Make Life Easy

User Manual

Closed-Loop Stepper System

AiC-D Series

Thank you for purchasing an Autonics product.
This user manual contains information about the product and its proper use,
and should be kept in a place where it will be easy to access.

www.autonics.com

Autonics

Preface

Thank you for purchasing Autonics product.
Please familiarize yourself with the information contained in the Safety Considerations section before using this product.
This user manual contains information about the product and its proper use, and should be kept in a place where it will be easy to access.

User Manual Guide

- Please familiarize yourself with the information in this manual before using the product.
- This manual provides detailed information on the product's features. It does not offer any guarantee concerning matters beyond the scope of this manual.
- This manual may not be edited or reproduced in either part or whole without permission.
- A user manual is not provided as part of the product package.
  Visit our website (www.autonics.com) to download a copy.
- The manual's content may vary depending on changes to the product's software and other unforeseen developments within Autonics, and is subject to change without prior notice. Upgrade notice is provided through out website.
- We contrived to describe this manual more easily and correctly. However, if there are any corrections or questions, please notify us these on our website.

User Manual Symbols

Symbol	Description
 **Note**	Supplementary information for a particular feature.
 **Warning**	Failure to follow instructions can result in serious injury or death.
 **Caution**	Failure to follow instructions can lead to a minor injury or product damage.
 **Ex.**	An example of the concerned feature's use.
※1	Annotation mark.

Safety Considerations

- Following these safety precautions will ensure the safe and proper use of the product and help prevent accidents, as well as minimizing possible hazards.
- Safety precautions are categorized as Warnings and Cautions, as defined below:

 **Warning**	**Warning**	Failure to follow these instructions may result in serious injury or death.
 **Caution**	**Caution**	Failure to follow these instructions may result in personal injury or product damage.

 Warning

- Fail-safe device must be installed when using the unit with machinery that may cause serious injury or substantial economic loss. (e.g. nuclear power control, medical equipment, ships, vehicles, railways, aircraft, combustion apparatus, safety equipment, crime/disaster prevention devices, etc.)
  Failure to follow this instruction may result in personal injury, economic loss or fire.
- Do not use the unit in the place where flammable/explosive/corrosive gas, high humidity, direct sunlight, radiant heat, vibration, impact, or salinity may be present.
  Failure to follow this instruction may result in explosion or fire.
- Do not connect, repair, or inspect the unit while connected to a power source.
  Failure to follow this instruction may result in fire or electric shock.
- Install the unit after considering counter plan against power failure.
  Failure to follow this instruction may result in personal injury, or economic loss or fire.
- Check 'Connections' before wiring.
  Failure to follow this instruction may result in fire.
- Do not disassemble or modify the unit.
  Failure to follow this instruction may result in fire or electrical shock.
- Install the driver in the grounded housing or ground it directly.
  Failure to follow this instruction may result in personal injury, fire or electric shock.
- Do not touch the unit during or after operation for a while.
  Failure to follow this instruction may result in burn or electric shock due to high temperature of the surface.
- Emergency stop directly when error occurs.
  Failure to follow this instruction may result in personal injury or fire.

Caution

- When connecting the power input, use AWG 18(0.75mm^2) cable or over.
- Brake is non-polar. When connecting the brake, use AWG 24 (0.2mm^2) cable or over.
  Failure to follow this instruction may result in fire or malfunction due to contact failure.
- To use the motor safely, do not apply external force to the motor.
- It is recommended to use STOPPER for the vertical load.
- Install over-current prevention device (e.g. the current breaker, etc.) to connect the driver with power.
  Failure to follow this instruction may result in fire.
- Check the control input signal before supplying power to the driver.
  Failure to follow this instruction may result in personal injury or product damage by unexpected signal.
- Install a safety device to maintain the vertical position after turn off the power of this driver.
  Failure to follow this instruction may result in personal injury or product damage by releasing holding torque of the motor.
- Use the unit within the rated specifications.
  Failure to follow this instruction may result in fire or product damage.
- Use dry cloth to clean the unit, and do not use water or organic solvent.
  Failure to follow this instruction may result in fire or electric shock.
- The driver may overheat depending on the environment.
  Install the unit in the well ventilated place and forced cooling with a cooling fan.
  Failure to follow this instruction may result in product damage or degradation by heat.
- Keep the product away from metal chip, dust, and wire residue which flowing into the unit.
  Failure to follow this instruction may result in fire or product damage.
- Use the designated motor only.
  Failure to follow this instruction may result in fire or product damage.

The above specifications are subject to change and somd models may be discontinued without notice.
Be sure to follow cautions written in the instruction manual, user manual and the technical descriptions (catalog, website).

Cautions during Use

- Follow instructions in 'Cautions during Use'.
  Otherwise, it may cause unexpected accidents.
- 24VDC power supply should be insulated and limited voltage/current or Class 2, SELV power supply device.
- Re-supply power after min. 1 sec from disconnected power.
- In case communication is unstable due to the noise generated by supplied power or peripheral device, use ferrite core at communication line.
- It is recommended to use 485 converter with the separate power.
  (Autonics product, SCM-38I, recommended)
- The thickness of cable should be same or thicker than the motor cable's when extending the motor cable.
  ① CN1 (power connector): AWG18
  ② CN2 (motor+encoder connector): AWG22, AWG24
  ③ CN3 (I/O connector): AWG28
- Keep the distance between power cable and signal cable more than 10cm.
- Motor vibration and noise can occur in specific frequency period
  ① Change motor installation method or attach the damper.
  ② Use the unit out of the dedicated frequency range when vibration and noise occurs due to changing motor RUN speed.
- For using motor, it is recommended to maintenance and inspection regularly.
  ① Unwinding bolts and connection parts for the unit installation and load connection
  ② Strange sound from ball bearing of the unit
  ③ Damage and stress of lead cable of the unit
  ④ Connection error with motor
  ⑤ Inconsistency between the axis of motor output and the center, concentric (eccentric, declination) of the load, etc.
- This product does not prepare protection function for a motor.
- This unit may be used in the following environments.
  ① Indoors (in the environment condition rated in 'Specifications')
  ② Altitude max. 2,000m
  ③ Pollution degree 2
  ④ Installation category II

Table of Contents

1 Product Overview

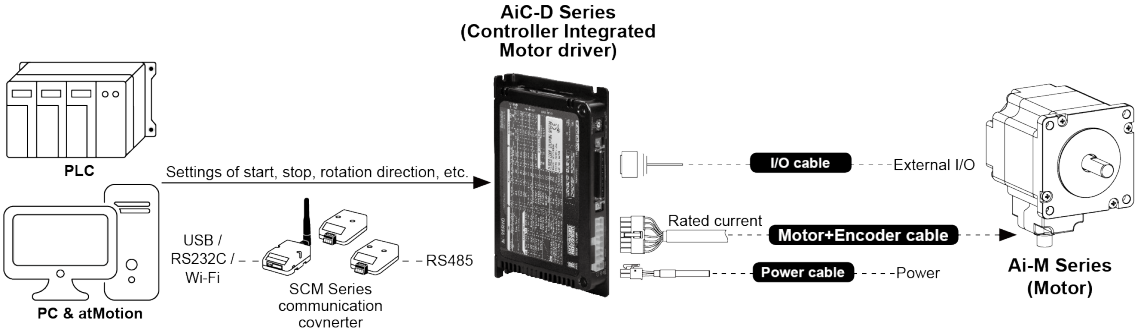
1.1 Features

AiC Series is 2-phase closed-loop stepper motor driver built-in motion controller function.
This unit is stand alone type and it drives through I/O with/without PC.
There are settings; PI-Gain, Speed Filter, In-Position and 4 modes.
It minimizes motor heat generation due to current setting during home search drive, stop.
It controls up to 31-axis via RS485 communication.

- Brake operation for safe control of vertical load at power OFF and alarm occur. (built-in brake type)
- Motor driver and controller integral type
- Competitive price compared to the servo motor and closed-loop function and fast response for short-distance continuous drive
- Controllable maximum 31 axis with RS485 communication
- Realizing a wide variety of operation up to 256 steps using 14 control commands combination
- 4 type of operation mode
  : jog mode, continuous mode, index mode (64), program mode (256)
- Improved user convenience with providing 50 I/O pins
- C language library provided (32-bit, 64-bit)
- Dedicated Windows program (atMotion) provided
- Responding rapidly and maintaining torque in stop without hunting
- Easy to use without tuning (various gain settings via programming)
- Applicable to the precision equipment such as optical inspection equipment with the features of maintaining torque in stop and having no micro vibration (hunting)
- Containing various resolutions (electric gear)
  : Frame size 20mm: 500, 1000, 1600, 2000, 3600, 4000, 5000, 6400, 7200, 10000
  Frame size 28, 35mm: 500, 1000, 1600, 2000, 3600, 5000, 6400, 7200, 10000, 16000
  Frame size 42, 56, 60mm: 500, 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000 (10-level)
- Various alarm functions
  : 17 alarms; over current, over speed, over heat, motor connection error, encoder connection error
- Frame size 20mm, 28mm, 35mm, 42mm, 56mm, 60mm motor supported

1.2 Configuration Diagram and Components

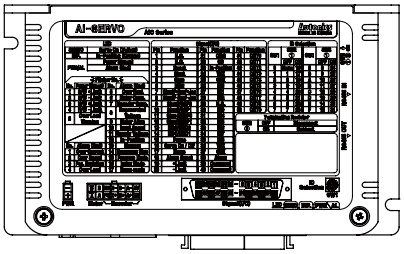
1.2.1 Configuration Diagram



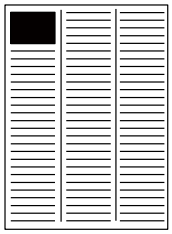
※ I/O cable, motor+encoder cable and power cable are sold separately.
For more information, refer to the '7.5 Sold Separately'.

1.2.2 Components

1.2.2.1 Driver

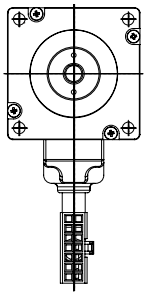


AiC-D Series

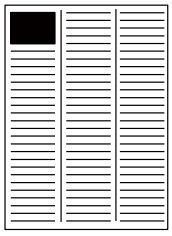


Instruction manual

1.2.2.2 Motor



Ai-M Series



Instruction manual

Note

Make sure all of the above components are included with your product package before use.
If a component is missing or damaged, please contact Autonics or your distributor.

1.3 Ordering Information

1.3.1 Driver

(1) Frame size 20 / 28 / 35mm

Ai	C	-	D	-	60	L		A	-	
①	②		③		④	⑤		⑥		⑦

Item	Description	
① Series	Ai	Artificial intelligent
② Category	C	Controller
③ Item	D	Driver
④ Motor frame size	20	20×20mm
	28	28×28mm
	35	35×35mm
⑤ Motor length	S	Short - Frame size 28mm: 46mm, Frame size 35mm: 41.5mm
	M	Middle - Frame size 20mm: 41.2mm, Frame size 28mm: 59mm, Frame size 35mm: 52mm
	L	Long - Frame size 20mm: 53.1mm, Frame size 28mm: 65mm, Frame size 35mm: 68.5mm
⑥ Encoder resolution	A	4,000PPR (1,000PPR x 4-multiply)
	B	16,000PPR (4,000PPR x 4-multiply)

(2) Frame size 42 / 56 / 60mm

Ai	C	-	D	-	60	L	A	-	
①	②		③		④	⑤	⑥		⑦

Item		Description	
① Series		Ai	Artificial intelligent
② Category		C	Controller
③ Item		D	Driver
④ Motor frame size		42	42×42mm
		56	57.2×57.2mm
		60	60×60mm
⑤ Motor length	Standard Type	S	Short - Frame size 42mm: 67.5mm, Frame size 56mm: 77.3mm, Frame size 60mm: 81.9mm
		M	Middle - Frame size 42mm: 73.5mm, Frame size 56mm: 90.3mm, Frame size 60mm: 102.8mm
		L	Long - Frame size 42mm: 81.5mm, Frame size 56mm: 111.3mm, Frame size 60mm: 119.8mm
	Built-in Brake type	S	Short - Frame size 42mm: 102.3mm, Frame size 56mm: 112.1mm, Frame size 60mm: 116.7mm
		M	Middle - Frame size 42mm: 108.3mm, Frame size 56mm: 125.1mm, Frame size 60mm: 137.6mm
		L	Long - Frame size 42mm: 116.3mm, Frame size 56mm: 146.1mm, Frame size 60mm: 154.6mm
⑥ Encoder resolution		A	10,000PPR (2,500PPR x 4-multiply)
⑦ Brake		No mark	Standard Type
		B	Built-in Brake type

1.3.2 Motor

(1) Frame size 20 / 28 / 35mm

Ai	-	M	-	20	L	A	-	
①		②		③	④	⑤		⑥

Item	Description	
① Series	Ai	Artificial intelligent
② Item	M	Motor
③ Motor frame size	20	20×20mm
	28	28×28mm
	35	35×35mm
④ Motor length	S	Short - Frame size 28mm: 46mm, Frame size 35mm: 41.5mm
	M	Middle - Frame size 20mm: 41.2mm, Frame size 28mm: 59mm Frame size 35mm: 52mm
	L	Long - Frame size 20mm: 53.1mm, Frame size 28mm: 65mm, Frame size 35mm: 68.5mm
⑤ Encoder resolution	A	4,000PPR (1,000PPR x 4-multiply)
	B	16,000PPR (4,000PPR x 4-multiply)

(2) Frame size 42 / 56 / 60mm

Ai	-	M	-	60	L	A	-	
①		②		③	④	⑤		⑥

Item		Description	
① Series		Ai	Artificial intelligent
② Item		M	Motor
③ Motor frame size		42	42×42mm
		56	57.2×57.2mm
		60	60×60mm
④ Motor length	Standard Type	S	Short - Frame size 42mm: 67.5mm, Frame size 56mm: 77.3mm, Frame size 60mm: 81.9mm
		M	Middle - Frame size 42mm: 73.5mm, Frame size 56mm: 90.3mm, Frame size 60mm: 102.8mm
		L	Long - Frame size 42mm: 81.5mm, Frame size 56mm: 111.3mm, Frame size 60mm: 119.8mm
	Built-in Brake type	S	Short - Frame size 42mm: 102.3mm, Frame size 56mm: 112.1mm, Frame size 60mm: 116.7mm
		M	Middle - Frame size 42mm: 108.3mm, Frame size 56mm: 125.1mm, Frame size 60mm: 137.6mm
		L	Long - Frame size 42mm: 116.3mm, Frame size 56mm: 146.1mm, Frame size 60mm: 154.6mm
⑤ Encoder resolution		A	10,000PPR (2,500PPR x 4-multiply)
⑥ Brake		No mark	Standard Type
		B	Built-in Brake type

1.4 Models

1.4.1 Standard Type

(1) Frame size 20 / 28 / 35mm

Set	Driver	Motor
AiC-20MA	AiC-D-20MA	Ai-M-20MA
AiC-20LA	AiC-D-20LA	Ai-M-20LA
AiC-28SB	AiC-D-28SB	Ai-M-28SB
AiC-28MB	AiC-D-28MB	Ai-M-28MB
AiC-28LB	AiC-D-28LB	Ai-M-28LB
AiC-35SB	AiC-D-35SB	Ai-M-35SB
AiC-35MB	AiC-D-35MB	Ai-M-35MB
AiC-35LB	AiC-D-35LB	Ai-M-35LB

(2) Frame size 42 / 56 / 60mm

Set	Driver	Motor
AiC-42SA	AiC-D-42SA	Ai-M-42SA
AiC-42MA	AiC-D-42MA	Ai-M-42MA
AiC-42LA	AiC-D-42LA	Ai-M-42LA
AiC-56SA	AiC-D-56SA	Ai-M-56SA
AiC-56MA	AiC-D-56MA	Ai-M-56MA
AiC-56LA	AiC-D-56LA	Ai-M-56LA
AiC-60SA	AiC-D-60SA	Ai-M-60SA
AiC-60MA	AiC-D-60MA	Ai-M-60MA
AiC-60LA	AiC-D-60LA	Ai-M-60LA

1.4.2 Built-in Brake Type

Set	Driver	Motor
AiC-42SA-B	AiC-D-42SA-B	Ai-M-42SA-B
AiC-42MA-B	AiC-D-42MA-B	Ai-M-42MA-B
AiC-42LA-B	AiC-D-42LA-B	Ai-M-42LA-B
AiC-56SA-B	AiC-D-56SA-B	Ai-M-56SA-B
AiC-56MA-B	AiC-D-56MA-B	Ai-M-56MA-B
AiC-56LA-B	AiC-D-56LA-B	Ai-M-56LA-B
AiC-60SA-B	AiC-D-60SA-B	Ai-M-60SA-B
AiC-60MA-B	AiC-D-60MA-B	Ai-M-60MA-B
AiC-60LA-B	AiC-D-60LA-B	Ai-M-60LA-B

2 Specifications

2.1 Driver

Model		–	AiC-D-28SB	AiC-D-35SB	AiC-D-42SA(-B)	AiC-D-56SA(-B)	AiC-D-60SA(-B)
		AiC-D-20MA	AiC-D-28MB	AiC-D-35MB	AiC-D-42MA(-B)	AiC-D-56MA(-B)	AiC-D-60MA(-B)
		AiC-D-20LA	AiC-D-28LB	AiC-D-35LB	AiC-D-42LA(-B)	AiC-D-56LA(-B)	AiC-D-60LA(-B)
Power supply		24VDC⎓					
Allowable voltage range		90 to 110% of the rated voltage					
Power consumption	STOP ※1	Max. 10W			Max. 10W	Max. 12W	Max. 15W
	Max. during operation ※2	Max. 60W			Max. 60W	Max. 120W	Max. 240W
Max. RUN current ※3		0.6A/Phase	1.0A/Phase	1.2A/Phase	1.7A/Phase	3.5A/Phase	
STOP current※4		20 to 100% of max. RUN current (factory default: 50%)					
Rotation speed		0 to 3000rpm					
Resolution※4		500 (factory default), 1000, 1600, 2000, 3600, 4000, 5000, 6400, 7200, 10000PPR	500 (factory default), 1000, 1600, 2000, 3600, 5000, 6400, 7200, 10000, 16000PPR		500 (factory default), 1000, 1600, 2000, 3200, 3600, 5000, 6400, 7200, 10000 PPR		
Speed filter ※4		0 (disable), 2, 4, 6, 8 (factory default), 10, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200 ms					
Positioning gain ※4		(P Gain, I Gain) = (1, 1), (2, 1), (3, 1), (4, 1), (5, 1), (1, 2), (2, 2), (3, 2), (4, 2), (5, 2), (1, 3), (2, 3), (3, 3), (4, 3), (5, 3), user setting					
Positioning range		-2,147,483,648 to +2,147,483,647					
In-Position		Fast Response: 0 to 7 or Accurate Response: setting range among 0 to 7					
Motor rotation direction※4		CW, CCW					
Status indicator		• Power/Warning indicator: green LED • In-Position indicator: yellow LED • RS485 DATA IN/OUT indicator: green/yellow LED • Alarm indicator: red LED • Servo On/Off indicator: orange LED					
I/O voltage level		[H]: 5-30VDC⎓, [L]: 0-2VDC⎓					
I/O	Input	Exclusive input: 20, general input: 9					
	Output	• Standard type - exclusive output: 4, general output: 10 • Built-in brake type - exclusive output: 6, general output: 9					
External power supply		VEX (recommended: 24VDC⎓): 2, GEX (GND): 2					
Operation mode		Jog / Continuous / Index / Program mode					
Index step numbers		64 steps					
Program function	Steps	256 steps					
	Control command	ABS (move absolute position), INC (move incremental position), HOM (home search), ICJ (jump input condition), IRD (waiting input), OPC (on/off of output port), OPT (on pulse from output port), JMP (jump), REP (start repetition), RPE (end repetition), END (end program), POS (position set), TIM (timer), CMP (compare output)					
	Start	Power ON program start function					
	Home search	Power ON home search function					

Home search mode		Home, limit home, zero home, torque home
RS485 comm.	Comm. speed ※4	9600, 19200, 38400, 57600, 115200(factory default) bps
Multiaxial control		31-axis
ID setting switch		16-bit rotary switch (0 to F), 1-bit piano switch
Alarm output		Over current, over speed, position tracking, over load, over heat, motor connection, encoder connection, regenerative voltage, motor misalignment, command speed, input voltage, in-position, memory, emergency stop, program mode, index mode, home search mode
Warning output		+software limit, +hardware limit, -software limit, -hardware limit, over load
Insulation resistance		Over 100MΩ (at 500VDC megger)
Dielectric strength		1,000VAC 60Hz for 1 min
Vibration		1.5mm amplitude at frequency of 10 to 55Hz (for 1 min) in each X, Y, Z direction for 2 hours
Shock		300m/s^2 (approx. 30G) in each X, Y, Z direction for 3 times
Environment	Ambient temp.	0 to 50°C, storage: -10 to 60°C
	Ambient humi.	35 to 85%RH, storage: 10 to 90%RH
Approval		CE
Protection structure		IP20 (IEC standard)
Weight ※5		Approx. 460g (approx. 300g)

※1: Based on the ambient temperature 25°C, ambient humidity 55%RH, and STOP current 50%.
※2: Max. power consumption during operation. When changing the load rapidly, instantaneous peak current may increase. The capacity of power supply should be over 1.5 to 2 times of max. power consumption.
※3: RUN current varies depending on the input RUN frequency and max. RUN current at the moment varies also.
※4: Settable with the dedicated program.
※5: The weight includes packaging. The weight in parenthesis is for unit only.
※Environment resistance is rated at no freezing or condensation.

2.2 Motor

2.2.1 Frame Size 20mm

Model	Ai-M-20MA	Ai-M-20LA
Max. stop torque※1	0.183kgf·cm(0.018N·m)	0.357kgf·cm(0.035N·m)
Rotor moment of inertia	2g·cm² (2 x 10⁻⁷kg·m²)	
Rated current	0.6A/Phase	
Resistance	6.6Ω/Phase ±10%	10.5Ω/Phase ±10%
Inductance	2.1mH/Phase ±20%	4.0mH/Phase ±20%
Weight※2	Approx. 0.192kg (approx. 0.092kg)	Approx. 0.219kg (approx. 0.120kg)

2.2.2 Frame Size 28mm

Model	Ai-M-28SB	Ai-M-28MB	Ai-M-28MB
Max. stop torque※1	0.51kgf·cm(0.05N·m)	1.42kgf·cm(0.14N·m)	1.63kgf·cm(0.16N·m)
Rotor moment of inertia	9g·cm² (9 x 10⁻⁷kg·m²)	12g·cm² (12 x 10⁻⁷kg·m²)	18g·cm² (18 x 10⁻⁷kg·m²)
Rated current	1.0A/Phase		
Resistance	5.78Ω/Phase ±10%	8.8Ω/Phase ±10%	10.1Ω/Phase ±10%
Inductance	3.2mH/Phase ±20%	6.0mH/Phase ±20%	6.2mH/Phase ±20%
Weight※2	Approx. 0.260kg (approx. 0.162kg)	Approx. 0.318kg (approx. 0.222kg)	Approx. 0.342kg (approx. 0.248kg)

2.2.3 Frame Size 35mm

Model	Ai-M-35SB	Ai-M-35MB	Ai-M-35LB
Max. stop torque※1	0.714kgf·cm(0.07N·m)	1.326kgf·cm(0.13N·m)	3.162kgf·cm(0.31N·m)
Rotor moment of inertia	8g·cm² (8 x 10⁻⁷kg·m²)	14g·cm² (14 x 10⁻⁷kg·m²)	22g·cm² (22 x 10⁻⁷kg·m²)
Rated current	1.2A/Phase		
Resistance	2.1Ω/Phase ±10%	3.25Ω/Phase ±10%	5.0Ω/Phase ±10%
Inductance	1.25mH/Phase ±20%	2.85mH/Phase ±20%	5.6mH/Phase ±20%
Weight※2	Approx. 0.278kg (approx. 0.180kg)	Approx. 0.347kg (approx. 0.250kg)	Approx. 0.456kg (approx. 0.366kg)

※1: Max. holding torque is standard torque when supplying the rated current (2-phase holding) and stopping the motor for comparing the specifications of motors.

※2: The weight includes packaging. The weight in parenthesis is for unit only.

2.2.4 Frame Size 42mm

Model		Ai-M-42SA-□	Ai-M-42MA-□	Ai-M-42LA-□
Max. stop torque※1		2.55kgf.cm (0.25N.m)	4.08kgf.cm (0.4N.m)	4.89kgf.cm (0.48N.m)
Rotor moment of inertia		35g.cm² (35 x 10⁻⁷kg.m²)	54g.cm² (54 x 10⁻⁷kg.m²)	77g.cm² (77 x 10⁻⁷kg.m²)
Rated current		1.7A/Phase		
Resistance		1.7Ω/Phase ±10%	1.85Ω/Phase ±10%	2.1Ω/Phase ±10%
Inductance		1.9mH/Phase ±20%	3.5mH/Phase ±20%	4.4mH/Phase ±20%
Weight※2	Standard Type	Approx. 0.45kg (approx. 0.34kg)	Approx. 0.52kg (approx. 0.41kg)	Approx. 0.59kg (approx. 0.48kg)
	Built-in brake type	Approx. 0.77kg (approx. 0.67kg)	Approx. 0.83kg (approx. 0.73kg)	Approx. 0.90kg (approx. 0.80kg)

2.2.5 Frame Size 56mm

Model		Ai-M-56SA-□	Ai-M-56MA-□	Ai-M-56LA-□
Max. stop torque※1		6.12kgf.cm (0.6N.m)	12.24kgf.cm (1.2N.m)	20.39kgf.cm (2.0N.m)
Rotor moment of inertia		140g.cm² (140 x 10⁻⁷kg.m²)	280g.cm² (280 x 10⁻⁷kg.m²)	480g.cm² (480 x 10⁻⁷kg.m²)
Rated current		3.5A/Phase		
Resistance		0.55Ω/Phase ±10%	0.57Ω/Phase ±10%	0.93Ω/Phase ±10%
Inductance		1.05mH/Phase ±20%	1.8mH/Phase ±20%	3.7mH/Phase ±20%
Weight※2	Standard Type	Approx. 0.76kg (approx. 0.62kg)	Approx. 0.99kg (approx. 0.85kg)	Approx. 1.36kg (approx. 1.22kg)
	Built-in brake type	Approx. 1.30kg (approx. 1.15kg)	Approx. 1.52kg (approx. 1.38kg)	Approx. 1.90kg (approx. 1.75kg)

2.2.6 Frame Size 60mm

Model		Ai-M-60SA-□	Ai-M-60MA-□	Ai-M-60LA-□
Max. stop torque※1		11.22kgf.cm (1.1N.m)	22.43kgf.cm (2.2N.m)	29.57kgf.cm (2.9N.m)
Rotor moment of inertia		240g.cm² (240 x 10⁻⁷kg.m²)	490g.cm² (490 x 10⁻⁷kg.m²)	690g.cm² (690 x 10⁻⁷kg.m²)
Rated current		3.5A/Phase		
Resistance		1.0Ω/Phase ±10%	1.23Ω/Phase ±10%	1.3Ω/Phase ±10%
Inductance		1.5mH/Phase ±20%	2.6mH/Phase ±20%	3.8mH/Phase ±20%
Weight※2	Standard Type	Approx. 0.89kg (approx. 0.75kg)	Approx. 1.27kg (approx. 1.13kg)	Approx. 1.58kg (approx. 1.44kg)
	Built-in brake type	Approx. 1.53kg (approx. 1.36kg)	Approx. 1.90kg (approx. 1.74kg)	Approx. 2.23kg (approx. 2.07kg)

※1: Max. holding torque is standard torque when supplying the rated current (2-phase holding) and stopping the motor for comparing the specifications of motors.

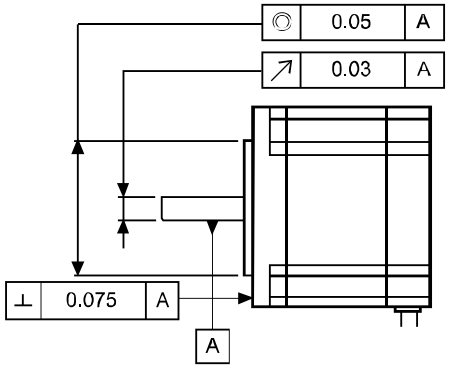
※2: The weight includes packaging. The weight in parenthesis is for unit only.

2.2.7 Common Specifications

Standard step angle		1.8° / 0.9° (Full / Half step)
Motor phase		2 phase
Run method		Bipolar
Insulation class		B type (130°C)
Insulation resistance		Over 100MΩ (at 500VDC megger) between motor coil-case
Dielectric strength		500VAC 50/60Hz for 1 min between motor coil-case
Vibration		1.5mm amplitude at frequency of 10 to 55Hz (for 1 min) in each X, Y, Z direction for 2 hours
Shock		Approx. max. 50G
Environment	Ambient temperature	0 to 50°C, storage: -20 to 70°C
	Ambient humidity	20 to 85%RH, storage: 15 to 90%RH
Approval		CE
Protection structure		IP30 (IEC34-5 standard)
Stop angle error※1		±0.09°
Shaft vibration※2		0.03mm T.I.R.
Radial movement※3	Frame size 20 / 28 / 35mm	Max. 0.025mm (load 450g)
	Frame size 42 / 56 / 60mm	Max. 0.025mm (load 25N)
Axial movement※4	Frame size 20 / 28 / 35mm	Max. 0.005mm (load 920g)
	Frame size 42 / 56 / 60mm	Max. 0.01mm (load 50N)
Concentricity for shaft of setup in-low		0.05mm T.I.R.
Perpendicularity of set-up plate shaft		0.075mm T.I.R.

※1: Specifications are for full-step angle, without load. (Values may vary by load size)

※2: T.I.R. (Total Indicator Reading): Indicate total dial gauge quantity in case of one complete rotating monitored reference around a base point.



※3: Amount of radial shaft displacement when adding a radial load
(450g – frame size 20 / 28 / 35mm, 25N – frame size 42 / 56 / 60mm) to the tip of the motor shaft.

※4: Amount of axial shaft displacement when adding a axial load
(920g – frame size 20 / 28 / 35mm, 50N – frame size 42 / 56 / 60mm to the shaft.

※Environment resistance is rated at no freezing or condensation.

2.2.8 Brake

Model	Frame size 42mm	Frame size 56mm	Frame size 60mm
Rated excitation voltage※1	24VDC⎓ ±10%		
Rated excitation current	0.208A	0.275A	
Static friction torque	Min. 1.8kgf.cm	Min. 8.0kgf.cm	
Rotation part inertia	6 g.cm^2	19 g.cm^2	
Insulation class	B type (130°C)		
B type brake	Power on: brake is released, power off: brake is operating		
Operating time	Max. 25ms	Max. 30ms	
Releasing time	Max. 10ms	Max. 20ms	

※1: Driver reduces power voltage from 24VDC to 11.5VDC and control the motor to reduce heat generation in the brake which is connected with the motor.

2.2.9 Encoder

(1) Frame size 20 / 28 / 32mm

Item			Magnetic INCREMENTAL rotary encoder
Resolution	Frame size 20mm		4,000PPR (1,000PPR x 4-multiply)
	Frame size 28 / 35mm		16,000PPR (4,000PPR x 4-multiply)
Electrical specification	Output phase		$A, \overline{A}, B, \overline{B}, Z, \overline{Z}$
	Output duty ratio		$\frac{T}{2} \pm \frac{T}{3}$ (T = 1 cycle of A phase)
	Phase difference of output		Output between A and B phase: $\frac{T}{4} \pm \frac{T}{4}$ (T = 1 cycle of A phase)
	Control output	Line driver output	• [Low] – Load current: max. 20mA, Residual voltage: max. 0.5VDC • [High] – Load current: max. -20mA, Output voltage: max. 2.5VDC⎓
	Response time (rise, fall)	Frame size 20mm	Max. 1.5μs (cable length: 2m, I sink=20mA)
		Frame size 28 / 35mm	Max. 1μs (cable length: 2m, I sink=20mA)
	Max. response frequency	Frame size 20mm	200kHz
		Frame size 28 / 35mm	1,000kHz
	Power supply		5VDC⎓ ±5% (ripple P-P: max. 5%)
	Current consumption		Max. 50mA (disconnection of the load)

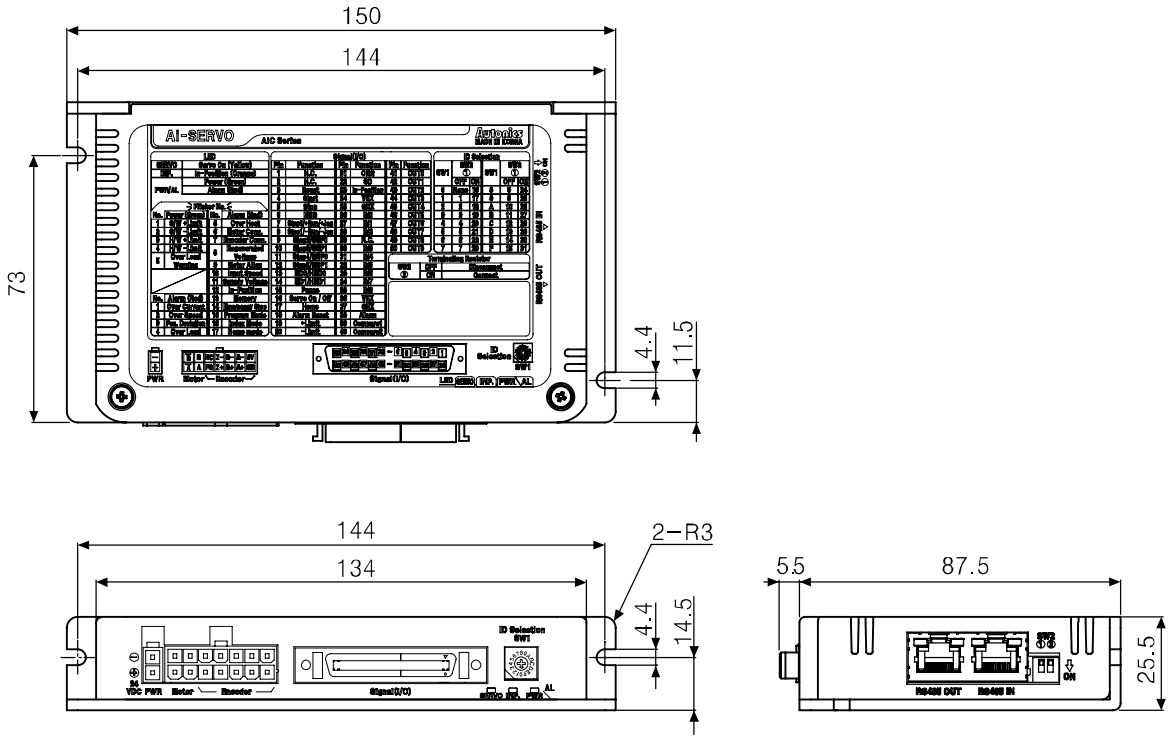
(2) Frame size 42 / 56 / 60mm

Item			INCREMENTAL rotary encoder
Resolution			10,000PPR (2,500PPR x 4 -multiply)
Electrical specification	Output phase		$A, \overline{A}, B, \overline{B}, Z, \overline{Z}$
	Output duty ratio		$\frac{T}{2} \pm \frac{T}{4}$ (T = 1 cycle of A phase)
	Phase difference of output		Output between A and B phase: $\frac{T}{4} \pm \frac{T}{8}$ (T = 1 cycle of A phase)
	Control output	Line driver output	• [Low] – Load current: max. 20mA, Residual voltage: max. 0.5VDC • [High] – Load current: max. -20mA, Output voltage: max. 2.5VDC⎓
	Response time (rise, fall)		Max. 0.5μs (cable length: 2m, I sink=20mA)
	Max. response frequency		300kHz
	Power supply		5VDC⎓ ±5% (ripple P-P: max. 5%)
	Current consumption		Max. 50mA (disconnection of the load)

3 Dimensions

3.1 Driver

(unit: mm)



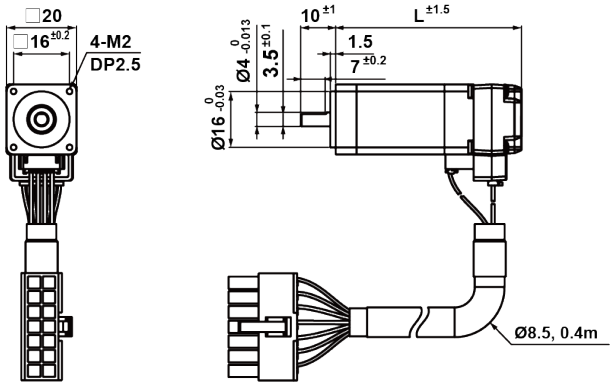
Note

Be sure that these figures may differ from the actual units.

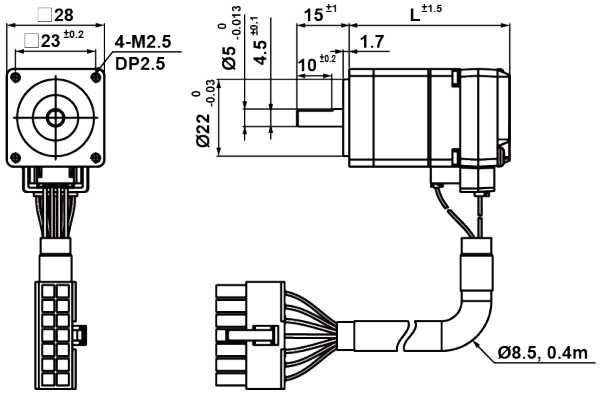
3.2 Motor

3.2.1 Standard Type

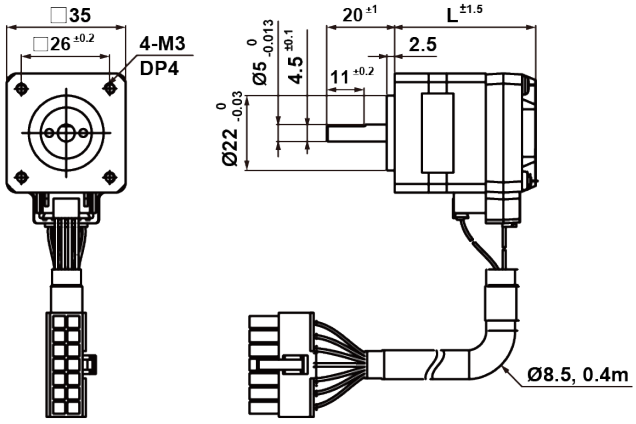
3.2.1.1 Frame Size 20mm



3.2.1.2 Frame Size 28mm



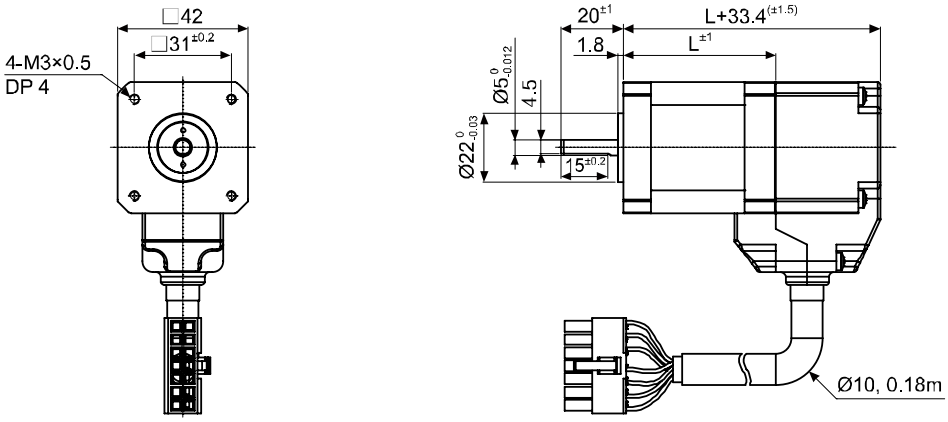
3.2.1.3 Frame Size 35mm



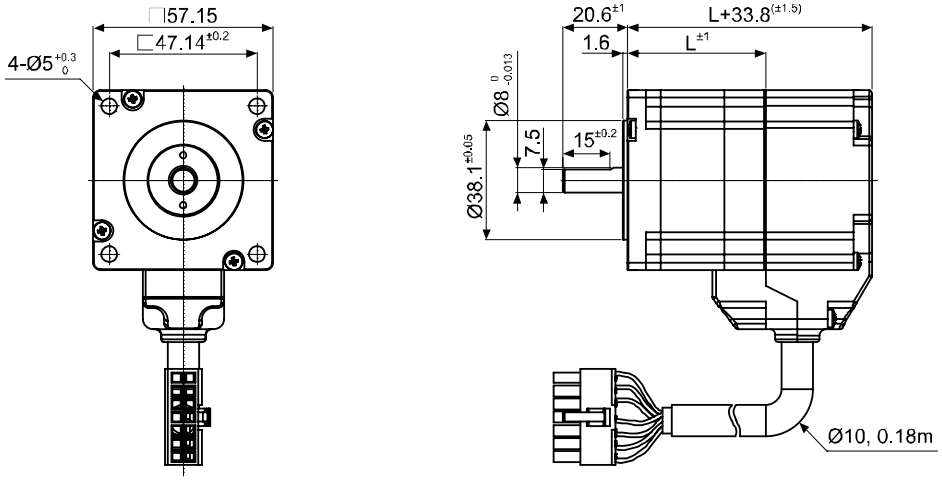
Note

Model	L	Model	L	Model	L
—		Ai-M-28SB	46	Ai-M-35SB	41.5
Ai-M-20MA	41.2	Ai-M-28MB	59	Ai-M-35MB	52
Ai-M-20LA	53.1	Ai-M-28LB	65	Ai-M-35LB	68.5

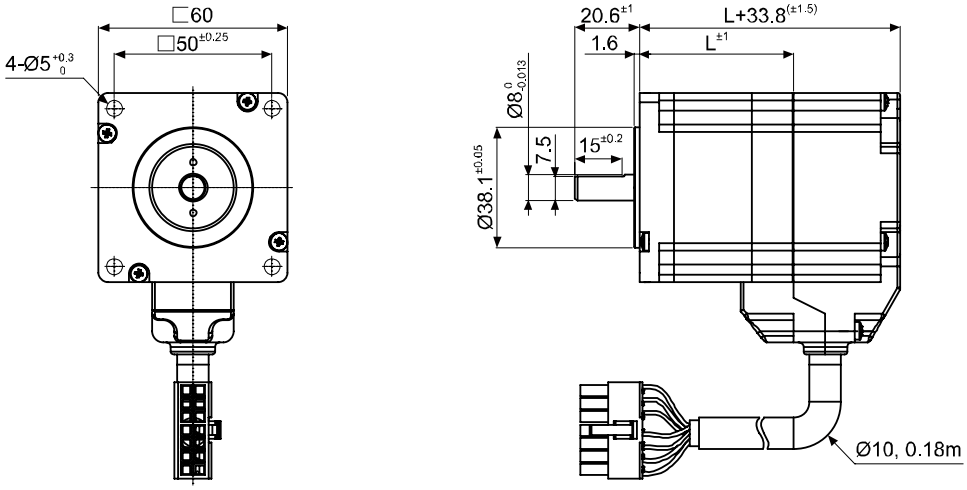
3.2.1.4 Frame Size 42mm



3.2.1.5 Frame Size 56mm



3.2.1.6 Frame Size 60mm

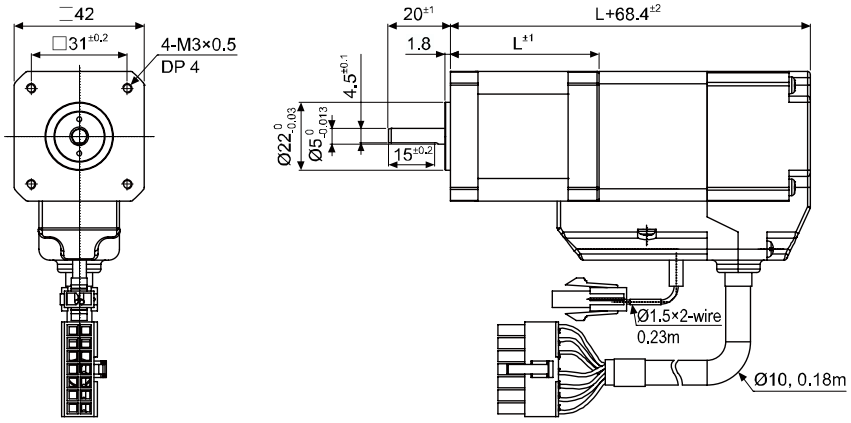


Note

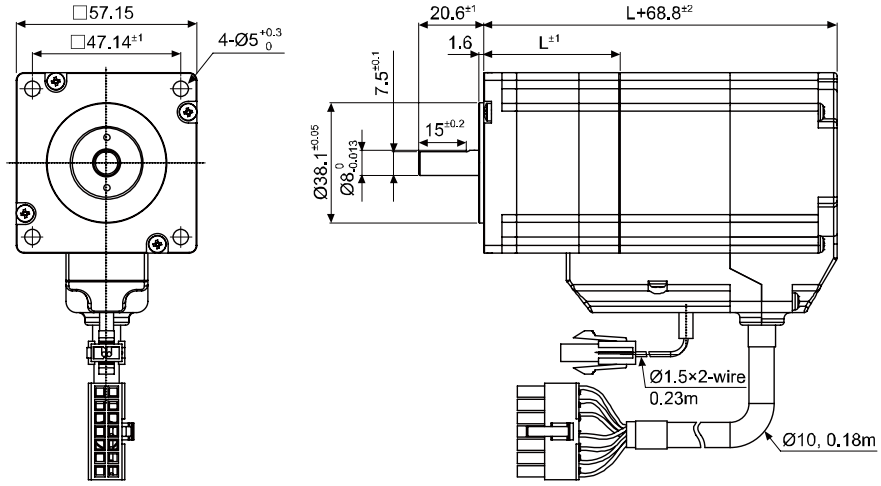
Model	L	Model	L	Model	L
Ai-M-42SA	34.1	Ai-M-56SA	43.5	Ai-M-60SA	48.1
Ai-M-42MA	40.1	Ai-M-56MA	56.5	Ai-M-60MA	69
Ai-M-42LA	48.1	Ai-M-56LA	77.5	Ai-M-60LA	86

3.2.2 Built-in Brake Type

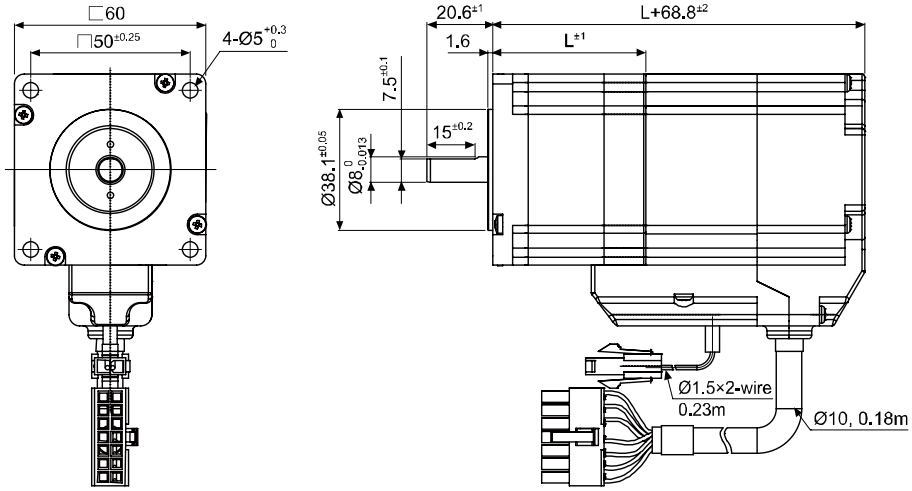
3.2.2.1 Frame Size 42mm



3.2.2.2 Frame Size 56mm



3.2.2.3 Frame Size 60mm



Note

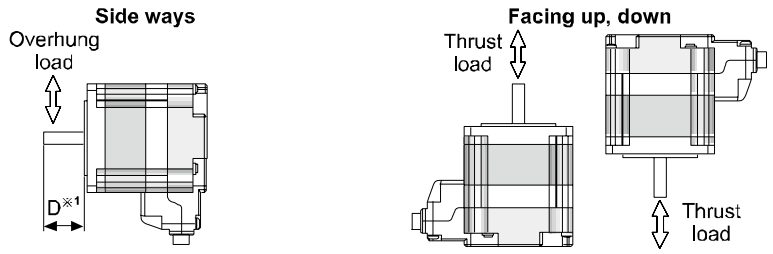
Model	L	Model	L	Model	L
Ai-M-42SA-B	33.9	Ai-M-56SA-B	43.3	Ai-M-60SA-B	47.9
Ai-M-42MA-B	39.9	Ai-M-56MA-B	56.3	Ai-M-60MA-B	68.8
Ai-M-42LA-B	47.9	Ai-M-56LA-B	77.3	Ai-M-60LA-B	85.8

4 Installation of Motor

4.1 Mounting Direction of Motor

Motor can be mounted in any directions-facing up, facing down and side ways. No matter which direction motors to be mounted, be sure not to apply overhung or thrust load on the shaft.

Refer to the table below for allowable shaft overhung load / thrust load.



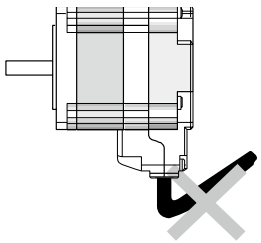
※1: The distance from the shaft in front (mm)

Motor size	The distance from the shaft in front (mm), Allowable overhung load [kgf (N)]				Allowable thrust load
	D=0	D=5	D=10	D=15	
Frame size 42mm	2 (20)	2.6 (25)	3.5 (34)	5.3 (52)	Below motor weight
Frame size 56mm	5.5 (54)	6.8 (67)	9.1 (89)	13.3 (130)	
Frame size 60mm					

Do not apply excessive force on motor cable when mounting motors.

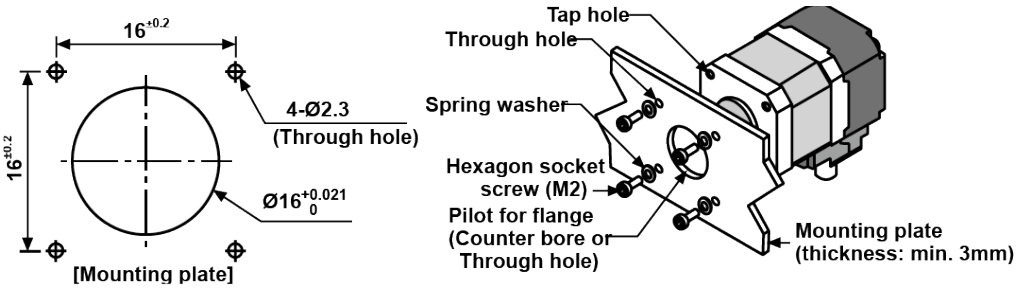
Do not forcibly pull or insert the cable. It may cause poor connection or disconnection of the cable.

In case of frequent cable movement required application, proper safety countermeasures must be ensured.

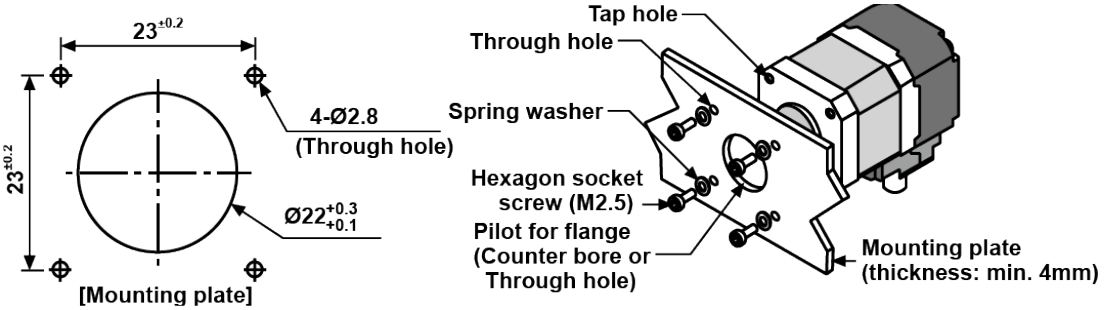


4.2 Mounting of Motor

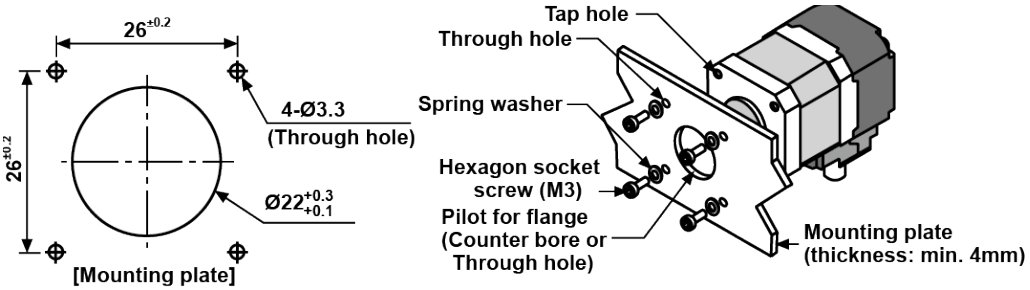
4.2.1 Frame Size 20mm



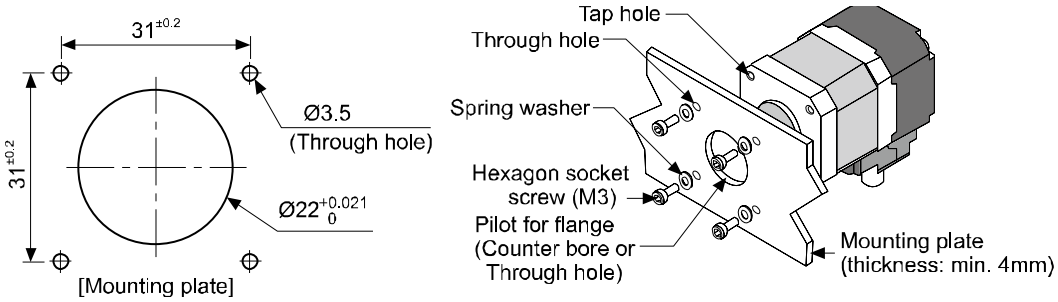
4.2.2 Frame Size 28mm



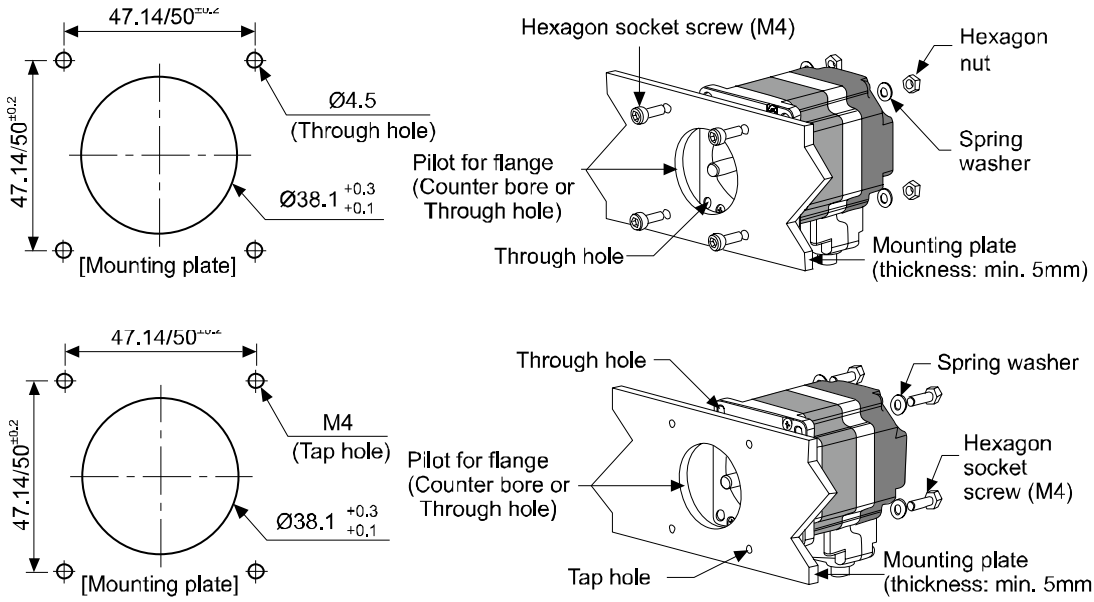
4.2.3 Frame Size 35mm



4.2.4 Frame Size 42mm



4.2.5 Frame Size 56mm / Frame Size 60mm

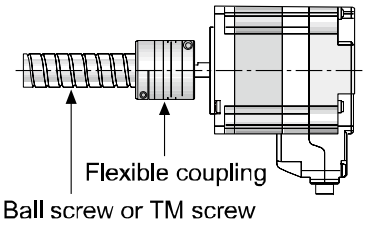


With considering heat radiation and vibration isolation, mount the motor as tight as possible against a metal panel having high thermal conductivity such as iron or aluminum.
When mounting motors, use hexagon socket screws, spring washers and flat washers.
Do not draw the wire with over strength 30N after wiring the encoder.

4.3 Connection with Load

When connecting the load, be sure of alignment of the center, tension of the belt, and parallel of the pulley. When connecting the load such as a pulley or a belt, be cautious of the allowable thrust load, radial load, and shock, as well as tighten the screw for a coupling or a pulley not to be unscrewed.
When attach a coupling or a pulley to the shaft, be cautious of damage on shaft or bearings and it is banned to disassemble or change structure of the device or the shaft for connecting with a load.

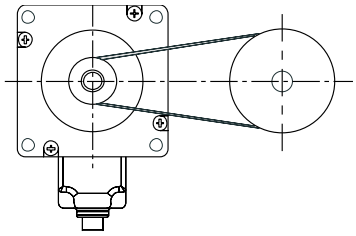
4.3.1 Direct Load Connection with Coupling



※Use Autonics flexible coupling (ERB Series).

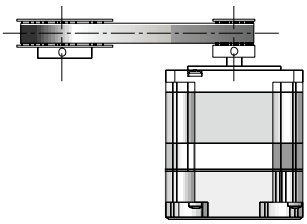
When connecting a load such as Ball screw or Tm screw directly to the shaft of the motor, use flexible coupling as image showing above. If the center of the load and the shaft is not aligned, it may cause severe vibration, damage on shaft or shortened life cycle of bearings.

4.3.2 Load Connection with Pulley, Belt, and Wire



The motor shaft and the load shaft should be parallel. Connect the motor shaft and the line which connects the center of two pulleys to a right angle.

4.3.3 Load Connection with Gear



The motor shaft and the load shaft should be parallel. Connect the motor shaft to the center fo gear teeth side to be interlocked.

4.4 Installation Conditions

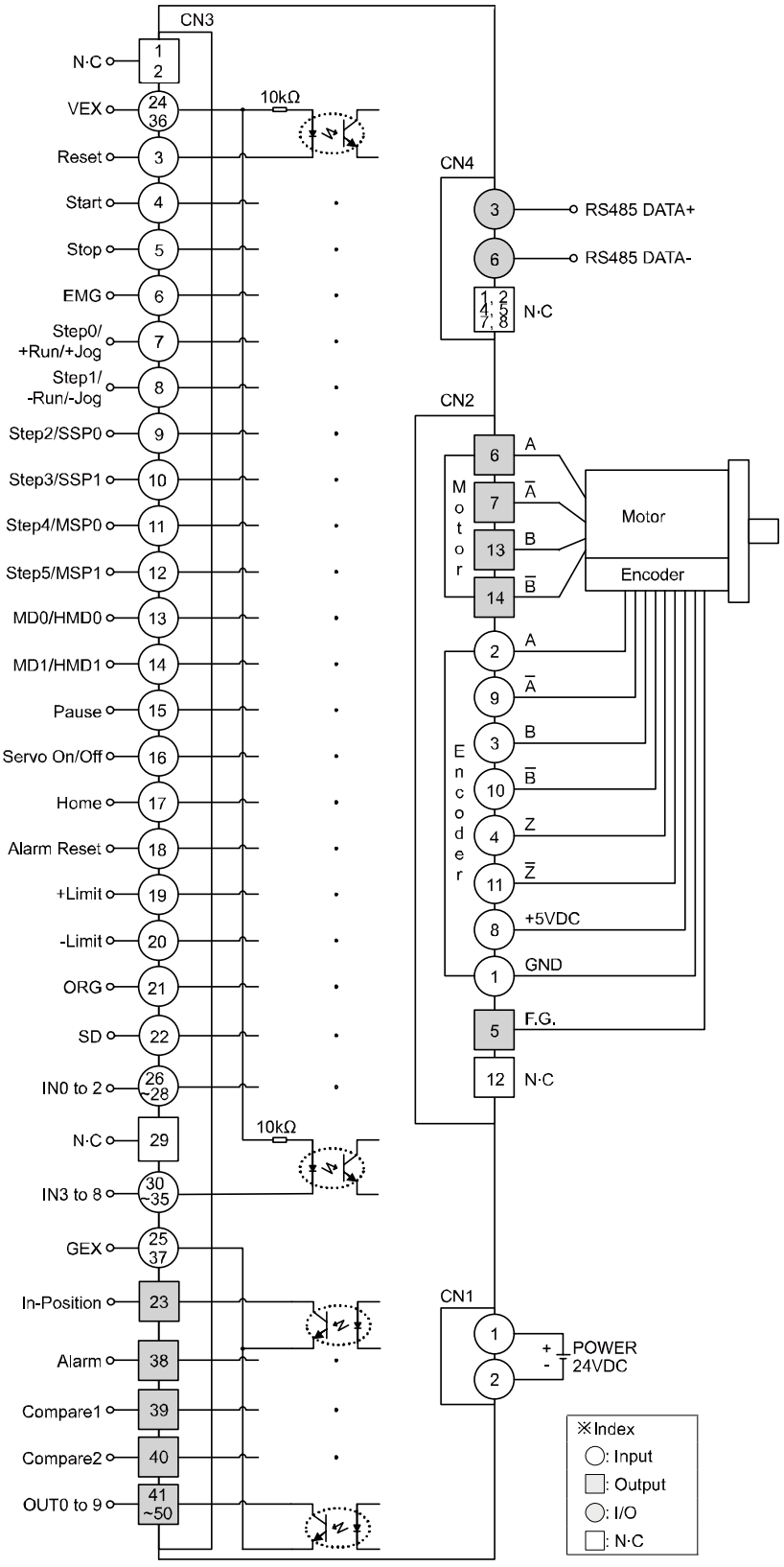
Install the motor in a place that meets certain conditions specified below.

It may cause product damage if instructions are not following.

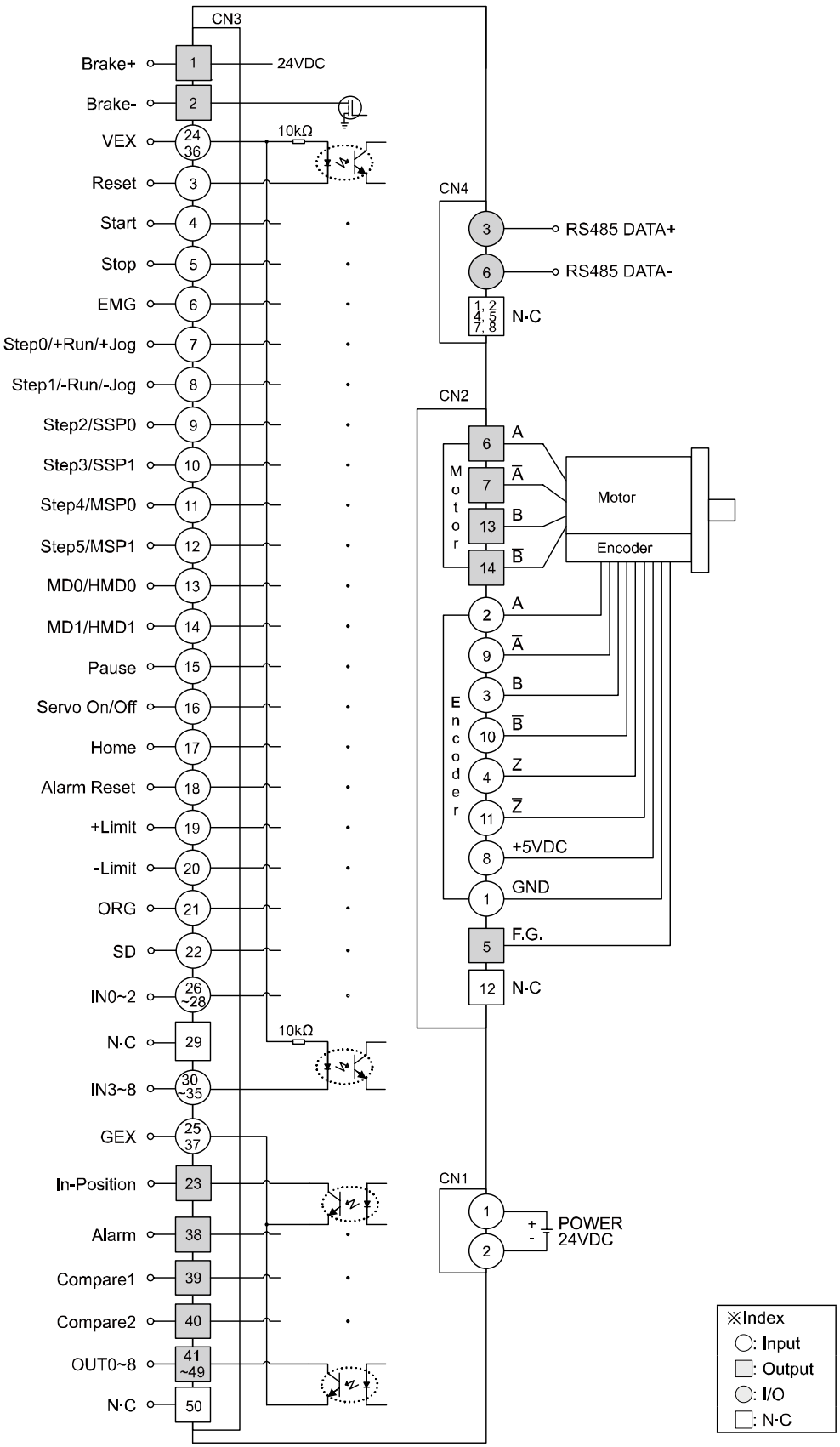
① The inner housing installed indoor
(This unit is manufactured and designed for attaching to equipment. Install a ventilation device.)
② Within 0 to 50℃ (at non-freezing status) of ambient temperature
③ Within 35 to 85%RH (at non-dew status) of ambient humidity
④ The place without explosive, flammable and corrosive gas
⑤ The place without direct ray of light
⑥ The place where dust or metal scrap does not enter into the unit
⑦ The place without contact with water, oil, or other liquid
⑧ The place without contact with strong alkali or acid material
⑨ The place where easy heat dissipation could be made
⑩ The place where no continuous vibration or severe shock
⑪ The place with less salt content
⑫ The place with less electronic noise occurs by welding machine, motor, etc.
⑬ The place where radioactive substances and magnetic fields does not exist and is not in the vacuum status

5 Connection

5.1 Standard Type



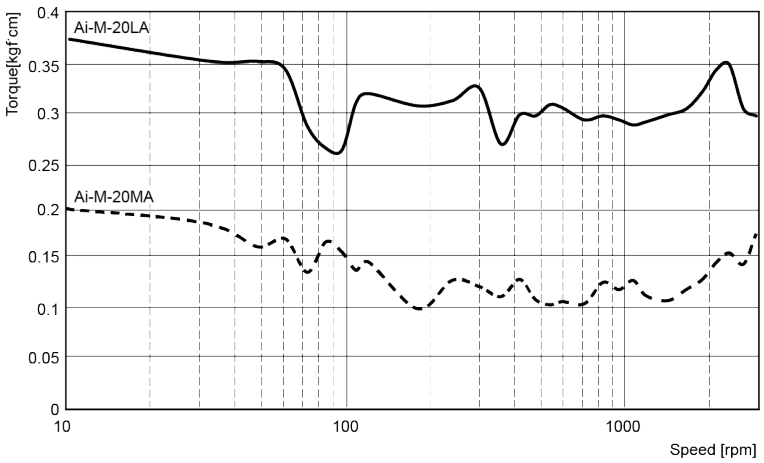
5.2 Built-in Brake Type



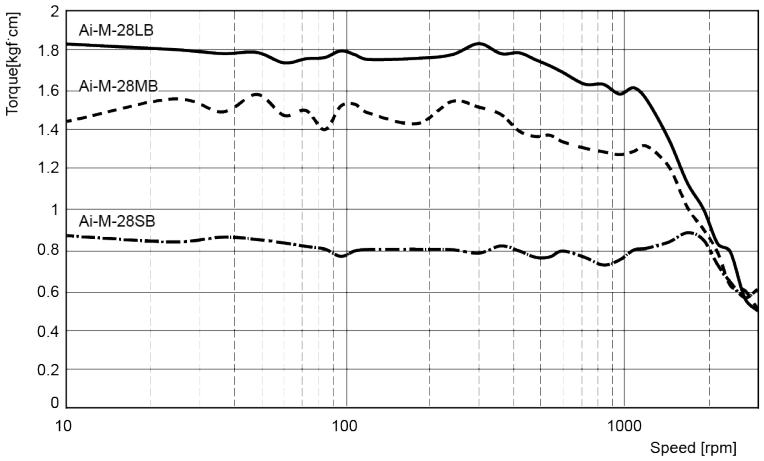
6 Characteristics

6.1 Standard Type

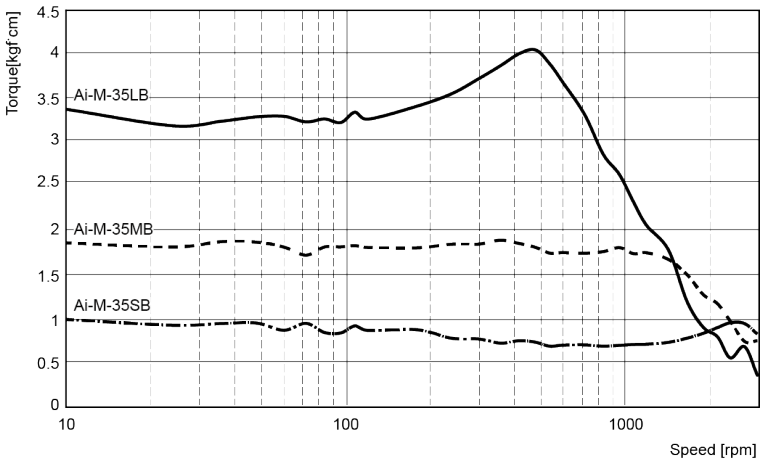
6.1.1 Frame Size 20mm



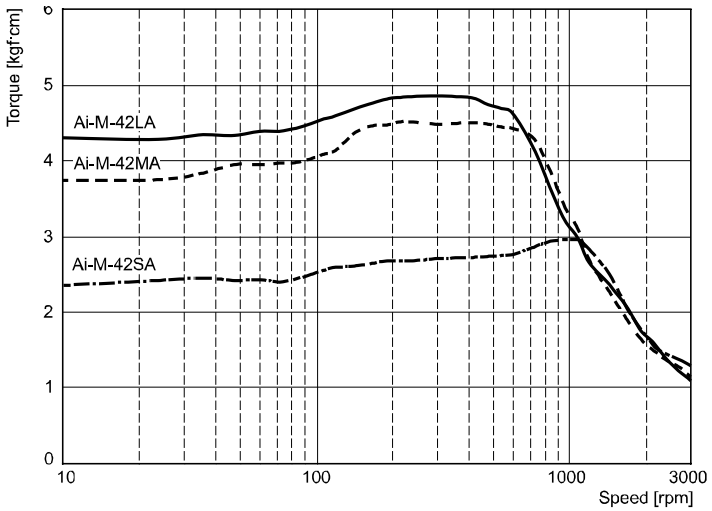
6.1.2 Frame Size 28mm



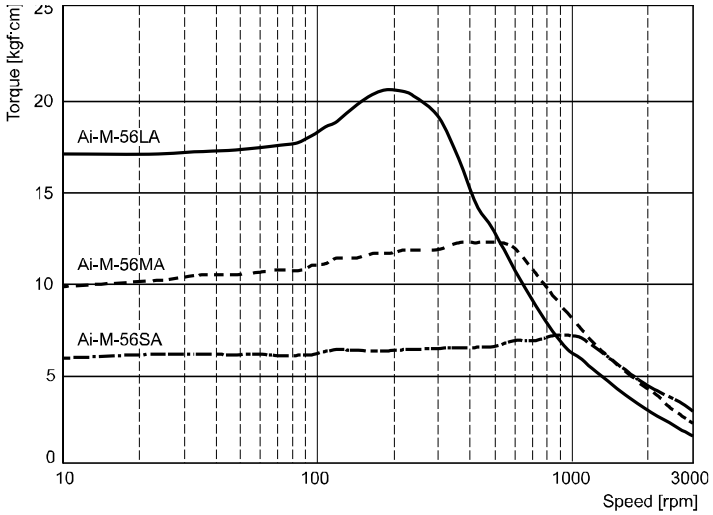
6.1.3 Frame Size 35mm



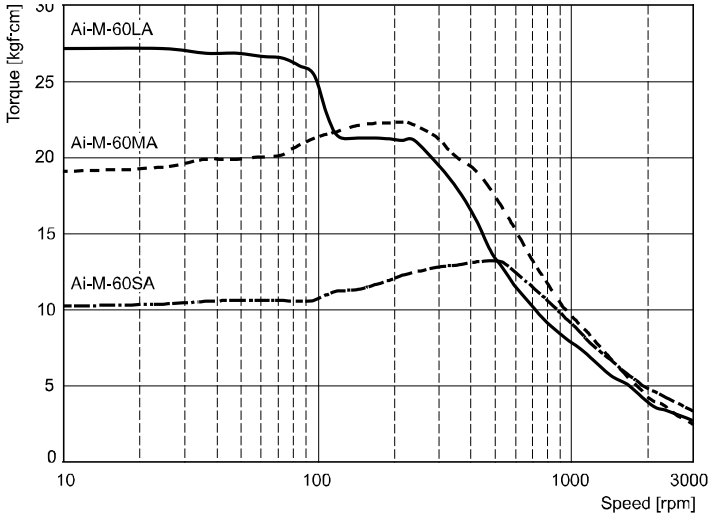
6.1.4 Frame Size 42mm



6.1.5 Frame Size 56mm

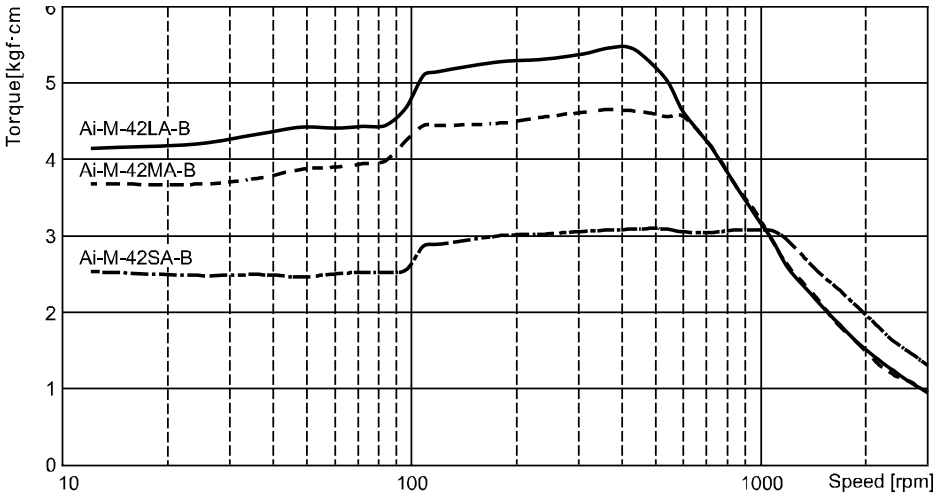


6.1.6 Frame Size 60mm

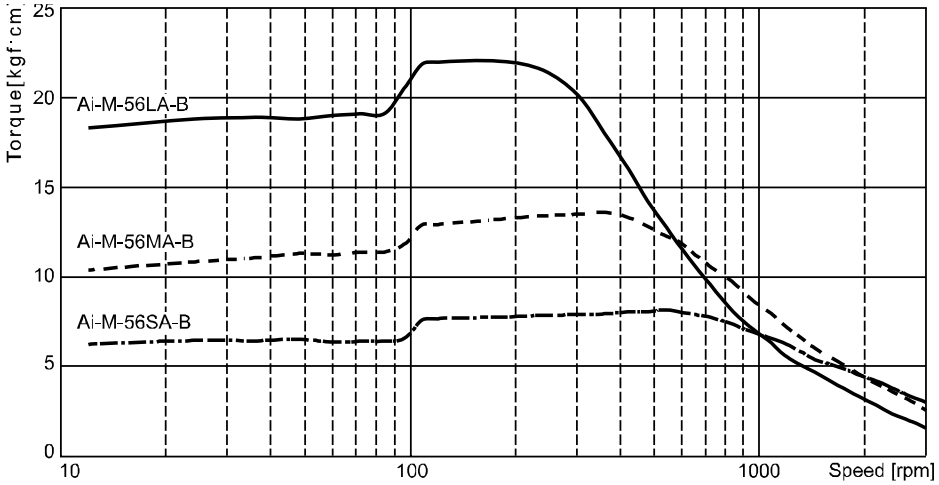


6.2 Built-in Brake Type

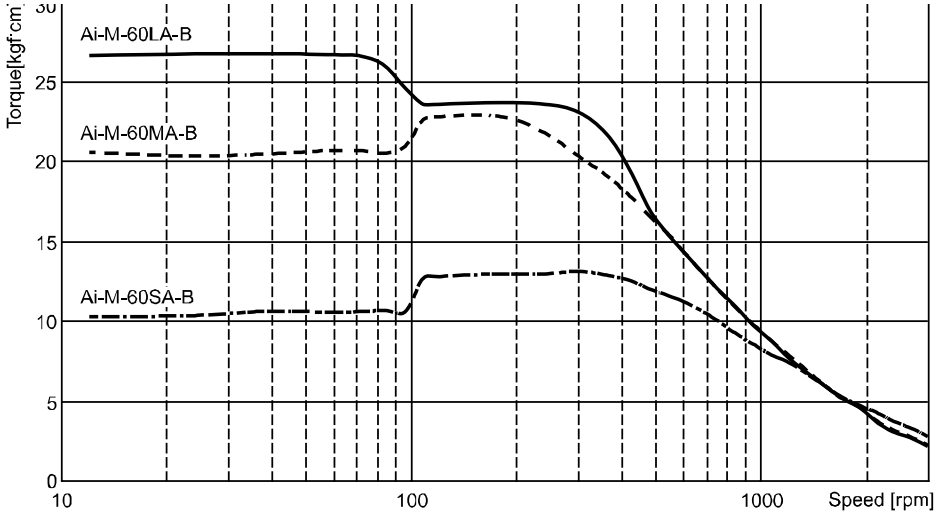
6.2.1 Frame Size 42mm



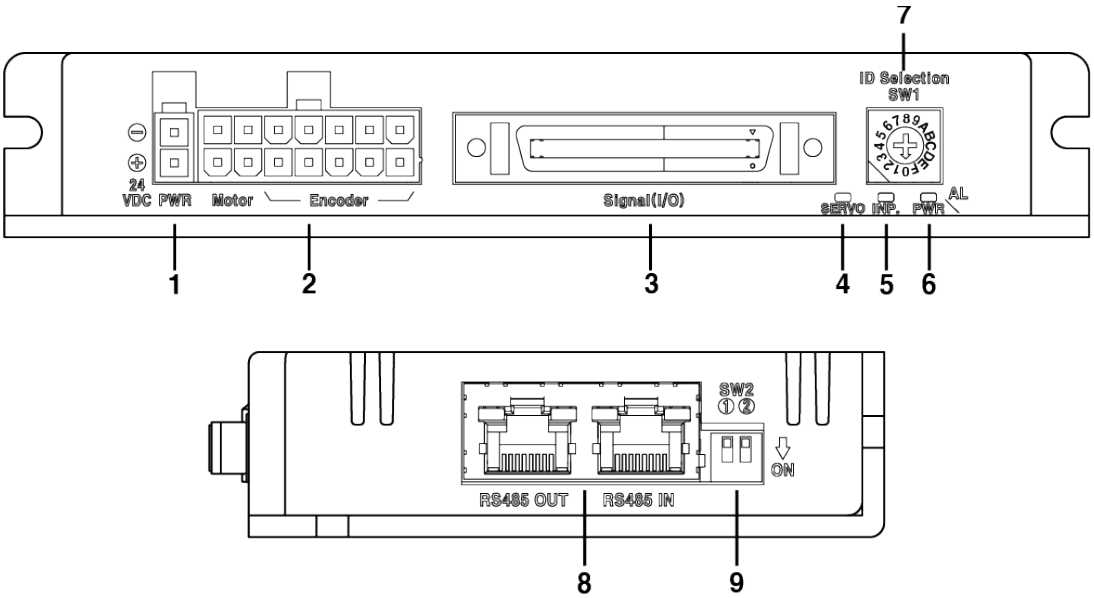
6.2.2 Frame Size 56mm



6.2.3 Frame Size 60mm



7 Driver Unit Descriptions

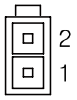


1. Power connector (CN1: PWR)
2. Motor+Encoder connector (CN2: Motor / Encoder)
3. I/O connector (CN3: Signal I/O)
4. Servo On/Off indicator (Servo, Orange)
5. In-Position indicator (INP., Yellow)
6. Power/Alarm indicator (PWR/AL, Green/Red)
7. Communication ID setting rotary switch (ID Selection SW1)
8. RS485 Communication connector (CN4: RS485 OUT / RS485 IN)
9. Communication ID setting/Terminating resistance setting DIP switch (SW2)

7.1 Connectors

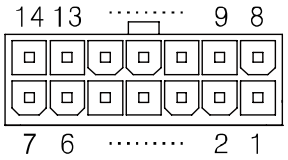
7.1.1 CN1: Power Connector

Connects with 24VDC power. Be sure to the polarity to correct connection.
When polarity direction is reversed, power is not turned on.

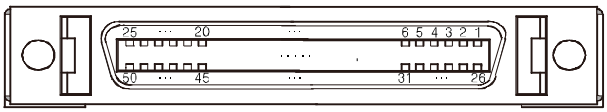
Pin arrangement	Pin no.	Function
	2	GND
	1	24VDC

7.1.2 CN2: Motor+Encoder Connector

Connects the motor and the encoder to the driver.

Pin arrangement	Pin no.	Function	Pin no.	Function
	1	GND	8	+5VDC
	2	Encoder A	9	Encoder $\overline{A}$
	3	Encoder B	10	Encoder $\overline{B}$
	4	Encoder Z	11	Encoder $\overline{Z}$
	5	F.G.	12	N.C
	6	Motor A	13	Motor B
	7	Motor $\overline{A}$	14	Motor $\overline{B}$

7.1.3 CN3: I/O Connector



Pin arrangement	I/O	Signal	Filter※1	Active※2	Function
1※3	Output	Brake+	-	-	Brake output (24VDC)
2※3	Output	Brake-	-	-	Brake output (GND)
3	Input	Reset	1.5, 10ms	[L]	Reset
4	Input	Start	1.5, 10ms	[L], [H]	Start drive
5	Input	Stop	1.5, 10ms	[L], [H]	Stop drive
6	Input	EMG	1.5, 10ms	[L], [H]	Emergency stop drive
7	Input	Step0/+Run/+Jog	1.5, 10ms	[L], [H]	Step designate0 / +Continuous / +Jog
8	Input	Step1/-Run/-Jog	1.5, 10ms	[L], [H]	Step designate1/-Continuous/-Jog
9	Input	Step2/SSP0	1.5, 10ms	[L], [H]	Step designate2/Start speed designate 0
10	Input	Step3/SSP1	1.5, 10ms	[L], [H]	Step designate3/Start speed designate 1
11	Input	Step4/MSP0	1.5, 10ms	[L], [H]	Step designate4/Max. speed designate 0
12	Input	Step5/MSP1	1.5, 10ms	[L], [H]	Step designate5/speed designate 1
13	Input	MD0/HMD0	1.5, 10ms	[L], [H]	Run mode designate0/ Home search mode designate0
14	Input	MD1/HMD1	1.5, 10ms	[L], [H]	Run mode designate 1/ Home search mode designate 1
15	Input	Pause	1.5, 10ms	[L], [H]	Pause
16	Input	Servo On/Off	1.5, 10ms	[L], [H]	Servo On/Off
17	Input	Home	1.5, 10ms	[L], [H]	Home search
18	Input	Alarm Reset	1.5, 10ms	[L], [H]	Alarm reset
19	Input	+Limit	1.5ms	[L], [H]	+ direction limit sensor
20	Input	-Limit	1.5ms	[L], [H]	- direction limit sensor
21	Input	ORG	1.5ms	[L], [H]	Home sensor
22	Input	SD	1.5ms	[L], [H]	deceleration drive signal
23	Output	In-Position	-	-	Drive end pulse
24	Input	VEX	-	-	External input power (24VDC)
25	Input	GEX	-	-	External input GND (0VDC)
26	Input	IN0	1.5, 10ms	[L], [H]	General input0
27	Input	IN1	1.5, 10ms	[L], [H]	General input1
28	Input	IN2	1.5, 10ms	[L], [H]	General input2
29	-	N.C	-	-	Disable
30	Input	IN3	1.5, 10ms	[L], [H]	General input3
31	Input	IN4	1.5, 10ms	[L], [H]	General input4
32	Input	IN5	1.5, 10ms	[L], [H]	General input5
33	Input	IN6	1.5, 10ms	[L], [H]	General input6
34	Input	IN7	1.5ms	[L], [H]	General input7
35	Input	IN8	1.5ms	[L], [H]	General input8
36	Input	VEX	-	-	External input power (24VDC)
37	Input	GEX	-	-	External input GND (0VDC)
38	Output	Alarm	-	-	Alarm output
39	Output	Compare1	-	-	Comparison output1

Pin arrangement	I/O	Signal	Filter※1	Active※2	Function
40	Output	Compare2	-	-	Comparison output2
41	Output	OUT0	-	-	General output0
42	Output	OUT1	-	-	General output1
43	Output	OUT2	-	-	General output2
44	Output	OUT3	-	-	General output3
45	Output	OUT4	-	-	General output4
46	Output	OUT5	-	-	General output5
47	Output	OUT6	-	-	General output6
48	Output	OUT7	-	-	General output7
49	Output	OUT8	-	-	General output8
50※4	Output	OUT9	-	-	General output9

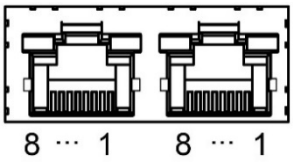
※1: It is software input filter to set 10ms or 1.5ms of parameter 'Input Filter'. The filter of +Limit, ORG, SD, IN7 to 9 is fixed as 1.5ms. When input turns ON over the set time, it recognizes as normal signal input.

※2: It is voltage level to recognize input signal as ON. It is available to set each input. [H]: 5-30VDC, [L]: 0-2VDC (however, reset is fixed as [L].)

※3: N.C for standard type motor.

※4: N.C for built-in brake type motor.

7.1.4 CN4: RS485 Communication Cable Connector



Pin no.	Input/Output	Function
1	-	N.C
2	-	N.C
3	Input/Output	RS485 DATA+
4	-	N.C
5	-	N.C
6	Input/Output	RS485 DATA-
7	-	N.C
8	-	N.C

7.2 Connector Specifications

Type		Specifications			Manufacture
		Connector	Connector terminal	Housing	
CN1	Driver	3930-1020 (5569-02A2)	-	-	Molex
	Power	CHD1140-02	CTD1140	-	HANLIM
CN2	Driver	35318-1420	-	-	Molex
	Motor+Encoder	5557-14R	5556T2※1 5556T		
CN3	Driver	10250-52A2 PL	-	-	3M
	I/O connector	10150-3000PE		10350-52F0-008	
CN4	Driver	KRM-U-02-8-8-4-7M5	-	-	KINNEXA

※1. It depends on the frame size of the motor.
5556T2: 20, 28, 35mm
5556T: 42, 56, 60mm

Note

Above connectors are suitable for AiC-D Series. You can use equivalent or substitute connectors.

7.3 Switches

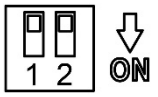
7.3.1 SW1: ID Setting Switch

Setting switch	Setting	ID		Setting	ID	
		SW2 1 OFF	SW2 1 ON		SW2 1 OFF	SW2 1 ON
 ID Selection SW1	0	Disable	16	8	8	24
	1	1 (factory default)	17	9	9	25
	2	2	18	A	10	26
	3	3	19	B	11	27
	4	4	20	C	12	28
	5	5	21	D	13	29
	6	6	22	E	14	30
	7	7	23	F	15	31

Note

※Set Node ID of the driver.
※Depending on the 1 switch setting of the SW2, it is possible to connect max. 31-axis.

7.3.2 SW2: ID Setting/Terminating Resistance DIP Switch



No.	Function	Switch position	
		ON	OFF (factory default)
1	ID setting	ID: 16 to 31	ID: 1 to 15
2	Terminating resistance	Use terminating resistance (120Ω)	Do not use terminating resistance

Note

※Set Node ID of the driver.

※Set to use terminating resistance.

7.4 Driver Status Indicator

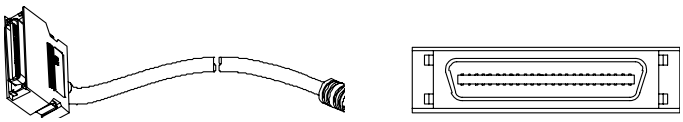
Status indicator	Location	LED color	Function	Descriptions
PWR	Front	Green	Power indicator	Turns ON when the unit operates normally after supplying power.
			warning indicator	Flashes when limit signal is input or overload, status is maintained.
AL		Red	Alarm indicator	When alarm occurs, it flashes in various ways depending on the situation. Refer to '8.2.1Exclusive Output (AiC-D: 4, AiC-D-B: 6)'.
INP.		Yellow	In-Position indicator	Turns ON when motor is placed at command position after positioning input.
SERVO		Orange	Servo On/Off indicator	Turns ON when Servo is operating, turns OFF when servo is not operating.
RXD IN※1	Right side	Yellow	RS485 Data I/O display	Flashes when receiving data.
TXD OUT※1		Green		Flashes when sending data.

Note

※1: Although RS485 OUT is disconnected, RXD IN/TXD OUT operates normally, if RS485 IN is communicating.

7.5 Sold Separately

7.5.1 I/O Cable (CO50-MP□-R, standard: AiC TAG)



Pin no.	Function (name tag)	Cable color	Dot line color-numbers	Pin no.	Function (name tag)	Cable color	Dot line color-numbers
1※1	BRAKE+	Orange	Black-1	26	IN0	White	Red-3
2※1	BRAKE-		Red-1	27	IN1		Black-4
3	RESET		Black-2	28	IN2		Red-4
4	START		Red-2	29	N.C		Black-5
5	STOP		Black-3	30	IN3		Red-5
6	EMG		Red-3	31	IN4	Gray	Black-1
7	STEP0/+RUN/+JOG		Black-4	32	IN5		Red-1
8	STEP1/-RUN/-JOG		Red-4	33	IN6		Black-2
9	STEP2/SSP0		Black-5	34	IN7		Red-2
10	STEP3/SSP1		Red-5	35	IN8		Black-3
11	STEP4/MSP0	Yellow	Black-1	36	VEX		Red-3
12	STEP5/MSP1		Red-1	37	GEX		Black-4
13	MD0/HMD0		Black-2	38	ALARM		Red-4
14	MD1/HMD1		Red-2	39	COMPARE1		Black-5
15	PAUSE		Black-3	40	COMPARE2		Red-5
16	SERVO ON/OFF		Red-3	41	OUT0	Pink	Black-1
17	HOME		Black-4	42	OUT1		Red-1
18	ALARM RESET		Red-4	43	OUT2		Black-2
19	+LIMIT		Black-5	44	OUT3		Red-2
20	-LIMIT		Red-5	45	OUT4		Black-3
21	ORG	White	Black-1	46	OUT5		Red-3
22	SD		Red-1	47	OUT6		Black-4
23	IN POSITION		Black-2	48	OUT7		Red-4
24	VEX		Red-2	49	OUT8		Black-5
25	GEX		Black-3	50※2	OUT9		Red-5

Note

※1: N.C for standard type motor.

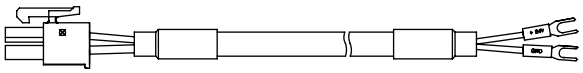
※2: N.C for built-in brake type motor.

※□ of model name indicates cable length (010, 020, 030, 050, 070, 100, 150, 200).

E.g.) CO50-MP070-R: 7m I/O cable

※It is recommended to use ferrite core at I/O cable.

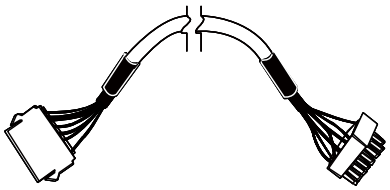
7.5.2 Power Cable (CJ-PW-□)



Note

※□ of model name indicates cable length (010, 020).
E.g.)CJ-PW-010: 1m power cable
※It is recommended to use ferrite core at Power cable.

7.5.3 Motor+Encoder Cable (normal: C1D14M-□/moving: C1DF14M-□)



Note

※□ of model name indicates cable length (1, 2, 3, 5, 7, 10, 15, 20).
E.g.)C1DF14M-10: 10m moving type motor+encoder cable
※It is recommended to use ferrite core at Motor+Encoder cable.

8 Control Input/Output

Inner signal of all input/output consists of photocoupler.
ON, [H]: photocoupler power ON
OFF, [L]: photocoupler power OFF

8.1 Input

8.1.1 Exclusive Input (20)

Signal name	Descriptions	Pin no.
Reset	Reset command	3
Start	Drive start command	4
Stop	Drive stop command	5
EMG	Drive emergency stop command	6
Step0/+Run/+Jog	Step designate0/+Continuous/+Jog	7
Step1/-Run/-Jog	Step designate1/-Continuous/-Jog	8
Step2/SSP0	Step designate2/ Start speed designate 0	9
Step3/SSP1	Step designate3/ Start speed designate 1	10
Step4/MSP0	Step designate4/ Max. speed designate 0	11
Step5/MSP1	Step designate5/ Max. speed designate 1	12
MD0/HMD0	Operation mode designate 0/Home search mode designate 0	13
MD1/HMD1	Operation mode designate 1/Home search mode designate 1	14
Pause	Pause	15
Servo On/Off	Servo On/Off	16
Home	Home search	17
Alarm Reset	Alarm reset command	18
+Limit	+ direction limit sensor	19
-Limit	- direction limit sensor	20
ORG	Home sensor	21
SD	Deceleration (Deceleration stop) signal	22

8.1.1.1 Reset

When driver is reset, it operates same as resupplying the power.
The parameter which is saved at atMotion is not reset.
During motor driving, it stops immediately and the driver is reset.

8.1.1.2 Start

It starts drive as the set mode; index mode or program mode.

Note

- When it stops by stop instruction during driving with program mode, supplying start input, it starts drive from the first step.
- When it pauses by pause instruction during driving with program mode, supplying start input, it starts drive from the next step of the paused one.

8.1.1.3 Stop

During continuous driving, it decelerates and stops the motor according to 'Deceleration Time 1' parameter setting.

Note

- During program mode driving, it stops after complete the current step.
- During home search, it decelerates and stops according to 'Home Search Deceleration Time' parameter setting. In this case, home search mode error alarm occurs.

8.1.1.4 EMG (emergency)

Motor stops immediately, emergency stop alarm occurs.
The current of motor is not blocked.
During stopping motor, EMG instruction does not run.

8.1.1.5 Step0, 1/±Run/±Jog

(1) Step0, 1

It is available to set the start address of program mode among 0 to 63 range by 6-digit bit of Step0 to Step5.

- Step0=Least significant bit
- Step5=Most significant bit

(2) ±Run

Accoridng to the set parameter, it drives to CW (+Run) / CCW (-Run) direction as continuous mode.

(3) ±Jog

Accoridng to the set parameter, it drives to CW (+Jog) / CCW (-Jog) direction during ON jog signal.

Note

If +Jog signal and –Jog signal are supplied at the same time, the motor stops.

8.1.1.6 Step2, 3/SSP0, 1 (start speed)

(1) Step2, 3

It is available to set the start address of program mode among 0 to 63 range by 6-digit bit of Step0 to Step5.

- Step0=Least significant bit
- Step5=Most significant bit

(2) SSP0, 1

It is available to set the start drive speed of jog mode, continuous mode by 2-digit bit of SSP0, SSP1.

	SSP1	SSP0
Start speed 1	OFF	OFF
Start speed 2	OFF	ON
Start speed 3	ON	OFF
Start speed 4	ON	ON

Note

Start speed 5 is not available.

8.1.1.7 Step4, 5/MSP0, 1 (max speed)

(1) Step4, 5

It is available to set the start address of program mode among 0 to 63 range by 6-digit bit of Step0 to Step5.

- Step0=Least significant bit
- Step5=Most significant bit

(2) MSP0, 1

It is available to set the max. drive speed of jog mode, continuous mode by 2-digit bit of MSP0, MSP1.

	MSP1	MSP0
Max speed 1	OFF	OFF
Max speed 2	OFF	ON
Max speed 3	ON	OFF
Max speed 4	ON	ON

Note

Max speed 5 is not available.

8.1.1.8 MD0, 1/HMD0, 1 (mode/home mode)

(1) MD0, 1

When it is not home search mode, it is available to set the drive mode among 4 types.

	MD1	MD0
Index mode	OFF	OFF
Jog mode	OFF	ON
Continuous mode	ON	OFF
Program mode	ON	ON

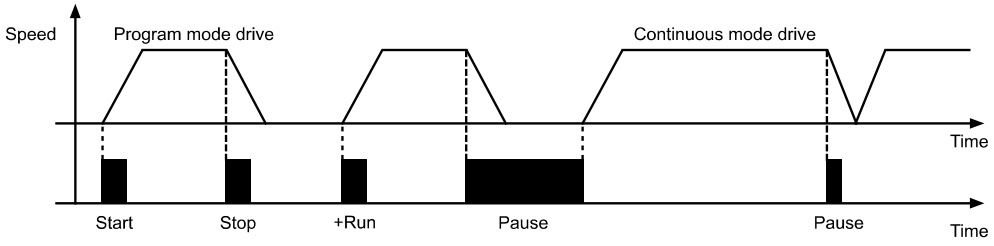
(2) HMD0, 1

When home signal is ON, it is available to set the home search mode among 4 types.

	HMD1	HMD0
Home search	OFF	OFF
Limit home search	OFF	ON
Zero home search	ON	OFF
Torque home search	ON	ON

8.1.1.9 Pause

- When pause signal is ON during program mode drive, it pauses after completing the current step driving.
  After start signal is ON, it starts drive from the next step of the paused one.
- During continuous mode driving, it decelerates and stops when pause signal is ON.
  When pause signal is OFF, it starts drive.
  If pause signal is OFF before stopping the motor, the motor stops and it starts drive as continuous mode.



8.1.1.10 Servo On/Off

- It is for adjusting shaft position of motor by external force manually.
- Servo On/Off signal is [H] over 1ms: It recognizes as servo off signal and the phase current of motor is blocked and torque is released.
  Servo On indicator, In-Position Output and the indicator turn OFF.
- Servo On/Off signal is [L] over 1ms: It recognizes as servo on signal and the phase current of motor is supplied and torque is return.
  Servo On indicator, In-Position Output and the indicator turn ON.

Note

The motor must stop.

8.1.1.11 Home

Home search mode is set at 'Home Search Method' parameter.
As below 4 parameters, it is avaliable to set home search speed and acceleration/deceleration time.
→Home Search High Speed / Home Search Low Speed
Home Search Acceleration Time / Home Search Deceleration Time

8.1.1.12 Alarm Reset

- It is for alarm reset.
- When alarm reset signal is [H],
  : alarm is reset and the alarm indicator and alarm output turn OFF.
  The driver returns to normal status.

Note

If alarm causes are not removed, the driver does not return to normal status.

8.1.1.13 ±Limit

When supplying the ±limit signal over 1.5ms, it recognizes as ±hardware limit input and it decelerates and stops or stops immediately accoridng to the set parameter.

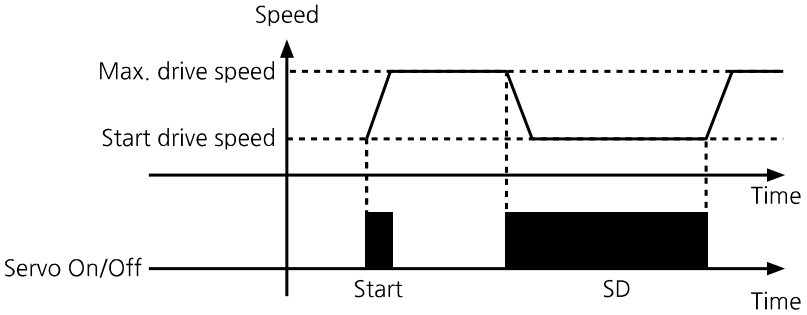
- +Limit=CW direction limit sensor signal
- -Limit=CCW direction limit sensor signal

8.1.1.14 ORG (origin)

During driving as general home search mode, it is used as home sensor input.
When suppling ORG signal over 1.5ms, it recognizes as home sensor.

8.1.1.15 SD (slow down)

When supplying SD signal over 1.5ms, the set the start drive speed decelerates.



8.1.2 General Input (9)

Signal name	Descriptions	Pin no.
IN0 to IN2	General input 0 to 2	26 to 28
IN3 to IN8	General input 3 to 8	30 to 35

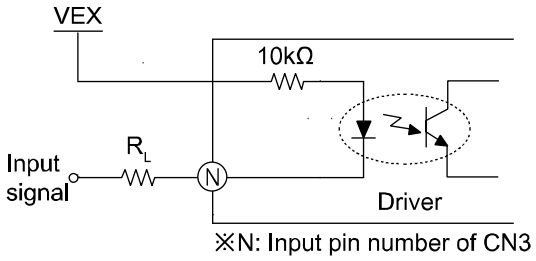
It is general input at program mode.
It is used with ICJ, IRD instruction.

- IN0 to IN5
  When supplying over 10ms or 1.5ms (set at 'Input Filter' parameter), it recognizes as input.
- IN6 to IN8
  When supplying over 1.5ms, it recognizes as input.

8.1.3 Example of Input Circuit Connection

All input circuits are insulated with photocoupler. It is recommended to use 24VDC at VEX and short RL.
In case using external power over 24VDC power, select R_L value that I_F (forward current of primary LED) of photocoupler to be around 2.5mA (max. 10mA).

$$R_L = \frac{VEX - 1.25V}{0.0025A} - 10 \times 10^3 \Omega$$



※N: Input pin number of CN3

8.2 Output

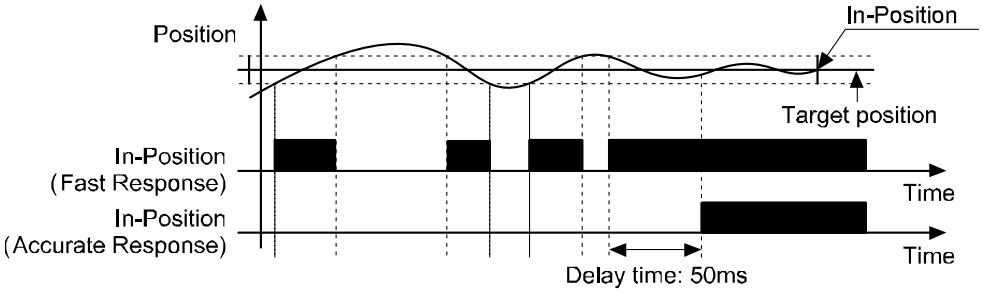
※Brake operation is only for built-in brake type.

8.2.1 Exclusive Output (AiC-D: 4, AiC-D-B: 6)

Signal name	Descriptions	Pin no.
Brake+	Brake output (24VDC)	1
Brake-	Brake output (GND)	2
In-Position	Drive ending pulse	23
Alarm	Alarm output	38
Compare 1 (Trigger)	Compare output 1	39
Compare 2 (Trigger)	Compare output 2	40

8.2.1.1 In-Position

In-Position output is output condition of positioning completion signal.
If the gap between target position and real position is under in-position setting value after position command pulse has finished, in-position output turns to [H] and the in-position indicator turns ON.
In reverse, when the gap is over in-position setting value, in-position output turns to [L] and the in-position indicator turns OFF.



Fast response		Accurate response	
Setting	Value	Setting	Value
0 (factory default)	0	8	0
1	±1	9	±1
2	±2	10	±2
3	±3	11	±3
4	±4	12	±4
5	±5	13	±5
6	±6	14	±6
7	±7	15	±7

Note

For accurate control, check the in-position output before the next drive.

- Fast Response: When the deviation of the target position and the current position is smaller the set value, In-Position signal outputs instantly.
- Accurate Response: When the deviation of the target position and the current position is smaller than the set value and maintains over 50ms In-Position signal outputs.

8.2.1.2 Alarm / Warning

(1) Alarm

- This function stops motor to protect driver, depending on the error status such as over current or over speed.
- In case of normal status, output is [H], and in case of alarming status, output is [L].
- When alarm occurs, brake operates.
- When supplying alarm reset, driver returns to the normal status.

※Refer to example of '8.2.3Example of Output Circuit Connection'.

(2) Warning

- This function notices dangers with the alarm indicator prior to motor stop with limit signal or over load alarm.
- When turning out from the alarming condition, driver returns to the normal status automatically.

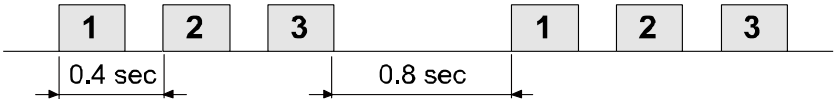
Note

※Even though warning occurs, it drives as normal status and it may cause damage by fire. It is recommended not to use the unit during warning status.

※Depending on the alarm/warning type, it flashes for 0.4 sec interval and it turns OFF for 0.8 sec repeatedly.

Ex.

In case of no. 3 alarm,



1) Alarm indicator (AL, red), motor stop

No. of flashing	Alarm type	Descriptions	Causes	Troubleshooting
1	Over current error	When over current flows at motor RUN element	1. Over load 2. Insufficient SMPS capacity	1. Change operation condition or reduce load so that sudden load fluctuation does not occur. 2. Check that less than the recommended SMPS capacity is used. 3. Check driver break.
2	Over speed error	When motor speed is over 4,000rpm	1. When overload is applied and released at a moment. 2. Turning more than 4,000 rpm by external force.	1. Change operation condition or reduce load so that sudden load fluctuation does not occur. 2. Change the operating condition so that the motor does not rotate more than 4,000 rpm.
3	Position tracking error	When the gap between position command value and current position value is over 90°	1. Over load 2. Motor connector and cable connection error 3. Burnout of line driver IC in encoder	1. Change operation condition or reduce load so that sudden load fluctuation does not occur. 2. Check motor connector and cable connection. 3. Replace the line driver IC in encoder.
4	Overload error	When applying load over the rated load for over 1 sec.	1. Over load 2. Insufficient SMPS capacity	1. Change operation condition or reduce load so that sudden load fluctuation does not occur. 2. Check that less than the recommended SMPS capacity is used. 3. Check driver break.
5	Overheat error	When driver inner temperature is over 80°C	1. Installed in an enclosed space	1. Change the installation environment. -Air flow around driver installation. -Heat dissipation (heat sink or fan)
6	Motor connec-tion error	When motor cable connection error occurs at driver	1. Motor connector and cable connection error 2. Burnout of the inverter in the driver	1. Check motor connector and cable connection. 2. Replace burned parts of the inverter in the driver.
7	Encoder connec-tion error	When encoder cable connection error occurs at driver	1. Motor connector and cable connection error 2. Burnout of line driver IC in encoder	1. Check motor connector and cable connection. 2. Replace the line driver IC in encoder.
8	Regener-ative voltage error	When regenerative voltage is over 78V	1. Over load 2. Excessive force due to rapid deceleration	1. Change operation condition or reduce load so that sudden load fluctuation does not occur.

No. of flashing	Alarm type	Descriptions	Causes	Troubleshooting
9	Motor mis-alignment	When motor is in misalignment	1. Motor connector and cable connector error 2. Burnout of line driver IC in driver 3. Burnout of line driver IC in encoder 4. Burnout of the inverter in the driver	1. Check motor connector and cable connection. 2. Replace the line driver IC in driver. 3. Replace the line driver IC in encoder. 4. Replace burned parts of the inverter in the driver.
10	Command speed error	When command speed is over 3,500rpm	1. Enter error of user command speed input	1. Use recommended specifications. (max. 3,000rpm input) 2. Enter the speed value (PPS) by checking the resolution.
11	Input voltage error	When input voltage is out of 24VDC ±10%	1. Over load 2. Insufficient SMPS capacity 3. Power input over the specification (24VDC ±10%)	1. Change operation condition or reduce load so that sudden load fluctuation does not occur. 2. Check that less than the recommended SMPS capacity is used. 3. Check the power specification. (24VDC ±10%)
12	In-Position error	When position error (over 1) is kept over 3 sec, after motor stopped.	1. Over load 2. Lack of stop torque.	1. Change operation condition or reduce load so that sudden load fluctuation does not occur. 2. Increase stop torque as 50% or use the other motor with higher torque.
13	Memory error	When memory error is detected as power supplied	1. EEPROM error	1. Replace EEPROM parts.

2) Alarm indicator (AL, red), motor stop and maintain torque

No. of flashing	Alarm type	Descriptions	Causes	Troubleshooting
14	Emer-gency stop	When emergently stopped with emergency stop command	1. When emergency stop enters	1. Check EMG signal. 2. Check Active Level Setting of EMG signal.
15	Program mode error	When 'END' command is not exist at the last step	1. If there is no ‘END’ instruction at the last step of the program 2. If there is an empty step in the middle of the program.	1. Add ‘END’ command at last step of program. 2. Remove an empty step in middle of a program.
16	Index mode error	When other instruction is used but 'INC', 'ABS' When index command is not completed due to the stop command	1. When running a step with commands other than ‘INC’ and ‘ABS’. 2. When entering the stop command during driving on index mode	1. Check whether the command of the step is ‘INC’ or ‘ABS’ 2. Check that the selected step number is correct.
17	Home search mode error	When failed to find home	1. If there is no ‘ORG’ or ‘+/- Limit’ input 2. If load above the set value is not applied (torque home search) 3. When a stop command is issued during home search operation	1. Check if the ORG signal is correctly input (general home search) 2. Check if the +/- Limit signal is correctly input (limit home search) 3. Check if the +/- Limit signal is correctly set with the motor rotation direction. (CW direction: +Limit, CCW direction: -Limit) 4. Change the value of the Home search Torque parameter (torque home search)

3) Warning indicator (PWR, green), motor stop and maintain torque

No. of flashing	Warning type	Descriptions	Causes	Troubleshooting
1	S/W +Limit	When normal direction (CW) software limit is ON	1. When the current position reaches the S/W + Limit value	1. Check S/W + Limit parameter value.
2	S/W -Limit	When reverse direction (CCW) software limit is ON	1. When the current position reaches the S/W - Limit value	1. Check S/W - Limit parameter value.
3	H/W +Limit	When normal direction (CW) hardware limit is ON	1. When + Limit signal (I/O no. 19-pin) is input	1. Check the + Limit signal is input correctly. 2. Check if the +/- Limit signal is correctly set with the motor rotation direction. (CW direction: + Limit, CCW direction: - Limit)
4	H/W -Limit	When reverse direction (CCW) hardware limit is ON	1. When - Limit signal (I/O no. 20-pin) is input	

4) Warning indicator (PWR, green), maintain torque

No. of flashing	Warning type	Descriptions	Causes	Troubleshooting
5	Over load warning	When maximum load is kept connected over 10 sec	1. Over load	1. Change operation condition or reduce load so that sudden load fluctuation does not occur.

8.2.1.3 Compare1, Compare2

It outputs trigger pulse at the designated cycle.

Mode	Description
0	It is not use compare output and outputs [L].
1	When the current absolute position value is higher than or same as the set position value (Compare 1 Position or Compare 2 Position), it outputs [H].
2	When the current absolute position value is lower than or same as the set position value (Compare 1 Position or Compare 2 Position), it outputs [H].
3	Trigger pulse outputs as the set period (Compare 1 Period or Compare 2 Period) and width (Compare 1 Pulse Width or Compare 2 Pulse Width).

Note

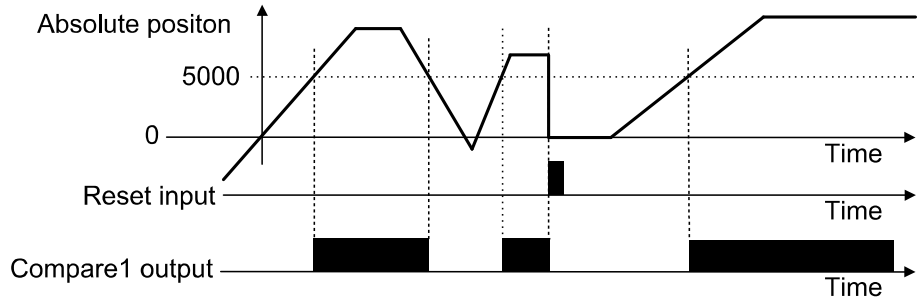
※Setting range of Compare 1 Position, Compare 2 Position: -2,147,483,648 to +2,147,483,647

※Setting range of Compare 1 Period, Compare 2 Period: 1 to 2,147,483,648 [pulse]

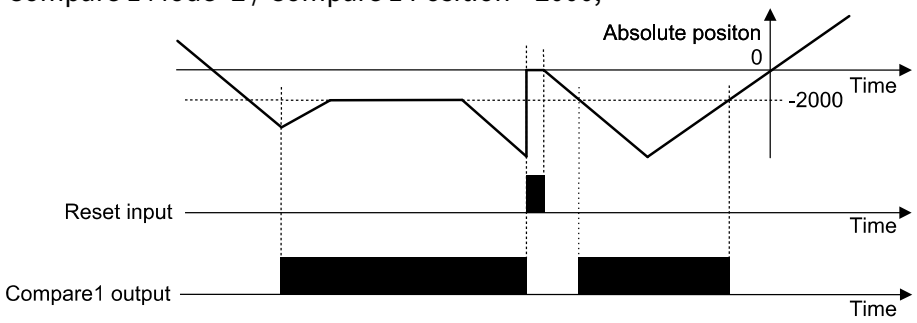
※Setting range of Compare 1 Pulse Width, Compare 2 Pulse Width : 1 to 1,000 [ms]

Ex.

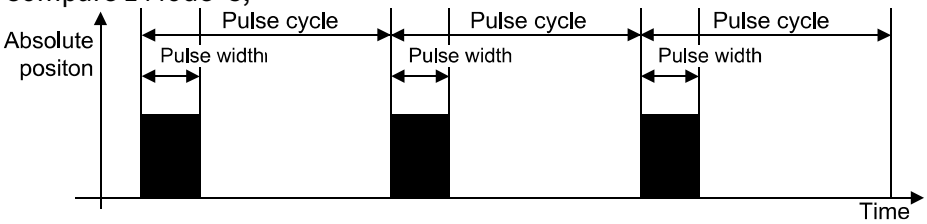
- Compare 1 Mode=1 / Compare 1 Position=5000,



- Compare 1 Mode=2 / Compare 1 Position=-2000,



- Compare 1 Mode=3,



8.2.2 General Output (AiC-D: 10, AiC-D-B: 9)

8.2.2.1 Standard type

Signal name	Description	Pin no.
OUT0 to OUT9	General Output 0 to 9	41 to 50

8.2.2.2 Built-in brake type

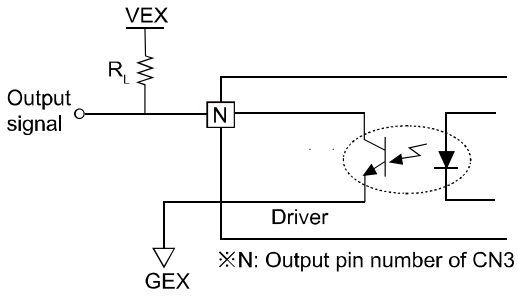
Signal name	Description	Pin no.
OUT0 to OUT8	General Output 0 to 8	41 to 49

It is general output at program mode.
It is used with OPC, OPT instruction.

8.2.3 Example of Output Circuit Connection

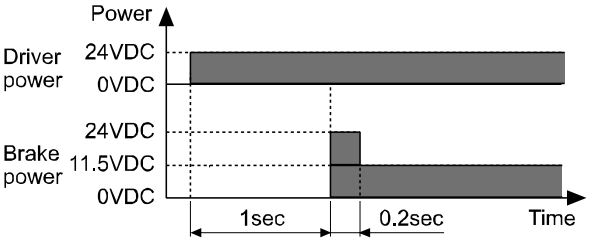
All output circuits are insulated with photocoupler.
External power input is available from 5VDC to 80VDC with the open collector method.
Select R_L value that I_C (collector current of secondary LED) of photocoupler to be around 10mA.

$$R_L = \frac{VEX - 0.7V}{0.01A}$$



8.2.4 Brake Output

In order to reduce heat in the brake, connected to the motor, the driver outputs DC power to turn off the brake.



When supplying power to the driver after connecting the driver and brake, the rated excitation voltage is supplied and the brake power is released after approx. 1 sec.
Then after approx. 0.2 sec, the excitation voltage is decreased to 11.5VDC and the released brake power is maintained.
※While power is supplied to the driver, the brake is kept turning on, except in the Servo On status.

9 Drive

As below, AiC Series has 4 drive modes and home search.
It operates each drive mode by I/O.

Drive mode name	Descriptions
Home search	Operates home search
Index mode	Designates and operates the one step among the saved instruction of the program
Jog mode	Outputs drive while instruction input signal is ON to ±direction
Continuous mode	Starts drive output when instruction input signal turns ON once to ±direction. Stops it when the signal turns stop.
Program mode	Operates by the designated program.

Caution

Do not operate instructions by I/O during communication between the driver and the PC (atMotion) (only monitoring is available.)
It may cause malfuncation due to double input.

9.1 Index Mode

At index mode, it operates the one step of “ABS” or “INC” instruction from the program.

- Index mode drive
  For operating index mode drive, the designated program step must have the instruction.
  When operating the other instruction, error occurs.

  1st Drive mode: “MD0”=0, “MD1”=0

  2nd Select Index mode.
  : It is available to set the step number from 0 to 63 combining with “Step0” to ”Step5”.

  3rd Start drive.
  : When “Start” input signal turns ON, the designated one step operates.

  4th Emergency stop
  : When “EMG” signal inputs, it stops emergently.

Note

- For index mode drive by I/O control, “MD0/HMD0”, “MD1/HMD1” are turn OFF and it selects index drive.

Caution

- When it stops by stop signal input, no. 16 alarm (Index mode error) occurs.
- When driving the step which does not have “ABS” or “INC” instruction, no. 16 alarm (Index mode error) occurs.

9.2 Jog Mode

At jog mode, it operates motor to CW direction or CCW direction while “+Jog” or “-Jog” signal is ON.

- Jog mode drive

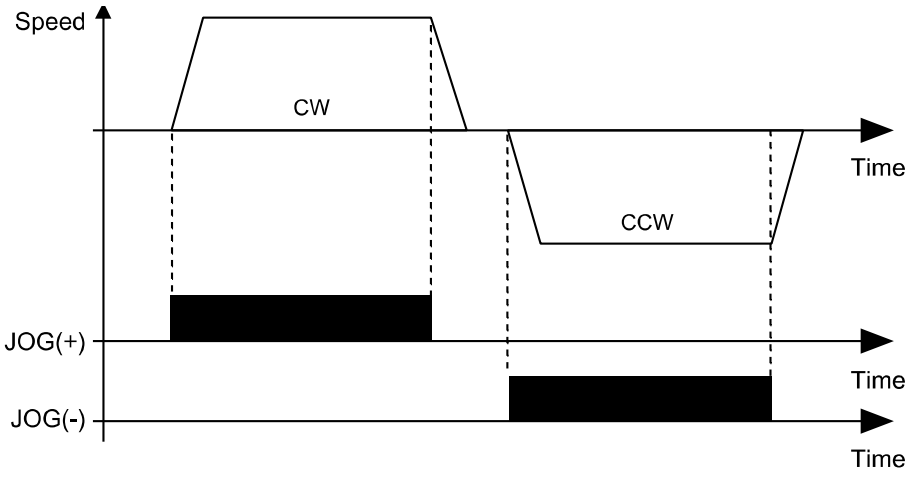
1st Dive mode: “MD0”=1, “MD1”=0

2nd Select start drive speed.
: It is available to set the start drive speed combining with “SSP0”, ”SSP1”.

3rd Select max. drive speed.
: It is available to set the max. drive speed combining with “MSP0”, ”MSP1”.

4th Drive: It drives to CW direction or CCW direction while “+Jog” or “–Jog” signal inputs.

5th Emergency stop
: When “EMG” signal inputs, it stops emergently.



Note

- For jog mode drive by I/O control, “MD0/HMD0” turns ON, “MD1/HMD1” turns OFF and it selects jog drive.
- It cannot stop by “Stop” signal input.

9.3 Continuous Mode

At continuous mode, it operates motor continuously when drive signal inputs to the designated direction.
When STOP signal inputs or limit signal of the direction inputs, it stops.

- Continuous mode drive

1st Drive mode: “MD0”=0, “MD1”=1

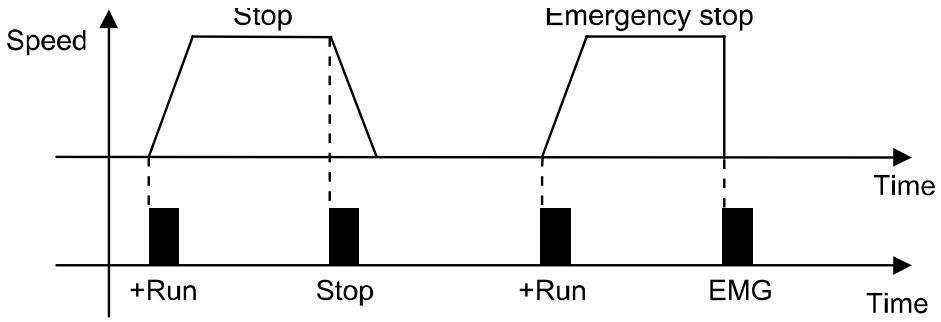
2nd Select start drive speed.
: It is available to set the start drive speed combining with “SSP0”, ”SSP1”.

3rd Select max. drive speed.
: It is available to set the max. drive speed combining with “MSP0”, ”MSP1”.

4th Drive: When “+Run” or “–Run” signal inputs, it drives to CW direction or CCW direction.

5th Stop: When “STOP” signal inputs or limit signal of the direction inputs, it stops.

6th Emergency stop: When “EMG” signal inputs, it stops emergently.



Note

For continuous mode drive by I/O control, “MD0/HMD0” turns OFF, “MD1/HMD1” turns ON, and it selects continuous drive.

9.4 Program Mode

At program mode, it operates the designated program from 0 to 255-step sequentially.

- Program mode drive

  The saved program should exist at memory.

  1st Drive mode: “MD0”=1, “MD1”=1

  2nd Drive

  : When “Start” input signal turns ON, it drives according to the set program.

  3rd Pause

  : When “Pause” signal inputs, it stops after completing the step.

  When “Start” signal inputs again, it drives from the completed next step.

  4th Stop

  : When “Stop” signal inputs, it stops after completing the step.

  When “Start” signal inputs again, it drives from the first step.

  5th When “EMG” signal inputs, it stops emergently.

  6th Program end: When “END” signal inputs, program mode drive is end.

Note

When “Power On Program Start” parameter is Enable, it operates program mode drive when resupplying power.

Caution

- For end of program mode, “END” signal must be input.

  If there is no “END” instruction input, no. 15 alarm (Program mode error) occurs.

9.5 Home Search

According to the setting of “HOME Active Level” parameter, it operates home search drive by [H] or [L] input.

For more information, refer to ‘9.5Home search’.

- Home search drive

  1st Drive mode

  : It is available to set the home search mode combining with “HMD0”, “HMD1”.

  2nd Drive

  : When “HOME” signal inputs, it operates home search according to the set mode.

  3rd Stop

  : When “STOP” signal inputs or limit signal of the direction inputs, it stops.

  4th Emergency stop

  : When “EMG” signal inputs, it stops emergently.

10 Program Instructions

There are 14 program instructions as below table.

Type	Instruction	Description
Drive	ABS	Absolute position move
	INC	Relative position move
	HOM	Home search
Input/Output	ICJ	Input condition jump
	IRD	Input wait
	OPC	Output port ON/OFF
	OPT	Output port ON pulse
	CMP	Compare output
Program control	JMP	Jump
	REP	Repeat start
	RPE	Repeat end
	END	Program end
	POS	Position set
Others	TIM	Ready

10.1 Drive Instruction

10.1.1 ABS (absolute position move)

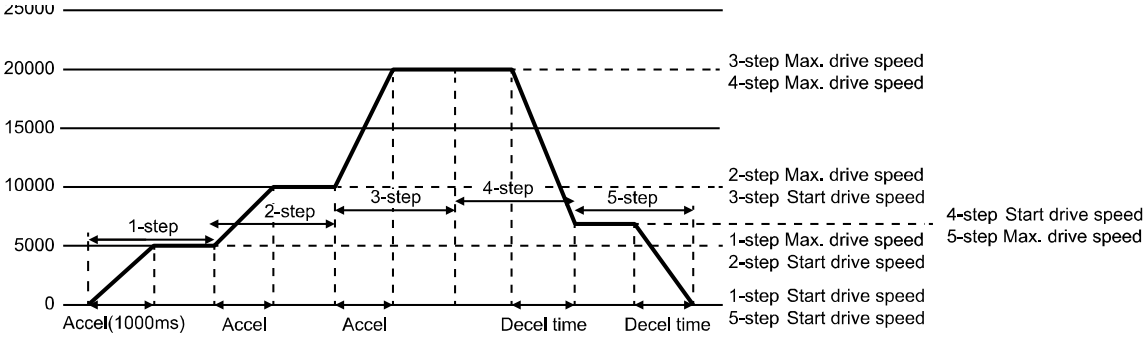
It is for moving to absolute position by a specified distance from home.

Instruction	DATA				
ABS	Instruction	Start speed	Max speed	Acceleration	Deceleration
	Position		S Curve	S Curve time	Continuation

For more information, refer to the '11.1.1Fixed Pulse and Continuous Pulse Drive'.

- Start speed (start drive speed)
  : Select the start drive speed during drive.
  Set the start drive speed from 1 to 5.
  When selecting start speed as 6, it is available to set as the desired value.
- Max speed (max. drive speed)
  : Select the max. drive speed during drive.
  Set the max. drive speed from 1 to 5.
  When selecting max. speed as 6, it is available to set as the desired value.
- Acceleration
  : Set the acceleration time of drive.
  Set the acceleration time from 1 to 5.
  When selecting acceleration as 6, it is available to set as the desired value.
- Deceleration
  : Set the deceleration time of drive.
  Set the deceleration time from 1 to 5.
  When selecting deceleration as 6, it is available to set as the desired value.
- Position: Moving position inputs as absolute value.
  In case of "Present position–Moving position > 2,147,483,647" or "Present position–Moving position < -2,147,483,648", it is out of range to move and program mode error occurs.
- S Curve
  : Set use/not use of S-curve acceleration/deceleration.
  - Enable=Use S-curve acceleration/deceleration
  - Disable=Not use S-curve acceleration/deceleration
- S Curve Time
  : When using S curve, set the S-curve acceleration/deceleration time.

- Continuation
  : It drives continuously removing acceleration/deceleration time of each step at program
  mode.
  Set the use/not use continuation.
  - Enable=Use continuation
  - Disable=Not use continuation



Step	Acceleration time (ms)	Deceleration time (ms)	Start drive speed (pps)	Max. drive speed (pps)
1	1,000	0	500	5,000
2	1,000	0	5,000	10,000
3	1,000	0	10,000	20,000
4	0	1,000	7,000	20,000
5	0	1,000	0	7,000

Note

- For the step with acceleration, set deceleration time as 0ms.
- For the step with deceleration, set acceleration time as 0ms.

10.1.2 INC (relative position move)

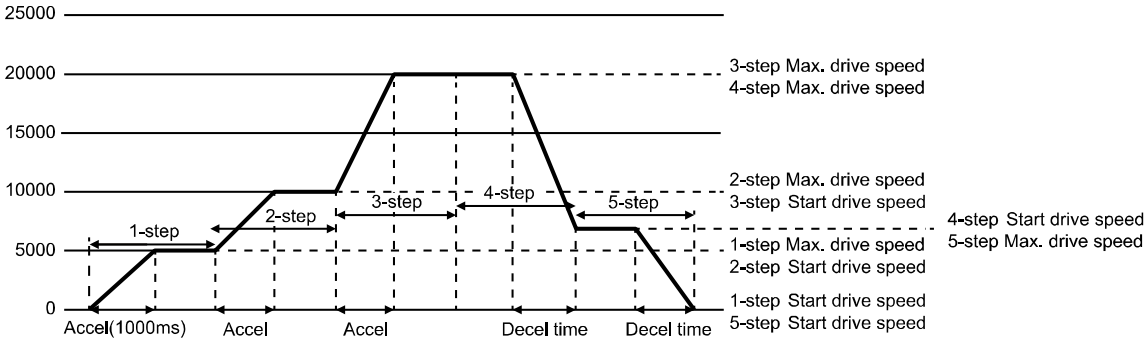
It is for moving to relative position by a specified distance from current position.

Instruction	DATA				
INC	Instruction	Start speed	Max speed	Acceleration	Deceleration
	Position		S Curve	S Curve time	Continuation

For more information, refer to the '11.1.1Fixed Pulse and Continuous Pulse Drive'.

- Start speed (start drive speed)
  : Select the start drive speed during drive.
  Set the start drive speed from 1 to 5.
  When selecting start speed as 6, it is available to set as the desired value.
- Max speed (max. drive speed)
  : Select the max. drive speed during drive.
  Set the max. drive speed from 1 to 5.
  When selecting max. speed as 6, it is available to set as the desired value.
- Acceleration
  : Set the acceleration time of drive.
  Set the acceleration time from 1 to 5.
  When selecting acceleration as 6, it is available to set as the desired value.
- Deceleration
  : Set the deceleration time of drive.
  Set the deceleration time from 1 to 5.
  When selecting deceleration as 6, it is available to set as the desired value.
- Position: Moving position inputs as relative position value.
  Moving range for input is -2,147,483,648 to 2,147,483,647.
- S Curve
  : Set use/not use of S-curve acceleration/deceleration.
  - Enable=Use S-curve acceleration/deceleration
  - Disable=Not use S-curve acceleration/deceleration
- S Curve Time
  : When using S curve, set the S-curve acceleration/deceleration time.

- Continuation
  : It drives continuously removing acceleration/deceleration time of each step at program
  mode.
  Set the use/not use continuation.
  - Enable=Use continuation
  - Disable=Not use continuation



Step	Acceleration time (ms)	Deceleration time (ms)	Start drive speed (pps)	Max. drive speed (pps)
1	1,000	0	500	5,000
2	1,000	0	5,000	10,000
3	1,000	0	10,000	20,000
4	0	1,000	7,000	20,000
5	0	1,000	0	7,000

Note

- For the step with acceleration, set deceleration time as 0ms.
- For the step with deceleration, set acceleration time as 0ms.

10.1.3 HOM (home search)

It is for home search according to the set parameter of Home Search Mode (Home search mode).

Instruction	DATA
HOM	instruction

For more information, refer to the ‘9.5Home search’ .

10.2 Input/Output Instruction

10.2.1 ICJ (input condition jump)

It is for jumping to the set step (Step No.) when the selected input port is activated.
When the input port is deactivated, it runs the next step.

Instruction	DATA		
ICJ	Instruction	Step no.	Input port

- Step No.: Set the step number to jump. Setting range is 0 to 255.
- Input port: Select Input port number.
  For more information of input port number, refer to '8.1.2General Input (9)'.

Caution

At the loop between REP, RPE instruction, do not use ICJ (Input condition jump).

10.2.2 IRD (input wait)

It is for moving the next step when the selected input port is activated.
When the input port is deactivated, it waits at the current step until the active status.

Instruction	DATA	
IRD	Instruction	Input port

- Input port: Select the input port number.
  For more information of input port number, refer to '8.1.2General Input (9)'.

10.2.3 OPC (output port ON/OFF)

Instruction	DATA		
OPC	Instruction	Output port	Level

It turns ON/OFF the selected output port.

- Output port: Select the output port number.
  For more information of output port number,
  refer to '8.2.2General Output (AiC-D: 10, AiC-D-B: 9)'.
- Level: When setting as Enable, it turns ON. When setting as Disable, it turns OFF.

10.2.4 OPT (output port ON pulse)

It turns the set output port ON during the set ON time.

Instruction	DATA			
OPT	Instruction	On time	Output port	Next step

- On Time: Set the ON time for output port.
  Setting range is 1 to 10,000msec.
- Output port: Set the output port number.
  For more information about output port number,
  refer to '8.2.2General Output (AiC-D: 10, AiC-D-B: 9)'.
- Next step
  - ON: It moves to the next step regardless of output operation.
  - OFF: It turns the set output port ON during the set ON time. After the time, it moves to the next step.

10.2.5 CMP (compare output)

It outputs trigger pulse for the set period.
For more information, refer to '8.2.1.3Compare1, Compare2'.

10.3 Program Control Instruction

10.3.1 JMP (jump)

It jumps to the designated step (Step No.).

Instruction	DATA	
JMP	Instruction	Step no.

- Step No. : Set the step number to jump. Setting range is 0 to 255.

Caution

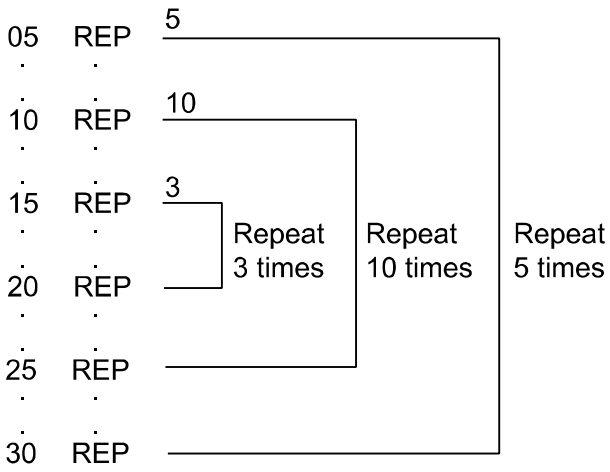
When using JMP instruction, be sure to the position of END instruction.
At the loop between REP, RPE instruction, do not use JMP (jump).

10.3.2 REP (repeat start)

It operates repeatedly for the set times from the next step of this instruction to RPE (repeat end instruction).

Instruction	DATA	
REP	Instruction	Repeat count

- Repeat Count
  : Set the repeat times. Setting range is 1 to 255.
  RPE (repeat end) instruction should be below (higher step number) of the REP (repeat start) instruction. The lower nested loops are available up to 3.



10.3.3 RPE (repeat end)

It is end instruction of REP (repeat start).

Instruction	DATA
RPE	Instruction

It operates repeatedly at the set times from REP (repeat start) instruction to the RPE (repeat end) instruction.

Caution

At the loop between REP, RPE instruction, do not use jump instruction (JMP, ICJ).

10.3.4 END (program end)

It ends program. You must enter this instruction at the end of program.

Instruction	DATA
END	Instruction

10.3.5 POS (position set)

It sets the position value.

Instruction	DATA	
POS	Instruction	Position

- Position: Set the position value. Setting range is -2,147,483,648 to +2,147,483,647.

10.4 Others

10.4.1 TIM (ready)

It is ready instruction for the set time.

Instruction	DATA	
TIM	Instruction	Delay time

Delay Time: Set the wait time as msec. Setting range is 1 to 10,000msec.

11 Driver Function

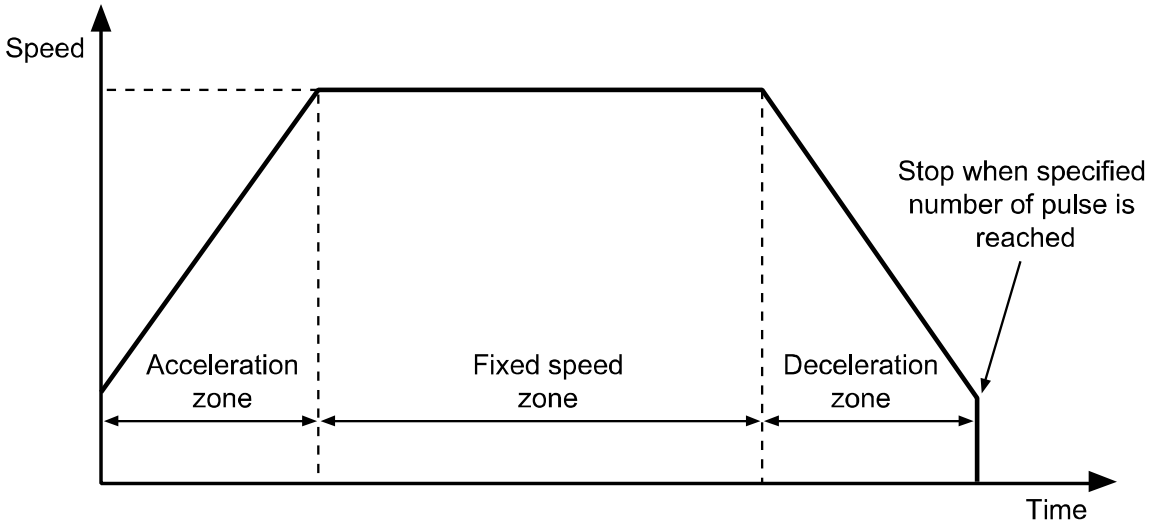
11.1 General Drive

11.1.1 Fixed Pulse and Continuous Pulse Drive

Drive pulse output on each axis is basically in +/- directions by drive instruction of a fixed or continuous pulse.

11.1.1.1 Fixed Pulse Drive

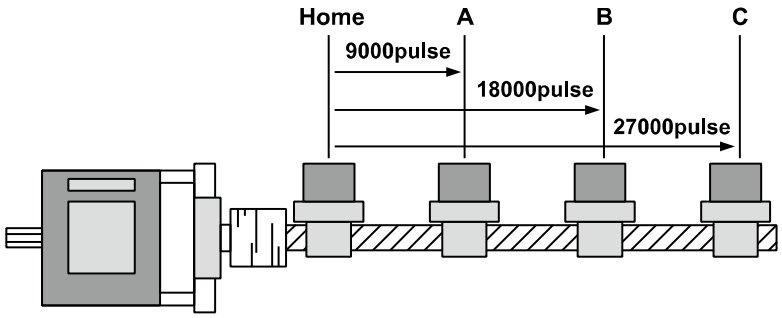
Fixed pulse drive is used to move something a fixed amount. It operates fixed speed or acceleration/deceleration drive for a specified number of output pulses.
Acceleration/Deceleration fixed pulse drive starts to reduce speed when remaining output pulse is less than the pulse used for acceleration. It ends drive when it finishes generating pulse, as shown in the image below.



- Absolute position movement and relative position movement
  : There are absolute position movement and relative position movement.
  These are fixed pulse drive.
- Absolute position movement drives from home to the position of a specified distance.
  This is ABS command in program mode.
- Relative position movement sets a distance to drive from present coordinates.
  This is INC of program mode.

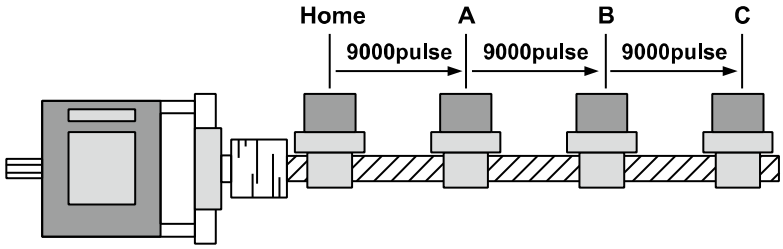
Ex.

- Example of Absolute position movement
  Absolute position movement uses home as a base point for movement command, unlike relative position movement. For example, if you execute the absolute position movement command ABS for 9,000 pulse 3 times, it moves to A in the image. In order to move to points A, B, C, as in an absolute position movement, you need to set ABS instruction for each of 9,000/18,000/27,000 pulse.



Ex.

- Example of relative position movement
  Move relative position works as shown in the image below. For example, if you execute relative position movement command INC for 9.000 pulse 3 times, it moves to points A→B→C.



11.1.1.2 Continuous Drive

Continuous pulse drive outputs drive pulse sequentially until the stop command from the high level or external stop signal becomes active. Continuous mode and home search mode are in this category.
Decelerating stop and immediate stop are in stop instruction. Slow stop is applied in almost every case except when drive speed is lower than initial speed, reset and emergency stop.

11.1.2 Speed Curve

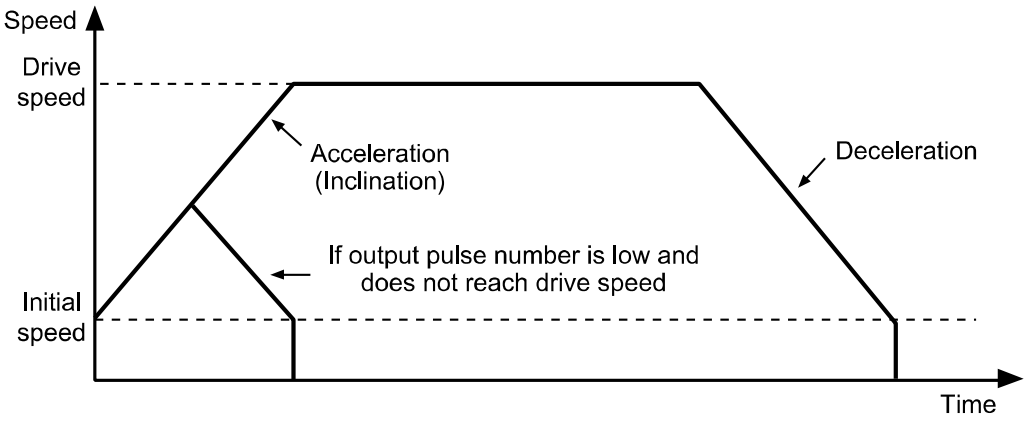
Drive pulse output of each axis operates by CW direction, CCW direction fixed pulse drive instruction or continuous drive instruction. However, it can operates speed curve of fixed speed, trapezoidal acceleration/deceleration, S-curve acceleration/deceleration by operation mode setting or parameter.

11.1.2.1 Constant Speed Drive

Constant speed drive outputs pulse at a constant speed.
When the start drive speed and the max. drive speed are set as same value or the acceleration or the deceleration time is set as 0, it operates constant speed drive without acceleration/ deceleration.
This max. drive speed settings should be higher than or same as start drive speed.

11.1.2.2 Symmetric Trapezoidal Acceleration/Deceleration Drive

- Trapezoidal acceleration/deceleration drive accelerates from initial speed to drive speed trapezoidally with an inclination of the designated acceleration.
- Set acceleration/deceleration time as msec at “Acceleration Time 1 to 5”, “Deceleration Time 1 to 5” parameter.
- It counts the pulses consumed while accelerating to a specified drive speed, and starts decelerating when the remaining output pulse becomes less than accelerating pulse. This decelerating drive reduces speed to initial speed with specified acceleration. In continuous pulse drive, it decelerates to initial speed when the stop signal is activated, and stops immediately when it reaches initial speed.

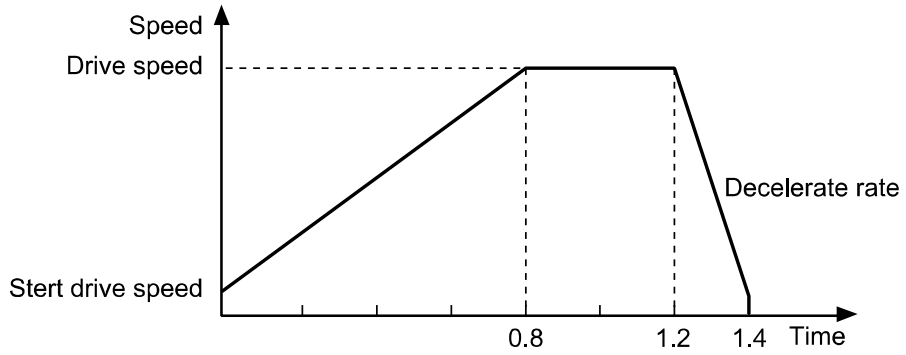


Note

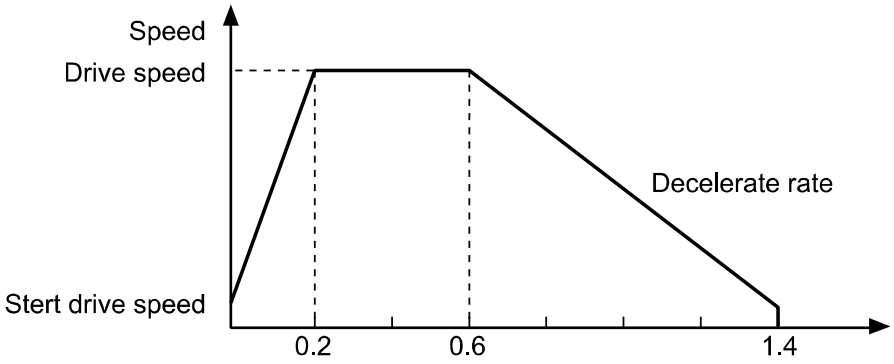
- When speed override operates during constant speed drive, the set acceleration/deceleration time is changeable.
- For continuous drive or jog drive by I/O, acceleration/deceleration time is set at “Acceleration Time 1”, “Deceleration Time 1”.
- When it arrives with not the max. drive speed at the target position due to long acceleration time and short command position, acceleration time may be changed.

11.1.2.3 Asymmetric Trapezoidal Acceleration/Deceleration Drive

- AiC-D is available as asymmetric trapezoidal acceleration/deceleration drive which is different between acceleration speed and deceleration speed.
  For moving the object to the vertical direction such as stacking device of semi-conductor wafer, the gravity acceleration speed is added to the object and acceleration speed and deceleration speed for up/down movement should be different.
  In this case, it operates asymmetric trapezoidal acceleration/deceleration drive.
  - When deceleration speed is higher than acceleration speed,



  - When acceleration speed is higher than deceleration speed,

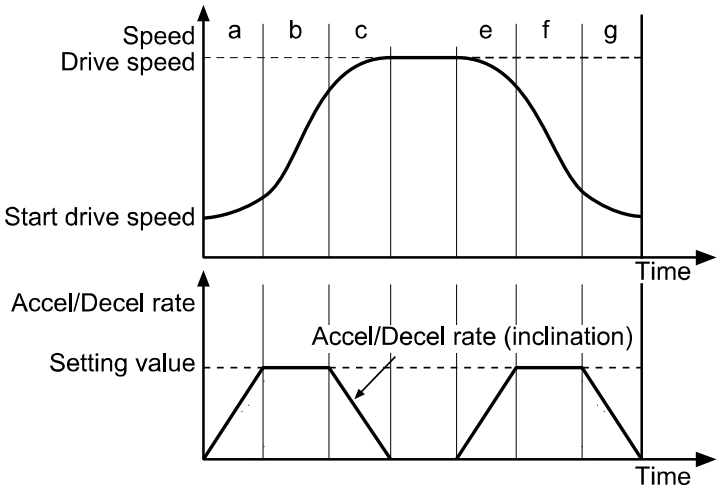


11.1.2.4 S Curve (S-curve acceleration/deceleration)

S curve generates an S shape speed curve according to linear increase/decrease of drive acceleration/deceleration. It smoothly increases and reduces speed when starting and stopping, and helps achieve smoother operation.

Note

- a, b, c=Acceleration Time
- d, e, f=Deceleration Time
- S curve occurs at the a, c, d, f zones during the set “S Curve Time”.
- When “S Curve Time” is set the half of “Acceleration Time (=Deceleration Time)”, it operates S curve without b, e (trapezoidal zone).



Caution

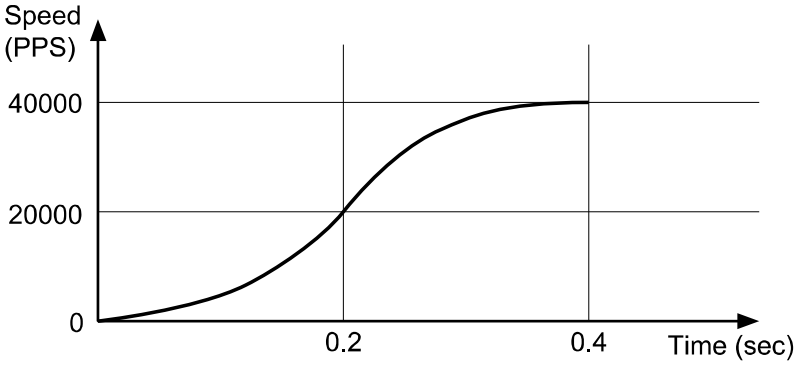
Precautions for S curve acceleration/deceleration drive

- In a fixed pulse S curve acceleration/deceleration drive, you cannot change speed while driving.
- At S-curve acceleration/deceleration fixed pulse drive, “S Curve Time (S-curve acceleration/deceleration time)” is set 1/2 of “Acceleration Time (=Deceleration Time)”. If it is set over 1/2, the drive pulse ends during deceleration before arriving the start drive speed or it outputs the left drive pulses as start drive speed and does not stop even though arriving the start drive speed.
- During S curve operation, acceleration/deceleration time should be set as same. If it is set differently, deceleration time is set same as acceleration time.

Ex.

- Example of S-curve acceleration/deceleration parameter setting (full S-curve acceleration/deceleration)

This example is S-curve acceleration with start drive speed 0 pps and max. drive speed 40 kpps during 0.4 sec. For full S-curve acceleration drive without trapezoidal zone, set the “S Curve Time” as 0.2 sec which is half of acceleration time.



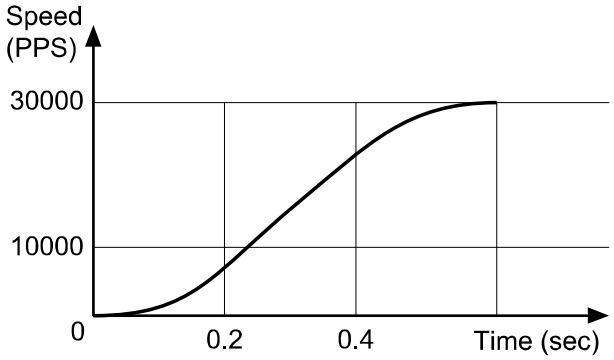
1st Start drive speed as 0 is ignored.
2nd This is full S-curve acceleration. During 0.2 sec, it drives trapezoidal acceleration up to 20,000pps.
3rd At the left 0.2 sec, it drives trapezoidal deceleration up to 40,000pps.

For each setting value of parameters and descriptions, refer to the below table.

Parameter	Setting value	Description
Acceleration Time (acceleration time)	4000 msec	For S-curve drive, acceleration/deceleration time should be same.
Deceleration Time (deceleration time)	4000 msec	
S Curve Time (S-curve acceleration/deceleration time)	2000 msec	For S-curve drive without trapezoidal, it should be set the half of acceleration/deceleration time.
Start Speed (start drive speed)	0 pps	-
Max Speed (max. drive speed)	40000 pps	-

- Example of S-curve acceleration/deceleration parameter setting (partial S-curve acceleration/deceleration)

This example is S-curve acceleration with start drive speed 0 pps and max. drive speed 40 kpps during 0.6 sec. Follow the below graph.



1st Start drive speed as 0 is ignored.
2nd During 0.2 sec, it drives trapezoidal acceleration up to 10,000pps.
3rd During 0.2 to 0.4 sec, it maintains the certain acceleration speed up to 30,000pps.
4th At the left 0.2 sec, it drives trapezoidal deceleration up to 40,000pps.

For each setting value of parameters and descriptions, refer to the below table.

Parameter	Setting value	Description
Acceleration Time (acceleration time)	6000 msec	For S-curve drive, acceleration/deceleration time should be same.
Deceleration Time (deceleration time)	6000 msec	
S Curve Time (S-curve acceleration/deceleration time)	2000 msec	It applies start drive speed + S Curve Time and max. drive speed - S Curve Time.
Start Speed (start drive speed)	0 pps	-
Max Speed (max. drive speed)	40000 pps	-

- Comparing S curve and Trapezoid acceleration/deceleration drive

Trapezoid acceleration/deceleration may cause problems at start and end points in a very sensitive system. When used for a system that must be heavy, fast and accurate, and acceleration sharply changes at start and end points, it is hard on the system. On the other hand, S curve smoothly increases acceleration at the start point and decreases it smoothly at the end point. Therefore S curve acceleration/deceleration is recommended for sensitive systems.

11.2 Home Search

During program mode drive, it operates home search drive by “HOM” instruction.
Set “Power On Home Search” parameter as Enable and home search drive operates when initial power is ON.

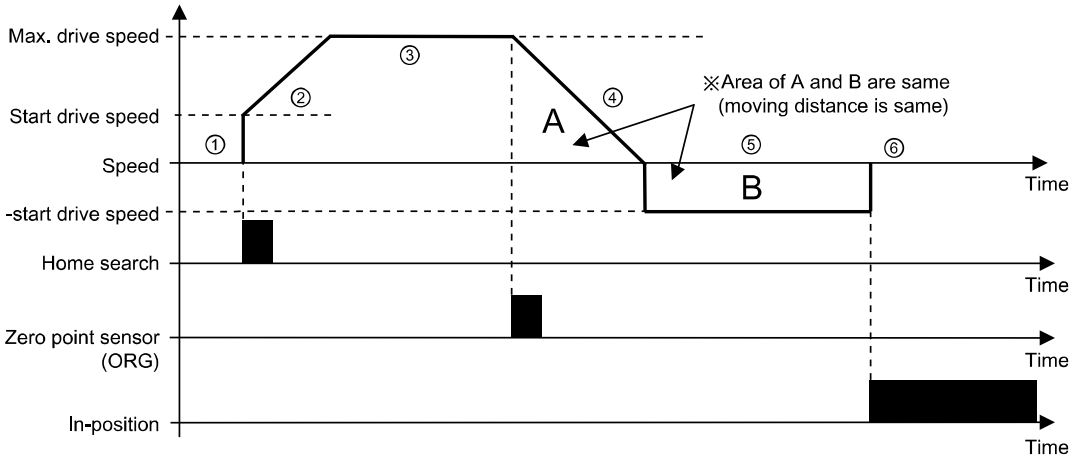
Note

It stops home search by “Stop” or “EMG” instruction.
During stop, home search drive is cancel.

11.2.1 General Home Search (home search method=0)

It operates home search by home sensor.

1st It operates home search drive to the set direction at “Home Search Direction”.
2nd It starts drive with the set start drive speed at “Home Search Start Speed” and operates acceleration drive with the set acceleration time at “Home Search Acceleration Time”.
3rd When acceleration drive is completed, it operates constant speed drive until “ORG (home sensor)” signal inputs with the set max. drive speed at “Home Search Max speed”.
4th If “±Limit (±direction limit sensor)” signal inputs before “ORG (home sensor)” signal inputs, it decelerates and stops drive to the reverse direction to find home.
5th If “ORG (home sensor)” signal inputs, it decelerates with the set deceleration time at the “Home Search Deceleration Time” and stops.
6th After stops, it moves home sensor to the reverse direction for the passing distance from home with the set start drive speed at “Home Search Start Speed”, finds home sensor and stops.
7th After finding home, “In-Position” signal outputs and the “INP. indicator (yellow)” turns ON.



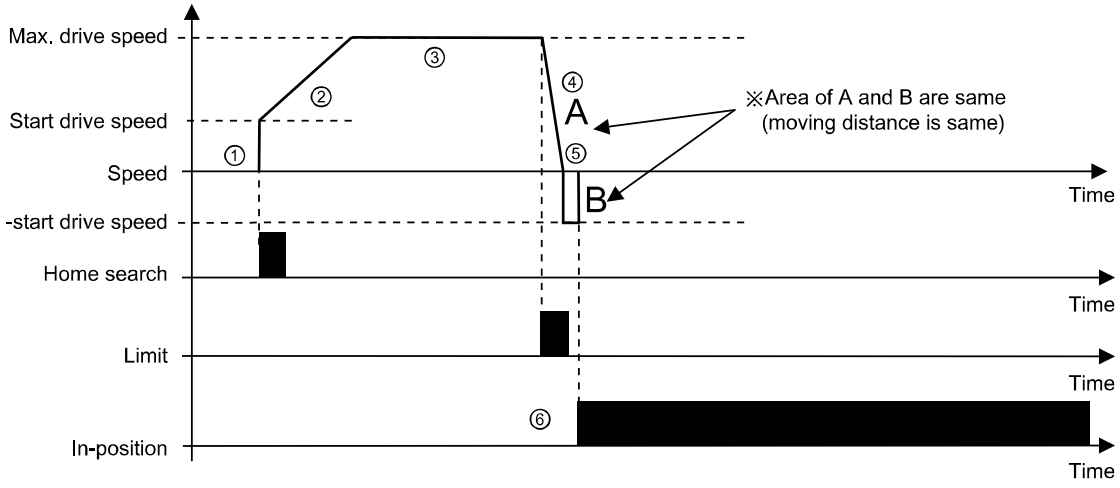
11.2.2 Limit Home Search (home search method=1)

It operates home search by limit sensor.

1st It operates home search drive to the set direction at “Home Search Direction”.
2nd It starts drive with the set start drive speed at “Home Search Start Speed” and operates acceleration drive with the set acceleration time at “Home Search Acceleration Time”.
3rd When acceleration drive is completed, it operates constant speed drive until meeting the limit sensor with the set max. drive speed at “Home Search Max speed”.
4th If “±Limit (±direction limit sensor)” signal inputs or it arrives to “Software Limit± (±software limit)”, it decelerates with the set deceleration time at “Home Search Deceleration Time”and stops.
5th After stops, it moves to the reverse direction for the passing distance from limit sensor with the set start drive speed at “Home Search Start Speed”, finds limit sensor and stops.
6th After finding home, “In-Position” signal outputs and the “INP. indicator (yellow)” turns ON.

Note

At “Home Search Offset”, the other value except 0 is set, it moves for the setting value with start drive speed, “In-Position” signal outputs, and the “INP. indicator (yellow)” turns ON.



Caution

For deceleration stop, set the deceleration time shortly. In case of long deceleration time, it may conflict with the structure.
Install the limit sensor with the certain distance from the structure.

11.2.3 Zero Home Search (home search method=2)

It operates home search by zero point (absolute coordinate=0) when there is no home sensor, limit sensor.

1st Set the zero (absolute coordinate=0) as home.
For changing home position, use the position reset.
If changing zero position by I/O, move the zero to the desired position and supply "RESET" signal and it resets.

Note

When reset or resupplying power, the zero point is also reset.

2nd The set direction at "Home Search Direction" is ignored and it operates drive at the set home direction.

3rd It starts drive with the set start drive speed at "Home Search Start Speed", and it operates acceleration drive with the set acceleration time at "Home Search Acceleration Time".

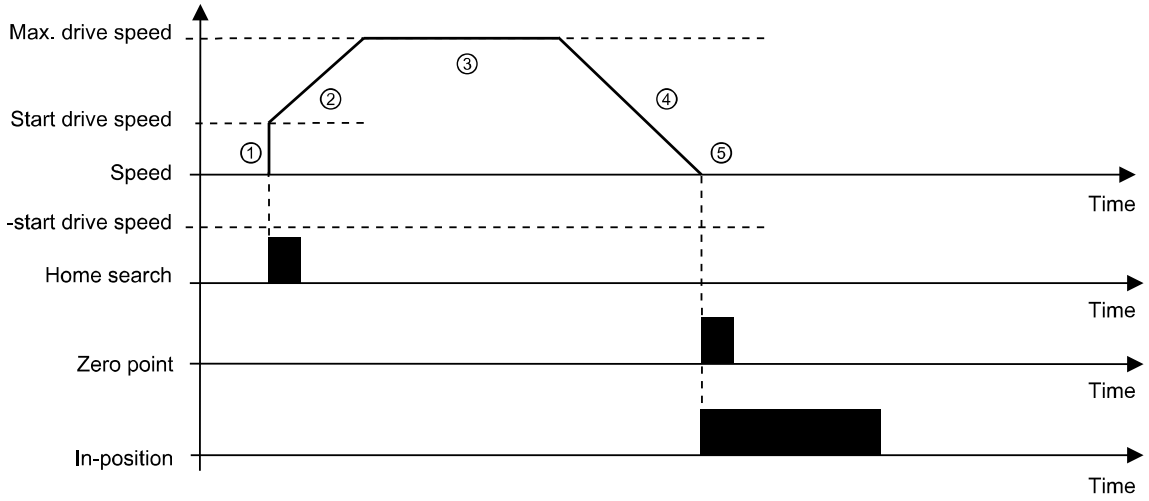
4th After acceleration drive is complete, it operates constant speed drive with the set max. drive speed at "Home Search Max speed".

5th When it is close to home, it decelerates with the set deceleration time at "Home Search Deceleration Time" and it stops.

6th After finding home, "In-Position" signal utputs and the "INP. indicator (yellow)" turns ON.

Note

At "Home Search Offset", the other value except 0 is set, it moves for the setting value with start drive speed, "In-Position" signal outputs, and the "INP. indicator (yellow)" turns ON.



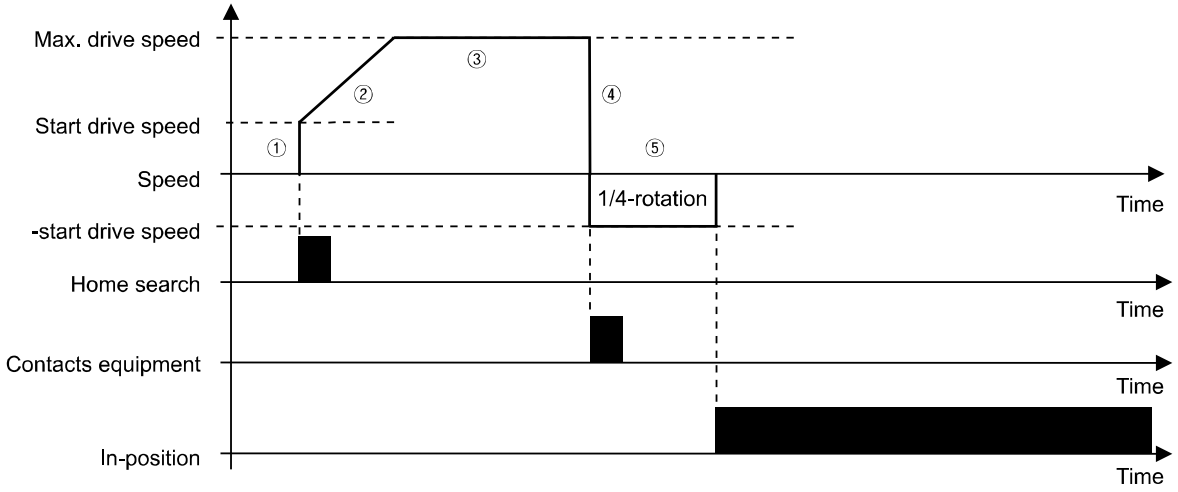
11.2.4 Torque Home Search (home search method=3)

It operates home search by contact with the sepcific equipment when there is no home sensor, limit sensor.

1st It operates home search drive to the set direction at “Home Search Direction”.
2nd It starts drive with the set start drive speed at “Home Search Start Speed” and operates acceleration drive with the set acceleration time at “Home Search Acceleration Time”.
3rd When acceleration drive is completed, it operates constant speed drive until contacting the specific equipment with the set max. drive speed at “Home Search Max speed”.
4th When it contacts with the specific equipment, the current of motor is higher. It stops when the current of motor is same value as the set value at "Home Search Torque”.
5th After stops, it rotates one-fourth time to the reverse direction with the start drive speed and stops.
6th After finding home, “In-Position” signal utputs and the “INP. indicator (yellow)” turns ON.

Note

At “Home Search Offset”, the other value except 0 is set, it moves for the setting value with start drive speed, “In-Position” signal outputs, and the “INP. indicator (yellow)” turns ON.



11.3 Other Functions

11.3.1 Limit Operation

Hardware and software limits can be used to stop drive.

- Hardware limit

  Install a limit sensor to the machine to monitor system operation directly.
  Connect Nlmt+/- (Pin19, 20) at I/O connector (CN3).

- Set Instant (instant stop) / Slow (deceleration stop) at Limit Stop Mode (limit Stop mode) of Operation Mode.
- Software limit

  Unlike the input of hardware limit signal by external sensor, this limit function is set using internal position data. To operate software limit, set software limit (software limit) as Enable.
  High and low limit values can be set the each axis separately at ±software limit (±software limit) parameter.

Operation Mode	Setting value	Parameter	Setting value
Software Limit	Enable	+Software Limit	100,000
		-Software Limit	-50,000

When the setting value is as above, the position value operates among -50,000 to 100,000 range. When it is out of the range, the drive decelerates and stops.

Note

Hardware limit operates independently regardless of the software limit settings, and only hardware limit except limit home search is operated during home search.

11.3.2 Stop Current

When it stops, set the stop current supplied at the motor phase to decrease motor heat and current consumption.

- Factory default is 50% of max. run current. It is available to set at the parameter.

Parameter	Setting range	Unit	Unit value	factory default
Stop Current	20 to 100	%	1	50

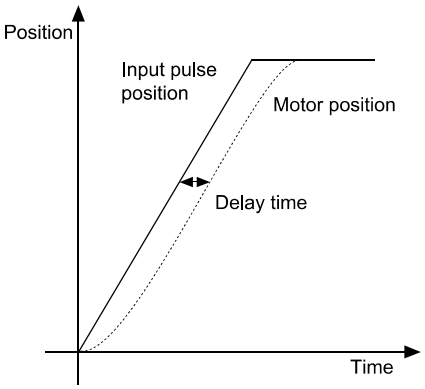
11.3.3 Stop Current Fix

Set the stop current control method; Enable, Disable (factory default).

- Enable: Fixed stop current
  : It maintains stop current as the set value at the parameter.
- Disable: Setting stop current
  : It adjusts by stop current load and it is able to reduce over heat of motor.

11.3.4 Speed Filter

It is available to set motor drive response according to the instruction at the parameter.



Set the speed filter value for time delay between the command position and motor. It is able to drive softly even though load changing or disturbance occurs.

Parameter	Setting	Value (ms)
Speed Filter	0	Disable
	1	2
	2	4
	3	6
	4	8
	5	10
	6	20
	7	40
	8 (factory default)	60
	9	80
	10	100
	11	120
	12	140
	13	160
	14	180
	15	200

11.3.5 Position Control Gain Setting

It is available to set responsiveness of motor to position instruction at the parameter. According to the motor load, set the gain for fast positioning and soft movement.

- P Gain: Adjusts vibration during drive
- I Gain: Adjusts vibration in acceleration/deceleration zone.
- The set gain value applies when motor stops.

Parameter	Setting	Value (ratio)	
		P	I
GAIN	0 (factory default)	1	1
	1	2	1
	2	3	1
	3	4	1
	4	5	1
	5	1	2
	6	2	2
	7	3	2
	8	4	2
	9	5	2
	10	1	3
	11	2	3
	12	3	3
	13	4	3
	14	5	3
	15	User setting	

Ex.

- When GAIN is set as 1,
  P: I=2:1
  The set value is the ratio between P and I.
- When GAIN is set as 15,
  user can set each GAIN value at the atMotion.

Parameter	Setting range	Unit
P GAIN	0 to 7	0.001
I GAIN	0 to 4	0.001

11.3.6 In-Position

In-Position output is output condition of the positioning complete signal.
If the gap between target position and real position is under in-position setting value after position command pulse has finished, in-position output turns to [H] and the in-position indicator turns ON.
In reverse, when the gap is over in-position setting value, in-position output turns to [L] and the in-position indicator turns OFF.
For more accuracte control, check the in-position output before operating the next one.
For more information, refer to '8.2.1.1 In-Position'.

12 Troubleshooting

Malfunction	Causes	Troubleshooting
When communication is not connected	The communication cable is not connected.	Check communication cable wiring. Check communication cable connection correctly.
	The communication port or speed settings are not correct.	Check communication port and speed settings are correct.
When motor does not excite	Servo is not ON.	Check that servo On/Off input signal is [L]. In case of [H], servo is off and excitation of motor is released.
	Alarm occurs.	Check the alarm type and remove the cause of alarm.
When motor rotates to the opposite direction of the designated direction	MotorDir parameter setting is not correct.	Check the MotorDir parameter settings.
When motor drive is unstable	Connection between motor and encoder is unstable.	Check the Motor+Encoder connection cable.
	Position control gain value is not correct.	Change the P Gain or I Gain parameter as the certain value.

Make Life Easy : Autonics

* Dimensions or specifications on this manual are subject to change and some models may be discontinued without notice.

MSO-AiCU1-V1.3-1908US