

High Performance Multifunction Programmable

Two-Axis/Four-Axis Stage Controller

SHOT-202 SHOT-204MS

— Full-Closed Loop Control —



User's Manual



SIGMA KOKI CO., LTD.

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For Your Safety

- Before using this product, read this manual and all warnings or cautions in the documentation provided.
- Only Factory Authorized Personnel should be changes and/or adjust the parts of controller.

The Symbols Used in This Manual

 WARNING	 CAUTION
This symbol marks warnings that should be read and used to prevent serious injury or death.	This symbol indicates where caution should be used to avoid possible injury to yourself or others, or damage to property.

The above indications are used together with the following symbols to indicate the exact nature of the warning or caution.

Examples of Symbols Accompanying Warnings and Cautions	
	△ Symbols enclosed in a triangle indicate warnings and cautions. The exact nature of the warning or caution is indicated by the symbol inside (the symbol at left indicates risk of electrocution).
	○ Symbols enclosed in a circle mark indicate prohibitions (actions that must not be performed). The exact nature of the prohibition is indicated by the symbol inside or next to the circle mark (the symbol at left indicates that the product must not be disassembled).
	● Symbols inside a black circle mark actions that must be performed to ensure safety. The exact nature of the action that must be performed is indicated by the symbol inside (the symbol at left is used in cases in which the AC adapter must be unplugged to ensure safety).

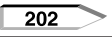
Symbols on the product

The symbol mark on the product calls your attention. Please refer to the manual, in the case that you operate the part of the symbol mark on the product.

	This symbol labeled on the portion calls your attention.
---	--

Symbols Used in This Manual

The following symbols are used in this manual.

	This symbol is used to indicate cross-references to relevant information in this manual or other documentation.
	This symbol marks items that should be confirmed before an operation (or action) is performed.
	This symbol marks definitions of terms and other useful information.
(Note)	This symbol marks supplementary information.
	This symbol is followed by precautions and directions in using the SHOT-202
	This symbol is followed by precautions and directions in using the SHOT-204MS

Disclaimer of Liability

- ① SIGMA KOKI CO., LTD. does not accept liability for damages resulting from the use of this product or the inability to use this product.
- ② SIGMA KOKI CO., LTD. does not accept liability for damages resulting from the use of this product that deviates from that described in the manual.
- ③ SIGMA KOKI CO., LTD. does not accept liability for damages resulting from the use of this product in extraordinary conditions, including fire, earthquakes, and other acts of God, action by any third party, other accidents, and deliberate or accidental misuse.
- ④ If the equipment is used in a manner not specified by the SIGMA KOKI CO., LTD., the protection provided by the equipment may be impaired.

WARNING

- Do not use this product in the presence of flammable gas, explosives, or corrosive substances, in areas exposed to high levels of moisture or humidity, in poorly ventilated areas, or near flammable materials.
- Do not connect or check the product while the power is on.
- Installation and connection should be performed only by a qualified technician.
- Do not bend, pull, damage, or modify the power or connecting cables.
- Do not touch the products internal parts.
- Connect the earth terminal to ground.
- Should the product overheat, or should you notice an unusual smell, heat, or unusual noises coming from the product, turn off the power immediately.
- Do not turn on the power in the event that it has received a strong physical shock as the result of a fall or other accident.
- Do not touch the stage while operation.
- Use dry clothes only for cleaning the equipment.

CAUTION

- Do not leave the product in an enclosed area or in areas in which it would be exposed to direct sunlight or vibration.
- Do not touch the product when your hands are wet.
- When unplugging the product, pull on the plug rather than the cord.
- Because some electrical charge remains after the power has been cut, do not touch the input or output terminals for ten seconds after the product has been turned off.
- When connecting peripherals to the product, adjust the product's initial setting (parameter settings) to suit the peripheral.
- Turn off the power before connecting the product to other devices. Connection should be performed following the connection diagram.
- Before turning the equipment on (or when beginning operations), be sure that you can turn the power off immediately in the event that an abnormality should occur.
- The product can only be repaired, modified, or disassembled by a qualified technician.
- Do not obstruct the product's air vents or other openings.
- For continued protection against risk of fire, replace only with same type and rating fuse. Fuse replacement is done by a qualified technician.

Chapter 1: Before You Begin

1. Package Contents

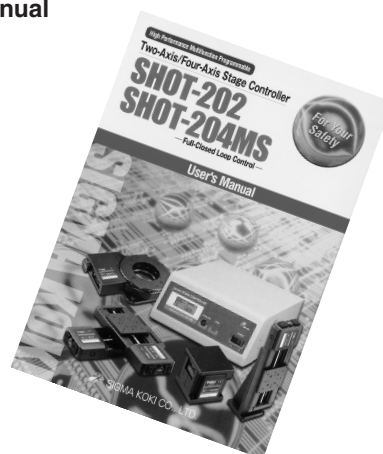
1-1 Accessories Provided with This Product

Purchasers of the Stage Controller should find that the package contains the items listed below. Check the package contents using the following checklist. Contact your retailer as soon as possible in the event that you should find that any item is missing or damaged.

☐ Stage Controller



☐ Manual



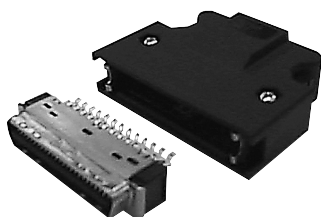
☐ 2.3meter AC power cable



Sample software
(option)

<http://www.sigma-koki.com>

I/O signal connector
(option)



(product number 10150 or 10350, equivalent
Sumitomo 3M product)

Control pad CJ-200
(option)



2. Overview

The SHOT-202 is a stepping motor-drive, two-axis stage controller with build-in drivers suited for measurement and device control applications. The SHOT-204MS is a magnescale-ready, four-axis stage controller for full-closed loop control. Compatible with existing models, this controller offers excellent applicability across a wide range of requirements at a low cost.

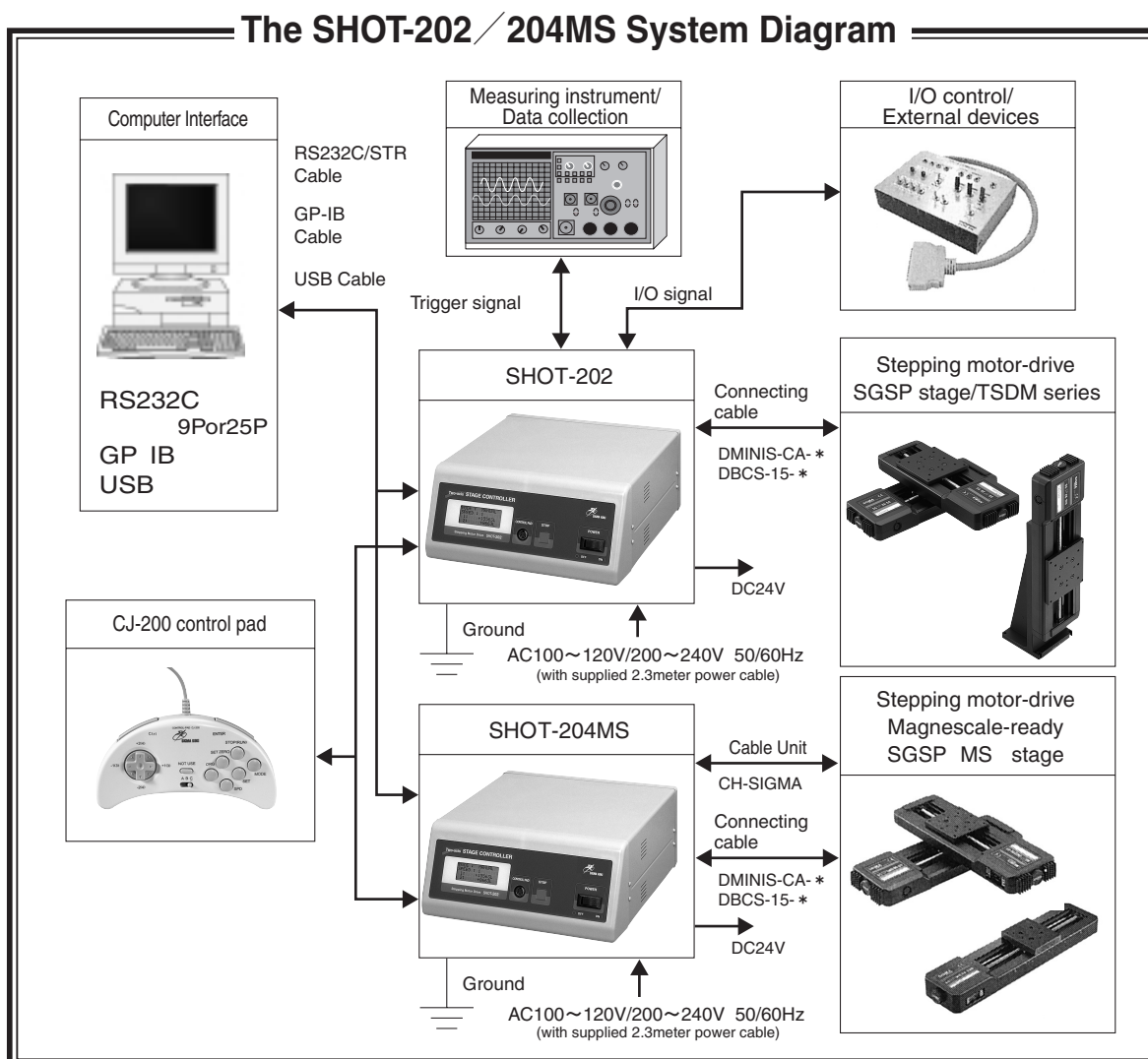
When the SHOT-202/204MS is connected to an ordinary personal computer via an RS232C, GP-IB or USB interface, the stage can be accurately moved to the desired position by simple commands sent from the PC. Also, it is possible to save internal data via program data downloads and uploads. The program has been simplified for ease of construction of complicated control systems.

Internal power supply for I/O (Input/Output) signals, trigger output signals, and DC 24V output signals makes it possible to control external input or output devices or to output trigger signals synchronized with external measuring devices.

3. The SHOT-202/204MS System

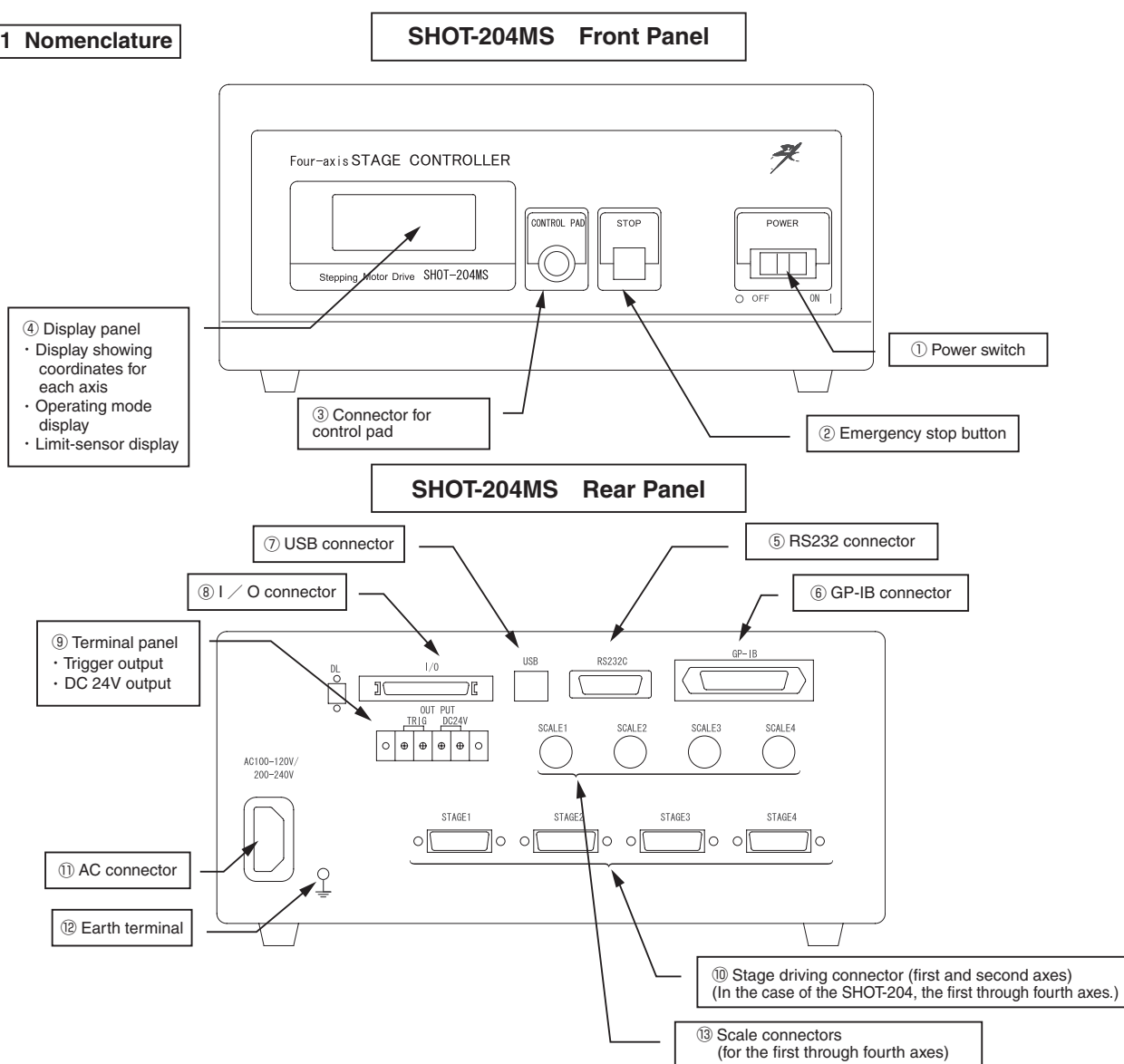
The SHOT-202, equipped with built-in stepping-motor drivers, forms a low-cost, space-saving system with stepping-motor-specification automatic stages (SGSP series) connected to it via standard cables.

The SHOT-204MS forms a full-closed loop controlled system with magnescale-specification automatic stages (SGSP (MS) series) and the cable (detector box) unit (CH-SIGMA) connected to it. In addition, stage equipment can be controlled in a variety of ways using I/O and trigger signals.



4. Parts of the SHOT-202/204MS

4-1 Nomenclature



4-2 Function

- ① Power switch : The SHOT-202/204MS is on when the switch is set to ON. Set the switch to OFF to turn the SHOT-202/204MS off.
- ② Emergency stop button : Press this button to stop immediately any motorized stages currently in progress.
- ③ Connector for control pad : This is where a control pad for button control is connected the CJ-200 may be used. The pad can be used to drive the motorized stage through button controls or the controls for each operating mode.
- ④ Display panel : Displays the position coordinates for each axis and the operating mode.
- ⑤ RS232C connector : This connector is used when the device is controlled from the computer via an RS232C interface.
- ⑥ GP-IB connector : This connector is used when the device is controlled from the computer via a GP-IB interface.
- ⑦ USB connector : This connector is used when the device is controlled from the computer via a USB interface.
- ⑧ I/O connector : This connector accepts a cable for sending and receiving I/O and control signals to/from an external device. It can also be used to drive motorized stages remotely or to start programmed operations.
- ⑨ Terminal panel : The terminal panel is used when you use trigger output signals or the DC 24V power source.
- ⑩ Stage driving connector : Connect to the motorized stage of your choice. supports up to four axes.
- ⑪ AC connector : This is where you connect the supplied 2.3meter power cable.

● USABLE DETACHBLE POWER CORDS

Type	Connector	Cord	Attachment plug cap
SHOT-202/204MS AC100-120V	Use the detachable power cord set attached to the product only.		
SHOT-202/204MS AC200-240V	IEC C-22 Rated 7A, 250V UL, CSA Approved	Type SJT, No16 AWG Min. 3-Conductors (Single phased; 2-current carrying & ground) UL, CSA Approved	NEMA6-15P Tandem blade Rated 7A, 250V UL, CSA Approved

Cable length of above Power Supply cord shall be shorter than 4.5m.

- ⑫ Earth terminal : Ground the equipment when in use.
- ⑬ Scale connectors : Connects to the magnescales to be used. Supports up to four axes.

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Chapter 2: Basic Operations

The basic operations needed to position motorized stages are outlined below, with cross-references to the sections of the manual in which these operations are described in detail. Mastering these operations will acquaint you with SHOT-202/204MS controllers and their operation.

5. Connecting to Motorized Stages



Connect each magnescape-specification motorized stage (SGSP series) to the respective connector (first through fourth axes) via the dedicated cable. Adjust the driver switch settings for each of the connected motorized stages.

- [See] 5-1 Connecting to Motorized Stages Page 7
 5-2 Connecting Power Cable and Control Pad Page 7
 5-3 Checking Driver Switch Settings Page 7

6. Turning the Controller On



Turn on the power switch on the front panel. The version number will be displayed in the LCD panel, followed by the initialization screen. Adjust the memory switch settings for each of the connected motorized stages.

- [See] 6-1 Operation Mode at Power On Page 8
 6-2 Operating Mode at Power On Page 8
 6-3 Checking Memory Switch Settings Page 9
 6-4 Settings Examples of the Memory Switches for SHOT-204MS Page 10

7. Changing the Operation Mode with the Control Pad



Press the MODE button on the control pad to cycle the controller through the available operating modes in the following order (press MODE while holding down the Ctrl key to cycle through mode settings in the reverse order):

HOST (COMPUTER) → MANUAL → REMOTE (EXECUTE) → TEACHING (PROGRAM) → EDIT → LOAD → TEST → HOST (COMPUTER) → ...

- [See] 7-1 The Control Pad Page 11
 7-2 Operating Modes and Control Buttons Page 12

8. Using the Control Pad (Joy Pad) to Position Motorized Stages



Manual mode (MANUAL: M) operation

You can move motorized stages in different directions using the cross-shaped button on the control pad. The remaining six buttons can be used to change speed or return the stage to its mechanical or logical origin.

- [See] 8-1 Using a Control Pad to Control Motorized Stages Page 13

9. Changing the Memory Switch



Manual mode (MANUAL: M) operation

Parameter settings for driving each of the motorized stages, including settings for speed, data transfer, and display, can be stored in memory switches.

The data stored in the memory switches can be confirmed or changed either by pressing the Ctrl and SET buttons on the control pad or using computer commands.

- [See] 9-1 Changing Memory-Switch Settings Page 13
 9-2 Setting Memory Switches: An Example Page 14
 9-3 Memory Switch Settings for the SHOT-202/204MS Page 15
 9-4 Memory Switch Settings in Detail Pages 16~18

10. Using a Computer to Position Motorized Stages

Host (computer) mode (HOST: H) operation

Motorized stages can be controlled by sending simple commands from the computer to the stage controller (e.g., Speed D command/parallel move M command/driver G command).

- [See] 10-1 Control Pad Operations Page 19
 10-2 List of Commands Page 19
 10-3 Command Format Page 20
 10-4 Commands in Detail Pages 20~26

5. Connecting to Motorized Stages

The controllers can be connected to a variety of different motorized stages (XYZ linear stages, rotation stages, and gonio stages) on from one to four axes using dedicated cables.

5-1 Connecting to Motorized Stages

First, connect the Controller to the motorized stages.

Here is an example of how to connect the motorized stages SGSP (MS) 20-85XY and SGSP (MS) 33-100XY to the SHOT-204MS controller.

<Connecting the cable for the motorized stages to the controller. >

- Example) ① Connect a standard cable (DMINIS-CA) to the connector (round-type 12P: male) of the motorized stage SGSP (MS) 20-85XY
- ② Connect a standard cable (DBCS-15) to the connector (D-sub15P: male) of the motorized stage SGSP (MS) 33-100XY.
- ③ Connect the cable from the SGSP20-85XY to the D-sub 15-pin female STAGE 1 connector on the rear panel of the SHOT-204MS controller.
- ④ Connect the cable from the SGSP(MS)33-100XY to the D-sub 15-pin female STAGE 2 connector on the rear panel of the SHOT-204MS controller.

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<Connecting the cable for the motorized stages to the controller. >

- Example) ⑤ Connect the cable (CH-SIGMA) for scales to the connector (D-sub9P) of the motorized stage SGSP (MS) 20-85XY
- ⑥ Connect the cable (CH-SIGMA) for scales to the connector (D-sub9P) of the motorized stage SGSP (MS) 33-100XY.
- ⑦ Connect the cable of the SGSP (MS) 20-85XY to the SCALE 1, 2 connectors (round-type 10P) on the rear panel of the SHOT-204MS controller.
- ⑧ Connect the cable of the SGSP (MS) 33-100XY to the SCALE 3, 4 connectors (round-type 10P) on the rear panel of the SHOT-204MS controller.

5-2 Connecting Power Cable and Control Pad

Connect the supplied power cable to the AC connector on the rear panel of the controller to plug the cable into an outlet.(Ensure that it is grounded.)

To use the control pad CJ-200 with the stage controller, insert the connector (male) with its arrow mark upward into "CONTROL PAD" in the center of the front panel.

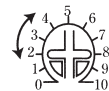
5-3 Setting the driver switches

Adjust the driver switch located on the bottom of the controller for each of the connected motorized stages.
( For details, see Section 19 "Driver Switch Settings.")

5-3-1 Setting the drive current (rotary volume RUN)

Set the current for running motors by adjusting the position of the rotary volume RUN according to the following table. The required driving current depends on the stage to be used. Make the settings according to the rated current value (specified on a side of the stage).

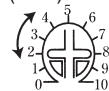
SW No.	0	1	2	3	4	5	6	7	8	9	10
Current value (A)	0.25	0.27	0.32	0.5	0.66	0.75	0.86	1	1.1	1.25	1.4



5-3-2 Setting the stop current (rotary volume STOP)

Set the current for motors at rest by adjusting the position of the rotary volume STOP according to the following table. Each figure in this table indicates a percentage of the drive (RUN) current value you set. The stop current is factory-set to 5 (50%).

SW No.	0	1	2	3	4	5	6	7	8	9	10
%	20	24	27	37	41	51	60	68	75	80	88



<RUN and STOP settings examples>

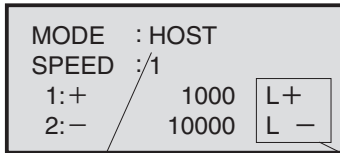
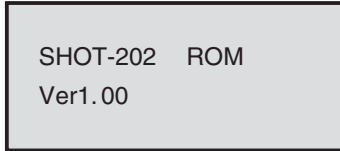
Examples	RUN	STOP
STAGE1,2 SGSP (MS) 20-85XY	4 (0.66A)	5 (51%)
STAGE3,4 SGSP (MS) 33-100XY	5 (0.75A)	5 (50%)

- ① Settings for Stages 1 and 2/SGSP (MS) 20-85XY
 RUN : Set the driving current to 0.66A (from motor).
 STOP : Set the stop current to 51% of the drive current.
- ② Settings for Stages 3 and 4/SGSP (MS) 33-100XY
 RUN : Set the drive current to 0.75A (from motor).
 STOP : Set the stop current to 51% of the drive current.

6. Turning the Controller On

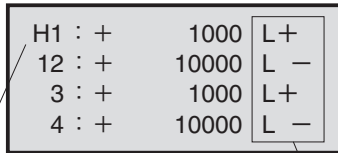
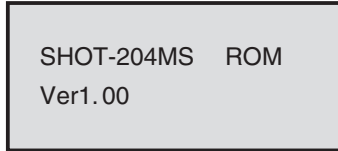
The controllers can be connected to a variety of different motorized stages (XYZ linear stages, rotation stages, and gonio stages) on from one to four axes using dedicated cables. Examples are shown in figures 6-2 and 6-3.

Figure 6-2 SHOT-202 LCD Display



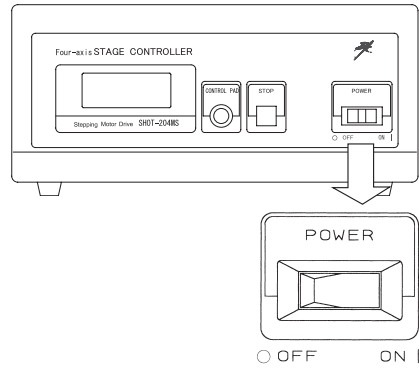
Operating mode display

Figure 6-3 SHOT-204MS LCD Display



Limit sensor mode display

Figure 6-1 SHOT-204MS Power Switch



<SHOT-204MS, Operating Mode Display>
H HOST (COMPUTER)
when P: "R" command is executed
P (PROGRAM) will appear.
M MANUAL
R REMOTE (EXECUTE)
T TEACHING (PROGRAM)
E EDIT
L LOAD
S TEST

6-1 Operating Mode at Power On

The operating mode at power on depends on the "MODE SEL" memory switch setting, which is stored in the controller. At shipment, the memory switch is set to "HOST (COMPUTER)". The operating mode at power on can be set to any of HOST (COMPUTER), MANUAL, REMOTE (EXECUTE), TEACHING (PROGRAM), EDIT, LOAD, and TEST.

Figure 6-4 Control pad CJ-200



6-2 Changing the Operating Mode at Power On

Follow the directions below to change the operating mode at power on. All operations use the buttons on control pad (CJ-200).

- Turn the controller on.
- Press the "MODE" button on control pad to change to MANUAL mode (see Figure 6-5).
- Press the "Ctrl" and "SET" buttons simultaneously. The display will show the memory switch setting screen (See Figure 6-6).
- Press the bottom of the cross-shaped button "-2 (4)" until "MODE SEL" is displayed, as shown in Figure 6-7.
- Press the "SET" or "SPD" button to select the desired operating mode. Pressing the "SET" button cycles through settings in the order, HOST (COMPUTER) → MANUAL → REMOTE (EXECUTE) → TEACHING (PROGRAM) → EDIT → LOAD → TEST. Pressing the "SPD" button cycles through settings in the order, TEST → LOAD → EDIT → TEACHING (PROGRAM) → REMOTE (EXECUTE) → MANUAL → HOST (COMPUTER).
- After selecting the desired setting, press the "MODE" button. A confirmation screen will appear as shown in Figure 6-8. (Press "MODE" to make further changes to settings. To cancel the settings, press the "SPD" button.)
- Press the "SET" button to return to MANUAL mode.

204MS Press the SET button to select OK, then press the MODE button.

Figure 6-5 MANUAL Mode

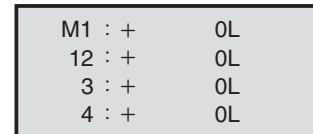


Figure 6-6 Memory-Switch Setting

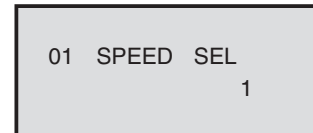


Figure 6-7 Operating Mode Selection

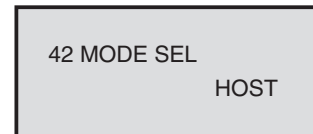
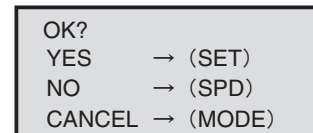


Figure 6-8 Confirmation Screen



6-3 Memory Switch Settings

The controller's internal memory switches are set to suit each of the connected stages.

Memory switches specify the speed and step angles (number of steps) for the motorized stage, and the (logical) conditions under which a stage event will be detected.

( For details, see 9, "Checking and Setting Memory Switches.")

To display the memory switch settings screen in MANUAL mode, press the "Ctrl" and "SET" buttons simultaneously.

204MS For the SHOT-204MS, press the SET button again after the above action.

How to operate the buttons for setting the memory switch

1) Cross-shaped -up button	Cycle through items in descending order (No. 2→1→71→70)
down button	Cycle through items in ascending order (No. 70→71→1→2).
2) Cross-shaped - right button	For numeric options, move cursor to right digit
left button	For numeric options, move cursor to left digit
3) SET button	Cycle through options for the current item (or increase the value of numeric options)
4) SPD button	Cycle through options for the current item (or decrease the value of numeric options)

Pressing the **Ctrl + ORG + ZERO** buttons simultaneously resets the memory switch to the defaults (factory settings).

To complete your settings, press the **MODE** button. This brings you to the confirmation screen, where the "SET" button is pressed to store the changed data and exit from the screen. You will be returned to the initial screen of the Manual mode.

(To exit with the changes cancelled, press the "SPD" button. To cancel the exit and set the memory switch again, press the "MODE" button.)

Each motorized stage requires different memory switch settings. It may not work without the required settings. See the table below indicating the settings required for each motorized stage to work properly.

204MS For the SHOT-204MS, press the SET button and select OK, then press the MODE button again. You will be returned to the initial screen of the MANUAL mode.

Each motorized stage requires different memory switch settings. It may not work without the required settings. See the table below indicating the settings required for each motorized stage to work properly.

Memory Switch No.	Settings to be made	Action
202	204MS	
14	14	AXIS
30, 31	32~35	LS/LEV
39, 40	47~50	ORG SEL

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If you connect motorized stages of the SGSP (MS) series to the SHOT-204MS, set the memory switches according to the following table.

Memory Switch No.	Settings to be made	Motorized stages of the SGSP (MS) series			
		20 (1mm lead)	26 (2mm lead)	33 (6mm lead)	46 (10mm lead)
	Travel per pulse	0.025μm/pulse(Note 3)	0.05μm/pulse(Note 3)	0.15μm/pulse(Note 3)	0.25μm/pulse(Note 3)
19~22	STAGE UNIT	MICRO	MICRO	MICRO	MICRO
23~26	DIVIDE	80	80	200	250
27~30	BASE RATE	20(2.0μm)	40(4.0μm)	120(12.0μm)	200(20.0μm)
32~35	LS/LEV	NC (Note1)	NC (Note1)	NC (Note1)	NC (Note1)
64~67	CONT	CLOSE (Note2)	CLOSE (Note2)	CLOSE (Note2)	CLOSE (Note2)
68~71	INPOS	2	2	2	2

Note 1) NC: NORMAL CLOSED/NO: NORMAL OPEN

Note 2) For CONT, one of the settings to be made, select either the open loop control or closed loop control.

Note 3) If you select the closed loop control, make sure to set the number of steps (DIVIDE) so that the travel/pulse is not more than 0.5μm (0.05μm recommended). (For a stage of the SGSP (MS) series, fix the number to "80.")

"Idea of the number of steps (DIVIDE) and base rate (BASE RATE)"

They are set so that the travel on the LCD agree with the actual travel.

$$\text{Number of steps} = \text{DIVIDE} = \frac{\text{BASE RATE (in } 0.1\mu\text{m steps)}}{10 \times \text{travel per pulse (in } \mu\text{m)}}$$

$$\text{Base rate} = \text{BASE RATE} = 10 \times \frac{\text{screw lead (in } \mu\text{m)}}{500}$$

6-4 Memory Switch Settings Examples

Examples are provided below of the settings used in connecting a SGSP(MS)20-85XY motorized stage and a SGSP(MS)33-100XY motorizedstage to the SHOT-204MS controller.

No.	Memory-switch setting (display)	Examples of settings for 1, 2 axis:SGSP(MS)20-85XY 3, 4 axis:SGSP(MS)33-100XY	Range/Options	Default value
01	SPEED SEL	1	1~4	1
02	SPEED1 (S)	4000	1~500000	100
03	SPEED1 (F)	40000	1~500000	1000
04	SPEED1 (R)	200	0~1000	200
05	SPEED2 (S)	20000	1~500000	500
06	SPEED2 (F)	200000	1~500000	5000
07	SPEED2 (R)	200	0~1000	200
08	SPEED3 (S)	30000	1~500000	750
09	SPEED3 (F)	300000	1~500000	7500
10	SPEED3 (R)	200	0~1000	200
11	SPEED4 (S)	40000	1~500000	1000
12	SPEED4 (F)	400000	1~500000	10000
13	SPEED4 (R)	200	0~1000	200
14	AXIS	4	1/2/3/4	1
15	INTERFACE	RS232C	RS232C/USB/GP-IB	RS232C
16	BAUDRATE	9600	4800/9600/19200/38400	9600
17	DELIMIT	CRLF	CR/LF/CRLF/EOI	CRLF
18	GP-IB ADDR	8	0~30	8
19	STAGE1 UNIT	MICRO	PULSE/MICRO/DEG/SENSOR	PULSE
20	STAGE2 UNIT	MICRO	PULSE/MICRO/DEG/SENSOR	PULSE
21	STAGE3 UNIT	MICRO	PULSE/MICRO/DEG/SENSOR	PULSE
22	STAGE4 UNIT	MICRO	PULSE/MICRO/DEG/SENSOR	PULSE
23	DIVIDE1	80	1/2/4/5/8/10/20/25/40/50/80/100/125/200/250	2
24	DIVIDE2	80	1/2/4/5/8/10/20/25/40/50/80/100/125/200/250	2
25	DIVIDE3	200	1/2/4/5/8/10/20/25/40/50/80/100/125/200/250	2
26	DIVIDE4	200	1/2/4/5/8/10/20/25/40/50/80/100/125/200/250	2
27	BASE RATE1	20	1~1000	20
28	BASE RATE2	20	1~1000	20
29	BASE RATE3	120	1~1000	20
30	BASE RATE4	120	1~1000	20
31	TRG/LEV	HI	HI/LO	HI
32	LS/LEV1	NORMAL CLOSE	NORMAL CLOSE/NORMAL OPEN	NORMAL CLOSE
33	LS/LEV2	NORMAL CLOSE	NORMAL CLOSE/NORMAL OPEN	NORMAL CLOSE
34	LS/LEV3	NORMAL CLOSE	NORMAL CLOSE/NORMAL OPEN	NORMAL CLOSE
35	LS/LEV4	NORMAL CLOSE	NORMAL CLOSE/NORMAL OPEN	NORMAL CLOSE
36	MOVE1	POS	POS/NEG	POS
37	MOVE2	POS	POS/NEG	POS
38	MOVE3	POS	POS/NEG	POS
39	MOVE4	POS	POS/NEG	POS
40	POSOUT	ON	ON/OFF	ON
41	TRG WIDTH	10	10/100/1000	10
42	MODE SEL	HOST	HOST/MANUAL/REMOTE TEACHING/EDIT/LOAD/TEST	HOST
43	ORIGIN1	ON	ON/OFF	ON
44	ORIGIN2	ON	ON/OFF	ON
45	ORIGIN3	ON	ON/OFF	ON
46	ORIGIN4	ON	ON/OFF	ON
47	ORG1 SEL	MINI	MARK/MINI/NOR	MINI
48	ORG2 SEL	MINI	MARK/MINI/NOR	MINI
49	ORG3 SEL	MINI	MARK/MINI/NOR	MINI
50	ORG4 SEL	MINI	MARK/MINI/NOR	MINI
51	ORG1 (S)	20000	1~500000	500
52	ORG1 (F)	200000	1~500000	5000
53	ORG1 (R)	200	0~1000	200
54	ORG2 (S)	20000	1~500000	500
55	ORG2 (F)	200000	1~500000	5000
56	ORG2 (R)	200	0~1000	200
57	ORG3 (S)	20000	1~500000	500
58	ORG3 (F)	200000	1~500000	5000
59	ORG3 (R)	200	0~1000	200
60	ORG4 (S)	20000	1~500000	500
61	ORG4 (F)	200000	1~500000	5000
62	ORG4 (R)	200	0~1000	200
63	COMM/ACK	MAIN	MAIN/SUB	MAIN
64	CONT1	CLOSE	OPEN/CLOSE	OPEN
65	CONT2	CLOSE	OPEN/CLOSE	OPEN
66	CONT3	CLOSE	OPEN/CLOSE	OPEN
67	CONT4	CLOSE	OPEN/CLOSE	OPEN
68	INPOS1	2	0~99	2
69	INPOS2	2	0~99	2
70	INPOS3	2	0~99	2
71	INPOS4	2	0~99	2

202

For the details of the memory switch for the SHOT-202, see 9-3 "Memory Switch Settings for the SHOT-202" (Page 15).

7. Changing the Operating Mode and Using the Control Pad

The control pad (CJ-200) allow for smooth operation of the stage controller (SHOT-202/204MS) in each operating mode.

The control pad, connected to the controller via a cable, provides remote operation. This means that the control pad allows you to work near the motorized stage while checking its behavior even if the controller and the motorized stage are away from each other.

7-1 The Control Pad

There is a control pad that can be used with the stage controller (SHOT-202/204MS):

The following table shows the names of the buttons and the name used when referring to the buttons in this manual.

Button	Control pad CJ-200		Name used in this manual
Cross-shaped button	+ 1(3)		Right
Cross-shaped button	− 1(3)		Left
Cross-shaped button	+ 2(4)		Up
Cross-shaped button	− 2(4)		Down
Round button	ORG		ORG
Round button	SET ZERO		ZERO
Round button	STOP (RUN)		STOP
Round button	SPD		SPD
Round button	SET		SET
Round button	MODE		MODE
Left and right buttons on front of controller	Ctrl		Ctrl
Left and right buttons on front of controller	ENTER		ENTER
Switch	A B C		Switch

Be sure to set the switches in the center of control pad to C position when device is connected to the controller.

When using the control pad (CJ-200) with the stage controller, insert the (male) connector into the terminal labeled “CONTROL PAD” with the arrow mark uppermost.

Be sure the controller is off when you connect the control pad. You may not able to use the buttons on control pad if you connect or disconnect either device while the controller is on.

If you are unable to use the buttons, perform the following operations to reset the device:

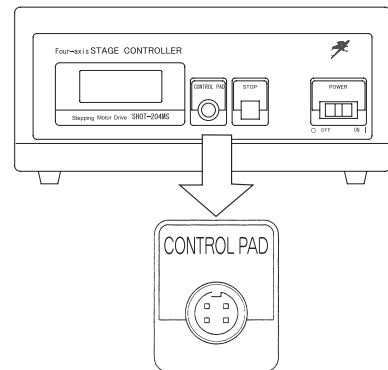
◆CJ-200 reset operation◆

Set the switch to A while pressing the ORG button.
Release the ORG button and return the switch to C.

Figure 7-2 Control Pad CJ-200



Figure 7-1 SHOT-202 front panel



7-2 Operating Modes and Control Buttons

The controller has seven operating modes.

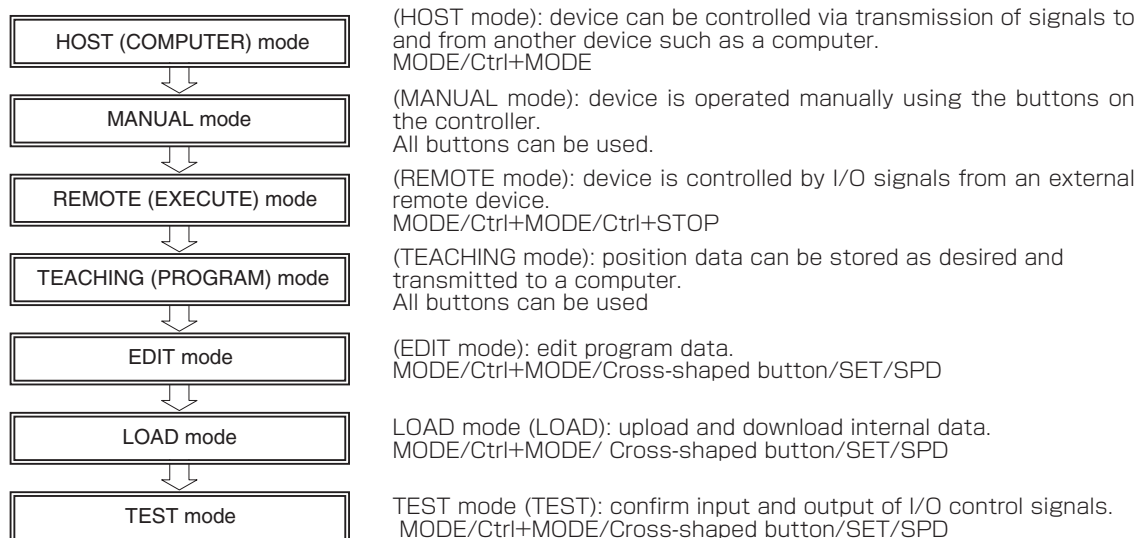
You can control motorized stages in a variety of different applications by changing modes. Press the "MODE" button on the control pad (CJ-200) to cycle through operating modes in the order,

HOST (COMPUTER) → MANUAL → REMOTE (EXECUTE) → TEACHING (PROGRAM) → EDIT → LOAD → TEST → HOST (COMPUTER).

Press the "MODE" button while holding down the "Ctrl" button to cycle through operating modes in reverse order:

HOST (COMPUTER) → TEST → LOAD → EDIT → TEACHING (PROGRAM) → REMOTE (EXECUTE) → MANUAL → HOST (COMPUTER).

The various operating modes and the buttons used in each mode are outlined below.



8. Using the Control Pad to Position Motorized Stages

In MANUAL mode, Motorized stages can be positioned using the buttons on the control pad .
Memory-switch settings can also be changed.

Figure 8-6 MANUAL Mode Display

8-1 Using a Control Pad to Control Motorized Stages

Motorized stages can be controlled using the buttons on the control pad.

M1: +	1000	L +
12: +	10000	L -
3: +	1000	L +
4: +	10000	L -

- 1) Cross-shaped drive button
 - Right Move first axis in “+” direction (forward rotation)
 - Left Move first axis in “-” direction (reverse rotation)
 - Up Move second axis in “+” direction (forward rotation)
 - Down Move second axis in “-” direction (reverse rotation)
 - Ctrl+right Move third axis in “+” direction (forward rotation SHOT-204MS only)
 - Ctrl+left Move third axis in “-” direction (reverse rotation SHOT-204MS only)
 - Ctrl+up Move fourth axis in “+” direction (forward rotation SHOT-204MS only)
 - Ctrl+down Move fourth axis in “-” direction (reverse rotation SHOT-204MS only)
- 2) Speed button
 - SPD Cycle through “SPEED1/2/3/4” settings stored in memory switches (1→2→3→4→1)
- 3) Clear coordinates button
 - ZERO Reset position coordinates for all axes to zero
- 4) Mechanical origin button
 - ORG Position stage at mechanical origin (for those axis for which “ORIGIN 1-4” memory switch is set to “ON”)
- 5) Logical origin button
 - Ctrl+ZERO Position stage at logical origin “0” for all axes
- 6) Trigger button
 - ENTER Output pulse from trigger-output terminals on rear-panel terminal panel
- 7) Stop button
 - STOP Stop all operating motorized stages immediately

9. Checking and Setting Memory Switches

Memory switch settings differ depending on the motorized stage used. Be sure to adjust memory switch settings for optimal operation of motorized stages.

9-1 Changing Memory-Switch Settings

To display the memory switch settings screen in MANUAL mode, press the “Ctrl” and “SET” buttons simultaneously. Memory switch settings can be changed using the buttons on the control pad.

- 1) Cross-shaped - up button Cycle through items in descending order (No. 2→1→71→70)
 down button Cycle through items in ascending order (No. 70→71→1→2).
- 2) Cross-shaped - right button For numeric options, move cursor to right digit
 left button For numeric options, move cursor to left digit
- 3) SET button ① Cycle through options for the current item (or increase the value of numeric options)
 ② After changes to settings have been completed, save changes to settings and exit
- 4) SPD button ① Cycle through options for the current item (or decrease the value of numeric options)
 After changes to settings have been completed, cancel changes to settings and exit
- 5) MODE button ① Press to end changes to settings (a confirmation screen will be displayed)
 ② Exit confirmation screen and return to memory switch settings screen
- 6) Ctrl+ORG+ZERO buttons **restore memory switch settings to factory defaults**

9-2 Setting Memory Switches: An Example

Here, you will change the detection method (logic) of the limit sensor from normal close to normal open as an example of memory switch settings.

In this example, we will change "LS/LEV1" memory switch setting item from **"NORMAL CLOSE"** to **"NORMAL OPEN"**.



The detection method of the limit sensor depends on the motorized stage used.
 Motorized stages that support the normal open method: CGO, CKR series, etc.
 Motorized stages that support the normal closed method: SGSP and SGSP (MS) and TSDM series



"Normal open" is defined as OFF when the limit sensor is not detected and ON when it is detected (the signal state defaults to OFF as long as the limit sensor is not detected). "Normal close" is defined as ON when the limit sensor is not detected and OFF when it is detected (the signal state defaults to ON as long as the limit sensor is not detected).

[Operations]

- ① Press the "Ctrl" and "SET" buttons on MANUAL mode simultaneously.

204MS Press the "SET" button again after the above action.

The memory switch settings screen will be displayed (see Figure 9-2).

- ② Press the "-2(4)" (down) on the cross-shaped button until "LS/LEV1" is displayed as shown in Figure 9-3.

- ③ Press the "SPD" button to display "NORMAL OPEN."
 Press the "SPD" button to change settings in the order,
 "NORMAL CLOSE." → "NORMAL OPEN."
 Press the "SET" button to change settings in the order,
 "NORMAL OPEN" → "NORMAL CLOSE."

- ④ Press the "MODE" button when changes to settings are complete.
 The confirmation screen shown in Figure 9-4 will appear, display
 "(YES: SET) (NO: SPD) (CANCEL: MODE)." Press the "MODE"
 button to return to the memory switch settings screen. Press "SPD"
 button to cancel changes to settings.

- ⑤ Press the "SET" button.

204MS Press the "SET" button to select OK, then press the MODE button.

Pressing the "SET" button saves changes to settings and returns you to MANUAL mode.

Figure 9-1 MANUAL Mode

M1 : +	OL
2 : +	OL
3 : +	OL
4 : +	OL

Figure 9-2 Memory Switch Settings

01	SPEED	SEL
		1

Figure 9-3 Sensor Detection Options

32	LS/LEV1
	NORMAL CLOSE

Figure 9-4 Confirmation Screen

OK?	
YES	→ (SET)
NO	→ (SPD)
CANCEL	→ (MODE)

Note:

Changes of the detection method (logic) of the limit sensor by the memory switch are limited only to switching + direction limit sensor (LS+) and - direction limit sensor (LS-). The near-point detection sensor and the mechanical origin are fixed to NORMAL OPEN.

9-3 Memory Switch Settings for the SHOT-202

Memory switch settings will return factory defaults if you press the “Ctrl,”“ORG,”and “ZERO”buttons simultaneously.

No.202	Memory-switch setting (display)	Range/Options	Default value
01	SPEED SEL	1 ~ 4	1
02	SPEED1 (S)	1 ~ 500000	100
03	SPEED1 (F)	1 ~ 500000	1000
04	SPEED1 (R)	0 ~ 1000	200
05	SPEED2 (S)	1 ~ 500000	500
06	SPEED2 (F)	1 ~ 500000	5000
07	SPEED2 (R)	0 ~ 1000	200
08	SPEED3 (S)	1 ~ 500000	750
09	SPEED3 (F)	1 ~ 500000	7500
10	SPEED3 (R)	0 ~ 1000	200
11	SPEED4 (S)	1 ~ 500000	1000
12	SPEED4 (F)	1 ~ 500000	10000
13	SPEED4 (R)	0 ~ 1000	200
14	AXIS	1 / 2	2
15	INTERFACE	RS232C / USB / GP-IB	RS232C
16	BAUDRATE	4800 / 9600 / 19200 / 38400	9600
17	DELIMIT	CR / LF / CR+LF / EOI	CRLF
18	GP-IB ADDR	0 ~ 30	8
19	STAGE1 UNIT	PULSE / MICRO / DEG	PULSE
20	STAGE2 UNIT	PULSE / MICRO / DEG	PULSE
21	NOT USE	—	—
22	DIVIDE1 M2	1,2,4,5,8,10,20,25,40,50,80,100,125,200,250	2
23	NOT USE	—	—
24	DIVIDE2 M2	1,2,4,5,8,10,20,25,40,50,80,100,125,200,250	2
25	NOT USE	—	—
26	NOT USE	—	—
27	BASE RATE1	1 ~ 1000	20
28	BASE RATE2	1 ~ 1000	20
29	TRG / LEV	HI / LO	HI
30	LS / LEV1	NORMAL CLOSE / NORMAL OPEN	NORMAL CLOSE
31	LS / LEV2	NORMAL CLOSE / NORMAL OPEN	NORMAL CLOSE
32	MOVE1	POS / NEG	POS
33	MOVE2	POS / NEG	POS
34	POSOUT	ON / OFF	ON
35	TRG WIDTH	10 / 100 / 1000	10
36	MODE SEL	HOST / MANUAL / REMOTE / TEACHING / EDIT / LOAD / TEST	HOST
37	ORIGIN1	ON/OFF	ON
38	ORIGIN2	ON/OFF	ON
39	ORG1 SEL	MARK / MINI / NOR	MINI
40	ORG2 SEL	MARK / MINI / NOR	MINI
41	ORG1 (S)	1 ~ 500000	500
42	ORG1 (F)	1 ~ 500000	5000
43	ORG1 (R)	0 ~ 1000	200
44	ORG2 (S)	1 ~ 500000	500
45	ORG2 (F)	1 ~ 500000	5000
46	ORG2 (R)	0 ~ 1000	200
47	COMM / ACK	MAIN / SUB	MAIN

 For more information, see 9-4, “Memory Switch Settings in Detail.”

204MS

For the details of the memory switch for the SHOT-204MS, see 6-4 “Memory Switch Settings Examples for the SHOT-204MS” (Page 10).

9-4 Memory Switch Settings in Detail

The numbers in each heading indicate the number of the memory switch setting item for the SHOT-202/204MS.

(Non-numeric options for memory switch settings data are listed in ascending order according to the values (0,1, 2, 3, ...) used at download and upload. The values used at download and upload are marked with an asterisk as follows.)

1/1) SPEED SEL: Speed selection

Choose the initial speed setting used at power on.

[Options] 1 to 4

2~13/2~13) SPEED 1 to 4 (S) (F) (R): Speed settings

Set the travel speed of stage (minimum S, maximum F, and acceleration/deceleration time R) (four settings).

[Options] S: 1 to 500000PPS
F: 1 to 500000PPS
R: 0 to 1000ms

14/14) AXIS: Specify number of axes controlled

Specify the number of stages connected or the number of axis controlled

(if one axis is selected, a second axis can not be controlled).

[Options] 1: one axis
2: two axis
3: three axes
4: four axes

15/15) INTERFACE: Interface selection

Specify the interface used to connect to the host (computer)

[Options] RS232C: RS232C interface [*0]
USB: USB interface [*1]
GP-IB: GP-IB interface [*2]

16/16) BAUDRATE: Set the baud rate

Set data transfer speed for an RS-232C connection.

[Options] 4800: 4800bps [*0]
9600: 9600bps [*1]
19200: 19200bps [*2]
38400: 38400bps [*3]

17/17) DELIMIT: Delimiter selection

Choose code used to delimit blocks of data for data transfer

[Options] CR: CR [*0]
LF: LF [*1]
CRLF: CR+LF [*2]
EOI: EOI (used when GP-IB interface is selected) [*3]

18/18) GP-IB ADDR: GP-IB address selection

Choose the address for a GP-IB connection

[Options] 1 to 30

19/19) STAGE1 UNIT: Select the units used for display (first axis)

20/20) STAGE2 UNIT: Select the units used for display (second axis)

21) STAGE3 UNIT: Select the units used for display (third axis)

22) STAGE4 UNIT: Select the units used for display (fourth axis)

Choose the units used to display position coordinates of LCD.

[Options] PULSE: ±999999999 (displays number of pulses) [*0]
MICRO: ±99999999.9 [*1]
DEG: ±999999.999 [*2]
SENSOR: ±999999.9 [*3](only SHOT-204MS)

21/) NOT USE:

22/23) DIVIDE1: Select number of steps for 1st axis(DIVIDE1 M2 for SHOT-202: select number of steps for 1st axis)

23/) NOT USE:

24/24) DIVIDE2: Select number of steps for 2nd axis(DIVIDE2 M2 for SHOT-202: select number of steps for 2nd axis)

25) DIVIDE3: Select number of steps for 3rd axis

26) DIVIDE4: Select number of steps for 4th axis

Input the value for the number of steps for each axis.

[Options] 1,2,4,5,8,10,20,25,40,50,80,100,125,200,250

$$\text{Number of steps} = \text{DIVIDE} = \frac{\text{BASE RATE (in } 0.1\mu\text{m steps)}}{10 \times \text{travel per pulse (in } \mu\text{m)}}$$

- 27/27) BASE RATE 1: Travel per pulse at the base (full) step for the first axis
 28/28) BASE RATE 2: Travel per pulse at the base (full) step for the second axis
 29) BASE RATE 3: Travel per pulse at the base (full) step for the third axis
 30) BASE RATE 4: Travel per pulse at the base (full) step for the fourth axis

Input the travel per pulse at the base (full) step for each axis. (MICRO: in 0.1- μm steps, DEG: in 0.001-degree steps)

[Options] At a setting of PULSE or SENSOR: Disabled
 At a setting of MICRO: 1 to 1000 (0.1 μm to 100 μm)
 At a setting of DEG: 1 to 1000 (0.001 degrees to 1 degree)

<Settings example> BASE RATE = 40 for a directly motorized stage with screw lead of 2mm

Stage	XYZ linear stage						Rotation stage (SKIDS/SGSP series)
Screw lead	1mm	2mm	6mm	10mm	20mm	25mm	—
Base step angles	0.72°						0.72°
Travel per pulse at base step	2 μm	4 μm	12 μm	20 μm	40 μm	50 μm	0.005°
BASE RATE	20	40	120	200	400	500	5

- 29/31) TRG/LEV: Logical settings for trigger output

Specify the logic (voltage levels) when the trigger is ON.

[Options] HI: Positive (active High) [*0]
 LO: Negative (active Low) [*1]

- 30/32) LS/LEV1: Specify the input logic for the first-axis limit sensor

- 31/33) LS/LEV2: Specify the input logic for the second-axis limit sensor

- /34) LS/LEV3: Specify the input logic for the third-axis limit sensor

- /35) LS/LEV4: Specify the input logic for the fourth-axis limit sensor

Select the conditions (input logic) for the limit sensor for each axis.

[Options] NORMAL OPEN: Normal open (switches ON from default value of
 OFF when limit sensor is detected) [*0]
 NORMAL CLOSE: Normal close (switches OFF from the default value of
 ON when limit sensor is detected) [*1]

Motorized stages that support normal open method: CGO/CKR series, etc.
 Motorized stages that support normal closed method: SGSP/SGSP (MS) and TSDM series

- 32/36) MOVE1: Direction of travel for first axis

- 33/37) MOVE2: Direction of travel for second axis

- /38) MOVE3: Direction of travel for third axis

- /39) MOVE4: Direction of travel for fourth axis

Select the + direction for each axis

[Options] POS: Positive (forward) rotation [*0]
 NEG: Negative (reverse) rotation [*1]

- 34/40) POSOUT: Select data output for TEACHING (PROGRAM) mode

Specify settings for data output to the host (computer) when the ENTER button is pressed in TEACHING (PROGRAM) mode.

[Options] ON: Enabled [*0]
 OFF: Disabled [*1]

- 35/41) TRG WIDTH: Set the pulse width of the trigger output

Specify the pulse width (time) of the trigger output.

[Options] 10 : 10 μs [*0]
 100: 100 μs [*1]
 1000: 1 ms [*2]

- 36/42) MODE SEL: Set the initial operating-mode at power on.
Specify the (initial) operating mode at power on.
- | | | |
|-----------|--------------------------------|------|
| [Options] | HOST: host (computer) mode | [*0] |
| | MANUAL: manual mode | [*1] |
| | REMOTE: remote (execute) mode | [*2] |
| | TEACH: teaching (program) mode | [*3] |
| | EDIT: edit mode | [*4] |
| | LOAD: load mode | [*5] |
| | TEST: test mode | [*6] |
- 37/43) ORIGIN1: First axis origin detection
38/44) ORIGIN2: Second axis origin detection
/45) ORIGIN3: Third axis origin detection
/46) ORIGIN4: Fourth axis origin detection
Specify whether to return to the mechanical origin for each axis.
- | | | |
|-----------|---------------|------|
| [Options] | ON: Enabled | [*0] |
| | OFF: Disabled | [*1] |
- 39/47) ORG1 SEL: Specify method used for return to first-axis origin
40/48) ORG2 SEL: Specify method used for return to second-axis origin
/49) ORG3 SEL: Specify method used for return to third-axis origin
/50) ORG4 SEL: Specify method used for return to fourth-axis origin
Specify method used when returning to the mechanical origin for each axis.
- | | | |
|-----------|---------------------------|------|
| [Options] | MARK: MARK (Sigma) method | [*0] |
| | MINI: MINI method | [*1] |
| | NOR: standard method | [*2] |
- 41~46/51~56) ORG1/2 SPEED (S) (F) (R): Specify speed when returning to origin
/57-62) ORG3/4 SPEED (S) (F) (R): Specify speed when returning to origin
Set the speed (minimum S, maximum F, and acceleration/deceleration time R)
when returning to the mechanical origin for the stage on each axis.
- | | |
|-----------|-------------------|
| [Options] | S: 1 to 500000PPS |
| | F: 1 to 500000PPS |
| | R: 0 to 1000ms |
- 47/63) COMM/ACK: Choose the communication protocol used when communicating with the computer
Specify whether the controller will return OK/NG in response to command signals sent from the computer in HOST (COMPUTER) mode.
- | | | |
|-----------|---|------|
| [Options] | MAIN: New system (return OK/NG when using RS232C, GP-IB or USB interface) | [*0] |
| | SUB: Old system (do not return OK/NG when using RS232C, GP-IB or USB interface) | [*1] |

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- /64) CONT1: Set the control method for the first axis
/65) CONT2: Set the control method for the second axis
/66) CONT3: Set the control method for the third axis
/67) CONT4: Set the control method for the fourth axis
Set the control method (open loop or closed loop method) for each axis.
- | | |
|-----------|-----------------------------------|
| [Options] | OPEN: open loop control method |
| | CLOSE: closed loop control method |
- /68) INPOS1: set the in-position range of the first axis when the closed loop method is selected
/69) INPOS2: set the in-position range of the second axis when the closed loop method is selected
/70) INPOS3: set the in-position range of the third axis when the closed loop method is selected
/71) INPOS4: set the in-position range of the fourth axis when the closed loop method is selected
Set the in-position range (range of the positioning stop at the time of positioning) for each axis when the closed loop is selected
- | | |
|---------|--------------|
| [range] | 0-99 degrees |
|---------|--------------|
- "Ideology of the in-position range (0-99)"
The value specified for the in-position range completes the positioning if the travel reaches this range against your travel instruction.
The range of 0-99 was determined based on 0.5 μ m, the precision per pulse from the magnescale.
<Examples>
- | | |
|----------------|--|
| Set value = 0 | range from 0 $\pm$ 0.5 μ m |
| Set value = 1 | 1 x $\pm$ 0.5 = range of $\pm$ 0.5 μ m |
| Set value = 99 | 99 x $\pm$ 0.5 = range of $\pm$ 49.5 μ m |

10. Using a Computer to Position Motorized Stages

The controller can be connected to a computer using an RS232C, GP-IB, or USB interface. Motorized stages can then be precisely controlled by commands (strings) transmitted from the computer. Note that some of the commands used by the SHOT-202/204MS are different from those used in existing controllers. The controller will enter HOST (COMPUTER) mode the first time you turn it on. (See Figure 10-1)

Figure 10-1 HOST Mode Display

H1	:	+	1000	L+
12	:	+	10000	L -
3	:	+	1000	L+
4	:	+	10000	L -

10-1 Control Pad Operations

Because the controller is controlled from the computer, only the mode selection buttons (MODE and Ctrl+MODE) can be used in HOST mode.

10-2 List of Commands

The following is a list of available commands:

Command	String	Details	Response
Control Commands 1 (Drive Commands)			
Return to mechanical origin	H	Detect mechanical origin	When new system (MAIN) is used: Command received normally: OK Problem receiving command: NG
Set number of pulses for relative movement	M	Axis of movement, direction, number of pulses	
Set number of pulses for absolute movement	A	Absolute coordinates	
Settings for linear movement	E	Circular interpolation (Move at minimum speed (S))	
Settings for rotary movement	K	Linear interpolation(Move at minimum speed (S))	When old system (SUB) is used: No response
Jog command	J	Move at minimum speed (S)	
Drive command	G	Start	
Control Commands 2 (Settings)			
Set electronic (logical) origin	R	Set the electronic (logical) origin to the current position	When new system (MAIN) is used: Command received normally: OK Problem receiving command: NG
Stop	L	Stop or reduce speed	
Speed settings	D	Set S, F, and R	
Alarm reset	U	Alarm reset	
Wait	W	Specify command wait time	When old system (SUB) is used: No response
Trigger output	T	Trigger output	
Free motor	C	Excitation ON/OFF	
Switch number of steps	S	Switch number of steps	
Confirmation Commands			
Status1	Q	Return current position etc.	refer to P25
Status2	!	Return B/R (READY)	
Internal information	?	Check internal information	
I/O Commands			
Output	O	Output to I/O connector	When new system (MAIN) is used: Command received normally: OK Problem receiving command: NG When old system (SUB) is used: No response
Input	I	Input from I/O connector	refer to P26
Other Commands			
Mode change	P : R	Enter remote (execute) mode	When new system (MAIN) is used: Command received normally: OK Problem receiving command: NG
Mode change	P : H	Enter host (computer) mode	
Start command	P : P 1or 2	Specify program number (1 or 2)	
Stop command	P : S	Start independent programmed operation	
Pause command	P : E	Stop independent programmed operation	When old system (SUB) is used: No response
Pause cancel	P : U0	Pause program	
Select signal sent on completion of operation	P : U1	Cancel program pause	
	P : C0	Signals can not be sent at completion of programmed operation	
	P : C1	Signal is sent at completion of programmed operation	When old system (SUB) is used: No response
Select signal sent on Trigger	P : T0	Trigger signal can not be sent at trigger signal output	
signal output	P : T1	Trigger signal is sent at trigger signal output	

10-3 Command Format

The communications protocol used between the controller and the computer depends on the memory switch COMM/ACK.

1. When COMM/ACK is set to MAIN (new system):
A protocol is used in which one response is issued for each command.

Command string receive
Response string sent

The response string when a command is received normally is "OK," that when the command was not received, "NG." In some cases, for example in response to confirmation commands, data will be returned instead of "OK." Commands should only be sent after checking the internal status of the controller.

2. When COMM/ACK is set to SUB (old system):
A protocol is used in which the controller does not respond to each command. Data will however be returned in response to some commands, such as confirmation commands.
To determine whether or not a command was received normally, use the Q command to check status.

10-4 Commands in Detail

Commands are categorized as follows:

- 1) Control commands 1 (drive commands)
- 2) Control commands 2 (settings)
- 3) Confirmation commands
- 4) I/O commands
- 5) Other commands

1) Control commands 1 (drive commands)

(1) H command: Return to mechanical origin

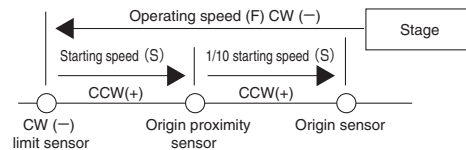
Features: This command is used to detect the mechanical origin for a stage and set that position as the origin. Once the mechanical origin has been detected, the value displayed will be 0. The stage will move at the speed specified in the ORG1 (2) SPEED (S, F, R) memory switches.

- H: 1 Detect the mechanical origin for the first axis.
H: 2 Detect the mechanical origin for the second axis.
H: 3 Detect the mechanical origin for the third axis. (SHOT-204MS)
H: 4 Detect the mechanical origin for the fourth axis (SHOT-204MS).
H: W Detect the mechanical origin for the first and second axes (detect the mechanical origin for the first, second, third, and fourth axes when SHOT-204MS is used).
The stage can be stopped using L: E.

<Detecting the Mechanical Origin>

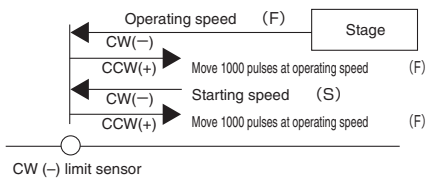
MARK (Sigma) system

When the command is given to detect the mechanical origin, the stage begins moving clockwise (i.e., in the - direction) at the operating speed (F) specified in the memory switches, stopping when the clockwise (-) limit sensor is detected. It then moves counter-clockwise (i.e., in the + direction) at the starting speed (S) until the origin proximity sensor is detected, at which point it reduces speed to 1/10. The stage continues moving until the origin sensor is detected and then stops (CKR series, etc.).



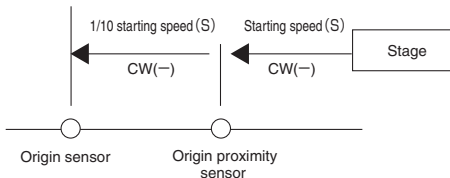
MINI system

When the command is given to detect the mechanical origin, the stage begins moving clockwise (i.e., in the - direction) at the operating speed (F) specified in the memory switches, stopping when the clockwise (-) limit sensor is detected. It then moves counter-clockwise (i.e., in the + direction) at the operating speed (F) for 1000 pulses. After stopping, it begins moving clockwise (i.e., in the - direction) once more at the starting speed (S), stopping when the clockwise (-) limit sensor is reached. It then moves counter-clockwise (i.e., in the + direction) at the operating speed (F) for 1000 pulses. This position is taken as the mechanical origin (SGSP series).



Standard system

When the command is given to detect the mechanical origin, the stage begins moving clockwise (i.e., in the - direction) at the starting speed (S) specified in the memory switches. When the origin proximity sensor is detected, speed is reduced to 1/10. The stage continues moving in clockwise (i.e., in the - direction) until the origin sensor is detected, at which point the stage stops.



(2) M command: Set number of pulses for relative travel

Features: This command is to specify the axis of travel, direction, and the travel (number of pulses). This command must always be followed by a drive (G) command. Travel is by means of acceleration/deceleration driving. The distance travelled is specified in pulses.

"Unit of travel"

Open loop control: number of pulses (SHOT-202/204MS: open loop)
Closed loop control: μm (SHOT-204MS: closed loop)

M: 1+P1000	Travel 1000 pulses in the + direction on the first axis
G:	
M: 2- P10000	Travel 10000 pulses in the - direction on the second axis
G:	
M: 3+P5000	Travel 5000 pulses in the + direction on the third axis (SHOT-204MS:closed loop)
G:	
M: 4-P9000	Travel 9000 pulses in the - direction on the fourth axis
G:	
M: W+P500-P200	Travel 500 pulses in the + direction on the first axis and 200 pulses in the - direction on the second axis (SHOT-202)
G:	
M: W+P50-P20+P30+P100	Travel 50 pulses in the + direction on the first axis, 20 pulses in the - direction on the second axis, 30 pulses in the + direction on the third axis, and 100 pulses in the + direction on the fourth axis (SHOT-204MS:open loop)
G:	

The SHOT-204MS carries out the closed loop control, if CONT1~4 are set to "CLOSE," and open loop control, if set to "OPEN."

If you have an axis in 204MS that is not driven, you need to designate P0 for that axis.

M: W+P100+P0+P200+P0

Travel 100 pulses in the + direction on the first axis, 200 pulses in the + direction on the third axis, move, and the second and fourth axes are not driven.

(3) A command: Set number of pulses for absolute travel

Features: This command is to specify the axis of travel, direction, and the travel (number of pulses). This command must always be followed by a drive (G) command. Travel is by means of acceleration/deceleration driving. The distance traveled is specified in μm or the number of pulses depending on the control method. This command also returns the axis to the electrical (logical) origin.

"Unit of travel"

Open loop control: number of pulses (SHOT-202/204MS: open loop)
Closed loop control: μm (SHOT-204MS: closed loop)

A: 1-P2000	Travel to the 2000 pulse position in the - direction on the first axis.
G:	
A: 2+P30000	Travel to the 30000 pulse position in the + direction on the second axis.
G:	
A: 3+P500	Travel to the 500 pulse position in the + direction on the third axis (SHOT-204MS:closed loop)
G:	
A: 4-P200	Travel to the 200 pulse position in the - direction on the fourth axis
G:	
A: W+P1000-P2000	Travel to the 1000 pulse position in the + direction on the first axis and the 2000 pulse position in the - direction on the second axis (SHOT-202)
G:	
A: W+P10-P20-P30+P400	Travel to the 10 pulse position in the + direction on the first axis, the 20 pulse position
G:	
A: 1+P0	Moves the first axis to the electrical (logical) origin.
G:	

(4) E command: Settings for rotary movement (circular interpolation)

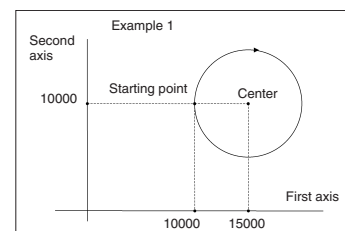
Features: This command is to specify the direction and amount (in pulses) of travel for simultaneous linear travel on two axes. This command must always be followed by a drive (G) command. The speed of travel is the minimum speed (S) of each axis setting. The coordinates for the final position are given in pulses (only the first and second axes may be set)

E : W + $\underbrace{\text{P0} + \text{P0}}_{\text{Final coordinates}} + \underbrace{\text{P2000} + \text{P100}}_{\text{Central coordinates}}$
G :

(Ex1) E : W + P0 + P0 + P5000 + P0
G

Travel in a circle to the final position, with the center of the circle being given using the relative coordinates (5000, 0) measured from the present position (travel is always clockwise).

With the center for circular travel set to the 2000 pulse position in the + direction on the first axis and the 100 pulse position in the + direction on the second axis, travel Final coordinates Central coordinates by circular interpolation in a full circle from the present position to the final position.



(5) K command: Settings for linear travel (linear interpolation)

Features: This command is to specify the direction and amount (in pulses) of travel for simultaneous linear travel on two axes. This command must always be followed by a drive (G) command. The speed of travel is the minimum speed (S) of each axis setting. The coordinates for the final position are given in pulses (only the first and second axes may be set).

K : W + P1000 + P500
Final coordinates

Travel using linear interpolation to the 1000 pulse position on the first axis and the 500 pulse position on the second axis

G:

(6) J command: Jog

Features: This command drives stages continuously (at a constant speed) at the starting speed (S). This command must always be followed by a drive (G) command.

J : 1+	move in the + direction on the first axis.
G:	
J : 2-	move in the - direction on the second axis.
G:	
J : 4-	move in the - direction on the fourth axis (SHOT-204MS)
G:	
J : W-+	move in the - direction on the first axis and in the + direction on the second axis (SHOT-202)
G:	
J : W-+-	move in the - direction on the first axis, in the + direction on the second- and third-axis, and in the - direction on the fourth axis (SHOT-204MS)
G:	

(7) G command: Drive

Features: When a drive command is issued, the stage starts moving, moves the specified number of pulses, and then stops. The G command is used after M, A, J, K, and E commands.

G: Drive

2)Control commands 2 (settings)

(8) R command: Return to electronic (logical) origin

Features: When this command is executed, the stage decelerates and stops.

R : 1	Set the electronic (logical) origin for the first axis
R : 2	Set the electronic (logical) origin for the second axis
R : 3	Set the electronic (logical) origin for the third axis (SHOT-204MS)
R : 4	Set the electronic (logical) origin for the fourth axis (SHOT-204MS)
R : W	Set the electronic (logical) origins for the first- and second-axis (set the electronic origins for the first-, second-, third-, and fourth-axis when the SHOT-204MS is used)

(9) L command: Decelerate and stop

Features: When this command is executed, the stage decelerates and stops.

L : 1	First axis decelerates and stops
L : 2	Second axis decelerates and stops
L : 3	Third axis decelerates and stops (SHOT-204MS)
L : 4	Fourth axis decelerates and stops (SHOT-204MS)
L : W	First- and second-axis decelerate and stop(first-, second-, third-, and fourth-axis decelerate and stop when SHOT-204MS is used)

(10) L: E command: Emergency stop

Features: This command stops all stages immediately, whatever the conditions.

L : E Stop first and second axes immediately (stop first-, second-, third-, and fourth-axis immediately when SHOT-204MS is used)

(11) D command: Speed settings

Features: The minimum speed (S), maximum speed (F), and acceleration/deceleration time (R) are set according to the SPEED SEL memory switches when the power is turned on. This command allows you to change these initial settings.

The following options are available:

Minimum speed (S)	1~500000PPS
Maximum speed (F)	1~500000PPS
Acceleration/deceleration time (R)	0~1000ms

Note that the minimum speed (S) must be less than or equal to the maximum speed (F).

D : 1S100F1000R50	Adjust speed settings for the first axis (S=100PPS/F=1000PPS/R=50ms)
D : 2S1000F5000R200	Adjust speed settings for the second axis (S=1000PPS/F=5000PPS/R=200ms)
D : 4S200F2000R100	Adjust speed settings for the fourth axis (S=200PPS/F=2000PPS/R=100ms) (SHOT-204MS)

D : WS100F1000R200S100F1000R200	Adjust speed settings for the first- and second-axis (SHOT-202)
First-axis speed settings	Second-axis speed settings

D : WS100F1000R50S100F1000R50S200F2000R100S300F3000R200	Adjust speed settings for the first-, second-, third-, and fourth-axis (SHOT-204MS)
First-axis speed settings	Second-axis speed settings
Third-axis speed settings	Fourth-axis speed settings

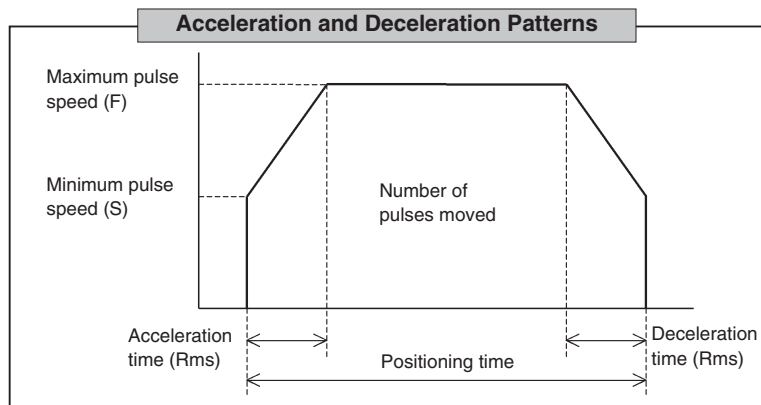


"Requirements for settings "

$S \leq F$

Where $F < 8000\text{PPS}$,
 $1 \leq (S, F) \leq 8000\text{PPS}$

Where $F \geq 8000\text{PPS}$,
 $64 \leq (S, F) \leq 2000000\text{PPS}$



(12) U command: Reset alarm

Features: This command resets the alarm when an error occurs.

U:1	Resets the alarm for the first axis
U:2	Resets the alarm for the second axis
U:3	Resets the alarm for the third axis (SHOT-204MS)
U:4	Resets the alarm for the fourth axis (SHOT-204MS)
U:W	Resets the alarm for the first and second axes (first, second, third, and fourth axes for the SHOT-204MS)

(13) W command: Set wait time

Features: This command specifies the time between stage move operations. Values range from 1 to 2550 (0.1 to 255.0 seconds).

W : 255	Wait 25.5 seconds before the next move
---------	--

(14) T command: Send trigger output

Features: This command outputs a trigger (terminal panel) to for each specified position, travel pulse, or interval. Data can be collected by position coordinates or time (the pulse width of the trigger signal can be set to 10 ms, 100 ms or 1 ms using the WIDTH memory switch).

T: T [time value]	Triggers output at specified intervals [Time value] 1 to 10000 (0.01 to 100.00 seconds)
T: P [axis] P [pulse value]	Triggers output for the specified axis each time the stage moves the specified number of pulses [Axis] 1 or 2 [Pulse value] 2 to 30000
T: S	Prevents pulse output
T: M	One trigger is output when this command is received

(15) C command: Free/hold motor (Excitation ON/OFF)

Features: This command is used to excite the motor or to turn excitation off, making it possible to move (rotate) stages manually.

The options available are 0: free motor, and 1: excitation (hold motor).

C : 10	Free first-axis motor
C : 21	Excite (hold) second-axis motor
C : 31	Excite (hold) third-axis motor (SHOT-204MS)
C : 40	Free fourth-axis motor (SHOT-204MS)
C : W1	Excite (hold) both the first- and second-axis motors (excite all of the first-, second-, third-, and fourth-axis motors when SHOT-204MS is used)

(16) S command: Changing the number of steps

Features: Use this command to change motor step angle (number of steps) Select one of the following 15 step angles built into the driver. First specify an axis, then set the value.

(Note) If the closed loop control is selected, the travel per pulse must not be more than $0.5\mu\text{m}$ ($0.05\mu\text{m}$ recommended).

S: 180	Divides the step angle of the first axis into 80 angles.
S: 280	Divides the step angle of the second axis into 80 angles.
S: 380	Divides the step angle of the third axis into 80 angles (SHOT-204MS).
S: 480	Divides the step angle of the fourth axis into 80 angles (SHOT-204MS).

If the base step (full step) angle is to 0.72 degrees, the stepping motor makes one full turn every 500 pulses. The motor is said to have a minimum resolution of 0.72 degrees (if the motor moves 10 mm for each turn, minimum resolution=10 mm $\div$ 500 pulses=20 mm). You can change the minimum resolution by dividing the motor step angle ($1/2=0.36^\circ$).

Effects of dividing step angle for a motor with a basic step angle of 0.72 degrees and a movement rate of 10 mm per turn

Number of steps	1	2	4	5	8	10	20	25	40	50	80	100	125	200	250
Step angle	0.72°	0.36°	0.18°	0.144°	0.09°	0.072°	0.036°	0.0288°	0.018°	0.0141°	0.009°	0.0072°	0.00576°	0.0036°	0.00288°
Number of pulses per full turn	500	1000	2000	2500	4000	5000	10000	12500	20000	25000	40000	50000	62500	100000	125000
Resolution	2μm	1μm	0.5μm	0.4μm	0.25μm	0.2μm	0.1μm	0.08μm	0.05μm	0.04μm	0.025μm	0.02μm	0.016μm	0.01μm	0.008μm

3)Confirmation commands

(1) Q command: Status1

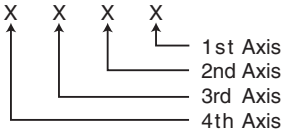
Features: On receipt of this command, the controller returns the coordinates for each axis and the current state of each stage.

Q :
 — 100, — 200, ACK1, ACK2, ACK3 Data returned (SHOT-202)
 First-axis coordinates Second-axis coordinates Three-character string data
 — 100, — 200, 100, 1000, ACK1, ACK2, ACK3 Data returned (SHOT-204MS)
 First-axis coordinates Second-axis coordinates Third-axis coordinates Fourth-axis coordinates Three-character string data

ACK1 X : Command or parameter errors.
 K : Command received normally.

ACK2 [SHOT-202]
 L : First axis stopped at LS
 M : Second axis stopped at LS
 W : First and second axes stopped at LS
 K : Normal stop

[SHOT-204MS]
 1 to E: LS stop axis display
 Example 1) 1 : 1: First axis stopped at LS
 Example 2) E : Second-, third-, and forth-axis stopped at LS



W : First-, second-, third-, and forth-axis stopped at LS
 K : Normal stop
 R : Alarm stop (To check the factor, use the L command)
 ACK3 B : (BUSY) L, I, O, Q, I, and P commands can be received
 R : (READY) all commands can be received

※Coordinate values for each axis have a fixed length of ten digits, including symbols (symbols are left-aligned, coordinates values right-aligned).

(2) ! command: Status 2

Features: On receipt of this command, the controller returns the stage operating status.

! :
 ACK3 Data returned
 ACK3 B : (BUSY) L, I, O, Q, I, and P commands can be received
 R : (READY) all commands can be received

(3) ? command: Request for internal information

Features: This command returns controller settings.

?: [Parameter] [AXIS]

[Parameter]	[Data returned]	[Examples]
V	Version numbers	V2.00
P	Travel per pulse	1.00
D	Travel speed	S100F1000R200
M	Size of relative linear pulses	1000
A	Size of absolute linear pulses	1000
O	Last output	15
W	Last settings value	255
K	Last settings value	1000, 1000
E	Last settings value	0, 0, 100, 100

[AXIS] 1, 2, 3, 4, W

Note that V, O, W, E, and K have no [AXIS].

4)I/O commands

(1) I command: Input

Features: This command checks the status of input (IN1-4) to the I/O connector and the nature of the alarm.

I:Value of data returned (0~15) (SHOT-202)
 I: 15, 00, 00, 00, 00Value of data returned (SHOT-204MS)
 { } Alarm numbers of the first through fourth axes (00, S1~)
 { } Status of the input signal (0~15)

<List of the alarms for the SHOT-204MS>

Alarm No.	Name of alarm	Description	Remarks
00	In order	In order	
S1	Sensor out of order	Generates an alarm when the alarm output of the magnescale is out of order while being monitored (Abnormal conditions such as broken wires between the detection head and detector).	Scale
S2	Broken wire detected	Generates an alarm when the encoder does not return a signal against the stage slightly moved. (It detects disconnected connectors (mini DIN) and others.)	Scale
S3	Control out of order	Generates a warning when the axis does not reach the in-position after the specified number of controls. (It detects malfunction of the driver, inconsistency of the number of steps, and others.)	Scale

<Listofthe Status of the input signal>

Input	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IN1	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON
IN2	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON
IN3	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
IN4	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON

※OFF indicates that the contact is open, and ON that it is closed.

(2) O commands: Output

Features: Use this command to specify the output (OUT 1~4) to the I/O connector.

0 : 15Parameter values are from 0 to 15

[illegible]

※OFF indicates that the contact is open, and ON that it is closed.

5)Other commands

(1) P commands: Extended commands (for remote operation)

Features: This command is used to determine position according to a controller-internal program by inputting commands for remote operation in place of external control signals from host (computer) mode.

P: R	Enter remote (execute) mode
P: H	Return to host (computer) mode
P: P [No.]	Set program number (1 or 2) [No.] 1, 2
P: S	Start independent programmed operation
P: E	Stop independent programmed operation
P: U0	Temporarily suspend independent programmed operation
P: U1	End temporary pause of independent programmed operation
P: C0	Prevent transmission of “operation complete” (COMP) signal when programmed operation is completed
P: C1	Allow transmission of “operation complete” (COMP) signal when programmed operation is completed
	※ The controller will send the data string “ COMP ” when programmed operation is completed
P: T0	Prevent transmission of trigger signal data (TRIG) when trigger is output
P: T1	Allow transmission of trigger signal data (TRIG) when trigger is output
	※ The controller will send the data string “ TRIG ” when trigger signal is output

Chapter 3: Commonly Used Features

The basic operations needed to position motorized stages are outlined below, with cross-references to the sections of the manual in which these operations are described in detail. Mastering these operations will acquaint you with SHOT-202/204MS controllers and their operation.

11. Recording Positions in TEACHING Mode



Determining positions in TEACHING (PROGRAM) mode (TEACHING: T)

Coordinates can be recorded in a program by moving motorized stages to the desired position and pressing the ENTER button in TEACHING mode.

- [See] 11-1 Recording Selections and Operating Motorized Stages Page 28
 11-2 Example of Entry Operations in TEACHING (PROGRAM) Mode Pages 28-29

12. Editing Programs in EDIT Mode



Editing programs in EDIT mode (EDIT: E)

In EDIT mode, you can edit and record patterns of operation, coordinates for the first and second axes, output directions, speed settings, and wait times.

- [See] 12-1 Recording Selections and Data Input Page 30
 12-2 Editing Programs: An Example Pages 30-31
 12-3 Explanation of Program Data Page 31-32
 12-4 Example Programs Page 33

13. Programmed Operation of Motorized Stages



Operating motorized stages in REMOTE (EXECUTE) mode (REMOTE: R)

Control motorized stages by selecting, executing, pausing, and terminating programs via control signals from the I/O connectors on the rear panel. The same operations can be performed using computer commands.

- [See] 13-1 Starting Programmed Operations from a Control Pad Page 34
 13-2 Starting Programmed Operations from a Computer Page 34
 13-3 Starting Programmed Operations Using I/O Signals Page 34

14. Sending and Receiving Program and Memory Switch Data from a Computer



LOAD mode operations (LOAD: L)

Upload program or memory switch data to, or download program or memory switch data from, the controller.

- [See] 14-1 Control Pad Operations Page 35
 14-2 Example of Upload and Download Operations Page 35
 14-3 Example of Format for Downloaded Data Page 35
 14-4 Example of Format for Uploaded Data Page 36

15. Testing I/O Signal Connections



TEST mode operations (TEST: S)

Check connections and wiring for control signals from the I/O connectors on the rear panel.

- [See] 15-1 Control Pad Operations Page 37
 15-2 Example of Input Signal Monitoring Page 37
 15-3 Example of Output Signal Testing Page 38

The programs created in TEACHING or EDIT mode are in REMOTE mode executed.

11. Recording Positions in TEACHING Mode

In teaching (program) mode, you can move motorized stages to the desired position using the buttons on the control pad and record position data to an internal program or computer.

11-1 Recording Selections and Operating Motorized Stages

Using the buttons on the control pad, you can select programs, record data, and operate motorized stages.

- 1) Record buttons
 - Cross-shaped, up, and down Cycle through program numbers in the order No.1→2→1
 - SET ①In the TEACHING PROGRAM mode start-up screen, press this button to begin teaching operations
 ②On exiting TEACHING mode, press this button to exit and record changes to settings
 - SPD On exiting TEACHING mode, exit without saving changes to settings
 - MODE ①Press to exit TEACHING mode (a confirmation screen will be displayed)
 ②In the confirmation screen displayed at completion of TEACHING mode operations, press MODE to return to TEACHING mode
- 2) Cross-shaped drive button
 - Right Move first axis in “+” direction (forward rotation)
 - Left Move first axis in “-” direction (reverse rotation)
 - Up Move second axis in “+” direction (forward rotation)
 - Down Move second axis in “-” direction (reverse rotation)
 - Ctrl+right Move third axis in “+” direction
 - Ctrl+left Move third axis in “-” direction
 - Ctrl+up Move fourth axis in “+” direction
 - Ctrl+down Move fourth axis in “-” direction
- 3) Speed button
 - SPD Cycle through “SPEED1/2/3/4” settings stored in memory switches (1→2→3→4→1)
- 4) Clear coordinates button
 - ZERO Reset position coordinates for all axes to zero
- 5) Mechanical origin button
 - ORG Position stage at mechanical origin (for those axis for which “ORIGIN 1-4” memory switch is set to “ON”)
- 6) Logical origin button
 - Ctrl+ZERO Position stage at logical origin “0” for all axes
- 7) Trigger button
 - ENTER ①Record relative position data and send to computer
 ②Output pulse from trigger-output terminals on rear-panel terminal panel
- 8) Stop button
 - STOP Stop all operating motorized stages immediately

11-2 Example of Entry Operations in TEACHING (PROGRAM) Mode

This example illustrates how to enter position data while operating motorized stages using the SHOT-204MS.

[Operations]

1. From the TEACHING (PROGRAM) mode screen, press the “SET” button to display the program numbers screen (Figure 11-2).
2. Select a program number by pressing the top or bottom of the cross-shaped button.
 Press the top or bottom of the button to cycle through settings
 No. 1→No. 2→No. 1)

In this example, position data will be recorded in Program No. 1.
 Press the “SET” button when “PROGRAM NO. 1” is displayed.
 The TEACHING (PROGRAM) mode screen will appear. At this point the buttons on the controller can be used to operate the motorized stage.

Figure 11-1 TEACHING Mode Screen

T1 :	+ 0.0L
42 :	+ 0.0L
3 :	+ 0.0L
4 :	+ 0.0L

Figure 11-2 Program Number Selection

TEACHING MODE
PROGRAM NO.1

3. Move the motorized stages to the desired positions using the buttons on the control pad .
To record the position of the motorized stage on each axis, press the ENTER button.

The relative positions for each axis will be recorded and the relative positional coordinates will be displayed as long as the ENTER button is held down, as shown in Figure 11-4. At the same time, the following operations are performed:

- The relative positional coordinates for axes 1 and 2 are recorded in Program 1.
- The relative positional coordinates for axes 1 through 4 are transmitted to the computer.

(Example of transmission format): 1234, 100, 0, 789

※The current coordinates are transmitted to external devices if the POSUT memory switch is set to allow transmission of data to external devices.

POSOUT ON: Transmission enabled

POSOUT OFF: Transmission disabled

- A pulse is output from the trigger output terminal in the terminal panel on the rear panel.

The relative positional coordinates for any number of points can be entered by repeating the above operations.

4. Press the "MODE" button when entry is complete.

The confirmation screen shown in Figure 11-5 will appear with the display, "(YES: SET) (NO: SPD) (CANCEL: MODE)."

Press the "MODE" button to make further changes to position data.

Press the "SPD" button to exit without saving position data.

5. Press the "SET" button

Position data will be saved and the initial screen for TEACHING (PROGRAM) mode will be displayed.

Figure 11-3 TEACHING Screen

```
T1 :      + 1234. OL
42 :      + 100. OL
3 :      + 0. OL
4 :      + 789. OL
```

Figure 11-4 Entering Position Data

```
Line No. 1
1234, 100, 0, 789
```



```
Line No. 2
1000, 900, 220, 0
```



```
Line No. 3
- 500, 350, 0, 100
```

Figure 11-5 Confirmation Screen

```
OK ?
YES      → (SET)
NO       → (SPD)
CANCEL   → (MODE)
```



Only relative coordinate positional data for each line number in the program can be recorded in TEACHING (PROGRAM) mode. Other data (operating patterns, output instructions, speed settings, and wait times) can be edited in EDIT mode.

(Table 1) Example of relative positional coordinates entered in Program No. 1

① Line number	② Operating pattern	③ First-axis coordinate	④ Second axis coordinate	⑤ Output instruction	⑥ Speed setting	⑦ Wait time
1	0	1234	100	0	1	0
2	0	1000	900	0	1	0
3	0	- 500	350	0	1	0
4	99	-	-	-	-	-
8000						



Programs can only record coordinates for the first and second axes.

12. Editing Programs in EDIT Mode

In EDIT mode, you can edit program data stored inside the controller.
There are two programs, No. 1 and No. 2.

12-1 Recording Selections and Data Input

Programs can be edited using the buttons on the control pad

1) Record buttons

- Cross-shaped, up, and down Cycle through program numbers in the order No.1→2→1→2
 SET ①In the EDIT mode start-up screen, press this button to begin editing
 ②On the confirmation screen, press this button to exit and record changes to settings
 SPD On the confirmation screen, exit without saving changes to settings
 MODE ①Press to exit EDIT mode (a confirmation screen will be displayed)
 ②In the confirmation screen displayed at completion of EDIT mode operations, press MODE to return to EDIT mode

2) Data-entry buttons

- cross-shaped, up Scroll through program line numbers in descending order (No.5→4→3→2)
 cross-shaped, down Scroll through program line numbers in ascending order (No.1→2→3→4)
 cross-shaped, right Move the edit cursor to the right
 cross-shaped, left Move the edit cursor to the left.
 SET Make changes to the selected item (numerical data increases)
 SPD Make changes to the selected item (numerical data decreases)

12-2 Editing Programs: An Example

This example illustrates how to edit programs with the SHOT-204MS.

[Operations]

- ①From the EDIT mode screen, press the "SET" button.
The program-number selection screen will appear.
 ②Select a program number by pressing the top or bottom of the cross-shaped button.
Press the top or bottom of the button to cycle through settings.
(No. 1→No. 2→No. 1)

In this example, position data will be recorded in Program No. 1. Press the "SET" button when "PROGRAM NO. 1" is displayed. The screen will change to program data Edit mode.

- ③Data are separating by commas. Move the cursor using the right and left sides of the Cross-shaped button.

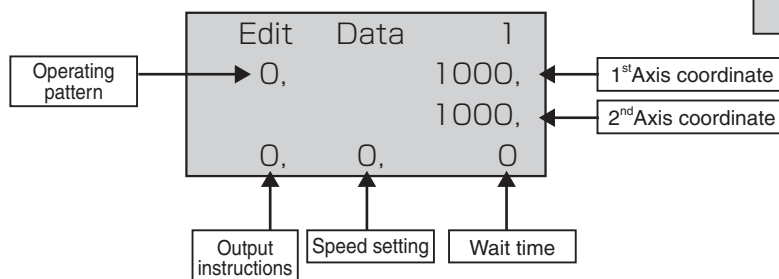


Figure 12-1 EDIT Mode Screen

E1 :	OL
42 :	OL
3 :	OL
4 :	OL

Figure 12-2 Program Number Selection

EDIT MODE
PROGRAM NO. 1

Figure 12-3 Editing Programs

Edit	Data	1
O,		1000,
		1000,
O,	O,	O

After moving the cursor to the item you wish to edit, press the "SET" or "SPD" buttons to change the setting for the item.

- ④ Press the "MODE" button when entry is complete
The confirmation screen shown in Figure 12-4 will appear display, "(YES: SET) (NO: SPD) (CANCEL: MODE)."
Press the "MODE" button to make further changes to position data.
Press the "SPD" button to exit without saving position data.
- ⑤ Press the "SET" button.
Position data will be saved and the initial screen for TEACHING (PROGRAM) mode will be displayed

Figure 12-4 Confirmation Dialog

OK ?	
YES	→ (SET)
NO	→ (SPD)
CANCEL	→ (MODE)

12-3 Explanation of Program Data

(Table 2) Example of relative positional coordinates entered in Program No. 1

① Line number	② Operating pattern	③ Specified First-axis coordinate	④ Specified Second axis coordinate	⑤ Output instruction	⑥ Speed setting	⑦ Wait time
1	0	1234	1000	0	1	0
2	0	1000	900	4	3	2
3	0	- 500	350	15	4	10
4	99	-	-	-	-	-
8000						

- ① Line number Programs can consist of from one to eight thousand lines.
- ② Operating pattern
- 0: normal operation (move to specified coordinates and stop)
- 10: continuous operation (specified first axis)
Operate continuously without stopping taking the specified coordinate as a point through which to pass
Only one axis may be specified; movement on the second axis stops
(No more than 256 continuous moves should be specified in a row)
※ **Set the speed to less than 25 KPPS when trigger output is used**
- 11: Continuous operation (specified second axis)
Operate continuously without stopping taking the specified coordinate as a point through which to pass
Only one axis may be specified; movement on the first axis stops
(No more than 256 continuous moves should be specified in a row)
※ **Set the speed to less than 25 KPPS when trigger output is used**
- 20: Two-axis linear-interpolation operation
Move simultaneously to the specified positional coordinates on both axis
- 30: Return to mechanical origin (specified first axis)
Only specified first axis returns to mechanical origin.
Specified second axis is still stopping.
- 31: Return to mechanical origin (specified second axis)
Only specified second axis returns to mechanical origin.
Specified first axis is still stopping.
- 32: Return to mechanical origin (specified both axes)
Specified first and second axes return to mechanical origin.
- Input the next two operating patterns for the circular interpolation operation.
- 40: circular interpolation (setting the end-coordinate)
Input the end-coordinate for the circular interpolation operation.
You must input the operating pattern 41 next to the operating pattern 40, otherwise the operation is abnormal operation.
- 41: circular interpolation (setting the center-coordinate)
Input the center-coordinate for the circular interpolation operation.
You must input the operating pattern 40 before the operating pattern 41, otherwise the operation is abnormal operation.

(Example)

Line number	Operating pattern	Specified first axis coordinate	Specified second axis coordinate	Output instruction	Speed setting	Wait time
1	40	0	0	-	-	-
2	41	2000	100	1	1	10

Specified first axis -- End coordinate; 0 pulse (current position), Center coordinate; +2000pulses.
Specified second axis -- End coordinate; 0 pulse (current position), Center coordinate; +100 pulses.
Moving speed -- 1
After stopping the stages, OUT1 trigger outputs are generated and wait for 1second.

- 50: Select specified axis (SHOT-204MS)
Select the two driving axes.
Program after this line number 50 drives the specified first axis and the specified

second axis.

Line number	Operating pattern	Specified first axis coordinates	Specified second axis coordinates	Output instruction	Speed setting	Wait time
1	50	3	4	—	—	—

Program after this line number 50 operates the specified first axis (stage 3) and the specified second axis (stage 4).

99: End of data

This pattern must be entered in the last line of the program (no operation is performed)

?: Start operation according to specified input conditions

External (four-bit) I/O input signals are monitored and operation is begun under identical conditions

I/O signal conditions can be input to the coordinates for the first axis

(see 0 to 15: "I commands," page 26)

F: Repeat a block of operations a specified number of times

The number of repeats can be input to the coordinates for the first axis (1 to 255).

N: Marks end of block of operations to be repeated

③ Movement distance on specified first axis

Input the relative distance to be moved (± 9999999 pulses)

※ If the operating pattern is 30/31/32/99/N, "—" will be input

④ Movement distance on specified second axis

Input the relative distance to be moved (± 9999999 pulses)

※ If the operating pattern is 30/31/32/99/?/F/N, "—" will be input.

⑤ Output

Determine position for I/O or trigger (pulse) output and output signal on completion

[Input ranges] I/O output : 0 to 15 (see "O commands," page 25)

Trigger T (time) : 1 to 10000 (0.01- to 100-seconds interval)

Trigger P (pulses) : 2- to 30000-pulse interval

[Example]

15 :OUT data=15 One trigger output

※ If the operating pattern is 30/31/32/40/41/50/99/?/F/N, "—" will be input.

※ The following trigger settings can be used when a program is downloaded from a computer:

0P1P10 :OUT data=0 One trigger output for every 10 pulses moved on first axis

※ **Set the speed to less than 56 KPPS when trigger output is used**

2T10 :OUT data=2 Trigger output every 100ms (10ms×10)

4M :OUT data=4 One trigger output

9S :OUT data=9 Trigger output disabled

⑥ Speed

Speed settings (S/F/R) stored in memory switches (1 to 4) are input

※ If the operating pattern is 30/31/32/40/41/50/99/?/F/N, "—" will be input.

⑦ Wait time

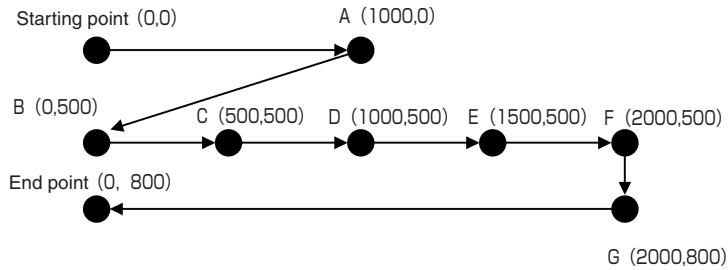
Enter wait time (0 to 2560 in units of 0.1 seconds)

※ If the operating pattern is 30/31/32/40/41/50/99/?/F/N, "—" will be input.

12-4 Example Programs

Examples of simple programs are as follow.

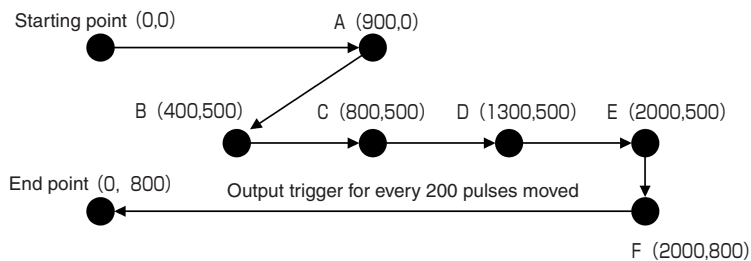
(1) Program Example 1 (edited in EDIT mode)



1. Move to point A at Speed 3.
After stopping, output trigger.
2. Move by linear interpolation to point B at the minimum speed (S) for Speed 4 and stop.
After stopping, output OUT=1 and trigger, then wait for 2 seconds.
3. Move 500 pulses on first axis at Speed 4 and stop. After stopping, output trigger and wait for 1 second. This operation is repeated four times.
4. Move to point G at Speed 2 and stop.
After stopping, output OUT=2 and trigger.
5. Move to end point at Speed 4. After stopping, output OUT=0 and trigger.

① Line number	② Operating pattern	③ Specified first axis coordinate	④ Specified second axis coordinate	⑤ Output instruction	⑥ Speed setting	⑦ Wait time
1	0	1000	0	0	3	0
2	20	-1000	500	1	4	20
3	F	4	—	—	—	—
4	0	500	0	1	4	10
5	N	—	—	—	—	—
6	0	0	300	2	2	0
7	0	-2000	0	0	4	0
8	99	—	—	—	—	—

(2) Program 2 (downloaded from the computer after editing)



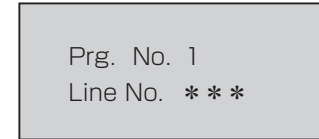
1. Move to point A at Speed 3. After stopping, output OUT=0 (no trigger output).
2. Move by linear interpolation to point B at the minimum speed (S) for Speed 4 and stop. After stopping, output OUT=1 and trigger, then wait for 2 seconds.
3. Wait until input condition I=1.
4. Move to point E at Speed 4 and stop. After stopping, output trigger output. Output trigger when passing points C and D.
5. Move to point F at Speed 2 and stop. After stopping, output OUT=1 (no trigger output).
6. Move to the end point at Speed 4, outputting a trigger for every 200 pulses moved on the first axis. After stopping, output OUT=2.

① Line number	② Operating pattern	③ Specified first axis coordinate	④ Specified second axis coordinate	⑤ Output instruction	⑥ Speed setting	⑦ Wait time
1	0	900	0	0S	3	0
2	20	-500	500	1M	4	20
3	?	1	—	—	—	—
4	10	400	—	—	4	—
5	10	500	—	—	4	—
6	10	700	—	—	4	—
7	0	0	300	1S	2	0
8	0	-2000	0	2P1P200	4	0
9	99	—	—	—	—	—

13. Programmed Operation of Motorized Stages

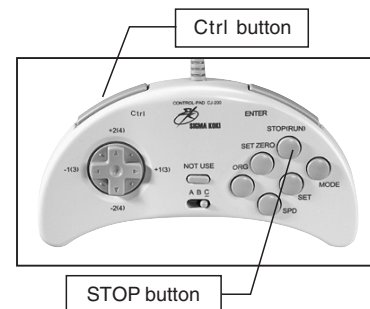
Programs edited in edit mode or downloaded from a computer can be used to operate motorized stages by means of commands received from the computer or by signals from the I/O connectors on the rear panel. There are two programs, No. 1 and No. 2. As end-of-operation signals are output when each operation is completed, programmed operation can be used for easy remote control while confirming the operating condition of each stage. The LCD display during programmed operation shows the program number and the line currently being executed (see right).

Figure 13-1 LCD Display during program execution



13-1 Starting Programmed Operations from a Control Pad

Pressing the **Ctrl and STOP buttons** simultaneously when no computer or I/O signal is connected will start programmed operation. Note that the program number is set by I/O signals even during control pad operations. Program No. 1 is selected when no I/O signals are connected.



13-2 Starting Programmed Operations from a Computer

When starting programmed operations from a computer, you can perform motorized operations (positioning) following the instructions in the program by sending remote (execute) commands from host (computer) mode in place of external control signals.

The available commands are shown below.

- P : R Enter remote (execute) mode
- P : H Return to host (computer) mode
- P : P [AXIS] Set program number (1 or 2) [AXIS] 1, 2
- P : S Start independent programmed operation
- P : E Stop independent programmed operation
- P : U0 Temporarily suspend independent programmed operation
- P : U1 End temporary pause of independent programmed operation
- P : C0 Prevent transmission of "operation complete" (COMP) signal when programmed operation completed
- P : C1 Allow transmission of "operation complete" (COMP) signal when programmed operation is completed
 - ※The controller will send the data string "**COMP**" when programmed operation is complete
- P : T0 Prevent transmission of trigger signal data (TRIG) when trigger is output
- P : T1 Allow transmission of trigger signal data (TRIG) when trigger is output
 - ※The controller will send the data string "**TRIG**" when trigger signal is output

13-3 Starting Programmed Operations Using I/O Signals

When starting programmed operations from an external device, you can perform motorized operations following the instructions in the program by turning START input for in I/O signals in the rear control panel ON.

Pauses (PAUSE input signals) and STOPS (STOP input signals) are used to pause motorized operations or for emergency stops.

There are two programs, No. 1 and No. 2, which can be selecting using I/O signals.

Program No.	No.1	No.2
I/O PRG signals	OFF	ON

Motorized stages can be operated (returned to mechanical origin, turned clockwise or counter-clockwise, have their speed settings changed, etc.) by turning I/O connector signals on or off.

End-of-operation signals, output from the I/O connectors when each operation is completed, make it possible to control stages remotely while confirming the operating condition of each stage.

14. Sending and Receiving Program and Memory Switch Data from a Computer

Program data and memory switch settings can be edited on a computer and downloaded to the controller (SHOT-202/204MS), or data can be uploaded to computer and saved to disk.

14-1 Control Pad Operations

- 1) Record buttons
- cross-shaped, up, and down①Select program number or memory switch
②Select UP LOAD or DOWN LOAD
 - SET①In the LOAD mode start-up screen, press this button to upload or download data
②Press to choose a program number or memory switch
③Press to upload or download data
 - MODEPress to cancel selection or upload/download (the previous screen will be displayed)

14-2 Example of Upload and Download Operations

This example illustrates how to upload Program No. 1 using the SHOT-204MS.
 [Operations]

- ①From the LOAD mode screen, press the "SET" button.
 The selection screen for program number and memory switch settings will appear.
- ②Press the "top and bottom of the cross-shaped" button until "PROGRAM NO. 1" is displayed.
 After checking the display, press the "SET" button to display the selection screen for upload and download. If you press the "MODE" button at this point, you will return to the previous screen.
- ③Press the "top and bottom of the cross-shaped" button until "UP LOAD" is displayed.
 After checking the display, press the "SET" button. The display, "(YES: SET)" "(CANCEL: MODE)" will appear. If you press the MODE button at this point, you will return to the previous screen.
 Press the "SET" button to upload the data for Program 1 to the computer.
- ④When upload has been completed, the message "Saving ... OK!" will appear, and the upload/download selection screen will be displayed.

When a download has been completed, the message "Receiving ... OK!" will appear, and the upload/download selection screen will be displayed.

Press the "MODE" button twice to return to the screen displayed at the beginning of LOAD mode.

Figure 14-1 LOAD Mode Screen

L1 :	+ O. OL
42 :	+ O. OL
3 :	+ O. OL
4 :	+ O. OL

Figure 14-2
Program Number Selections

LOAD MODE PROGRAM NO. 1

Figure 14-3
Memory Switch Selections

LOAD MODE MEMORY SWITCH

Figure 14-4
UP LOAD/DOWN LOAD Selection

LOAD MODE 1 UP LOAD

Figure 14-5 Confirmation Screen

DATA1 UP LOAD OK? (YES : SET) (CANCEL : MODE)

Figure 14-6
UP LOAD/DOWN LOAD Selection

Saving OK !

14-3 Example of Format for Downloaded Data

(1) Program data

Program data are variable length and are recorded as CSV files (comma separation, CR+LF)

[Example] 1,0,2000,1000,0,1,3 [CR] [LF]
 2,0,1000,1000,0,1,2 [CR] [LF]
 3,99,3000,1000,3,0,4 [CR] [LF]
 [EOF] [EOF] : End of File=1A(H) or Z (ASCII)

(2) Memory switches

All memory switches can be set simultaneously. Commas are used as separators.

[Example] 1, 100, 1000, 200, 500, 5000, 200, ...
 ...1, 1, 10 [EOF] [EOF] : End of File=1A(H) or Z (ASCII)

14-4 Example of Format for Uploaded Data

(1) Program data

Program data are variable length CSV files (comma separation, CR+LF). Variable-length data are used.

[Example] 1,0,1000,1000,0,1,2 [CR] [LF]
 2,0,2000,1000,0,1,3 [CR] [LF]
 3,99,3000,1000,3,0,4 [CR] [LF]
 [EOF] [EOF] : End of File=1A(H)

(2) Memory switches

Commas are used as separators.

[Example] 1, 100, 1000, 200, 500, 5000, 200, ...
 ... 1, 1, 10
 [EOF] [EOF] : End of File=1A(H)

Download (reference)

1. Preparation and check
 Check that Windows 98, 2000, Me, XP works with Stage Controller using Hyper Terminal.
2. Turn on your computer and Stage Controller.
3. Make a program list that you want to send using Note Pad etc. and save as text.
 <Example of program list>
 1,0,10000,0,0,4,0 (line no., operating pattern, coordinate of first axis, coordinate of second axis,
 2,0,-10000,0,0,4,0 output specification, set speed, wait time)
 3,99,-,-,-,-
 Z
4. Press the "MODE" button on the control pad to switch to LOAD MODE. Press the "SET" button, select the program number you want to download, then press the "SET" button.
5. After you choose "UP LOAD," press the "SET" button. Press the "SET" button again and the screen will display "Receiving..." and the standby screen for download will appear.
6. Start Hyper Terminal on Windows 98, 2000, Me, XP.
7. Select "Transfer of text file" from "Transfer."
8. On "Transfer of text file" screen, select the text file you have saved and click "Open."
9. "Hyper Terminal" screen displays the text file.
10. Press "ctrl" and "z" on the keyboard of the computer.

At this stage, the program is downloaded from your computer to Stage Controller.

Upload (reference)

1. Start Hyper Terminal on a computer with Windows 98, 2000, Me, XP and set the connection.
2. Press the "MODE" button on the control pad to switch to LOAD MODE. Press the "SET" button, select the program number you want to upload, then press the "SET" button.
3. When the selection screen for "UP LOAD" and "DOWN LOAD" appears, select "UP LOAD" and press the "SET" button twice.
4. Data will be sent to Hyper Terminal.

At this stage, a program is uploaded from Stage Controller to your computer.

15. Testing I/O Signal Connections

Test mode is used to monitor input signals from the I/O connector and to test output signals from the I/O connector.

Connections to external devices can be checked easily.

15-1 Control Pad Operations

1) Record buttons

cross-shaped, up, and down ①Select from input signal monitoring or output signal tests

..... ②Select the signals used for I/O tests

SET ①In the TEST mode start-up screen, press this button to conduct an I/O test

..... ②Set signals used in output test to OFF (Lo)

SPD Set signals used in output test to ON (Hi)

MODE Press to cancel selection or I/O test

(the previous screen will be displayed)

15-2 Example of Input Signal Monitoring

This example illustrates how to test I/O connector input signals using the SHOT-204MS.

[Operations]

①From the TEST mode screen, press the "SET" button.

The selection screen for input-signal monitoring and output-signal testing will appear.

②Press the "top and bottom of the cross-shaped button" until "INPUT MONITOR" is displayed.

After checking the display, press the "SET" button to display the input-signal monitor screen. If you press the "MODE" button at this point, you will return to the previous screen.

③Press the "top and bottom of the cross-shaped" button to scroll through the names of the input signals, where you can check the signal level (H/L: OFF/ON) for each signal. After checking the display, press the "SET" button to display the input-signal monitor screen. If you press the "MODE" button at this point, you will return to the previous screen.

[Input-signals]

<Input signal>	<Name>	<Parameter>
I/O input	DIN1	H/L
	DIN2	H/L
	DIN3	H/L
	DIN4	H/L
Program number selection	PROG	H/L
Program operation start	START	H/L
Return to first-axis origin	ORIG1	H/L
Return to second-axis origin	ORIG2	H/L
Pause	PAUSE	H/L
Stop	STOP	H/L
First-axis clockwise rotation	JOG1 +	H/L
First-axis counter-clockwise rotation	JOG1 -	H/L
Second-axis clockwise rotation	JOG2 +	H/L
Second-axis counter-clockwise rotation	JOG2 -	H/L
Speed setting1	SPEED1	H/L
Speed setting2	SPEED2	H/L
Select axis 1, 2/3, 4	AXISSEL	H/L
Alarm Reset	ALMRST	H/L

Figure 15-1 TEST Mode Screen

S1 :	+ O. OL
42 :	+ O. OL
3 :	+ O. OL
4 :	+ O. OL

Figure 15-2
Input Signal Monitor Selection

TEST MODE INPUT MONITOR

Figure 15-3
Input Signal Monitor Screen

INPUT MONITOR
DIN1 H

15-3 Example of Output Signal Testing

This example illustrates how to check I/O connector output signals using the SHOT-204MS.

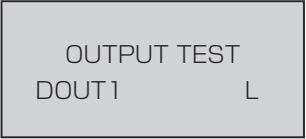
[Operations]

- ① From the TEST mode screen, press the "SET" button.
The selection screen for input-signal monitoring and output-signal testing will appear.
- ② Press the "top or bottom of the cross-shaped button" until "OUTPUT TEST" is displayed.
After checking the display, press the "SET" button to display the output-signal test screen. If you press the "MODE" button at this point, you will return to the previous screen.
- ③ Press the "top or bottom of the cross-shaped button" to scroll through the names of the output signals.
Press the "SET" button to change the output signal to "L (OFF)" or the "SPD" button to set the signal to "H (ON)".
If you press the "MODE" button at this point, you will return to the previous screen.

Figure 15-4
Output Signal Test Selection



Figure 15-5 Output Signal Test



[Output-signals]

〈Input signal〉	〈Name〉	〈Parameter〉
I/O output	DOUT1	H/L
	DOUT2	H/L
	DOUT3	H/L
	DOUT4	H/L
Start operation complete	MOVE_C	H/L
Return to first-axis origin completed	ORG_C1	H/L
Return to second-axis origin completed	ORG_C2	H/L
BUSY	BUSY	H/L
Alarm	ALARM	H/L

The control pad is used to set the ON/OFF parameter for output signals.

SET...L (OFF)
SPD...H (ON)

Chapter 4: Specifications

16. Specifications

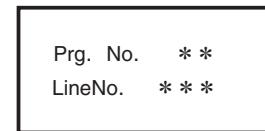
1) General specifications	
Power source	AC 100-120V/200-240V 50/60Hz
Voltage fluctuations	± 10%
Consumption	160VA(SHOT-202)/300VA(SHOT-204MS)
Operating temperature	5 to 40°C
Storage temperature	-20 to 60°C
Altitude	up to 2000m
Indoor use only	
Installation category	II
Pollution degree	2
Ambient humidity	20 to 80%RH (no condensation)
External dimensions	270W x297D x118H (excluding projections)
Weight	5.5 kg (SHOT-202)/6.5 kg (SHOT-204MS)
(2) Performance	
Controlling axis	2 axis (SHOT-202)/4 axis (SHOT-204MS)
Coordinate display	999999999 pulses
Maximum driving speed (F)	500kPPS
Minimum driving speed (S)	1PPS
Acceleration/deceleration time (R)	0 to 1000ms
Sensor input	Origin sensor/proximity sensor/CW (+) limit/CCW (-) limit (Memory switches can be used to change input logic for limit sensors.)
Trigger output	Open-collector output (Maximum use conditions DC24V 30 mA)
Interface	RS232C interface
	Communication Parameters
	- Baud rate 38400, 19200, 9600, 4800
	- Data bits 8 bits
	- Parity None
	- Stop bit 1 bit
	- Flow control Hardware
	- Delimiters CR, LF, CR+LF
	GP-IB interface
	- Setting address 1 to 30
	- Delimiters CR, LF, CR+LF, EOI
	Universal serial bus (USB) interface
DC output	DC36V 3.2A (non-isolated) - For motor driver
	DC24V 1.0A (non-isolated) - external I/O power source Terminal-panel output (motor braking, etc.)
	DC12V 0.2A (non-isolated) - Sensor power source
	DC5V 1.0A (isolated) - CPU logic circuit/Driver IF
I/O	4 input points (photo-coupler input, internal resistance 2.2 kΩ)
	4 output points (open-collector output, maximum use conditions DC24V 100mA)
Control signals	14 input points (photo-coupler input, internal resistance 2.2 kΩ)
	Program number-1 point/Operating commands-1 point
	Return-to-origin command-2 points/Pause-1 point/Emergency stop-1 point
	Rotation-2 points/Reverse rotation-2 points/Speed settings-2 points
	1, 2/3, 4 axis switch-1 point (compatible with SHOT-204MS)
	5 output points (open-collector output, maximum use conditions DC24V 20mA)
	Start operation completed 1 point
	Return-to-origin operation completed 2 points
	BUSY 1 point
	ALARM 1 point
(3) Driver Specifications	
Driver type	bi-polar pentagon micro-steps system
Driving electric current (output current)	0.25A/phase to 1.4A/phase
Current down (stop current)	20 to 88% of the specified output current
Motor excitation	Motor excitation ON/OFF by input signals
Division (micro-step) settings	1, 2, 4, 5, 8, 10, 20, 25, 40, 50, 80, 100, 125, 200, 250 divisions
(4) Electrical fast transmit/burst immunity	EN61000-4-4 (1995) Level2
(5) Electrical isolation voltage	When AC1000V 60Hz is applied between the power terminal and the case for one minute at room temperature and humidity, no abnormality shall occur
(6) Surge immunity	EN61000-4-5 (1995) Level2
(7) Electrostatic discharge	EN61000-4-2 (1995)+A1 (1998) Level2.

17-1-2 I/O Signals for Motorized Operations

Programmed Motorized operations will start when the I/O signal START input is set to ON.

During operation, the LCD shows the program number and line being executed as (Figure 17-2).

Figure 17-2
Motorized Operation Display



(1) Description of Input (Start/Stop) Signals

- PRG input Program settings (specifies the number of the program data to be executed)
- | | | |
|-------------|------|------|
| Program No. | No.1 | No.2 |
| PRG signal | OFF | ON |
- START input Start command for motorized operations (program execution begins when signal is ON)
 - PAUSE input Pause command (operations are paused while signal is ON, and resume when signal is turned OFF)
 - Stop input Stop command for motorized operations (programmed operations stop when signal is turned ON)
 - ALMRST input Reset the alarm (The error is reset when the signal is turned ON)

(2) Descriptions of Output Signals (while Program Is Running)

- COMP output program completed (ON when motorized operations are complete)
Signal output as 100ms pulse
- BUSY output Busy (ON during operations)
- ALARM output Alarm (ON when an alarm is generated)

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17-1-3 I/O Connector Signals

No.	Name	No.	Name
1	ALARM (H)	26	ALARM (L)
2	BUSY (H)	27	BUSY (L)
3	YORGCOMP (H)	28	YORGCOMP (L)
4	XORGCOMP (H)	29	XORGCOMP (L)
5	COMP (H)	30	COMP (L)
6	ALMRST (H)	31	ALMRST (L)
7	AXIS SEL (H)	32	AXIS SEL (L)
8	SPEED2 (H)	33	SPEED2 (L)
9	SPEED1 (H)	34	SPEED1 (L)
10	YJOG - (H)	35	YJOG - (L)
11	YJOG + (H)	36	YJOG + (L)
12	XJOG - (H)	37	XJOG - (L)
13	XJOG + (H)	38	XJOG + (L)
14	STOP (H)	39	STOP (L)
15	PAUSE (H)	40	PAUSE (L)
16	YORG (H)	41	YORG (L)
17	XORG (H)	42	XORG (L)
18	START (H)	43	START (L)
19	PRG (H)	44	PRG (L)
20	+ V (DC24V)	45	GND (0V)
21	OUT3	46	OUT4
22	OUT1	47	OUT2
23	COM	48	NC
24	IN3	49	IN4
25	IN1	50	IN2

10250-52A2JL connector (Sumitomo 3M) used

Figure 17-3 I/O Out1~4 Circuit

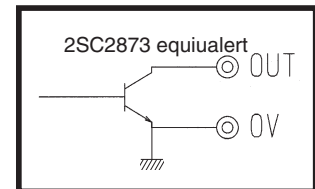


Figure 17-4
Control signal Output Circuit

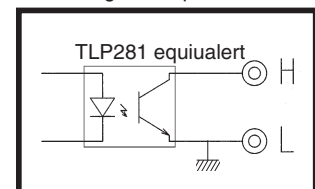


Figure 17-5
Control signal Input Circuit

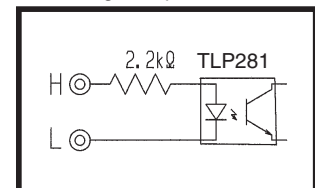
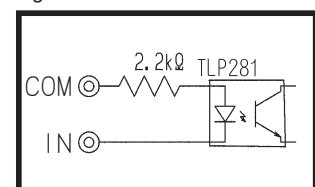


Figure 17-6 I/O IN1~4 Circuit

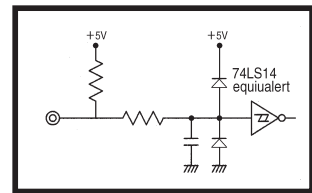


17-2 STAGE1~4 Connector

No.	Name	No.	Name
1	Blue: motor wiring	9	—
2	Red: motor wiring	10	—
3	Orange: motor wiring	11	LS (+): limit detection on +
4	Green: motor wiring	12	LS (-): limit detection on -
5	Black: motor wiring	13	GND: sensor common
6	GND: sensor common	14	NEAR: proximity detection
7	ORG: mechanical origin detection	15	+12V: sensor power supply
8	+12V: sensor power supply		

Female XM2F-1510 connector (OMRON products) used

Figure 17-6 Sensor Input Circuit



17-3 SCALE1~4 Connector

No.	Name	No.	Name
1	+5V (120mA)	6	NC
2	-5V (70mA)	7	NC
3	GND	8	ALARM output
4	Phase A input	9	GND
5	Phase B input	10	GND

TCS7705-012010 connector (Hosiden Corporation products) used

17-4 RS-232C Connector

No.	Name	No.	Name
1	—	6	DTR
2	TxD	7	CTS
3	RxD	8	RTS
4	DSR	9	—
5	SG		

XM2C-0912-112 connector (OMRON products) used

17-5 USB Connector

No.	Name	No.	Name
1	—	3	DATA +
2	DATA -	4	GND

XM7B-0442 connector (OMRON products) used

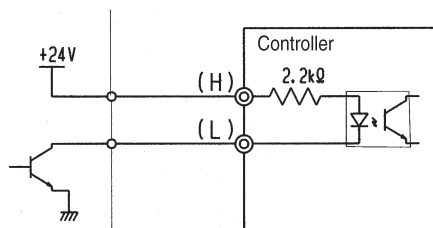
17-6 Control Pad

No.	Name	No.	Name
1	DATA	4	+5V
2	—	5	CLK
3	GND	6	—

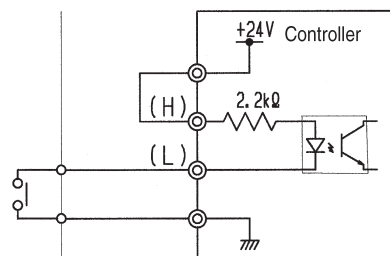
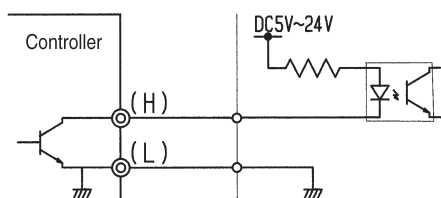
TCS7668-01-201 connector (Hosiden Corporation products) used

17-7 Examples of External Signal Connections

Controller Input Circuit



Controller Output Circuit



※ Example of connection when controller-internal power source is used.

18. Trigger Signals

Trigger signals are output as pulse wave signals when fixed-length signals from the trigger-signal terminals on the rear panel of the controller ("TRIG") to an external device are set to ON.

The signal output circuit is shown in Figure 18-2.

The trigger-signal pulse width (the length of time the signal is ON) is set in the TRG WIDTH memory switches stored in the controller (three values (lengths) are available).

You can choose the width of pulse from 10 μ sec, 100 μ sec, or 1msec.

Trigger signals can be output at specified positions or intervals synchronized with the positioning of an motorized stage. As a result, they can be used to give instructions to an external device during positioning.

Trigger signals can also be output at the completion of motorized stage positioning, allowing instructions to be given to external devices when the stage has reached a specified position.

The following four methods are available for trigger-signal output:

- (1) Trigger signals are output once when the ENTER button on the control pad is pressed in MANUAL mode.
- (2) Trigger signals are output once when the ENTER button on the control pad is pressed when positioning information is acquired in TEACHING (PROGRAM) mode.
- (3) Trigger signals can be output according to control commands from the computer in HOST COMPUTER mode. Use the "T:" command to trigger output by command in HOST COMPUTER mode.

[T command settings]

- Time trigger-output interval : 1 to 10000 (intervals of 0.01 to 100.00 seconds)
- Pulse trigger-output interval : 2 to 30000 pulse intervals
- Axis for trigger : 1 to 2

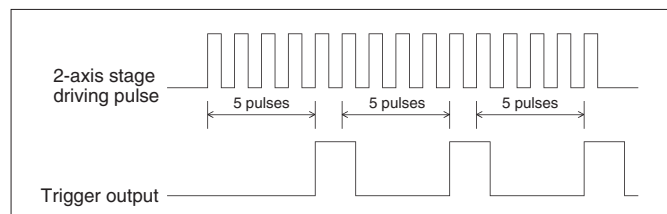
[T command format]

- Set the axis for trigger output and the trigger pulse interval during positioning.

T: P [axis for trigger output] P [trigger pulse interval]

Note: Set the movement speed for motorized stages to less than 56KPPS when using the above commands. (Trigger signals may not output at speeds of over 56KPPS.)

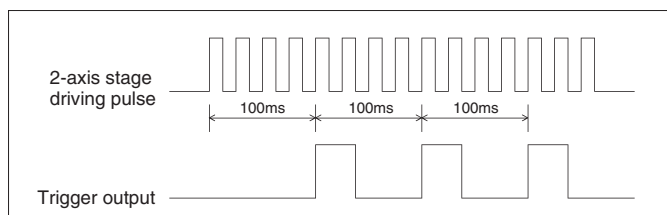
(Example) T: P2P5: Output trigger every 5 pulses when 2-axis stage is in operation.



- Set moving trigger-time intervals of trigger output.

T: T [Trigger output-time intervals]

(Example) T: T10: Output trigger every 100msec (10 $\times$ 0.01 seconds) when 2-axis stage is in operation.



- Output trigger once when the command is executed.

T: M

- Disable trigger output after the command is executed.

T: S

Figure 18-1 SHOT-202 Rear Panel

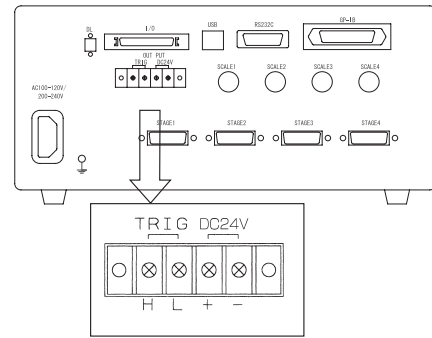
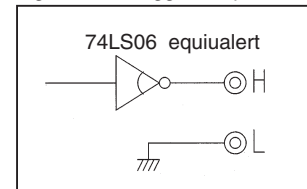


Figure 18-2 Trigger Output



(4) Output trigger according to program output instructions in REMOTE (EXECUTE) mode.

In program output setting instructions, triggers are output during positioning or when positioning is completed (I/O input settings are made at the same time).

[Output instruction settings]

- I/O output : 0 to 15 (four-bit data output)
- Positioning time trigger output : 1 to 10000 (intervals of 0.01 to 100.00 seconds)
- Positioning pulse trigger output : intervals of 2 to 3000 pulses

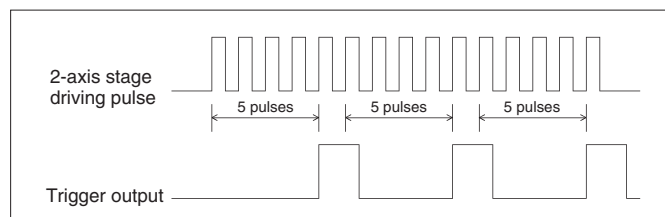
[Format for output instructions]

- Set axis for trigger output and positioning trigger pulses.

[I/O output data] P [axis for trigger output] P [trigger pulses]

Note: Set the movement speed for motorized stages to less than 56KPPS when using the above commands. (Trigger signals may not output at speeds of over 56KPPS.)

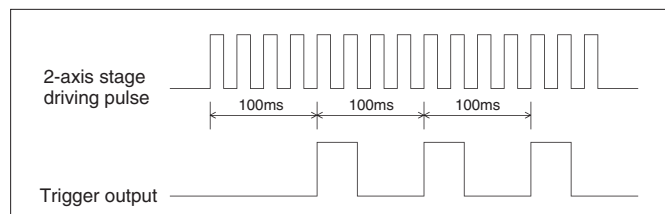
(Example) 0P2P5: I/O output data=0, trigger output every 5 pulses while positioning 2-axis stage.



- Set trigger-time intervals for trigger output during positioning.

[I/O output data] T [Trigger time]

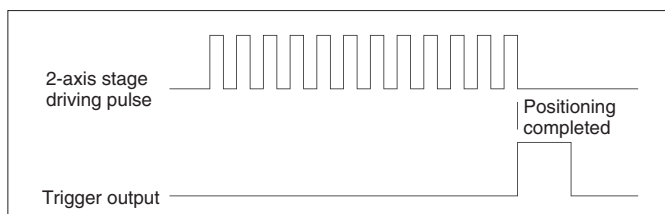
(Example) 2T10: I/O output data=2, trigger output every 100msec (10×0.01 seconds) while positioning 2-axis stage.



- Output trigger once when the command is issued.

[I/O output data] M [M can be omitted]

(Example) 4M: I/O output data=4, trigger output once when positioning of 2-axis stage is completed.



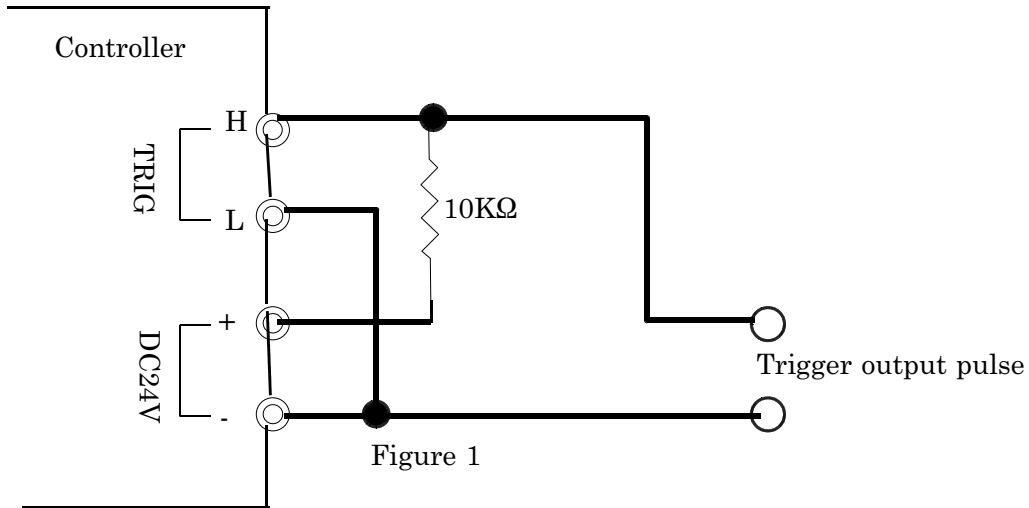
- Disable trigger output after the command is executed.

[I/O output data] S

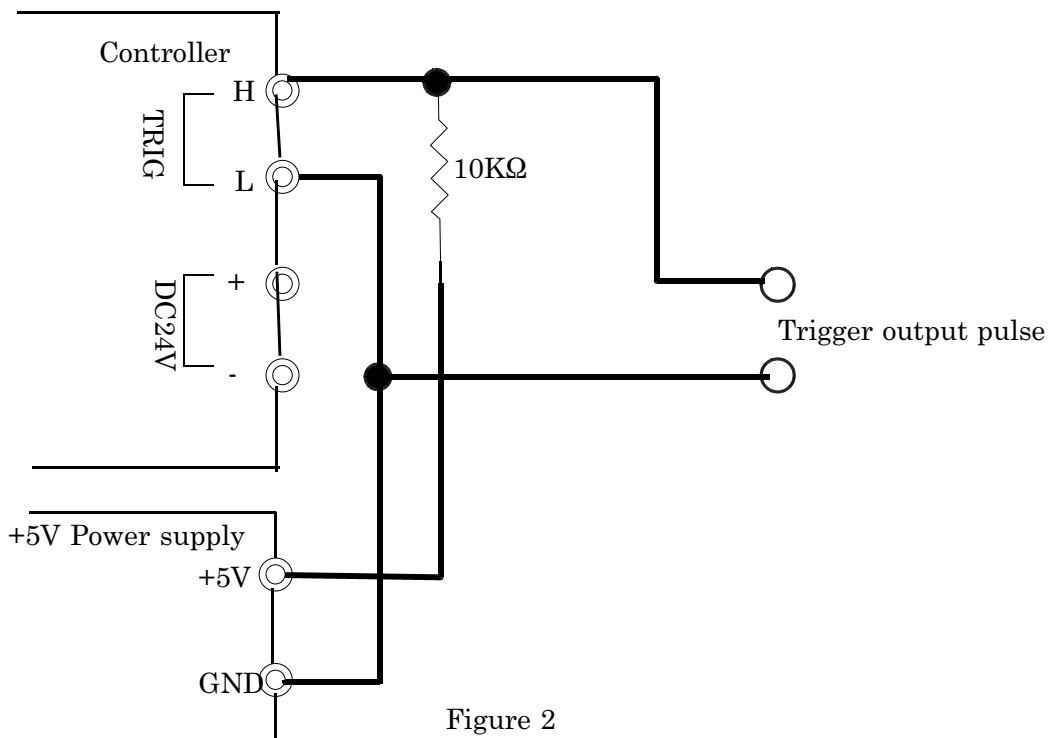
(Example) 9S: I/O output data=9, disable output trigger.

Example for Trigger output connection

The open collector gate(74LS06) is used for the trigger output circuit in the controller. In the Figure 1, the amplitude of the trigger output pulse is 24V, because of the DC24V power supply connection.



In the Figure 2, the amplitude of the trigger output pulse is 5V, because of the +5V power supply connection. In this case, you need to prepare the +5V power supply.

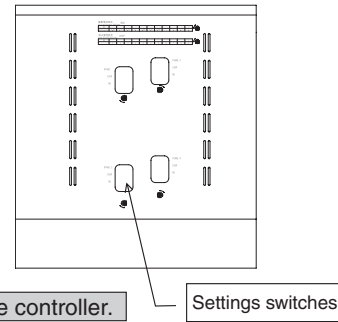


19. Driver Settings

Switches for driver settings (driving current, and stopping current) are found in the base of the controller case.

driving/stop torque of the motors change by settings of each switch.

Figure 19-1 Base of SHOT-204MS



19-1 Division Settings

If the base step (full step) angle is to 0.72 degrees, the stepping motor makes one full turn every 500 pulses. The motor is said to have a minimum analytic capacity of 0.72 degrees (if the motor moves 1mm for each turn, minimum resolution=1mm ÷ 500 pulses=2μm).

You can change the minimum resolution by dividing the motor step angle (1/2=0.36°)

Micro-step angles per pulse = Basic step angle (full-step angle) ÷ number of divisions

Division	1(full)	2(half)	4	5	8	10	20	25	40	50	80	100	125	200	250
Step angle	0.72°	0.36°	0.18°	0.144°	0.09°	0.072°	0.036°	0.0288°	0.018°	0.0141°	0.009°	0.0072°	0.00576°	0.0036°	0.00288°
Number of pulses per full turn	500	1000	2000	2500	4000	5000	10000	12500	20000	25000	40000	50000	62500	100000	125000
Resolution	2μm	1μm	0.5μm	0.4μm	0.25μm	0.2μm	0.1μm	0.08μm	0.05μm	0.04μm	0.025μm	0.02μm	0.016μm	0.01μm	0.008μm

(Example) Set Memory switch to 80 to divide step angle by 80.)

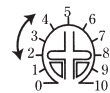
Note 1) If you select the closed loop control, make sure to set the number of steps (DIVIDE) so that the travel/pulse is not more than 0.5μm(0.05μm recommended). (For a stage of the SGSP (MS) series, fix the number to "80."

$$\text{Number of divisions} = \text{DIVIDE} = \frac{\text{BASE RATE (in 0.1}\mu\text{m steps)}}{10 \times \text{travel per pulse (in }\mu\text{m)}}$$

19-2 Driving Current Settings (RUN)

Current settings for motor rotation can be set by adjusting the position of the RUN rotary volume as shown in the following chart.

SW No.	0	1	2	3	4	5	6	7	8	9	10
Amperage (A)	0.25	0.27	0.32	0.5	0.66	0.75	0.86	1	1.1	1.25	1.4



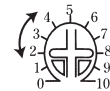
(Example) Set the digital switch to 5 for a motor rated for a current of 0.75 A/phase.

19-3 Stop Current Settings (STOP)

The motor stop amperage can be set by adjusting the position of the STOP rotary volume as shown in the following chart.

The figures in this chart are given as a percentage (%) of the RUN amperage.

SW No.	0	1	2	3	4	5	6	7	8	9	10
%	20	24	27	37	41	51	60	68	75	80	88



(Example) When the digital switch is set to 5 with a motor rated for a current of 1.4A/phase, the motor will be supplied with a current of 0.7A/phase when stopped.

20. Capabilities of Magnescale Interface (only for the SHOT-204MS)

20-1 Control mode

The stage controller (SHOT-204MS) carries out both of the closed loop control and open loop control. You can change the control mode by setting the memory switch.

(1) Closed loop control

In HOST command, the following commands are carried out in the closed loop control.

M: command

Value in μm (The set resolution is $0.05\mu\text{m}$ or more.)

A: command

Value in μm (The set resolution is $0.05\mu\text{m}$ or more.)

Any other action is carried out in the open loop control.

(2) Open loop control

Pulse instructions activate the operations without monitoring the position information from the magnescale.

The control method is the same as that of the SHOT-204 specification.

(3) Scale correction feature

The scale correction feature divides one scale pulse of the $0.5\mu\text{m}$ resolution into 10 to make the resolution $0.05\mu\text{m}$.

In the HOST mode, it is effective with the M and A commands.

In the MANUAL mode, it is effective when you make movements pulse by pulse with the buttons on the control pad CJ-200

In any other action, the basic resolution is $0.5\mu\text{m}$.

20-2 Automatic setup feature

Unsmooth positioning may be caused by improper settings of the motorized stage and magnescale.

The stage controller (SHOT-204MS) is equipped with an "automatic setup feature" that judges the specification of the motorized stage and compares the travel per pulse with the actual magnescale value to set the memory switch for the best operation.

You can operate the automatic setup in the Manual mode.

<How to perform the automatic setup>

Follow the steps below to perform the automatic setup.

Use the buttons on the control pad CJ-200.

① Turn on the controller.

② Press the "MODE" button on the control pad to switch to the MANUAL mode.

Press the "Ctrl" and "SET" buttons at the same time.

Change MANUAL SETUP to "AUTO SCALE" with the upper and lower parts of the cross-shaped button.

③ Press the "SET" button to start the automatic setup.

The automatic setup progresses in the following order.

1) Returning each axis to the mechanical origin

2) Execution of the automatic setup (movement to the + direction)

3) Returning each axis to the mechanical origin

④ When the automatic setup is complete, you will be returned to the MANUAL mode screen.

20-3 Alarm

When an abnormal condition arises, for example, the magnescale is out of order or a cable is broken, an alarm (out of order) appears with the description of the abnormal condition on the LCD of the controller. (See Figure 20-1)

When an alarm is generated, first correct the abnormal condition, then clear the alarm as follows:

- ① Press the "ZERO" button on the control pad.
- ② Send the reset command (U:) in the HOST (COMPUTER) mode.
- ③ Turn on the alarm reset signal of the I/O connector signal in the REMOTE (EXECUTE) mode.

Figure 20-1 Alarm example

ALRAM No S1 (H)
RESET !

If any of the axes is in an alarm (abnormal) condition, the rest of the axes are not allowed to be driven as well.

(1) Types of alarms and causes

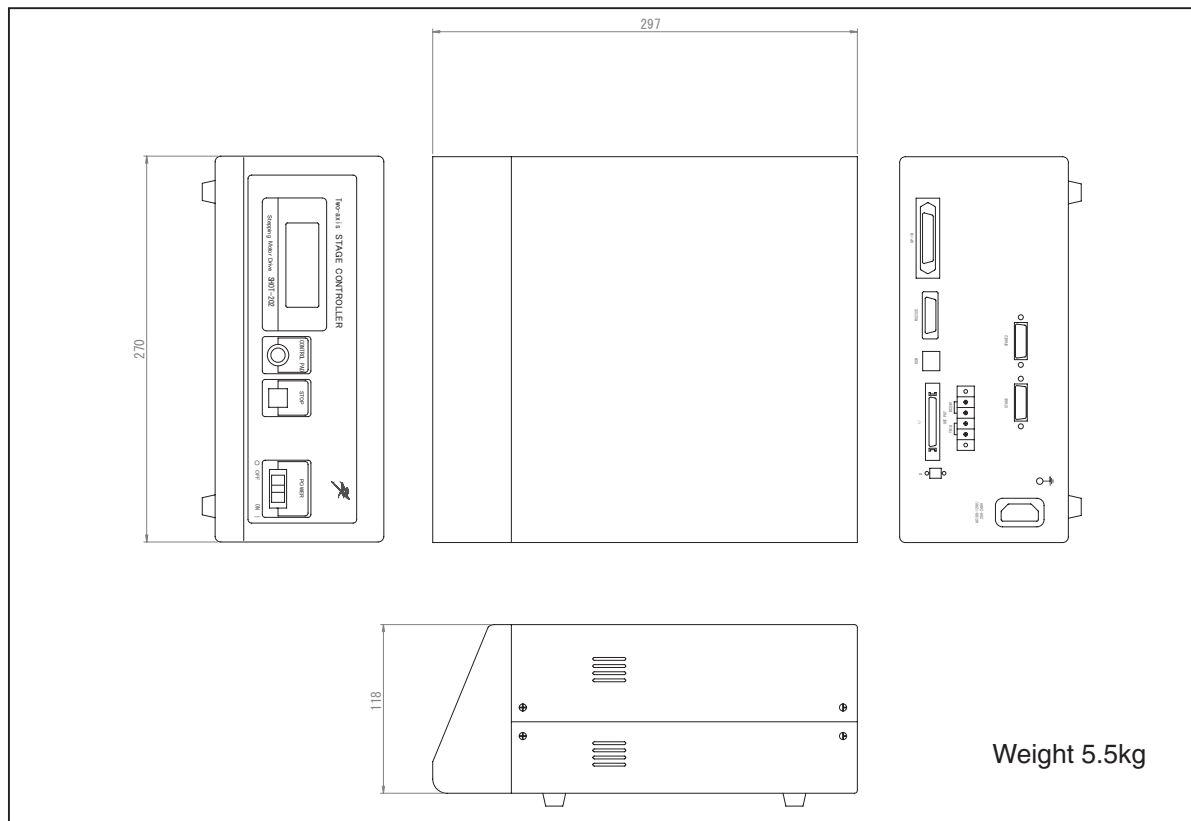
When an alarm is generated, check the alarm number that appears on the LCD of the controller to correct the cause of it.

Here is a list of the alarm numbers, nature of the alarms and causes

Alarm No.	Name of alarm	Description	Remarks
00	Normal	Normal	
S1	Sensor abnormality	Generates an alarm when the alarm output of the magnescale is out of order while being monitored. (Abnormal conditions such as broken wires between the detection head and detector)	Scale
S2	Broken wire detected	Generates an alarm when an encoder does not return a signal against the stage slightly moved. (It detects disconnected connectors (mini DIN) and others.)	Scale
S3	Control abnormality	Generates a warning when the axis does not reach the in-position after the specified number of controls. (It detects malfunction of the driver, inconsistency of the number of steps, and others.)	Scale

21. Exterior Dimensions

21-1 Exterior of SHOT-202



21-2 Exterior of SHOT-204MS

