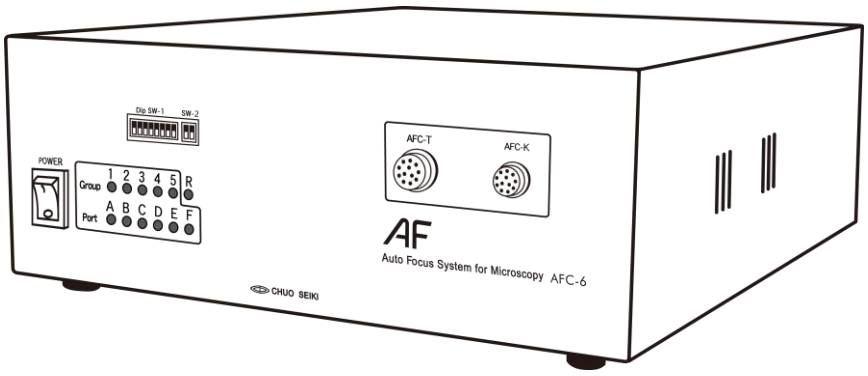
AF
Auto Focus System for Microscopy **AFC-6**

Auto Focus Controller

AFC-6

INSTRUCTION MANUAL

- Operation Box -



CHUO PRECISION INDUSTRIAL CO.,LTD.

Introduction

Thank you for purchasing our Auto Focus Controller AFC.
AFC is an exclusive controller for our Auto Focus Microscopes and Auto Focus Units. This INSTRUCTION MANUAL provides specifications, operational methods and precautions for AFC. Please read this manual thoroughly before using this product. In order to deliver sufficient information for the full understandings of the functions and performance of this product, we hope the users find this manual helpful.

Outline of this manual

AFC-6 instruction manual consists of following five sections.

Section 1	AFC Main Unit
Section 2	Parameters
Section 3	Communication Commands
Section 4	I/O Ports
Section 5	Operation Box

Please read each section carefully to understand the product and for the proper use before using AFC for the first time.

Section 1 AFC Main Unit
Describes product specifications and main functions of AFC-6.

Section 2 Parameters
Describes control parameters of AFC-6.

Section 3 Communication Commands
Description for controlling AFC-6 with communication.

Section 4 I/O Ports
Description for controlling AFC-6 with I/O port connection.
Only limited functions are controllable.

Section 5 Operation Box
Description for controlling AFC-6 with operation box.

Expressions used in this manual

■Abbreviations

Following abbreviations are used in this manual. Please refer to the following list and replace as appropriate.

AF	: Auto Focus
AFC	: Auto Focus controller
Auto Focus mode	: Collective term for following Auto Focus movements; SC0, SC1, SC2, SC3, SC4, SC5, SC6, SC7, AF0, AF2, PF, PFH, PN and PNH
AF mode	: Auto Focus mode
Search	: Search for AF signal
Peak detection	: Peak detection of AF signal
AF driving section	: Driving section to move lens tube to z-axis direction
Pattern driving section	: Driving section to project AF patterns (*not included in some models)

■Typestyle

Bold (gothic) typefaces are used to call attention or emphasize in this instruction manual.

■Numerical values

Decimal values are used in principle. "0x" is added before the first digit of a numerical value when hexadecimal values are used. For instance, "1000" in a decimal system are expressed as “0x03E8” in a hexadecimal system.

■Hardware

Hardware, such as keys, LED and switches of AFC, Auto Focus Microscope, Auto Focus Unit, are expressed in the following ways: **[…] KEY, […] LED, and […] SWITCH**.

Examples : **[Home] KEY**
[A] LED
[POWER] SWITCH

■Communications

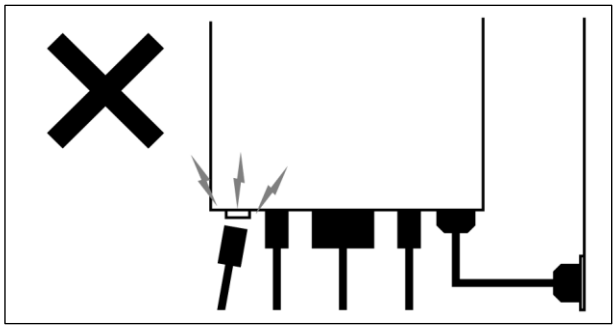
Communications are performed via RS-232C. In RS-232C communications, data sent from an external device to AFC is referred to as “**command**.” Data sent from AFC to an external device is simply referred to as “**data**”. For expressions of commands and data, special characters are used in addition to regular alphanumeric characters. These are control characters called delimiters which indicate the break (end) of commands or data. Delimiters used in AFC are ASCII code characters 10 (0x0A) and 13 (0x0D), which are referred to as “Line Feed” (L_F) and “Carriage Return” (C_R) respectively.

■I/O ports

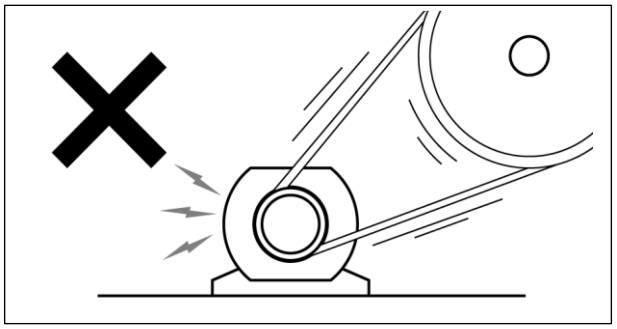
The I/O ports of AFC are normally maintained at TTL level (+5V). This state is called TTL level (+ 5V) or H level in this manual. When keeping input port at COMMON level (0V), it is referred to as input to I / O port or setting to L level.

⚠ Precautions

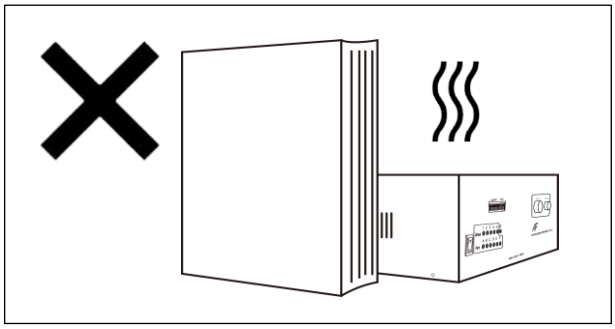
Never do the following actions as it may cause a malfunction.



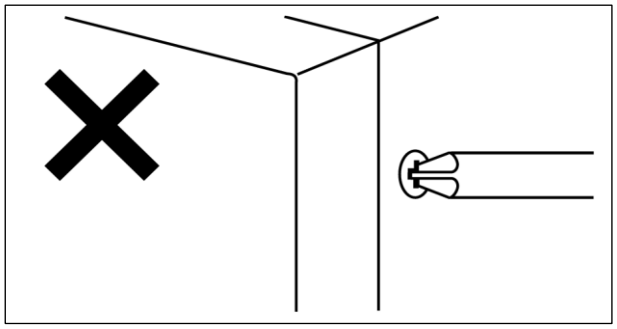
- Do not use other than the provided power cable.
- Never disconnect the connector while the power is turned on. Turn off the power before connecting and disconnecting the connector.
- Place the device where AC inlet is accessible when connecting.



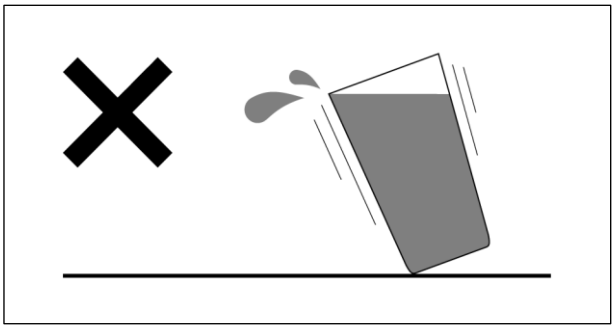
- Use the AC100-240V (50/60Hz) power source.
- Do not use the product near a large generator or heavy electrical appliances, or equipment radiating strong electro-magnetic fields in the neighborhood, as it may cause a malfunction to the product.
- As this product is composed of precision parts, avoid physical impact and minimize vibration when in use.



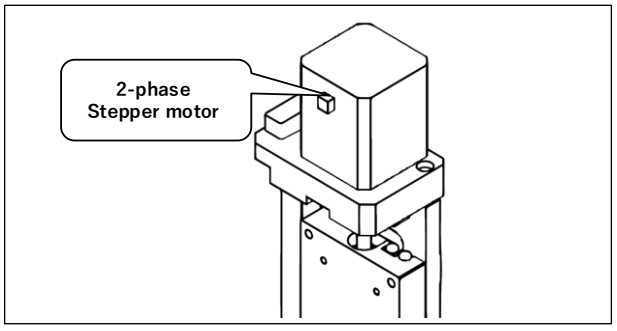
- The product generates considerable heat while it is charged with electricity. Never block the heat discharge slit. Do not use in a place where ventilation is insufficient.
- Use the product at least 100 mm away from surrounding objects.



- Do not disassemble or modify the product.
- To prevent scratches, use soft cloth to wipe only the surface when cleaning the device.
- Do not open the cabinet. Do not modify the product by replacing parts. It may cause a fire, electric shock or malfunction.



- Install on a flat surface.
- Avoid contact with water. It is extremely dangerous when the device gets wet.



- The motor that can be used with this product is 2-phase stepper motor. Any motor different from this type (e.g. 5-phase stepper mortor, servomotor) cannot be driven.

Section 5

Operation Box

Contents

1. Outline

Manual operation will be available when operation box AFC-K is connected to AF controller AFC-6. Operation box mainly performs Auto Focus operation, travel, operation stop, HOME return and parameter setting. Operation box is capable of processing Auto Focus operations SC0, SC1, SC2, SC3, SC4, SC5, SC6, SC7, AF0 and AF2. Travel operation includes JOG travel, STEP travel, travel to specified coordinates and HOME return. Forced stop of AFC operation and reading/writing all parameters are other functions available. Changing color saturation and sound of operation box display are also modifiable as preference setting.

Caution!! **Please turn off 8-pole Dip switch No.3 of AFC-6 when using operation box.**

2. Part names and main functions

This section describes names and main functions of each part of operation box. Each key functions differ depending on screen. This section describes **typical applications**. Detailed functions are explained in each section.

Panel

Displays information of port, coordinate, Auto Focus operation and settings.

Status display LED

Displays AF status.

[Search] key

Executes currently selected Auto Focus operation.

[Z/P] key

Switches travel target to AF driving unit or pattern driving unit.

[Menu] key

Displays menu screen.

[Port] key

Switches ports.

A→B→C→D→E→F (Returns to A after F)

[Far] key, [Near] key

Travel key.

Currently selected driving unit travels slowly to [FAR] or [NEAR] direction.

[High] key

Press and use simultaneously with travel keys ([Far] key, [Near] key).

JOG mode: high speed JOG travel (only supports AF driving unit).

STP mode: performs STEP travel operation for number of steps set.

[Stop] key

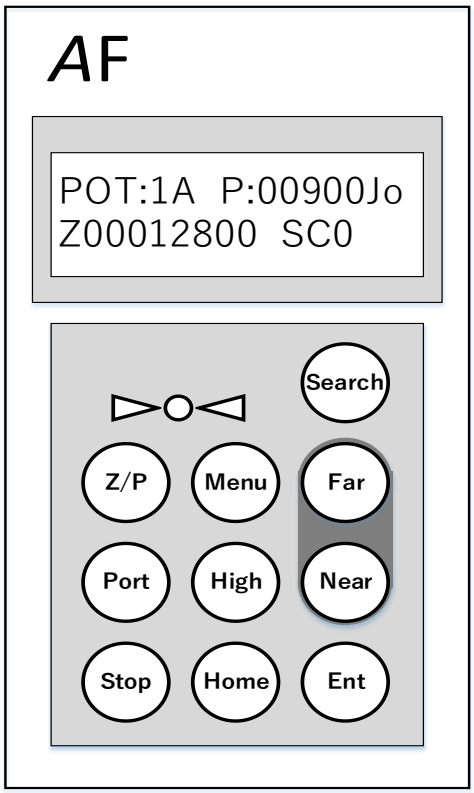
Stops all operation (same as communication command Q.

[Home] key

Performs HOME return.

[Ent] key

Works as enter key.



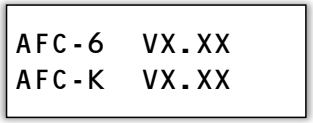
3. Activation operation

■ Operation for activation

AF controller automatically performs HOME return for pattern driving unit and AF driving unit upon power on. Operation box screen after activation is displayed as ①-④. Key operations other than [Stop] key will be rejected during this activation operation although it completes in brief instant.

① Version display

Displays version for 1 second after power is turned ON.



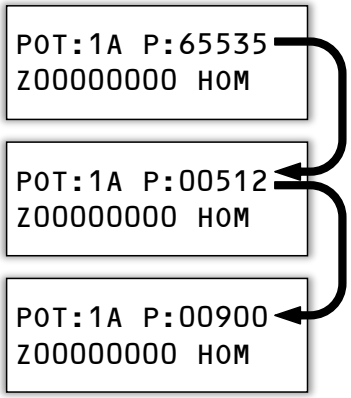
② Pattern driving unit HOME return

Travels to [FAR] limit from current position, resets position information to 512 and moves to coordinate set in parameter No.023: Pattern-INF.

(a) Starts HOME return
Pattern driving unit travels to [FAR] direction, Coordinates are decremented from maximum value (65535).

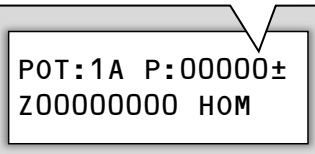
(b) Reaches [FAR] limit
Stops after detecting [FAR] limit. Sets coordinate of pattern driving unit to 512.

(c) Travels to coordinate in parameter No.023: Pattern-INF
Travels to coordinate 900 for initial value status.



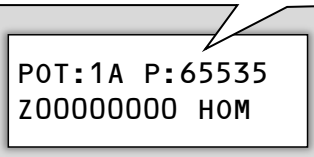
Following display will be shown in cases of incorrect setting of limit logic or incorrect cable connection for pattern driving unit. Please restart after setting and installing correctly.

Displays coordinate of pattern driving unit as 00000±



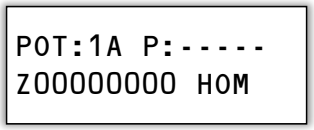
Start process continues but is invalid.

Coordinates of pattern driving unit continues to decrement from maximum value to 0



Press [Stop] key.

HOME return is not performed with setting not to use pattern driving unit. Coordinate information of pattern driving unit is displayed as shown on the right.



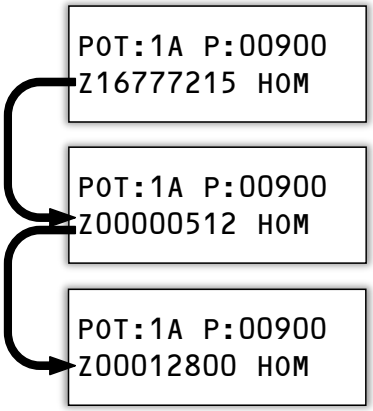
③ AF driving unit HOME return

Travels to [FAR] limit from current position, resets position information to 512 and moves to coordinate set in parameter No.002: STOP.

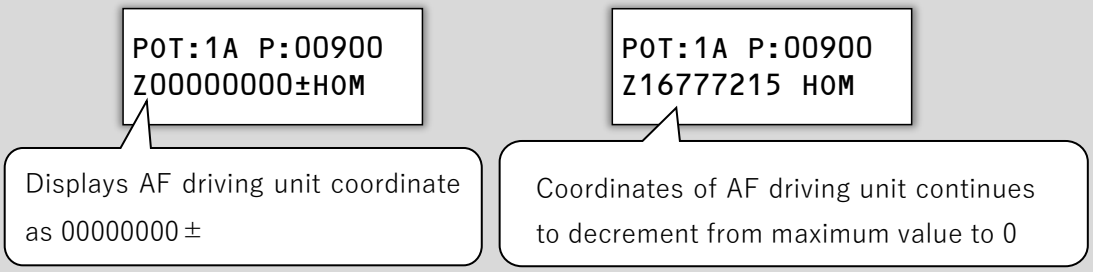
(a) Starts HOME return
AF driving unit travels to [FAR] direction, Coordinates are decremented from maximum value (16777215).

(b) Reaches [FAR] limit
Stops after detecting [FAR] limit. Sets position coordinate of AF driving unit to 512.

(c) Travels to coordinate set in parameter No.002: STOP
Travels to coordinate 12800 for initial value status.



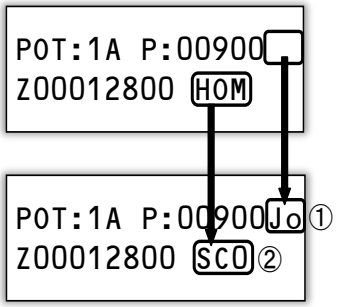
Following display will be shown in cases of incorrect setting of limit logic or incorrect cable connection for AF driving unit. Please restart after setting and installing correctly.



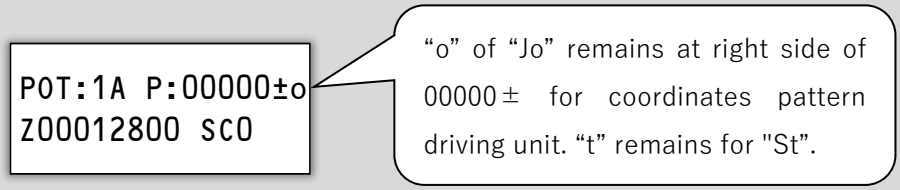
④ Completing activation operation

Travel mode display① and Auto Focus operation display② changes as one of following display.

① Jo, St
② SC0, SC1, SC2, SC3, SC4, SC5, SC6, SC7, AF0, AF2

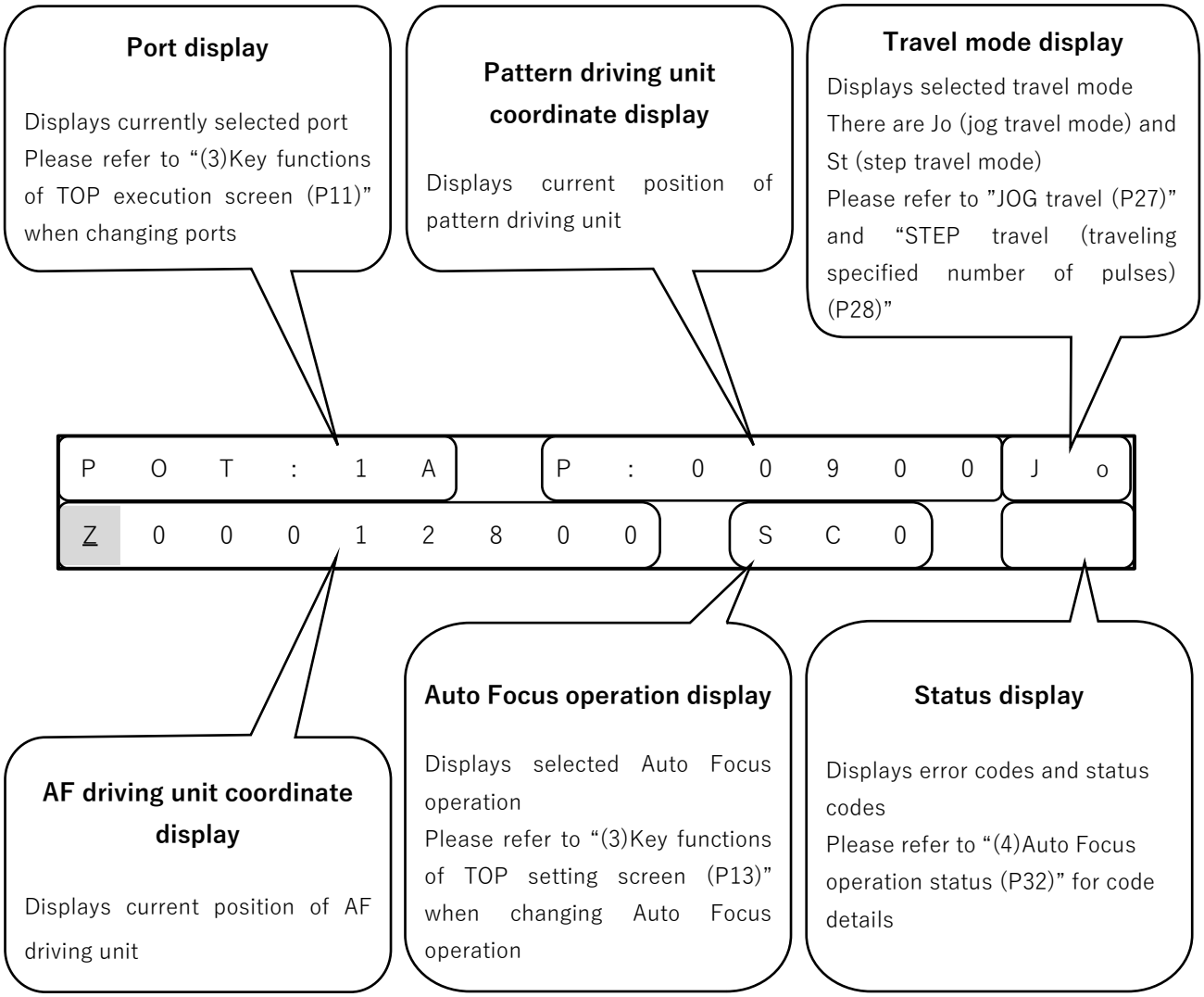


Following display will be shown when failing to HOME return pattern driving unit while succeeding to terminate normally in AF driving unit HOME return. Please restart after setting and installing correctly.



■ Initial screen after activation

Initial screen to perform operation will be displayed after completing activation operation. This initial screen is called “TOP execution screen”.



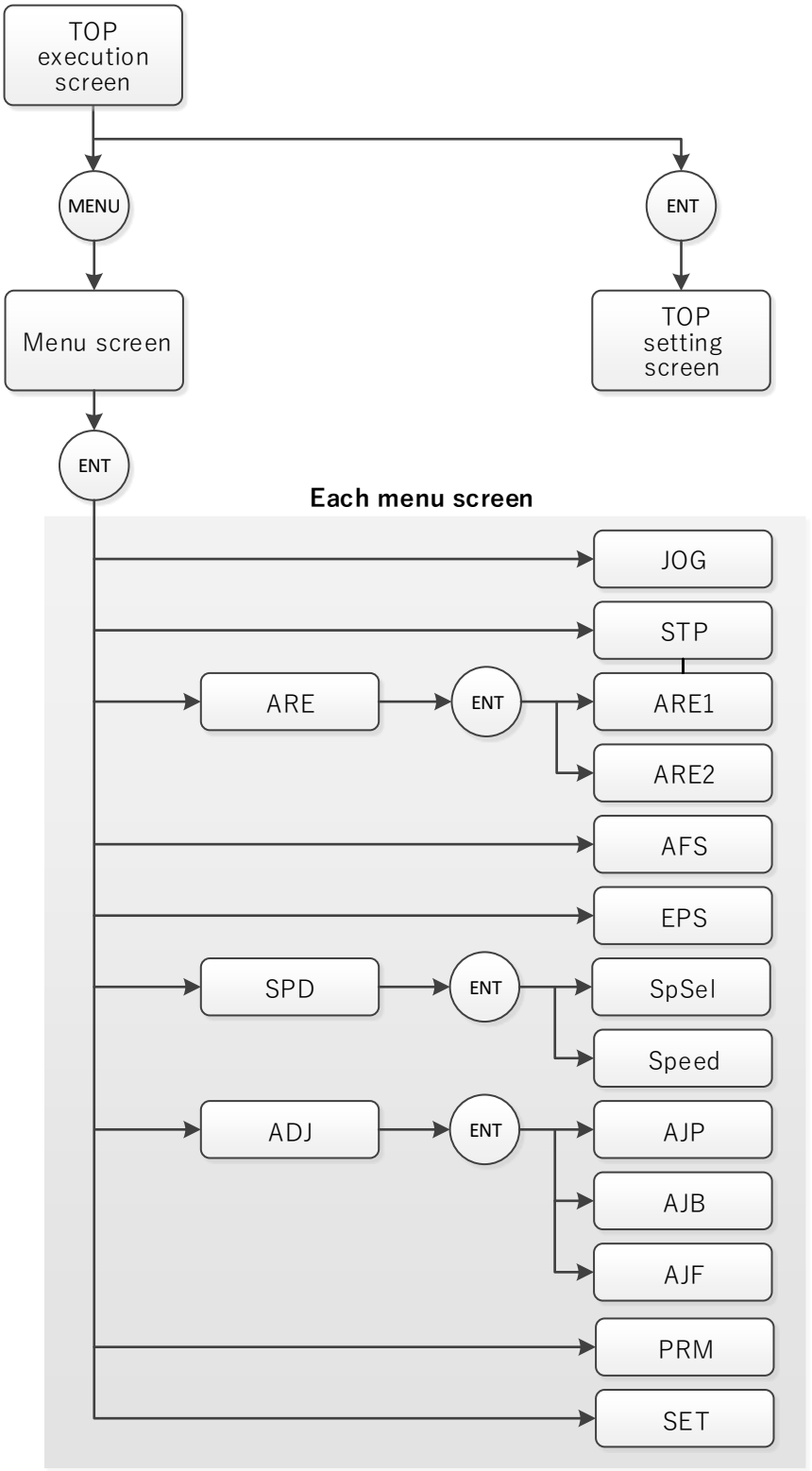
*Cursor position display: Underlined characters are displayed with gray background.

Without cursor : Z

With cursor : Z

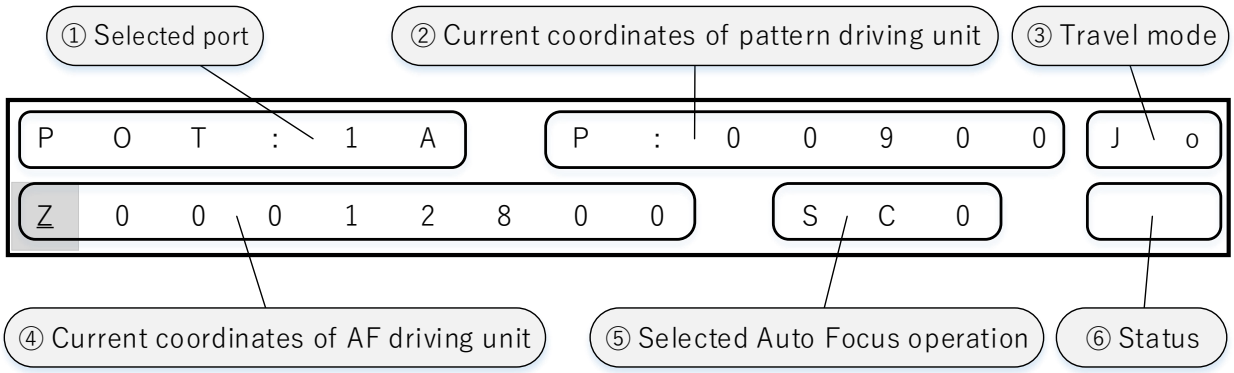
4. Operation box screen

Operation box has three screens; TOP execution screen to mainly perform Auto Focus operation and driving unit travel, TOP setting screen to select settings of TOP execution screen for operations and menu screen to select/set operation modes and various parameters.



■ TOP execution screen

(1) Screen



① Displays selected port. Please refer to "(3)Key functions of TOP execution screen (P11)" as for selecting ports of TOP execution screen.

② Displays current coordinates of pattern driving unit. Value changes while traveling.

③ Displays selected travel mode. Two travels modes are JOG mode (displays Jo) and STEP mode (displays St). Please refer to "JOG travel (P27)" and "STEP travel (traveling specified number of pulses) (P28)" for travel mode settings.

④ Displays current coordinates of AF driving unit. Value changes while traveling.

⑤ Displays selected Auto Focus operation.
Selectable from SC0, SC1, SC2, SC3, SC4, SC5, SC6, SC7, AF0 and AF2. Please refer to "(3)Key functions of TOP setting screen (P13)" for Auto Focus operation settings.

⑥ Display Auto Focus status. Please refer to "(4)Auto Focus operation status (P32)" for status.

(2) LED of TOP execution screen

LED	Contents
▶ ● ◀	Just focused
▶ ○ ◁	Low
▷ ○ ◀	High

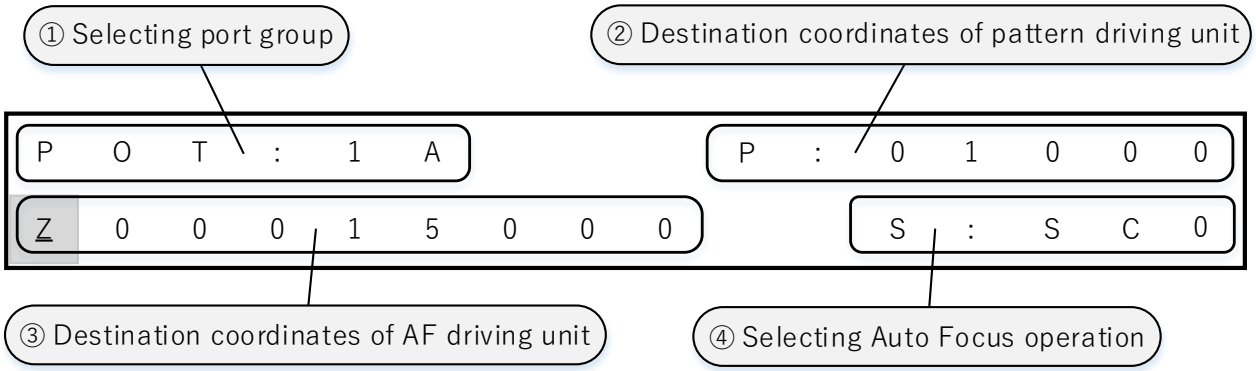
*White indicates OFF and colored indicates ON.

(3) Key functions of TOP execution screen

Key	Contents
Search	Executes selected Auto Focus operation
Z/P	Switches travel target to AF driving unit or pattern driving unit
Port	Switches ports (A-F) A→B→C→D→E→F (Returns to A after F)
Stop	Stops executing travel or Auto Focus operation
Menu	Displays menu screen
High	Press and use simultaneously with travel keys ([Far] key, [Near] key)
Home	Performs HOME return
Far	Moves driving unit to [FAR] direction
Near	Moves driving unit to [NEAR] direction
Ent	Displays TOP setting screen

■ TOP setting screen

(1) Screen



① Selects port group.

② Sets destination coordinates of pattern driving unit. Parameter No.23: Pattern-INF is updated to setting value.

③ Sets destination coordinates of AF driving unit.

④ Selects Auto Focus operation. Selectable operations are SC0, SC1, SC2, SC3, SC4, SC5, SC6, SC7, AF0 and AF2.

(2) LED of TOP setting screen

Not in use.

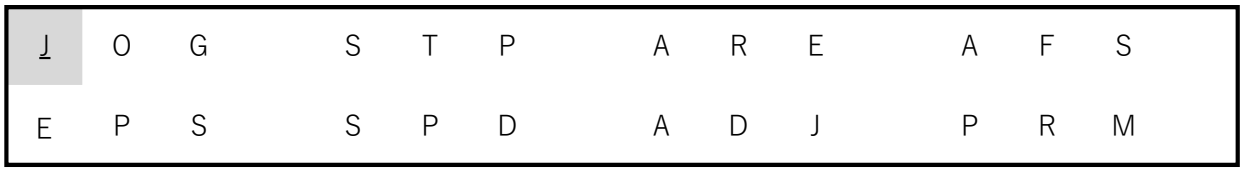
(3) Key functions of TOP setting screen

Key	Contents
Search	Not in use
Z/P	Not in use
Port	Switches ports (A-F) A→B→C→D→E→F (Returns to A after F)
Stop	Cancels all entered settings and returns to TOP execution screen
Menu	Not in use
High	Uses to travel digits when entering destination coordinates Used with [Far] key or [Near] key [High]+[Far]: Moves cursor to left digit (moves to the smallest digit after the largest digit) [High]+[Near]: Moves cursor to right digit (moves to the largest digit after the smallest digit)
Home	Not in use
Far	Port group : Increments port value (1 comes after 5) Destination coordinates: Increments value of cursor position (0 comes after 9) Autofocus operation : Displays Auto Focus operations in following order SC0, SC1, SC2, SC3, SC4, SC5, SC6, SC7, AF0, AF2 (SC0 comes after AF2)
Near	Port group : Decrements port value (5 comes after 1) Destination coordinates: Decrements value of cursor position (9 comes after 0) Autofocus operation : Displays Auto Focus operations in following order SC0, AF2, AF0, SC7, SC6, SC5, SC4, SC3, SC2, SC1 (SC0 comes after SC1)
Ent	Temporary sets items of ①-③ Returns to TOP execution screen when [Ent] key is pressed at ④ reflecting all settings

■ Menu screen

(1) Menu screen

Menu screen consists of 2 pages.



(2) LED of menu screen

Not in use.

(3) Key functions of menu screen

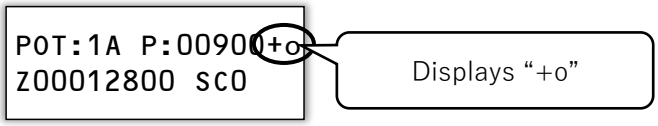
Key	Contents
Search	Not in use
Z/P	Cursor moves to item on right (left end on next row when it is on right end) Page changes to SET after PRM and page changes to JOG after SET
Port	Not in use
Stop	Returns to TOP execution screen
Menu	Not in use
High	Cursor moves to item on left (right end on previous row when it is on left end) Page changes to SET after JOG and page changes to PRM after SET
Home	Not in use
Far	Not in use
Near	Not in use
Ent	Displays selected menu screen

5. Limit sensors

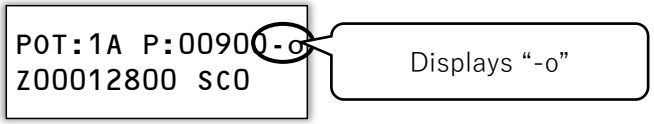
Driving unit is unable to travel towards limit direction when it detects limit sensor and displays limit detection.

- Pattern driving unit

  Detecting [NEAR] side limit sensor

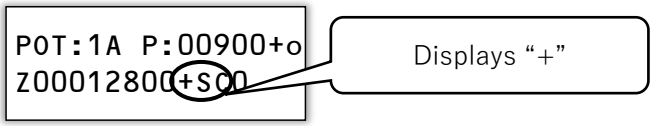


  Detecting [FAR] side limit sensor

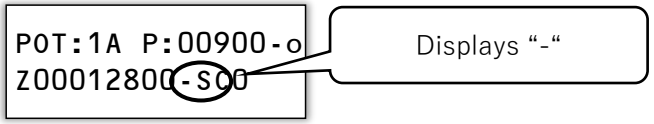


- AF driving unit

  Detecting [NEAR] side limit sensor



  Detecting [FAR] side limit sensor



Caution!! **“±” will be displayed in cases of incorrect setting of limit logic, disconnected cables or cables not connected for driving unit.**

6. Operate AFC from operation box

■ AFC operable items from operation box

Performs following 7 operations.

- JOG travel
- STEP travel
- Traveling to specified coordinates
- Executing Auto Focus operations
- HOME return
- Auto adjustment
- Reading/writing parameters

■ Parameter settings for driving unit operations and Auto Focus operations

Parameters are easily set for JOG travel, STEP travel, traveling to specified coordinates and AF driving unit during Auto Focus operation. Checking parameter values is also available. Parameters to be set are as follows.

- Parameter for travel speed
- Parameter for travel range coordinates and HOME
- Parameter for AF trace operation
- Parameter for AF just focus determination factor

(1) Parameter for travel speed

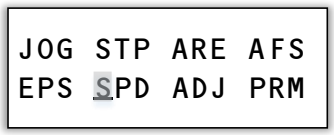
Checks and sets following 4 types of travel speed and Speed_Table.

Parameter No.041: Home_Speed
Parameter No.042: Jog_Speed
Parameter No.043: S-Speed
Parameter No.044: P-Speed

Check and set parameters as follows.

① Press [Menu] key on TOP execution screen

② Move cursor to “SPD” using [Z/P] key or [High] key and press [Ent] key on menu screen



③ Use [Z/P] key or [High] key to move cursor to “SpSel” and press [Ent] key to check and set speed table on SPD screen

(a) Check or change port group

Currently selected port group will be displayed. Change port when cursor is on "P" of "POT”.

Perform following key operations to change port group.

Key	Contents
Port	Switches ports (A-F) A→B→C→D→E→F (Returns to A after F)
Far	Increments group value (1 comes after 5)
Near	Decrements group value (5 comes after 1)
Stop	Returns to TOP execution screen
Ent	Temporary sets port group and cursor moves to lower digit of number for “JogSpd”

(b) Check or change table number of Jog_Speed

Change Jog_Speed table number when cursor is at number after “JogSpd”.

Perform following key operations to change table number.

Key	Contents
Stop	Returns to TOP execution screen Cancels all changed settings
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key [Far] + [High]: Moves cursor to left digit (moves to the smallest digit after the largest digit) [Near] + [High]: Moves cursor to right digit (moves to the largest digit after the smallest digit)
Far	Increments value of cursor position (0 comes after 9) Setting range is 0-31
Near	Decrements value of cursor position (9 comes after 0) Setting range is 0-31
Ent	(b) - (d) : Temporarily sets parameter and cursor moves to lower digit of next item (e) : Returns to (a) after confirming parameters for (b) - (e)

*Please press [Ent] key even parameter values are not changed.

(c) Check and change table number of Home_Speed

Change Home_Speed table number when cursor is at number after “HomeSpd”.

Please refer to (b) for key operations to change table number.

(d) Check and change table number of S-Speed

Change S-Speed table number when cursor is at number after “S-Speed”.

Please refer to (b) for key operations to change table number.

(e) Check and change table number of P-Speed

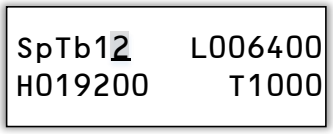
Change P-Speed table number when cursor is at number after “P-Speed”.

Please refer to (b) for key operations to change table number.

④ Use the [Z/P] key or [High] key to move cursor to “Speed” and press [Ent] key to check and set speed for each speed table number on “SPD” screen

(a) Check speed of table number

Number after “SpTb” indicates table number. Displays speed of indicated table number. L shows low speed, H shows high speed and T for acceleration/deceleration time. Change table number when cursor is at number after “SpTb”. Table number is 0-31.



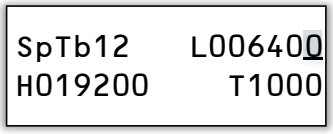
Perform following key operations to change table number, speed and acceleration/deceleration time.

Key	Contents
Stop	Returns to TOP execution screen Cancels all changed settings
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key [Far] + [High]: Moves cursor to left digit (moves to the smallest digit after the largest digit) [Near] + [High]: Moves cursor to right digit (moves to the largest digit after the smallest digit)
Far	Increments value of cursor position (0 comes after 9)
Near	Decrements value of cursor position (9 comes after 0)
Ent	(a) - (c) : Temporarily sets parameter and cursor moves to lower digit of next item (d) : Returns to (a) after confirming parameters for (a) - (d)

*Please press [Ent] key even parameter values are not changed.

(b) Change table number of low speed

Change settings of low speed for displayed table number when cursor is at number after “L”. Setting range is 10-500,000pps.

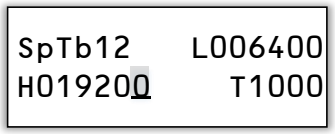


Please refer to (a) for key operations to change settings of low speed.

Caution!! **Unable to perform speed setting when following relationship is not satisfied.**
Low speed ≦ High speed

(c) Change table number of high speed

Change settings of high speed for displayed table number when cursor is at number after "H". Setting range is 10-500,000pps

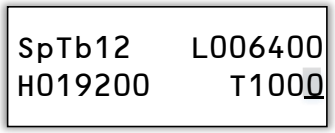


Please refer to (a) for key operations to change settings of high speed.

Caution!! **Unable to perform speed setting when following relationship is not satisfied.**
Low speed ≦ High speed

(d) Change table number of acceleration/deceleration time

Change settings of acceleration/deceleration time for displayed table number when cursor is at number after "T". Setting range is 1-1,000ms.



Please refer to (a) for key operations to change settings of acceleration/deceleration time.

(2) Parameter for travel range coordinates and HOME

Checks and sets following 4 coordinates.

Parameter No.001: FSP
Parameter No.002: STOP
Parameter No.003: MSP
Parameter No.004: NSP

Check and set parameters as follows.

① Press [Menu] key on TOP execution screen

② Move cursor to "ARE" using [Z/P] key or [High] key and press [Ent] key on menu screen

③ Use [Z/P] key or [High] key to move cursor to “ARE1” and press [Ent] key to check and set FSP and NSP on “ARE” screen

(a) Check or change port group

Same as “Parameter for travel speed”. Please refer to “(a)Check or change port group (P17)”.

(b) Check/Change FSP of specified port group

Change FSP coordinate when cursor is at number after “F”. Setting range is 512-16,777,215.

Perform following key operations to change coordinates.

Key	Contents
Stop	Returns to TOP execution screen Cancels all changed settings
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key [Far] + [High]: Moves cursor to left digit (moves to the smallest digit after the largest digit) [Near] + [High]: Moves cursor to right digit (moves to the largest digit after the smallest digit)
Far	Increments value of cursor position (0 comes after 9)
Near	Decrements value of cursor position (9 comes after 0)
Ent	(b) : Temporarily sets parameter and cursor moves to lower digit of next item (c) : Returns to (a) after confirming parameters for (b) and (c)

Caution!! **Unable to perform range setting when following relationship is not satisfied.**

FSP < NSP

(c) Check/Change NSP of specified port

Change NSP coordinate when cursor is at number after “N”. Setting range is 513-16,777,215.

Please refer to (b) for key operations to change NSP.

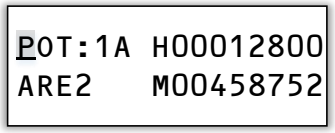
Caution!! **Unable to perform range setting when following relationship is not satisfied.**

FSP ＜ NSP

④ Use the [Z/P] key or [High] key to move cursor to “ARE2” and press [Ent] key to check and set STOP and MSP on “ARE” screen.

(a) Check or change port group

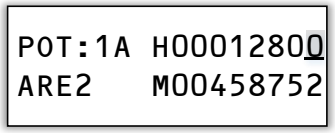
Same as “Parameter for travel speed”.



Please refer to “(a)Check or change port group (P17)”.

(b) Check/Change STOP of specified port

Change STOP coordinate when cursor is at number after “H”. Setting range is 512-16,777,215.

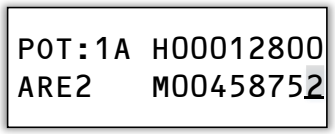


Perform following key operations to change coordinates.

Key	Contents
Stop	Returns to TOP execution screen Cancels all changed settings
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key [Far] + [High]: Moves cursor to left digit (moves to the smallest digit after the largest digit) [Near] + [High]: Moves cursor to right digit (moves to the largest digit after the smallest digit)
Far	Increments value of cursor position (0 comes after 9)
Near	Decrements value of cursor position (9 comes after 0)
Ent	(b) : Temporarily sets parameter and cursor moves to lower digit of next item (c) : Returns to (a) after confirming parameters for (b) and (c)

(c) Check/Change MSP of specified port

Change MSP coordinate when cursor is at number after “M”. Setting range is 512-16,777,215.



Please refer to (b) for key operations to change MSP.

(3) Parameter for AF trace operation

Checks and sets following 2 parameters.

Parameter No.045: AF-Speed

Parameter No.046: AF-Step

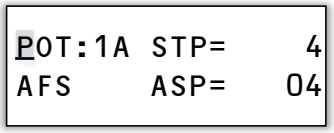
Check and set parameters as follows.

① Press [Menu] key on TOP execution screen

② Move cursor to “AFS” using [Z/P] key or [High] key and press [Ent] key on menu screen

③ Check or change port group

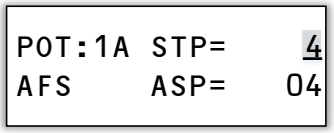
Same as “Parameter for travel speed”.



Please refer to “(a)Check or change port group (P17)”.

④ Check/Change AF-Step of specified port

Change table number of AF-Step when cursor is at number after “STP”. Setting range is 0-7.

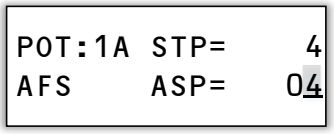


Perform following key operations to change table number.

Key	Contents
Stop	Returns to TOP execution screen Cancels all changed settings
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key [Far] + [High]: Moves cursor to left digit (moves to the smallest digit after the largest digit) [Near] + [High]: Moves cursor to right digit (moves to the largest digit after the smallest digit)
Far	Increments value of cursor position AF-Step : 0 comes after 7 AF-Speed: 0 comes after 9
Near	Decrements value of cursor position AF-Step : 7 comes after 0 AF-Speed: 9 comes after 0
Ent	④: Temporarily sets parameter and cursor moves to lower digit of next item ⑤: Returns to ③ after confirming parameters for ④ and ⑤

⑤ Check/Change AF-Speed of specified port

Change table number of AF-Speed when cursor is at number after “ASP”. Setting range is 0-31.



Please refer to ④ for key operations to change AF-Speed (ASP).

(4) Parameter AF just focus determination factor

Checks and sets following 3 parameters.

Parameter No.051: Epsilon

Parameter No.052: 2nd_Epsilon

Parameter No.053: 3rd_Epsilon

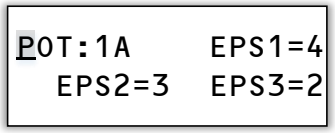
Check and set parameters as follows.

① Press [Menu] key on TOP execution screen

② Move cursor to "EPS" using [Z/P] key or [High] key and press [Ent] key on menu screen

③ Check or change port group

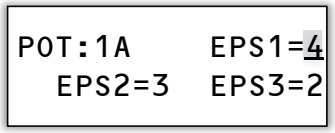
Same as "Parameter for travel speed".



Please refer to "(a)Check or change port group(P17)".

④ Check/Change Epsilon of specified port

Change Epsilon value when cursor is at number after "EPS1". Setting range is 1-7.

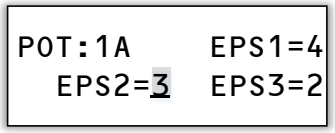


Perform following key operations to change AF just focus determination factor.

Key	Contents
Stop	Returns to TOP execution screen Cancels all changed settings
Far	Increments value of cursor position (1 comes after 7)
Near	Decrements value of cursor position (7 comes after 1)
Ent	④-⑤ : Temporarily sets parameter and cursor moves to lower digit of next item ⑥ : Returns to ③ after confirming parameters ④-⑥

⑤ Check/Change 2nd_Epsilon of specified port

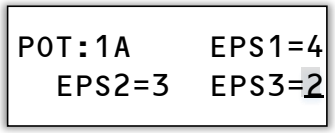
Change 2nd_Epsilon value when cursor is at number after “EPS2”. Setting range is 1-7.



Please refer to ④ for key operations to change 2nd_Epsilon (EPS2).

⑥ Check/Change 3rd_Epsilon of specified port

Change 3rd_Epsilon value when cursor is at number after “EPS3”. Setting range is 1-7.



Please refer to ④ for key operations to change 3rd_Epsilon (EPS3).

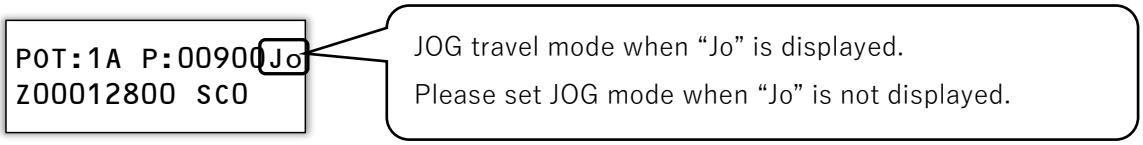
Caution!!

Unable to perform the setting when following relationship is not satisfied.

EPS1 ≧ EPS2 ≧ EPS3

■ JOG travel

JOG travel is available on TOP execution screen. Driving unit keeps traveling while travel key is pressed in JOG travel operation. Use parameter No.042: Jog_Speed for travel speed.



Pattern driving unit is operable when cursor is at “P” and AF driving unit when it is at “Z”.

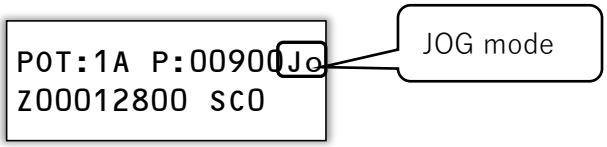
(1) Key operations of JOG travel

Key	Contents
Z/P	Switches travel target to AF driving unit or pattern driving unit
Port	Switches ports (A-F) A→B→C→D→E→F (Returns to A after F)
High	Uses with pressing travel keys ([Far] key, [Near] key) together Switches travel speed to high speed while pressing (Only effective for AF driving unit)
Far	Driving unit travels to FAR direction in low speed while pressing (Displayed value decrements) *Do not press with [Near] key
Near	Driving unit travels to Near direction in low speed while pressing (Displayed value increments) *Do not press with [Far] key

(2) JOG mode settings

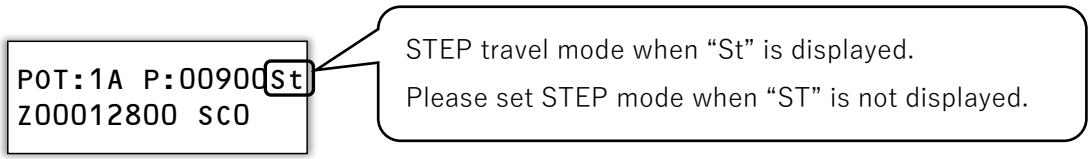
- Check and set parameter Jog_Speed
  Please refer to “(1)Parameter for travel speed (P16)” for details.
- Set JOG mode
  ① Press [Menu] key on TOP execution screen
  ② Press [Ent] key when cursor is at “JOG” on menu screen

  ③ Return to TOP execution screen and operate in JOG mode
  Check JOG mode is displayed.



■ STEP travel (traveling specified number of pulses)

STEP travel operation is available on TOP execution screen. STEP travel is to travel number of pulses and travel distance per pulse depends on driving unit and parameter No.643: Motor-Div. Use parameter No.042: Jog_Speed for travel speed.



Pattern driving unit is operable when cursor is at “P” and AF driving unit when it is at “Z”.

(1) Travel distance

Switch Motor-Div setting to change travel distance of AF driving unit per 1 pulse. Travel distance of pattern driving unit per 1 pulse is fixed to 5 μ m.

Motor_Div	Travel distance for 1 pulse	
	CHUO standard driving unit (except AF-261ZA)	AF-261ZA
0, 1, 2	0.3125 μ m	0.15625 μ m
3	0.15625 μ m	0.078125 μ m
4	0.078125 μ m	0.0390625 μ m

(2) Key operations for STEP travel

Key	Contents
Stop	Stops executing travel
Z/P	Switches travel target to AF driving unit or pattern driving unit
Port	Switches ports (A-F) A→B→C→D→E→F (Returns to A after F)
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key [Far] : Press once to travel 1 pulse to FAR direction (Displayed value decrements) [Near] : Press once to travel 1 pulse to NEAR direction (Displayed value increments)
Far	Press once to travel specified number of steps to FAR direction (Displayed value decrements)
Near	Press once to travel specified number of steps to NEAR direction (Displayed value increments)

(3) STEP mode settings

- Check and set Jog_Speed

  Please refer to "(1)Parameter for travel speed (P16)" for details.

- Set STEP mode

  ① Press [Menu] key on TOP execution screen

  ② Move cursor to "STP" using [Z/P] key or [High] key and press [Ent] key on menu screen

  ③ Set number of steps for pattern driving unit

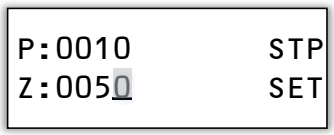
  Change number of steps for pattern driving unit when cursor is at number after "P".

Key operations for setting number of steps

Key	Contents
Stop	Returns to TOP execution screen Cancels all changed settings
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key [Far] + [High]: Moves cursor to left digit (moves to the smallest digit after the largest digit) [Near] + [High]: Moves cursor to right digit (moves to the largest digit after the smallest digit)
Far	Increments value of cursor position (0 comes after 9)
Near	Decrements value of cursor position (9 comes after 0)
Ent	③: Temporarily sets parameter and cursor moves to lower digit of next item ④: Returns to ③after confirming parameters for ③ and ④

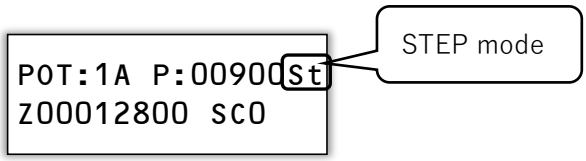
  ④ Set number of steps for AF driving unit

  Change number of steps for AF driving unit when cursor is at number after "Z".



  Please refer to ③ for key operations to change number of steps for AF driving unit.

⑤ Return to TOP execution screen by pressing [Stop] key and operate in STEP mode
Check STEP mode is displayed.

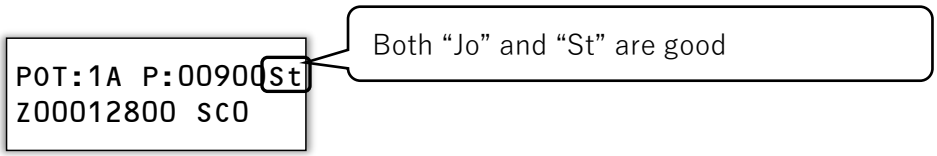


■ Travel to specified coordinates

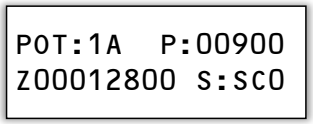
Traveling to specified coordinates is operable on TOP setting screen.
Travel speed is parameter No.041: Home_Speed.

① Check and set Home_Speed
Please refer to "(1)Parameter for travel speed (P16)" for details.

② Press [Ent] key on TOP execution screen



③ Enter destination coordinates on TOP setting screen
Please refer to "TOP setting screen (P12)" for entering coordinates.



④ Press [Ent] key when cursor is at "S"
Return to TOP execution screen to start traveling. When both pattern driving unit and AF driving unit are traveling, AF driving unit travels after pattern driving unit.
Press [Stop] key to cancel travel

■ Execute Auto Focus operation

(1) Auto Focus operation procedure

Specified Auto Focus operation is operable on TOP execution screen.

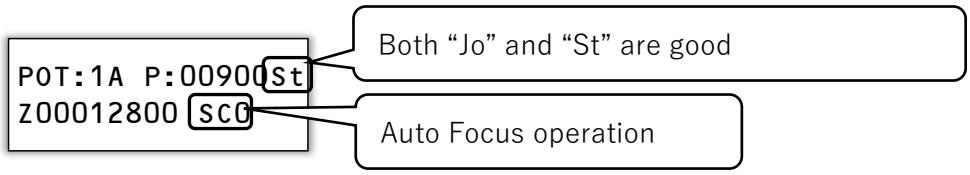
① Check and set parameters related to Auto Focus operation (menu screens)

- Check and set travel speed of AF driving unit
  Please refer to "(1)Parameter for travel speed (P16)".
- Check and set travel range coordinates and HOME of AF driving unit
  Please refer to "(2)Parameter for travel range coordinates and HOME (P20)".
- Check and set AF trace step and AF trace speed
  Please refer to "(3)Parameter for AF trace operation (P23)".
- Check and set AF just focus determination factor
  Please refer to "(4)Parameter AF just focus determination factor (P25)".

② Check and set Auto Focus operation

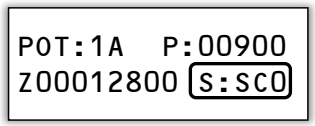
Resume to ⑤ when desired Auto Focus mode is already set.

Press [Ent] key in other cases to transit to ③ TOP setting screen.



③ Select Auto Focus operation on TOP setting screen

Please refer to "TOP setting screen (P12)" for operating TOP setting screen.



④ Confirm input items on TOP setting screen ([Ent] key operation), return to TOP execution screen

⑤ Execute Auto Focus operation by pressing [Search] key

(2) Key operations of Auto Focus operation

Key	Contents
Search	Executes selected Auto Focus operation
Port	Switches ports (A-F) A→B→C→D→E→F (Returns to A after F)
Stop	Stops travel or Auto Focus operation under execution
Ent	Displays TOP setting screen

(3) Status of Just Focus

LED	Contents
▷ ● ◁	Just focused
▶ ○ ◁	Low signal level (low intensity) status during AF trace operation
▷ ○ ◀	High signal level (high intensity) status during AF trace operation

*White indicates OFF and colored indicates ON

(4) Auto Focus operation status

Displays Auto Focus status on TOP execution screen.

Display	Contents
J (JUST FOCUS)	Just Focused and signal level is stable
L (LOW)	AF signal not satisfying Low level determination voltage
H (High)	AF signal exceeding High level determination voltage
B (BUSY)	Under control for AF trace operation
FE (FOCUS Error)	Unable to detect appropriate AF signal during search operation
PE (Peak Error)	Unable to detect peak value of AF signal during peak detection

■ HOME return

Perform HOME return on TOP execution screen

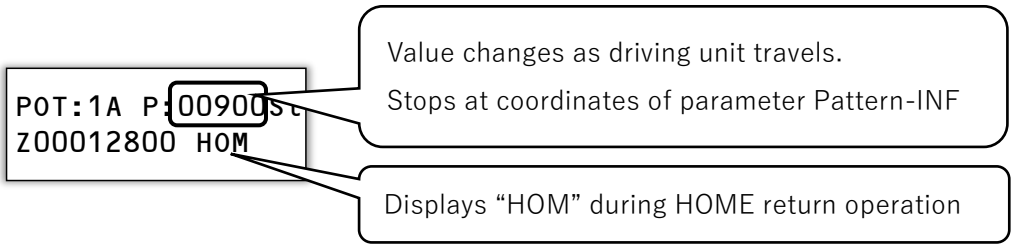
(1) HOME return procedure

Press [Home] key on TOP execution screen.

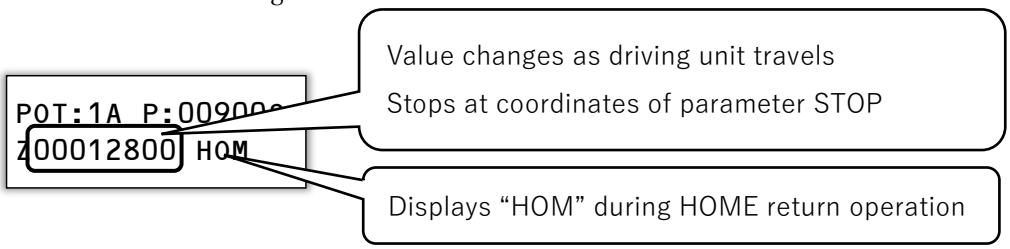
Unable to perform during Auto Focus operation or while traveling.

① and ② will be executed continuously.

① Starts HOME return of pattern driving unit (Section① will be skipped if there is no pattern driving unit)



② Starts HOME return of AF driving unit



*Press [Stop] key to interrupt HOME return operation. Driving unit stops near the interrupted timing when operation is interrupted. Displayed coordinate may not be accurate at this point. Please perform HOME return again after preparing to perform HOME return correctly.

(2) Key operations for HOME return

Key	Contents
Port	Switches ports (A-F) A→B→C→D→E→F (Returns to A after F)
Stop	Interrupts HOME return operation under execution
Home	Performs HOME return operation

■ Auto adjustment

Please refer to “Main Unit” for auto adjustment function. Following parameters are adjusted automatically in auto adjustment function.

Parameter No.021: BPF
Parameter No.022: Balance
Parameter No.023: Pattern-INF

Adjust Pattern-INF by executing AJP, Balance by AJB and BPF by executing AJF mode. Available auto adjustment mode will differ depending on whether pattern driving unit is used or not.

- Pattern driving unit is used
  Adjusting Pattern-INF (AJP)
  Adjusting BPF value (AJF)
- Pattern driving unit is not in use
  Adjusting Balance value (AJB)
  Adjusting BPF value (AJF)

Caution!! **Some parameters will be updated when auto adjustment is performed. It is recommended to create backup file with the adjustment software in advance.**

- Updated parameters
  Parameter No.001: FSP
  Parameter No.004: NSP
  Parameter No.021: BPF
  Parameter No.022: Balance
  Parameter No.023: Pattern-INF
  Parameter No.101: Target_Point
  Parameter No.102: Pattern_Step
  Parameter No.103: In-position_Area
  Parameter No.104: Agc
  Parameter No.105: BpfSrch

(1) Preparation

Prepare following before performing auto adjustment.

- Set port group
  Please refer to “(3)Key functions of TOP setting screen (P13)”.
- Adjust focus position

Focus manually to the point where blur image is visible. Please do not move AF driving unit (Due to put target focus position into travel range of AF driving unit).

Use operation box to move AF driving unit upward/downward after adjusting manually. Fine-tune focus position and adjust precisely to desired just focus position of observation sample.

(2) TOP screen of auto adjustment (ADJ)

- Key operations of ADJ

Key	Contents
Z/P	Switches JOG and STEP of travel mode
Stop	Returns to TOP execution screen
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key Operation of target focus position: : [Far] + [High]: Moves selected driving unit at high speed to FAR direction [Near] + [High]: Moves selected driving unit at high speed to NEAR direction Input of coordinates: : [Far] + [High]: Moves cursor to left digit (moves to the smallest digit after the largest digit) [Near] + [High]: Moves cursor to right digit (moves to the largest digit after the smallest digit)
Far	Operation of target focus position: : Moves selected driving unit at low speed to FAR direction Input of coordinates: : Increments value of cursor position (0 comes after 9)
Near	Operation of target focus position: : Moves selected driving unit at low speed to NEAR direction Input of coordinates: : Decrements value of cursor position (9 comes after 0)
Ent	Confirms settings and moves to next item

- Operation of ADJ

Set common parameters necessary for auto adjustment.

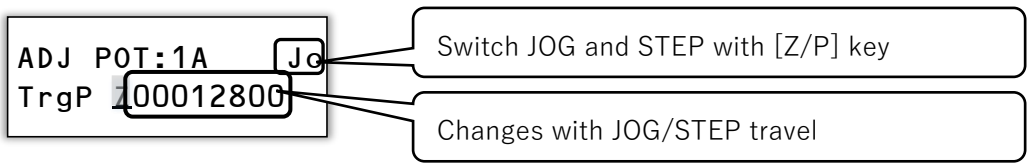
① Press [Menu] key on TOP execution screen

② Move cursor to “ADJ” using [Z/P] key or [High] key and press [Ent] key on menu screen

③ Set target focus of auto adjustment

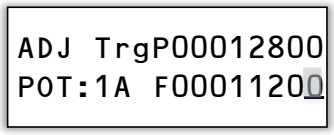
Switches to ADJ screen. Cursor is at "Z" and port group set on TOP execution screen will be displayed on POT. Travel mode will be displayed on upper right corner to set JOG mode or STEP mode.

Move AF driving unit by JOG or STEP travel to determine focus position. Coordinate value at this point will be saved in parameter No.101: Target_Point by pressing [Ent] key. This coordinate becomes target focus position (TrgP).



④ Set FSP of search area

Cursor will be displayed on right end of the lower row to set FSP. Press [Ent] key to fix FSP after entering coordinates. Unable to se FSP <512.



Please set FSP on FAR side from Target_Point.

⑤ Set NSP of search area

Cursor will be displayed on right end of the lower row to set NSP. Press [Ent] key to fix NSP after entering coordinates. Values of parameter No.001: FSP and parameter No.004: NSP will be saved at this point. Unable to set NSP≦512. Error will be displayed when values of FSP＞NSP are input. Please try again from FSP input.

Please set NSP on NEAR side from Target_Point.

⑥ Select auto adjustment mode

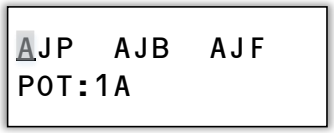
There are 3 modes in auto adjustment modes. Available auto adjustment mode will differ depending on whether pattern driving unit is used or not.

- Pattern driving unit is used

  AJP, AJF

- Pattern driving unit is not in use

  AJB, AJF



Press [Ent] after selecting auto adjustment mode to be executed.

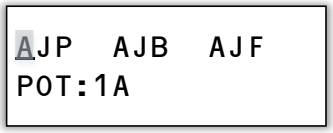
(3) Adjust Pattern-INF (AJP)

Adjust parameter No.023: Pattern-INF in AJP mode. Set following parameters to execute AJP.

- Parameter No.021: BPF
- Parameter No.022: Balance
- Parameter No.102: Pattern_Step
- Parameter No.103: In-position_Area

Following are AJP execution procedure.

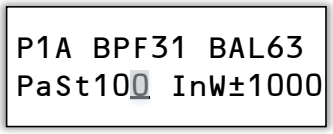
① Move cursor to "AJP" using [Z/P] key or [High] key and press [Ent] key on ADJ auto adjustment mode selection screen.



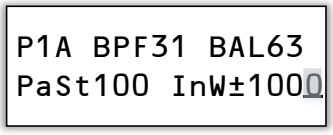
② Upper left block starting with P displays selected port group. Initial position of cursor is at BPF. Enter BPF value and press [Ent] key to save the value.

③ Cursor position changes to BAL (Balance). Enter Balance value and press [Ent] key to save the value.

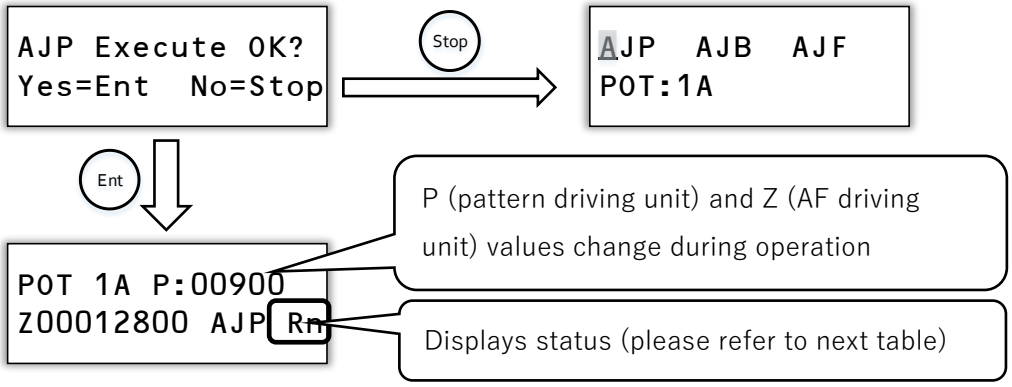
④ Cursor position changes to PaSt (Pattern_Step). Enter Pattern_Step value and press [Ent] key to save the value.



⑤ Cursor position changes to InW (In-position_Area). Enter In-position_Area value and press [Ent] key to save the value.

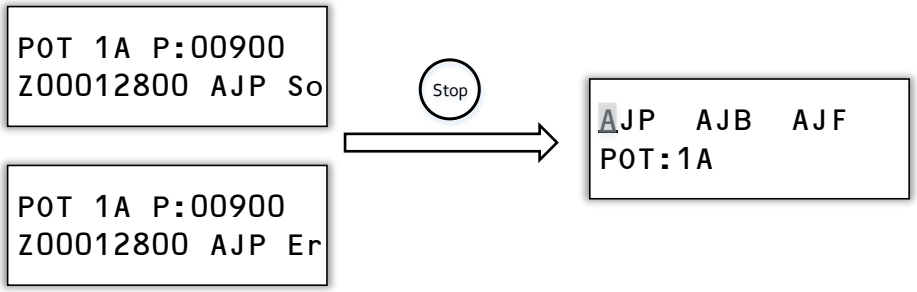


⑥ Changes to AJP execution screen. Press [Ent] key to execute AJP or [Stop] key to transit to ADJ auto adjustment mode selection screen



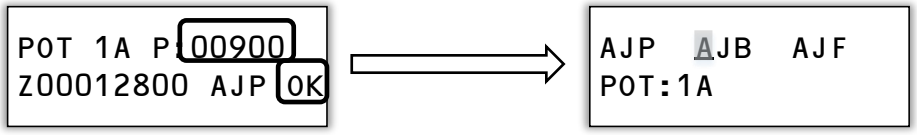
Symbol	Contents
Rn	Executing
So	[Stop] key was pressed during execution
Er	Terminated with error (auto adjustment failed)
OK	Normal termination

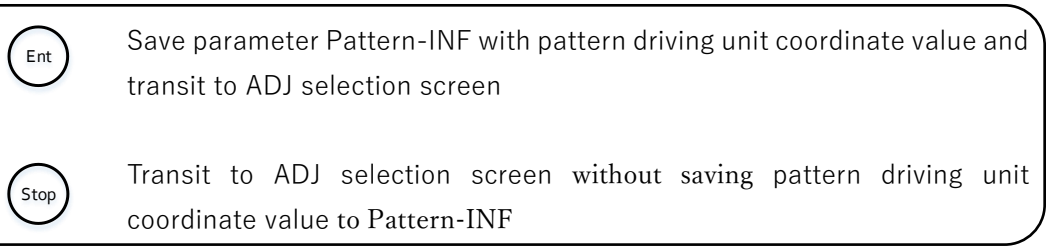
⑦ Please return to ADJ auto adjustment mode selection screen with [Stop] key when “So” or “Er” is displayed



Decrease Pattern_Step or increase In-position_Area and try again when “Er” is displayed.

⑧ “OK” will be displayed upon normal termination. Returns to ADJ auto adjustment mode selection screen after pressing [Ent] key and saves coordinate values of pattern driving unit upon termination to Pattern-INF. Returns to ADJ auto adjustment mode selection screen if [Stop] key is pressed without saving to Pattern-INF.





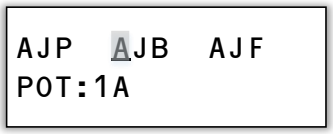
(4)Adjust Balance (AJB)

Adjust Balance in AJB mode. Set following parameters and execute AJB.

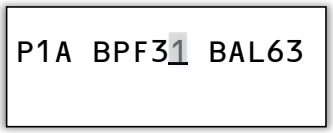
- Parameter No.021: BPF
- Parameter No.022: Balance (Initial value is sufficient for temporary setting)

Following are AJB execution procedure.

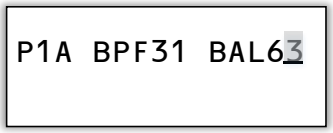
① Move cursor to "AJB" using [Z/P] key or [High] key and press [Ent] key on ADJ auto adjustment mode selection screen.



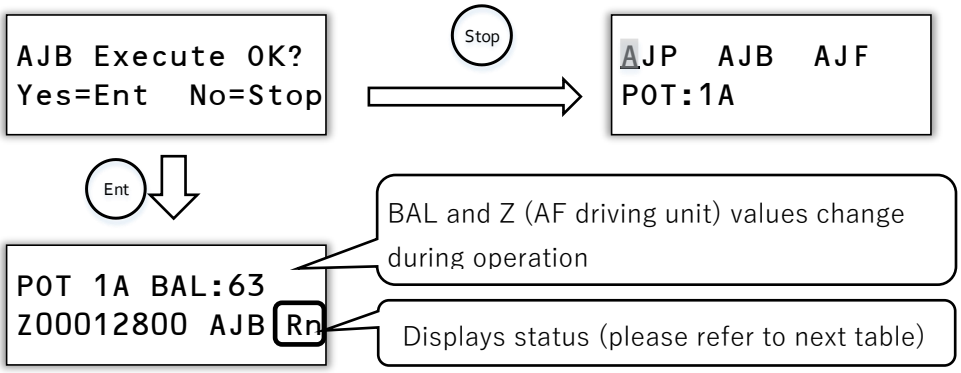
② Upper left block starting with "P" displays selected port group. Initial position of cursor is at BPF. Enter BPF value and press [Ent] key to save the value.



③ Cursor position changes to BAL (Balance). Enter Balance value and press [Ent] key to save the value.

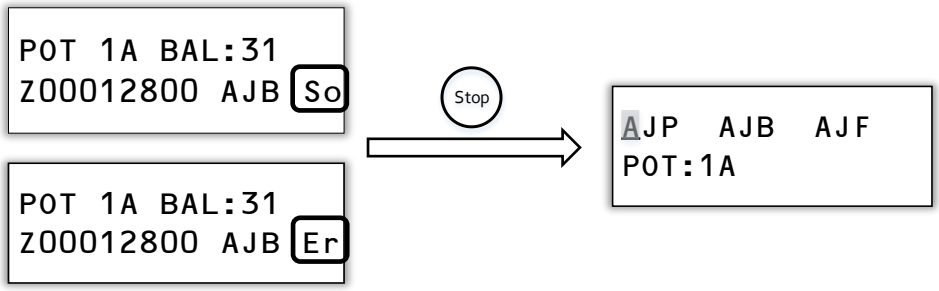


④ Changes to AJB execution screen. Press [Ent] key to execute AJB or [Stop] key to transit to ADJ auto adjustment mode selection screen



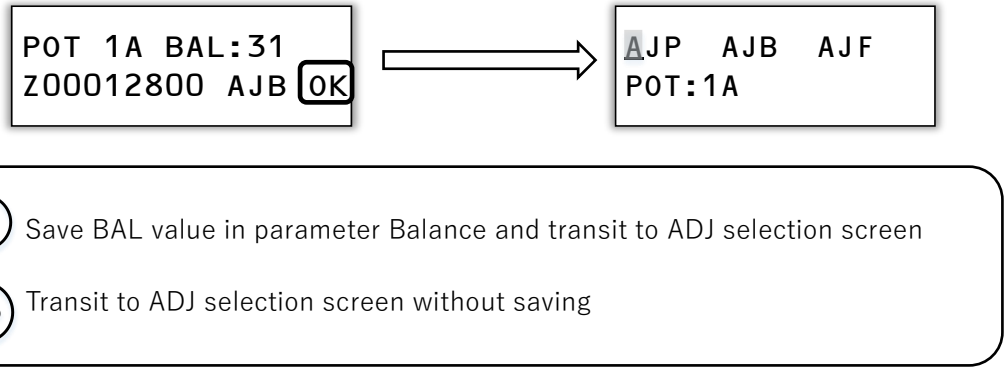
Symbol	Contents
Rn	Executing
So	[Stop] key was pressed during execution
Er	Terminated with error (auto adjustment failed)
OK	Normal termination

⑤ Please return to ADJ auto adjustment mode selection screen with [Stop] key when “So” or “Er” is displayed



Decrease BPF value when “Er” is displayed.

⑥ “OK” will be displayed upon normal termination. Returns to ADJ auto adjustment mode selection screen after pressing [Ent] key and saves BAL values upon termination to parameter Balance. Returns to ADJ auto adjustment mode selection screen if [Stop] key is pressed without saving to Balance.



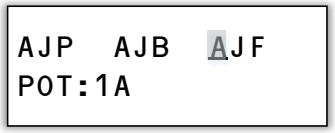
(5)Adjust BPF (AJF)

Adjust BPF value in AJF mode. Set following parameters and execute AJF.

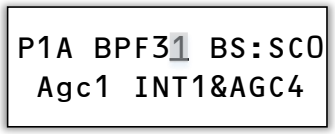
- Parameter No.021: BPF (Initial value is sufficient for temporary setting)
- Parameter No.104: Agc
- Parameter No.105: BpfSrch

Following are AJF execution procedure.

① Move cursor to “AJF” using [Z/P] key or [High] key and press [Ent] key on ADJ auto adjustment mode selection screen.



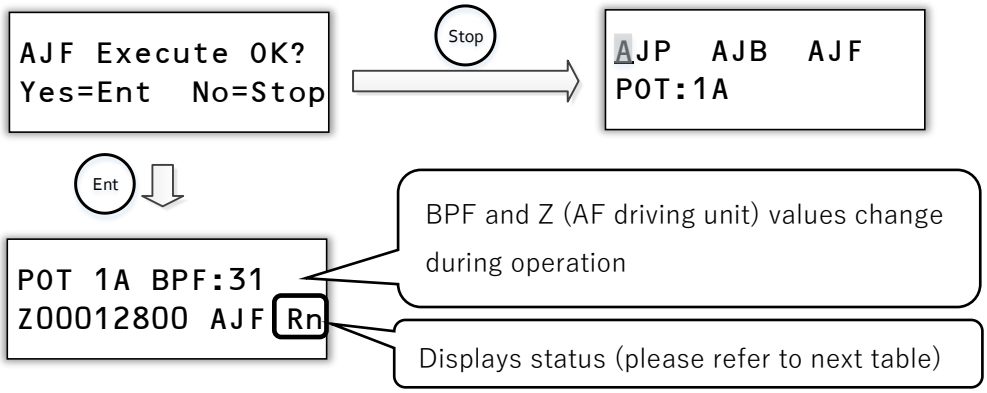
② Upper left block starting with P displays selected port group. Initial position of cursor is at BPF. Enter BPF value and press [Ent] key to save the value.



③ Cursor position changes to BS (BpfSrch). Select BpfSrch and press [Ent] key to save the value.

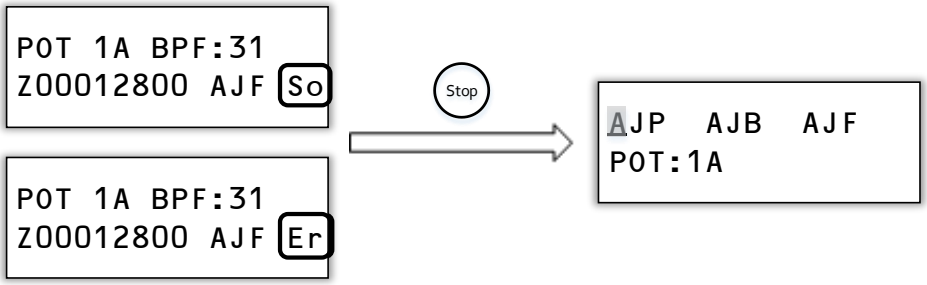
④ Cursor position changes to Agc. Select Agc value (0 or 1) and press [Ent] key to save the value.

⑤ Changes to AJF execution screen. Press [Ent] key to execute AJF or [Stop] key to transit to ADJ auto adjustment mode selection screen.



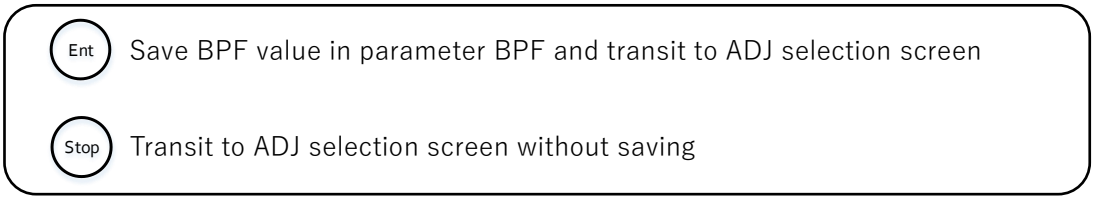
Symbol	Contents
Rn	Executing
So	[Stop] key was pressed during execution
Er	Terminated with error (auto adjustment failed)
OK	Normal termination

⑥ Please return to ADJ auto adjustment mode selection screen with [Stop] key when “So” or “Er” is displayed.



Brighten AF illumination when “Er” is displayed. Please contact CHUO if it still does not terminate normally without executing auto adjustment.

⑦ “OK” will be displayed upon normal termination. Returns to ADJ auto adjustment mode selection screen after pressing [Ent] key and saves BPF values upon termination to parameter BPF. Returns to ADJ auto adjustment mode selection screen if [Stop] key is pressed without saving to BPF.



■ Reading/writing parameters

- Key operations of reading/writing parameters

Key	Contents
Stop	Returns to TOP execution screen Cancels all changed settings
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key [Far] + [High]: Moves cursor to left digit (moves to the smallest digit after the largest digit) [Near] + [High]: Moves cursor to right digit (moves to the largest digit after the smallest digit)
Far	Increments value of cursor position (0 comes after the largest digit)
Near	Decrements value of cursor position (the largest digit comes after 0)
Ent	Confirms or temporarily sets selected item or input value

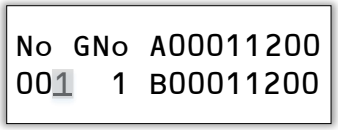
- Reading and writing parameters

All AFC-6 parameters can be read and written using operation box. Please follow the steps below.

① Press [Menu] key on TOP execution screen

② Move cursor to "PRM" using [Z/P] key or [High] key and press [Ent] key on menu screen

③ Enter parameter number and press the [Ent] key



Input value will be rejected when corresponding parameter does not exist. Input parameters will be processed differently for port parameters and system parameters.

④ Display and rewrite parameters

- For port parameters

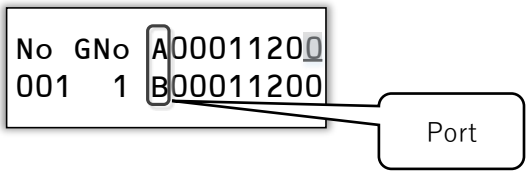
(a) Displays initial screen of parameter number for input port parameter. Cursor locates on group (GNo) displaying current group.

```
No GNo A00011200
001  1 B00011200
```

Group can be changed within setting range of 1-5.

Press [Ent] key to continue reading/writing parameters and transit to (b). Press [Stop] key to terminate and return to TOP execution screen.

(b) Cursor position moves to first digit of A port and A port data will be rewritable



Change value and press [Ent] key to temporarily set the value. Press [Ent] key directly to change value of other ports without changing A port value and transit to (c). Press [Stop] key to terminate and return to TOP execution screen.

(c) Cursor position moves to first digit of B port and B port data will be rewritable (same operation as A port)

```
No GNo A00011200
001  1 B00011200
```

Press [Ent] key to change to C and D port setting screen after setting B port

(d) Cursor position moves to first digit of C port and C port data will be rewritable (same operation as A port)

```
No GNo C00011200
001  1 D00011200
```

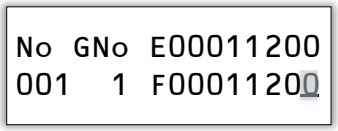
Press [Ent] key to change to E and F port setting screen after setting C and D ports.

(e) Cursor position moves to first digit of E port and E port data will be rewritable (same operation as A port)

```
No GNo E00011200
001  1 F00011200
```

Press [Ent] key to move cursor to first digit of F port after entering E port.

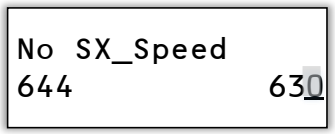
(f) Cursor position moves to first digit of F port and F port data will be rewritable (same operation as A port)



Press [Ent] key to set parameters for A-F and move cursor position to parameter number. Transits to TOP execution screen by pressing [Stop] key.

・ For system parameter

Displays initial screen of parameter number for input system parameter. Cursor is positioned at first digit of data



Press [Ent] key after changing value to set parameter and move cursor position to parameter number. Transits to TOP execution screen by pressing [Stop] key

7. Save setting

Currently set parameter values can be saved. Operation can be resumed upon next activation if setting values are saved.

■ When to save

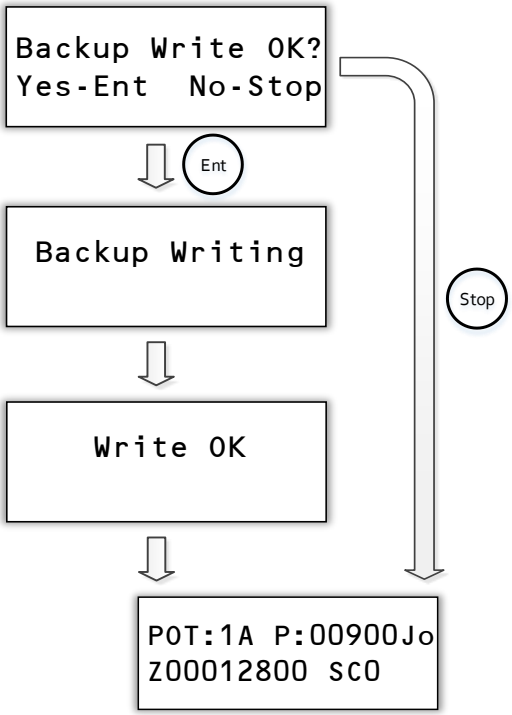
Save timing is when various settings input has completed. This timing can be determined with LED lights.

LED	Contents
▷ ● ◁	Saving available
▷ ○ ◁	Saving not available

＊ White indicates OFF and colored indicates ON

■ How to save

Save process starts with pressing [Menu] key while LED is turned ON. Save confirmation will be displayed. Executes save with [Ent] key or cancel save process with [Stop] key. Returns to TOP execution screen after saving process has completed.



* The settings are valid without even saving. However, in this case, the original setting will be restored when the power is rebooted (or "RESTA" command).

8. Change operation box preferences

Following settings of operation box can be changed.

- Screen brightness
- Screen contrast
- Backlight off time
- Key operation buzzer sound (tone)

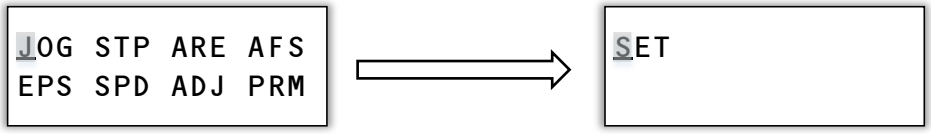
■ Key functions of SET screen

Key	Contents
Stop	Transits to TOP execution screen with SET status
Menu	Starts saving SET setting when pressed LED is turned ON
High	Uses to press travel keys ([Far] key, [Near] key) while pressing [High] key [Far] + [High] : Press once to increment value by 10 [Near] + [High] : Press once to decrement the value by 10
Home	Reset settings of SET screen to initial values
Far	Press once to increment the value by 1 (fix the value)
Near	Press once to decrement the value by 1 (fix the value)
Ent	Transits SET setting items

■ Change operation box preferences

① Press [Menu] key on TOP execution screen

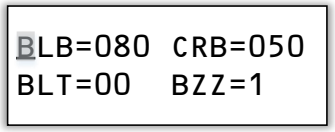
② Move cursor to “SET” using [Z/P] key or [High] key and press [Ent] key on menu screen



*“SET” will be displayed after “PRM”

③ Change screen brightness

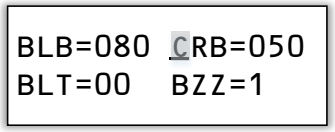
Enter brightness value when cursor is at “BLB”. Press [Ent] key after input to move cursor to “CRB”.



Changing BLB value affects screen brightness. Check brightness while setting to adjust from 0 to 100. 0 is backlight off.

④ Change screen contrast

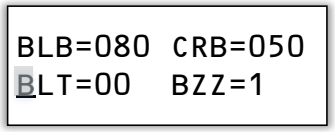
Enter contrast value when cursor is at “CRB”. Press [Ent] key after input to move cursor to “BLT”.



Changing CRB value affects screen contrast. Check contrast while setting to adjust from 0 to 100.

⑤ Change backlight off time

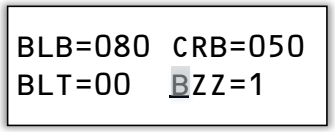
Enter backlight off time value when cursor is at “BLT”. Press [Ent] key after input to move cursor to “BZZ”.



Set time of backlight to turn off from the last operation of operation box. Unit is minutes and set from 0 to 60. It does not turn off when it is set at 0.

⑥ Change key operation buzzer sound (tone)

Enter key operation buzzer value for operation box when cursor is at “BZZ”. Press [Ent] key after input to return cursor to “BLB”.



4 types of buzzer sounds can be set from 0 to 3. 0 is muted.

Caution!! **Press [Home] key when characters are invisible and unable to operate. All preferences will be reset to initial values.**

Warranty and repair

■Warranty period

Repair services are available for free of charge in the event of technical failure under warranty period in accordance with CHUO regulations.

Warranty period	1 year from shipment

Repair costs will not be covered for following cases.

- Due to improper use, inappropriate repair or remodeling the product
- Due to applying external shock after purchasing the product
- Due to fire, earthquake, flood, lightning or other natural disasters
- Due to environmental pollution or by applying abnormal voltage
- For defects predetermined by CHUO not to apply this warranty
- Due to any use not following this instruction manual

■Repair service during warranty period

Please contact the authorized distributors or company of purchase for repair service.

■Repair service for out-of-warranty products

Contact the authorized distributors or company of purchase for out-of-warranty products. Repair services will be provided with charges depending on conditions. Please provide the following information in order to prepare and deliver effective repair services.

- Date of purchase, product name and manufacturing number
- Details of how the product is used
- Specific description of defects
- Matters that may be the cause of defect

Please note in advance that there may be cases that CHUO is unable to provide repair services.

All descriptions and specifications in this manual are subject to change without prior notice.
Please note in advance that products are also subject to change without prior notice.

Auto Focus Controller AFC-6　INSTRUCTION MANUAL

- Operation Box - Ver. 1.0

Oct. 31, 2019 YUA.

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