AF

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

Auto Focus Controller

AFC-6

INSTRUCTION MANUAL

－ I/O Ports －

AF

Auto Focus System for Microscopy AFC-6

CHUO SEIKI
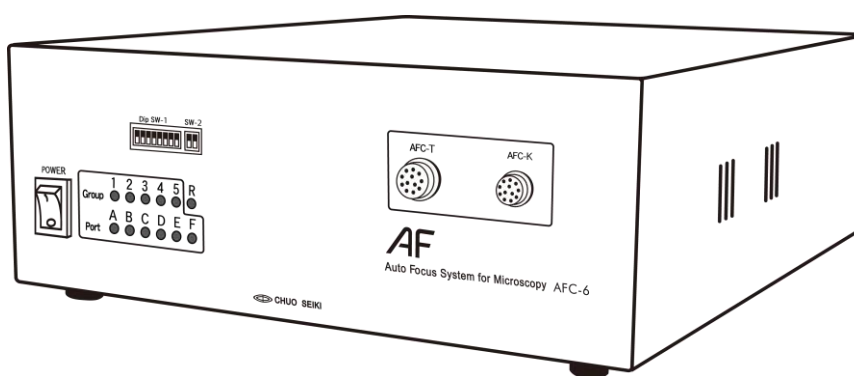
CHUO PRECISION INDUSTRIAL CO.,LTD.

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.
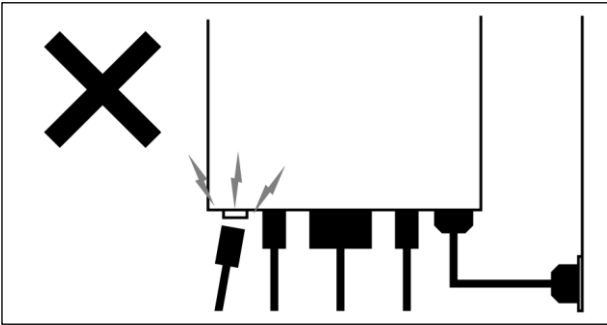
- ●Do not use other than the provided power cable.
- ●Never disconnect the connector while the power is turned on. Turn off the power before connecting and disconnecting the connector.
- ●Place the device where AC inlet is accessible when connecting.
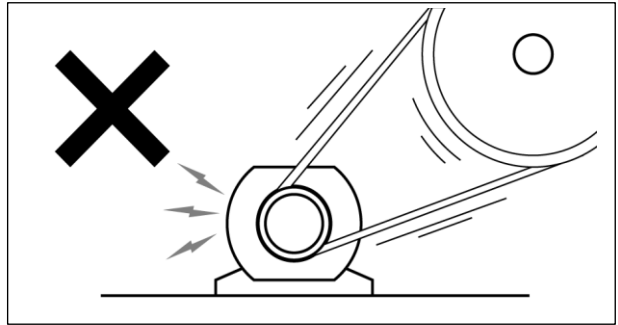
- ●Use the AC100-240V (50/60Hz) power source.
- ●Do not use the product near a large generator or heavy electrical appliances, or equipment radiating strong electro-magnetic fields in the neighborhood, as it may cause a malfunction to the product.
- ●As this product is composed of precision parts, avoid physical impact and minimize vibration when in use.
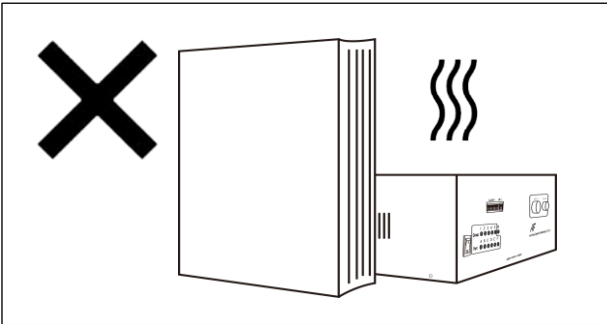
- ●The product generates considerable heat while it is charged with electricity. Never block the heat discharge slit. Do not use in a place where ventilation is insufficient.
- ●Use the product at least 100 mm away from surrounding objects.
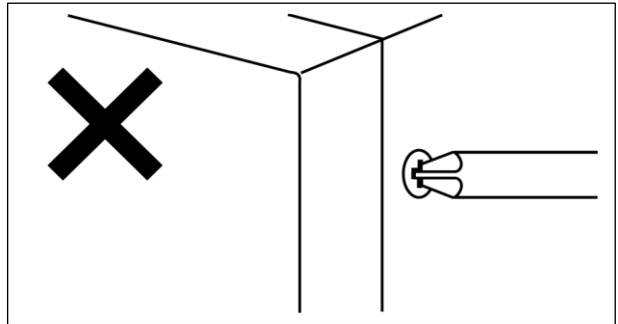
- ●Do not disassemble or modify the product.
- ●To prevent scratches, use soft cloth to wipe only the surface when cleaning the device.
- ●Do not open the cabinet. Do not modify the product by replacing parts. It may cause a fire, electric shock or malfunction.

2-phase
Stepper motor
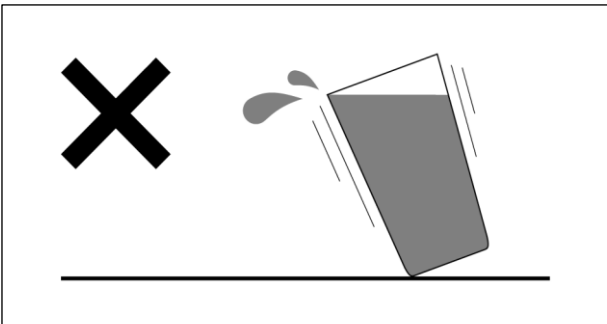
- ●Install on a flat surface.
- ●Avoid contact with water. It is extremely dangerous when the device gets wet.
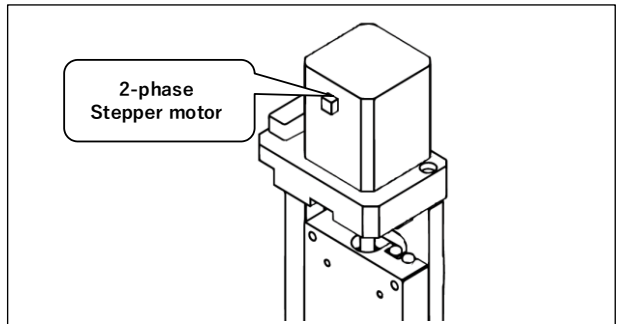
- ●The motor that can be used with this product is 2-phase stepper motor. Any motor different from this type (e.g. 5-phase stepper mortor, servomotor) cannot be driven.

Section 4

I/O Ports

Contents

1. Outline

It enables to control and observe status externally by connecting AFC-6 and I/O ports.
Following list describes the applicable functions and operations to be controlled.

- Change groups
- Change ports
- Stop operations
- Pulse travel control of AF driving unit
- Continuous travel control of AF driving unit
- Auto Focus operation (AF0, SC0, SC2)
- Operation of AF driving unit returning to HOME
- Observation of Auto Focus status
- Limit detection of AF driving unit
- Notification of Auto Focus controller internal error

2. Terminals

■ **List of terminals**

Pin No.	Signal	IN/OUT	Description
1	+5V		+5V output(Maximum output current: 1A)
2	+5V		+5V output(Maximum output current: 1A)
3	EXO-NEAR	OUT	AF driving unit travelling to NEAR direction
4	EXO-FAR	OUT	AF driving unit travelling to FAR direction
5	EXO-AF_MODE	OUT	AF0 status
6	EXO-SEARCH	OUT	SC0 status
7	EXO-2FC	OUT	Second function
8	EXO-OVER	OUT	Signal output over
9	EXO-UNDER	OUT	Signal output under
10	EXO-J_FOCUS	OUT	Just focus
11	EXO-A	OUT	A port selected signal
12	EXO-B	OUT	B port selected signal
13	EXO-C	OUT	C port selected signal
14	EXO-D	OUT	D port selected signal
15	EXO-E	OUT	E port selected signal
16	EXO-F	OUT	F port selected signal
17	EXI-STOP	IN	Stop signal
18	EXI-A	IN	A port enabled
19	EXI-B	IN	B port enabled
20	EXI-C	IN	C port enabled
21	EXI-D	IN	D port enabled
22	EXI-E	IN	E port enabled
23	EXI-F	IN	F port enabled
24	EXI-NEAR	IN	AF driving unit travel to NEAR direction
25	EXI-FAR	IN	AF driving unit travel to FAR direction
26	EXI-AF_MODE	IN	AF0 enabled
27	EXI-SEARCH	IN	SC0 enabled
28	EXI-2FC	IN	Second function enabled
29	GND		GND
30	GND		GND
31	EXO-N_LIMIT	OUT	NEAR limit
32	EXO-F_LIMIT	OUT	FAR limit
33	EXI-RESET	IN	Reset operation Performs the same operation as power reset

34	Exclusive for system	IN	Do not connect
35	Exclusive for system	OUT	Do not connect
36	EXO-GP1	OUT	Group selected address [0]
37	EXO-GP2	OUT	Group selected address [1]
38	EXO-GP3	OUT	Group selected address [2]
39	ALERT	OUT	Internal monitoring signal
40	Exclusive for system	OUT	Do not connect
41	EXI-GP1	IN	Group specified address [0]
42	EXI-GP2	IN	Group specified address [1]
43	EXI-GP3	IN	Group specified address [2]
44	Exclusive for system	IN	Do not connect
45	Exclusive for system	IN	Do not connect

＊ Please do not connect to terminal which is exclusive for system. Do not use it as relay terminal either as it may cause malfunction.
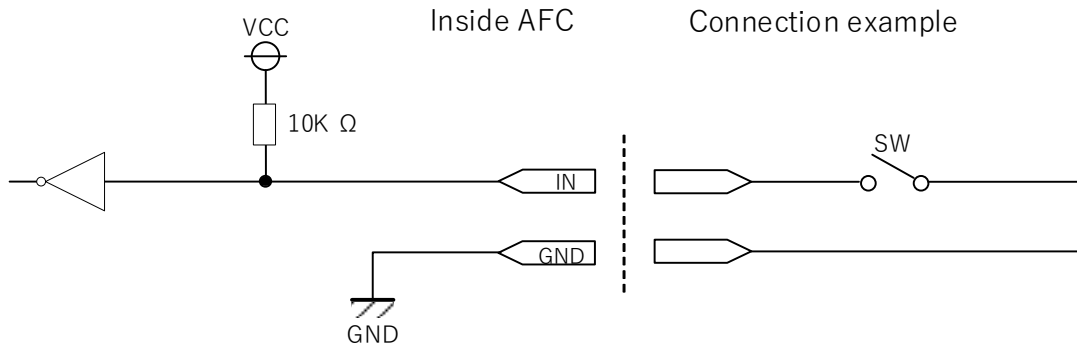
■ Examples of terminal connection

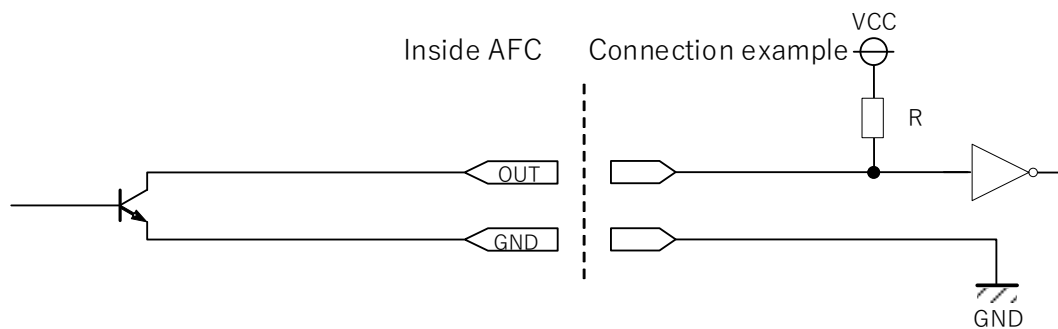It is controlled at +5V level and GND (0V) level. Kept as OPEN when not in use.

① IN terminal (EXI-RESET)
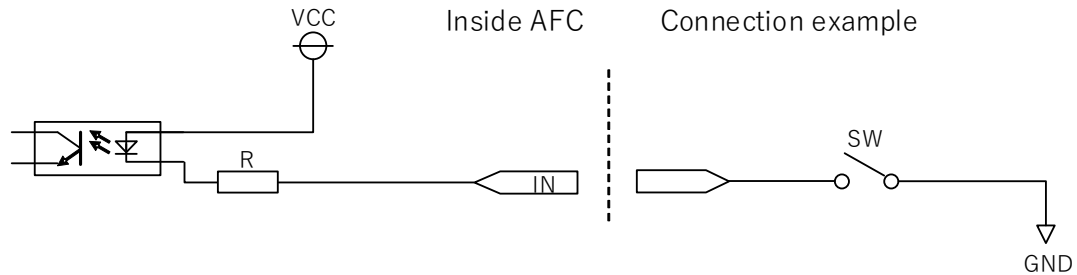
② IN terminal (except EXI-RESET)

③ OUT terminal

Output for OUT terminal is an open collector. Please prepare an external power supply.

Maximum voltage is DC 50 [V] and maximum current is 100 [mA].

Caution: control with an external circuit not to exceed maximum voltage and maximum current.

3. Operation

■ **Power**

① GND

[Pin name]	GND (Pin 29), GND (Pin 30)
[Function]	GND with 0V

② +5V

[Pin name]	+5V (Pin 1), +5V (Pin 2)
[Function]	Power with 5V. Maximum output current up to 1A. Pin1 and Pin2 are connected inside AFC.

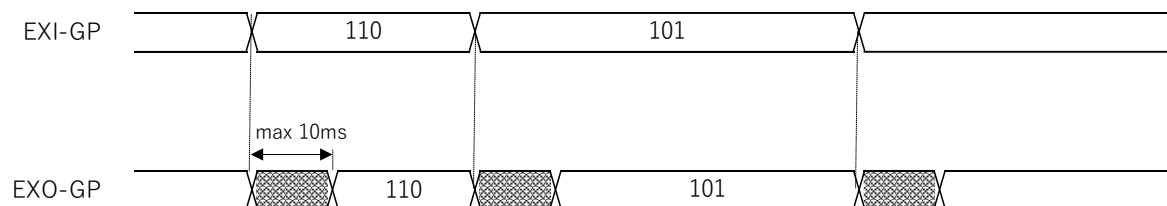## ■ Input/Output signals

① Group specified address

| [Pin name] | Input | : EXI-GP1 (Pin 41), EXI-GP2 (Pin 42), EXI-GP3 (Pin 43) |

[Pin name]   Input   : EXI-GP1 (Pin 41), EXI-GP2 (Pin 42), EXI-GP3 (Pin 43)

Output   : EXO-GP1 (Pin 36), EXO-GP2 (Pin 37), EXO-GP3 (Pin38)

[Function]   Able to specify a group by input signal and check selected group by output signal.

[Description] EXI-GP[2:0] = {EXI-GP2, EXI-GP1, EXI-GP0}

*Bus notation for EXI-GP[2:0] is in sequence of EXI-GP2, EXI-GP1, EXI-GP0

When specifying a group with mixed channel of I/O pin and POT command, the latest setting becomes effective. Do not set invalid values.

[Caution]   EXO-GP is an unknown value for 10 milliseconds after changing the settings with EXI-GP or other operations (operation box, command).

[Truth table] The following value means {EXI-GP2, EXI-GP1, EXI-GP0}.

Value	Control
111	Invalid
110	Group 1
101	Group 2
100	Group 3
011	Group 4
010	Group 5
001	Invalid
000	Invalid

[Timing chart]

This output value is unknown. Do not use the data during this period.

② Port Enable

[Pin name]	Input	: EXI-A (Pin 18), EXI-B (Pin 19), EXI-C (Pin 20), EXI-D (Pin 21),
		EXI-E (Pin 22), EXI-F (Pin 23)
	Output	: EXO-A (Pin 11), EXO-B (Pin 12), EXO-C (Pin 13), EXO-D (Pin 14),
		EXO-E (Pin 15), EXO-F (Pin 16)

[Function] Able to specify a group by input signal and check selected group by output signal.

[Description] Enable by setting the port to L level before use.

EXI-A, EXI-B, EXI-C, EXI-D, EXI-E and EXI-F is set as exclusive control. Not able to set multiple pins to specify ports at a time.

When specifying a group with mixed channel of I/O pin and POT command, the latest setting becomes effective. Invalid values will be ignored.

Group specification with I/O pins becomes ineffective when invalid values are set and EXO-A to EXO-F follow settings of other operations (operation box, commands)

[Caution] EXO-A, B, C, D, E and F are unknown values for 10 milliseconds after changing the settings with EXI- A, B, C, D, E and F or other operations (operation box, command).

[Truth table] Following are listed in order of EXI-A, EXI-B, EXI-C, EXI-D, EXI-E and EXI-F.

Value	Control
011111	Port A
101111	Port B
110111	Port C
111011	Port D
111101	Port E
111110	Port F
Other	Invalid

[Timing chart]

③ Stop command

| [Pin name] | Input : EXI-STOP (Pin 17) |

[Function]　　Stops all ongoing operations.

[Description]　Same as communication command Q. "K"$C_R L_F$ will be sent to serial port when it is controlled by EXI-STOP.

[Caution]　　"K"$C_R L_F$ is sent to serial port inevitably. Please note when using the computer for RS-232C communication.

If stop at EXI-STOP during a move instruction or AF operation instruction by input signals, set EXI-STOP to L level and set the input signals during these instructions to H level.

[Truth table]

Value	Control
0	Stop operation
1	Normal status

[Timing chart]
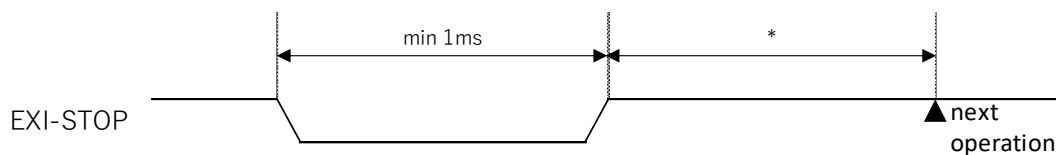
∗ After executing EXI-STOP, make sure that the drive unit is stopped before performing the next processing.

④   AF driving unit travel (pulse control)

[Pin name]   Input   : EXI-NEAR (Pin 24), EXI-FAR (Pin 25)

Output   : EXO-NEAR (Pin 3), EXO-FAR (Pin 4)

[Function]   Moves AF driving unit. NEAR direction is controlled by EXI-NEAR and FAR direction by EXI-FAR. Travels in units of one pulse.

[Description]   Moves 1 pulse when it reaches H level if EXI-NEAR or EXI-FAR is set to L level between 1ms and 15ms.

[Caution]   Do not set EXI-NEAR and EXI-FAR to L level at the same time.

[Timing chart]

・Timing for continuous travel of one pulse movement

After one pulse is output, EXO-NEAR returns to H level.
(The length of the L level period changes depending on the speed setting.)
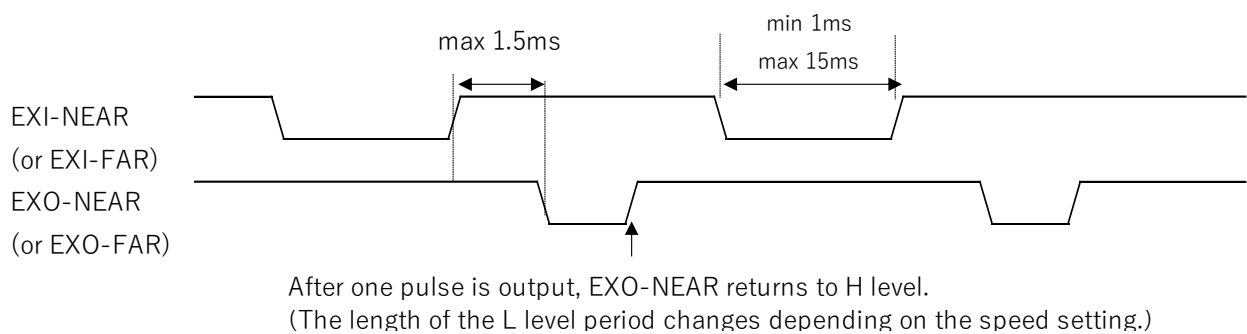
・Timing for switching of travel direction
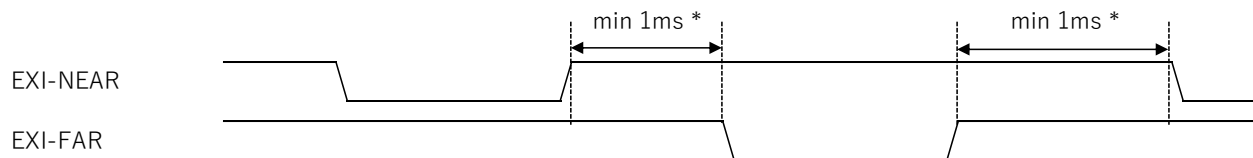
*Interval for switching of travel direction depends on travel speed and load. Please switch direction after the travel in order to operate safely.

⑤　AF driving unit travel (continuous travel)

[Pin name]	Input	: EXI-NEAR (Pin 24), EXI-FAR (Pin 25), EXI-2FC (Pin 28)
	Output	: EXO-NEAR (Pin 3), EXO-FAR (Pin 4)
[Function]		Moves AF driving unit with jog travel in continuous mode. NEAR direction is controlled by EXI-NEAR and FAR direction by EXI-FAR.
[Description]		Travels in continues mode when EXI-NEAR or EXI-FAR is set to L level for more than 18ms. It switches to high speed travel when EXI-2FC is set to L level during continues mode. EXI-2FC is switchable between high/low speed travel at any point. Travel speed is set by the parameter.
[Caution]		Do not set EXI-NEAR and EXI-FAR to L level at the same time.

[Timing chart]
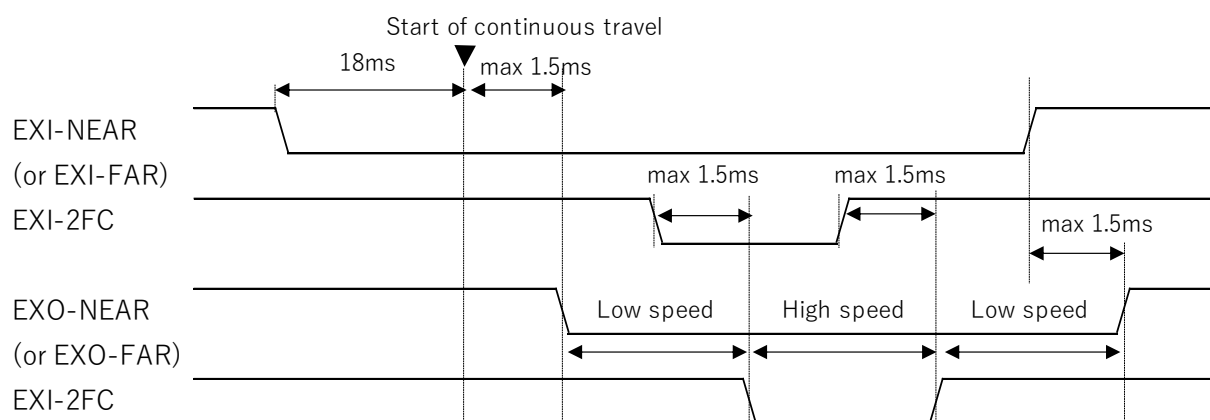
⑥   Auto Focus operation (AF0)

[Pin name]   Input   : EXI-AF_MODE (Pin 26), EXI-STOP (Pin 17)

Output   : EXO-AF_MODE (Pin 5)

[Function]   Executes Auto Focus operation AF0.

[Description] Auto Focus operation AF0 starts when EXI-AF_MODE is set to L level for more than 2ms. EXI-AF_MODE level can be set to H/L after AF0 has started. However, set it to H level when stopped . Auto Focus operation stops when either EXI-STOP is set to L level for more than 1ms, communication command Q is sent, or [STOP] key is pressed.

Re-search (switch to SC0 or SC2) can perform during AF tracking when parameter No.603:Re-PushAF is 0. Return EXI-AF_MODE to H level and operate SC0 or SC2.

[Timing chart]

・ AF0 start and stop
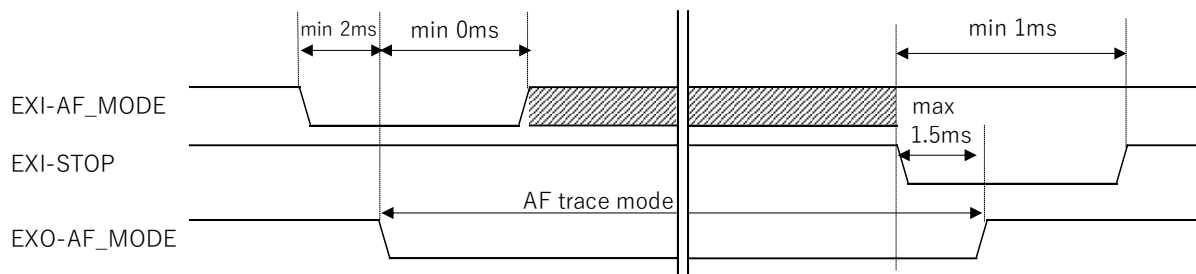
This can be set either H/L level input.

∗   In one-shot mode, EXO-AF_MODE will be at H level when the number of continuous just focus reaches the set value.

・ AF0 → SC0 (Re-PushAF=0)
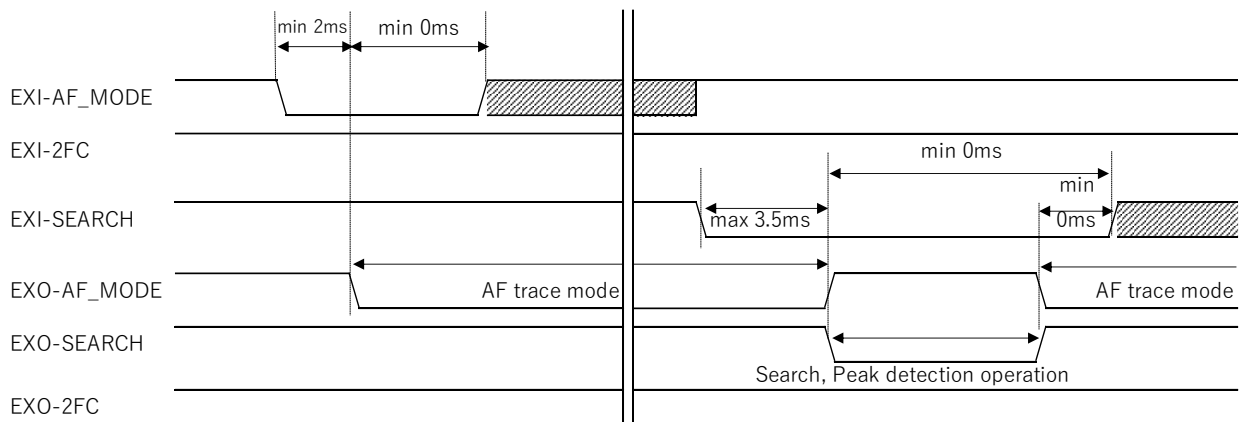
・ AF0 → SC2 (Re-PushAF=0)
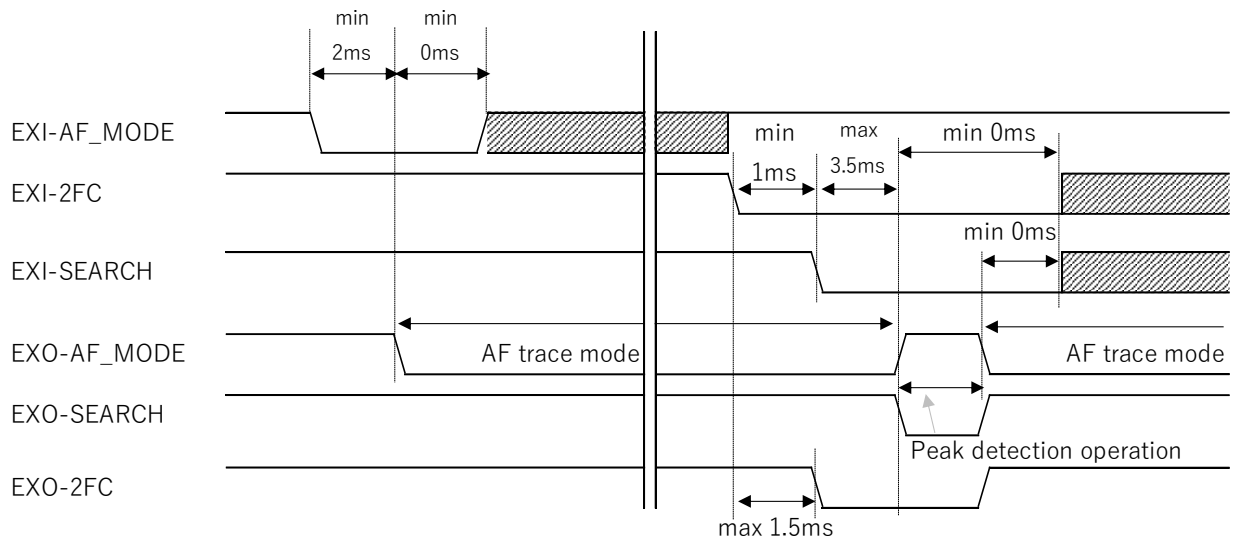
⑦　Auto Focus operation (SC0)

[Pin name]　　Input　　　: EXI-SEARCH (Pin 27), EXI-STOP (Pin 17)

　　　　　　　Output　　: EXO-SEARCH (Pin 6)

[Function]　　Executes Auto Focus operation SC0.

[Description]　Auto Focus operation SC0 starts when EXI-SEACH is set to L level for more than 2ms. EXI-SEACH level can be set to H/L after SC0 has started. However, set it to H level when stopped or performed a re-search by Re−PushAF. Auto Focus operation stops when either EXI-STOP is set to L level for more than 1ms, communication command Q is sent, or [STOP] key is pressed on operation box.

　　　　　　　Re-search (switch to SC0 or SC2) can perform during AF tracking when parameter No.603:Re-PushAF is 0. Return EXI-AF_MODE to H level and operate SC0 or SC2.

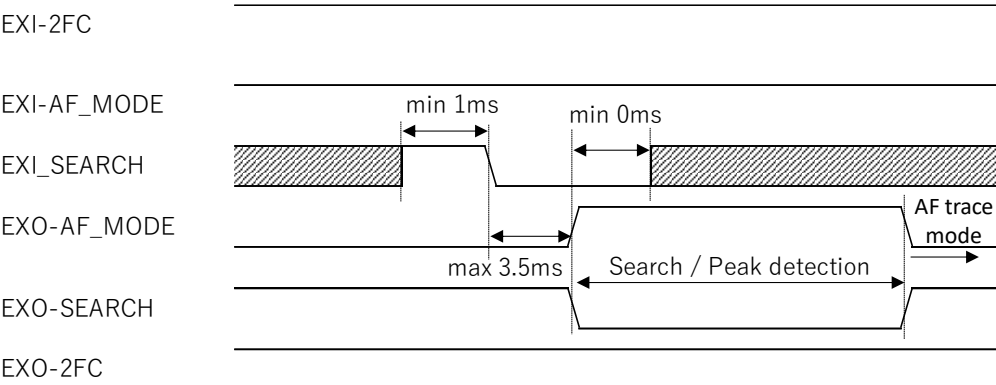[Timing chart]

・ Start SC0 and interrupt search/peak detection
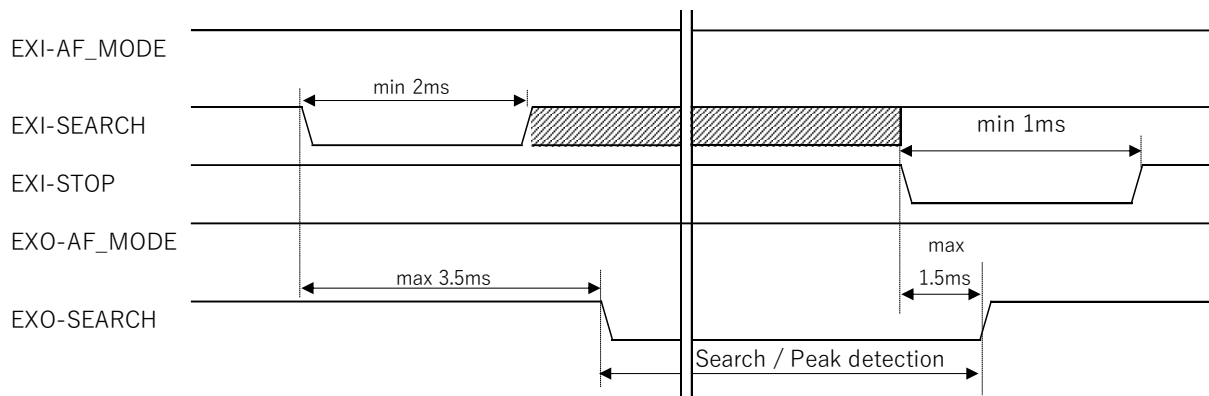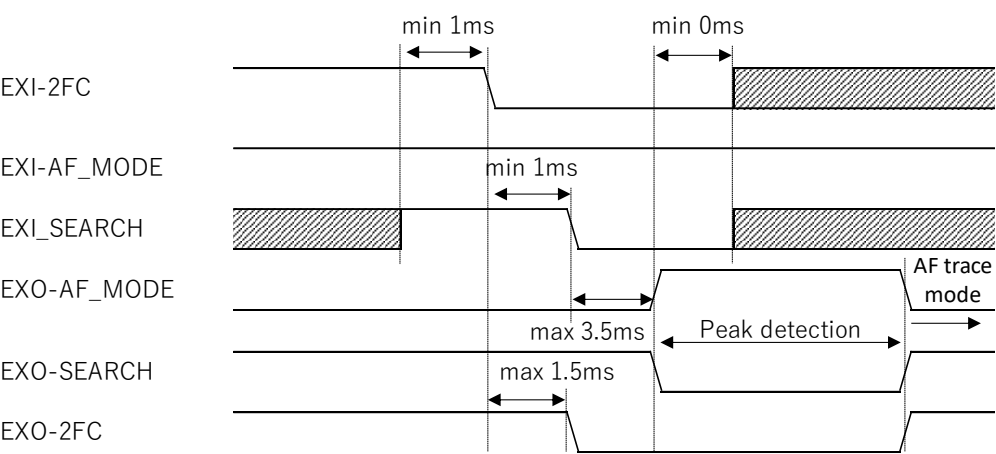

・ Start SC0 (search/peak detection and AF trace mode)
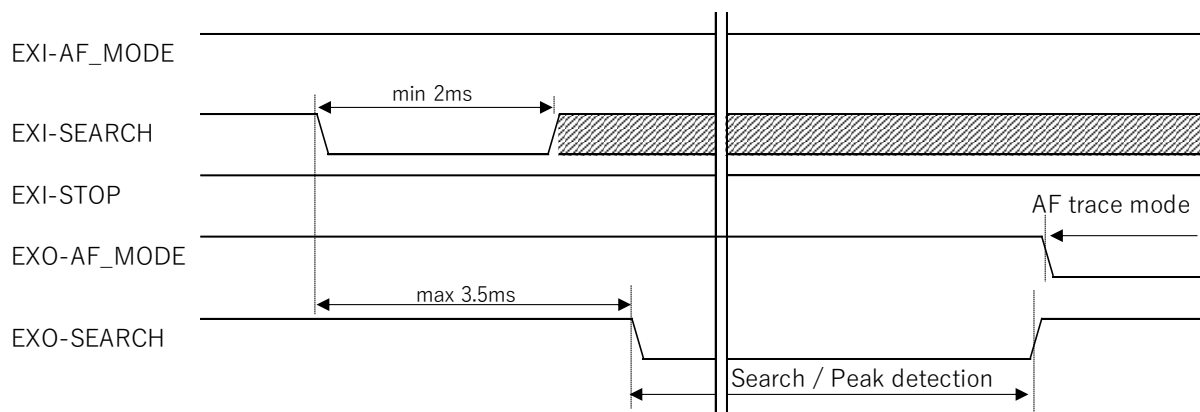
＊　In one-shot mode, EXO-AF_MODE will be at H level when the number of continuous just focus reaches the set value, and stop AF trace mode.

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・Execute SC0 during AF trace mode（Re-PushAF=0）

EXI-2FC

EXI-AF_MODE

min 1ms

EXI_SEARCH

min 0ms

EXO-AF_MODE

AF trace mode

max 3.5ms   Search / Peak detection

EXO-SEARCH

EXO-2FC

・Execute SC2 during AF trace mode（Re-PushAF=0）

min 1ms   min 0ms

EXI-2FC

EXI-AF_MODE

min 1ms

EXI_SEARCH

EXO-AF_MODE

AF trace mode

max 3.5ms   Peak detection

EXO-SEARCH

max 1.5ms

EXO-2FC

⑧　Reset operation

[Pin name]	Input	: EXI-RESET (Pin 33)

[Function]　Executes reset operation. Performs the same operation as power reset.

[Description]　Same operation as command RESTA.

Reset operation is to reset the parameters to power reset status and return pattern driving unit and AF driving unit to HOME position.

[Timing chart]

min 5ms　　　Returns to HOME

EXI-RESET

other INPUT PIN
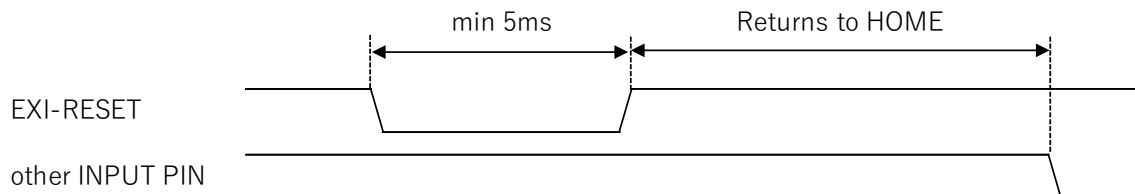
⑨　AF status signal

[Pin name]　Output　: EXO-OVER (Pin 8), EXO-UNDER (Pin 9), EXO-J_FOCUS (Pin 10)

[Function]　Outputs Auto Focus status during operation (not only I/O controlled operation but including all Auto Focus operation).

[Description]　Relates with operation box and autofocus status display of commands.

[Truth table]　The following value means { EXO-OVER, EXO-UNDER, EXO-J_FOCUS}.

Value	Control
011	Focused and signal level OVER
101	Focused and signal level UNDER
000	Just focus
Other	Not focused

[Timing chart]

min 1ms　　min 0ms

EXO-OVER

EXO-UNDER

EXO-J_FOCUS

Signal level : OVER　　Signal level : UNDER　　Just focus

17
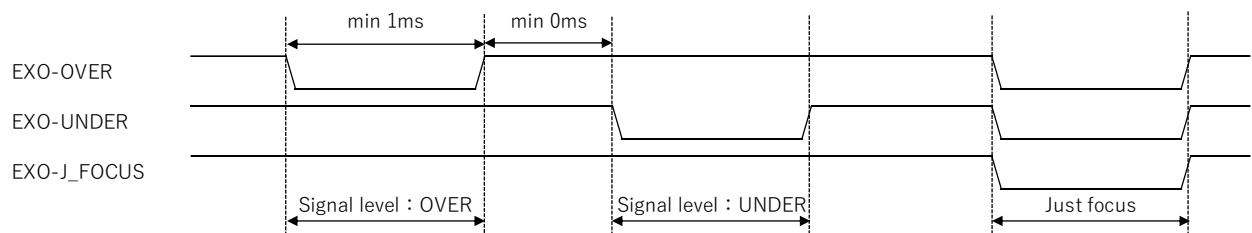
⑩ Limit detection signal

[Pin name] Output : EXO-N_LIMIT (Pin 31), EXO-F_LIMIT (Pin 32)

[Function] EXO-N_LIMIT is set to L level when driving unit is located at NEAR limit range and EXO-F_LIMIT is set to L level when driving unit is located at FAR limit range.

[Description] Detected while AF driving unit is located within limit range. When AF driving unit moves out from the limit range (returns to driving range), limit detection signal is set to H level.

[Truth table] EXO-N_LIMIT, EXO-F_LIMIT

Value	Control
0	Detects limit signal
1	Able to operate

[Timing chart]

Limit detection period

EXO-N_LIMT
(EXO-F_LIMT)
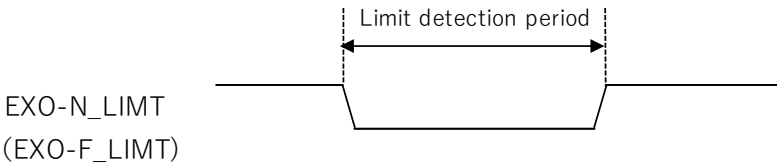
⑪　Second function enable

[Pin name]　　Input　　　: EXI-2FC (Pin 28), other PIN (please refer to [Function] as follows)

　　　　　　　Output　　: EXO-2FC (Pin 7)
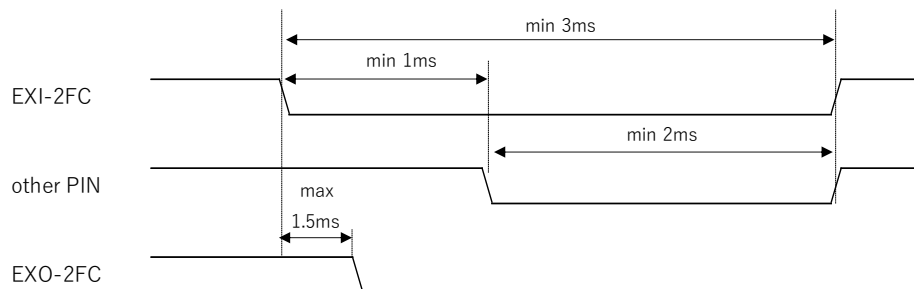
[Function]　　Enables second function. Following functions are available.

　　　　　　　Return to HOME :　EXI-AF_MODE (Pin 26)

　　　　　　　Search (SC2)　　:　EXI-SEARCH (Pin 27)

[Description]　Second function will be executed respectively when EXI-AF_MODE or EXI-SEARCH is set to L level while keeping EXI-2FC to L level.

[Timing chart]

⑫　Returns to HOME position

[Pin name]　　Input　　　: EXI-AF_MODE (Pin 26)、EXI-2FC (Pin 28)

　　　　　　　Output　　: EXO-2FC (Pin 7)

[Function]　　Returns to Home position.

[Description]　Operation starts to return HOME when EXI-2FC is set to L level for more than 1ms, followed by keeping XI-2FC=L level and EXI-AF_MODE=L level for more than 2ms.

[Caution]　　After returning to HOME position, make sure that the drive unit is stopped before performing the next processing.

[Timing chart]
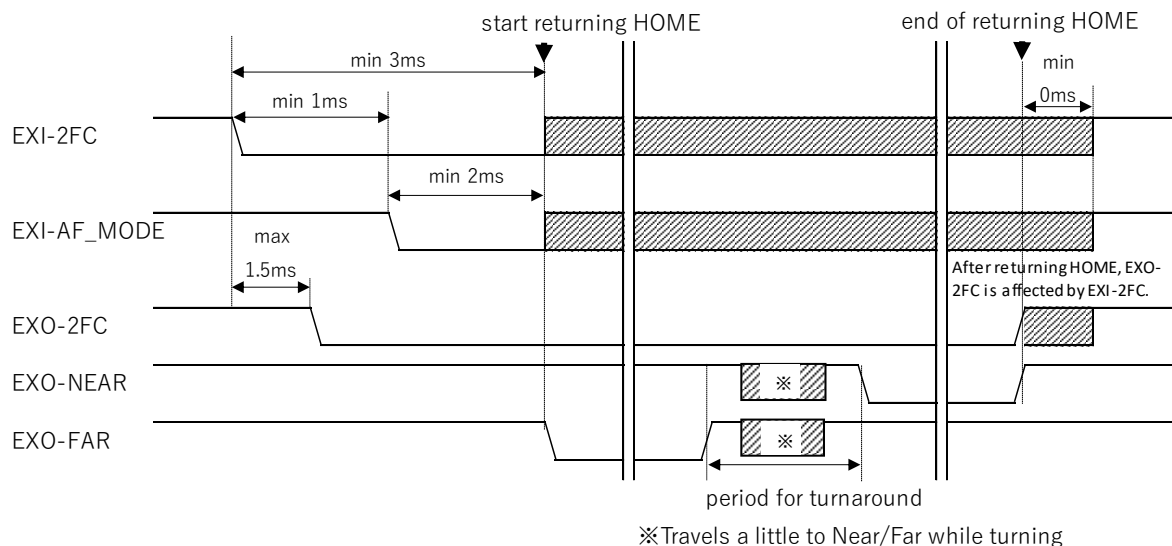
⑬　　Auto Focus operation (SC2)

|		
[Pin name]	Input	: EXI- SEARCH (Pin 27), EXI-2FC (Pin 28), EXI-STOP (Pin 17)
	Output	: EXO-SEARCH (Pin 6)

[Function]　Executes Auto Focus operation SC2.

[Description]　Auto Focus operation SC2 starts if EXI-2FC is set to L level for more than 2ms, followed by EXI-SEARCH being set to L level, 1ms after EXI-2FC reaches L level. EXI-SEARCH level can be set to H/L level after SC2 has started. However, set it to H level when stopped or performed a re-search by Re-PushAF. Auto Focus operation stops when either EXI-STOP is set to L level for more than 1ms, communication command Q is sent, or [STOP] key is pressed.
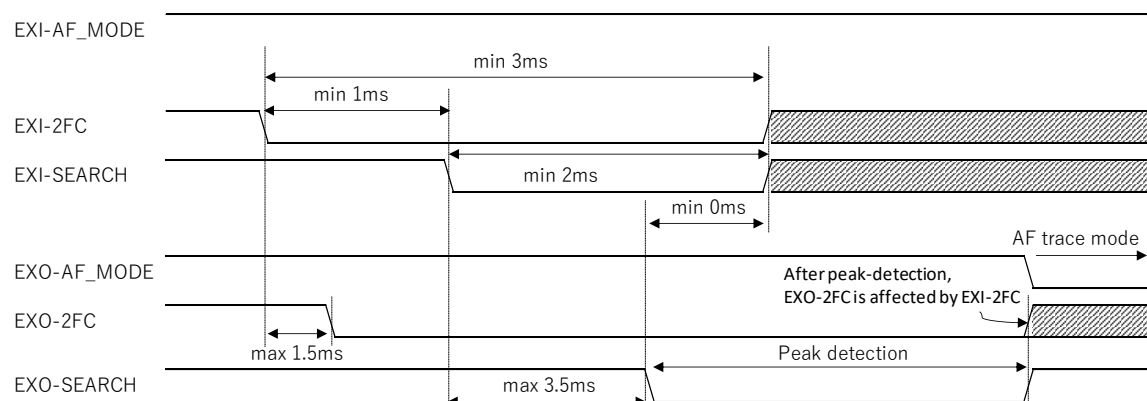
Re-search (switch to SC2 or SC0) can perform during AF tracking when parameter No.603:Re-PushAF is 0. Return EXI-SEARCH to H level (also EXI-2FC in case of switching to SC0), and operate SC0 or SC2.

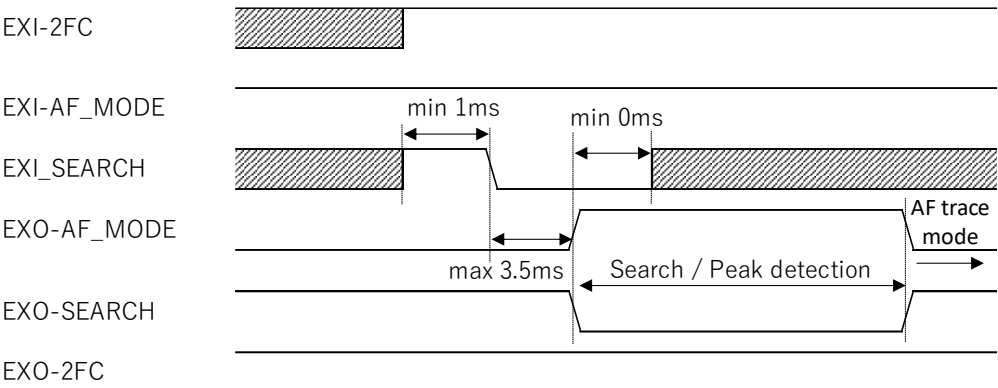[Timing chart]

・Start SC2 and interrupt search/peak detection
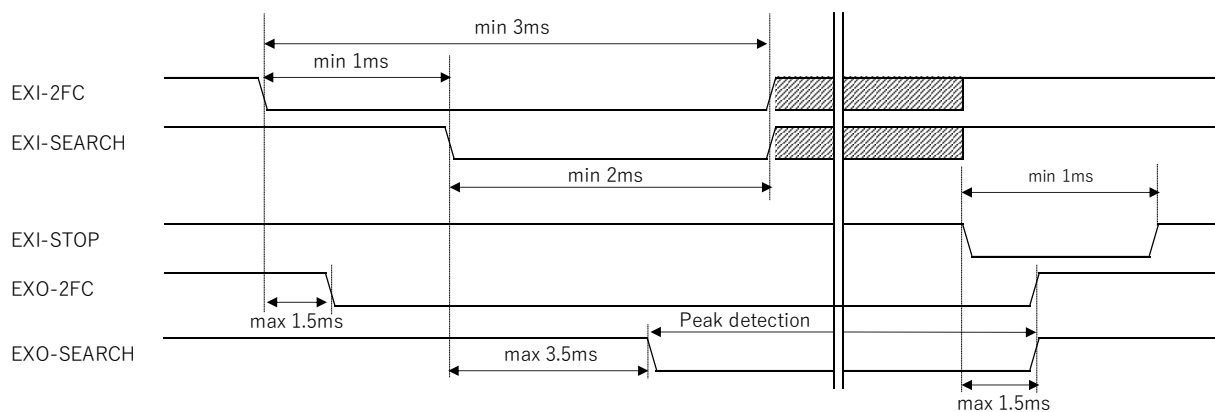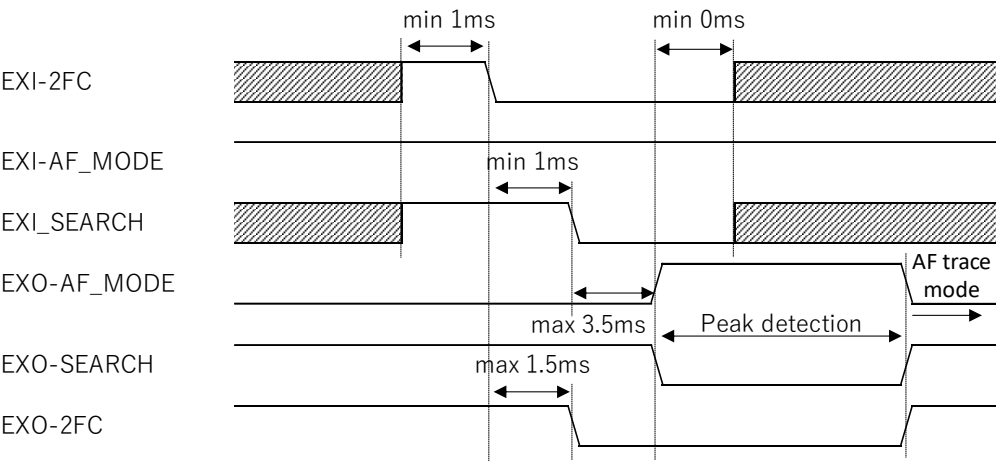

・Start SC2 (peak detection and AF trace mode)

＊　In one-shot mode, EXO-AF_MODE will be at H level when the number of continuous just focus reaches the set value, and stop AF trace mode.

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・Execute SC0 during AF trace mode（Re-PushAF=0）

・Execute SC2 during AF trace mode（Re-PushAF=0）

⑭   Search error, Peak detection error status(FE, PE)

|		
[Pin name]	Output	: EXO-AF_MODE(Pin5)、EXO-SEARCH(Pin 6)
[Function]	Notifies search or peak detection error.
[Description]	Search error or peak detection error has occurred while EXO-AF_MODE and EXO-SEARCH are at L level at the same time.

Perform the stop operations (EXI-STOP, STOP command, operation box) to clear the error. Moves to previous just focus detection position after the stop operations (If just focus determination has not been performed after power is turned on, moves to STOP position). Also, AF operation (AF0, SC0 or SC2) can restart during search error or peak detection error has occurred when parameter No.603:Re-PushAF is 0. Return EXI-AF_MODE, EXI-SEARCH and EXI-2FC to H level before restarting.
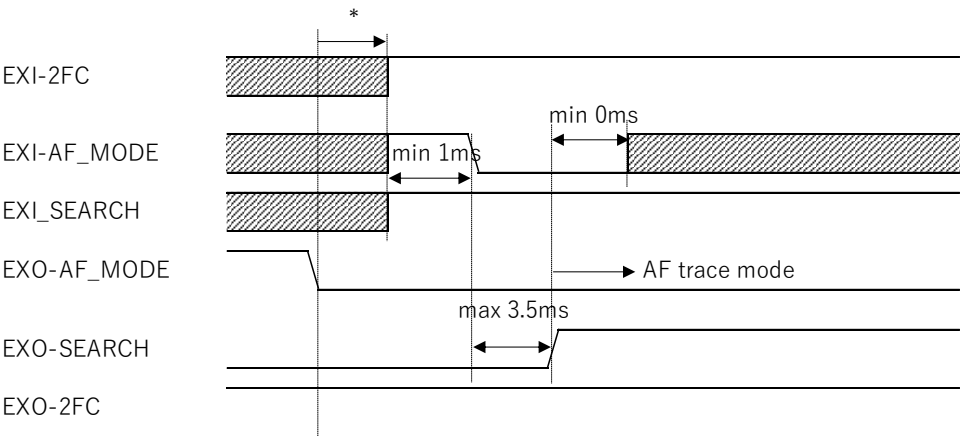
[Timing chart]

・Clears error by stop operation

*

EXI-AF_MODE

EXI-SEARCH   min 0ms

EXI-STOP

EXO-AF_MODE
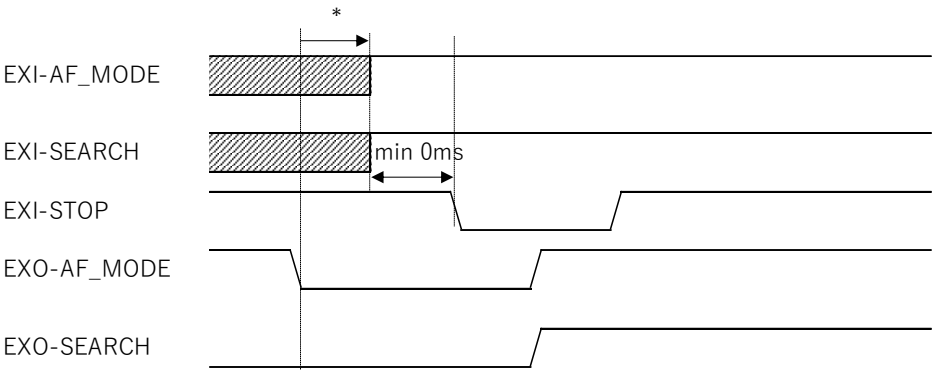
EXO-SEARCH

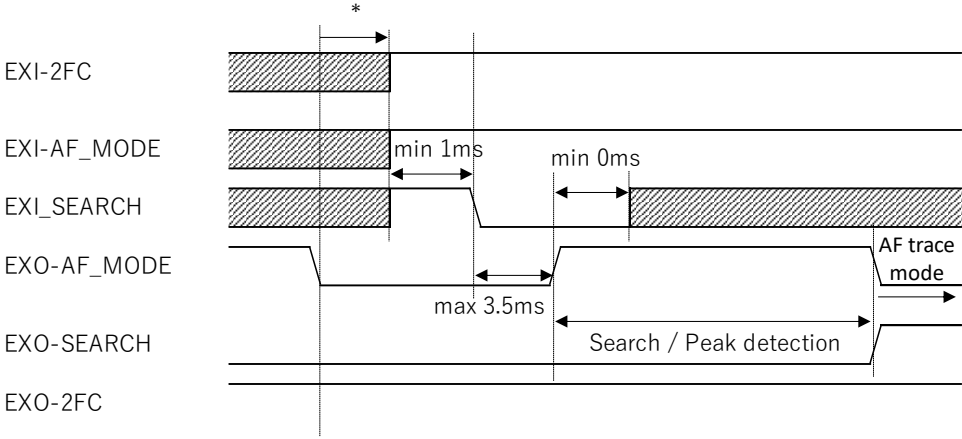* When EXO-AF_MODE and EXO-SEARCH are L level,
  EXI-AF_MODE and EXI-SEARCH set to H level if they are L level.

・Clears error by restarting AF operation (Re-PushAF=0)
  restarting with AF0

*

EXI-2FC

                                    min 0ms

EXI-AF_MODE   min 1ms

EXI_SEARCH

EXO-AF_MODE   AF trace mode

                   max 3.5ms

EXO-SEARCH

EXO-2FC

* When EXO-AF_MODE and EXO-SEARCH are L level,
  EXI-2FC、EXI-AF_MODE and EXI-SEARCH set to H level if they are L level.
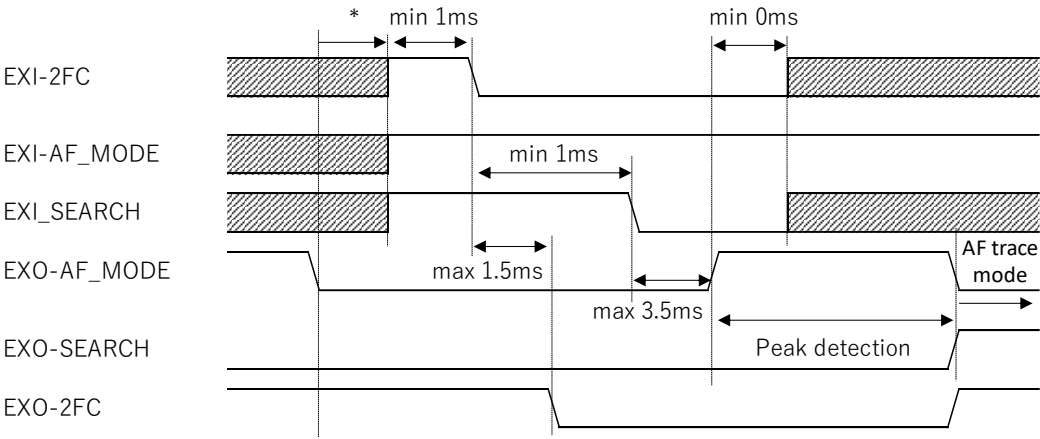
restarting with SC0

* When EXO-AF_MODE and EXO-SEARCH are L level,

EXI-2FC, EXI-AF_MODE and EXI-SEARCH set to H level if they are L level.

restarting with SC2

* When EXO-AF_MODE and EXO-SEARCH are L level,

EXI-2FC, EXI-AF_MODE and EXI-SEARCH set to H level if they are L level.

⑮　　Internal monitoring signal

[Pin name]　　Output　　: ALERT (Pin 39)
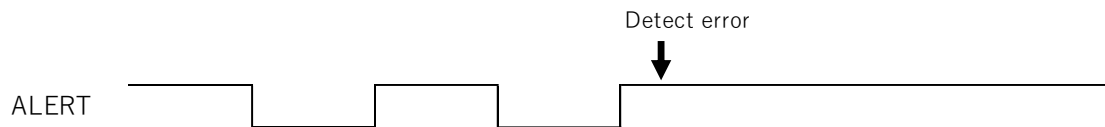
[Function]　　Notifies internal error.

[Description]　H/L is repeated every 500ms at normal status. It will be fixed to H level or L level when error

is detected. Power reset operation or reset operation with I/O control or command is needed

for release.

[Timing chart]

・Error at L level

Detect error

ALERT

・Error at H level

Detect error

ALERT

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.

Auto Focus Controller AFC-6   INSTRUCTION MANUAL
- I/O Ports - Ver. 1.0

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