Canon

# DIGITAL GALVANO SCANNER SYSTEM

GM-1000 Series

GC-201 / 101

# User's Manual

Be sure to read this guide before using the product.
Keep this guide carefully for future use at any time.

ENG

## For Safe and Correct Use

To prevent injury to the user or damage to property, this guide gives information for the safe and correct use of this product.

Before installation, operation, maintenance, or inspection, be sure to read this guide.

## Markings

This guide uses the following markings:

**⚠ Warning**

This indicates the possibility of death or serious injury by a fire or electric shock.

**⚠ Caution**

This indicates the possibility of injury or damage to property.

### ⚠ Warning

- Do not use the product in an atmosphere of inflammable or explosive gas or vapor.
- Use the product at the specified voltage.
- Connect the power supply line correctly.
- Do not install, operate, maintain, or inspect the product with wet hands.
- Do not disassemble or alter this product.
- Do not drop or cause impact to the product.

### ⚠ Caution

- Before installation, operation, maintenance, or inspection, thoroughly check that the device is safe.
- When connecting a connector, check the pin numbers with the power off.
- When connecting oscilloscope probes to the test pins, be careful not to apply tension to them.
- Since this product is a precision device, use it under the specified environmental conditions.
- Do not store or transport this product in a place exposed to direct sunlight, moisture, dust, or temperature of 60ºC or higher.

## Contents

# 1. Product Outline

## 1.1. Features

The Canon Digital Galvano Scanner System is fully digitally controlled with a high-precision optical encoder on the galvano motor and a high-speed digital signal processor (DSP) on the controller.

This system has the following features:

- High positioning precision
- Low temperature drift
- Fast and stable operation by a unique control system
- Easy tuning by parameter setting

## 1.2. Configuration

This system supports various applications by the combination of a galvano motor and a controller.

**Galvano motor:** Encoder-mounted galvano motor

| | | |
|---|---|---|
| GM-1010 | • • • • | Beam diameter: φ6 to φ10 mm |
| GM-1015 | • • • • | Beam diameter: φ10 to φ15 mm |

**Controller:** Digital servo-controller

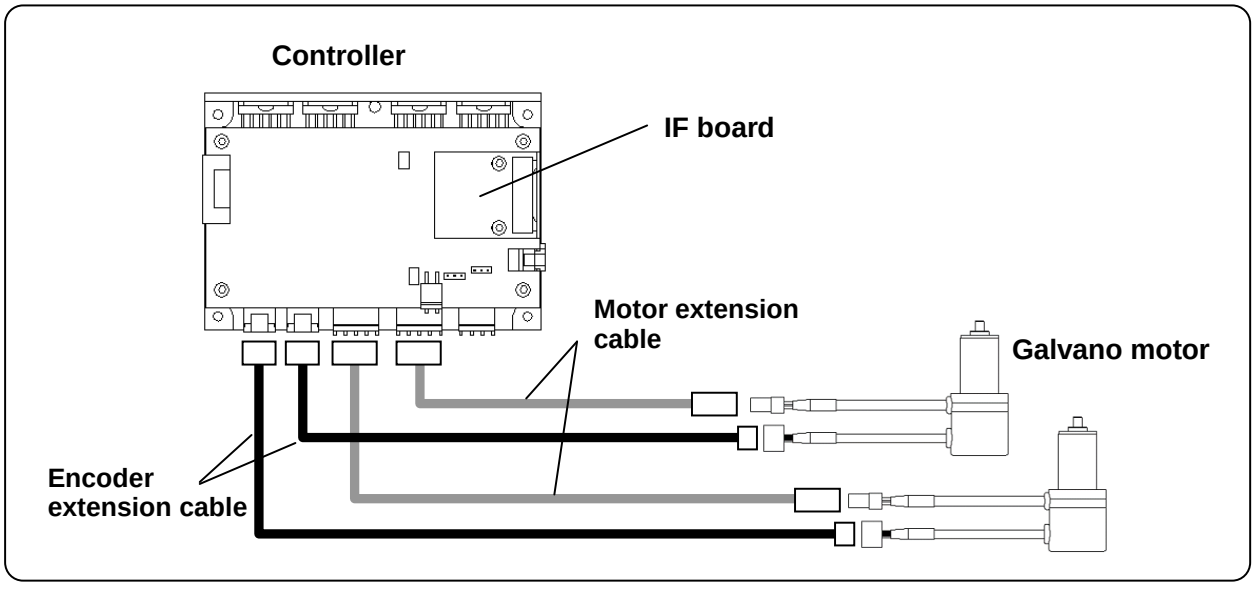
| | | |
|---|---|---|
| GC-201 | • • • • | Controller for two-axis control |
| GC-101 | • • • • | Controller for one-axis control |

**IF board:** IF board for high-speed serial communication

| | | |
|---|---|---|
| GC-422 | • • • • | IF board for 5V-TTL (RS-422) |
| GC-LVDS | • • • • | IF board for LVDS level |

**Extension cable:** Extension cable for galvano motor and controller connection

| | | |
|---|---|---|
| GM-EC10, 20, 30 | • • • • | Encoder extension cable (1, 2, 3 m) |
| GM-MC10, 20, 30 | • • • • | Motor extension cable (1, 2, 3 m) |



# 2. Specifications

## 2.1. Galvano Motor (GM-1010, GM-1015)

*Performance and shape*

| | GM-1010 | GM-1015 |
|---|---|---|
| Conforming beam diameter | φ6 to φ10 | φ10 to φ15 |
| Scan angle | ±15 deg | ±15 deg |
| Number of encoder pulses | 1000 pulses/rotation | 1500 pulses/rotation |
| Command resolution | 3.07 μrad | 2.05 μrad |
| Torque constant | 0.0127 Nm/A | 0.0226 Nm/A |
| Weight | 200 g | 300 g |

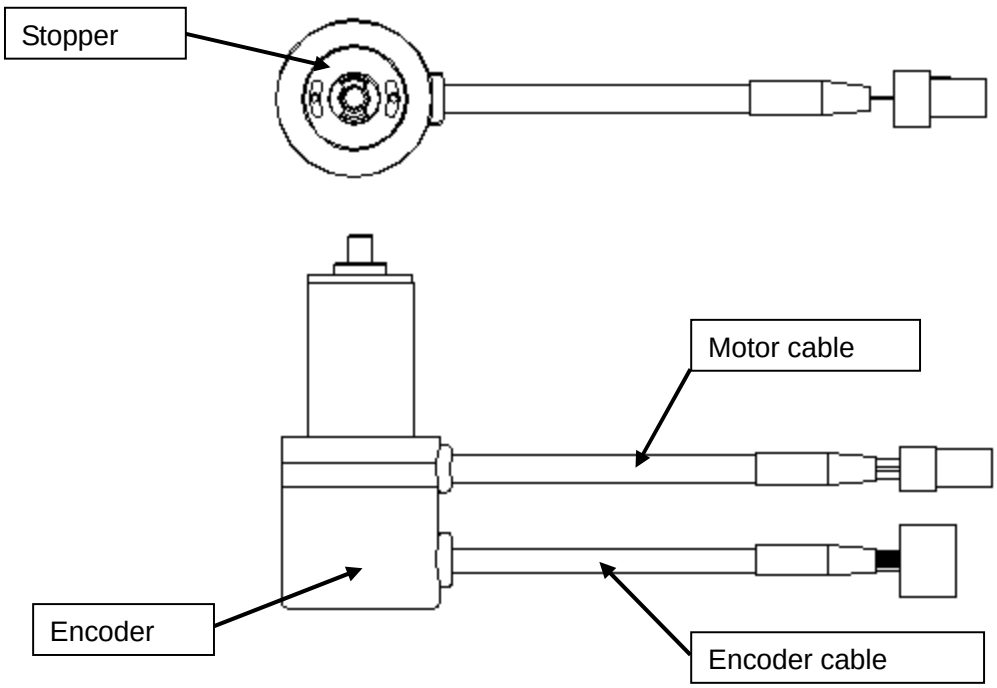
(Reference) Command resolution
The controller of this system divides one encoder cycle into 2048.
GM-1010 is controlled by the following command resolution:
1000 pulses × 2048 divisions = 2048000 pulses/rotation (360°)
360° / 2048000 = 0.0001757° = 3.07 μrad

*Environmental conditions*

| | |
|---|---|
| Operating temperature and humidity | 0 to 50°C, 90% RH or less (No condensation) |
| Storage temperature and humidity | –20 to 60°C, 90% RH or less (No condensation) |

Note: The above operating temperature and humidity conditions depend on the operating and heat radiation conditions.

*Section names*



## 2.2. Controller (GC-201, GC-101)

*Performance and shape*

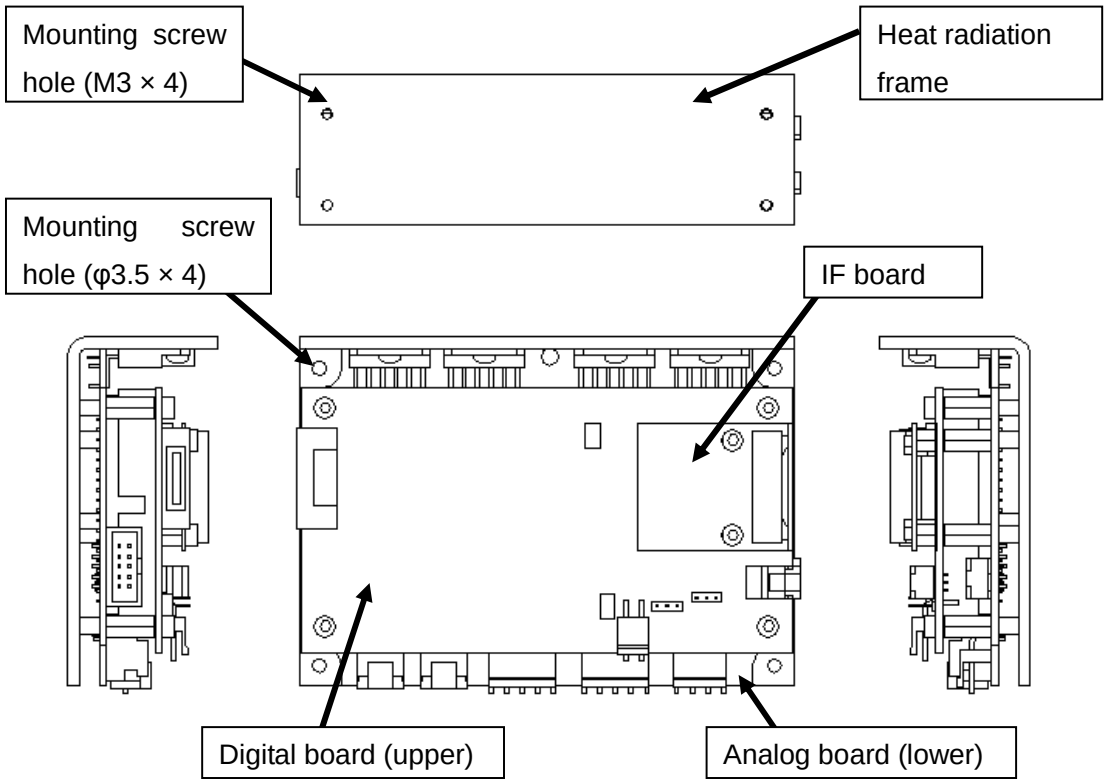
| | GC-201 | GC-101 |
|---|---|---|
| Number of control axes | 2 | 1 |
| Control sampling | 100 kHz | |
| Maximum drive current | 10 A (each axis) | |
| Interface | High-speed serial communication for position input (XY2-100)<br>Control RS-232C | |
| Notch filter | Digital notch filter ×2<br>Digital low-pass filter ×1<br>Analog notch filter ×3 | |
| Weight | 500 g | |

*Environmental conditions*

| | |
|---|---|
| Operating temperature and humidity | 0 to 50ºC, 90% RH or less (No condensation) |
| Storage temperature and humidity | -20 to 60ºC, 90% RH or less (No condensation) |

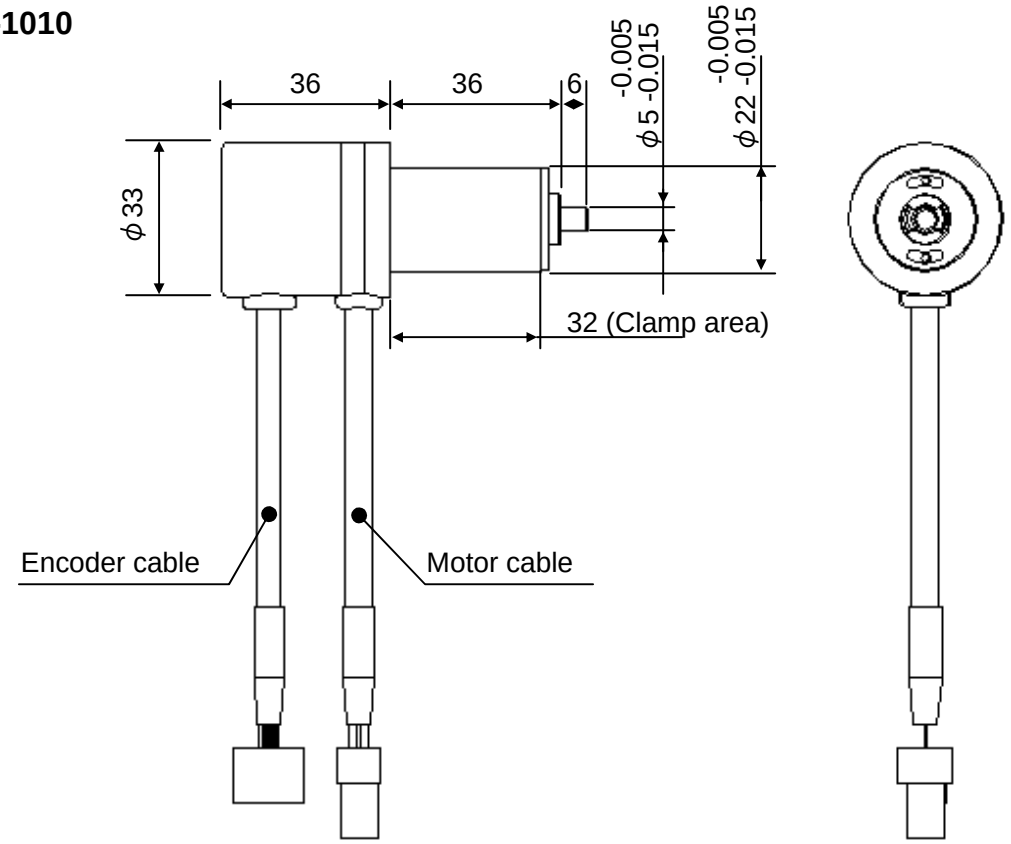
Note: The above operating temperature and humidity conditions depend on the operating and heat radiation conditions.

*Section names*

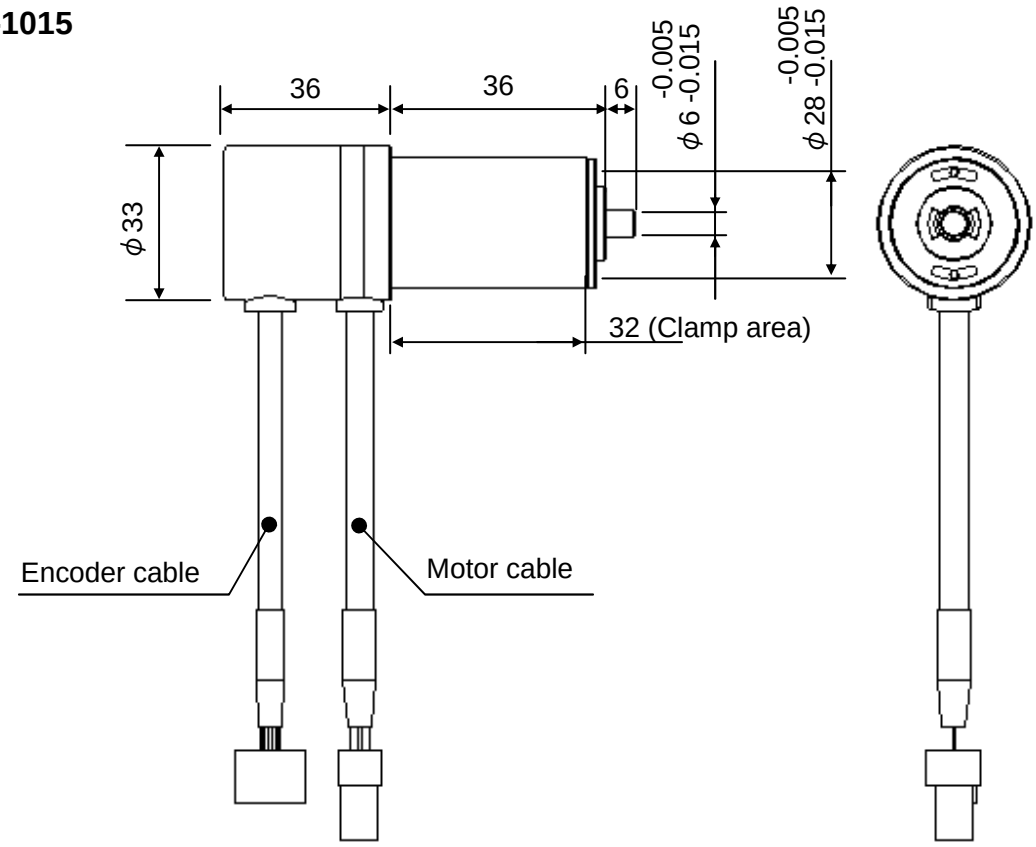


## 2.3. Outline Drawing

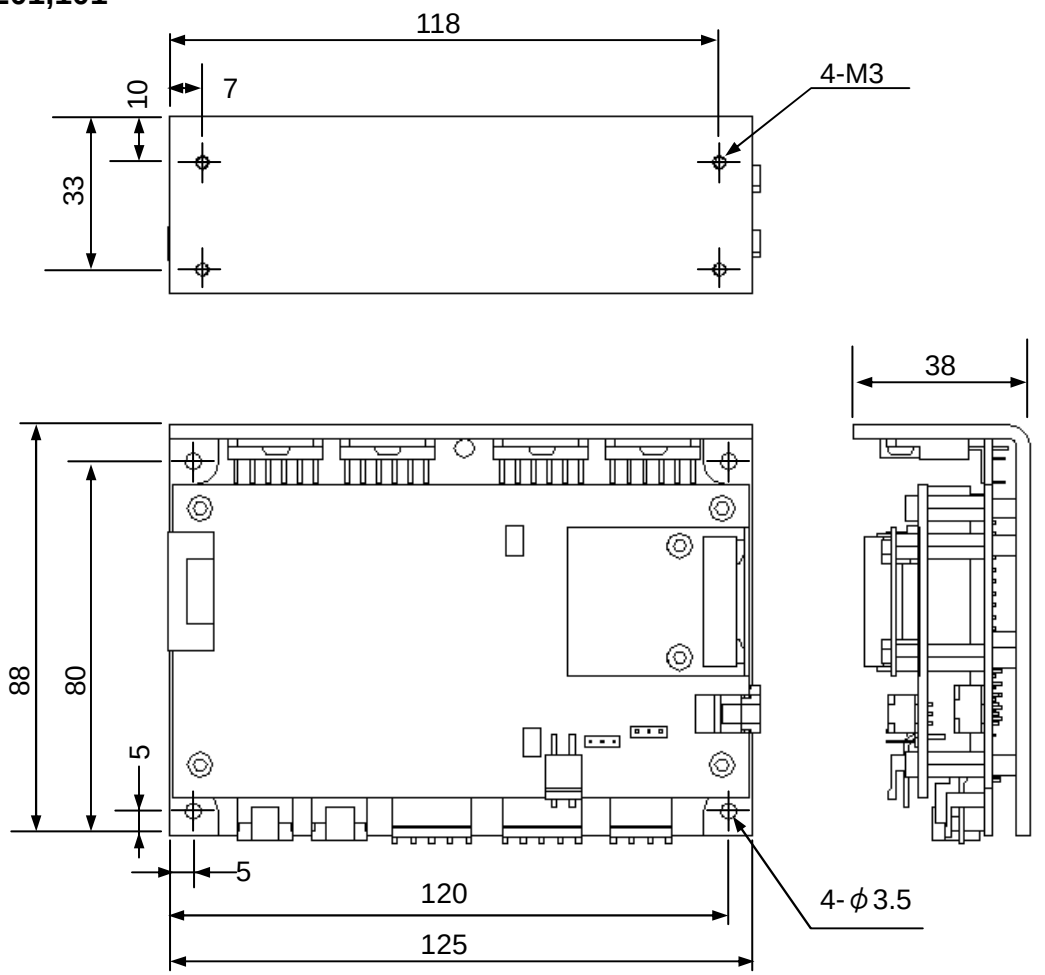
**GM-1010**




**GM-1015**



**GC-201,101**

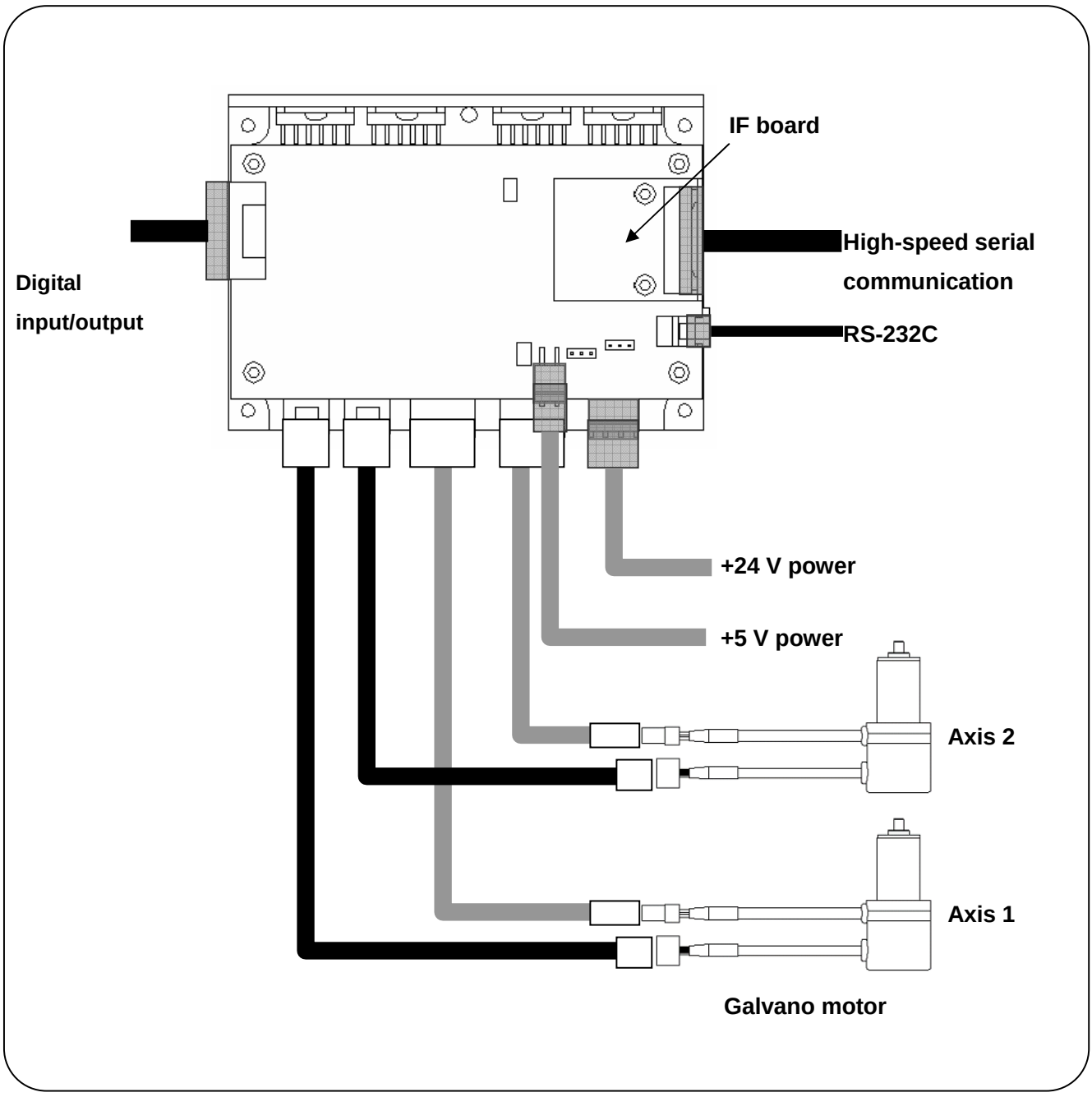


## 2.4. Power Supply

*Power supply specifications*

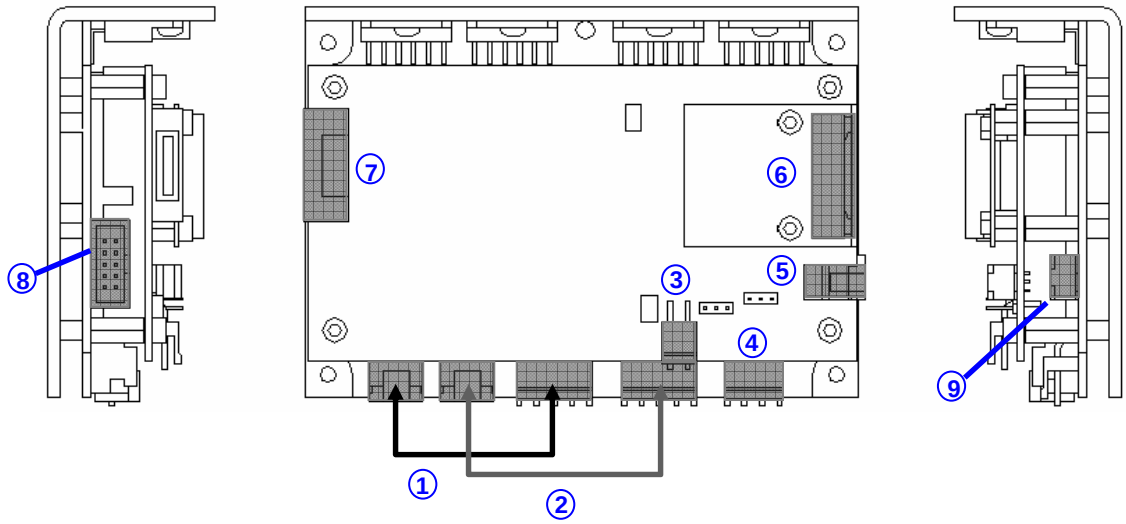
| | | |
|---|---|---|
| +24 V ± 10% | 10 A (max) × 2 axes | (For motor drive) |
| +5 V ± 5% | 2.8 A | (For control circuit) |

## 2.5. Connections



## 2.6. Connector Pin Arrangement

### (Connector types)




| | |
|---|---|
| ① | Axis 1 motor encoder |
| ② | Axis 2 motor encoder |
| ③ | +5 V power supply |
| ④ | +24 V power supply |
| ⑤ | RS-232C |
| ⑥ | High-speed serial communication |
| ⑦ | Digital input/output |
| ⑧ | Analog monitor |
| ⑨ | Fan power supply (+24 V) |

## (Pin arrangement)

### 3 +5 V power supply

Connector model number

| Connector | Model No. | Manufacturer |
|---|---|---|
| Board side | S2P-VH | JST |
| Cable side | VHR-2N | JST |

Connector pin arrangement

| Pin No. | Signal Description |
|---|---|
| 1 | +5 V |
| 2 | GND |

### 4 +24 V power supply

Connector model number

| Connector | Model No. | Manufacturer |
|---|---|---|
| Board side | S4P-VH | JST |
| Cable side | VHR-4N | JST |

Connector pin arrangement

| Pin No. | Signal Description |
|---|---|
| 1 | +24 V input for Axis 1 |
| 2 | +24 V input for Axis 2 |
| 3,4 | GND |

### 5 RS-232C

Connector model number

| Connector | Model No. | Manufacturer |
|---|---|---|
| Board side | S03B-PASK-2 | JST |
| Cable side | PAP-03V-S | JST |

Connector pin arrangement

| Pin No. | Signal Description |
|---|---|
| 1 | Send data (Signal level complying with RS-232C) |
| 2 | Receive data (Signal level complying with RS-232C) |
| 3 | GND |

## 6 High-speed Serial Communication

Connector model number

| Connector | Model No. | Manufacturer |
|---|---|---|
| Board side | SM12B-PASS-1-TB | JST |
| Cable side | PAP-12V-S | JST |

Connector pin arrangement

| Pin No. | Signal Name | Signal Description |
|---|---|---|
| 1 | CLK- | Clock (-) |
| 2 | CLK+ | Clock (+) |
| 3 | FS- | Frame sync (-) |
| 4 | FS+ | Frame sync (+) |
| 5 | XD- | Axis 1 data (-) |
| 6 | XD+ | Axis 1 data (+) |
| 7 | YD- | Axis 2 data (-) |
| 8 | YD+ | Axis 2 data (+) |
| 9 | - | (No connection) |
| 10 | - | (No connection) |
| 11 | GND | System GND |
| 12 | FG | Frame GND |

The signal levels depend on the IF board.

GC-422 - Receiver: AM26LV32C (TI), Driver: SN75179B (TI)

GC-LVDS - Receiver: SN65LVDS32 (TI), Driver: SN65LVDS179 (TI)

## 2.7. Control Specifications

The controller (GC-201, GC-101) is operated by:

- RS-232C command input
- High-speed serial communication

In addition, either the internal clock or external clock (high-speed serial communication) can be selected for operation.

| | Internal Clock | External Clock<br>(High-speed serial communication) |
|---|---|---|
| Clock input | Clock pulses generated by the controller internal circuit | High-speed serial communication clock pulses |
| Target position command | RS-232C command | High-speed serial communication command<br><br>(When RS-232C command input mode is set, a high-speed serial communication command is ignored.) |
| Operation setting parameter setting | RS-232C command | RS-232C command |
| | | |

With the default settings at shipping, power-on activates the controller with the internal clock.
The parameter can be set so that the controller starts with the external clock after power-on.
For activation with the external clock, however, signal input by high-speed serial communication is necessary at power-on.

**RS-232C command input**

RS-232C command input allows the following:

- Operation setting
- Parameter setting
- Error processing
- Status check

(For details, see 7, “Commands.”)

If position data send by high-speed serial communication is disabled, RS-232C command input is enough for the following:

- Step movement
- Raster scan (Continuous oscillation of a certain angle at a fixed frequency)

(Communication specifications)

| | |
|---|---|
| Wiring | Cross wiring |
| Communication rate | 38400 bps |
| Data length | 8 bits |
| Stop bit | 1 |
| Parity | None |
| Data format | ASCII code |
| Delimiter code | LF (0x0a) or CR (0x0d) |

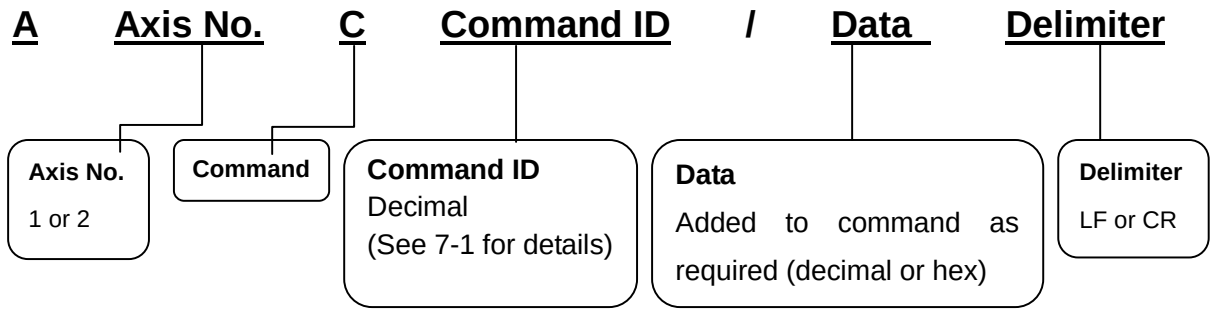
(Command specifications)

In response to command send, the controller returns a reply with data.

The data contents depend on the command.

(For details, see 7-2, “Command Details.”)

**Command send**



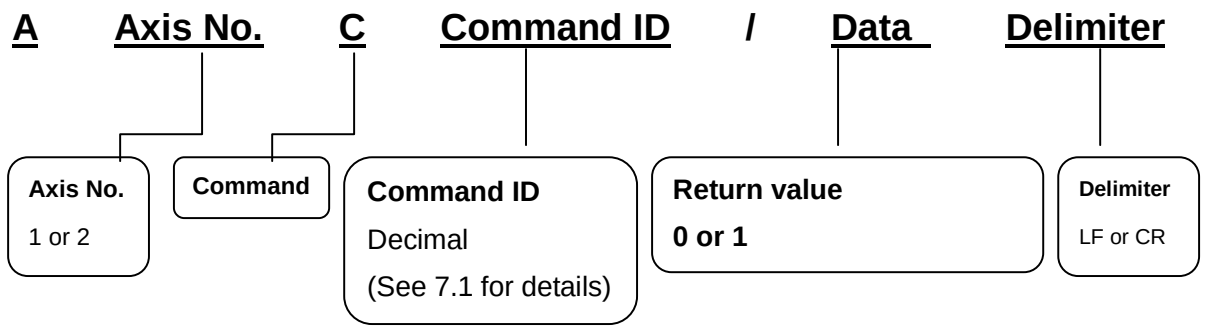

E.g. Servo ON ID = 4 Data = 1

A1C004 / 1 (LF)

(ASCII code: 0x41 0x31 0x43 0x30 0x30 0x34 0x2f 0x31 0x0a)

A 1 C 0 0 4 / 1 (LF)

**Command reply**




E.g. Servo ON ID = 4 Data = 1

A1C004 / 1 (LF)

(ASCII code: 0x41 0x31 0x43 0x30 0x30 0x34 0x2f 0x31 0x0a)

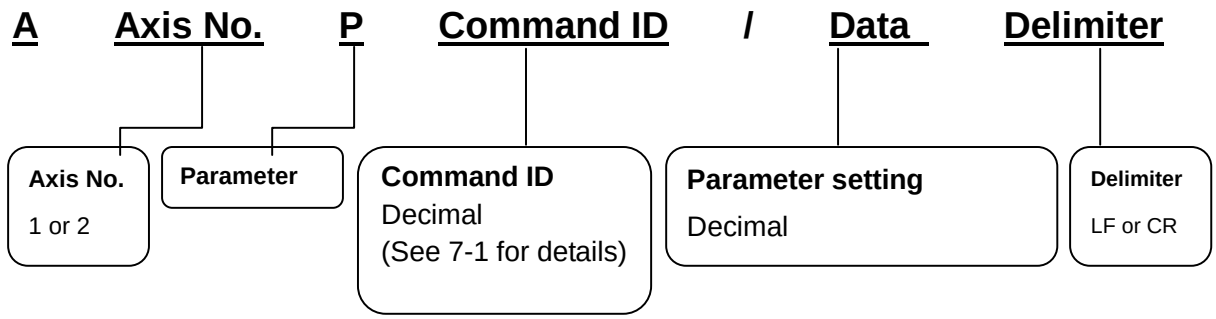
A 1 C 0 0 4 / 1 (LF)

Also in response to parameter send, the controller always returns a reply with data.

The data contents depend on the command.

(For details, see 7-2, “Command Details.”)

**Parameter send**



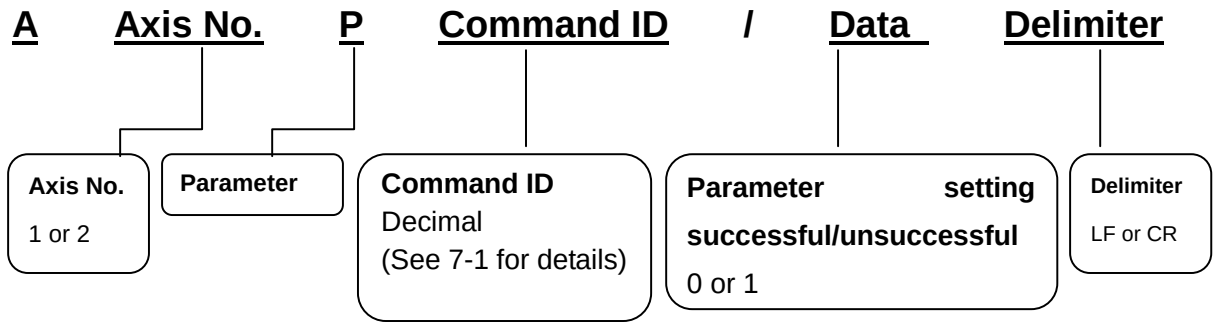

E.g. LQ gain parameter ID = 6 Data = 4500

A1P006 / 4500 (LF)

(ASCII code: 0x41 0x31 0x50 0x30 0x30 0x36 0x2f 0x34 0x35 0x30 0x30 0x0a)

A 1 P 0 0 6 / 4 5 0 0 (LF)

**Parameter reply**




E.g. LQ gain parameter ID = 6 Data = 4500

A1P006 / 4500 (LF)

(ASCII code: 0x41 0x31 0x50 0x30 0x30 0x36 0x2f 0x30 0x0a)

A 1 P 0 0 6 / 0 (LF)

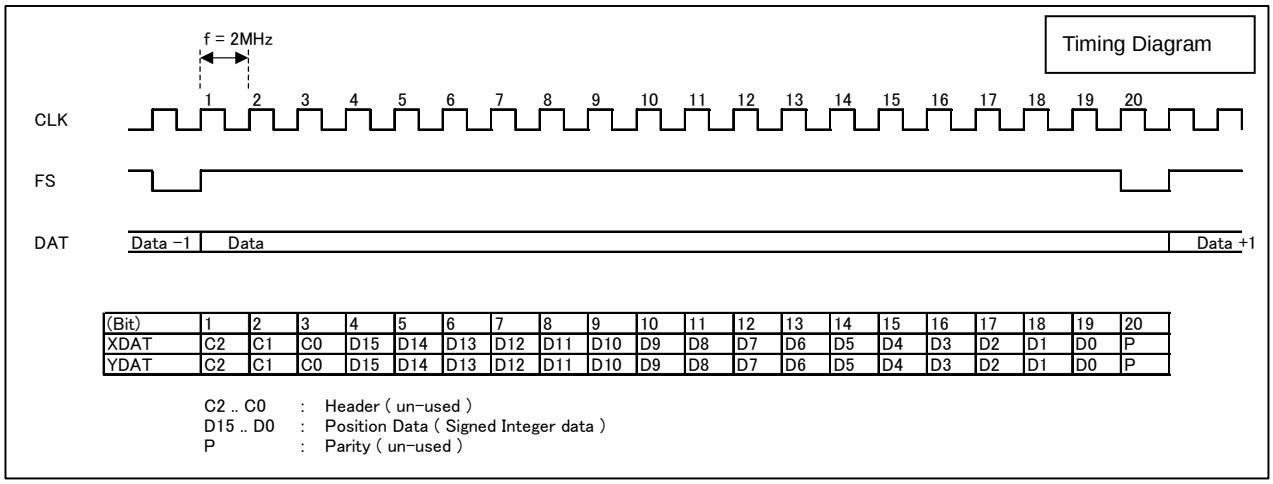
**High-speed serial communication**

To control the mirror to an arbitrary position by Marking or any other application, target position data updated as required can be given to the controller by using high-speed serial communication.

By setting, the controller can be activated in the mode of tracking a target position specified by high-speed serial communication. (For details, see 6-1, “Setting Activation Mode.”)

(Communication specifications)

| | |
|---|---|
| Base clock (CLK) | 2 MHz |
| Frame sync (FS) | 100 kHz |
| Data (DAT) | 20 bits (Position data: 16 bits) |
| Transmission system | Differential signal |
| Signal level | 5V-TTL, LVDS<br>(Selectable by the optional IF board) |




| (Bit) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| XDAT | C2 | C1 | C0 | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | P |
| YDAT | C2 | C1 | C0 | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | P |

High-speed serial communication data: 16-bit data

Ordinary data: 1 for one pulse that can be specified up to the following positions:

Maximum position: 0xFFFF = 32767 pulses = About 5.76 deg (GM-1010)

0-pulse position: 0x8000 = 0

Minimum position: 0x0000 = –32768 pulses = About –5.76 deg (GM-1010)

If a greater angle is specified, set a magnification by using the High-speed Serial Communication Conversion Gain parameter (Parameter ID = 13)

E.g. For x2 (Setting: 2000), the following angle can be specified:

–5.76 × 2 deg to –5.76 × 2 deg

The command resolution will be two times.

For the support of other communication specifications, contact the Sales Department.

Note: For setting high-speed serial communication mode or controller activation in high-speed serial communication mode at power-on, high-speed serial communication signals are necessary. Enter the CLK, FS, and DAT signals in advance.
For how to set the activation mode, see 6-1, “Setting Activation Mode.”

## 2.8. Heat Radiation and Installation

Since the controller and motor generate heat, their heat radiation should be considered carefully.

Generated heat depends on the operating conditions. Determine a heat radiation method according to the operating conditions.

The controller and motor have a temperature detection sensor (thermistor) at the heat generating section. As a safety function, the thermistor stops control if the detector temperature reaches:

| | |
|---|---|
| Controller | About 70ºC |
| Motor | About 70ºC |

(For details, see 9, “Safety Functions.”)

The controller and motor require heat radiation so that their temperatures will not exceed the above values.

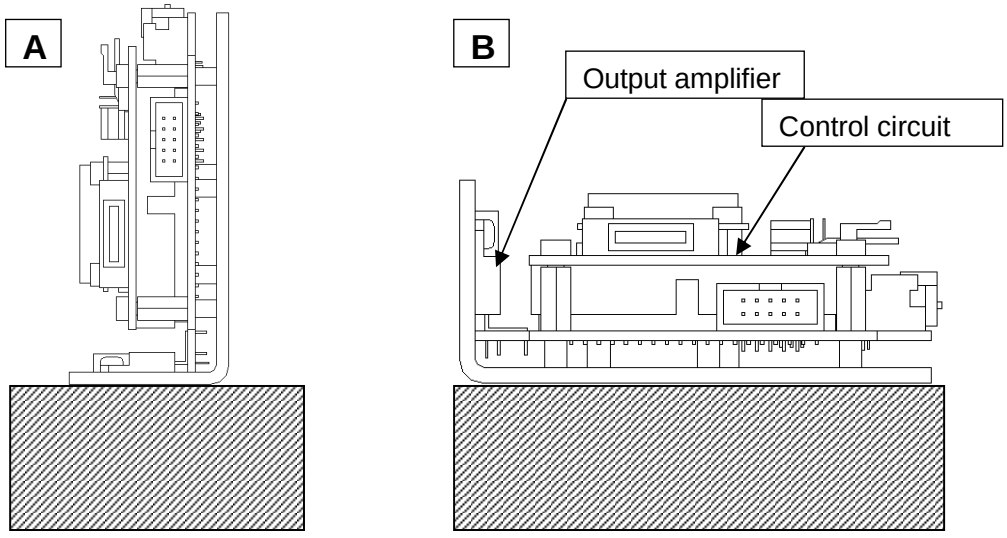
*Controller installation methods*

The controller can be installed by either Method A or B below.

At installation, put the controller frame in contact with a heat-radiating structure (heat sink or cabinet).

Method A has higher heat radiation efficiency. However, select either method by considering the operating conditions and cable routing. When installing the controller frame, apply thermal grease or attach a thermal conductive sheet to the contact surface.

Under some operating conditions, forced air cooling by a fan is necessary. Cool the heat-radiating structure (heat sink or cabinet) and the controller.




In addition to the output amplifier, which is the main source of heat, the control circuit section (DSP) generates heat.

Allow as much space as possible around the equipment.

**Caution**

**The controller becomes hot during operation.**

# 3. Software

The controller (GC-201, 101) comes with dedicated control software “GALILEO (Galvano Integrated Leading Operator (GALILEO).”

GALILEO makes the following controller operations easy:

- Parameter setting
- Servo tuning (Frequency characteristic measurement)
- Status check
- Operation setting (Step movement and raster scan)

Most of the functions that can be performed by GALILEO can also be executed by external command input through RS-232C connection without using GALILEO. This manual describes operations both by GALILEO and by external command input.

**Note:** The following function can be executed by GALILEO only, and not by external command input:

- Frequency characteristic measurement

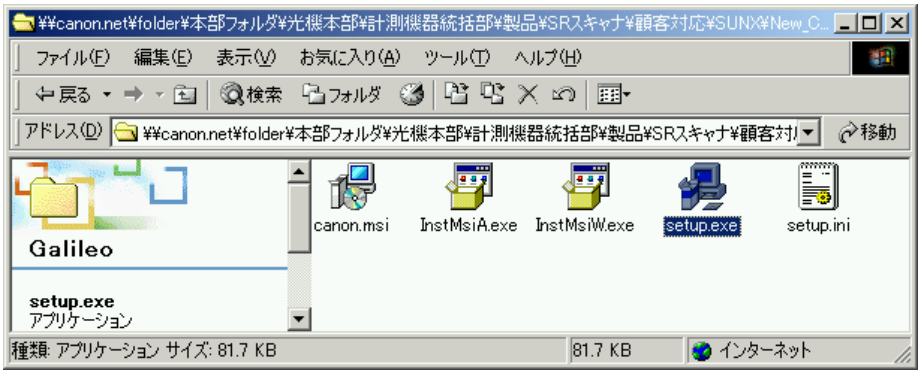
## 3.1. Supported PC Environment

| | |
|---|---|
| Supported OS | MS-Windows 2000, XP, Vista |
| Connection port | RS-232C port (with USB-RS-232C conversion cable) |

## 3.2. Installation

・ Insert the accessory application CD into the CD drive.

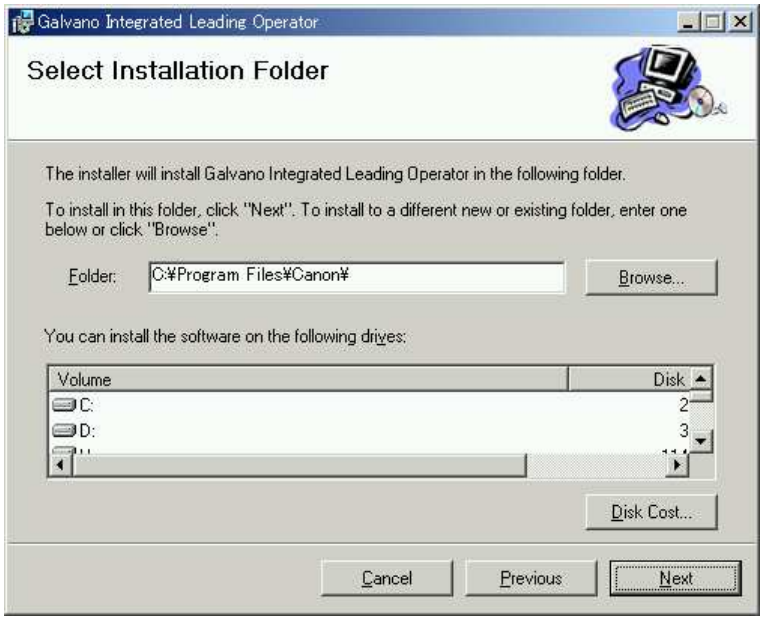
・ Execute Setup.exe in the GALILEO folder.



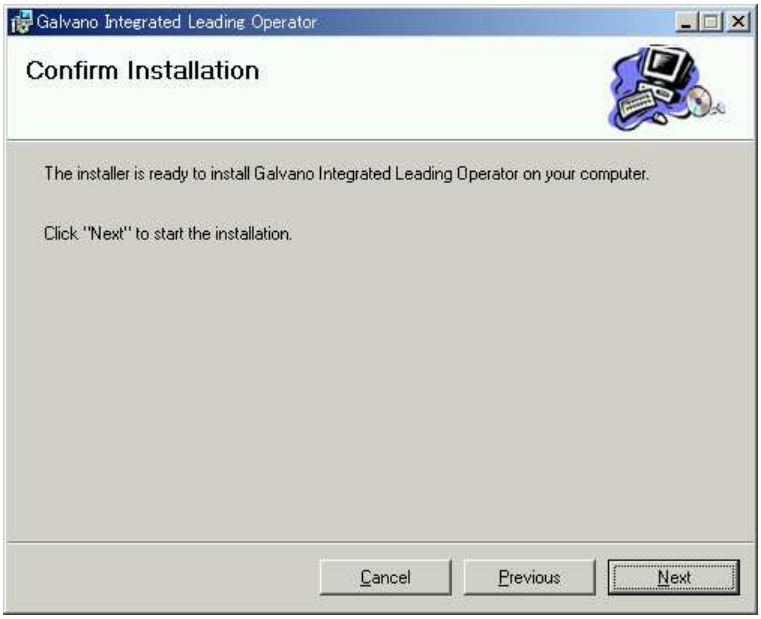

After change

- Press the Next button.

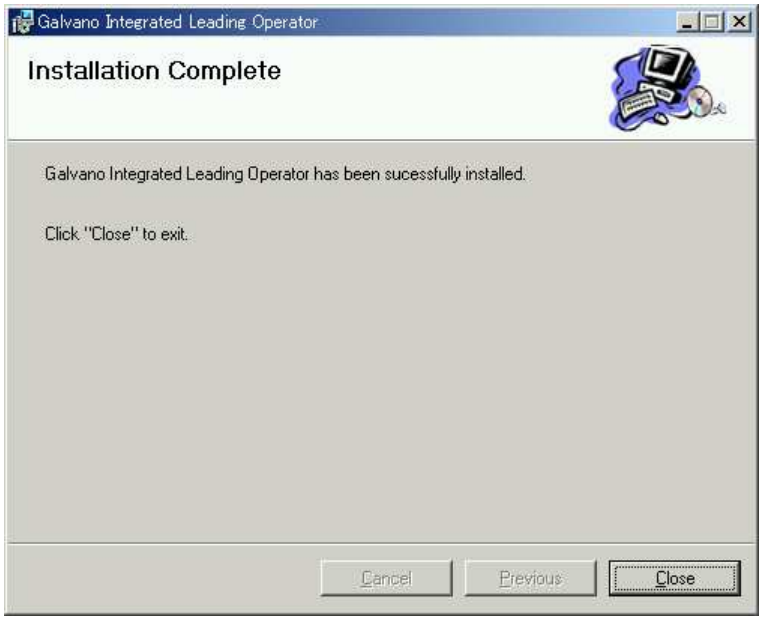

- Specify an installation folder and press the Next button.
  (Recommendation: Do not change usually.)



- Press the Next button.




- Press the Close button. This completes installation.

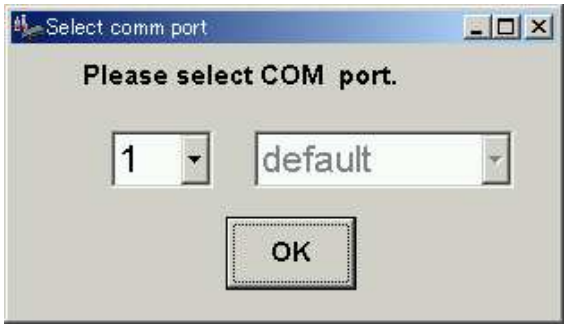


## 3.3. Activation

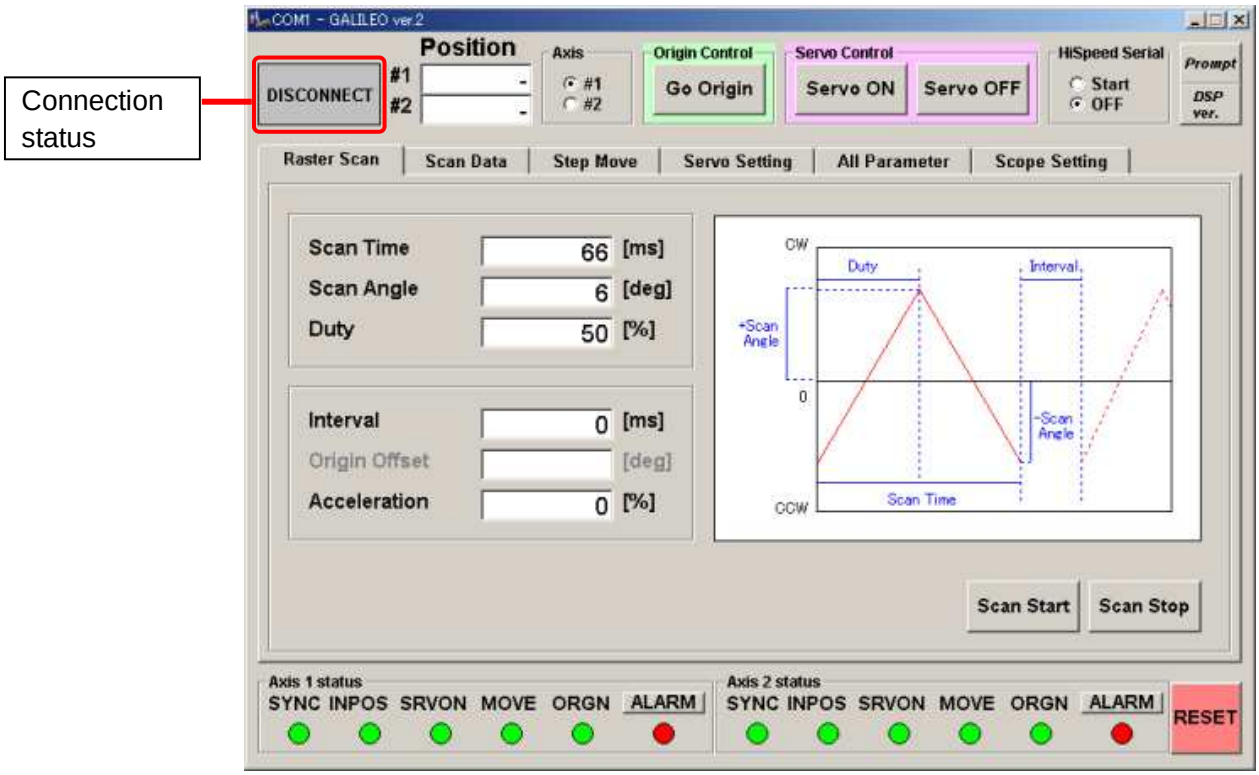
- Connect the controller and the PC with the optional RS-232C cable.

- Click “START” - “Programs” - “Canon Scanner” - “GALILEO”.

- Setting the COM port
  Select the connected RS-232C port and press the OK button.



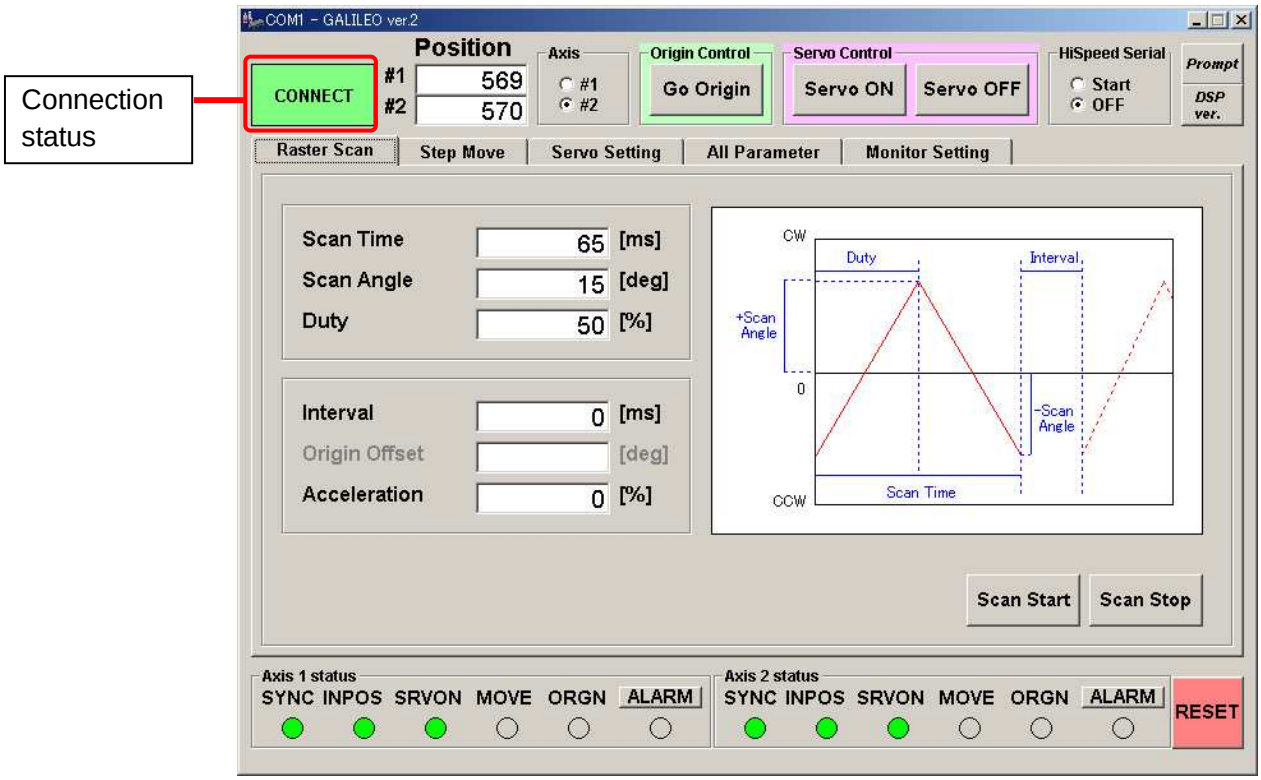

- The control screen is displayed.
  While communication with the controller has not started yet, the screen displays “DISCONNECT” in gray at the upper left as the connection status.




Note: The value of each item on the above screen depends on the controller status.

・ When the power to the controller is turned on, communication automatically starts.

When communication starts, the connection status at the upper left changes to “CONNECT” in green.

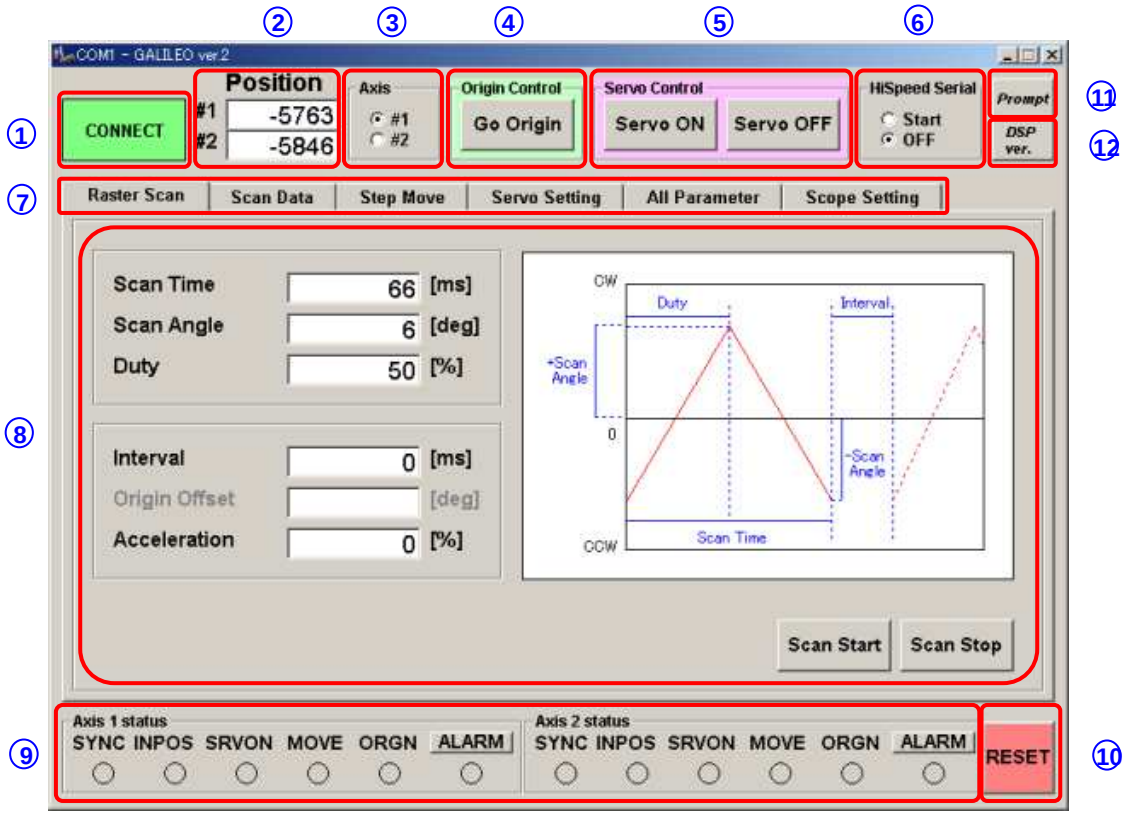



GALILEO can be activated after power to the controller has been turned on. Then communication starts automatically. (“CONNECT” is displayed.)

Note: The value of each item on the above screen depends on the controller status.

## 3.4. Control Screen

This section explains the buttons and other items on the control screen.




| | | |
|---|---|---|
| ① | Connection display | The status of RS-232 connection to the controller is displayed.<br>Connected: CONNECT (green)<br>Not connected: DISCONNECT (gray) |
| ② | Position display | The encoder position of each axis is displayed.<br>(Unit: pulse)<br>Note: Since the number of encoder pulses per rotation depends on the galvano motor, the relationship between the number of pulses and the angle also differs with the motor type. |
| ③ | Axis selection | Select an axis for control and information display.<br>(#1 = Axis 1, #2 = Axis 2)<br>The screen can display the information of only one axis selected here, although the position displayed at ② and the status displayed at ⑨ always show the information of both axes. |
| ④ | Origin control<br>(Homing to origin) | Press this button to go to or detect the origin.<br>The operation depends on the controller status.<br>(During ordinary servo control)<br>Moving to the origin (where the position display is 0)<br>Invalid during high-speed serial communication<br>(After servo OFF and soft reset)<br>Starting origin detection |

| | | |
|---|---|---|
| ⑤ | Servo ON/OFF | Start or stop servo control. |
| ⑥ | High-speed serial communication selection | Select the high-speed serial communication command or internal command for position specification. (For details, see Chapter 4.)<br>(Start = High-speed serial communication, OFF = Internal command) |
| ⑦ | Tab selection | The screen of each function can be displayed by tab selection.<br>(A detailed explanation of the screen is shown when each function is displayed.) |
| ⑧ | Control display | This area displays the screen of each function selected by a tab at ⑦. |
| ⑨ | Status display | The controller status of two axes is displayed. |
| ⑩ | Soft reset | Press this button for soft reset. |
| ⑪ | Command input screen | Allows direct command input. |
| ⑫ | DSP version | The version of the controller software is displayed.<br>During troubleshooting, the support staff may ask for the version number. |

# 4. Operating Procedure

This chapter explains how to use the system.

Operations by [GALILEO] and by [RS-232C command] are explained together.

## 4.1. Controller Activation

When the power (+5 V, +24 V) is turned on, the controller first does the following automatically:

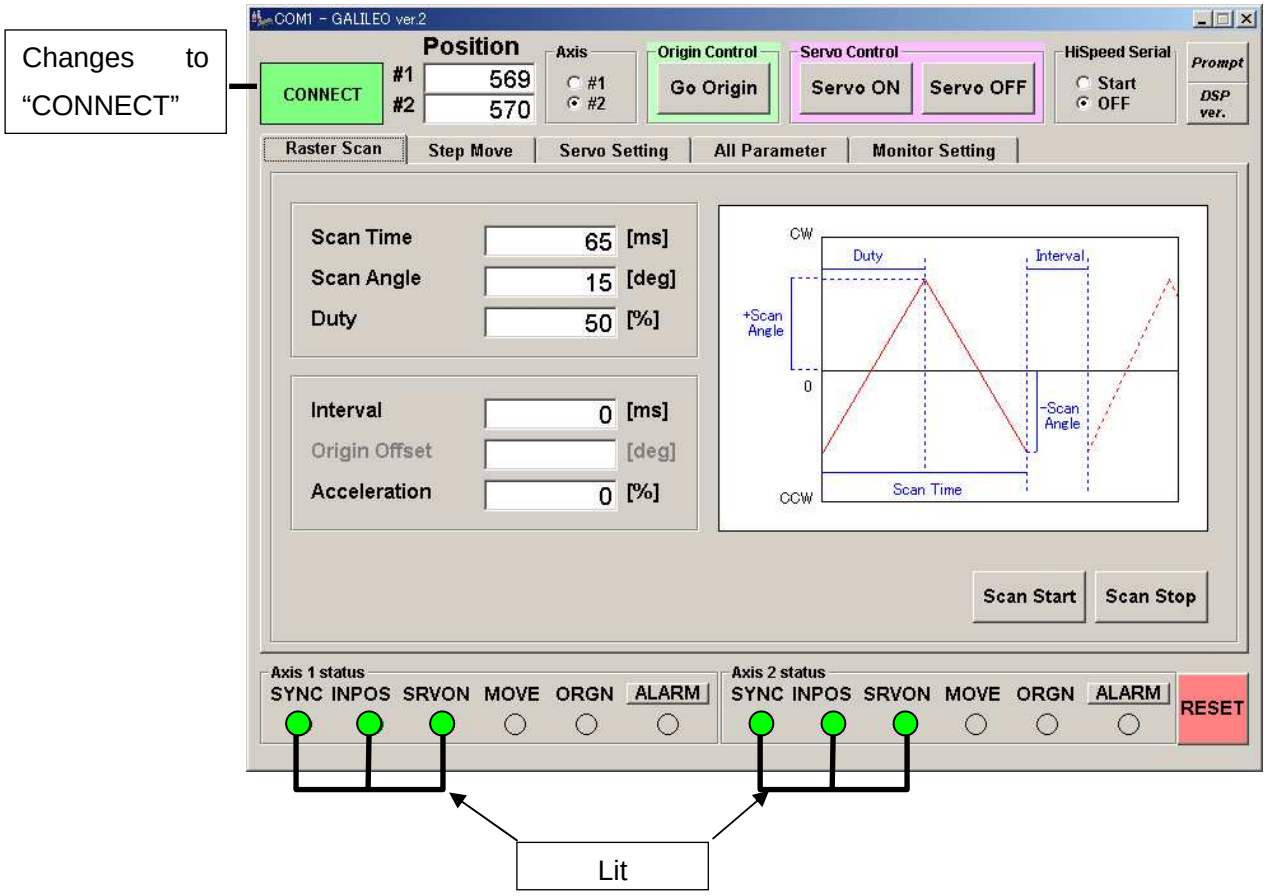
- Reads saved parameters from ROM
- Homes to the origin
- Corrects the encoder (high-speed oscillation of a fixed angle)

It takes about 15 seconds until the controller is activated.

With the default settings at shipping, the controller is activated with the internal clock.

The completion of activation can be confirmed as follows:

**GALILEO**




Note: At activation, the status temporarily changes to "DISCONNECT" and the ALARM lamp lights (about 5 s). This is not an error. Wait for a while.

**RS-232C command**

Send Command ID14 “Status read” and check the following:

SRVON, SYNC, INPOS = High

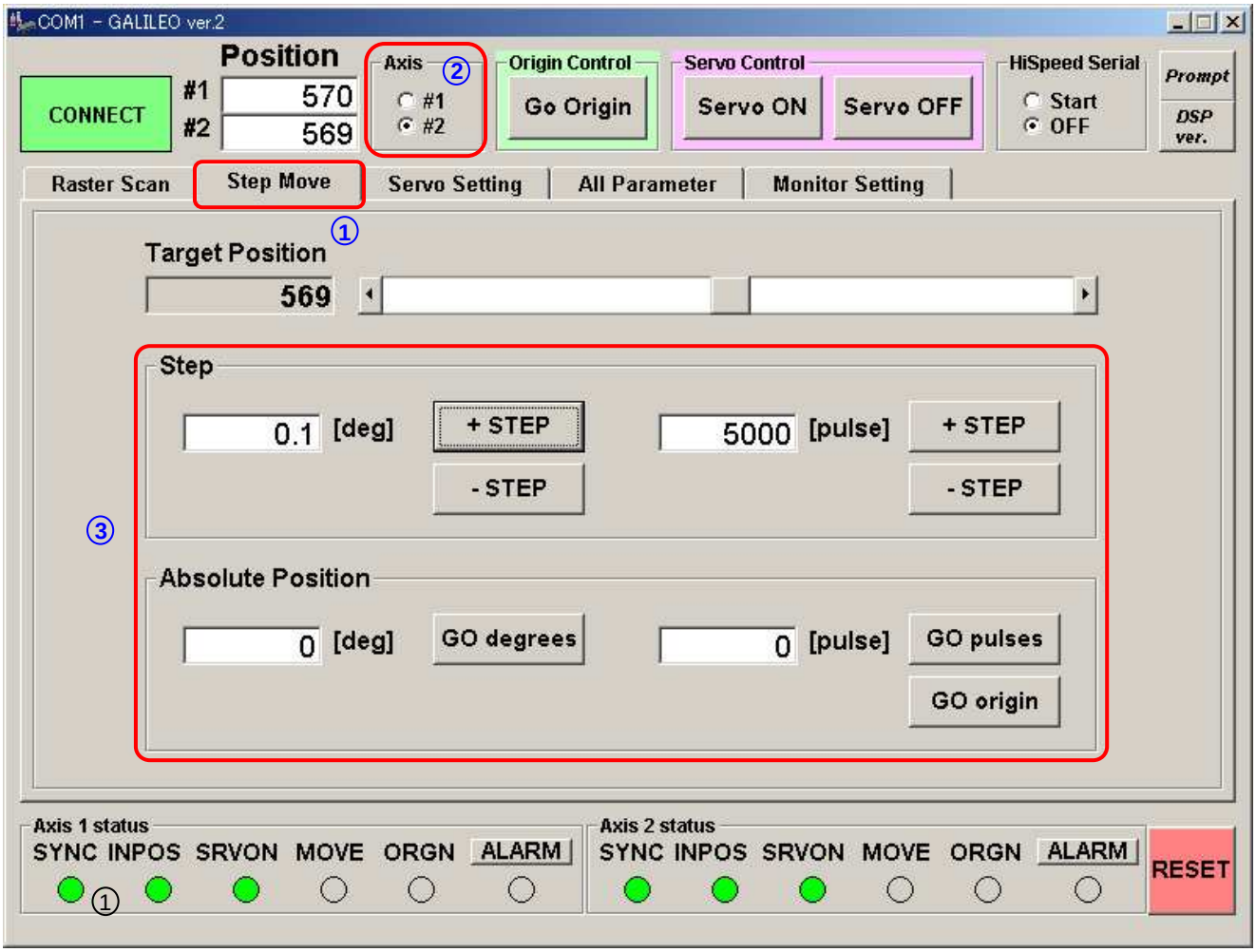
ORGN = Low

(For details, see 7-2, “Command Details.”)

## 4.2. Step Movement

Execute step movement for a fixed angle.

**GALILEO**




- Select the Step Move tab.①
- Select an axis for step movement.②
- Specify the displacement (angle and pulse count) for relative position (STEP) and absolute position.③
- Press the MOVE button (either positive or negative position direction can be specified).③

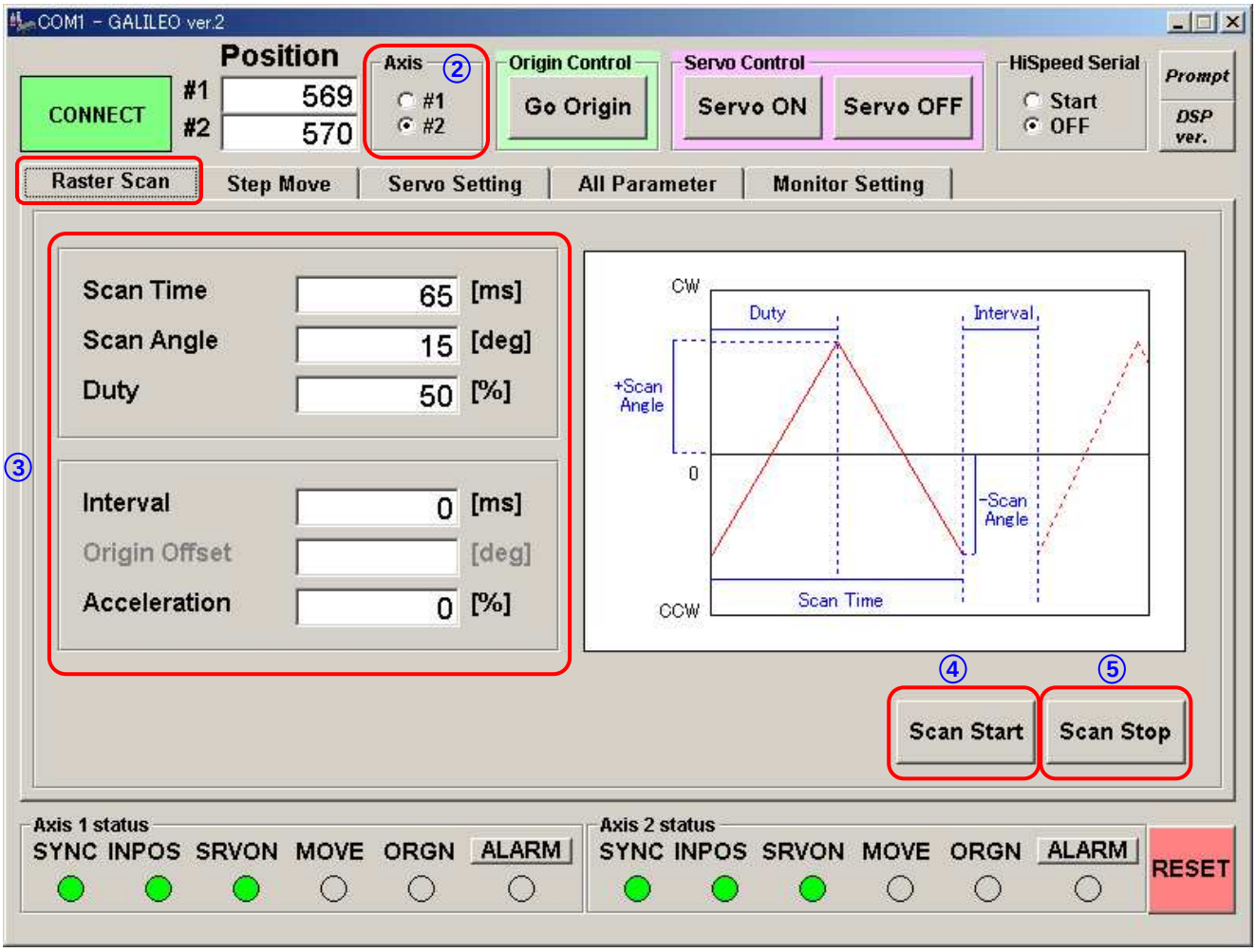
**RS-232C command**

- Target value setting mode (Command ID = 10)
- Target position setting (Command ID = 20)
- Movement start (Command ID = 8)

## 4.3. Raster Scan

Execute oscillation of a fixed angle at a fixed frequency.

**GALILEO**




- Select the Raster Scan tab.①
- Select an axis for raster scan.②
- Specify the operation parameters (Scan Time, Scan Angle, and Duty).③
- Press the Scan Start button to start operation.④
- Press the Scan Stop button to stop operation.⑤

**RS-232C command**

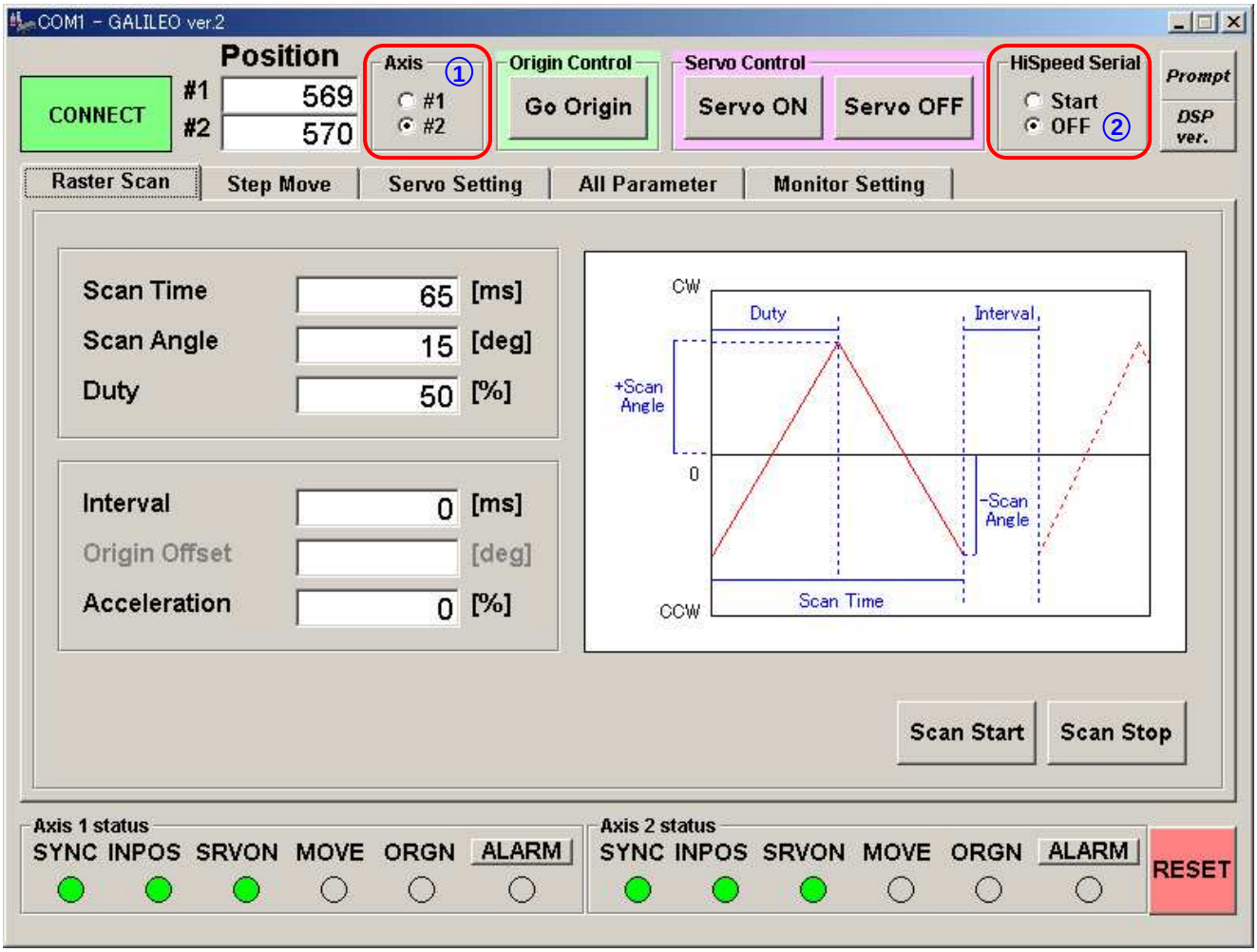
- Raster scan interval setting (Parameter ID = 26)
- Raster scan duty ratio setting (Parameter ID = 27)
- Raster scan oscillation angle setting (Parameter ID = 28)
- Scan start (Command ID = 23 Data = 3)
- Scan stop (Command ID = 23 Data = 0)

## 4.4. Position Command Input by High-speed Serial Communication

For a vector scan, give target position data to the controller by high-speed serial communication, The data is updated as required.

Switch the controller to the status of receiving target position data by high-speed serial communication. For switching, it is necessary to enter high-speed serial communication signals into the controller in advance.

**GALILEO**




- Select an axis for high-speed serial communication.①
- Switch HiSpeed Serial to Start.②

  This switching makes the controller follow target position data by high-speed serial communication.
- Switch HiSpeed Serial to OFF.②

  Input of the MOVE command is awaited.

**RS-232C commands**

- Switch to high-speed serial communication (Command ID = 23 Data = 7)
- Return to internal clock operation (Command ID = 23 Data = 0)

# 5. Monitor Output and Digital Input Functions

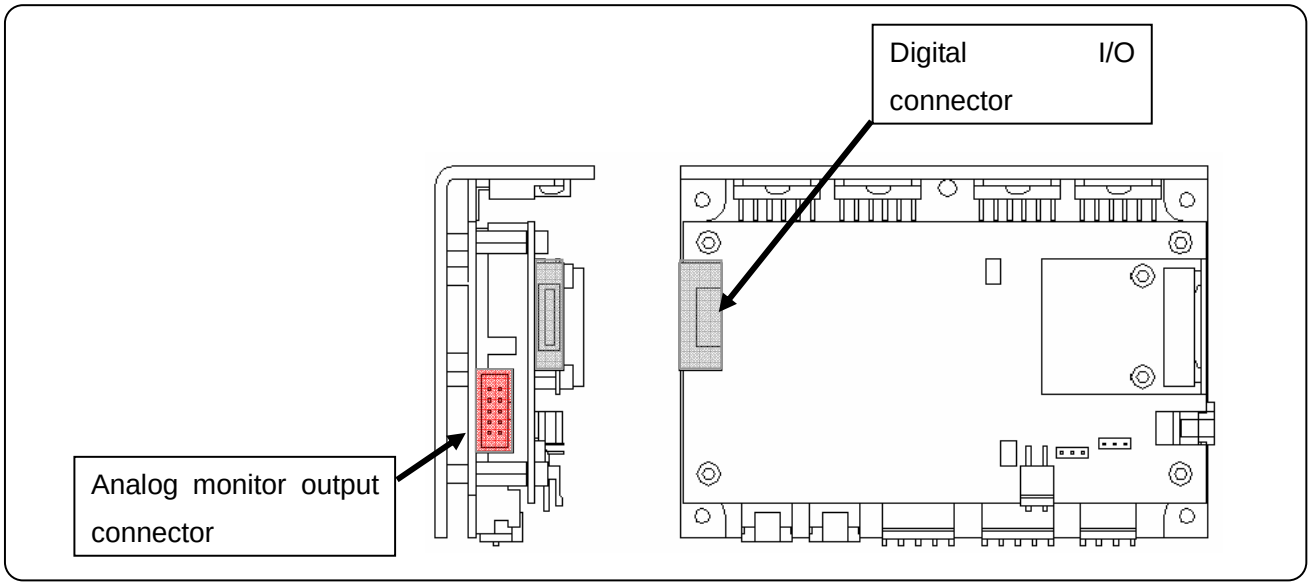
The controller has an analog monitor output connector for monitoring the operation status and a digital I/O connector for external signal input.

## 5.1. Connector Pin Arrangement

The controller is equipped with the following:

Analog monitor output connector ×1

Digital I/O connector ×1



**Analog monitor output connector**

Connector model number

| Connector | Model No. | Manufacturer |
|---|---|---|
| Board side | XG4C-1034 | OMRON |
| Cable side | XG4M-1030-T | OMRON |

Connector pin arrangement

| Pin No. | Signal Name | Signal Description |
|---|---|---|
| 1 | A1 | Axis 1 current command value |
| 2 | A2 | Axis 1 analog monitor 1 (Monitor item switching) |
| 3 | A3 | Axis 1 analog monitor 2 (Monitor item switching) |
| 4 | A4 | Axis 1 analog monitor 3 (Monitor item switching) |
| 5 | A5 | Axis 2 current command value |
| 6 | A6 | Axis 2 analog monitor 1 (Monitor item switching) |
| 7 | A7 | Axis 2 analog monitor 2 (Monitor item switching) |
| 8 | A8 | Axis 2 analog monitor 3 (Monitor item switching) |
| 9 | A9 | Analog GND |
| 10 | A10 | Analog GND |

The controller has three monitor terminals for each of the two axes to check the operation status. The output signal contents can be changed and the output magnification can also be changed. (For details, see 5.2, “Analog Monitor Output Switching.”)

**Digital I/O connectors**

Connector model number

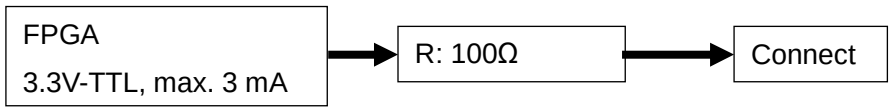
| Connector | Model No. | Manufacturer |
|---|---|---|
| Board side | 8931E-020-178L | KEL |
| Cable side | 8925E-020-179 | KEL |

Connector pin arrangement

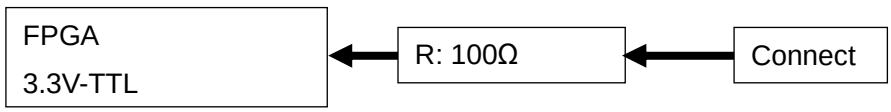
| Pin No. | I/O | Signal Description | Logic | Remarks |
|---|---|---|---|---|
| A1 | Output | Axis 1 error 1 (Priority high) | 1: Error | See Circuit 1 below. |
| B1 | Output | Axis 1 error 2 (Priority low) | 1: Error | See Circuit 1 below. |
| A2 | Output | Axis 1 servo interrupt period | Edge | See Circuit 1 below. |
| B2 | Output | Axis 2 error 1 (Priority high) | 1: Error | See Circuit 1 below. |
| A3 | Output | Axis 2 error 2 (Priority low) | 1: Error | See Circuit 1 below. |
| B3 | Output | Axis 2 servo interrupt period | Edge | See Circuit 1 below. |
| A4 | - | GND | | |
| B4 | - | GND | | |
| A5 | Input | External servo interrupt input | ↑: INT generation | See Circuit 2 below. |
| B5 | Input | External interrupt FG input | 1: FG_ON | See Circuit 2 below. |
| A6 | Input | Activation mode switching | | See Circuit 2 below. |
| B6 | | No connection | | |
| A7 | - | GND | | |
| B7 | - | GND | | |
| A8 | | No connection | | |
| B8 | | No connection | | |
| A9 | | No connection | | |
| B9 | | No connection | | |
| A10 | | No connection | | |
| B10 | | No connection | | |

Connection specifications

(Circuit 1)




(Circuit 2)



## 5.2. Analog Monitor Output Switching

The analog monitor output can be switched to monitor various operation and signal statuses.

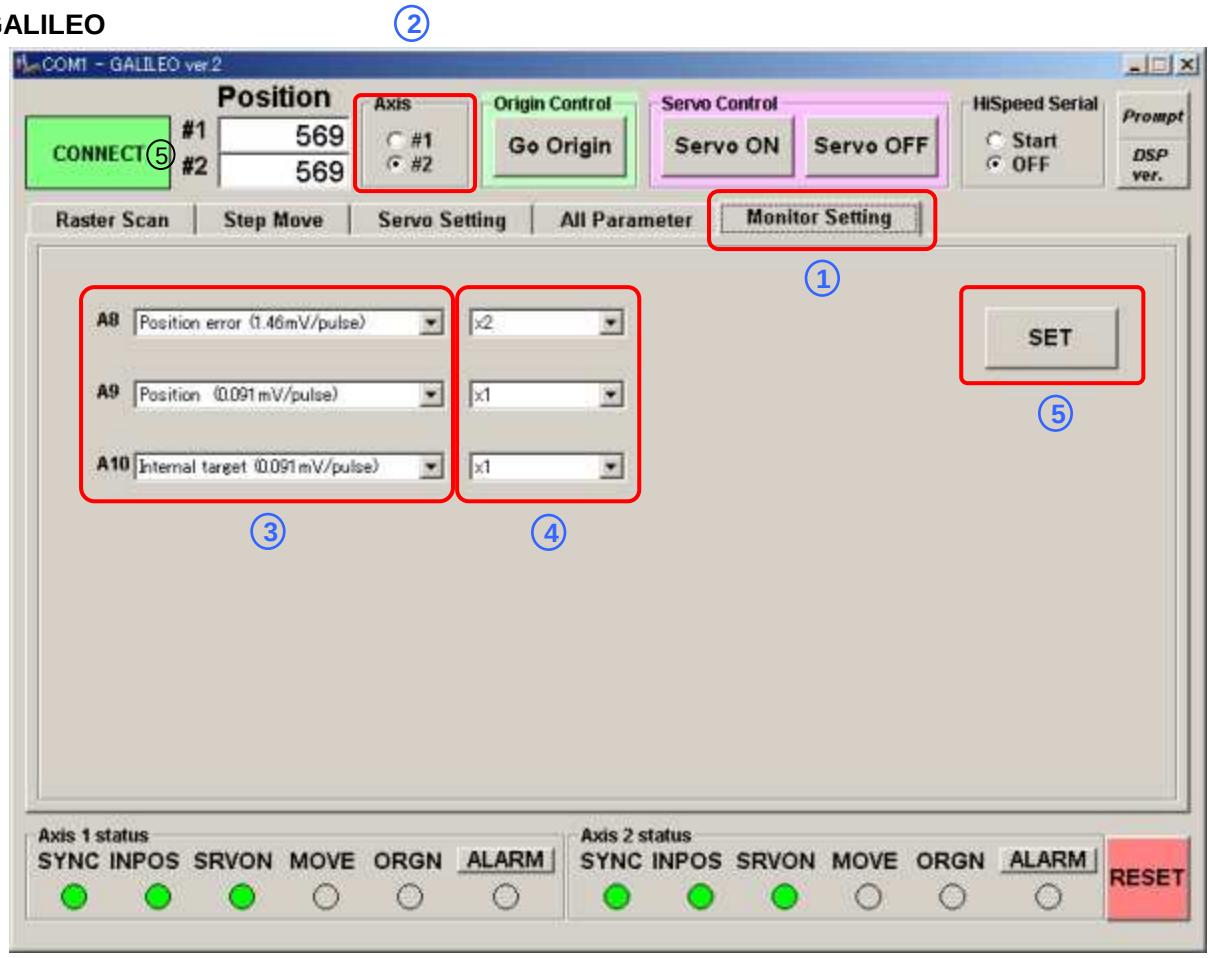
This switching can be executed from **[GALILEO]** or **[RS-232C command send]**.

Output contents

| Terminal | Power-on Selection | Signal Description | Signal Level (At Power-on) |
|---|---|---|---|
| A2 (Axis 1)<br>A6 (Axis 2) | | Phase A of Encoder Head 1 | |
| | | Phase A of Encoder Head 2 | |
| | | Phase A of encoder after synthesis | |
| | * | Positional deviation signal | 1.46 mV / pulse |
| A3 (Axis 1)<br>A7 (Axis 2) | | Position | 0.091 mV / pulse |
| | * | Velocity | 0.091 mV / pulse / 10 usec |
| | | Coarse angle | |
| | | Fine angle | |
| A4 (Axis 1)<br>A8 (Axis 2) | | Phase B of Encoder Head 1 | |
| | | Phase B of Encoder Head 2 | |
| | | Phase B of encoder after synthesis | |
| | * | Target position | 0.091 mV / pulse |

The signal level differs between signals. The output magnification can be switched individually.

**GALILEO**




- Select the Monitor tab.①
- Select an axis for monitor output switching②
- Select the monitor item of each output terminal③
- Select an output signal magnification④
- Press the SET button.⑤

**Note:**

• The analog monitor output is from the D/A converter of the controller.

Since the output range of the D/A converter is from –3 to +3 V, output is looped by magnification setting if it exceeds this range.

• The relationship between encoder pulse and angle depends on the galvano motor.

GM-1010

360° = 1000 pulses × 2048 divisions = 20480 00 pulses

1° = 2048000 pulses / 360° = 5689 pulses

At the monitor output position (0.091 V/pulse), the analog monitor output changes:

1° = 5689 × 0.091 = 517 mV

GM-1015

360° = 1500 pulses × 2048 divisions = 30720 00 pulses

1° = 3072000 pulses / 360 = 8533 pulses

At the monitor output position (0.091 V/pulse), the analog monitor output changes:

1° = 8533 × 0.091 = 777 mV

## 5.3. Digital Input-Output Function

The controller has a digital input-output function for checking the status of the controller.

| Pin No. | I/O | Signal Description | Logic | Explanation |
|---|---|---|---|---|
| A1 | Output | Axis 1 Error 1 (Priority high) | 1: Error | If an error occurs, the corresponding error signal is output.<br>According to the priority of the error, Error 1 or 2 is output.<br>See 9-2, “Errors.” |
| B1 | Output | Axis 1 Error 2 (Priority low) | 1: Error | |
| B2 | Output | Axis 2 Error 1 (Priority high) | 1: Error | |
| A3 | Output | Axis 2 Error 2 (Priority low) | 1: Error | |
| A2 | Output | Axis 1 servo interrupt period | Edge | These are output at a servo interrupt timing in the controller. |
| B3 | Output | Axis 2 servo interrupt period | Edge | |

# 6. Other - Operation Setting

## 6.1. Setting Controller Activation Mode

**Clock selection**

With the default settings at shipping, a parameter is set to activate the controller with the internal clock. When assembling the device, however, the mode can be switched for activation with an external clock (high-speed serial communication). For this switching, the following parameter is set:

| Parameter ID | Data |
|---|---|
| 64 | Bit 1 0: Internal clock<br>1: High-speed serial communication |

P64 = 1: Activation with internal clock

P64 = 3: Activation by high-speed serial communication

(Bit 0 of P64 is used to enable or disable encoder correction when homing to the origin; it is usually set to 1. For details, see 8-2, “Parameter Details.”)

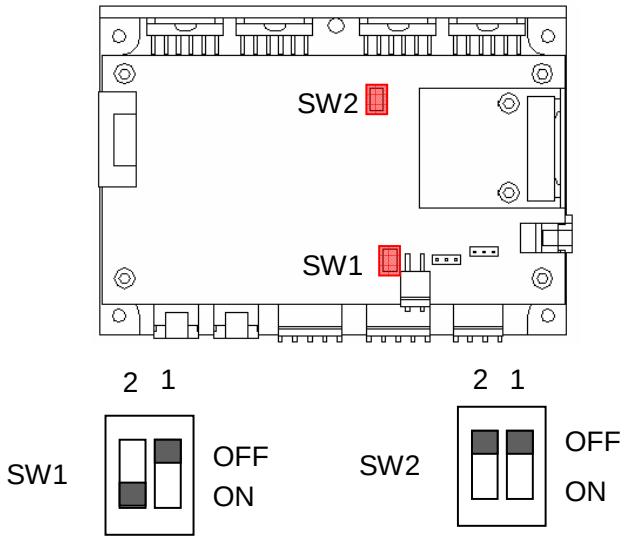
**Activation mode**

Power-on usually executes the following automatically:

- Reading parameters from EEPROM
- Starting homing and servo control

If there is a problem with the parameters read from EEPROM or if oscillation occurs when homing and servo control are executed automatically, the power-on activation mode can be changed.

For this switching, the switches (SW1 and SW2) on the controller board and the logic of the digital I/O terminal (A6) are combined.




Axis 1

| SW1-2 | Terminal A6 | Auto EEPROM Read | Auto Homing |
|---|---|---|---|
| OFF | 0 | Disabled | Disabled |
| OFF | 1 or open | Enabled | Disabled |
| ON | 0 | Enabled | Disabled |
| ON | 1 or open | Enabled | Enabled |

Axis 2

| SW2-2 | Terminal A6 | Auto EEPROM Read | Auto Homing |
|---|---|---|---|
| OFF | 0 | Disabled | Disabled |
| OFF | 1 or open | Enabled | Disabled |
| ON | 0 | Enabled | Disabled |
| ON | 1 or open | Enabled | Enabled |

: Setting at shipping

# 7. Commands

The controller has a monitor output (analog output) terminal for monitoring the RS-232C command operation status and an external signal input terminal for controller operation.

## 7.1. List of Commands

| ID | Command Name | Data | Data | Return Value |
|---|---|---|---|---|
| 0 | Soft Reset | Yes | 0: Auto homing<br>1: Reset only | KEL |
| 1 | Error Clear | | | |
| 2 | Homing Start | | | |
| 4 | Servo OFF | Yes | 0: OFF<br>1: ON | |
| 7 | Control Mode Specification | Yes | 0: PI<br>1: LQ | |
| 8 | Movement Start | Yes | 0: Ordinary<br>5,6: Scan | |
| 9 | Forced Stop | | | |
| 10 | Target Value Setting Mode | Yes | 0: Absolute<br>1: Relative | |
| 11 | Thermistor Temperature | Yes | 0: Controller temperature<br>1: Motor temperature | A/D converted value of thermistor voltage |
| 12 | Current Position Read | Yes | 0: Current position<br>1: Current target value (Program origin)<br>2: Current target value (Absolute position) | |
| 13 | Version Read | Yes | 0: Main DSP Ver<br>1: Sub DSP Ver | |
| 14 | Status Read | | | |
| 15 | Alarm Read | | | |
| 18 | Acceleration Control | Yes | 0: OFF<br>1: ON | |
| 20 | Target Position Setting | Yes | Target position (pulse) | |
| 22 | Target Velocity Setting | Yes | Target velocity (pulse/second) | |
| 23 | Operation Mode Setting | Yes | See “Command Details.” | |
| 24 | Monitor Output Selection | Yes | | |
| 26 | Parameter Value Check | Yes | Parameter ID | Parameter value |
| 30 | Program Coordinate System | Yes | 0: Z phase<br>1: Program origin | |
| 101 | Counter Clear Timing | Yes | 0: Axis 1<br>1: Axis 2 | 0 or 1 |

## 7.2. Command Details

| **Command ID** | 0 | **Command Name** | Soft Reset |
|---|---|---|---|
| **Data** | 0: Reset + automatic homing<br>1: Reset only | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | This command resets the system to the initial status after activation.<br>However, the parameter values are retained.<br>If a high-priority error requiring soft reset occurs (see 9-2, “Errors” for details), execute this command after solving the cause. | | |
| **Related Command** | Command ID = 2: Homing Start<br>If only reset is executed, homing is necessary for a return. | | |

| **Command ID** | 1 | **Command Name** | Error Clear |
|---|---|---|---|
| **Data** | - | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | If a low-priority error occurs (see 9-2, “Errors” for details), execute this command for a return. If this command is not executed, other commands cannot be accepted. The parameters and other set values are retained. | | |

| **Command ID** | 2 | **Command Name** | Homing Start |
|---|---|---|---|
| **Data** | - | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | This command detects the origin.<br>If the status is already SYNC after origin detection, this command executes homing to the origin only. | | |
| **Related Command** | Command ID = 0: Soft Reset<br>If only soft reset is executed, origin detection is necessary. | | |

| **Command ID** | 4 | **Command Name** | Servo ON |
|---|---|---|---|
| **Data** | 0: OFF<br>1: ON | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | This command starts or stops servo control.<br>Turning servo control off makes the motor axis free.<br>When the controller is operating on the internal clock, servo control starts at the servo ON position.<br>When the controller is operating on high-speed serial communication and a target position is entered, the scanner moves to the target position after the start of servo | | |

| | |
|---|---|
| | control. |

| | | | |
|---|---|---|---|
| **Command ID** | 7 | **Command Name** | Control Mode Specification |
| **Data** | 0: PI control<br>1: LQ control | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | LQ control is usually used. | | |

| | | | |
|---|---|---|---|
| **Command ID** | 8 | **Command Name** | Movement Start |
| **Data** | 0: Ordinary movement<br>6: Movement to the initial position of raster scan | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | After a target position is set, this command is executed to start movement.<br>Raster scan start position | | |
| **Related Command** | Step movement procedure<br>Command ID = 10: Target Value Setting Mode<br>Command ID = 20: Target Position Setting<br>Command ID = 8: Data = 0: Movement Start<br><br>Raster scan movement procedure<br>Parameter ID = 26: Raster Scan Interval<br>Parameter ID = 27: Raster Scan Duty Ratio<br>Parameter ID = 28: Raster Scan Oscillation Angle<br>Command ID = 8 Data = 6: Movement Start – Movement of the raster scan initial position<br>Command ID = 23 Data = 3: Scan Start<br>Command ID = 23 Data = 0: Scan Stop | | |

| | | | |
|---|---|---|---|
| **Command ID** | 9 | **Command Name** | Forced Stop |
| **Data** | - | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | This command is used for a stop before the target position during movement by Command ID = 8. | | |
| **Related Command** | Command ID = 8 Data = 0: Movement Start | | |

| **Command ID** | 10 | **Command Name** | Target Value Setting Mode |
|---|---|---|---|
| **Data** | 0: Absolute value<br>1: Relative value | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | This command is used to specify a position coordinate system for setting by “Command ID = 20: Target Position Setting.”<br>Before setting a target position, this command should be executed.<br>Absolute position: Position with the origin as 0<br>Relative position: Distance from the current position<br>This command should be executed each time a target position is set because its setting is not retained after the start of movement. | | |
| **Related Command** | Step movement procedure<br>Command ID = 10: Target Value Setting Mode<br>Command ID = 20: Target Position Setting<br>Command ID = 8 Data = 0: Movement Start | | |

| **Command ID** | 11 | **Command Name** | Thermistor Temperature Read |
|---|---|---|---|
| **Data** | 0: Controller temperature<br>1: Motor temperature | | |
| **Return Value** | Thermistor voltage A/D converted value | | |
| **Explanation** | | | |

| **Command ID** | 12 | **Command Name** | Current Position Read |
|---|---|---|---|
| **Data** | 0: Current position<br>1: Current target value (Program origin)<br>2: Current target value (Absolute position) | | |
| **Return Value** | Position (Pulse) | | |
| **Explanation** | Command ID = 30: Program Coordinate System | | |

| **Command ID** | 13 | **Command Name** | Version Read |
|---|---|---|---|
| **Data** | 0: Main DSP<br>1: Sub DSP | | |
| **Return Value** | Ver. No | | |
| **Explanation** | | | |

| **Command ID** | 14 | **Command Name** | Status Read |
|---|---|---|---|
| **Data** | - | | |
| **Return Value** | Status (16 bits) | | |

**Explanation**

| Bit | Abbreviation | Meaning | Hex Format |
|---|---|---|---|
| 0 | SRVON | Servo ON | 0x0001 |
| 1 | SYNC | Counter 0-position confirmed | 0x0002 |
| 2 | INPOS | Settlement in in-position range | 0x0004 |
| 3 | ALARM | Error | 0x0008 |
| 4 | ORGN | Homing to origin | 0x0010 |
| 5 | PROG | Program coordinate setting | 0x0020 |
| 6 | | | |
| 7 | | | |
| 8 | MOVE | Moving (including scan) | 0x0100 |
| 9 | CMODE | Control mode 0: PI 1: LQ | 0x0200 |
| 10 | WARN | Encoder signal warning | 0x0400 |
| 11 | | | |
| 12 | TARGET | Target position 0: Absolute position 1: Relative position | 0x1000 |
| 13 | ACC | Acceleration control 0: OFF 1: ON | 0x2000 |
| 14 | SETPOS | Target position set | 0x4000 |
| 15 | | | |

| **Related Command** | |
|---|---|

| **Command ID** | 15 | **Command Name** | Error Read |
|---|---|---|---|
| **Data** | | | |
| **Return Value** | Error (16 bits) | | |
| **Explanation** | | | |

| Bit | Abbreviation | Meaning | Hex Format |
|---|---|---|---|
| 0 | STRK | Stroke over | 0x0001 |
| 1 | CNT | Counter over | 0x0002 |
| 2 | INP | In-position overtime | 0x0004 |
| 3 | SRV | No clock | 0x0008 |
| 4 | CUR | Driver overheat | 0x0010 |
| 5 | HOT | Motor overheat | 0x0020 |
| 6 | FOM | Format error | 0x0040 |
| 7 | COM | Command data error | 0x0080 |
| 8 | PAR | Parameter error | 0x0100 |
| 9 | STA | Status error | 0x0200 |
| 10 | TRN | Communication error | 0x0400 |
| 11 | ORG | Homing error | 0x0800 |
| 12 | ENC | Encoder signal error | 0x1000 |
| 13 | OTP | Out-position error | 0x2000 |
| 14 | CMPER | Servo OFF by hardware | 0x4000 |
| 15 | ETC | Current saturation | 0x0800 |

| **Command ID** | 18 | **Command Name** | Acceleration Control |
|---|---|---|---|
| **Data** | 0: OFF<br>1: ON | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | | | |

| **Command ID** | 20 | **Command Name** | Target Position Setting |
|---|---|---|---|
| **Data** | Target position (Pulse) | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | This command is used to set a target position by step movement. | | |
| **Related Command** | Step movement procedure<br>Command ID = 10: Target Value Setting Mode<br>Command ID = 20: Target Position Setting<br>Command ID = 8 Data = 0: Movement Start | | |

| **Command ID** | 22 | **Command Name** | Target Velocity Setting |
|---|---|---|---|
| **Data** | Target velocity (Unit: pulse/s) | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | This command is used to set the maximum velocity of step movement.<br>The velocity cannot be higher than “Parameter ID = 2: Maximum velocity.”<br>If this command is not set, the velocity specified by “Parameter ID = 2: Maximum velocity” is used. | | |
| **Related Command** | Step movement procedure<br>Command ID = 22 Target Velocity Setting<br>Command ID = 10: Target Value Setting Mode<br>Command ID = 20: Target Position Setting<br>Command ID = 8 Data = 0: Movement Start | | |

| **Command ID** | 23 | **Command Name** | Operation Mode Selection |
|---|---|---|---|
| **Data** | 0: Raster scan stop<br>3: Raster scan start<br>6:<br>7: High-speed serial communication mode | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | 0: Raster scan stop<br>If this command is sent during a raster scan, the scanner stops after moving to the scan start position.<br>This command is also used for a return from high-speed serial communication mode to internal clock mode.<br><br>3: Raster scan start<br>Raster scan starts after step movement to the scan start position.<br><br>7: High-speed serial communication mode<br>This command switches the mode to high-speed serial communication. However, high-speed serial communication signals should be input in advance. | | |
| **Related Command** | Raster scan movement procedure<br>Parameter ID = 26: Raster Scan Interval<br>Parameter ID = 27: Raster Scan Duty Ratio<br>Parameter ID = 28: Raster Scan Oscillation Angle<br>Command ID = 8 Data = 6: Movement Start — Movement of the raster scan initial position<br>Command ID = 23 Data = 3: Scan Start<br>Command ID = 23 Data = 0: Scan Stop | | |

| **Command ID** | 24 | **Command Name** | Monitor Output Selection |
|---|---|---|---|

| | |
|---|---|
| **Data** | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful |
| **Explanation** | |

| **Command ID** | 26 | **Command Name** | Parameter Value Check |
|---|---|---|---|
| **Data** | Parameter ID | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | This command returns the parameter setting of Data ID. | | |

| **Command ID** | 30 | **Command Name** | Program Coordinate System |
|---|---|---|---|
| **Data** | 0: Z phase<br>1: Program | | |
| **Return Value** | 0: Command execution successful<br>1: Command execution unsuccessful | | |
| **Explanation** | For a raster scan, the center of the oscillation angle can be changed.<br>0: Z phase; Set the Z-phase position as the center. This setting is in the default after activation.<br>1: Program; Set the current position as the center.<br>When setting the program origin, move once to the desired center and then specify the position by this command. | | |

| **Command ID** | 101 | **Command Name** | Counter Clear Timing |
|---|---|---|---|
| **Data** | 0: Head 1<br>1: Head 2 | | |
| **Return Value** | Timing 0 or 1 | | |
| **Explanation** | | | |

# 8. Parameters

## 8.1. List of Parameters

| ID | Parameter Name |
|---|---|
| 0 | CW Limit |
| 1 | CCW Limit |
| 2 | Max Velocity |
| 3 | In-position Width |
| 4 | Settling Check Time |
| 5 | In-position Overtime |
| 6 | LQ Control Gain |
| 7 | Torque Constant |
| 8 | Total Inertia |
| 9 | Current Limit |
| 10 | Encoder Periodicity |
| 11 | Sampling Time |
| 12 | Origin Clearance Timing (Head 1) |
| 13 | High-speed Serial Communication Conversion Gain |
| 14 | Origin Clearance Timing (Head 2) |
| 16 | First Digital Notch Filter Central Frequency |
| 17 | Q Value of First Digital Notch Filter |
| 18 | First Digital Notch Filter Depth |
| 19 | Second Digital Notch Filter Central Frequency |
| 20 | Second Digital Notch Filter Q Value |
| 21 | Second Digital Notch Filter Depth |
| 22 | Cutoff Frequency of Digital Low-pass Filter |
| 23 | First Analog Notch Filter Central Frequency |
| 24 | Second Analog Notch Filter Central Frequency |
| 25 | Third Analog Notch Filter Central Frequency |
| 26 | Raster Scan Interval |
| 27 | Raster Scan Duty Ratio |
| 28 | Raster Scan Oscillation Angle |
| 29 | Internal Generation Acceleration Percentage |
| 30 | Raster Scan Wait Time |
| 31 | Raster Scan Start Position |
| 32 | Z-phase Offset |
| 33 | Acceleration Time |
| 34 | Deceleration Time |
| 36 | Out-position Width |
| 40 | Feed-forward Gain |
| 42 | Pole Rearrangement |
| 44 | Deviation Limit |

| | |
|---|---|
| 48 | Encoder VR adjustment Head 1 A/B-phase Offset |
| 49 | Encoder VR adjustment Head 1 A-phase Amplitude |
| 50 | Encoder VR adjustment Head 1 B-phase Amplitude |
| 51 | Encoder VR adjustment Head 2 A/B-phase Offset |
| 52 | Encoder VR adjustment Head 2 A-phase Amplitude |
| 53 | Encoder VR adjustment Head 2 B-phase Amplitude |
| 64 | DSP Operation Setting |

## 8.2. Parameter Details

| **Parameter ID** | 0 | **Parameter Name** | CW Limit |
|---|---|---|---|
| **Data** | Movable range (Unit: pulse) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | Specify the limit of the clockwise movable range viewed from the axial direction of the motor.<br>In case of input or movement beyond the movable range of angle, an error is output.<br>Note: The relationship between the number of pulses and the angle depends on the motor. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 1 | **Parameter Name** | CCW Limit |
|---|---|---|---|
| **Data** | Movable range (Unit: pulse) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | Specify the limit of the counterclockwise movable range viewed from the axial direction of the motor.<br>In case of input or movement beyond the movable range of angle, an error is output.<br>Note: The relationship between the number of pulses and the angle depends on the motor. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 2 | **Parameter Name** | Max Velocity |
|---|---|---|---|
| **Data** | Maximum velocity (Unit: pulse/s) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to specify step movement by command execution.<br>This maximum velocity applies if “Command ID = 22: Target Velocity Setting” is not set.<br>Note: The relationship between the number of pulses and the angle depends on the motor. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 3 | **Parameter Name** | In-position Width |
|---|---|---|---|
| **Data** | In-position width (Unit: pulse) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | The end of movement is judged when a difference from the target value (number of pulses) enters this range.<br>Note: The relationship between the number of pulses and the angle depends on the motor. | | |
| **Related Command /Parameter** | Bit 2 “Settlement in In-position Width” becomes 1 in status read (Command ID = 14). | | |

| **Parameter ID** | 4 | **Parameter Name** | Settling Check Time |
|---|---|---|---|
| **Data** | Settling check time (Unit: 10 µs) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | The completion of movement is judged if the position remains within the In-position Width (Parameter ID = 3) for the set time after movement.<br>Note: The unit is 10 us. For 1 ms, set 100. | | |
| **Related Command /Parameter** | Bit 8 “Moving” becomes 0 in status read (Command ID = 14). | | |

| **Parameter ID** | 5 | **Parameter Name** | In-position Overtime |
|---|---|---|---|
| **Data** | In-position overtime (Unit: sec) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | If the position remains beyond the number of pulses set by “Parameter ID = 3: In-position Width” from the target position for a time longer than this setting, an alarm is issued and the servo is turned OFF.<br>When this parameter is set to 0, judgment is disabled. | | |
| **Related Command /Parameter** | Bit 2 “Moving” becomes 0 in error read (Command ID = 15). | | |

| **Parameter ID** | 6 | **Parameter Name** | LQ Control Gain |
|---|---|---|---|
| **Data** | LQ control gain (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the LQ control gain. | | |
| **Related Command /Parameter** | LQ control related parameters:<br>Total Inertia (Parameter ID = 8)<br>Torque Constant (Parameter ID = 7) | | |

| **Parameter ID** | 7 | **Parameter Name** | Torque Constant |
|---|---|---|---|
| **Data** | Torque constant (Unit: gf•cm / A) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the torque constant of the motor.<br>Note: Do not change this parameter. A unique value is available depending on the motor model. This is set at shipping. | | |
| **Related Command /Parameter** | LQ control related parameters<br>LQ Control Gain (Parameter ID = 6)<br>Total Inertia (Parameter ID = 8) | | |

| **Parameter ID** | 8 | **Parameter Name** | Total Inertia |
|---|---|---|---|
| **Data** | Total inertia (Unit: 0.01 gf•cm$^2$) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the inertia due to the motor rotation shaft and the mirror.<br>Note: Be careful about the unit. Set a value of gf•cm$^2$ multiplied by 100. | | |
| **Related Command /Parameter** | LQ control related parameters:<br>LQ Control Gain (Parameter ID = 6)<br>Torque Constant (Parameter ID = 8) | | |

| **Parameter ID** | 9 | **Parameter Name** | Current Limit |
|---|---|---|---|
| **Data** | Current limit (Unit: %) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the upper limit of a current command value. (Setting for each axis as a ratio to 10A)<br>E.g.: 90% (10A × 0.9 = 9A)<br>If the current remains over the upper limit for a specified time, a current saturation error occurs. | | |
| **Related Command /Parameter** | Bit 5 “Current Saturation” becomes 1 in error read (Command ID = 15). | | |

| **Parameter ID** | 10 | **Parameter Name** | Encoder Periodicity |
|---|---|---|---|
| **Data** | Encoder periodicity (Unit: pulse) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the number of pulses per rotation of the motor encoder.<br>GM-1010: 1000 pulses<br>GM-1015: 1500 pulses<br>Whenever the motor model is changed, the setting of this parameter should be changed. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 11 | **Parameter Name** | Sampling Time |
|---|---|---|---|
| **Data** | Sampling period (Unit: ns) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the sampling interval of the controller.<br>The usual value is 10000 for 10 μs.<br>Note: This parameter usually requires no change. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 12 | **Parameter Name** | Origin Clearance Timing (Head 1) |
|---|---|---|---|
| **Data** | Origin clearance timing (0 or 1) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is related to origin detection.<br>The value checked by “Command ID = 101: Counter Clear Timing” is set.<br>Each motor has a unique value.<br>Note: An appropriate value is set at shipping. When only the motor is replaced, the value should be checked and set by a command.<br>The Origin Clearance Timing (Head 2) parameter should be set at the same time. | | |
| **Related Command /Parameter** | Counter Clear Timing (Command ID = 101)<br>A1C101/ 0 (Axis 1 Head 1)<br>Set the value checked above. | | |

| **Parameter ID** | 13 | **Parameter Name** | High-speed Serial Communication Conversion Gain |
|---|---|---|---|
| **Data** | High-speed serial communication conversion gain (Unit: Multiple × 1000) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | High-speed serial communication data is specified by 16 bits.<br>Ordinary data is 1 for one pulse and can be specified up to the following positions:<br>Maximum position: 0xFFFF = 32767 pulses = About 5.76 deg (GM-1010)<br>0-pulse position: 0x8000 = 0<br>Minimum position: 0x0000 = –32768 pulses = About –5.76 deg (GM-1010)<br><br>If a greater angle is specified, set a magnification by using the high-speed serial communication conversion gain (Parameter ID = 13).<br>E.g. For x2 (Setting: 2000), the following angle can be specified:<br>–5.76×2 deg to –5.76×2 deg<br>The command resolution will be two times. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 14 | **Parameter Name** | Origin Clearance Timing (Head 2) |
|---|---|---|---|
| **Data** | Origin clearance timing (0 or 1) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is related to origin detection.<br>The value checked by “Command ID = 101: Counter Clear Timing” is set.<br>Each motor has a unique value (0 or 1).<br>Note: An appropriate value is set at shipping. When only the motor is replaced, the value should be checked and set by a command.<br>The Origin Clearance Timing (Head 1) parameter should be set at the same time. | | |
| **Related Command /Parameter** | Counter Clear Timing (Command ID = 101)<br>A1C101/ 1 (Axis 1 Head 2)<br>Set the value checked above. | | |

| **Parameter ID** | 16 | **Parameter Name** | First Digital Notch Filter Central Frequency |
|---|---|---|---|
| **Data** | Central frequency of the first digital notch filter (Unit: Hz) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the central frequency of the first digital notch filter. | | |
| **Related Command /Parameter** | First Digital Notch Filter Q Value (Parameter ID = 17)<br>First Digital Notch Filter Depth (Parameter ID = 18) | | |

| **Parameter ID** | 17 | **Parameter Name** | First Digital Notch Filter Q Value |
|---|---|---|---|
| **Data** | Q value of the first digital notch filter (Unit: ×100) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the Q value of the first digital notch filter.<br>Set a value multiplied by 100. | | |
| **Related Command /Parameter** | First Digital Notch Filter Central Frequency (Parameter ID = 16)<br>First Digital Notch Filter Depth (Parameter ID = 18) | | |

| **Parameter ID** | 18 | **Parameter Name** | First Digital Notch Filter Depth |
|---|---|---|---|
| **Data** | Depth of the first digital notch filter (Unit: dB) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the depth of the first digital notch filter. | | |
| **Related Command /Parameter** | First Digital Notch Filter Central Frequency (Parameter ID = 16)<br>First Digital Notch Filter Q Value (Parameter ID = 17) | | |

| **Parameter ID** | 19 | **Parameter Name** | Second Digital Notch Filter Central Frequency |
|---|---|---|---|
| **Data** | Central frequency of the second digital notch filter (Unit: Hz) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the central frequency of the second digital notch filter. | | |
| **Related Command /Parameter** | Second Digital Notch Filter Q Value (Parameter ID = 17)<br>Second Digital Notch Filter Depth (Parameter ID = 18) | | |

| **Parameter ID** | 20 | **Parameter Name** | Second Digital Notch Filter Q Value |
|---|---|---|---|
| **Data** | Second digital notch filter Q value (Unit: ×100) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the Q value of the second digital notch filter.<br>Set a value multiplied by 100. | | |
| **Related Command /Parameter** | Second Digital Notch Filter Central Frequency (Parameter ID = 16)<br>Second Digital Notch Filter Depth (Parameter ID = 18) | | |

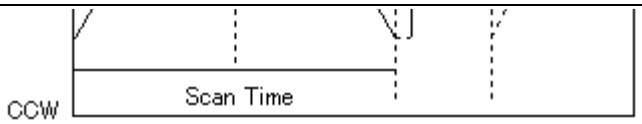
| **Parameter ID** | 21 | **Parameter Name** | Second Digital Notch Filter Depth |
|---|---|---|---|
| **Data** | Depth of the second digital notch filter (Unit: dB) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the depth of the second digital notch filter. | | |
| **Related Command /Parameter** | Second Digital Notch Filter Central Frequency (Parameter ID = 16)<br>Second Digital Notch Filter Q Value (Parameter ID = 17) | | |

| **Parameter ID** | 22 | **Parameter Name** | Digital Low-pass Filter Cutoff Frequency |
|---|---|---|---|
| **Data** | Cutoff frequency of the digital low-pass filter (Unit: Hz) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the cutoff frequency of the digital low-pass filter. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 23 | **Parameter Name** | First Analog Notch Filter Central Frequency |
|---|---|---|---|
| **Data** | Central frequency of the first analog notch filter (Unit: Hz) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the central frequency of the first analog notch filter.<br>The setting range is from 9750 to 42820 Hz. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 24 | **Parameter Name** | Second Analog Notch Filter Central Frequency |
|---|---|---|---|
| **Data** | Central frequency of the second analog notch filter (Unit: Hz) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the central frequency of the second analog notch filter.<br>The setting range is from 9750 to 42820 Hz. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 25 | **Parameter Name** | Third Analog Notch Filter Central Frequency |
|---|---|---|---|
| **Data** | Central frequency of the third analog notch filter (Unit: Hz) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the central frequency of the third analog notch filter.<br>The setting range is from 9750 to 42820 Hz. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 26 | **Parameter Name** | Raster Scan Interval |
|---|---|---|---|
| **Data** | Raster scan interval (Unit: See Explanation.) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This comman<br>The interval is<br>E.g. For the ir<br>  <br> | | ımand). |
| **Related Command /Parameter** | Raster Scan Duty Ratio (Parameter ID = 27)<br>Raster Scan Oscillation Angle (Parameter ID = 28)<br>Raster Scan Wait Time (Parameter ID = 30)<br>Raster Scan Start Position (Parameter ID = 31) | | |

| **Parameter ID** | 27 | **Parameter Name** | Raster Scan Duty Ratio |
|---|---|---|---|
| **Data** | Raster scan duty ratio (Unit: %) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the duty ratio of raster scan (operation by command).<br>(See Explanation of Parameter ID = 26.) | | |
| **Related Command /Parameter** | Raster Scan Interval (Parameter ID = 26)<br>Raster Scan Oscillation Angle (Parameter ID = 28)<br>Raster Scan Wait Time (Parameter ID = 30)<br>Raster Scan Start Position (Parameter ID = 31) | | |

| **Parameter ID** | 28 | **Parameter Name** | Raster Scan Oscillation Angle |
|---|---|---|---|
| **Data** | Raster scan oscillation angle (Unit: degree × 10000) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the oscillation angle of raster scan (operation by command).<br>(See Explanation of Parameter ID = 26.)<br>Set the oscillation angle × 10000.<br>For ±5°, set 50000 (5 × 10000). | | |
| **Related Command /Parameter** | Raster Scan Interval (Parameter ID = 26)<br>Raster Scan Duty Ratio (Parameter ID = 27)<br>Raster Scan Wait Time (Parameter ID = 30)<br>Raster Scan Start Position (Parameter ID = 31) | | |

| **Parameter ID** | 30 | **Parameter Name** | Raster Scan Wait Time |
|---|---|---|---|
| **Data** | Raster scan wait time (Unit: second × 100) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the wait time of raster scan (operation by command).<br>(See Explanation of Parameter ID = 26.)<br>Set the wait time (sec) × 100.<br>For 0.1 sec, set 10 (0.1 × 100). | | |
| **Related Command /Parameter** | Raster Scan Interval (Parameter ID = 26)<br>Raster Scan Duty Ratio (Parameter ID = 27)<br>Raster Scan Oscillation Angle (Parameter ID = 28)<br>Raster Scan Start Position (Parameter ID = 31) | | |

| **Parameter ID** | 31 | **Parameter Name** | Raster Scan Start Position |
|---|---|---|---|
| **Data** | Raster scan start position (Unit: 0 or 1) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the start of raster scan (operation by command) from the negative or positive side.<br>0: Scan start from the negative side<br>1: Scan start from the positive side | | |
| **Related Command /Parameter** | Raster Scan Interval (Parameter ID = 26)<br>Raster Scan Duty Ratio (Parameter ID = 27)<br>Raster Scan Oscillation Angle (Parameter ID = 28)<br>Raster Scan Wait Time (Parameter ID = 30) | | |

| **Parameter ID** | 32 | **Parameter Name** | Z-phase Offset |
|---|---|---|---|
| **Data** | Z-phase (0-point position) offset value (Unit: pulse) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set an offset from the actual Z-phase position for determining the 0-pulse position. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 33 | **Parameter Name** | Acceleration Time |
|---|---|---|---|
| **Data** | Acceleration time (Unit: ms) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is valid when “Command ID = 18: Acceleration Control” is ON.<br>Set the time until the velocity reaches the value set by “Parameter ID = 2: Max Velocity” in step movement (movement by command).<br>If 0 is set, the target command of the maximum velocity is followed from the start of movement. | | |
| **Related Command /Parameter** | Acceleration control (Command ID = 18)<br>Maximum velocity (Parameter ID = 2)<br>Movement start (Command ID = 8) | | |

| **Parameter ID** | 34 | **Parameter Name** | Deceleration Time |
|---|---|---|---|
| **Data** | Deceleration time (Unit: ms) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the deceleration time for a stop by “Command ID = 9: Forced Stop.” | | |
| **Related Command /Parameter** | Forced Stop (Command ID = 9) | | |

| **Parameter ID** | 36 | **Parameter Name** | Out-position |
|---|---|---|---|
| **Data** | Out-position (Unit: pulse) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | An error is output if a difference from the target value exceeds the setting of this parameter becoming static.<br>Setting 0 is invalid. | | |
| **Related Command /Parameter** | Bit 13 “Current Saturation” becomes 1 in error read (Command ID = 15). | | |

| **Parameter ID** | 40 | **Parameter Name** | Feed-forward Gain |
|---|---|---|---|
| **Data** | Feed-forward gain (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the feed-forward gain. This is usually set at shipping.<br>Setting 0 disables feed-forward. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 42 | **Parameter Name** | Pole Rearrangement |
|---|---|---|---|
| **Data** | Pole rearrangement (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set pole rearrangement. This is usually set at shipping.<br>Setting 100 disables pole rearrangement. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 44 | **Parameter Name** | Deviation Limit |
|---|---|---|---|
| **Data** | Deviation limit (Unit: pulse) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | If a deviation from the target value is great, an excess current usually flows, causing a current saturation error.<br>Make adjustments so that the controller will not deviate beyond this setting.<br>Note: This is usually set appropriately at shipping. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 48 | **Parameter Name** | Encoder VR Adjustment<br>Head 1 A/B-phase Offset |
|---|---|---|---|
| **Data** | A/B-phase offset of encoder VR adjustment head 1 (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to adjust the offset of encoder signal.<br>Note: This is usually set appropriately at shipping. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 49 | **Parameter Name** | Encoder VR Adjustment<br>Head 1 A-phase Amplitude |
|---|---|---|---|
| **Data** | A-phase amplitude of encoder VR adjustment head 1 (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to adjust the A-phase amplitude of the encoder signal.<br>Note: This is usually set appropriately at shipping. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 50 | **Parameter Name** | Encoder VR Adjustment<br>Head 1 B-phase Amplitude |
|---|---|---|---|
| **Data** | B-phase amplitude of encoder VR adjustment head 1 (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to adjust the B-phase amplitude of the encoder signal.<br>Note: This is usually set appropriately at shipping. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 51 | **Parameter Name** | Encoder VR Adjustment<br>Head 2 A/B-phase Offset |
|---|---|---|---|
| **Data** | A/B-phase offset of encoder VR adjustment head 2 (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to adjust the offset of encoder signal.<br>Note: This is usually set appropriately at shipping. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 52 | **Parameter Name** | Encoder VR Adjustment<br>Head 2 A-phase Amplitude |
|---|---|---|---|
| **Data** | A-phase amplitude of encoder VR adjustment head 2 (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to adjust the A-phase amplitude of the encoder signal.<br>Note: This is usually set appropriately at shipping. | | |
| **Related Command /Parameter** | | | |

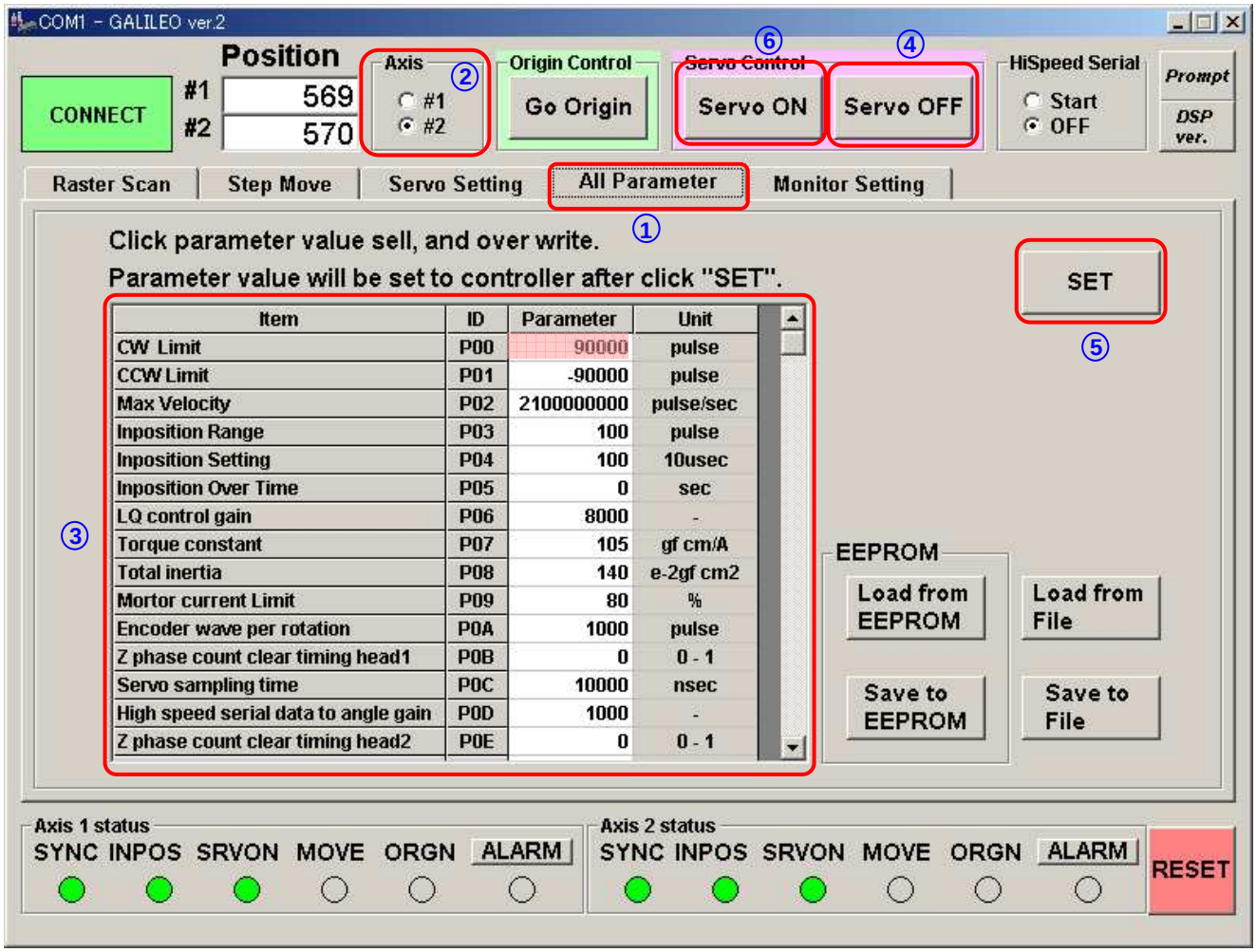
| **Parameter ID** | 53 | **Parameter Name** | Encoder VR Adjustment<br>Head 2 B-phase Amplitude |
|---|---|---|---|
| **Data** | B-phase amplitude of encoder VR adjustment head 2 (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to adjust the B-phase amplitude of the encoder signal.<br>Note: This is usually set appropriately at shipping. | | |
| **Related Command /Parameter** | | | |

| **Parameter ID** | 64 | **Parameter Name** | DSP Operation Setting |
|---|---|---|---|
| **Data** | DSP operation setting (Unit: none) | | |
| **Return Value** | 0: Parameter setting successful<br>1: Parameter setting unsuccessful | | |
| **Explanation** | This parameter is used to set the activation mode. Each bit has a meaning.<br><br>Bit 0 0: No automatic encoder correction at homing to the origin<br>1: Automatic encoder correction at homing to the origin<br><br>Bit 1 0: Activation in internal clock mode<br>1: Activation in high-speed serial communication (external clock) mode<br><br>Bit 1 0: High-speed serial communication specification (XY2-100) (Usually 0)<br><br>Note: The setting is decimal. | | |
| **Related Command /Parameter** | | | |

## 8.3. Modifying Parameters

This section explains how to modify parameters.

### GALILEO




- Select the All Parameter tab. ①
- Select an axis for parameter settings. ②
- The current parameter values are displayed. ③
- Modify the parameter values as required. When a parameter value is modified, its cell turns red. ③
- Turn the servo OFF (necessary for modifying parameters). ④
- Press the SET button to reflect modified parameters in the controller settings. ⑤
- Turn the servo ON. ⑥

Note: Pressing the SET button reflects modified parameters in the controller settings but does not write them into the controller ROM. When the power is turned off and on again, the controller starts with the old parameters read from ROM. See 8-4 for writing modified parameters into ROM.

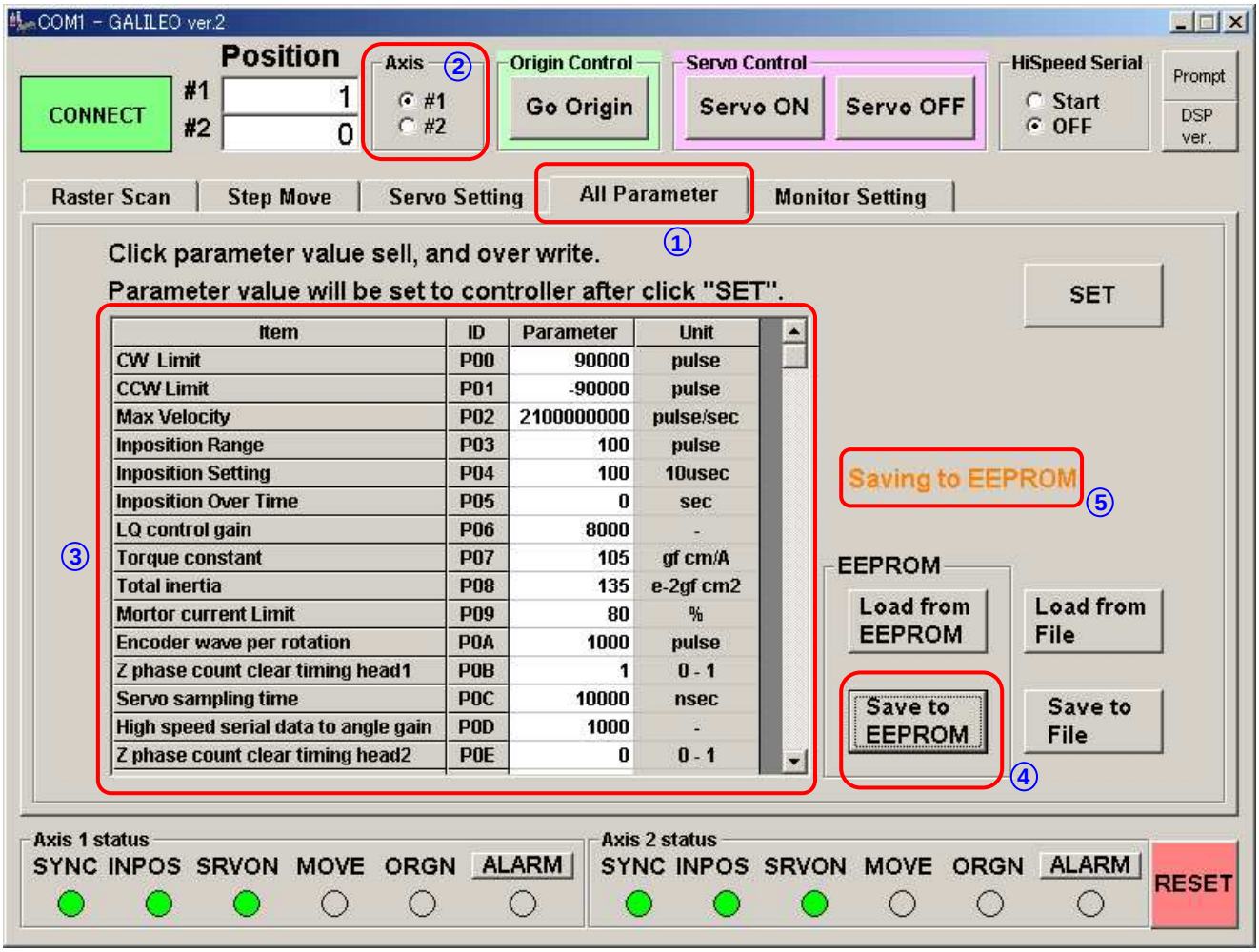
## 8.4. Writing Parameters into ROM

All parameters are written in the controller ROM. At activation, the parameters are automatically read and set in the controller.

If parameters are modified, they should be written into ROM for activation with the same settings at the next power-on.

Write modified parameters into ROM as follows:

**GALILEO**




- Select the All Parameter tab.①
- Select an axis for parameter settings.②
- The current parameter values are displayed.③
- Press the Save to EEPROM button.④
- “Saving to EEPROM” is displayed. ⑤

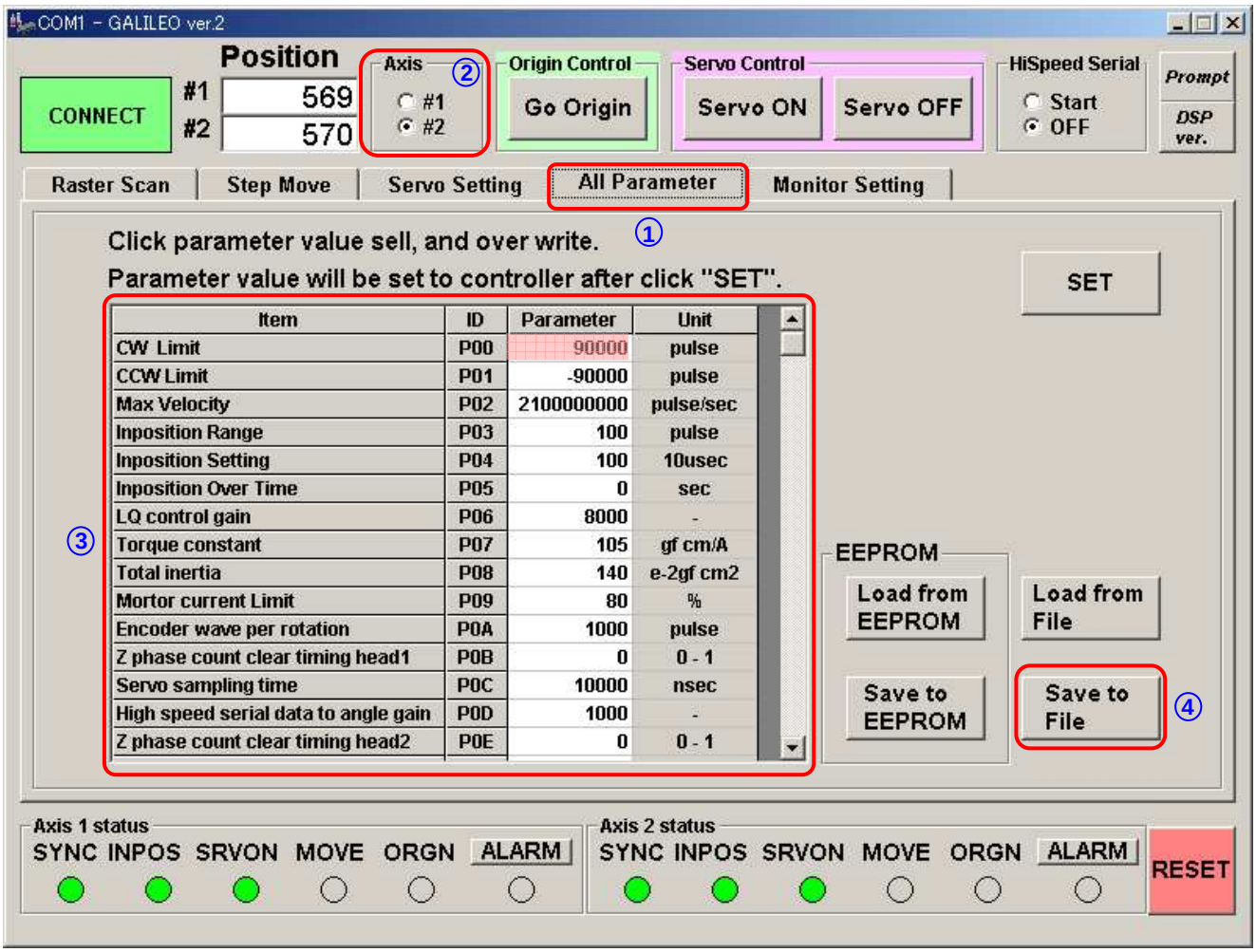
Note: Some parameter settings may disable normal activation next time.

If this problem occurs, change the activation mode for no automatic homing to the origin and check the set values. (See 6-1, “Setting Controller Activation Mode.”)

## 8.5. Saving a Parameter File

All parameters can be saved into a PC file.

Save a parameter file as follows:




- Select the All Parameter tab.①
- Select an axis for parameter settings.②
- The current parameter values are displayed.③
- Press the Save to File button. Specify a location and save the file.④

# 9. Safety Functions

This system has various safety functions to ensure safe use.

## 9.1. Safety Functions

The safety functions can be classified into hardware monitoring and software monitoring.

**Hardware monitoring**

- Power supply fuse +24 V line (each axis)
  +5 V line
- Output amplifier overheat Temperature monitoring by thermistor (abut 80ºC)
- Motor overheat Temperature monitoring by thermistor (abut 75ºC)

(If output amplifier or motor overheat is detected, the amplifier output is shut down.)

- Output amplifier IC Shutdown function

**Software monitoring**

The controller status is always monitored by software and error notification is made if an abnormality occurs.

Depending on the error type (priority), digital monitor I/O (2 bits) is used for this notification.

The details of an error can be checked by an RS-232C command.

See 9-2 for the error contents.

Note: The post-error system status and recovery method depend on the priority of the error.
See 9-2, “Errors.”

## 9.2. Errors

**Priority: High**

| Error | Hex | Monitor Item | Error Condition | Setting Change Possible /Impossible (Parameter) | Post-error System Status | Digital Output | Recovery Method |
|---|---|---|---|---|---|---|---|
| Stroke over | 0x0001 | Encoder pulse count | The encoder count is outside the range set by parameters P00 (CW Limit) and P01 (CCW Limit). | Possible (P00, P01) | Error output Servo OFF | D1 (Each axis) | Soft reset (C00) + Homing (C02) or Power-off/on |
| Counter over | 0x0002 | Velocity (calculated from encoder pulses) | The velocity exceeds the setting by P02 (Maximum Velocity). | Possible (P02) | | | |
| In-position overtime | 0x0004 | Encoder pulse count | The accumulated time based on the setting of P03 (In-position Width) exceeds the setting of P05 (In-position Overtime). | Possible (P03, P05) | | | |
| No clock | 0x0008 | Clock | Clock pulses are not input. | Impossible | | | |
| Driver overheat | 0x0010 | A/D value of thermistor at controller output amplifier | The driver temperature exceeds the A/D value corresponding to 70ºC. (Software monitoring) | Impossible | | | |
| Motor overheat | 0x0020 | A/D value of thermistor at motor coil | The motor temperature exceeds the A/D value corresponding to 70ºC. (Software monitoring) | Impossible | | | |
| Homing error | 0x0800 | Homing to the origin | Homing is not completed normally. | Impossible | | | |
| Encoder signal error | 0x1000 | Encoder signal level at homing to origin | An encoder signal is abnormal. | Impossible | | | |
| Hardware servo OFF | 0x4000 | Output amplifier shutdown function Thermistor (controller and motor) | The output amplifier is shut down. The thermistor-detected temperature exceeds the setting. (Hardware monitoring). Error notification by software is usually made first. | Impossible | | | |
| Current saturation | 0x8000 | Output current command | Current saturation (10A×P09 (Current limit)) continues for a specified time or longer. | Possible (P09) | | | |

**Priority: Low**

| Error | Hex | Monitor Item | Error Condition | Setting Change Possible /Impossible (Parameter) | Post-error System Status | Digital Output | Recovery Method |
|---|---|---|---|---|---|---|---|
| Format error | 0x0040 | Command format | An undefined command or parameter is sent. | Impossible | Error output only | D2 (Each axis) | Error clearance (C01) |
| Command data error | 0x0080 | Command data | Command data is illegal.<br>No data is given to a command requiring data.<br>Data is given to a command requiring no data.<br>Data outside the setting range is set. | Impossible | | | |
| Parameter error | 0x0100 | Parameter value | A parameter value is beyond the setting range. | Impossible | | | |
| Status error | 0x0200 | Command description | A command not valid for the current status is sent. | Impossible | | | |
| Communication error | 0x0400 | Communication flag | Communication flag time-out occurs. | Impossible | | | |
| Out-position error | 0x2000 | Encoder pulse count | The setting of P24 (Out-position Width) is exceeded. | Possible (P24) | | | |

**CANON USA., INC.**
**New York Office**
One Canon Plaza Lake Success, NY 11042
Phone : +1-516-328-4611, Fax : +1-516-328-4601

**San Jose Office**
3300 North First Street San Jose, CA 95134
Phone : +1-408-468-2211, Fax : +1-408-468-2219

**CANON PRECISION INC.**
c/o Canon Europa N.V.
Bovenkerkerweg 59-61, P.O.BOX 2262
1180 EG Amsterveen, The Netherlands
Phone : +31-20-545-8587, Fax :+31-20-545-8204

**CANON MARKETING JAPAN INC.**
2-16-2, Kounan, Minato-ku, Tokyo
108-8011, Japan
Phone : +81-3-3740-3336 Fax :+81-3-3740-3356

**CANON INC.**
20-2, Kiyohara-Kogyodanchi, Utsunomiya-shi,
Tochigi-ken, 321-3292, Japan
Phone : +81-28-667-5164, Fax :+81-28-667-9587

**The contents of this document may change without prior notice.**
**If you find any question, error, or omission in this document, please contact Canon.**

CUD-L006-E01  PRINTED IN JAPAN