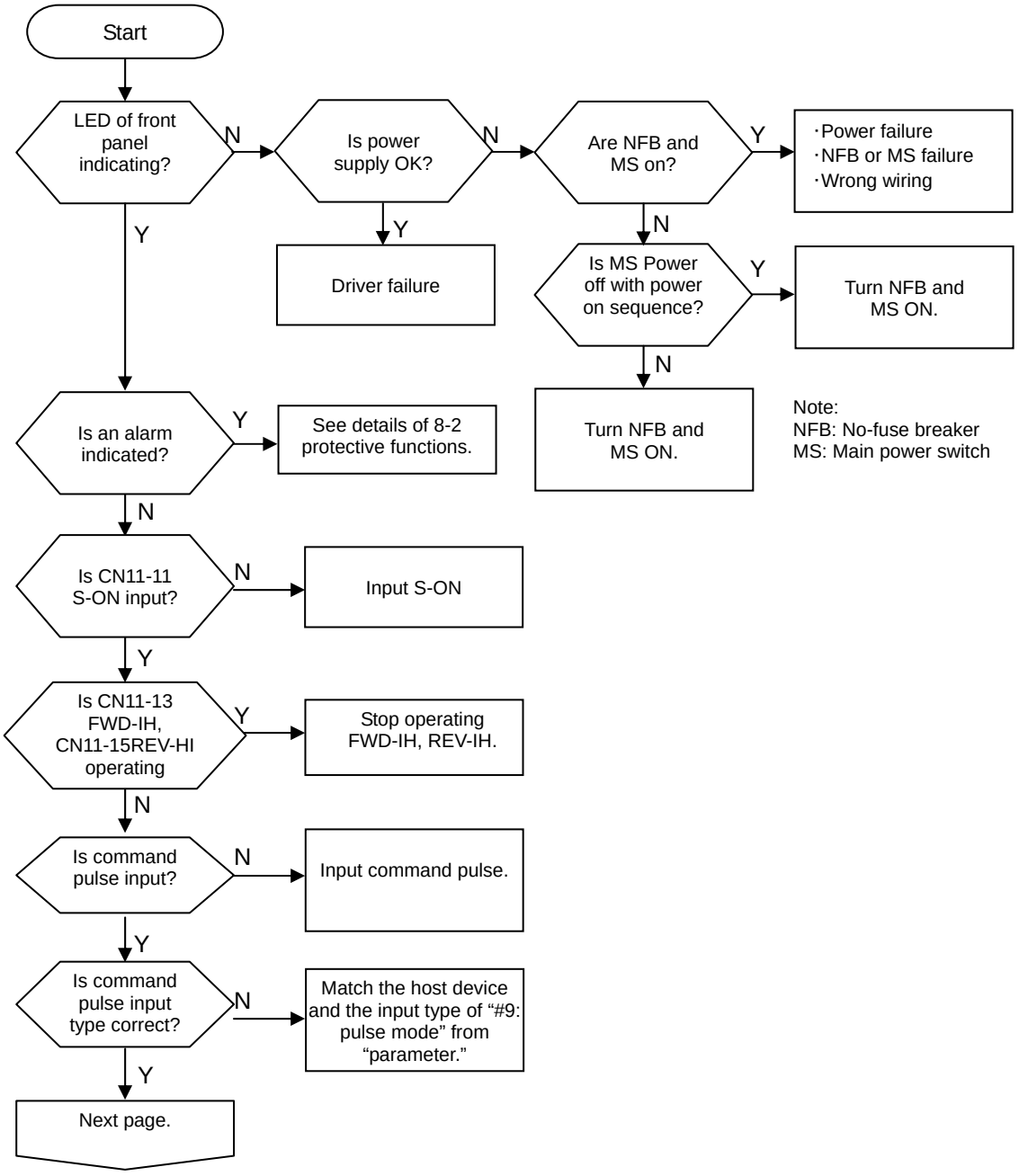
Chapter 9 Troubleshooting

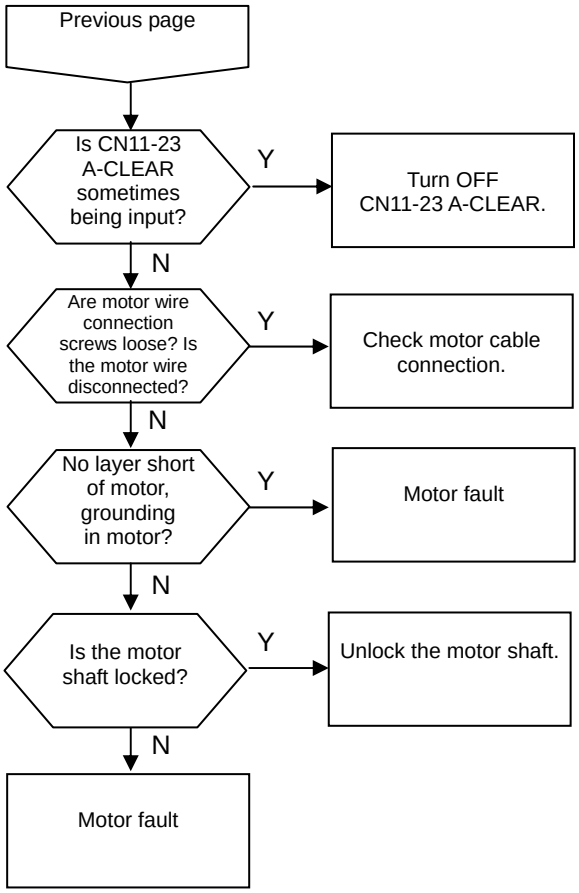
Troubleshooting procedures of direct drive motor for problems other than alarms are described separately in the position control, in the speed control and in the Torque control. They are also described for the following cases:

9-1 Motor does not rotate
9-2 Motor rotation is unstable
9-3 Poor positioning accuracy

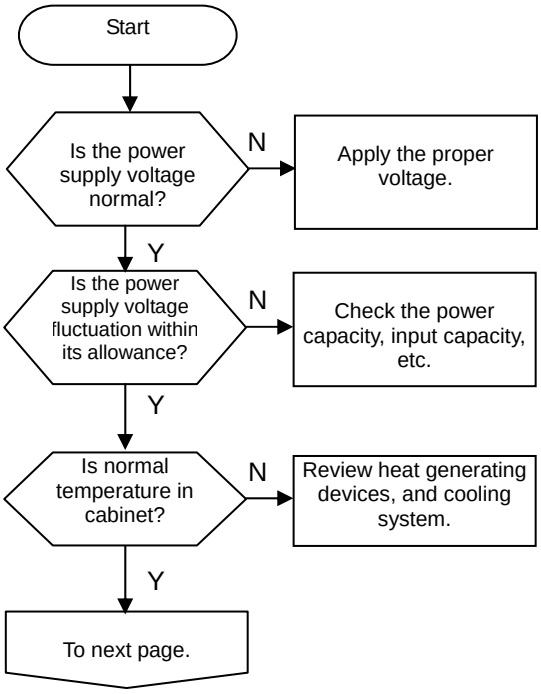
Note: In the flowcharts, "Y" and "N" represent "Yes" and "No", respectively.

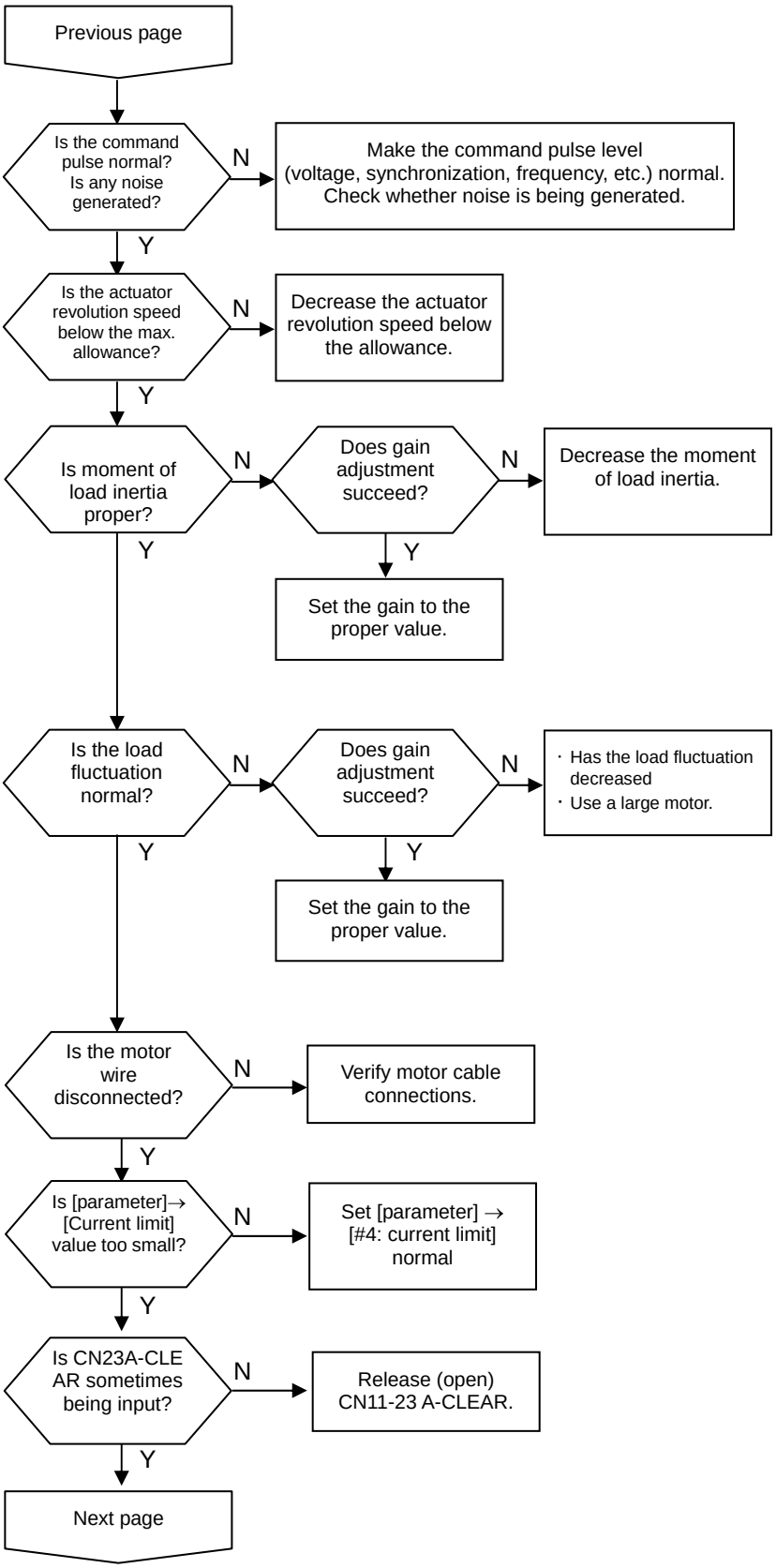
9-1 Motor does not rotate

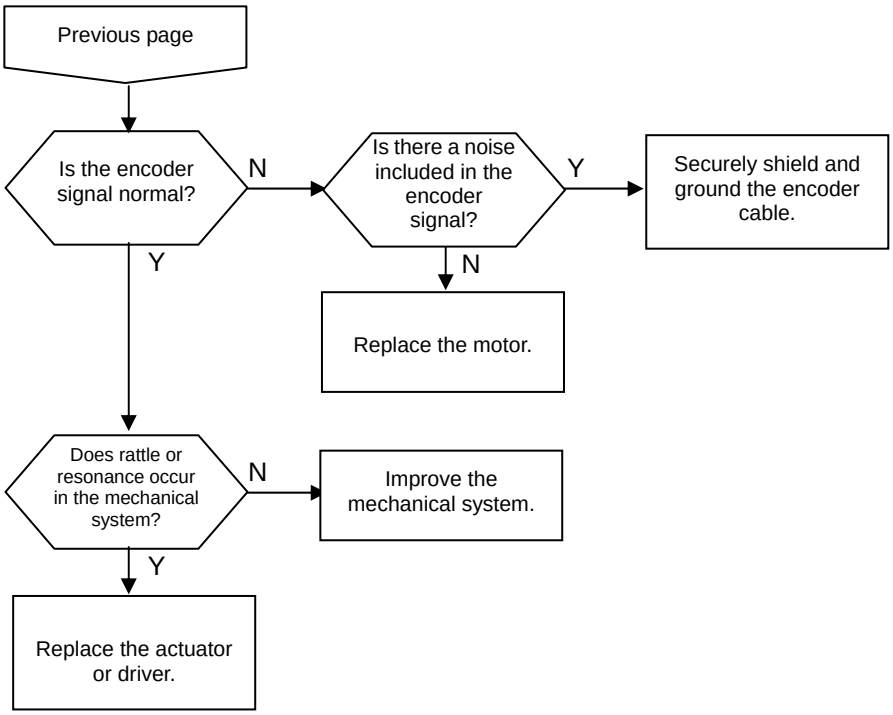




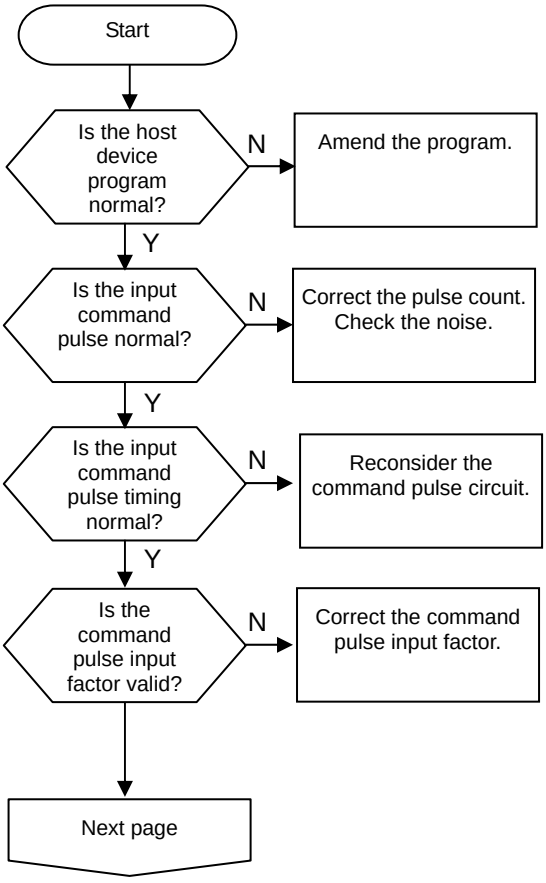
9-2 Motor rotation is unstable

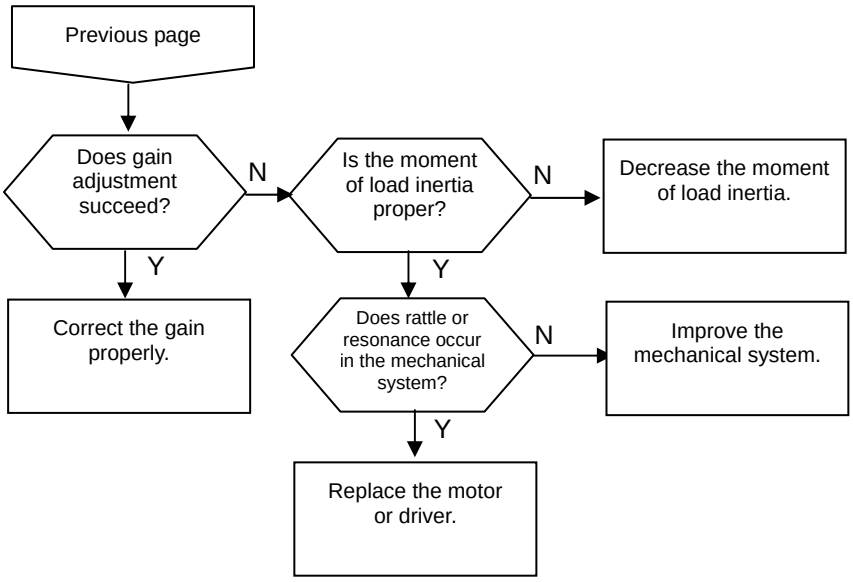



Previous page
Is the command pulse normal? Is any noise generated?
N
Make the command pulse level (voltage, synchronization, frequency, etc.) normal. Check whether noise is being generated.
Y
Is the actuator revolution speed below the max. allowance?
N
Decrease the actuator revolution speed below the allowance.
Y
Is moment of load inertia proper?
N
Does gain adjustment succeed?
N
Decrease the moment of load inertia.
Y
Y
Set the gain to the proper value.
Is the load fluctuation normal?
N
Does gain adjustment succeed?
N
· Has the load fluctuation decreased
· Use a large motor.
Y
Y
Set the gain to the proper value.
Is the motor wire disconnected?
N
Verify motor cable connections.
Y
Is [parameter]→ [Current limit] value too small?
N
Set [parameter] → [#4: current limit] normal
Y
Is CN23A-CLEAR sometimes being input?
N
Release (open) CN11-23 A-CLEAR.
Y
Next page



9-3 Poor positioning accuracy




Previous page
Does gain adjustment succeed?
N
Is the moment of load inertia proper?
N
Decrease the moment of load inertia.
Y
Y
Correct the gain properly.
Does rattle or resonance occur in the mechanical system?
N
Improve the mechanical system.
Y
Replace the motor or driver.

Chapter 10 Options

10-1 Relay cables

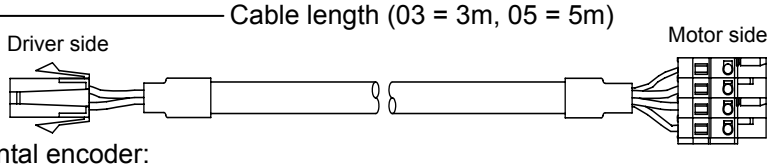
These are relay cables that connect the direct drive motor of KDU series and driver. There are two types of relay cable: for motors and incremental encoder.

- **Relay cable models** ("**" indicates the cable length (1m, 3m, or 5m).)

(1) For motors:

EWA－M* *-A04-WG04

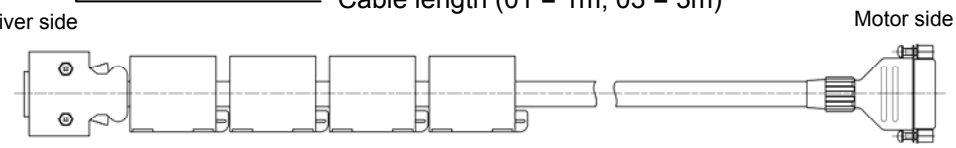
Cable length (03 = 3m, 05 = 5m)



(2) For incremental encoder:

EWA－E**－J15-3M20

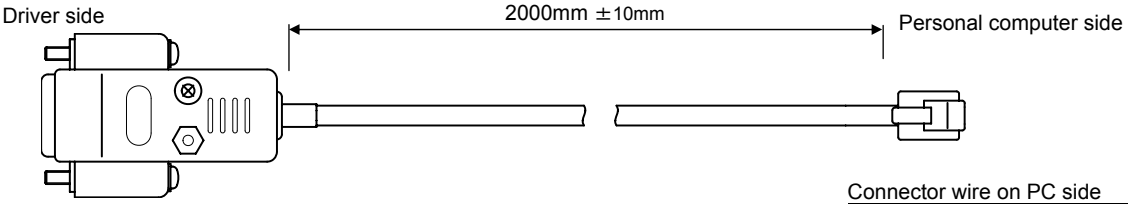
Cable length (01 = 1m, 03 = 3m)



10-2 EIA-232 (RS-232C) communication cable

This cable is an EIA-232 (RS-232C) communication cable connecting a personal computer and HA-720 driver.

Cable mode: HDM-RS232C-HA720



Connector wire on driver side

Pin No.	Signal line
1	—
2	GND
3	RXD
4	TXD
5	GND
6	—

Connector wire on PC side

Pin No.	Signal line
1	—
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	—

10-3 List of standard combinations

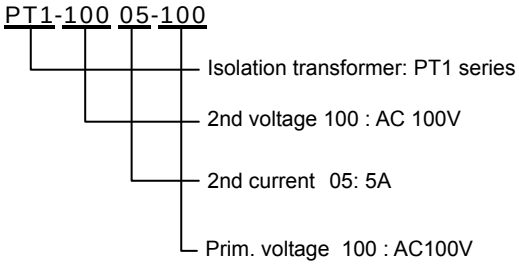
Standard combinations of a direct driver motor in the KDU series, servo driver and relay cables are as follows.

System mode	Max torque	Motor model	Servo driver model	Incremental encoder relay cable model / Motor relay cable model	Total cable length (excluding cable length for connector)
KDU-13-S-D	7.0Nm	KDU-13SA-E08-100	HA-720-5-100	EWA-E01-J15-3M20 / EWA-M03-A04-WG04	Encoder cable: 3m, Motor cable: 3.3m
KDU-13-S-D	7.0Nm	KDU-13SA-E08-100	HA-720-5-100	EWA-E03-J15-3M20 / EWA-M05-A04-WG04	Encoder cable: 5m, Motor cable: 5.3m
KDU-13-W-D	15.0Nm	KDU-13WA-E08-100	HA-720-5-100	EWA-E01-J15-3M20 / EWA-M03-A04-WG04	Encoder cable: 3m, Motor cable: 3.3m
KDU-13-W-D	15.0Nm	KDU-13WA-E08-100	HA-720-5-100	EWA-E03-J15-3M20 / EWA-M05-A04-WG04	Encoder cable: 5m, Motor cable: 5.3m

10-4 Isolation transformer

(1) Interpretation of model names and symbols

The model name and symbols for the isolation transformer shall be interpreted as shown below.



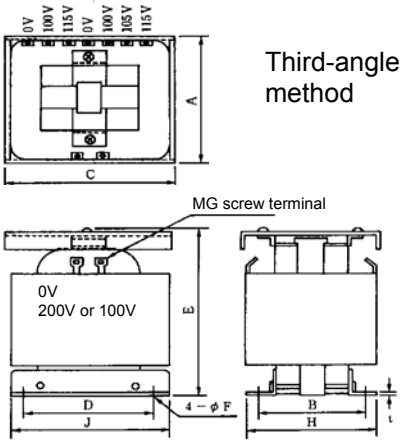
(2) Specifications of the isolation transformer

The specifications of the isolation transformer are as shown below.

	PT1-10005-100
Number of phases	Single phase
Secondary rated voltage	100V
Secondary rated current	5A
Primary input voltage	100/115/200/220VAC, 50/60Hz
Rated capacity	500VA
Insulation classification	B class insulation
Insulation resistance	500MΩ or more (1000VDC)
Withstand voltage	2000VAC for 1 minute (50/60Hz)
Operating ambient temperature	-10 ~ +55°C
Overheat protection	Built-in thermal switch (cutoff temperature: 130°C)

(3) External dimension of the isolation transformer

The outside dimensions of the isolation transformer are as shown below.



Third-angle projection method

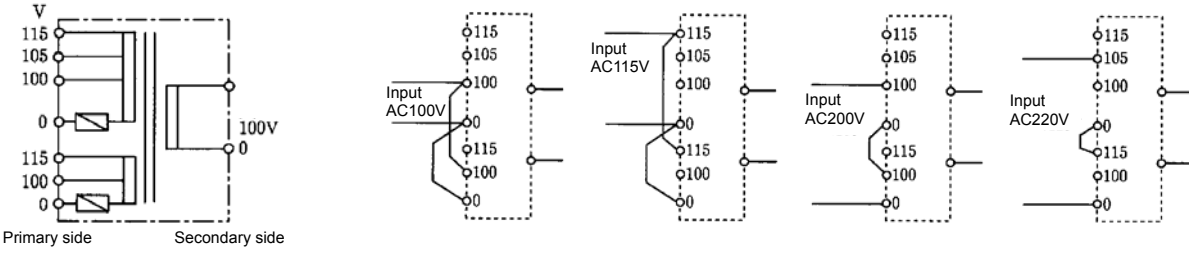
Unit: mm

A	B	C	D	E	F
145	90	150	105	160	6.5

G	H	J	t	Mass
4	110	125	1.6	5.5kg

(3) Connection method for the isolation transformer

The left figure below shows the internal connection of the isolation transformer. To select the input voltage from 100, 115, 200, and 220V, the connection shall be made as shown in the right figures below.



Warranty Period and Terms

The HA-720 series servo drivers are warranted as follows:

■ Warranty period

Under the condition that the actuator are handled, used and maintained properly followed each item of the documents and the manuals, all the HA-720 series drivers are warranted against defects in workmanship and materials for the shorter period of either one year after delivery or 2,000 hours of operation time.

■ Warranty terms

All the HA-720 series drivers are warranted against defects in workmanship and materials for the warranted period. This limited warranty does not apply to any product that has been subject to:

(1) user's misapplication, improper installation, inadequate maintenance, or misuse.

(2) disassembling, modification or repair by others than Harmonic Drive Systems, Inc.

(3) imperfection caused by the other than the FHA-C series actuator and the HA-720 servo driver.

(4) disaster or others that does not belong to the responsibility of Harmonic Drive Systems, Inc.

Our liability shall be limited exclusively to repairing or replacing the product only found by Harmonic Drive Systems, Inc. to be defective. Harmonic Drive Systems, Inc. shall not be liable for consequential damages of other equipment caused by the defective products, and shall not be liable for the incidental and consequential expenses and the labor costs for detaching and installing to the driven equipment

HARMONIC DRIVE SYSTEMS INC

Certified to ISO14001 (HOTAKA Plant) / ISO9001 (TÜV Management Service GmbH)
All specifications and dimensions in this manual subject to change without notice.

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